Iron-carbonate interaction in the lower mantle and at the core-mantle boundary

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The presence of carbonates in the deep Earth strongly depends on the oxygen fugacity, controlled by oxidation state of iron in minerals and melts. A large part of the lower mantle can be significantly reduced with detectable amount of Fe^0. Therefore, subducted carbonates would interact with Fe^0 dispersed in the ambient mantle. However, the mechanism of this interaction remains controversial. We investigated the $MgCO_3$–Fe^0 system at 70–145 GPa and 800–2600K using *in situ* X-ray diffraction in a diamond anvil cell. $MgCO_3$ crystals and Fe foil (99,9%) were used as the starting materials. Formation of wustite (FeO), ferropericlase $(Mg_{0.6}Fe_{0.4})O$, carbide (Fe_7C_3) and diamond was observed. Three different modifications of FeO were detected: B1 at T = 1100–2600K and 70–145 GPa, rB1 at T<1100 K and P<136GPa; and B8 at P = 143-145 GPa. Interestingly, we observed coexistence of wüstite and ferropericlase, which may suggest an existence of immiscibility gap in FeO-MgO system at P > 70 GPa. Mg-carbonate reduction can be presented by following reaction: $6MgCO_3 + 19Fe = 8FeO + 10(Mg_{0.6}Fe_{0.4})O + Fe_7C_3 + 3C$. The formation of diamond was confirmed by TEM study of run products at 100-145 GPa. The studied carbonate-iron reaction supports formation of the (Fe,Mg)O, carbide and diamond in the lower mantle and at the Earth’ s core-mantle boundary indicating that subducted carbonates transported to the core-mantle boundary would be reduced to carbide or diamond. Similar reaction may occur in the Fe-CaMg-carbonate systems. Using these data we propose that core-mantle boundary is important to produce diamond and Fe-carbide.

Keywords: Mg-carbonate, carbide, diamond, lower mantle, core-mantle boundary