GLASSY CHONDRULE MESOSTASIS IN EET 96029: A CM3 COMPONENT OF A MINIMALLY ALTERED CM2 CARBONACEOUS CHONDRITE.

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Introduction: The CM carbonaceous chondrites were altered by aqueous fluids within 4 Ma after their formation [1]. Most of them have petrologic subtypes ranging from CM2.0 (totally altered) to CM2.6 (moderately altered) [2], but exceptions include the Paris meteorite which has been suggested to be a CM2.9±0.1 [3]. These mildly altered CMs are extremely rare, but very important for recording the earliest stages of parent body aqueous alteration. One of the first reactions is likely to be chondrule alteration [4] and the leaching of chondrule mesostasis could have been an important source of Ca for the CM carbonates [5]. Here we have studied the mildly altered CM2 carbonaceous chondrite EET 96029. Our sample contains at least one chondrule with a mesostasis that has only been minimally altered, so that it retains glass. This unique finding provides an opportunity to study pristine CM chondrules, and to investigate the earliest stages of aqueous alteration.

Methods: One polished thin section of EET 96029,9 was coated with carbon prior to BSE imaging and quantitative elemental X-ray analyses using a field emission Zeiss Sigma SEM operated at 20kV. TEM work was performed on two FIB liftouts. One was extracted from an area with glassy mesostasis and one section was cut across a sharp interface between glass and altered mesostasis. The foils were cut using a FEI Nova 200 Dualbeam FIB instrument and welded on to a Cu support. Diffraction contrast images and selected area diffraction (SAED) patterns were acquired using a FEI T20 TEM operated at 20 kV.

Results and discussion: EET 96029 is minimally altered. It contains abundant well preserved metal, which occurs as blebs both in chondrules and in the matrix. Porphyritic type IIA chondrules ($Fa_{27\text{-}37}$, n=37) are common, and at least one of them retains mesostasis glass, as identified by TEM diffraction contrast imaging and SAED. The glass contains numerous µm sized pyroxene crystallites. Parts of the glassy mesostasis have been altered, although can retain pyroxene crystallites. Quantitative analyses show that Ca, Al and Si have been lost from the mesostasis during alteration, and Fe added. SAED patterns of the alteration phase are consistent with ferrihydrite. This mineral could be a product of terrestrial weathering [6], which then implies a pristine mesostasis of EET 96029 prior to its fall.

Currently the least altered CM2 meteorite known is Paris, but the mesostasis in Paris chondrules has been completely replaced by aluminous serpentine [3]. Serpentine is also the phase replacing chondrule mesostasis in e.g. the mildly altered QUE 97990 (CM2.6) [7]. We therefore conclude that EET 96029, or at least parts of it, are the most pristine CM material yet described.

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References: [1] Fujiya W. et al. 2012. *Nature Comm.* 3:627 [2] Rubin A.E. et al. 2007. *GCA* 71:2361-2382 [3] Hewins R.H. et al. 2014. *GCA* 124:190-222 [4] Hanowski N.P. and Brearley A.J. 2001. *GCA* 65:495-518 [5] Brearley A.J. 2006. *27th LPSC.* Abstract#2074 [6] Bland et al. 2006. *Meteorites and the Early Solar System II*: 853-867 [7] Maeda M. et al. 2009. *J. Mineral. Petr. Sci.* 104:92-96.