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The influence of water and oxygen fugacity on Mg-Fe interdiffuion in (Mg,Fe)O

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The knowledge of transport properties such as atomic diffusion, viscosity and electrical conductivity in the ferropericlase magnesiowustite solid solution, (Mg,Fe)O, is critical for understanding the dynamics of the lower mantle and interpreting its geophysical observations. Some previous studies based on point defects concentrations suggest that the behavior of transport properties in (Mg,Fe)O may change with increasing pressure from mechanisms sensitive to Fe^{3+}content (or oxygen fugacity) to those sensitive to H^{+}content (or water fugacity). It is thus important to explore if such a transition is likely to be present in the lower mantle. However, the critical conditions above which water fugacity plays an important role are not well explored at present.
We have conducted high pressure experiments on interdiffusion of Mg and Fe in (Mg,Fe)O in order to quantify the relative contributions of oxygen fugacity and water fugacity. The diffusion couples consisting of single crystals of MgO and (Mg,Fe)O with Mg# around 70 were annealed at temperatures from 1673 to 2073 K and pressures from 5 to 15 GPa under hydrous and anhydrous conditions with several oxygen fugacity buffers (Mo-MoO_2, Ni-NiO, Re-ReO_2). Preliminary results suggest that water fugacity does not significantly increase Mg and Fe interdiffusion at 5 to 8 GPa and 1873 K with Mo-MoO_2oxygen fugacity buffer. This is consistent with a diffusion model of defect mechanisms since cation vacancies charge balanced by $Fe^{3+}$are significantly more abundant than those charge balanced by H^{+}under these conditions. We will extend experiments to a wider range of pressures and discuss implications of these results for transport properties in the lower mantle.

Keywords: Point defects, Transport properties, Lower mantle, (Mg,Fe)O, Diffusion