CHONDRULE SIZE VARIATION WITHIN CM CHONDRITE LITHOLOGIES

C. J. Floyd[1] and M. R. Lee[1], [1]School of Geographical and Earth Sciences, University of Glasgow, G12 8QQ, U.K. (c.floyd.1@research.gla.ac.uk).

Introduction: Chondrule size variation between the different chondrite classes and within different chondrite groups has long been recognized, with chondrule sizes used as a key criterion for class and group level classification [1,2]. Despite this, chondrules can differ in size within individual chondrite groups including the CMs, whose chondrules are commonly reported as ~300 μm [1,3] but can vary significantly [3]. Differences in chondrule sizes between CM lithologies could provide valuable information regarding processes within the chondrule-forming region of the nebula, and/or processes occurring during parent body accretion and evolution [3].

Methods: Clasts and their constituent chondrules were identified in four CM carbonaceous chondrites using backscattered electron images (BSE) and energy-dispersive X-ray Spectroscopy (EDS) collected via a Zeiss Sigma SEM: Aguas Zarcas (AGZ) (CM2.0-2.6) [3]; Murchison (MUR) (CM2.5-2.7) [4,5]; Lewis Cliff (LEW) 85311 (CM2.7) [6]; and LaPaz Icefield (LAP) 02239 (petrologic type 1.4) [6]. Identified whole chondrules were manually segmented using GNU Image Manipulation Program (v. 2.10) and exported to Fiji (v. 2.10/1.53c) were best fit ellipsoids were produced and measurements taken. X-ray computued tomography (XCT) was also conducted on a separate chip of AGZ, with 200 chondrules in two clasts being partially segmented in Avizo™ and measured in Blob3D, following the procedure set out by [7]. XCT data had a reconstructed voxel size of 12.1371 μm.

Results: The results displayed in Fig 1. demonstrate significant variability in the mean chondrule sizes observed between different CM chondrites and their component lithologies. Inter-clast mean chondrule sizes vary from 1.72% (LAP) to 180% (AGZ). Metal-rich clasts were identified in three of the meteorite samples and are not thought to correlate with the metal-rich lithology identified by [3]. 2D measured chondrule sizes within these clasts are broadly consistent across the samples. Within the metal-rich clasts of AGZ, chondrules appeared 34% larger when measured by XCT methods compared to BSE, in keeping with previous findings of the differential between 2D/3D chondrule measurements [8].

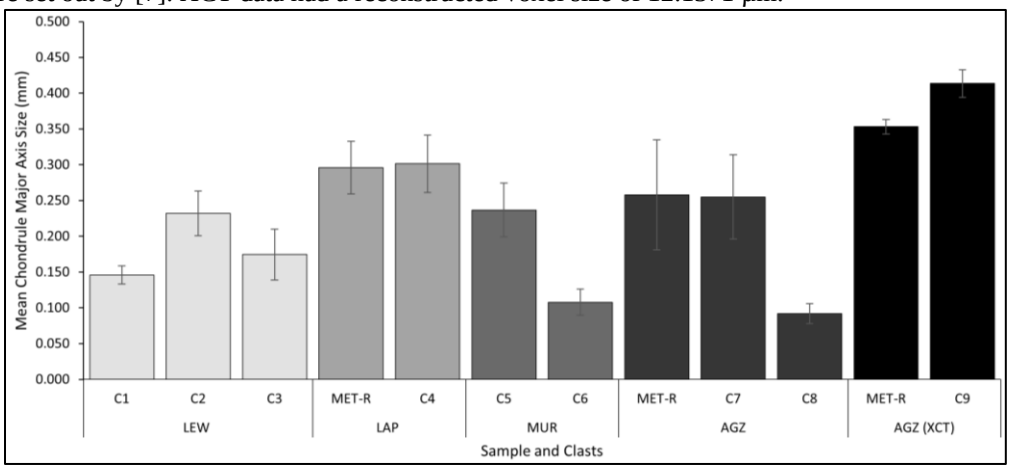

Figure 1. *Graph showing the change in average chondrule major axis length between different CM chondrites and the different clasts within (C1,2,3 etc.). Error bars represent standard error.*

Discussion: Whilst there are intrinsic difficulties in determining what constitutes a chondrule and clast within the CM chondrites, these results indicate typical CM chondrule sizes of <300 μm when measured in 2D, and potentially significant differences in chondrule sizes within and between meteorites and their constituent clasts. The chondrule size variations observed here could indicate sorting processes occurring within the original chondrule population from which the CM parent body formed and/or processes occurring during parent body accretion and evolution [9]. This work highlights the need to further examine chondrules in CM chondrites in respect to the different lithologies present.

References: [1] Friedrich J. et al. (2015) *Chemie der Erde, 75*, 419-443. [2] Jones R. (2012) *Meteoritics and Planet. Sci, 47* 1176-1190 [3] Weisberg M. et al. (2006) *Meteorites and the Early Solar System II*, 19-5. [3] Kerraouch I. et al. (2021) *Meteoritics and Planet Sci, 56*, 277-310. [4] Rubin A. et al. (2007) *Geochimica et Cosmochimica Acta, 71*, 2361-2382. [5] Lentfort s. et al. (2020) *Meteoritics and Planet. Sci, 56*, 127-147. [6] Lee M. et al. (2019) *Geochimica et Cosmochimica Acta, 264*, 224-244. [7] Hanna R. et al. (2015) *Geochimica et Cosmochimica Acta, 171*, 256-282. [8] Metzler K. (2018) *Meteoritics and Planet. Sci, 53*, 1489-1499. [9] Rubin A. (2010) *Geochimica et Cosmochimica Acta, 74*, 4807-4828.

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