FINDING “PEBBLES” IN BARWELL WITH X-RAY MICRO-COMPUTED TOMOGRAPHY (µCT)

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Introduction: Barwell is one of the best known British meteorites, having fallen as a shower of stones on Christmas Eve, 1965. It is an equilibrated L6 ordinary chondrite that is notable for its igneous inclusions, first investigated by [1] who found a dark grey object protruding from a flat broken surface on a piece of BM1966.59. This “Barwell Pebble” carries an oxygen isotopic signature similar to H-group chondrites while exhibiting the texture, mineralogy and trace element concentrations of an igneous rock [1]. Other unusually large igneous inclusions have since been identified [e.g. 2]. Previous work shows that I-Xe ages of some inclusions [1, 2, 3] are very similar to the age of bulk Barwell (4566.1 Ma [1]), indicating that an H group body underwent differentiation and crystallisation before fragments were incorporated into the Barwell, L-group parent body. This supports the paradigm of first generation differentiated planetesimals. The aim of this work is to use µCT to elucidate how common inclusions like the Pebble are, and to identify potential areas for further in-depth investigation using a variety of different analytical techniques.

Methods: Two specimens of BM 1966.59 - the mass containing the Pebble (233 g) and an additional sample (441 g) - were µCT scanned at 38 and 50µm/vox, respectively, using the NHM Nikon HMXST 225 System. The greyscale data were manually thresholded by outlining and interpolating between slices using the Avizo software.

Results: The Barwell meteorite has a fairly uniform texture with approximately 3.5% metal, 7.5% oxides and sulphides, and 89% silicates. The original Pebble (volume = 0.731 cm³) has an irregular but well-rounded shape and accounts for 1% of the bulk volume. So far, we have found 7 additional inclusions similar to the Pebble in both morphology and greyscale range (i.e. density). They have volumes: 0.190cm³, 0.109cm³, 0.097cm³, 0.084cm³, 0.064cm³, 0.040 cm³, and 0.027 cm³. Subparallel fractures, as witnessed in [1], are evident in the µCT images of several of these clasts, and do not continue into the host. All the inclusions have rounded shapes with fairly smooth outlines, ranging from near spherical to elliptical. This does not agree with [2] and [4], which describe broken surfaces and angular outlines to the clasts.

Micro-CT is a non-destructive and non-contaminating technique for identifying areas of interest, characterising three-dimensional shapes and accurately measuring volumes. Additional samples of Barwell are being scanned to identify further inclusions. We will also scan individual clasts at higher resolution which will allow visualisation of their internal textures. The NHM group intends to further explore Barwell, revisiting the Pebble and matrix using different techniques to study their mineralogical, chemical and isotopic compositions in detail. Our work will add insight into the extent of mixing of asteroidal sources in the early Solar System.