A POPULATION STUDY OF THE REFRACTORY INCLUSIONS IN MILLER RANGE (MIL) 090019 CO3 CARBONACEOUS CHONDRITE.

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Introduction: Calcium-Aluminum-rich Inclusions (CAIs) and chondrules are major components of chondritic meteorites that formed within the first ~4 million years of the solar system formation [1, 2]. These particles formed at high temperatures in nebular settings and then were accreted onto their primitive meteoritic parent bodies. The MIL 090019 CO 3.1 carbonaceous chondrite is an Antarctic meteorite find. A polished thin section of MIL 090019 was analyzed for its mineralogy and petrography. A total of ~127 CAIs and ~14 amoeboid olivine aggregates (AOAs) were identified in the thin section [3]. The MIL 090019 meteorite is similar to some rare carbonaceous chondrites such as Acfer 094, DOM 08004/6, and ALH 77303 that contain a higher abundance and variety of refractory inclusions [4–6]. Therefore, a population study of CAIs and chondrules in this meteorite will provide insights into the accretionary processes that are recorded in this meteorite and further compare them to similar studies conducted on other chondritic meteorites [7].

Analytical Methods: The mineralogical and petrological characterization of the CAIs was performed using the JEOL Hyperprobe JXA-8530F electron microprobe at NASA Johnson Space Center (JSC) with an energy dispersive spectrometer (EDS) to produce X-ray elemental maps and a backscattered electron (BSE) detector to acquire BSE images. The X-ray elemental maps were used to create false-color composite phase maps to identify CAIs.These CAIs were digitized in image processing software Adobe Illustrator and their shapes, sizes, and areas were determined using FIJI (64-bit NIHimage), similar to the methods described in [7,8].

Results and Discussion: The CAIs in MIL 090019 range from 10 to 200 µm in size. Based on their mineralogy, CAIs were classified into the following categories; corundum-rich, grossite-hibonite-rich, spinel-hibonite-rich, melilite-rich, spinel-rich, anorthite-rich, and AOAs. The average sizes of these CAI subgroups vary, but all populations show broad size ranges. These CAIs display different degrees of thermal processing in the disk, as recorded in their textures. Based on their textures, these CAIs are classified as fluffy, fluffy-compact, compact, and spherules. Although these mineralogical and textural divisions are not unquie, they represent some broader trends observed in this sample set. For example, most ultrarefractory CAIs, i.e., those containing corundum, grossite, and hibonite show fluffy-compact textures, they may have seen some compaction, but they are mostly thermally unaltered and escaped the thermal processing event in the disk. This lack of thermal processing could be either because they formed in a spatially different reservoir that was not subjected to subsequent thermal heating events or as they are ultra-refractory, they were more resistant to thermal processing than other inclusions. Melilite-rich (mostly type-A composition) show a broader range in their textures, where fluffy-compact to compact are more common. Spinel-rich CAIs show a broad range in their textures, all degrees of thermal-processing are more or less equally distributed. This range in textures suggests that they were subjected to different degrees of heating in the nebula. A majority of anorthite-rich CAIs are fluffy, which is different than the type-C anorthite-rich inclusions seen in CV3 chondrites. Their fluffy textures suggest either their formation via gas-solid reactions in nebular settings or later aqueous alteration on the meteoritic parent body. Many of the AOAs contain inclusions of CAIs, however, the total number of AOAs is small. We plan to extend this study to the chondrule population in MIL 090019.

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