FABRIC ANALYSIS OF ALLENDE MATRIX USING EBSD.

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Introduction: The abundant fine-grained matrix material in chondrites has limited the application of traditional fabric analysis techniques. Instead fabric analysis has been restricted to qualitative observations involving the large scale (>100 m) components of chondrites, e.g. flattened chondrules [1], and bulk meteorite studies using x-ray pole figure goniometry [2], magnetic susceptibility [3] and natural remnant magnetization [4]. Due to significant advances in microscopy, it has recently become possible to analyse the 3D crystallographic orientation of the fine-grained (sub-micron) matrix material in chondrites using an electron backscatter diffraction (EBSD) technique, thus allowing fabrics in these materials to be visualized for the first time [5].

EBSD Technique: EBSD is a scanning electron microscopy technique, in backscatter electron (BSE) mode, which permits the measurements of the full crystallographic orientation of any point [6]. BSE's that escape from the specimen will form a diffraction pattern that can be imaged on a phosphor screen. 3D crystallographic orientation data are obtained by automatically indexing these diffraction patterns, which are unique for any given phase. Samples are mapped by beam movement on a grid with a fixed step of 0.2 m to ensuring that each (sub) grain contains several measurement points. The EBSD technique enables the construction of orientation maps and the quantitative collation of data in a 3D sense using equal area, lower hemisphere pole figure plots of crystallographic orientations for a given area.

Results: Our work has focused on the analysis of the fine-grained, platy, fayalitic olivine in Allende matrix, of which multiple areas have been mapped using EBSD. Although the data are preliminary, several interesting features have been highlighted:

1. Fayalitic matrix olivines have a short a-axis. This differs to terrestrial and chondrule olivines which have a short b-axis.
2. There is a well developed 'short axis alignment fabric', which rotates around chondrule rims. Thus, platy olivine grains appear to 'tile' chondrules.
3. Any sample-scale fabric in the overall matrix, away from inclusions, is very weak.

Conclusions: The absence of a strong overall, sample-scale fabric in Allende, coupled with the presence of a well-developed chondrule rim fabric, would suggest that rim fabrics formed prior to their incorporation into the Allende host. The occurrence of a short a-axis in matrix olivines compared to a short b-axis in terrestrial [7] and chondrule olivines is likely to be explained by differences in their formation mechanisms. We are currently extending our EBSD analysis to investigate the alternative formation mechanisms for matrix olivine using experimentally generated samples. This will include looking at thermally and aqueously altered serpentinite samples and olivine condensates to see if we can recreate Allende fayalitic olivine crystallography.

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