MISIP 2024 Project :-5 Water cycle in Mars inferred from water contents of Fe-rich silicates.

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Water might have been retained in the Martian mantle since its formation, mainly within nominally anhydrous minerals. Geochemical data using Martian meteorites indicate that the Martian mantle contain 14 to 250 ppm of H_2O. However, the estimation might be underestimated due to limited sample number and possible alteration processes. Since ringwoodite, a high pressure polymorph of olivine that is the major Martian mantle mineral region can accommodate weigh percent levels of water, it might play a significant role to estimate the water budget of the Martian mantle. In this study, we used starting materials with compositions (Fo65 and Fo68) with 5 wt% H_2O. High pressure experiments were performed with 1000/5000 ton multi-anvil press, at pressures ranging from 16 to 20 GPa and temperatures between 1200°C and 1600°C. The resulting products were analysed using XRD, SEM, Raman Spectroscopy, and FTIR.

At 16 GPa and temperatures of 1200 - 1400°C, we observed three phases with melt: wadsleyite, stishovite and ferropericlase. At 18-20 GPa and a temperature of 1200°C, three phases without were present: Ringwoodite, Stishovite, and Ferropericlase, with no melt observed. At 18 GPa and 1400°C, we identified two phases with melt: ringwoodite and stishovite. At the same pressure but 1600°C, the phases present were ringwoodite, stishovite, enstatite, and melt. At 20 GPa and 1400-1600°C, we found wadsleyite-2, along with Stishovite, ferropericlase, and melt.

Wadsleyite-2 has a comparatively longer lattice than wadsleyite due to the additional SiO_4 unit between two sorosilicates. Based on these findings, it is possible that in the bottom of the lower Martian mantle, wadsleyite-2 may be present instead of ringwoodite. The phase transition might occur from wadsleyite-stishovite-ferropericlase, transitioning to Ringwoodite and then to wadsleyite-2-stishovite-ferropericlase in the lower part of the Martian mantle along an average Martian mantle temperature

From the FTIR analysis of ringwoodite obtained at 18 GPa and 1400°C, we estimated the water content to be 0.3 wt%. However, compared with previous results, it is possible that due to the additional strong water partitioning to hydrous melt, ringwoodite in our sample is water-undersaturated. Therefore, future experiments are necessary to understand water solubility of Martian ringwoodite using samples with different water content like 15 wt% H_2O.