Effect of water on the $MgCO_3$–Fe reaction and the fate of carbonates in the reduced mantle

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Thermodynamic calculations, experiments and metallic iron inclusions in diamonds suggest that mantle becomes metal-saturated at the depths ≥250 km [1, 2]. Subduction of carbonates beyond this depth will result in the redox reaction with Fe^0 in silicate rocks. The carbonate–Fe^0 system is a simplified model of this interaction and has been studied up to 150 GPa [3]. Here we investigated effect of H_2O-fluid on the $MgCO_3$–Fe^0 reaction in the hydromagnesite(hMgs)–Fe^0 system at 6 and 16 GPa and peridotite–CO_2–H_2O–Fe system at 6 GPa using multianvil apparatus.

The formation of (Fe,Mg)O (Mws), graphite and Fe_7C_3 was observed in both systems. Additionally, in the silicate-containing system, Mws reacts with pyroxene with formation of olivine, and increase of CaO and FeO content in garnet. This reactions lead to the change of the modal composition of the initial peridotite from the typical four mineral garnet lherzolite to the olivinite.

The kinetic calculations show that the reaction rate constant in the hMgs–Fe^0 system increases by two orders of magnitude in comparison with the anhydrous system. The observations in peridotite–CO_2–H_2O–Fe^0 system indicate a pronounced effect of water on the rate of mass transfer in the mantle silicates. Our results suggest the carbonates in the presence of water will be completely or largely consumed during typical subduction time to the mantle transition zone of 8–12 Ma (5 cm/yrs), and their preservation during subduction to the lower mantle is possible only in the case of ‘coldest’ subduction PT-profiles.

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[1] Frost., McCammon (2008). *Annu. Rev. Earth Planet. Sci. Lett*., 36: 389-420. [2] Smith et al (2016). *Science*, 354: 1403-1405. [3] Martirosyan et al (2016). *AGU abstract*.