The Geological and Cultural Significance of Impact Melt Nodules from Lake Mistastin in Northern Labrador

Tania Evans[1], Cari Corrigan[2], Stephen Loring[2]

University of Maryland, Baltimore County[1], Smithsonian Institution[2]

REU Site, OCE-1560088

Smithsonian National Museum of Natural History

Background

After a meteorite collides with the ground, intense shock waves and extremely high temperatures are produced, resulting in the melting of the target rock. This cools to form a very glassy rock, referred to as impact melt. Lake Mistasin in Northern Labrador is a meteorite impact site and a significant location for the native Innu. Before the impact, the rocks at this location were anorthosites and granodiorites. The impact melt from this site is an obsidian-like, black, shiny material, which looks very similar to the lithic raw material that have been found in several parts of North America. Our goal is to characterize the impact melt in order to determine if recovered stone tools originate from the Mistastin region. The ability to determine an artifact's origin can provide valuable insight into cultural exchange and trading practices.

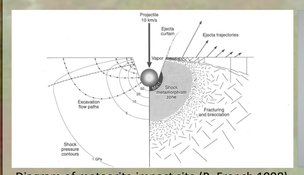


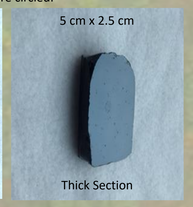
Diagram of meteorite impact site (B. French 1998)

Mistastin Lake impact site (B. French 1998)

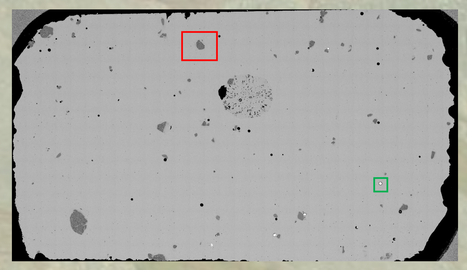
Methodology

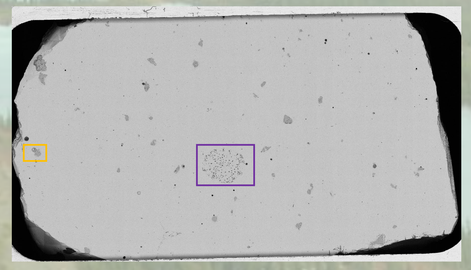
- Among multiple specimens, we chose two for analysis.
- Cut each rock in half, then cut a 30 micron thin section from each sample. The remainder of the rock was polished to make a thick section.
- Used a FEI Nova NanoSEM 600 (with <5% deadtime and a 15 KV electron beam) to take backscattered electron images (BSE) and perform energy dispersive spectroscopy (EDS) elemental analysis.
- Used Noran System Six software to process the images and data.

Samples taken from Mistastin Lake. Samples chosen for analysis are circled.

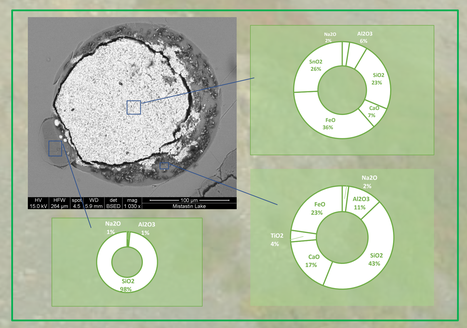


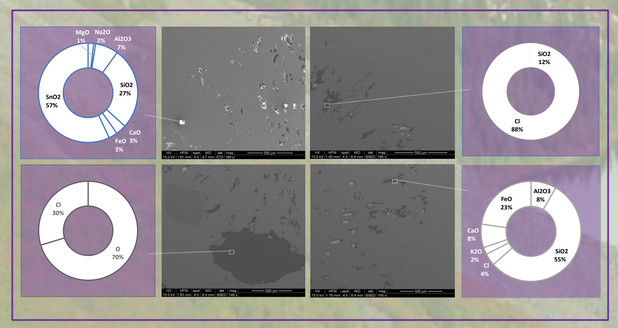
Results



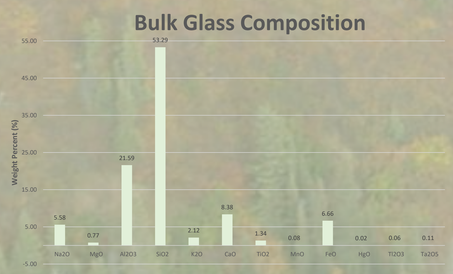


Mosaic backscattered electron images of a thin section (left) and a thick section (right), produced using a scanning electron microscope.





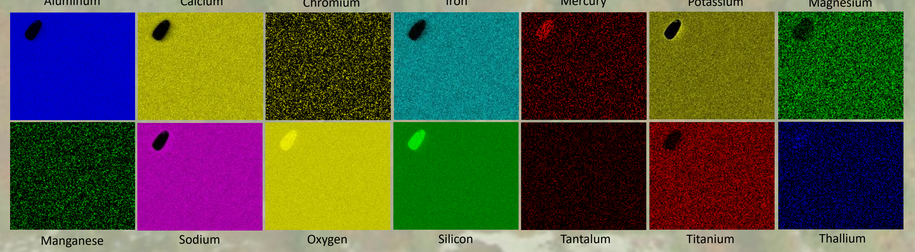
Bulk Glass Composition



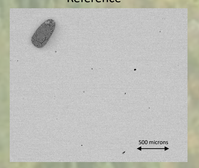
Oxide Weight Percentages in Glass (%)												
Oxide	Na_2O	MgO	Al_2O_3	SiO_2	K_2O	CaO	TiO_2	MnO	FeO	HgO	Tl_2O_3	Ta_2O_5
Weight Percent	5.6 ± 0.5	0.8 ± 0.2	21.6 ± 2.4	53.3 ± 4.4	2.1 ± 0.1	8.4 ± 0.6	1.3 ± 0.1	0.1 ± 0.0	6.7 ± 0.4	0.1 ± 0.0	0.1 ± 0.1	0.12±0.11

Elemental Weight Percentages in Glass												
Element	O	Na	Mg	Al	Si	K	Ca	Ti	Mn	Fe	Hg	Tl
Weight Percent	44.4 ± 6.1	3.9 ± 0.3	0.5 ± 0.1	10.2 ± 1.3	28.8 ± 3.0	2.0 ± 0.3	5.3 ± 1.0	0.7 ± 0.2	0.01 ± 0.0	4.04 ± 1.6	0.0 ± 0.0	0.0 ± 0.0

The glass bulk composition is similar to that found in literature (Marion, 2010 and Pickersgill, 2015). However, the textures were slightly different, as ours was more glassy and had fewer crystals.



Reference

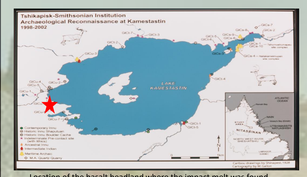


Elemental maps (left) and greyscale backscattered electron image (above). Produced using SEM, electron beam 15 kV, spot size 4.5.

Discussion/Implications

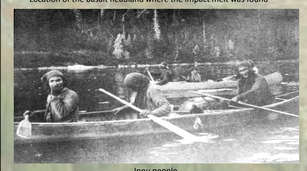
For over 8000 years, Innu living in Labrador used a variety of different stones from which they shaped the tools necessary for their survival. The discovery, identification and interpretation of the impact melt from Lake Mistastin sheds new light on the on the events of a meteorite impact ~38 million years ago and documents a unique lithic raw material that was sought by Innu ancestors to fashion the tools they needed for survival.

By "fingerprinting" the Mistastin impact melt it will be possible to distinguish it from other look alike raw materials (especially obsidians from the western U.S.) and contribute to a better understanding of the ancient systems of trade/interaction that linked ancient peoples across North America. Knowing the origin of the stone that was used to make tools provides clues to former settlement as well as economic and exchange systems.



Location of the basalt headland where the impact melt was found

Arrowheads made from various lithic materials



Innu people

Arrowheads made from obsidian

Future Work

As first steps, bulk glass was measured separately from inclusions. Future work will include determining the overall bulk composition of the entire assemblage and the structure of the silica inclusions. These will be done using the electron microprobe as well as other techniques possibly to include electron microprobe, X-ray Fluorescence and X-ray Diffraction.

References:

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Acknowledgements:

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