CM2 clasts are present in CR2 chondrite NWA 15175 - but in general CM xenoliths are uncommon.

Michael Zolensky*, ARES NASA JSC, Houston, TX 77058 USA* (michael.e.zolensky@nasa.gov)

Introduction: NWA 15175 is an ordinary CR2 chondrite (Meteoritical Bulletin 112) with a low weathering grade and total mass of 309g. We recently obtained a slice of this meteorite with obvious black xenoliths. To data we have only performed a brief SEM/EDS investigation to investigate its origin.

Techniques: SEM imaging of the polished samples was made using the JEOL 7600 FEG-SEM in the ARES E-beam lab. This instrument has an Oxford SDD type X-ray detector system for the X-ray maps.

Results: The clasts range up to 1cm in maximum dimension. They are crosscut by numerous rust veins, but this did not interfere with the characterization reported here. Figure 1 shows a low magnification back-scattered electron (BSE) view of a portion of the best preserved CM2 clast.

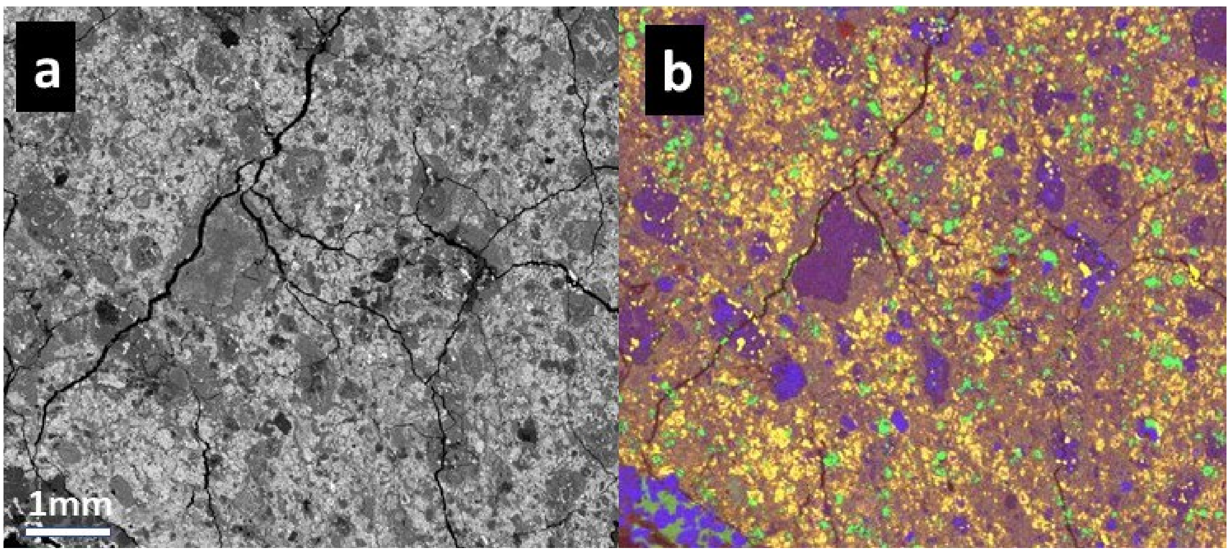

Figure 1. CM2 clast in NWA 15175. (a) BSE image. (b) Composite X-ray map, Mg:blue, Al:red, Ca:green, S:yellow. Olivine is blue, tochilinite and pyrrhotite are yellow, Ca carbonate is green, phyllosilicates are brown.

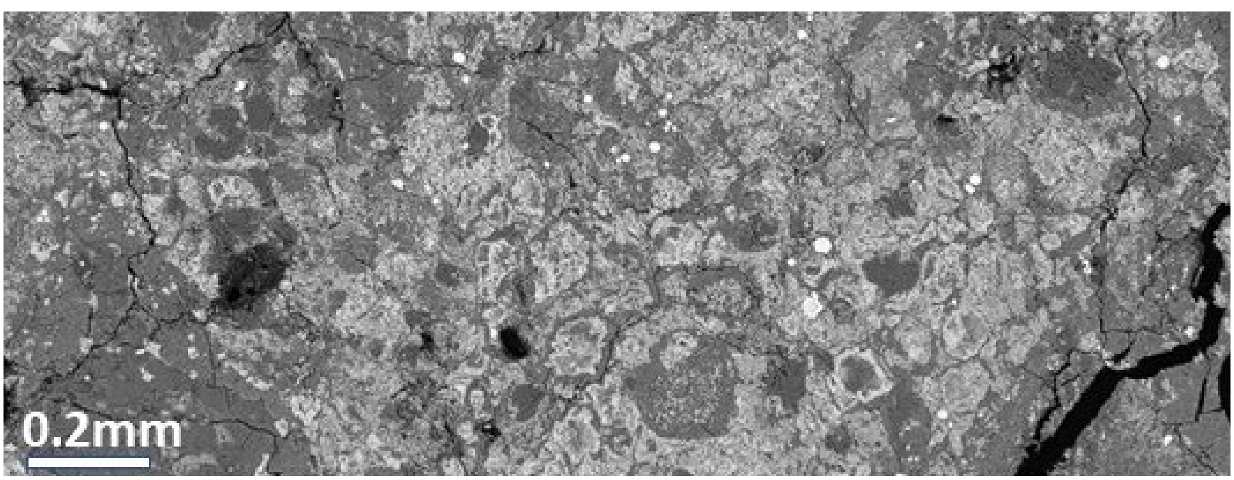

Figure 2. Higher magnification BSE image of the center of Fig.1, showing the relatively unbrecciated ("accretionary") [1] texture of the CM2 lithology. Note occasional spheroidal magnetite grains (white).

While we have yet to make EPMA measurements of the minerals in this clast, there is no doubt that this is a CM2 lithology. In fact, it is a very unbrecciated example of the "accretionary" texture first described by Metzler et al. [1], and therefore physically primitive.

We are not aware of a previous report of CM material in a CR chondrite. It turns out that CM lithologies are uncommon as xenoliths in all but HEDs. We have been making an investigation of xenoliths for several decades, and in the 127 clast-bearing meteorites we have examined, CM xenoliths are present in only 23. CM lithologies are not reported in ureilites, even though carbonaceous chondrite clasts here can be very abundant. Lithic clasts are abundant in LL chondrites [e.g. 2], but none appear to be CMs. CM clasts have now been reported in only 2 carbonaceous chondrites – CR2 NWA 15175 and Tagish lake [3] - despite an enormous number of carbonaceous chondrites that have been carefully characterized.

The HEDs where we have observed CM clasts are:
Bholghati, EET 87513, Jodzie, Kapoeta, LEW 85300, LEW 85441, LEW 87015, LEW 87295, Mundrabilla 020, NWA 6475, PRA 04401, QUE 97002, SCO 06040, Y000178, Y86795, Y791834, and Y793497 [4].

However, we have observed CM2 lithologies in four H chondrites:
Abbott (H3-6), NWA 8369 (H5), Plainview (1917) (H5), and Willard (b) (H3.6. (Figure 3).

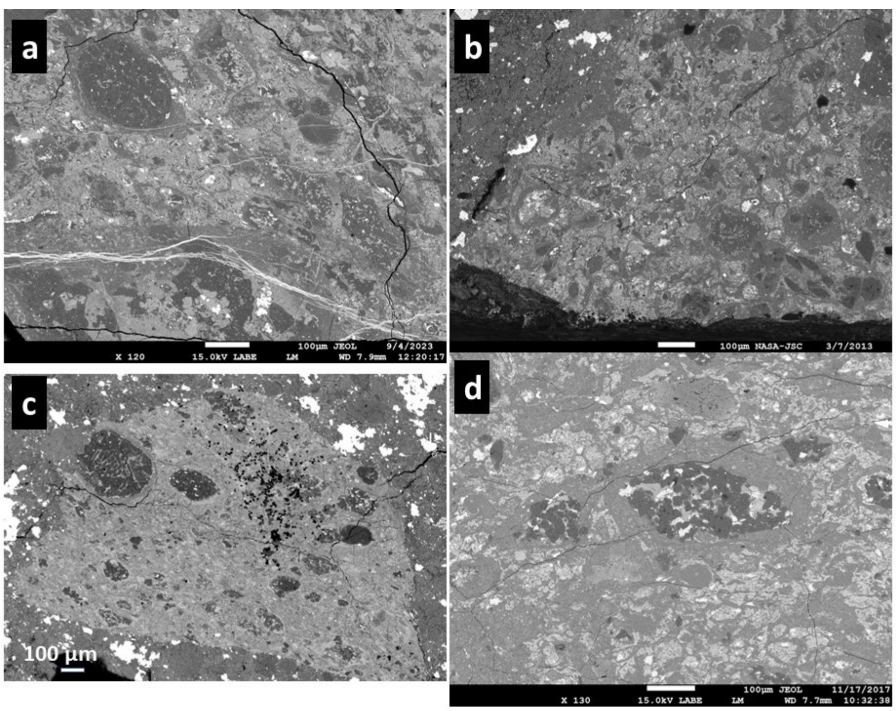

Figure 3. BSE views of CM2 clasts in (a) Abbott (H3-6), (b) NWA 8369 (H5), (c) Plainview (1917) (H5), and (d) Willard (b) (H3.6). Scale bars measure 100 µm.

Our observations raise the question of why CMs chondrite clast xenoliths are almost entirely restricted to HEDs and H chondrites, when CMs are relatively abundant as individual meteorites. Several explanations are immediately evident. The most probable is that only two asteroids have been struck by CM impactors and subsequently became prolific source of meteorites. Our results also highlight the fact that many carbonaceous xenoliths reported in the literature as being CM (or C2 in even older literature) have been misidentified [e.g. 5].

References: [1] Metzler et al. (1992) *Geochim. Cosmochim. Acta* **56,** 2873-2897. [2] Fodor and Keil (1978) *Catalog of lithic fragments in LL-group chondrites. Special Pub. No. 19*, UNM, 38p. [3] Zolensky et al. (2002) *Meteoritics and Planetary Science* **37**, 737-761. [4] Zolensky et al. (1996) *Meteoritics and Planetary Science* **31**, 518-537. [5] Zolensky et al. (1996) *Lunar and Planetary Science XXVII*, The Lunar and Planetary Institute, pp. 1507-1508.

Acknowledgements: MZ was funded by the NASA Emerging Worlds Program. We thank Mike Bandli and Jutta Zipfel for providing NWA 8369 and Plainview, respectively.