VISUALIZING THE MAGNETIC BEHAVIOR OF CHONDRULE DUSTY OLIVINE USING ELECTRON HOLOGRAPHY.

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Introduction: Early Solar System reduction of olivine grains resulted in the formation of forsteritic olivine containing micron-sized clusters of kamacite [1]. These 'dusty' olivine grains are found within unequilibrated chondrites, and have the potential to have recorded early Solar System magnetic fields [2]. Understanding of the magnetic fields present during this period is crucial to models of the protoplanetary disk [3]. Estimates of the paleomagnetic field using dusty olivine suggest magnetic fields played an important role in turning the protoplanetary disk into a planetary system [4]. Synthetic dusty olivine has been analyzed for its magnetic recording fidelity [5]. Here, we present the first off-axis electron holography study of natural dusty olivine in Bishunpur (LL3.1) to investigate its nanoscale rock magnetic properties.

Method: Off-axis electron holography is a transmission electron microscopy (TEM) technique [6]. A Lorentz lens is used instead of the standard objective lens in order to operate in magnetic field free conditions. Using an electrostatic biprism, a reference 'vacuum electron beam' is made to interfere with the 'specimen beam' to determine the phase shift of the electron beam due to the sample. This information can be used to generate a magnetic induction map of the sample at the nanoscale. Dusty olivine was prepared for TEM analysis by focused ion beam (FIB) milling electron transparent lamellae from a polished section of Bishunpur (BM 80339).

Results: We find highly magnetic, multi-vortex domain structures within the dusty olivine kamacite.

Conclusion: Bishunpur has the potential to have recorded and retained its paleomagnetic history since its formation. A recent study demonstrates that vortex state magnetite is capable of recording reliable thermoremanent magnetization [7], and the same may apply to the kamacite present in dusty olivine. We are in the process of applying similar variable temperature electron holography experiments to the kamacite grains to determine whether a thermoremanence can be recorded, and whether estimations of paleomagnetic fields from dusty olivine are credible.

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