# Scientific Analysis of Lakota Engineering

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This work was made possible by the National Science Foundation
REU Security Printing and Anti-Counterfeiting Site EEC-1560421

## Introduction

We utilized scientific methods and technologies available at SDSM&T to authenticate an artifact from the Great Plains. We learned and interpreted the story the artifact has to tell from the analyses performed.

The Heritage Center at Red Cloud Indian School entrusted us with a wrought iron dagger fitted with an American Black Bear jaw hilt. The item was claimed to have come from the site of the "Custer Battle," *the Battle of the Little Bighorn.*

In addition, this project investigated the viability of security ink on unusual substrates: quillwork and beadwork. The staggering multi-billion dollar industry of counterfeit Native American art could be combatted with covert signatures and quick response (QR) codes printed on authentic art pieces to provide more information to the consumer about the production. Technologies such as this could bolster Lakota culture and economies with exponential benefits.

## Objectives

- Investigate cultural provenance and materials of manufacturing
- Provide insight to authenticity of the artifact
- Test developmental security ink for use with unusual substrates

## Procedure

To further authenticate this item, we need to examine some of the characteristics that might give us doubt. Are the materials contradicting what was available during the 17th or 18th century? Is the construction a modern technique? We will use a few different scientific analyses to answer these questions:

- Laser Induced Breakdown Spectroscopy to determine chemical composition
- X-ray Fluorescence to give us multiple analyses of elemental content
- Micro X-ray Computed Tomography to view 3D internal volume

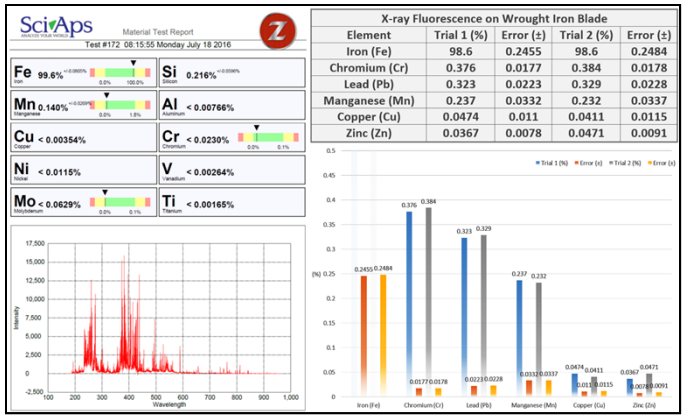
## American Black Bear Jaw

- Mato was a wild female American Black Bear of the Northern Great Plains
- She was middle-aged; as seen by the porous bone structure
- Perhaps food was scarce for this wild bear, or had a more plant-based diet

Figure 1
The first step in our authentication of these pieces is to verify the materials. In this regard, Dr. Sally Shelton and Darrin Pagnac served as Paleontology resources. These two field experts can accurately classify and analyze the specimen fixed to the knife blade. Figure 1 below at left shows the specimen with which we compared our bear, Mato.

## Elemental Spectroscopy & CT Imaging

Our metal analyses (see figure 2) report the metal as appropriately unrefined steel and matches the time frame in question. The single trial with the Laser Induced Breakdown Spectrometer returned unexpected data about several probable elements, but the X-ray Fluorescence provided more appropriate date for this steel.




X-ray Fluorescence on Wrought Iron Blade

| Element | Trial 1 (%) | Error (±) | Trial 2 (%) | Error (±) |
|---|---|---|---|---|
| Iron (Fe) | 98.6 | 0.2455 | 98.6 | 0.2484 |
| Chromium (Cr) | 0.376 | 0.0177 | 0.384 | 0.0178 |
| Lead (Pb) | 0.323 | 0.0223 | 0.329 | 0.0228 |
| Manganese (Mn) | 0.237 | 0.0332 | 0.232 | 0.0337 |
| Copper (Cu) | 0.0474 | 0.011 | 0.0411 | 0.0115 |
| Zinc (Zn) | 0.0367 | 0.0078 | 0.0471 | 0.0091 |

Figure 2
To examine the chemistry of the tools, Dr. Edward Duke, manager of analytical services at SDSM&T and professor of Geology/Geological Engineering, assisted Shane and I with the laser induced breakdown spectroscopy. Data report shown at above left. Dr. William Cross assisted us with X-ray Fluorescence, data shown at right, on July 19th of 2016.

- X-ray Fluorescence reported additional elements that LIBS could not detect
- Sulfur and Phosphorus are common contaminants that surprisingly did not appear in either test
- The instrument used for LIBS may have needed calibration for less refined steel specimen; surface oxide and inorganic matter could compromise data
- Carbon content cannot be accurately measured without using a more pervasive analytical technique
- Computed tomography shows that the metal part was previously machined, therefore a recycled steel as predicted

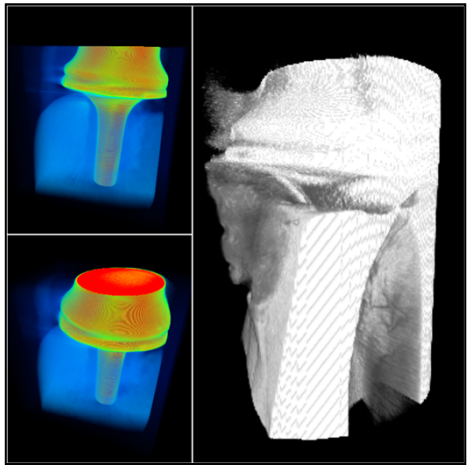


Figure 3 (Left)
Xradia CT images

Figure 4 (above)
Shane 'Flexhard' Star

## Conclusion

Circular nature suggests it is a previously machined part the leather strips and pitch wrapping is an incredibly efficient technique of the 17th/18th centuries adapted from Stone Age engineering. Much knowledge about Earth materials was needed to craft this knife. Bears are seen as powerful entities and are highly respected, this item was probably made for a particular person of importance.

It is very likely that this artifact originated in the Great Plains region, and was very important to a particular warrior. The steel and nature of the build are coherent with pre-colonization and reservation era weapon-making style. Therefore, it is inconclusive that this item was recovered from where Custer took his last stand. We can confirm, that this is a very sacred and important artifact for understanding the nature of the Lakota people and the way they utilized resources in a minimalistic and holistic way.

One needs to appreciate the artifact from a cultural perspective; we must be cautious as to avoid excessive damage. An item such as this is made of a being that once walked the Earth and was cognizant. Bears are intelligent and powerful animals that understand healing. They are highly respected by Native American people and thought to have 'good medicine,' an interpretation of the energy that comes from connectedness with the Earth and the restoration of a unified balance.

## Future Work

The knife can be more accurately dated and traced with DNA samples from the leather and tooth. The unexposed dentine shelters prime organic matter for core sampling. Teeth are time capsules for DNA. If we preform another LIBS analysis, in the same spot as the first, we should get a more conclusive dataset.

It was found by previous SPACT REU students that fluorescein based ink is a viable option for covert printing on feathers. We want to extend that study of unusual substrate printing to quillwork and beadwork. Smaller trinket and jewelry items are the most counterfeited items. With the correct ink formulation, we hope to apply ultraviolet (UV) responsive security inks to a greater variety of art forms.

## Broader Impact

This project is part of a movement to interest more Native youth in science, technology, engineering, and math while unraveling some of the mysteries of our histories. Documentation is scarce and potentially incorrect with oral history. There is much to learn from the Lakota people and their techniques that sustained their harmonic existence.

Protecting and preserving our Lakota history is critical to empowering the youth to make sySTEMic change to the conduction of education on the reservation. Native Americans are natural engineers, advantageously using an acute understanding of the natural world.

Art is the livelihood of many Native Americans across the continent. Government regulations such as the Indian Arts and Crafts Act of 1990 do what they can to protect our creative rights. Another great defense would be printing individual 'watermarks' on art to help prevent counterfeit products from flooding the market.

## Wopila Tanka

Very big thank you to the faculty and staff in the Materials and Metallurgical Engineering department at SDSM&T for help with university equipment and programming, and Dr. Duke in Geology. Much appreciation is extended to James Rattling Leaf and JhonDuane Goes In Center for their consultation and guidance into the cultural interpretation of this reconditioned soul, Mato. A warm handshake to Mary Maxon and Ashley Pourier at the Heritage Center for entrusting us with their artifacts.