60 Years in a Capsule: The Bruderheim Meteorite as a Means to Advance the Curation of Meteorites and Sample Return Material

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Abstract #2139
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History of Sample

- The L6 ordinary chondrite, Bruderheim, fell at 01:06 MST on March 4, 1960 near the town of Bruderheim, Alberta, Canada.
- 350 individual specimens amounting to over 300 kg of material were recovered.
- Shortly after recovery, two large specimens were sealed under vacuum conditions within blown-glass tubes. The masses of the two samples are ~1.4 kg and ~1.2 kg, including the glass capsule.
- From Prof. H. Baadsgaard, who worked on Bruderheim immediately after it fell, the contents of the capsule are most likely under vacuum although they may be in air. It is likely that the sealing was done on a K-Ar vacuum line within the geochronology lab at the University of Alberta in April of 1960.

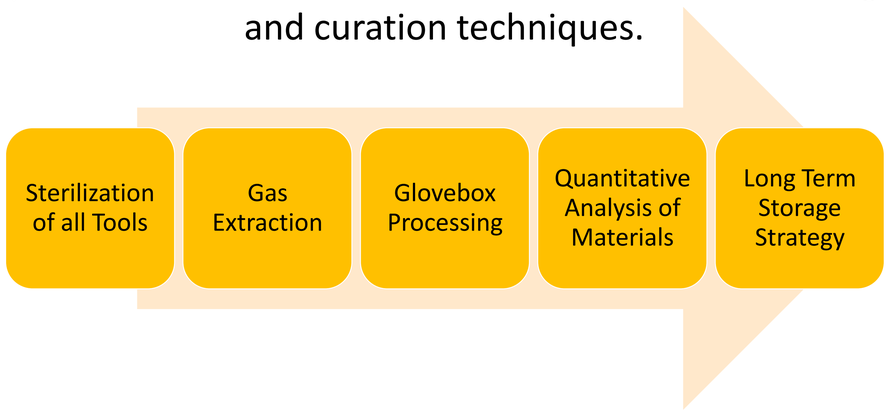
Figure 1: A photograph of MET4170/B-194 within the capsule.

Sterilization & Organic Contamination

- As this study is an assessment on curation and preservation, the presence of different organic compounds on the surface of these meteorites are also of interest.
- Organic compounds from a small fragment of the fusion crust will be extracted with HPLC-grade dichloromethane (DCM) and analyzed by GC-MS to determine if contamination occurred when the sample was sealed within the glass vessel.
    - Prior to any work being conducted on the samples, all tools and materials will be sterilized to remove any potential contamination.
    - All Teflon containers will be rinsed with DCM and sterilized within an autoclave.
    - All glassware, metal tools, and ceramic materials will be sterilized in an oven at 450°C for a minimum of 4 hours.

Analogue Sample Return Mission

These specimens provide the opportunity to investigate not only how well the vacuum conditions preserved the meteorites, but also advanced handling and curation techniques.



By treating these specimens as analogues for sample return missions, we hope to better inform curation protocols for upcoming sample return missions such as OSIRIS-REx and Hayabusa 2.

Controlled Environment

- The University of Alberta's Sub-Zero Facility for the Curation of Astromaterials' low temperature reduces reaction rates and its argon atmosphere glovebox pro-vide optimal conditions for working with meteoritic material [1].
- Given the pristine nature of the sealed specimen, all appropriate measures will be taken to ensure that the sample will not be exposed to an oxygen-rich environment.

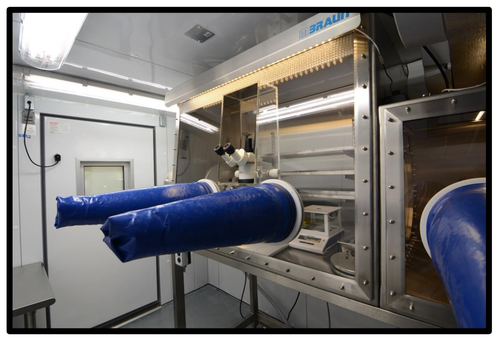
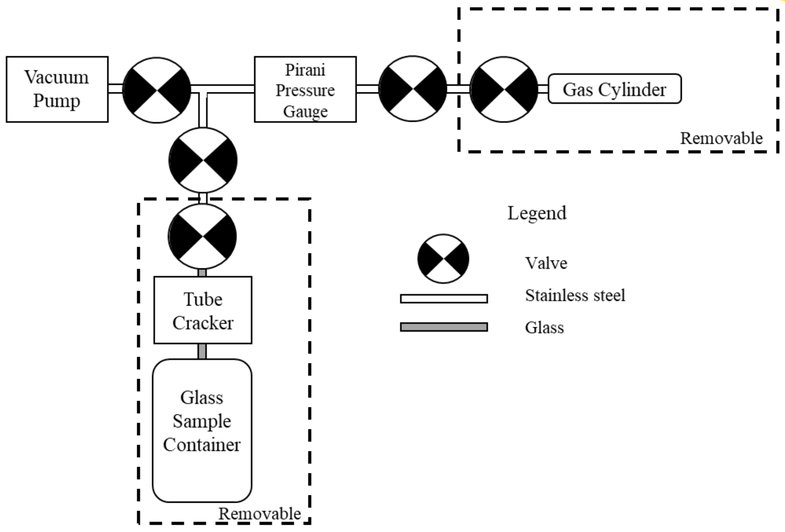


Figure 3: The argon atmosphere glove box, which will be utilized to process all specimens.

Gas Extraction

- The composition of the gas within the capsule is of interest to understand better both the potential ingas into the capsule from the air and whether the meteorite continued to outgas over the decades.
- The goal is to transfer the gas into a metal gas cylinder before transferring the capsule to the glovebox (Fig. 2).
- The cylinder can then be sent off for analysis and the capsule can be immediately transferred to the glove box, minimizing the risk of atmospheric exposure.
- Two main investigations are of interest: the general chemistry of the gas (molecules such as CO_2, CO, O_2, N_2 etc.) and the potential presence of rare gases.

Figure 2: Schematic plan for extraction of gas within the headspace of the capsule. The areas within the dashed line are removable so that they can be taken away for further analysis while sealed. The Pirani pressure gauge will be utilized to monitor the vacuum of the line and calculate the yield of gas produced. The gas cylinder will be heated to 200°C under vacuum conditions to bake off any gases already within the cylinder. Once the gas has been the extracted, the glass capsule, while still sealed, will be transferred to the argon atmosphere glove box.



Procedural References & Blanks

Figure 4: A photograph of MET4170/B-163. Note the exposures of the interior on the top surface and weathering associated with the exposure.

Figure 5: A photograph of MET4170/B-196. Note that the sample is completely enclosed in fusion crust.

- Alongside MET4170/B-194, two additional samples of Bruderheim will be processed and undergo the same analytical procedures.
- MET4170/B-163 is a 224.5 g sample of Bruderheim that has a smooth, dark black fusion crust. This sample was chosen for its minor exposure of the interior (Fig. 4).
- MET4170/B-196 is a 41 g sample of Bruderheim that is completely enclosed in its dark black-brown fusion crust (Fig. 5).
- Additionally, quartz beads will be used as procedural blanks.

Additional Information: If you have any comments or suggestions for the proposed work, please contact pjhill@ualberta.ca. We are looking for any improvements to the procedure and how we can better advance curation techniques for future sample return missions.

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References: [1] Herd C. D. K. et al. (2016) *Meteoritics & Planet. Sci., 51*(3), 499–519.