Elasticity and Phase Transitions of the Deep-Mantle Ferromagnesite

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Ferromagnesite [$(Mg,Fe)CO_3$] has been commonly proposed to be a major carbon carrier in the Earth's mantle. Knowing its physical and chemical properties under relevant P-T conditions of the deep mantle is thus important for our understanding of the deep-Earth carbon storage and cycle. Here I will discuss our recent research results on single-crystal elasticity, spin transition, structural transitions in ferromagnesite in the deep mantle [1-4]. An electronic spin transition of iron in ferromagnesite occurs at approximately 40 GPa and can significantly affect its elasticity, phase stability, and chemistry at high P-T [3-4]. Drastic softening in some elastic constants and sound velocities of ferropericlase is observed across the spin transition, while high-spin and low-spin ferromagnesite alone exhibits extremely high compressional wave (V_P) anisotropy and shear wave (Vs) splitting anisotropy as well as distinct seismic parameters at high pressures. These anisotropies and seismic parameters are very different from those of major constituent minerals in the Earth's mantle, suggesting that the presence of a certain amount of ferromagnesite as a deep-carbon carrier in the subducted slabs can contribute to regional seismic heterogeneities that are quite different from normal mantle materials.

Following the spin transition in ferromagnesite at mid-lower mantle P-T conditions, the rhombohedral phase transforms into an orthorhombic 4high-pressure phase in the low-spin state with unique physical and chemical properties that can become a stable deep-carbon carrier at deeper parts of the lower mantle below 2000 km in depth. Further studies have indicated the occurrence of the four-fold coordinated carbon in ferromagnesite at extreme pressures. These results will be used to refer the physics and chemistry of the deep carbon cycle and storage in the lower mantle.

[1] Liu et al. (2015) *Sci. Rep.*, **5**, 7640. [2] Yang et al. (2014) *Earth Planet. Sci. Lett.*, **392**, 292-299, 2014. [3] Liu, et al. (2014) *Am. Miner.*, **99**, 84-93. [4] Lin et al. (2012) *Am. Miner.*, **97**, 583-591, 2012.