QUANTIFYING THE DEFORMATION OF LEOVILLE CHONDRULES IN 3D: IMPLICATIONS FOR THE POST-ACCRETIONAL HISTORY OF THE CV3 PARENT BODY

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Introduction: Non-spherical chondrules with aspect ratios ≥1.2 have been observed in both carbonaceous and ordinary chondrites [1-5]. Leoville is a reduced CV3 that exhibits one of the most severe deformation regimes observed amongst the chondritic meteorites [2]. Previously studied in 2D, Leoville chondrules were found to have aspect ratios of 1.9 (σ=0.4) [2]. Potential causes of elongation include compaction through overburden [2] and shock [6-8]. Using micro-CT, we can obtain non-destructive 3D analyses that provide new insight into the degree of deformation and direction of any preferred orientation.

Method: A 27 x 25 x 5mm (11.15g) sample of Leoville (BM1969,144) was scanned at 19 µm/voxel using a Nikon HMXST 225 system. The micro-CT data was segmented in Avizo using manual outlining and interpolation tools. Shape analyses were completed in Blob3D through the fitting of ellipsoids to the segmented chondrules [9]. Similar analyses were carried out on two regions of the scan (328 and 462mm^3) to represent the two distinct lithologies present. Random slices in each orthogonal plane were segmented and analysed in ImageJ to compare 2D and 3D interpretations of chondrule shape.

Discussion: Chondrules analysed range in volume from 0.06mm^3 to 9.77mm^3. The average chondrule aspect ratio across the whole sample is 1.82 (n=52, σ=0.33), falling predominantly into compact-platy and compact-bladed fields [10]. This corresponds to a uniaxial shortening of 65% or 52% assuming constant volume and an initial aspect ratio of 1.1 or 1.2 respectively. The two lithologies vary in their mean chondrule aspect ratio with 1.81 (n=41, σ=0.39) for the matrix-rich (~65-70%), high-metal region, and 1.96 (n=33, σ=0.34) for the matrix-poor (~50-55%), low-metal region. High aspect ratios favour shock over overburden models for the cause of the deformation. Chondrule orientations in both lithologies are similar, indicating that deformation occurred after accretion of the sample. Consequently, the differences in aspect ratio may be due to compositional differences, and/or a result of matrix volume and porosity variation between the lithologies [7, 11]. The aspect ratios of chondrules in Leoville are comparable to those observed in Allende (CV) after experimental shocking with pressures >20GPa [12].

Analyses of random slices in each orthogonal plane yielded aspect ratios varying from 1.25 to 1.76, indicating that the deformation is consistently underestimated using 2D methodologies. Orientation measurements of chondrules illustrate that 2D analyses are insufficient to fully describe the foliation.

References: [1] Rubin A. E. and Wasson J. T. 2005. *GCA* 69:211-220 [2] Cain et al. 1986. *EPSL* 77:165-175. [3] Martin P. M. and Mills A. A. 1980. *EPSL* 51:18-25 [4] Dodd R. T. 1965. *Icarus* 4:308-316. [5] Hanna R. D. et al. 2012. Abstract #1242. 43rd LPSC. [6] Sneyd D. S. et al. 1988. *Meteoritics* 23:139-149. [7] Scott E. R. D. et al. 1992. *GCA* 56:4281-4293. [8] Gattacceca J. et al. 2005. *EPSL* 234:351-368. [9] Ketcham R. A. 2005. *Geosphere* 1:32-41. [10] Sneed E. D. and Folk R. L. 1958. *J. of Geology* 66:114-150. [11] Bland P. A. et al. 2014. *Nature Comms* 5:5451. [12] Nakamura T. et al. 2000. *Icarus* 146:289-300.