SURFACE MAPPING OF CARBONACEOUS CHONDRITE MURCHISON IN SEARCH OF ORGANIC CARBON INCLUSIONS. Z. Peeters[1,2], B. Liebig[1], M.C. Liu[1]; [1] Academia Sinica Institute of Astronomy and Astrophysics, Roosevelt Road, sec. 4, no. 1, Taipei 10617, Taiwan R.O.C; [2] zan@asiaa.sinica.edu.tw.

Introduction: Organic matter (OM) in the fine-grained matrix of primitive meteorites has traditionally been studied in extracted form, where the insoluble organic matter (IOM) was obtained by dissolving away the surrounding material [1]. Previous *in situ* studies have shown that meteoritic OM can occur in inclusions of up to 10 µm [2, 3, 4]. Those studies focussed on the very primitive CR chondrites Queen Alexandra Range (QUE) 99177 [5, 6] and Graves Nunataks (GRA) 95229. In this study, we present the results of a search for similar µm-sized OM inclusions in Murchison, a CM2 carbonaceous chondrite. The data presented here are the first results obtained with the newly inaugurated Cameca nanoSIMS 50L at Academia Sinica in Taiwan.

Experimental: A 1 cm sample of the Murchison meteorite was pressed into indium, polished, and carbon coated. $^{12}C^{12}C^-$, $^{13}C^{12}C^-$, $^{14}N^{12}C^-$, $^{15}N^{12}C^-$, $^{28}Si^-$, $^{29}Si^-$, and $^{30}Si^-$ secondary ions, produced by incidence of a ~1 pA Cs^+ beam, were measured in parallel. 22 Images (23 × 23 µm, 256 × 256 pixels, 4 ms per pixel dwell time, 15 iterations per image) were recorded in automated chain mode.

Results and discussion: Figure 1 shows two maps of Murchison meteorite as obtained by nanoSIMS. The top panel displays the map in $^{12}C_2$ counts on a log scale. The various shades of blue and red show that carbon is present throughout the matrix as a fine-grained material at varying levels of abundance, except where crystalline grains have replaced the matrix (black areas; the composition of these grains is not known from this measurement). The yellow to white coloured areas show regions with a higher carbon abundance.

In the bottom panel of figure 1, the $^{15}N/^{14}N$ ratio is shown (measured as $^{12}C^{15}N/^{12}C^{14}N$). Several of the areas that display a high carbon abundance in the top panel, also appear in the bottom panel, but not all. For example, in the second image from the right, bottom row, there is a feature (two round spheres) with a high carbon abundance. No nitrogen was detected in the same location, which may indicate a grain of carbonate, graphite, or metal carbide, although not SiC, since no silicon was detected.

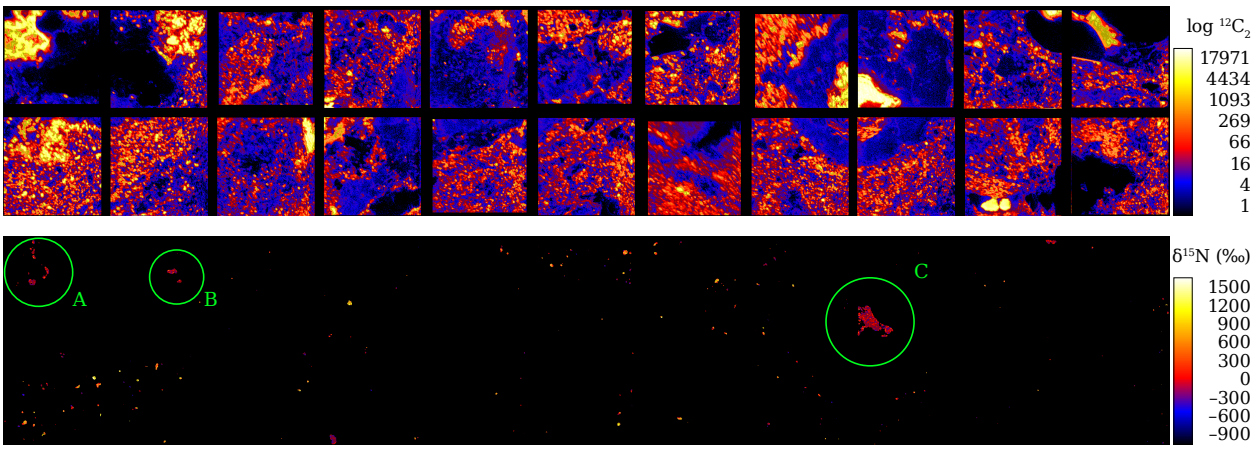

Figure 1: Murchison meteorite nanoSIMS map in $^{12}C_2$ (top, log scale) and $\delta^{15}N$ (bottom, ‰). Each image is 23 × 23 µm, and separated by 2 µm. Supra-µm-sized, organic, carbon-rich inclusions, candidates for further investigation, are circled in green.

The three areas in figure 1, bottom panel, circled in green, display a high carbon and nitrogen abundance, indicating that those inclusions are likely organic matter. They range in size from 10 µm (C) to 4 µm (B). The δ^{15}N of these inclusions ranges from -15 ± 9.5 ‰ (C), to $+31 \pm 19$ ‰ (A). The errors on the ^{15}N abundances are large because of low ^{15}N counts; for better statistics a longer integration time is needed, which would have prevented us from covering a large area. The δ^{15}N values obtained here for the inclusions are nonetheless indicative of OM, and are close to the δ^{15}N value previously reported for Murchison's bulk IOM: -1.0 ± 0.4 ‰ [1].

Outside the large carbon-rich inclusions, 90 smaller ($\geq$ 5 pixels) ^{15}N hot spots have been found, ranging in δ^{15}N value from -380 ‰ to $+1100$ ‰. Again, the values are associated with high errors, but are indicative of the presence of small grains with a wide range in ^{15}N enrichments or depletions.

Conclusion: We have reported the discovery of large (several µm), organic, carbon-rich inclusions in the CM2 meteorite Murchison. These inclusions are similar to those previously found in CR chondrites QUE 99177 and GRA 95229 [3, 4]. The ^{15}N isotopic composition of these inclusions is variable, but close the bulk δ^{15}N value previously measured for Murchison's IOM [1]. Future research will target these inclusions for FIB-liftout and further analysis. This work also represents the first results of a newly established laboratory for cosmochemistry and the recently inaugurated nanoSIMS at the Academia Sinica Institute for Astronomy and Astrophysics.

References: [1] Alexander C. M. O'D. et al. (2007) *Geochim. Cosmochim. Act.* 71, 17, 4380–4403. [2] Nguyen A. N. et al. (2008) *Meteorit. Planet. Sci.* 43, A5277. [3] Peeters Z. et al. (2011) *Meteorit. Planet. Sci.* 46, A185. [4] Peeters Z. et al. (2012) in *LPS XLIII* A2612. [5] Floss C. et al. (2009) *Astrophys. J.* 697, 2, 1242–1255. [6] Abreu N. M. et al. (2010) *Geochim. Cosmochim. Act.* 74, 3, 1146–1171.