Ground Stone Technology: Material characterization of a lithic collection at the Agnes Etherington Art Center

AGNES ETHERINGTON ART CENTRE

Queen's UNIVERSITY

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Introduction

The purpose of this project is to **use non-destructive and minimally invasive methods of analysis to characterize the materials used in production of the lithic pieces in a collection at the Agnes Etherington Art Center donated by Archibald E. Malloch (1844-1919).** The aim of this project is to create a methodical approach to studying these archeological objects and the possible eventual repatriation of these objects to the source community. This project will contribute to the understanding of the lithic pieces in this collection and will allow other scholars to further research the pieces. The aim of this project is to aid other scholars in their art historical, archaeological, and anthropological research in the provenance and techniques used in the production of ground stone tools.

Right: Glass plate negative of A.E. Malloch. Library and Archives Canada
Left: "Indian Artifacts" photo at the Niagara Falls Public Library Archives**.**

Experimental

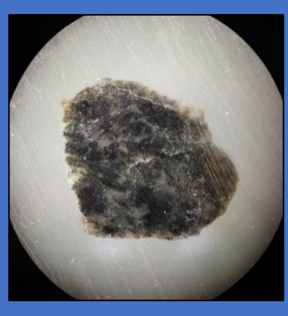
The basis of this research begins with a **survey of 55 lithic objects** in the collection with the associated name, Archibald E. Malloch. The survey included photo documentation and a description of the stone material based on geological standards of description as well as typological features such as axe, gouge, cutting stone, etc.

The **equipment used in the photo documentation** of these objects include the use of a Nikon D300s with a zoom lens of 18-55mm. Soft box flash lighting was used along with a light box .

The photomicrographs were taken with the DINO-Lite digital microscope tethered to a laptop. The lighting used in the DINO-Lite microscope are LED bulbs. The photomicrographs were taken at 50x magnification. Images were taken of the surface and of a break edge if one existed to show the variation in the worked surface and the body of the stone.

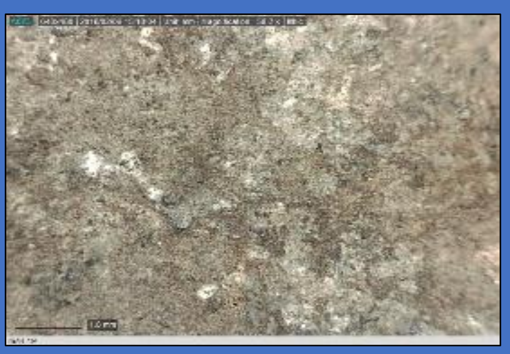
Following the survey of these lithic objects, **X-ray fluorescence (XRF), a non-destructive surface analytical technique**, was utilized to group the lithic objects based on the elements on the top surface of each object. The X-ray fluorescence instrument used is a Handheld Bruker Tracer III XRF analyser. The settings used for the first round of x ray fluorescence spectrometry were operated with no filter, tube voltage, 80kV, tube current 60 micro amperes.

Polarized Light Microscopy (PLM) was used to look at the crystal structure and distinguish the individual rock type from each tool. The sample preparation involved taking a small sample from an inconspicuous area such as a break edge or crack to get a representative image of the surface and the body of the rock. This will involve the use of a tungsten point and chisel to extract the sample and Bioplastic casting resin to create thick and thin cross sections of each sample.



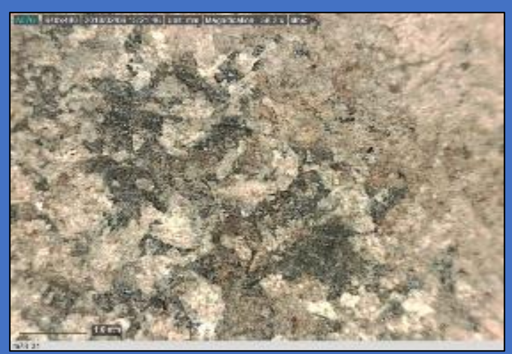
Results

M78.18 grooved axe under normal illumination and photomicrograph
Weight: 1040g Length: 16.6cm Width: 10cm

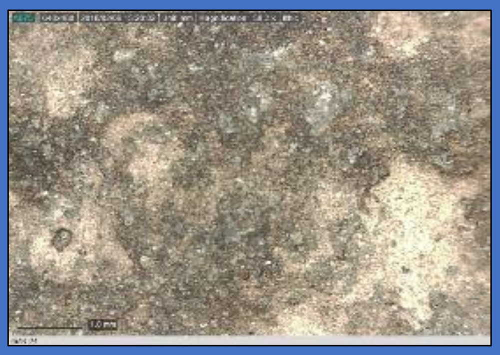


M78.19 grooved axe under normal illumination and photomicrograph
Weight: 867g Length: 17.1cm Width: 9.2 cm

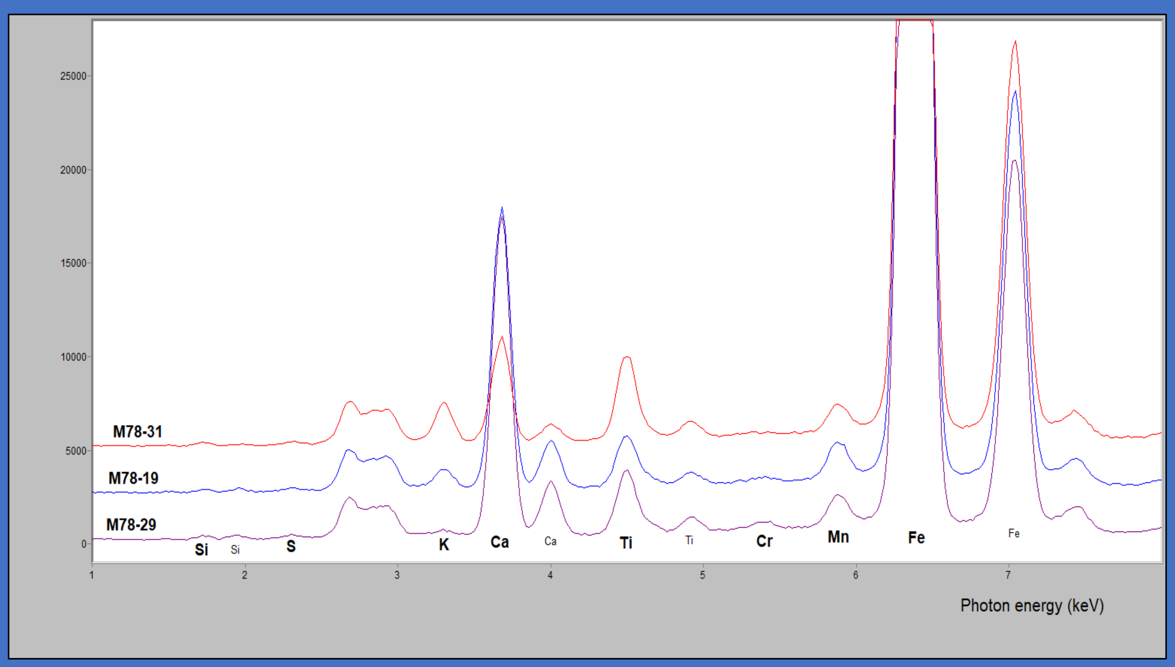
M78.29 grooved axe under normal illumination and photomicrograph
Weight: 1366g Length: 19.4cm Width: 11.2cm



M78.31 grooved axe under normal illumination and photomicrograph
Weight: 403g Length: 14cm Width: 7.9cm



M78.24 grooved axe under normal illumination and photomicrograph
Weight: 728g Length: 16cm Width: 9.5cm



The XRF spectra of three grooved axes with very high iron content. The four lithics in comparison are M78.31, M78.29, and M78.19.

Reference number	Collection time (sec)	Potassium (K)	Calcium (Ca)	Titanium (Ti)	Manganese (Mn)	Iron (Fe)	Other elements (normalized, counts per second)	Fe/Ca ratio
M78.18	19.98	43	473	315	85	7,146	zirconium (Zr) 18	15.1:1
M78.19	21.00	44	713	130	99	6,244	Sr 16, Zr 10	8.8:1
M78.24	21.20	144	193	91	-	2,904	Sr 25, S 19, Zr 16	15.0:1
M78.29	20.08	-	846	168	85	6,231	Sr 25, Zr 17	7.4:1
M78.31	21.04	96	263	212	75	6,260	Sr 16, Zr 15	23.8:1
M78.31.1	21.03	-	615	320	83	6458	Sr 23, Zr 20	10.5:1

Normalized table of XRF results showing the various elements present and relative amounts in the grooved axes.

Discussion

Photo Documentation: Results from the survey include photographs, type of object, photomicrograph and macro descriptive features which can be found in the appendix. **The survey is to show the reader of vast differences and similarities within the collection though the macroscopic and photomicrographs that are shown.** UV fluorescence, infrared, and x-radiography of the stones were not possible as a part of this photo documentation survey due to the time constraints of the project.

XRF: The X-ray fluorescence done on all 55 lithics shows that there **is mostly calcium and iron present in most of the samples with trace amounts of manganese, potassium, silicon, chromium and zirconium**. The large amount of calcium and iron present in the samples could be due to the actual surface of the rock or the soiling deposits present on the rock. Further analysis such as SEM is needed to confirm this theory.

PLM: Polarized Light Microscopy was done on M78.29, M78.31, and M78.19 due to the similar chemical constituents under XRF as well as slightly similar geological features through visual observation. The analysis of these thin sections is pending.

Conclusion

XRF and PLM alone is not sufficient enough to determine source of the stone tools.

SEM, NAA, and other analytical techniques must be considered to geochemically link the stone to discrete locations. Neutron activation analysis gives the best results for any provenance studies on objects with little information attached to them.

NAA will be considered as a part of future research to get a more precise provenance study on the grooved axes, and hopefully the rest of this collection so that more information could be given back to the objects history. The only drawback of this analytical technique is the potential for the sample to become "too hot" i.e. radioactive and therefore unable to return for further research or investigation.

The normalized tables of the XRF results in tandem with the visual observations of the survey, along with the typological features show little to no correlations between the data. There are no trends which exist between the visual observations of the stone type, function of the tool, and the chemical constituents of the stone type.

The information gathered from this research project will ideally be used to inform provenance studies and further study into trade relations in pre-contact societies. The provenance of these objects can also help solidify source communities' historical context through the trade and use of these objects throughout history. Working with pre-contact indigenous material can also allow for conversations around the ethical responsibility of the conservator to contact the indigenous communities in the surrounding areas to discuss possible rehousing or simply allow this information to be accessible to interested parties which may include indigenous peoples.

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