TEXTURES IN METAL INCLUSIONS OF THE L5 ORDINARY CHONDRITE TAIBAN VIEWED USING ELECTRON BACKSCATTER DIFFRACTION AND ELEMENTAL MAPPING.

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Shocked ordinary chondrites typically contain metal inclusions that have endured high shock temperatures leading to melting and in some cases transportation of Fe and Ni. The thermal history is poorly understood for many of these inclusions. In reflected light the opaque inclusions often appear mono-minerallic and mono-crystalline. Using electron backscatter diffraction, orientation contrast imaging and elemental mapping it has been possible to view polymineralllic/polycrystalline phases and complex inter-granular textures. Such textures may reveal new information and lead to a better understanding of the shock and thermal histories of these inclusions.

In studying the petrography of rocks and minerals, the traditional method is to use optical microscopy. This becomes difficult when dealing with opaque or isotropic minerals. Using electron microscopy it is possible to gain more precise and detailed information. This study involved two methods, firstly, by using back scattered electron imaging (BSE) and element mapping using a Cameca SX100 microprobe for compositional variations and secondly, using orientation contrast imaging (OCI) in a Phillips XL30 SEM combined with electron backscatter diffraction (EBSD) for crystallographic orientation data. BSE in the microprobe provides compositional contrast based on atomic number or Z-contrast, this gives textural information with sub-micron resolution as long as compositional variations exist.

OCI combined with electron backscatter diffraction patterns (EBSP) separates grains based on crystallographic orientation (typically <1° for misorientations). In order to achieve this the specimen was tilted to a high angle (70°) to the electron beam and the OCI collected with semiconductor chips as forescatter detectors mounted below the specimen, a phosphor screen is used to collect the EBSPs. For a full description of the OCI and EBSP technique and sample preparation see (1, 2). Using this relatively new technique to the geological community it has been possible to view textures based on their crystallographic structure in metal inclusions within a meteorite without the need for transmission electron microscopy (TEM) and the preparation problems associated with it. The technique also has the benefit of rapidly obtaining information on a large area of the specimen, maintaining a sub-micron resolution.

A polished thin section of the meteorite Taiban, an L5 ordinary chondrite shocked to S6 was examined under reflected light and found to contain metal inclusions. Following a further stage of mechanical chemical polishing (OCI is dependent upon sample preparation to obtain a pristine crystal lattice as the information is extracted from the uppermost few nms of the sample) we examined the inclusion using electron backscatter diffraction and orientation contrast imaging. A texture of interlocking grains including triple junctions and complex inter-granular globules and apparently melt structures were observed. The variations in contrast to reveal these textures may purely be attributed to crystallographic mis-orientations but it may also be a result of compositional variation. In order to establish elemental compositions, maps for Fe, Ni, S and P were produced using the microprobe and BSE images obtained. BSE images revealed very little textural differences within the inclusion suggesting a crystallographic texture, however, the Ni element map did reveal some of the grain boundaries observed in the OC images. No sulfur was detected so the textures are not representative of metal-troillite rapid cooling (3). It is clear however that much of the metal inclusion is compositionally homogeneous kamacite and Ni-poor taenite. The majority of the texture can therefore be attributed to crystallographic misorientation with slight Ni increases at grain boundaries. These initial results appear promising and may lead to a better understanding of the thermal histories of metal inclusions in highly shocked ordinary chondrites.

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