EVIDENCE FOR PARENT-BODY AQUEOUS FLOW IN THE MET 01070 CM CARBONACEOUS CHONDRITE. J. M. Trigo-Rodríguez[1,2] and A. E. Rubin[3]. [1]Institut d'Estudis Espacials de Catalunya. Gran Capità 2-4, Ed. Nexus. 08034 Barcelona, Spain, [2]Institut de Ciències de l'Espai-CSIC. Campus UAB, Facultat de Ciències, Torre C5-p2. 08193 Bellaterra, Spain. [3]Institute of Geophysics and Planetary Physics, University of California, Los Angeles, CA 90095-1567, USA.

Introduction: The CM carbonaceous chondrite group has experienced aqueous alteration to different degrees [1-3]. A large variety of mineral phases (e.g. phyllosilicates, sulfides, carbonates, oxides, and other poorly characterized phases or "PCP") contained in these meteorites was produced via alteration of primitive materials by water [2,4]. The source of this water is unknown but could include water of hydration in phyllosilicates within the chondrites [5] or accreted ice [6]. Parent-body processing (e.g., impact-heating) caused water to be lost from the initial host phases and produced aqueous alteration of primitive CM materials. Petrographic observations and the mineralogy of CM matrices are consistent with aqueous alteration at temperatures <400 K [2]. The presence of PCP clumps in CM matrices and the absence of glassy mesostases in CM chondrules attest to microscopic-scale aqueous alteration.

The presence of ice could have promoted hydrocryogenic alteration of anhydrous material through the action of unfrozen water [3] over long time scales, but other processes involving soaking some regions of thes CM body over shorter time scales are also possible [7]. An extended period of aqueous alteration would require the presence of liquid water and would imply a heating mechanism [8]. As a consequence of heating, water exhalation or convection could be generated on the CM parent body [7]. However, the picture is complicated because many CM meteorites are regolith breccias that were subjected to extensive impact-gardening processes. Some CM chondrites (e.g., Murray) contain clasts that exhibit different degrees of aqueous alteration. These differences suggest that the degree of aqueous alteration of primitive CM materials was a localized process and varied either with depth or with lateral location on (or near) the parent-body surface. The examination of newly discovered CM chondrites from Antarctica and hot desert regions provides new evidence bearing on the nature of aqueous alteration on the CM parent asteroid. We examined a suite of CM chondrites spanning the aqueous alteration sequence [9] and found that one of these chondrites (MET 01070) contains a 12-mm-long, PCP-rich lens that appears to be a product of aqueous flow on the parent body. This is the first such object discovered in CM chondrites.

Methods: We prepared a mosaic of moderately high-resolution (1 μm/pixel) back-scattered electron (BSE) images of thin-section MET 01070,7 with a magnification of 130×. BSE images were made with the LEO 1430 VP scanning electron microscope (SEM) at UCLA using a 15 keV accelerating voltage and a working distance of ~26 mm. We also made multi-element X-ray maps of one representative 1-mm^2 portion of the lens in order to identify the main mineral phases. We determined the composition of representative lens regions using the JEOL JXA-8200 electron microprobe at UCLA.

Results and discussion: MET 01070 was initially classified as a CM1 chondrite [10]. It exhibits extensive aqueous alteration: no mafic silicate or metallic Fe-Ni grains remain in the rock [9]. Although less-altered CM chondrites (e.g., Cold Bokkeveld) contain large clumps of PCP within the matrix, such clumps are rare in MET 01070. The principal exception is a large PCP-rich lens that cuts cross most of thin section MET 01070,7.

Although the lens is discernable microscopically in reflected light, it is most apparent in the BSE mosaic. The lens consists of 20- to 60-μm-size clumps of PCP and associated Ni-bearing sulfide; some Ca phosphate occurs at the lens margin and within the lens itself. The lens cuts most of the way across the thin section; it varies in width from 60-1000 μm and narrows at its two ends (Fig. 1). The lens wends its way among numerous phyllosilicate clumps and chondrule pseudomorphs. Because the regions outside the lens appear to be homogeneously altered, it seems plausible that the lens was produced in a relatively short time compared to the genereal period of aqueous alteration that affected the whole meteorite. The lens may have been produced after an episode of local heating (possibly generated by an impact) mobilized an aqueous fluid and forced it through the rock.

Conclusions: The lens reported in MET01070 appears to be the first one described in CM chondrites. It is a good example of how the preparation of high-resolution-BSE mosaics can bring to light important petrographic features in primitive meteorites. The lens mineralogy suggests that it was produced by precipitation of several soluble minerals from a water-rich fluid. Such an extended feature can only be produced in the meteorite parent body [11] and not in the solar nebula [12]. The similarities in chemical composition between PCP portions within the lens and PCP-rich clumps in other CM chondrites [9] suggest that lens formation is a normal consequence of the aqueous alteration process. The formation of the lens clearly suggests that centimeter-scale water flow occurred on the CM parent body. Future searches for similar structures in other MET 01070 thin sections (and sections of other CM1 chondrites) would provide additional clues on the formation of PCP-rich lenses.

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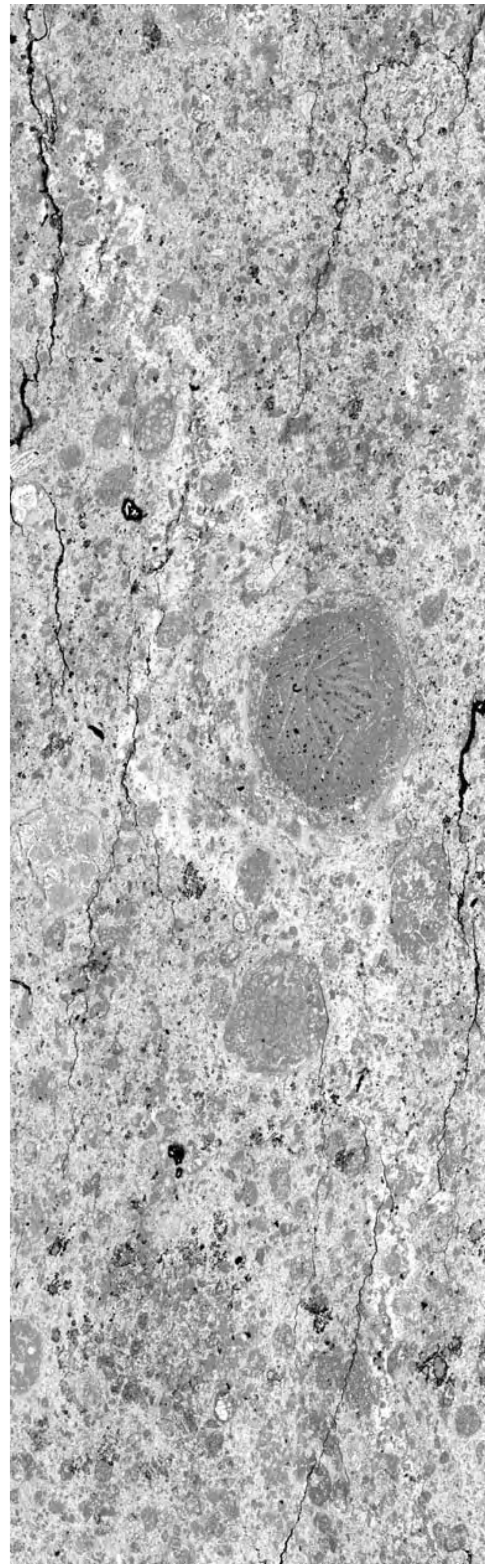

Figure 1. BSE image of the 12-mm-long PCP-rich lens discovered in MET 01070,7.