LON 94101 Provides a Unique Record of C-Class Asteroid Regolith Diversity

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Introduction: LON 94101 and its pairing mate LON 94102 are two of the largest CM finds, with a collective mass of 3.8kg. Over the years we noticed that every section of these meteorites appeared significantly different. These stones are highly brecciated and display an unprecedented range of CM lithologies [1-3, and numerous other papers]. They thus record direct information regarding the physical and petrologic characteristics of the CM parent asteroid(s) at the greatest scale observable from meteorites. Still unanswered questions are what the typical clast size was for each lithology, and what the full range of CM textures in LON 94101 could be. We were also interested in learning whether there were xenoliths in these breccias, these being apparently unknown for CM chondrites. Detailed characterization of an especially large sample is required to address these issues. This abstract reports results of the initial characterization of one large sample of LON 94101.

X-Ray Computed Tomography: We obtained a single 42g mass of LON 94101 from the Meteorite Working Group. LON 94101,4 is a relatively unweathered sample, simplifying measurements. The allocated stone measured 7 cm across in maximum dimension. In order to predetermine where to properly explore the stone we performed X-Ray Computed Tomography (XRCT) at the University of Texas High-Resolution X-ray CT Facility. We used the NSI scanner with a fine focus source, high power, 150kV, 0.25mA, no filter, Perkin Elmer detector. The beam-hardening correction = 0.25. Voxel size = 0.0352 mm. Total slices = 1846. Figure 1 shows a sample of the XRCT results.

XRCT imaging revealed over 20 distinct lithologies in the 42g stone, with individual lithologic clasts up to 2 cm each, and abundant, fine-grained, comminuted matrix powder between each clast. Inspection of the XRCT "slices" revealed the optimal place to slice through the stone, in order to maximize the variety of exposed materials (Figure 2). The stone was vacuum impregnated into a single block of epoxy and sawed slowly using no fluids to prevent compromising possible aqueous fluid inclusions. Figure 1 shows the plane where the stone was sliced.

Petrography, Spectroscopy and other Investigations: The two facing halves have now traveled different paths. One half (A) is described briefly here. The other half (B) was transferred to collaborators at the Open University (Ross Findlay, Ian Franchi, Richard Greenwood) where it has been undergoing petrographic and isotopic analysis, lithology by lithology. These latter investigations will be reported separately.

Slice A was polished (dry) and examined in a JEOL 7600 FEG SEM. It was in fact the largest sample ever examined in that instrument at JSC. We collected a BSE map, shown as Figure 3, and made petrographic investigations by EDS. Future electron microprobe measurements work will obviously require considerable subsampling. We transferred the still-intact sample to the Department of Earth Sciences, Tohoku University, for reflectance IR measurements of separate lithologies, using a Thermo Scientific Nicolet iN10 Fourier Transform Infrared Spectrometer. These results will be reported at the Symposium. Slice A reveals at least 18 distinct lithologies, ranging from CM2 to CM1, including C1 material lacking coarse-grained objects (i.e. no chondrules or chondrule pseudomorphs, etc.). These materials will be briefly described at the symposium.

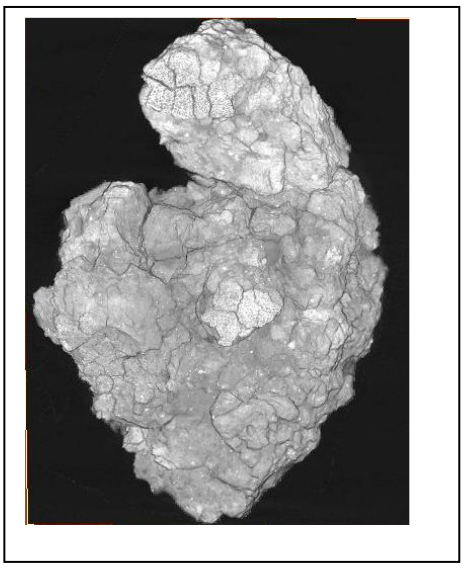
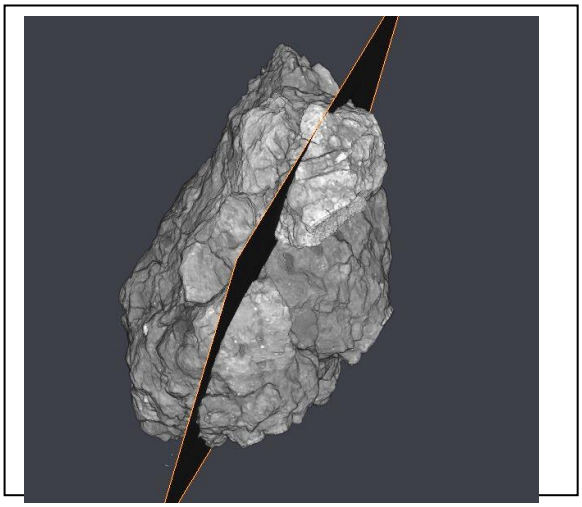


Figure 1 (left) Composite of XRCT imaging slices of LON 94101,4.
Figure 2 (right) Black plane indicates position of slice that bisected the sample into halves A and B.



Conclusions: The work on this sample is still in progress but will reveal important details of CM C-class asteroid regolith properties to complement similar information from asteroid Bennu samples to be returned by the OSIRIS-REx spacecraft in 1 year. This work is only possible due to the deliberate collection and careful curation of meteorites from Antarctica.

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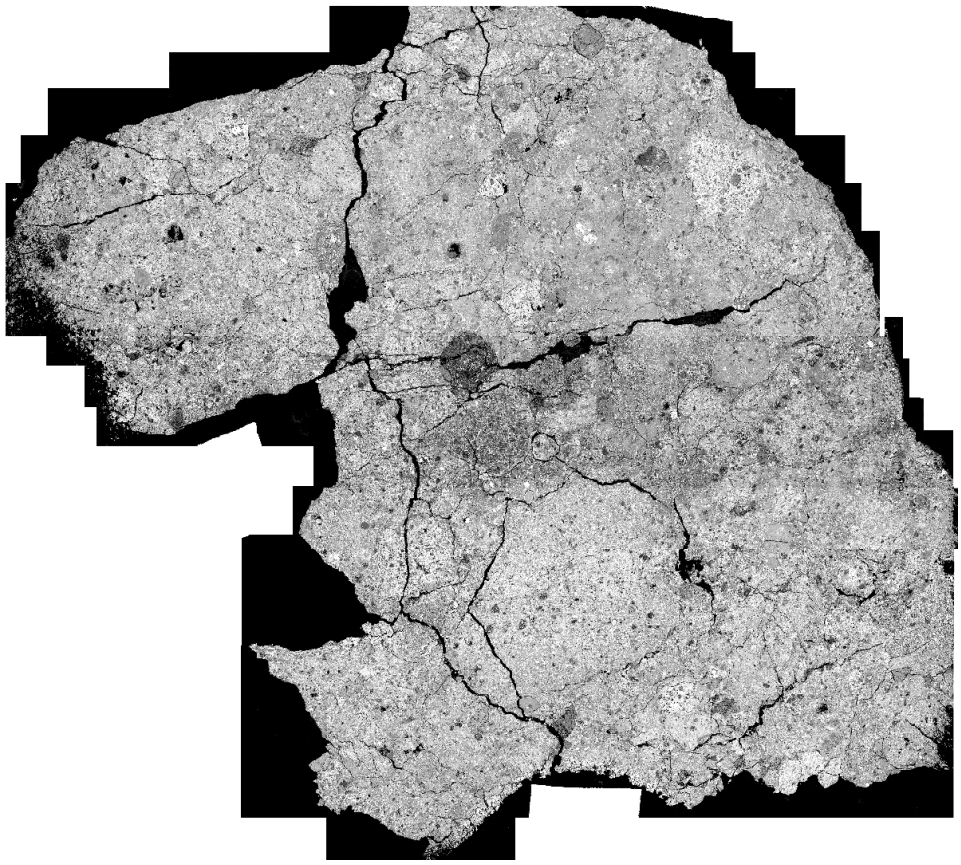

Figure 3. Backscattered Electron image of the face of slice A. Sample measures 7 cm across, diagonally.

References: [1] Lindgren et al. (2013) *MAPS* 48, 1-17**;** [2] Lentfort et al (2021) *MAPS* 56, 127-147; [3] Zolensky et al. (2021) *MAPS* 56, 49-55**.**