MAGNETIC FABRICS IN ALLENDE: IMPLICATIONS FOR MAGNETIC REMANENCE ACQUISITION.

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Introduction: It has been suggested that palaeomagnetic data from Allende are evidence for a short-lived internally generated magnetic field within the parent asteroid, and a liquid metallic core [1-3], directly implying that the CV parent body was a differentiated object [3,4]. In this interpretation other mechanisms of magnetization were excluded; e.g., impact-generated fields were rejected on the absence of macroscopic shock textures in Allende (S1) [5]. Prior to becoming chondritic meteorites, primordial solids were a poorly consolidated mix of mm-scale igneous inclusions (chondrules) and high-porosity sub-mm dust (matrix). Recent high-resolution numerical simulations that track the effect of impact-induced compaction [6], show that only relatively low-speed impacts are capable of causing matrix temperatures > 1000 K; chondrules were unaffected, acting as heat-sinks: temperature excursions were brief. As impact-induced compaction was a primary and ubiquitous process, this new understanding of its effects requires that key aspects of the chondrite record be re-evaluated: Magnetic fields may be recorded at the grain scale without raising the bulk temperature above the Curie point; and this can occur without generating obvious macroscopic shock metamorphic textures, i.e., it may have affected meteorites that have been classified as low shock. In a previous study [7] we conducted magnetic fabric measurements on matrix from Allende. In that study the number of specimens was statistically too low; in this report we have repeated the study on a larger data set of matrix material from Allende.

Results and Discussion: Our new magnetic fabric analysis of Allende is consistent with our previous study [7], though now statistically significant; that is, we find evidence for a strong intrinsic magnetic anisotropy in the matrix. This anisotropy may be coincident with a pervasive uniaxial crystallographic fabric delineated by oriented matrix grains that was plausibly impact-induced [8]. Based on EBSD analysis we can quantify pre-compaction porosity, and by modeling impact-induced porosity reduction [6] we can determine the continuum shock pressure and temperature that Allende must have experienced. At sub-µm scales in porous materials – relevant to matrix – shock is highly heterogeneous, with temperature excursions of 2–3× above background commonly observed [6], i.e., pyrrhotite (the principle magnetic carrier), should have experienced temperature excursions of 200–400 K above their Curie temperature; the matrix experiences much higher peak shock pressure and temperatures, and shows significant heterogeneity in shock effects. There is evidence for this in Allende: TEM studies of matrix indicate high shock pressure and temperature [9, 10].

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