Magnesite stability at the reduced mantle conditions from the metal saturation depth to the lower mantle

N.S. Martirosyan[12]*, K.D. Litasov[12], A. Shatskiy[12], S. Lobanov[123]

[1] Novosibirsk State Univ., Pirogova st., 2, Novosibirsk 630090, Russia
(*correspondence: martirosyanns@gmail.com)
[2] Sobolev Institute of Geology and Mineralogy, RAS, Koptyuga ave. 3, Novosibirsk 630090, Russia
(klitasov@igm.nsc.ru,
anton.antonshatskiy.shatskiy@gmail.com)
[3] Geophysical Laboratory, Carnegie Institution of Washington, Washington, DC 20015, USA
(slobanov@carnegiescience.edu)

Magnesite is suggested to be a major oxidized carbon storage phase in the mantle due to its wide *P-T* range of stability [1]. However, the presence of magnesite in the Earth's interior depends highly on the redox conditions. Large part of the mantle is significantly reduced, with detectable amount of Fe^0 dispersed in the silicate rocks [2]. Therefore, subducted carbonates would interact with Fe^0. However, the mechanism of this interaction remains controversial.

We investigated $MgCO_3$–Fe^0 interaction at 6–145 GPa and 800–2600 K. To determine influence of water on the reaction, additional experiments were conducted in the hydromagnesite–Fe^0 system at 6 and 16 GPa. Redox reactions in both systems occur with the formation of $(Mg,Fe)O$, graphite/diamond, and Fe_3C/Fe_7C_3. The fundamental difference was connected with the reaction mechanisms. In the "dry" system solid state diffusion of components was suggested to be the major rate-limiting process with the reaction rate constant (k) in the range of 10^{-11} -10^{-13} at 6 GPa and 1400 - 1600 K. In the water-bearing system, reactions were governed by solubility of components in the water fluids, and were controlled by the hydrogen fugacity. Water acts as a transporting agent for the reactants. Calculations of the kinetic parameters clearly detected the increase of k by two order of magnitude in comparison with the "dry" system.

The sluggish kinetics of the $MgCO_3$–Fe^0 reaction established in our study suggests that carbonates could survive during subduction from metal saturation boundary near 250 km depth down to the transition zone and even to the core-mantle boundary. At the same time, in the water-containing systems magnesite would be completely reduced to carbide or diamond.

[1] Fiquet et al. (2002). *Am. Min.*, 87:1261-1265 [2] Frost., McCammon (2008). *Annu. Rev. Earth Planet. Sci. Lett.*, 36: 389-420.