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Investigating the Effects of Hydrothermal Alteration on Chondrite Matrices Through the Synthesis of Low-Temperature Olivine Using Magnesium-Bearing Amorphous Silicates

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Iron-rich olivine is ubiquitous in the matrices of unequilibrated ordinary (UOCs) and carbonaceous (CV, CK, CO) chondrites with a petrologic type >3.1 [1-3]. Previous studies have synthesized FeO-rich olivines with the compositions and textures observed in the matrices of chondrites at 220°C [4]. Understanding the formation conditions of these olivines using different temperatures, durations, water-to-rock (W/R) mass ratios, and reactants is paramount to better understand the effects of hydrothermal alteration on chondrite matrices. We performed five hydrothermal alteration experiments to synthesize FeO-rich olivines at low-temperature (200°C). We used four different reactants: (1) amorphous silicates (~3.5 mg), (2) iron metal powder (~11 mg), (3) Fe-metal foil, and (4) different amounts of deionized water (18 megohms) to simulate W/R mass ratios of 0.2, 0.5, and 1. These reactants were loaded in gold (Au) capsules, which were placed in Parr bombs, and heated at 200°C for 14 days. The powder inside the gold tube was deposited onto carbon tape. This powder and the surface of the iron foil were studied using the FEI Helios 660 dual-beam focused ion beam SEM. One transmission electron microscopy (TEM) section of a selected region containing new phases in the experiment performed on the iron foil was prepared using the FIB technique. New minerals were formed in all the experiments analyzed in this study. Magnetite ($Fe^{2+}Fe^{3+}{}_2O_4$), brucite [$Mg(OH)_2$], and greenalite [$(Fe^{2+},Fe^{3+})_{2\text{-}3}Si_2O_5OH_4$] were identified by quantitative energy-dispersive X-ray spectroscopy analysis. The formation of these new products suggests that the iron from the foil and magnesium from the amorphous silicate were mobile during the experiment. No crystalline olivine was observed in the experiment performed on the iron foil. We suggest that the low abundance of silicon in the reactants (~0.3 Si/Mg) could be an important factor in the absence of olivine formation during the hydrothermal reactions in these experiments.

[1] Krot A. N. et al. (1997) *Meteoritics & Planet. Sci*. **32**, 31-49.

[2] Dobrica E. and Brearley A.J. (2014) *Meteoritics & Planet. Sci.* **49**, 1323-1349.

[3] Doyle P. M. et al. (2015) *Nature Communications* **6**, 1-10.

[4] Dobrica E. et al. (2022) *Meteoritics & Planet. Sci.* **57**, 381-391.