Nanoscale Analyses of a Carbonaceous Chondrite Exposed to Simulated Space Weathering Conditions

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Introduction

The micorsturcture and chemical composition of grains on the surfaces of airless bodies are continually modified by micrometeorite impacts and solar wind irradiation in a process known as space weathering [1]. The effects of space weathering have been studied through the analysis of returned samples (e.g., lunar samples from the Apollo missions and grains from near-Earth asteroid Itokawa via the Hayabusa mission) and by simulating these processes in the laboratory using experimental techniques e.g., [2]. Our understanding of how space weathering processes alter primtive, oragnic-rich bodies is limited and investigations of this nature are relevant for upcoming missions (e.g., OSIRIS-REx and Hayabusa2).

Methods, Results and Implications for Space Weathering

We performed pulsed-laser irradiation experiments to simulate micrometeorite impacts of the Murchsion carbonaceous chondrite and collected the vapour plume resulting from this irradiation. We extracted sections of the irradiated sample and the vapor deposit using the focused ion beam for analysis in the transmission electron microscope (TEM). We observed vesiculated textures and nanoparticles of variable compositions (e.g., magnetite, troilite, and pentlandite) present in both the vapor deposit and the irradiated meteorite matrix (Fig. 1). Our analyses indicate the vapor deposit is chemically and microstructurally complex and the irradiated meteorite shows melt textures. The presence of Fe-Ni-Sulfide and oxidized-Fe-bearing nanoparticles indicate space weathering affects primtive materials differently than their lunar counterparts.

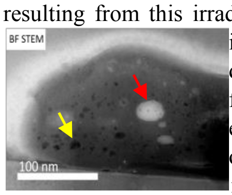

Figure 1: Scanning TEM image of the vapour deposit with nanoparticles (yellow arrow) and vesicles (red arrow).

[1] Pieters (2016) *J. Geophys. Res-Planet.* **121,** 1865-1884
[2] Keller (1997) *Geochim. Cosmochim. Ac*. **61**, 2331-2341.