A XENOLITH FROM AN EARLY FORMED PARENT BODY IN THE CM CARBONACEOUS CHONDRITE LAPAZ ICEFIELD 02239

M. R. Lee[1], P. M. C. Martin[1], C. J. Floyd[1] and L. Jenkins[1] (School of Geographical and Earth Sciences, University of Glasgow, G12 8QQ, U.K. E-mail: Martin.Lee@Glasgow.ac.uk).

Introduction: The CM2 carbonaceous chondrites are composed of chondrules, refractory inclusions and mineral grains in a fine-grained phyllosilicate-rich matrix. The chondrules and other objects characteristically have fine-grained rims that were acquired whilst moving through a dust-rich region of the protoplanetary disk [1]. Many CM chondrites are regolith breccias containing lithic clasts, many of which have close affinities to the CMs, but within any one meteorite can differ significantly in their degree of aqueous alteration [2]. All of the CM clasts are likely to have been derived from the same parent body, where they were mixed by impacts (i.e., 'regolith gardening'). CMs can also contain xenoliths - clasts that are compositionally and mineralogically distinct from other clasts and the host meteorite [3]. The most common types of xenoliths are lithologically comparable to the CI carbonaceous chondrites, and so have been derived from a different parent body. Although they may have moved considerable distances through the protoplanetary disk in order to be accreted by the CM parent bodies, it is notable that CI clasts lack fine-grained rims. Thus, the CI fragments may have been transported after the rim-forming dust had dissipated and/or when the CI and CM parent bodies were in a dust-free region of the disk.

Here we describe a xenolith in the CM carbonaceous chondrite LaPaz Icefield (LAP) 02239 that has a fine-grained rim. This object therefore offers the opportunity to understand conditions during the movement of the lithic clasts through the protoplanetary disk, and the relative timing of accretion of various parent bodies.

Methods: The xenolith of interest is in a polished thin section of LAP 02239 that was studied by backscattered electron imaging and energy dispersive X-ray microanalysis using a Zeiss Sigma SEM at the University of Glasgow.

Results: LAP 02239 has a petrologic type of 1.7 [4] and 1.5 [5], and is petrographically comparable to other mildly aqueously altered CMs. Chondrules, chondrule fragments and refractory inclusions all have fine-grained rims. The xenolith is oval, 1.5 mm by 0.6 mm in size, and enclosed by a 0.15 mm thick fine-grained rim. The xenolith contains three intact chondrules, several refractory inclusions, and silicate mineral grains, none of which have fine-grained rims. These objects are supported in a fine-grained matrix. The xenolith stands out from the host CM lithology by an absence of tochilinite-cronstedtite intergrowths and being heavily fractured. Nonetheless, the xenolith's matrix is qualitatively similar in chemical composition to the fine-grained rim and so inferred to be equally phyllosilicate rich.

Discussion: The xenolith is clearly not a CM lithology, but the presence of chondrules and refractory inclusions demonstrates that it is also not a CI; it could therefore be a carbonaceous chondrite lithology that is not represented by a meteorite group. The likely sequence of events by which this xenolith was incorporated into the LAP 02239 parent body is as follows: (i) the xenolith's parent body formed by accretion of material including un-rimmed chondrules; (ii) this parent body was partially aqueously altered; (iii) a fragment was impact-ejected, and acquired a fine-grained rim as it moved through a dust-rich region of the protoplanetary disk; the same region hosted chondrules, refractory inclusions and silicate mineral grains; (iv) all of these rimmed objects were accreted into the LAP 02239 parent body, which was subsequently aqueously altered.

This scenario for formation of the rimmed xenolith has several important implications. First, its parent body accreted in a part of the protoplanetary disk that was near to the chondrule forming region but free of rim-forming dust. Secondly, the xenolith's parent body must have been aqueously altered relatively early so that a fragment of it moved through the same dust-rich region of the disk as the constituents of CM parent bodies (e.g., chondrules and refractory inclusions). Other xenoliths including those with CI affinities were never exposed to rim-forming dust, probably because they were incorporated into the CM parent bodies relatively late, and after the dust had dissipated. The LAP 02239 xenolith is therefore a fragment of a carbonaceous chondrite parent body that formed and was aqueously altered early relative to CM parent bodies. Why so few rimmed clasts or xenoliths have been reported previously is an important unanswered question.

References: [1] Hannah R. D. and Ketcham R. A (2018) *Earth and Planetary Science Letters* 481:201–211. [2] Lentfort S. et al. (2021) *Meteoritics & Planetary Science* 56:127–147. [3] Bischoff A. et al. (2006) In *Meteorites and the early solar system II*, edited by Lauretta D. S. and McSween H. Y. Jr. Tucson, Arizona: The University of Arizona Press. pp. 679–712. [4] Alexander C. M. O'D. (2013) *Geochimica et Cosmochimica Acta* 123:244–260. [5] Howard K. T. et al. (2015) *Geochimica et Cosmochimica Acta* 149:206–222.

Acknowledgements: We are grateful to NASA/JSC for the loan of LAP 02239. US Antarctic meteorite samples are recovered by the Antarctic Search for meteorites (ANSMET) program which has been funded by NSF and NASA, and characterized and curated by the Department of Mineral Sciences of the Smithsonian Institution and Astromaterials Acquisition and Curation Office at NASA Johnson Space Center.