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Meeting Halfway: Collaborative Public Outreach and Lithic Material Sourcing in the High Plains of Nebraska

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MEETING HALFWAY: COLLABORATIVE PUBLIC OUTREACH AND LITHIC MATERIAL SOURCING IN THE HIGH PLAINS OF NEBRASKA

By

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MEETING HALFWAY: COLLABERATIVE PUBLIC OUTREACH AND LITHIC MATERIAL SOURCING ON THE HIGH PLAINS OF NEBRASKA

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This master's thesis is comprised of one technical paper and two public archaeology initiatives that support the creation of a significant digital heritage product that utilizes citizen science to further the stewardship of archaeological and historical resources. The first chapter is comprised of a methodological use of the Video Spectral Comparator 6000 and ImageJ software. The methodology explores quantitative and qualitative aspects of lithic sourcing utilizing ultraviolet light treatments on two macroscopically similar lithic material sources, Knife River Flint and White River Group Silicates. The development of a non-destructive, non-invasive method to source lithic raw materials provides a tool for researchers to simplify and standardize the process of qualitative lithic sourcing using ultraviolet fluorescence. The second chapter examines the role that professional archaeologists and private landowners can play in the realm of public outreach in the High Plains. Utilizing the case studies from United States Forest Service sponsored 'Artifact Roadshows', this chapter provides methodological guidelines aimed toward professional archaeologists utilizing interpretation as a way to create collaborative relationships with private landowners. Finally, the third chapter contains the implementation of a digital archive which utilizes citizen science efforts and data derived from the 'Artifact Roadshows'. This digital archive provides sound, analytical data for professional archaeologists and educational materials derived from analytical data for the consumption of the general public.

Acknowledgements

I would especially like to thank Matthew Douglass for his continuous support, contributions, and willingness to assist me with each project. I want to thank my advisor, LuAnn Wandsnider for her professional guidance while developing my final thesis. I also want to thank Dr. Peter Bleed for accepting my invitation to be the final member of my committee and providing strategic guidance throughout my graduate career. I would like to thank National Grasslands Visitor Center Director Dennis Kuhnel, for introducing me to the interpretive method as well as being the foundation for the public archaeology events called the 'Artifact Roadshows'. Additionally, I would like to thank the numerous United States Forest Service employees and University of Nebraska field school students who assisted in the public outreach during the 'Artifact Roadshow' events. Work done with the VSC 6000 could not be done without the technical guidance of Dr. Jeevan Meruga of the South Dakota School of Mines & Technology. Department of Anthropology support in the form of funds from the John L. Champe and Ward Weakly, and the Nebraska Academy of Sciences McGinnis Prize supported many conference presentations and posters. Matthew Padilla, Kristina Hill, and Rebecca Wong deserve special thanks for motivating my passion for heritage resource management throughout my career in archaeology. My fellow graduate students and friends were an immense support for the completion of my thesis. Finally, I would like to thank Bob and Laurie Hittner, my parents, for believing in me and trusting me to work towards my dream.

Table of Contents

Table of Figures

CHAPTER 1: INTRODUCTION

This thesis is comprised of two journal-ready papers that present methodologies of two aspects of archaeological method. The second chapter consists of a non-destructive, non-invasive methodology to source lithic materials utilizing consistent ultraviolet light frequencies. The second and third chapters are focused on a specific public archaeology initiative called the 'Artifact Roadshow' which were hosted in Nebraska, South Dakota, and Wyoming during 2013 -2015. The third chapter describes an interpretive approach to conduct archaeologically focused public outreach which utilizes private collections and collaborative approaches for archaeological conservation. Finally, the fourth chapter outlines the process for sustainably archiving data and information obtained through the 'USDA-Sponsored Artifact Roadshows.' It describes the development of a digital archive with both two- and three-dimensional models along with oral histories from local landowners bordering the National Grasslands as well as participants to the 'USDA-sponsored Artifact Roadshow'. The entire archive has a dual audience in mind and was specifically designed to meet the needs of both research professionals and the general public.

Lithic raw material sourcing is an important and widely used analytic tool to discover range, curation, cultural affiliation and prehistoric economy of cultural groups. This aspect of archaeological research is important on the Great Plains, owing to the fact that we find an abundance of artefactual material representing lithic debitage or artifacts

in archaeological contexts and we suspect that highly mobile cultural groups that inhabited this region into the distant past. This study focuses on the study of ultraviolet fluorescence of the macroscopically similar White River Group Silicates and Knife River Flint. Utilizing a combination of tools, a Video Spectral Comparator 600 and ImageJ, this study provides a qualitative standard for visual comparison of these two widely utilized lithic materials. A quantitative principal components analysis was also performed on both 254 nm and 365 nm red, green, and blue average values to examine the factors that define the sample average ranges. Being able to control for numerous variables and obtaining high quality photographs of these lithic materials under controlled ultraviolet wavelengths of 254 and 365 nm, future researchers will be able to easily visually discriminate lithic sources.

The interest and passion for stewardship of the past is not unique to heritage professionals and it can be argued that for many professional archaeologists, the main motivation to scientifically decipher artefactual remains is to preserve or contribute to the preservation of the archaeological record. Moreover, most of the archaeological research in the United States is done on public land with public monies for the benefit of the American people. Archaeologists, inspired by a passion for discovery and interpretation of the past, have historically had a difficult time translating their technical jargon into a consumable version for the general public. Using case studies from the public archaeology initiative titled the ‘“USDA-Sponsored Artifact Roadshows’, this chapter explores the evolution of an interactive interpretation methodology with participants who own private collections as a way to foster positive and conservation based relationships. While the end-goal of this exploration is not to turn archaeologists into professional

resource interpreters, it aims to provide an explanation of why and how professional resource interpreters are effective in translating dense, technical jargon into relatable stories. In addition to the method of interpretation utilized at ‘Artifact Roadshows’, the third chapter describes the process of converting the data and information obtained at the ‘Artifact Roadshows’ into a publicly viewable website and digital archive. This digital archive is the product of the collaboration between heritage resource professionals, academic archaeologists, and private landowners. Participants with private collections are encouraged to work with archaeologists to create a publicly curated and readily displayable digital archive. Including these potential avocational archaeologists in the real collection of a potentially significant amount of archaeological data has already shown to have an impact to the local public perception of professional archaeologists.

CHAPTER 2: AN ANALYSIS OF THE ULTRAVIOLET FLUORESCENCE ON WHITE RIVER GROUP SILICATES AND KNIFE RIVER FLINT

Introduction and Background:

Lithic material sourcing is an important aspect of archaeological research in that it facilitates interpretations of economy, movement, and territory for prehistoric populations (Ahler 1977; Andrefsky 2005; Andrefsky 2009; Bamforth 1991; Bamforth 2002; Borrero *et. al.* 2009, Douglass 2010; Douglass and Holdaway 2011; Douglass *et. al.* 2015; Gramley 1980; Holdaway *et. al.* 2015; Montet-White and Holen 1991). The methods that have been used to source lithic material from archaeological sites have been both qualitative (e.g., visualization of color and texture) as well as quantitative methodologies such as Neutron Activation Analysis, X-Ray Diffraction, and X-Ray Fluorescence.

In its simplest guise, qualitative sourcing relies on an assessment of the visual characteristics of a raw material, macroscopically assessed color under natural lighting conditions, in comparison with known source materials. Other qualities of lithic material include: grain size, texture, luster, or translucency (Ahler 1977; Crandall 2006).

Beyond natural light, ultraviolet lighting has also proven to be a useful tool for sourcing. Hoffman and Todd (1991) experimented with the identification of Texas

Edwards Chert compared to cherts with a similar appearance using qualitative visual analysis of ultraviolet light. Church (1990) attempted to utilize ultraviolet fluorescence to distinguish a variety of materials housed in a lithic repository in South Dakota. Shockey (1993) utilized the ultraviolet fluorescence of both heat treated and primary fabric lithic materials in Oklahoma. Ultraviolet fluorescence is based on the activation of chemical components in the material by exciting the components with the light radiation given off by specific wavelengths of light. The identification of lithic materials using a macroscopic approach relies on the pre-identified attributes of a certain source material's to discriminate between lithic materials. Macroscopic, qualitative studies are potentially problematic due to a range of uncontrollable variables that are inherent in the data collection process. Uncontrolled visual analysis has a degree of subjectivity caused by factors such as, the lack of a photographic record for future comparison, differing capabilities of ultraviolet light sources, and the duration it takes for the eye to adjust to the specific wavelength of ultraviolet light. All of these can significantly affect findings (Hillsman 1992).

In this study, I develop a standardized approach to using ultraviolet light fluorescence in lithic, here focusing on Knife River Flint (KRF) from North Dakota and the White River Group Silicates (WRGS) from Nebraska, South Dakota, and Colorado. These materials look alike and have been featured in debates surrounding lithic sources in the Great Plains, especially in relation to the Alberta Paleoindian age lithic materials found at the Hudson Meng Bison Bonebed in far northwestern NE (Agenbroad 1978; Todd and Rapson 1996). To provide a highly controlled and replicable measure of ultraviolet fluorescence, I used the Foster + Freeman Video Spectral Comparator 6000

(VSC) This device is a forensic document analytic tool that is primarily used to detect forgeries in legal documents using a variety of ultraviolet wavelengths that expose the presence or absence of fluorescent properties. The benefits to using the VSC is that it can impose conditions of specific and consistent wavelengths of ultraviolet radiation (254 nm and 365 nm), it possesses an internal casing which fully contains the wavelengths of ultraviolet light to eliminate ambient 'noise' of other light wavelengths, and it includes a high resolution digital camera.

UV images then serve as the primary data source for analysis. In some cases, a simple qualitative visual comparison of two or more lithic materials and artifacts under ultraviolet wavelengths will suffice, while in other cases output images can be examined quantitatively using photo processing software. In this study, scans are both compared qualitatively and quantitatively. Quantitative analysis uses a protocol based on non-proprietary software ImageJ and proprietary Excel Spreadsheet add-on, XLSTAT, which allowed me to perform a principal components analysis (PCA) of the Red, Green, and Blue (RGB) pixel averages generated by ImageJ.

This study focuses on the ultraviolet fluorescence differences between the two very similar "root-beer" colored silicate fabrics of WRGS and KRF. In addition, I found that the patinated surfaces of artifacts also fluoresced distinctively, which may further aid in identifying a specific raw material source (Rottlander 1975b).

Background:

Knife River Flint (KRF), with quarries found in Dunn County in North Dakota as well as secondary alluvial gravel deposits in Minnesota and Iowa, is ubiquitous during the Plains Paleoindian period, being one of the most widespread lithic materials from the Great Plains region (Morrow 1994:109-110). KRF is a glossy, 'root-beer' colored, semi-translucent silicate that contains fuslinid palm tree frond fragments (Crandall 2006:15). The natural cortex of KRF resembles a thick chalky opaque white, while the natural patination, caused by the weathering of the exposed fabric, is nearly invisible. The KRF samples used in this study were acquired from primary sources in North Dakota.

White River Group Silicate (WRGS) primary sources occur in a wide arc in the southwestern South Dakota and northwestern Nebraska badlands, eastern and central Wyoming basin, and the northeastern Colorado foothills. Well known primary sources of WRGS in southwestern South Dakota include West Horse Creek, Table Mountain from east-central Wyoming, and Flattop Butte in northeastern Colorado. This study focuses on WRGS primary and secondary cobble deposit sources from southwestern South Dakota and northwestern Nebraska. This lithic material occurs in thin veins of chalcedony that are encased by an opaque, chalky-white cortex, similar to that seen for Knife River Flint. Additionally, the specific WRGS fabric that occurs naturally can be described as isomorphic to Knife River Flint; it is a semi-translucent, 'root-beer' colored silicate that contains fuslinid deposits of ostracods, which have been described as the carapace of small Oligocene bi-valves (Rettalack 1983:10-11). The samples of the White River Group Silicate utilized here came from the educational collection at the Hudson-Meng

Education and Research Center (HMERC) and loaned samples from the Nebraska State Historical Society (NSHS); both were collected near the West Horse Creek in SW South Dakota.

Both WRGS and KRF, in their basic lithic fabric, resemble one another visually and have been mistaken for one another because of the similar qualities (Huckell and Agenbroad 1978; Nowak and Hannus 1981; Todd and Rapson 1994). The importance of developing a lithic sourcing technique that is accessible and able to be replicated and improved upon is emphasized by the research on the *Bison antiquus* bonebed at the Hudson-Meng site in the Oglala National Grasslands of Nebraska, which began to accumulate about 10,000 BP. Projectile points recovered from the Hudson-Meng bonebed, with two disparate interpretations, inspired the need to distinguish between KRF and WRGS.

Hudson-Meng: Two Interpretations

The importance of developing a lithic sourcing technique that is both accessible and replicable is emphasized by competing interpretation of lithic artifacts found at the at the Hudson-Meng site in the Oglala National Grasslands of Nebraska. One interpretation is that the semi-translucent, brown, lithic artifacts at Hudson Meng were made of KRF while the interpretation is that the source material is WRGS.

Interpretation One

Larry Agenbroad, then of Chadron State University, was the first researcher to examine the *Bison antiquus* remains that constitute the majority of the Hudson-Meng Bison Bonebed in Sioux County, Nebraska (Agenbroad 1978). The discovery of an Alberta type projectile point *in situ* inside the ribcage of one *Bison antiquus* skeleton changed the nature of the site from solely paleontological to an archaeological site of Paleoindian importance. Over the course of a seven year excavation, Dr. Agenbroad and others documented the remains of approximately 300 *Bison antiquus* remains and also discovered 18 additional Paleoindian projectile points as well as tens of thousands of pieces of debitage that seemed to be arranged in patterns reflecting processing and butchering activities. Bruce B. Huckell, a colleague of Agenbroad, was tasked to analyze the stone tool assemblage and identify the probable lithic material source for the majority of debitage and tool forms that comprised the archaeological assemblage (Huckell 1978). Huckell concluded, based on the quality of lithic material, color, known primary sources, and the patterns of Paleoindian activities reported in the literature, that this root beer-brown material that dominated the lithic assemblage came from the Knife River Flint quarries in Dunn County, North Dakota. This conclusion of the KRF material in particular, suggested that either the Alberta age projectile points made of KRF were owed to extensive mobility or trade by Agenbroad (1978;87)

Interpretation Two

In 1991 a team of researchers from Colorado State University and the University of Wyoming, Lawrence Todd and David Rapson, re-examined the Hudson-Meng Bison Bonebed using modern geo-archaeological and taphonomic techniques. The work done by Todd and Rapson supported an alternative conclusion to that of Agenbroad. Todd and Rapson concluded the Hudson-Meng Bison Bonebed was likely a natural death assemblage that was later used by Paleo-Indian peoples or perhaps scavenged by these same people (Todd and Rapson 1996). During the course of their research, the discovery of two additional Alberta age projectile points increased the total count to 21. One of these projectile points, M83-10-346, was sent to James C. Miller of Colorado State University for sourcing analysis. Miller concluded that the lithic source material of M83-10-346 was a more local White River Group Silicate based on absence of fossil plant fragments (characteristic of KRF), and the presence of ostracod carapaces not seen in KRF but present in samples of WRGS (Todd and Rapson 1994).

The different conclusions raised about the origin of the Hudson-Meng lithic material provides the need for increased analysis of lithic sources, specifically through newer technologies not available in the 1970s or 1990s eras of excavations. The opposing views have implications for understanding variation in Paleoindian mobility, trade, or the use of local vs nonlocal lithic resources. If Agenbroad and Huckell are correct then at the activities associated with Hudson-Meng reflect the use of lithic materials transported over a considerable distance. Such an outcome could support interpretations of large

Paleoindian ranges or groups, or extensive trade among cultural groups in the northern high plains.

If, however, Todd, Rapson, and Miller are correct, then Hudson-Meng reflects local material use of the WRGS deposits in South Dakota. This finding would support a very different interpretation of range, mobility, and the use of extensive trade. With either conclusion, the identification of the source material that cultural groups utilize is an extremely important aspect to archaeological research. The potential issues of misidentification between lithic materials can represent a drastically different conclusion to the external aspects of site construction and interpretation.

Clearly, some definitive measure is needed to discern between these two materials. Based on fabric color, both KRF and WRGS have the same root-beer like color and similar translucency. Though macroscopic fuslinid inclusions have helped in large specimens, not all specimens evidence these fuslinid inclusions. Therefore, a potential secondary evaluation of lithic material aspects is necessary. Hoffman ET. al. (1994) and Hillsman (1991) suggested UV might be of assistance help, however their approach remains subjective due to the uncontrollable variables of inconsistent lighting, consistent photographic macro settings, or even the consistency of being able to discern the same color due to varying degrees of color-blindness. Here a pilot study using the VSC is presented to explore the use of ultraviolet light fluorescence as a means to distinguish between these two materials.

The raw material samples utilized here come from primary source locations, while a second set of artifact collected from the an area north of Hudson-Meng in the drainages of the Oglala National Grasslands are used to explore the ability of ultraviolet light

fluorescence to identify the raw material of archaeological specimens. In order to develop a more refined ultraviolet light analysis to examine the KRF and WRGS samples, a proof of concept study was conducted utilizing the power of the VSC's controlled variables.

Methods:

Materials

The primary KRF comparative samples used in this study were acquired from primary sources in Dunn County, North Dakota (Figure adapted from Hoard ET. al. 1993: Figure 2-1). The KRF samples were knapped from collected non-artefactual nodules, which revealed an unpatinated fabric on the fresh edges. Some of the remaining nodule cortex was left on for purpose of this analysis.

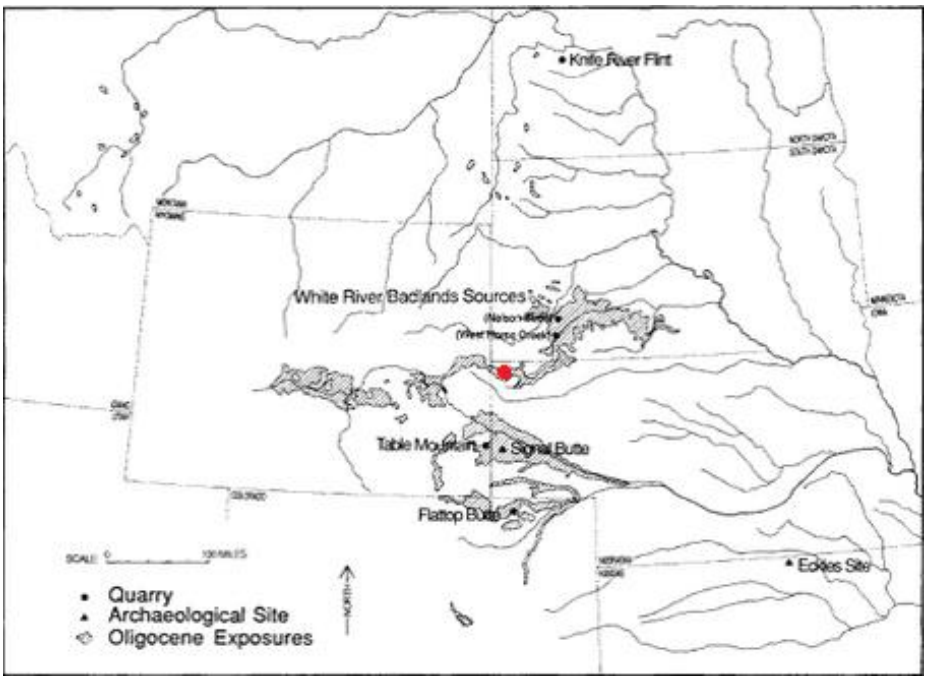

Figure 2-1: Regional Map identifying locations of KRF, WRGS, and the Hudson-Meng Site.

The samples of the White River Group Silicate were provided by Hudson-Meng Education and Research Center (HMERC) and the Nebraska State Historical Society (NSHS). Samples from both organizations were collected near West Horse Creek, in southwestern South Dakota (Figure 2-1). The WRGS samples that were acquired from the HMERC were collected as non-artefactual nodules and subsequently knapped to reveal the lithic fabric of the West Horse Creek type of WRGS in the 1990s. The nodules acquired from the NSHS were collected and not knapped, thus retaining the exposed lithic fabric and likely the natural patination acquired from weathering processes.

I also examined artifacts coming from the Hat Creek survey conducted by Agenbroad on the Oglala National Grasslands of the Nebraska National Forests and Grasslands over the course of the 1971-1977 excavations at Hudson-Meng. While little provenience data exists about the artifacts, the decision to utilize them for the ultraviolet light analysis was based on the relative good information that they were collected on the surface in the Sand Creek and Petesmith Hill areas that surround the Hudson-Meng site. These artifacts display the characteristic ‘root-beer’ colored, semi-translucence seen for KRF or WRGS specimens.

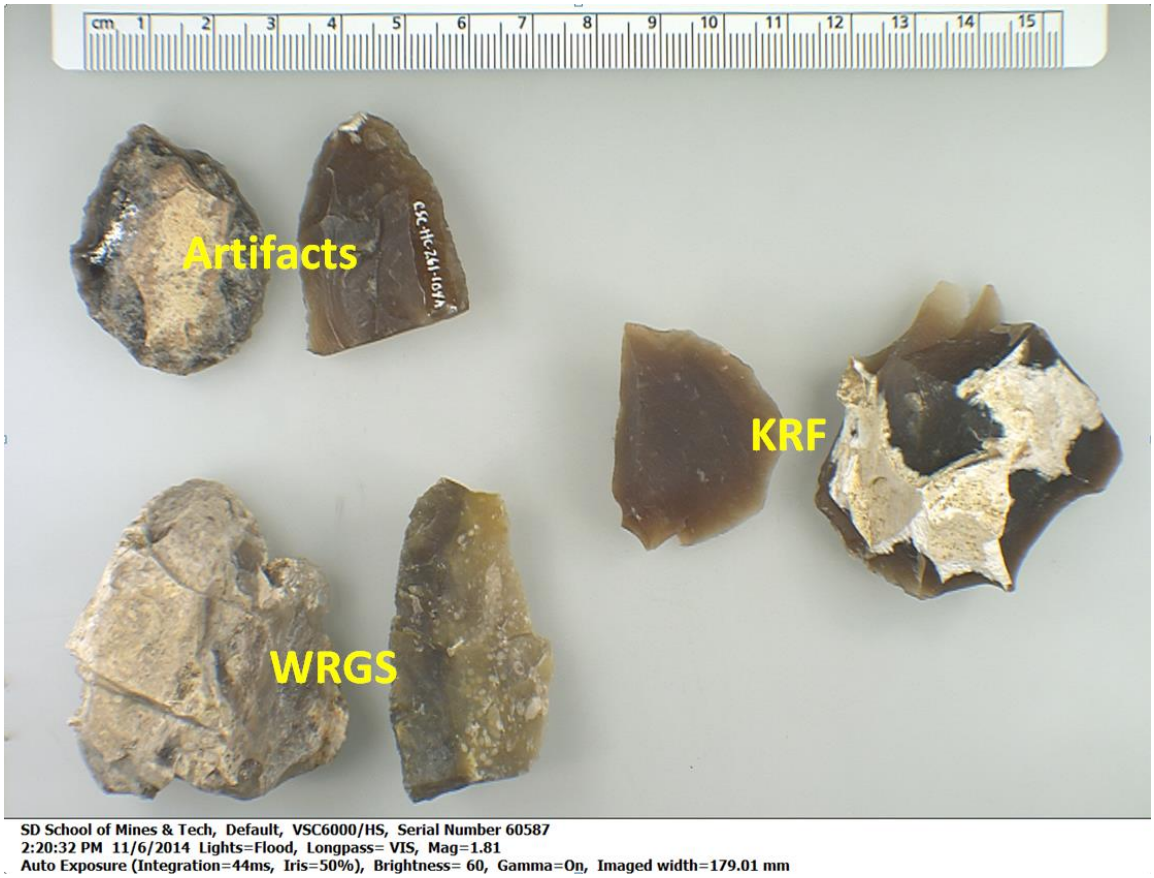

Figure 2-2: Samples of WRGS, KRF, and Artifacts

VSC 6000 Specifications:

In total, 17 artifacts from the Agenbroad collection, 29 non-artefactual KRF specimens, and 22 non-artefactual WRGS specimens were subjected to two treatments under static ultraviolet light (Figure 2-2))). Consistent with the ultraviolet wavelengths utilized in other studies, I specified imaging the specimens at ultraviolet wavelengths of 254nm and 365nm. The specimens were then separated into respective categories of KRF, WRGS, and ART, and photographed under each ultraviolet wavelength and white light under a consistent magnification of 1.81 according to VSC specifications of

magnification. The artificial brightness for each wavelength was controlled at 60, according to VSC specifications of brightness. This study also controlled for auto-exposure integration and iris which were set at 2.3s and 91%, respectfully. The decisions of brightness, auto-exposure, and iris percentages were left to the VSC technician as for what the preferred settings would be. These photographs were then transferred as .bmp files, to maintain a high quality image, to a portable thumb drive for further analysis.

Image J Specifications:

ImageJ is a Java open-source photo analytical software produced by the National Institute of Heath for the analysis of cellular fluorescence in microscopic samples (https://imagej.nih.gov/ij/). The strength of ImageJ is that additional tools and plugins can be written in JavaScript for specific types of photo/pixel analysis. Fortunately, this study was able to utilize the suite of applications already designed for simple RGB/pixel studies, specifically, the "Analyze > Histogram" and the "Plugin > Analyze > RGB Measure" tools provided in the default version of ImageJ. RGB consist of values from 0 – 255 for each hue (Red, Green, and Blue) that make up the specific pixel to form a larger picture. Using this data through the Image-J software's Analyze/Measure RGB, the user specifies the size of a square sample frame in pixels and then utilizes the 'Plugins' menu, the 'Analyze' sub-menu and selects "Analyze RGB'. For this study, a consistent sample frame of 64 x64 pixels, that is, 4096 pixels, was used that was positioned on the greatest amount of lithic fabric and as close to the center of the specimen as possible (Figure 2-3). In addition, the ImageJ histogram function allows for quick visual and basic statistical analysis of the RGB pixel values within the sample frame. The "Analyze RGB" java-script tool collected and averaged R, G, B, and grey luminance values from the sample

frame, exporting these values to an xml document. A principal components analysis of the average R, G, and B values for all samples was performed to identify potential groupings of samples.

Figure 2-3: An example of the sample frame in ImageJ

Results:

Visual inspection

During the preliminary scanning of the WRGS, KRF, and artifact specimens, notable visual differences between the samples were observed. The KRF lithic samples fluoresced a dark green hue within both the 254 nm and the 365 nm treatments, with the dark green hue especially prominent in the 365 nm treatment compared to the 254 nm treatment. Of note, the cortex in both treatments fluoresced a dark orange with both the 254 (Figure 2-4) and 365 (Figure 2-5) nm treatments.

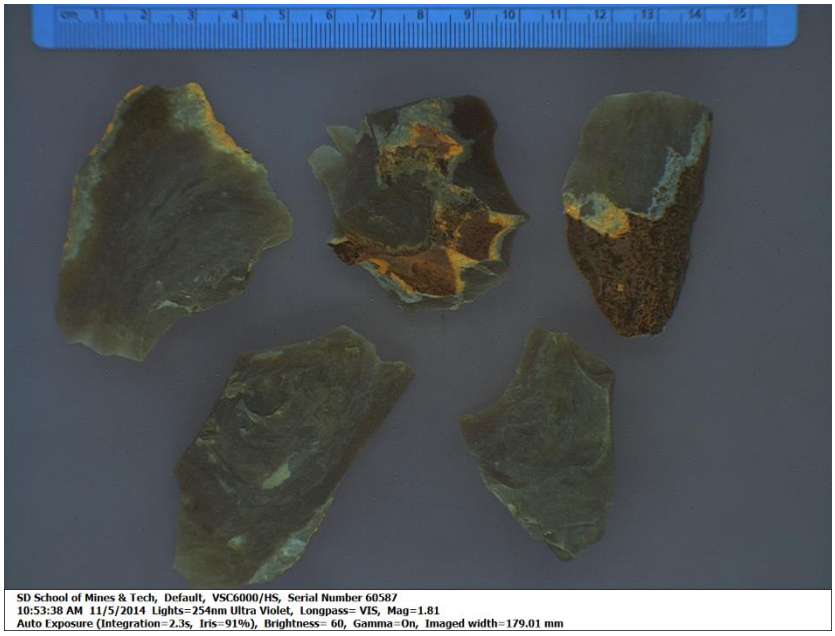

Figure 2-4: Batch 1 of KRF samples under 254 nm ultraviolet light treatment

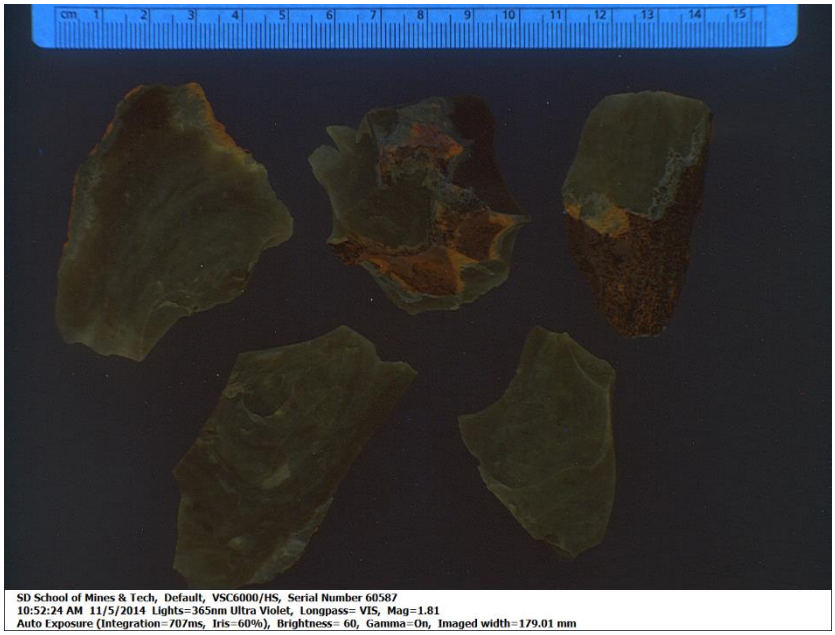

Figure 2-5: Batch 1 of KRF samples under 365 nm ultraviolet light treatment

The WRGS samples fluoresced a very bright green hue in the 254 nm treatments and, for half of the samples, a very dull orange in the 365 nm treatments. There is also a noticeable difference in the WRGS sample fluorescence between the samples gathered from the HMERC and the NSHS. The samples obtained from NSHS visually appear with a much lighter hue of light green fluorescence, while the samples obtained from the HMERC collection appear with a much duller hue of green fluorescence in the 254 nm ultraviolet treatments. The 365 nm ultraviolet treatments exhibit a dull orange fluorescence on the NSHS samples, and a dull brown fluorescence on the samples obtained from the HMERC collections (Figure 2-7). This result may be due to the potential patination of the samples obtained from the NSHS collections, while the HMERC collections of WRGS were freshly knapped to reveal the lithic fabric. It is also important to note that half of the WRGS samples 'reflected' the ultraviolet wavelength of

365 nm, representing the absence of fluorescent chemicals within the chemistry of the material, resulting in a null value. The cortex in the 254 nm treatment fluoresced a much brighter green compared to the fabric. In the cortex of the orange fluorescent lithic fabric 365 nm treatment samples, it was represented as an off-white to grey color (Figure 2-6).

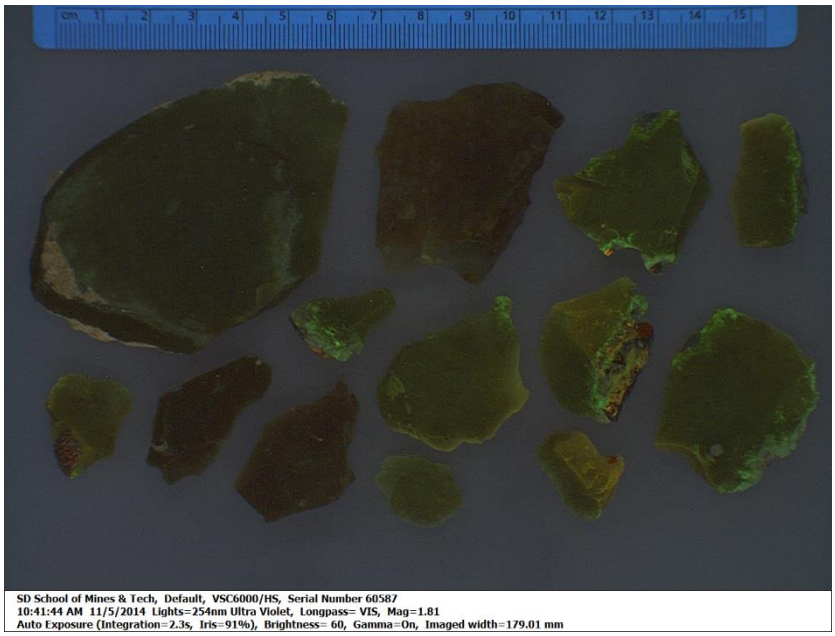

Figure 2-6: Batch 2 of WRGS under 254 nm ultraviolet light treatment

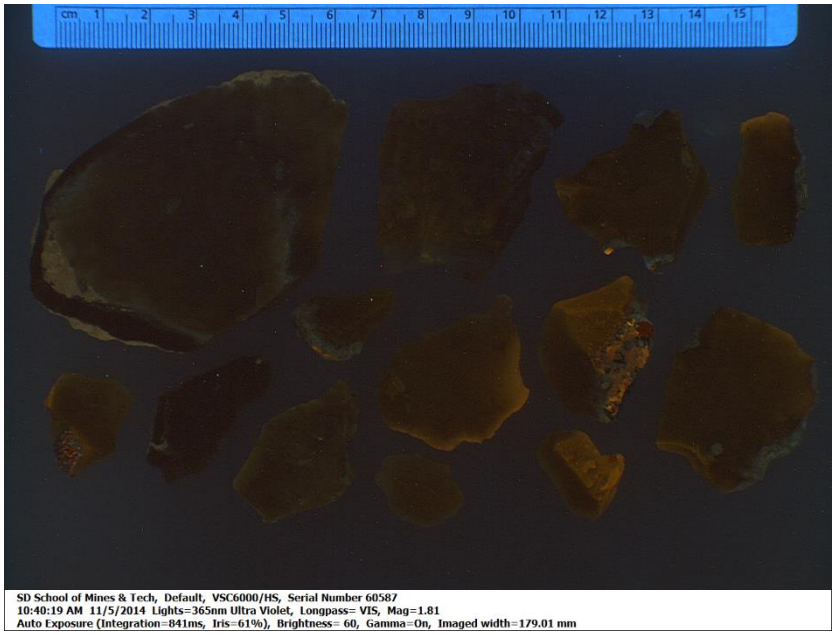

Figure 2-7: Batch 2 of WRGS under 365 nm ultraviolet light treatment

The artifact sample responded in a more varied way to the ultraviolet treatments. At 254 nm, a large majority of the samples fluoresced an orange hue while at 365 nm, the lithic fabric fluoresced an increased or darker orange hue. The samples that retained original cortex imaged either a bright green hue or a grey-green hue in both the 254 nm and 365 nm treatments (Figure 2-8 and Figure 2-9). It is also interesting to note that the visual characteristics of the lithic fabric fluorescence in the 365 nm WRGS samples

exhibit an orange hue similar to a majority of the artefactual samples from that Hat Creek Survey.

Figure 2-8: Batch 1 of artifact samples under 254 nm ultraviolet light treatment

Figure 2-9: Batch 1 of artifact samples under 365 nm ultraviolet light treatment

Quantitative Analysis

To reduce subjectivity in interpretation, this study also quantifies the output of the fluorescence RGB of images obtained from the VSC using the non-proprietary ImageJ photo analytical software**.** ImageJ is a Java open-source photo analytical software produced by the National Institute of Heath for the analysis of cellular fluorescence in microscopic samples (https://imagej.nih.gov/ij/). The strength of ImageJ is those additional tools and plugins can be written in JavaScript for specific types of photo/pixel analysis. Fortunately, this study was able to utilize the suite of applications already designed for simple RGB/pixel studies, specifically, the "Analyze > Histogram" and the "Plugin > Analyze > RGB Measure" tools provided in the default version of ImageJ. RGB consist of values from 0 – 255 for each hue (Red, Green, and Blue) that make up the specific pixel to form a larger picture. Using these data through the Image-J software's Analyze/Measure RGB, the user specifies the size of a square sample frame in pixels and then utilizes the 'Plugins' menu, the 'Analyze' sub-menu and selects "Analyze RGB'. For this study, a consistent sample frame of 64 x64 pixels, that is, 4096 pixels, was used. In addition, the ImageJ histogram function allows for quick visual and basic statistical analysis of the RGB pixel values within the sample frame. The "Analyze RGB" java-script tool collected and averages R, G, B, and grey luminance values from the sample frame into an output that can be exported to an xml document. Two principal components analysis of the averages of the R, G, and B for all samples under each

ultraviolet light treatment was performed to reduce the output data from 3 attributes to 2 attributes.

Principal Components Analysis Results

Principal Components Analysis was performed on the R, G, and B sample averages from each selection box of 4096 px. This means that all the 0-255 R, G, and B values were collected during the RGB analysis function, and averaged together to produce a normal distribution of the values of each pixel (See Appendix B). PCA was performed to discover the greatest amount of explained variance for each sample. During this process, R and G were discovered to have a majority of influence on the total variance of each sample in the respective groups (WRGS 254, ART 254, KRF 254, and WRGS 365, KRF 365, and ART 365). Therefore, B values were then excluded due to the low amount of potential influence that they had on each sample group. Notably, R seems to still hold a majority of influence over G in each PCA plot. After PCA processing through XLSTAT, a visual scatter plot was constructed to show groupings of similarly influenced samples. For this study, F1 represents the influence of the R values on the samples, and F2 represents the influence of the G values on the samples. Ellipses have been placed over significant groupings.

254 nm Ultraviolet Results

Principle Components 1 (Red) and 2 (Green) together explains 97.34% of the variance seen in the RGB values for the KRF, WRGS, and ART samples. Specifically, PC 1 explains 73.09% of the variance and PC 2 explains 24.26% of variance. Specifically, Factor 1 represents 73.09% and Factor 2 represents 24.26% of variance. The principal components analysis (Figure 2-10) of 365 nm ultraviolet light treatment on KRF, WRGS, and the ART samples represent two visually significant groupings. The WRGS grouping along the center of the Factor 1 and 2 axes also represents ART samples 1, 13, 15, and 16. Additionally, there is a smaller tight cluster of ART samples 7, 10, 11, 14 near the center of the F1 axis. Many of the ART observations vary significantly from the KRF samples, and represent a smaller cluster along the negative F1 axis. However, no artifact samples in this analysis fall within the larger KRF samples (Figure 2-10).

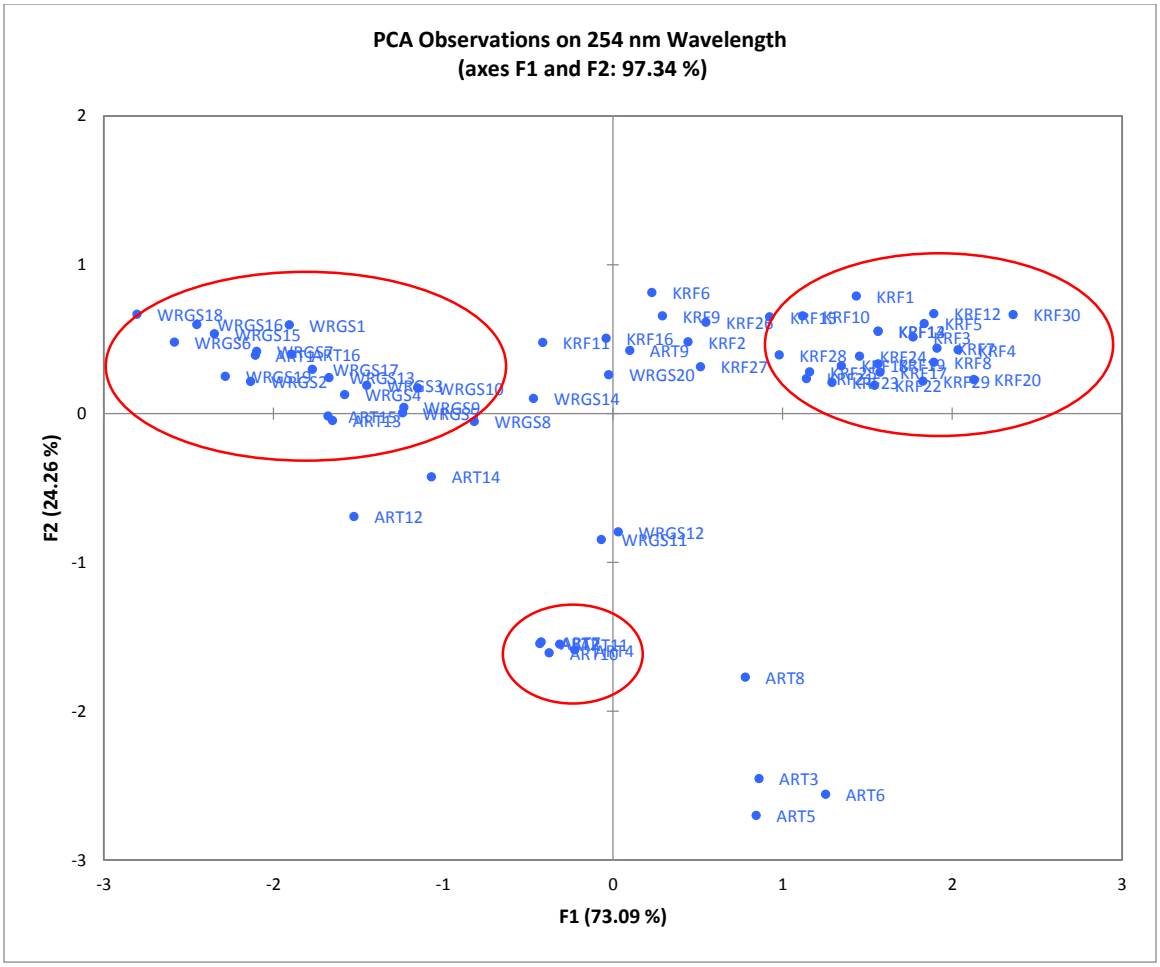

Figure 2-10: PCA Observations on 254 nm Wavelengths

365 nm Ultraviolet Results

PC 1 (Red) and PC2 2 (Green) together explain 99.65% of the variation seen in the average RGB values captured from the KRF, WRGS, and ART samples. Specifically, Factor 1 represents 61.07% and Factor 2 represents 38.58% of variance. The principal components analysis (Figure 12) of 365 nm ultraviolet light treatment on KRF, WRGS, and the ART samples represent two visually significant groupings. The WRGS grouping along the center of the Factor 1 and 2 axes also represents ART samples 1, 4, 13, 14, 15, and 16 (Figure 2-11). The KRF grouping, along the positive axes of Factor 1 and Factor 2

is represented by a tight clustering indicating a high level of similarity and low variability of the KRF sample observations. The ART samples do not lend themselves to clustering aside from what was included in the WRGS grouping.

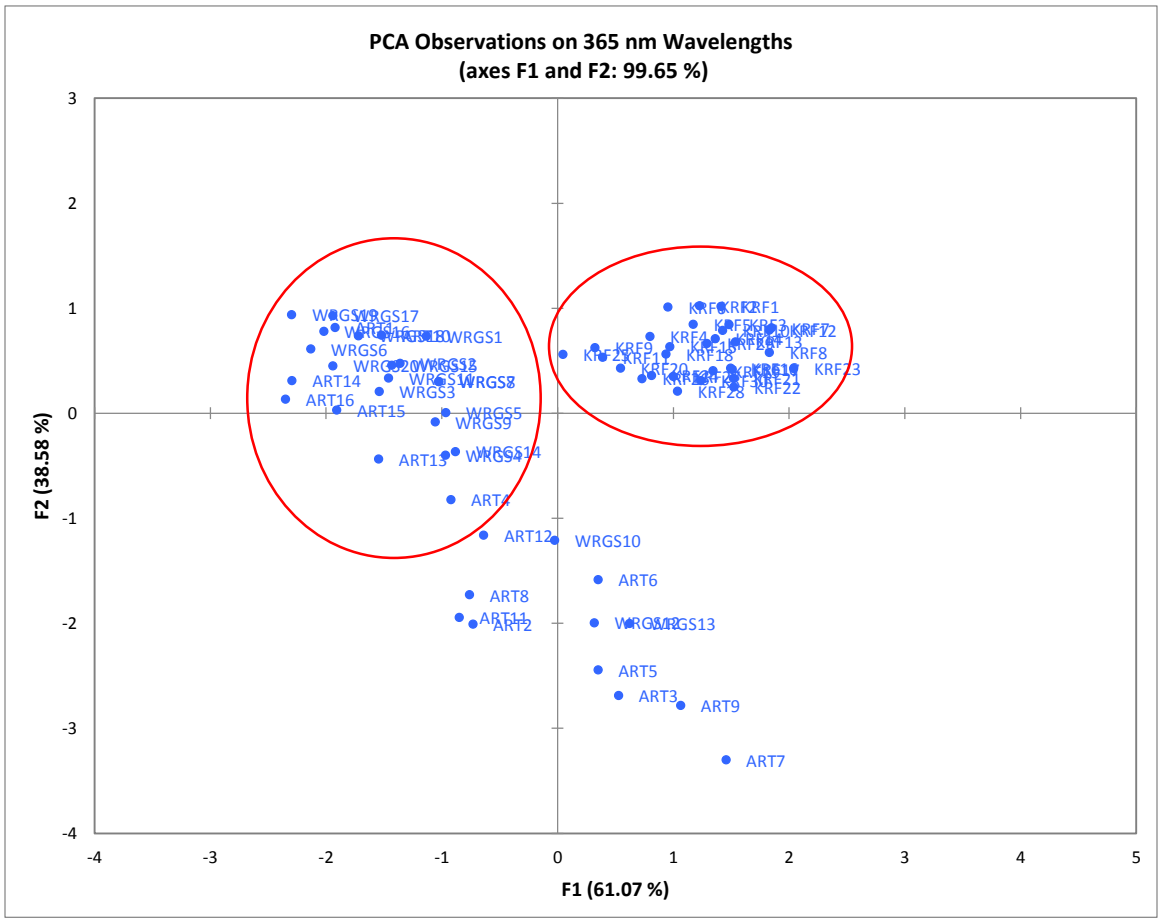

Figure 2-1: PCA Observations on 365 nm Wavelengths

Discussion:

In this study, notable similarities and differences between all samples of KRF, WRGS, and the selected artifacts were observed. The KRF samples, for all intents and

purposes, were identical in the visual and ImageJ analysis. WRGS on the other hand showed variance based on where sample specimens were from. In the VSC photos under 254 nm, the NSHS samples from the West Horse Creek quarries fluoresced a much brighter green than the samples utilized from the HMERC from the West Horse Creek Quarries. Additionally, under 365 nm treatment the samples from NSHS fluoresced orange, while the fluorescence of the HMERC samples either reflected (null) or exhibited a very dark green hue.

The artifact samples that were acquired from the Agenbroad collection were documented to be collected in the drainages just north of Hudson-Meng within the Oglala National Grasslands and in relatively close proximity to the HMERC. These ART samples may represent an extended period of time for the exposed fabric of the knapped lithic to acquire a natural patination. It is notable that a majority of the artifacts sampled exhibited an orange to a darker orange hue during the 254 nm treatments and 365 nm ultraviolet treatments respectfully. Visual comparisons between the 365 nm artifact samples and the 365 nm WRGS samples would potentially conclude that due to the patination that is present, these artifacts would be from the same or similar source of West Horse Creek in southwestern South Dakota. This, combined with the knowledge of the patination that would likely be present on the exposed fabric of the WRGS from the NSHS collections, it is likely that the artefactual samples which exhibited the orange hue would be sourced to the West Horse Creek quarries. It also should be noted that the selection frame of 64x64 in ImageJ was centered on the artifact, so a majority of the orange hues exhibited on the feathered edges of the WRGS samples under 365 nm were not sampled. In future analysis, it is important to obtain lithic materials that show

exposed lithic fabric as well as to maintain a natural patination. The 254 nm treatments on both samples differ from a very light green hue on the WRGS treatments and a brighter orange hue on the artifact treatments. There is also something to be said about the similarity between the artifact fluorescence hues and the orange cortex fluorescence hues of the KRF samples at the 254 nm and 365 nm treatment levels. Both the KRF cortex and artifact fluorescence resemble one another, but it is important to note that the cortex fluorescence values represent a much thicker patination than the artifacts.

The Principal Components analyses resulted in specific groupings of KRF and WRGS in both the 365 nm and 254 nm wavelength treatments. In the 365 nm PCA, the KRF samples represented a tightly clustered grouping of samples that did not include any of the WRGS samples or ART samples (Figure 2-11). This pattern was also seen in the 254 nm PCA analysis, but the grouping of the KRF samples were not as tight as in the 365 nm PCA. The WRGS samples in both the 365 nm and 254 nm PCA are not part of tight clusters as seen for KRF samples, however, they show distinct clustering. Notably, between the two analyses ART samples 1, 13, 15, and 16 share the cluster group with the WRGS samples. This observation lends evidence to support sourcing of these materials to the WRGS group. The ART samples, many of which were visually distinct in visual observations during the 254 nm and 365 nm treatments, resulted in a scattered plot in PCA. The ART samples in the 254 nm PCA were much more variable than in the 365 nm PCA, however this was not unexpected due to the visual observations (Figure 2-10).

Interestingly, the unexpected variable of glossy patination of the lithic fabrics and the fluorescent differences was found to be extremely valuable for future examination of ultraviolet treatments on lithic materials. There were significant visual differences in the

fluorescence between the unpatinated WRGS lithic fabric and the patinated in both 254 nm and 365 nm treatments. The KRF samples, being knapped to expose fresh edges in preparation for VSC ultraviolet treatment, exhibited no obvious visual differences except from small areas of noticeable inclusions in either the 365 nm or the 254 nm treatments. The artifacts that exhibited an orange hue in both the 365 nm and the 254 nm treatments were all exposed to natural weathering and patination likely owed to their exposure on the surface rather than an excavation through multiple cycles of exposure (Purdy and Clark 1987).

Conclusion:

This study demonstrates the utility of the VSC 6000 in capturing consistent images of lithic material subjected to ultraviolet with specific wavelengths, Qualitative visual analysis is possible using the digital images produced by the VSC 6000 by creating a reference for the representation of different lithic materials under multiple ultraviolet light treatments. It is may be possible to utilize the photographs of lithic materials as a legend or tool while utilizing more cost efficient means of handheld geologic ultraviolet lights to conduct field testing of lithic materials. The utilization of ImageJ's 'Analyze RGB' JavaScript plugin feature allowed me to derive average RGB values for sampled portion of each image. Subsequent principal component analyses of the RGB values resulted in distinct groupings of KRF and WRGS, with the addition of ART samples 1, 13, 15, and 16 within the WRGS clustered grouping. The inclusion of additional samples of source materials KRF and WRGS to further refine a confident range of KRF and

WRGS groupings would be useful in expanding studies of this sourcing technique. Future studies involving the use of ImageJ to statistically examine color and hue, especially after discovering the variability that natural patination and cortex exhibit, are proposed to be utilized in the future analysis of ultraviolet fluorescence of lithic material. The variation seen in patination of the WRGS and the relatively consistent patination of the artifact sample raises important questions for future study. Is there regional variation in the patination or natural weathering processes? Does patination vary by lithic fabrics found in similar regions? Does the patination of manuport lithic materials present differently under ultraviolet light treatments?

While the evidence of the similarity between 365 nm WRGS and 365 nm artifact samples tentatively supports the conclusion that the ART samples 1, 13, 15, and 16 from the Agenbroad collection can be sourced to the WRGS outcroppings in South Dakota, more analysis is needed with greater control on sample acquisition. Controlling for the variable of patination in samples is the next most important step in the process of developing a non-destructive, non-invasive, lithic sourcing technique. The case-study of the Alberta projectile point lithic source found at the Hudson-Meng are not addressed directly by this study, but through refining methodologies on acquisition and analysis techniques, this study takes one step closer to a resolution**.**

CHAPTER 3: COLLABORATIVE PUBLIC OUTREACH AND DIGITAL HERITAGE THROUGH THE UNL/USDA 'ARTIFACT ROADSHOW' INTERACTIVE INTERPRETATION

Introduction:

Public support and involvement plays an extremely important role in archaeological research in the Great Plains. In most cases, archaeologically based research projects completed in the Great Plains take advantage of public funding through federal/state grants are completed on public lands. It follows that then public support of heritage conservation through the study of archaeology is intrinsic to ensure the

continuation of accessible information. This paper explores the fundamental use of interpretive methodology to relate archaeological values to a public audience through events that cater to the exploration of private collections. Specifically, by providing, demonstrating, and allowing the public to be an integral part of archaeological study, we hope to foster positive attitudes about their role in the ongoing discussion of heritage conservation. This paper is about expanding the traditional interpretive theory pioneered by Freeman Tilden and the National Association of Interpretation's methodological standpoint of interpretation. Utilizing these theories and methods as a blueprint for emphasizing archaeological public outreach, this paper explores a more symmetrical viewpoint between serious archaeological study and private collections through the case studies of the 'Artifact Roadshows' hosted in the high plains of Nebraska, Wyoming, and South Dakota. These case studies will highlight the importance of an 'interactive interpretation', where private interests are symmetrical to the research interests of professional archaeologists. Finally, this paper will describe the constant evolution and adaptation of the 'interactive interpretation' methodology as new opportunities arise in the near future.

Differing Perspectives and Meeting Halfway

Professional archaeologists are trained to appreciate, understand, and actively speak on behalf of the protection of archaeological resources for the plethora of stakeholder communities. Many of the most ardent spokespeople for the protection, conservation, and value of heritage resources are typically found in academic settings.

These settings allow for interpretation of the holistic value of these resources to future generations of archaeologists who will likely take a similar view to public involvement in heritage resource management. It is this passion for this resource that is disseminated to students of archaeology, who are active participants in the discussion, but are also a captive audience. During the academic dissemination, students of archaeology learn of heritage resource value as a scientific and humanistic one. Discussions of the legal, ethical, and responsible stewardship will also play out in academic settings that these students of archaeology will carry and defend throughout their professional careers. What then can be said for public knowledge of what we consider "public heritage resources?" How can we as professional stewards/defenders of the past relate 4+ years of academic or practical ethical, legal, and moral arguments of the conservation of the past to our interested public?

We, as archaeologists, are extremely fortunate to work with federal agencies like the National Park Service (NPS), United States Forest Service (USFS), Bureau of Land Management (BLM) and various state or local agencies that practice building the hypothetical bridge between the research and the public through resource interpretation. Freeman Tilden, who laid the framework for resource interpretation, famously quoted through an anonymous ranger's National Park Service manual, wrote, "Through interpretation, understanding; through understanding, appreciation; through appreciation, protection" (Tilden, 1957). Resource interpretation focuses on the dissemination of tangible and intangible archaeological research to the public as well as to make clear the importance of conservation or preservation regarding natural or heritage resources.

Basics of Interpretation

Traditional interpretation, theoretically, provokes personal thought from the intended audience rather than instructing the audience how to think (Larson 2011; Ham 2009; Hughes 2006; Clark 2003). The archaeological record is a unique resource that applies an intangible behavioral explanation to a tangible resource using the scientific method. The tangible resource is easy to identify, it is the artifact, the site, and the natural environment. Archaeologists could classify the latter two 'tangibles' as the context, considered to be intrinsic to the meaning or data that can be derived from the artifact. Through the systematic study of artifacts in context, archaeologists create the intangible resource of information, data, and meaning. It is in the bridging of the established intangible meanings to the tangible artifact that lacks context where interpretive opportunities occur. The National Association for Interpretation (NAI) is a key resource for individuals in federal or state agencies that practice interpretation of these resources for the benefit of the public. Most park rangers have undergone interpretive training that has been outlined by the NAI for the goal of creating interpretive plans or programs and, most importantly, recognizing 'interpretive opportunities'. An interpretive opportunity is defined by the NAI as "a place, time, and experience where interpretation may occur" (National Association of Interpretation, 2007). The interpretation algorithm that has been created by NAI consists of (Kr + Ka) x AT = IO, and is the consistent 'bread and butter' identifying interpretive opportunities. 'Kr' is the "knowledge of the resource" which covers the tangible and intangible aspects of the resource that is or can be presented. 'Ka', arguably the most important aspect of the algorithm for this discussion, is the

"knowledge of the audience." Understanding the audience's personal beliefs through introductory oral questionnaires can entirely change the interpretation of the tangible and intangible aspects of the resource so that the audience can come to their own conclusions through personal experience. 'AT' represents "appropriate time" and is multiplied by the interpreter's knowledge of the audience and resource. This is due to the interpreter's pre-planned interpretive 'stops' on a tour or event.

Overall, the interpretation is as much a value judgement by the park ranger or archaeologist as much as it is an educational technique. Executing a successful interpretive opportunity lies in the ability to relate the information directly to the visitor's experiences or character. "The principle aim of interpretation is not instruction, but provocation" (Tilden, 1957). To make a visitor experience a provocative one, as well as a productive one, the interpreter should be able to convey the intangible experience of archaeological theory or method to provoke personal thought on the tangible subject matter at hand, in this case a projectile point. For example, a visitor who is passionate about hunting may relate more to subsistence practices and hunting practices of a prehistoric population due to an established knowledge of predator/prey behavior that had been instructed to them through their experiences. Establishing a link between a projectile point to an idea of modern hunting and what it may say about animal behavior is an example of a successful interpretive opportunity where a provocative message can be established. In addition, describing the projectile point as potential evidence of a prehistoric hunting locality can lead to a conversation about context, archaeological stewardship, and how professional archaeology can interpret the aforementioned behavior based on specific data recovery and recording methods. Prior to starting an interpretive

message or theme, the park ranger or archaeologist must establish the background and experiences of the intended audience. This method takes practice and flexibility to not only establish an interpretive theme, but create and execute interpretive opportunities that speak to the character of the intended audience based on sometimes a cursory oral questionnaire. Experienced interpreters can construct a theme and create interpretive opportunities for the future based on past audience responses to constructed interpretive opportunities as well as the interpreter's own personal experiences.

Ethical Imperative

A recently published by paper by Dr. Bonnie L. Pitblado discusses the ethical considerations and potential benefits for archaeologist-artifact collector collaboration which compiles 24 significant Clovis sites that were discovered through collecting activities (Pitblado, 2014). Pitblado argues for a cautious approach for the applied application of the Society for American Archaeology's (SAA) ethnical principles, particularly the principle of *Stewardship* (SAA, 1996). We argue for a similar, involved application of the fourth ethical principle of *Public Education and Outreach* which states:

> "Archaeologists should reach out to, and participate in cooperative efforts with others interested in the archaeological record with the aim of improving the preservation, protection, and interpretation of the record. In particular, archaeologists should undertake to: 1) enlist public support for the stewardship of the archaeological record; 2) explain and promote the use of archaeological methods and techniques in understanding human behavior and culture; and 3) communicate archaeological interpretations of the past. Many publics exist for archaeology including students and teachers; Native Americans and other ethnic, religious, and cultural groups who find in the archaeological record important aspects of their cultural heritage; lawmakers and government officials; reporters, journalists, and others involved in the media; and the general public.

> Archaeologists who are unable to undertake public education and outreach directly should encourage and support the efforts of others in these activities."

W.C. McKern had argued himself at the founding of the SSA that professional archaeologists make peace with the reality of private artifact collections and seek to abide by the SSA ethical guidelines to approach and deal with responsible or responsive collectors, which was restated up again by Guthe in 1967 and more recently by Labelle, Schott, Peebles and Pitblado (Labelle 2003: 124-125 McKern 1935: 1-2; Peebles 2014; Schott, Pitblado 2015: 12). The humanistic nature of archaeology as anthropology consistently places researchers as the advocates for furthering the field of anthropology in addition to the subfield of archaeology (Binford 1962). An archaeologist does not become less than an archaeologist once they leave the dig, the lab, or the classroom. The need for a proactive approach to attempt to deal with issues such as site looting or vandalism means that mindful collaboration with these 'responsible or responsive collectors' is part of anthropology. Understanding the motivation or desire to collect, especially from a casual or hobbyist perspective, is what anthropologists are trained to do (Rotenstein 1997; Sawaged 1999).

While there are ethical and practical considerations involved in removing an artifact from its context, it is believed that by engaging the responsible or responsive public in a planned interpretive setting is quite possibly one of the best ways to protect these resources, according to interpretive methodology and studies in community archaeology. (Hughes et. al. 2009; Reid 2011: 18) The casual artifact collector or local rancher is interested in the unusual artifact and typically is willing to share the artifact

with professional archaeologists. This is would be not unlike receiving a visitor with a question about an artifact in their possession.

These are the situations where interpretive opportunities may occur to both entertain the participant and provoke thought about the archaeological record as a resource that tells about human behavior, or most importantly, a resource worth conserving. This alone, the opportunity to directly make a convincing argument for the conservation of the archaeological story, is furthering the ethical imperative of archaeology. More importantly, it is an opportunity to engage with the interested public that is outside the realm of academic instruction. The "Archaeologist as Storyteller" argument does not center itself just around publications that are intended for public consumption (Young, 2003).

When these types of participants are interested and value heritage resources they will most likely opt to protect it which may sometimes results in allowing for the public display of heritage resources (Cox 2015; Shott 2008). Bridging the gap between the participant and the professional archaeologist has largely been spearheaded by the participant themselves in this scenario. The participant with the small collection demonstrates their interest by seeking out the accessible professionals who may have some insight. This is not to say that archaeologists in professional settings do not reach out to the community stakeholders or provide intuitive or successful public outreach events. On the contrary, there are many accessible public outreach events that reach a wide audience to promote collaborative archaeology. However, it is the goal of the 'Artifact Roadshow' initiative to provide a space where the publicly minded archaeologist and the local participants foster greater interest and understanding of what

makes the archaeological record special. Specifically, fostering an understanding of mutual goals through the direct involvement of public participants with their collection and adding previously unknown knowledge to a citizen science based digital archive (Douglass et. al. 2015). It is the hope that professional archaeologists can return this favor by initiating more opportunities for collaboration and interpretation by hosting events that cater to this demographic. This type of reciprocal relationship can help us, as archaeologists, better understand what the public desires to understand about our shared human past.

While there are immense benefits for traditional interpretation in classic settings (National Monuments, National Parks, or Museums) due to the controlled nature of the collections or features. It is also important for the interpretative method to adapt to changing conditions or collections. The fundamental difference between traditional interpretation and the type of 'interactive interpretation' experimented with at the 'Artifact Roadshows' is that the intended audience is also an important interpretive tool. Furthermore, the intended audience is also included to contribute archaeological information, in the forms of private collections, oral histories of collections, or potential site locations to the visiting professional researcher. This is done symmetrically with the professional researcher, also an interpretive tool, to provide relevant information to the nature of the private collections based on the participant's general interests, not unlike the traditional interpretive method's 'knowledge of the audience'. This, in turn is aimed to provide symmetrical benefits to both the private and the professional in terms of archaeological data or interpreted history.

This type of ‘interactive interpretation’ would thus identify their intended audience for inclusion as a functional part of the public outreach event as well as a functional part of the professional research being performed. Furthermore, prior to the identification of these motivated individuals, the adaptation of a form of the interpretive method to provide a measure of inclusive interaction between professional and private must be created to suit the specific needs of both parties. During the ‘Artifact Roadshows’, interpretive opportunities included the introductory oral questionnaire, discussion of the artifact(s) in question, photogrammetry or 3-dimensional scanning, tours of the facility where the event is hosted, and exit interviews. During this time, based on the knowledge of the resource and audience, discussions of stewardship, archaeological values and ethics, data or site recordation, or avocation of citizen science roles in archaeology as interpretive themes were practiced.

In order to perform this type of educational experience for the benefit of the public, the Nebraska National Forests & Grasslands (NNF&G) and the University of Nebraska-Lincoln (UNL) teamed up to initiate public involvement through a series of events “Artifact Roadshows”, hosted at multiple public arenas (The Hudson-Meng Education and Research Center, The National Grasslands Visitor Center, and The Vore Buffalo Jump).

The ‘Artifact Roadshows’

This project was initially born out of a need for more inclusive data in states that do not contain large percentages of state or federally owned land. The inclusion of Wyoming and South Dakota, both states with substantially more federal land, was a regional choice based on archaeological similarities. Due to the majority of land in Nebraska under the ownership of private landowners, it is important to discover what lies beyond the federal and state land. In an attempt to further the research and education benefits that the archaeological record of Nebraska or surrounding private land holds, this public outreach event is designed to include private landowners to share in the discovery and education of their own land. Labelle has also commented on the greater region of the Great Plains by discussing the extraordinary record that can be found by intensive surface survey, this he argues is what creates the Great Plains as a "haven for collecting" (Labelle 2003: 116-118). This project is a continuous and ever-evolving process in which responsible relationships with private collections are not simply done overnight, but done over repeated mutual understanding and trustful interactions. From 2013-2015, these Artifact Roadshows encountered many of the same questions regarding the issue of private land and the ownership of the artifacts found there. There is a great misunderstanding of who the stewards of the archaeological record are, and how there are so many artifacts in museums, public displays, or university storage facilities (Molyneaux and Stone 2011). Many private landowners, who collect occasionally when working on their land with cattle or crops, are fearful of the archaeologists finding an important archaeological site on their property which would lead to the confiscation of their land, the artifacts on them, and part of their livelihood. In some cases the build-up to trust between the professional and the private of revealing a location or source of the artifacts

had taken three separate Artifact Roadshows in which the same participant returned. It is evident now that a new goal to build trusting, responsible, and responsive relationships between collectors/private landowners and the professional archaeologists is as or more important than discovering the disparity of artifacts between private and federal lands.

Seven separate Artifact Roadshows, hosted by the NNF&G and the Vore Buffalo Jump, were held during the summers of 2013 – 2015 that were received with good attendance (15-20 people with artifacts per event). Due to the unprecedented community involvement which lead to the success of the programs in 2013, the University of Nebraska-Lincoln was invited to participate in the outreach and education program during the summer of 2014. The University of Nebraska-Lincoln featured the application of digital recordation using a 3-dimensional laser scanner, plan view photographs, and advanced photogrammetry techniques with portable equipment. The use of photogrammetry and three-dimensional scanning technologies were utilized in conjunction with the public outreach interpretation initiative. A plan for the dissemination of three-dimensional, scaled artifacts to be accessed and utilized by the professional audience through digital archives was put forth in the 2014-2105 'Artifact Roadshows'. Furthermore, the digital archive will be accessible for members of the public to showcase collaborative citizen science efforts.

The mission of the Artifact Roadshows is to establish cooperative working relationships with private landowners for conservation initiatives. Interpretive methods that were designed and facilitated by the Hudson-Meng staff following the NAI

guidelines that were adapted to include the SAA code of ethics and USFS conservation mission goals (Morgan et. al. 2011; USFS 2014). Specifically, by emphasizing the importance of context in identification of artifacts, the interpretation of archaeological resources was careful to avoid the process of authentication. Because the process of interpretation is a process by which the interpreter guides and adapts to the participant's own interests or values, it is difficult to outline the methodology. It is important to remember that interpretation is not equivalent to a lecture, a peer-reviewed paper, or cold, hard data. For the publicly-minded archaeologist, it looks more akin to a discussion section or potentially a plot hook in a novel based on the reality of evidence. A good interpretive session is consistent expression of the interpreter's (in this case, the archaeologist's) passion for the resource and a somewhat 'secret argument' of why the visitor should be passionate about the resource as well.

What Constitutes Success?

As mentioned above, the object of the 'Artifact Roadshow' is to create a safe space for participants and professionals to interact. The participants are invited to bring personal collections in which the professional would evaluate and discuss potential research value that would be gained through collection documentation. The participant's motivation, or intended motivation based on the press release information, is to find out additional information about their collection. This further increases the capability of the participant to absorb the information about the collection, and thus would increase the possible information that would be disseminated by the participant about their particular

collection. The motivation for the professional would be the documentation of the participant's collections, as well as the dissemination of the ethical imperative concerning the importance of context in the archaeological record. Furthermore, based on the interest of responsible and responsive collectors, a symmetrical relationship to assist the conservation of the archaeological record can be achieved. A successful interaction is one where the participant and professional both deem that something of value was gained by documenting and discussing the collection. Thus, a successful roadshow includes the participant's willingness to participate in a responsible conservation of archaeological values. This can take the form of repeated visits to various roadshows with existing collections, invitations for professional archaeologists to examine potential heritage resources on private land, or developing an avocational network that supports the citizen science initiative. Besides the participant/professional interactions, this has been a publicly visible event that allows visitors without artifacts to view the collections and participate by asking both the participants and professionals questions pertaining to the nature of the event, archaeologists, or the private collections themselves. This constitutes a successful event through familiarity with the type of interpretive experience through the continuation of multiple roadshows. The idea for a greater, and more inclusive interaction with both visitors and participants in a public location discussing the benefits and insights that professional archaeologists have on the archeological record may also lead to a decline in systematic looting of private or public land. Through approaching the subject of conservation and public/private land rights of heritage resources, there is a great desire for participants or visitors to understand the need for the decline in systematic looting. If professionals receive calls from private landowners or the general public about

looting/vandalism of heritage sites, then the ‘interactive interpretation’ event can also be considered influential.

During the 2013-2015 seasons of the “Artifact Roadshow” events, there was a noticeable increase in the participation from the public for each sequential event. During this initial roadshow, the focus of the entire event was to gauge interest of the private landowners surrounding the Oglala National Grasslands about the frequency or potential for private artifact collections. Beyond the normal visitation rate to the HMERC, which averaged around 20-25 visitors, approximately eight individuals participated by bringing personal collections of artifacts or singular pieces that were interpreted by the team of park rangers and archaeologists. The participants were invited into the classroom of the HMERC, which is away from normal visitation areas, where the artifacts were examined and discussed with the participants. Depending on the size of the collection, the discussion and examination periods could be prolonged 1-2 hours each. The event was set up like a traditional interpretation tour that focused on creating an atmosphere of familiarity as well as a strong conservation message that was delivered by the interpretive staff. No pictures were taken at this time, but personal contact information from the participants to the USFS heritage resource staff was exchanged.

The second “Artifact Roadshow” which coincided with the 24th annual Knap-In at the HMERC, brought nearly 150 visitors per day and approximately 12 participants with personal collections. These were also interpreted by park rangers, professional archaeologists, and the visiting flint knapping demonstrators. Among these participants, there were several individuals that were also present at the first “Artifact Roadshow” a

few months earlier. Because of the nature of the HMERC Knap-In event, the participants were moved from the solidarity of the HMERC classroom, and into or around the main visitation areas of the visitor center. This was a conscious effort due to the predicted amount of visitors that frequent the Knap-In, as well as the objective to publicly advertise the conservation goals of the 'Artifact Roadshow'. This roadshow included some of the previous participants, with some who invited friends or family, who brought in the same artifact collections to have them interpreted by the staff of the HMERC and the professional archaeologists of the NNF&G. A major success of this roadshow hinged on the fact that these previous participants of the first 'Artifact Roadshow' brought additional information attached to the previous collections of their context or general locality. Again, this interpretive event garnered public participation and interest about the methods archaeologists utilize to conserve the archaeological record.

2014 marked the inauguration of the University of Nebraska-Lincoln's participation with digital recordation and curation techniques. At the first 'Artifact Roadshow of the 2014 season, approximately 15 participants brought in personal collections to be digitally recorded by the UNL team of archaeologists. The professionals and graduate students at the 2014 Artifact Roadshow events utilized a 3-dimensional scanner, photogrammetry equipment, and a high quality camera to digitally photograph and record the private collections. With the exception of some repeat participants, a wider range of new participants was garnered due to the increased press release ranges in Scottsbluff, NE and Rapid City, SD. Again, creating the open and publicly visible space

for the discussion and examination of the private collections piqued a tremendous amount of interest by visitors who wished to see the digital recordation process of large amounts of private collections. The participants were also included in the methods of photogrammetry and 3-dimensional laser scanning by choosing the artifacts that would undergo special treatments of digital documentation. These files were then processed and transformed into 3d PDF files to be distributed to the participants as a gift for allowing professionals to discuss the importance of the recordation process. The second "Artifact Roadshow" in 2014 brought approximately 15 participants, many of which were returning visitors from the previous events, along with 125 regular visitors to the HMERC. As with the first 2014 'Artifact Roadshow', a team of professional archaeologists from the NNF&G, HMERC park rangers, and the UNL digital documentation teams were integral to the development of the 'interactive interpretive' method that was being tested. During this event, multiple private landowners were responsive to the idea of archaeological survey or site examination on their land, now knowing the private landowner rights regarding heritage resources. The idea of creating a citizen science initiative, due to the popularity and response of the four events thus far, was developed as a way to include participants and their collections to be representative of the 'missing data' of the archaeological record on private lands.

The 2015 season saw a dramatic increase in the quantity of visitors which is most likely due to the experience from the 2013-2013 seasons, as well as the inclusion of the National Grasslands Visitor Center in Wall, South Dakota (NGVC) and the Vore Buffalo Jump in Beulah, Wyoming as event locations. The 2015 season saw three 'Artifact Roadshows' in total. Being so centrally located along Interstate 90 for both the NGVC

and the Vore Buffalo Jump ‘Artifact Roadshows’, the quantity of visitors without artifacts greatly outnumbered the participants with artifacts. Additionally, due to the predicted increases in community response over the past two seasons, scheduled visits of visitors with larger collections were necessary. This event still featured the team of UNL archaeologists and the archaeological field school, NNF&G park rangers and professional archaeologists, as well as the interpretive staff at the Vore Buffalo Jump. Photogrammetry and 3-Dimensional scanning were utilized as before to be interpretive as well as functional documentation tools. Digital photography was greatly enhanced with the addition of multiple field school students and an assembly line process to gather large amounts of photographs in a limited time. The photography set up was done with a bed of homogenous salt and a scale bar to expedite the processes to crop the artifacts into files that could be easily displayed on a website digital archive. These roadshows dwarfed the previous 2013-2014 seasons with the amount of participants whom invited professional archaeologists to site locations on their private land. Additionally, an experimental facet of the interpretive experience was the documentation of oral histories from invited landowners to discuss the acquisition of artifacts on their land, growing up on and around the National Grasslands, among other living history topics.

Reflections on ‘Artifact Roadshows’ as Ethical Interpretation

During the course of these seven events, approximately 350 artifacts were individually photographed and described for the purposes of the stewardship and conservation theme as well as to create a better spatial understanding of where artifacts

are located outside of public land. Approximately 90 individual artifacts were documented using photogrammetry, with special reference to larger artifacts from personal collections. Large bifaces, *manos y metates*, and unique or interesting artifacts were the subject of photogrammetry. Approximately 20 artifacts of special note were 3D laser scanned for further documentation, with special preference to projectile points that displayed a high amount of craftsmanship. Overall, from an interpretive experience perspective, the results "Artifact Roadshows" were a success. Because the interpretive plans were two-fold between the general visitors that do not own any private collections and the participants who did own private collections, both USFS personnel and professional archaeologists could work independently to create a dual atmosphere of excitement and an exhibit technique that is reminiscent of open excavations. The interpretive opportunities with the participants as well as the general public created a large amount of discussion and interest regarding stewardship, responsible collecting and recording contextual information, and how the participants or public can help with the archaeological science by opening up a list of potential contacts with professional archaeologists. Most importantly, it allowed for productive discussions about the USFS and academic institution's role in the conservation of archaeology as a resource for future generations. Visitors and participants seemed to respond to the methodology of photogrammetry and 3D laser scanning with piqued interest. In addition, these methodologies made great interpretive exhibits and stations for the park rangers to 'pass the buck' from personal interpretation to a collaborative interpretation with professional archaeologists. More importantly, however, the execution of a relaxed and informative atmosphere created by the visiting scholars and USFS personnel was apparent in the

willingness and openness of many participants to discuss the collections, regulations, ethics, and future collaboration.

The issue of trust concerning the fate of archaeological resources on private land was a major concern and driving factor for the implementation of researcher-led public outreach (McManamon 1999). The federal/public interface is a driving motivator when considering hosting a public event that aims to discuss and discover how the public interacts with federal conservation issues, laws, and regulations concerning archaeological resources (Gerstenblith 2013; McManamon and Hatton 1991). There was no doubt during these events that issues of private land ownership over cultural resources and why both state and federal employees would be interested. During these conversations, it was important for the archaeologist to discuss the importance of physical cultural heritage as a resource that can benefit both the land owner, as well as the general public by participating in events like the Artifact Roadshow. The goal was to ensure that the participant was comfortable discussing the collections fully knowing the high regard for land owner permission to perform archaeological research on private land. This goal was judged on the participant's openness or willingness to return and collaborate with federal or state entities regarding cultural heritage resources. Overall, this goal of establishing trusting relationships was achieved with great success. Participants were generally open about the idea of context playing an important role in archaeological research, enthusiastic about participating in events like these, and in some cases, open to the idea of archaeological research being performed on their land.

Archaeological ethics and USFS policy, especially regarding private collections, were considered at every step of the process in creating and hosting the event. The SAA's

Principles of Archaeological Ethics specifically state that archaeologists should avoid enhancing or participating in the commercialization of archaeological objects. This principle also states that there should be considerable care when participating in activities that involve archaeological materials that are not professionally curated, readily available for scientific study, or available public interpretation and display (SAA 1995). The "Artifact Roadshow" was created as an event that was focused on disseminating values of conservation and archaeological stewardship through a publicly viewable event (Childs 2015). This dissemination was performed through professional interpretive methods and specifically avoided discussions of monetary value or authenticity of particular artifacts. In addition, the adaptation of a digital archive hosted on the Center for Great Plains Studies at the University of Nebraska Lincoln which is designed for the public display and professional reference of a plethora of Artifact Roadshow data will hopefully allow the validation of private collections for the consideration of archaeological research (Hittner, Douglass 2016; Douglass et. al.). The vast majority of participants were private landowners who owned few artifacts, but were enthusiastic when ideas of these materials as a resource to understand the history of their land were discussed. This was the target demographic for the outreach event, specifically the private landowners who wished to learn about the interesting objects that were found on their land. Many of these landowners are considered 'neighbors' to USFS owned land, and the event helped spark discussion about what could be understood about the places that are not publicly owned and readily available for academic research. Another demographic that was encountered was the 'casual collector', whom were actively interested, well-read, and enthusiastic individuals who wished to assist in archaeological research, but lack the understanding or

the tools that a professional archaeologist has. These participants were open to ideas of contextual information being of prime importance to archaeological research, and some actively sought to replicate proper recordation of materials using zip-lock bags and post-it notes with locational information. The third demographic encountered can be considered 'active collectors'. During the course of the seven "Artifact Roadshows", only one participant could be considered in this group, and the interpreters in charge treaded lightly in discussing particular aspects of archaeological research and stewardship. While it is unfortunate that this demographic exists, it is important to consider the ethical imperatives of the SAA and the USFS conservation messages (Whittaker and Stafford 2011; Goebel 2015; Watkins 2015).

Discussion & Future Directions

The 2013 Artifact Roadshows laid the groundwork for the establishment of an integrated and cooperative agreement with the University of Nebraska-Lincoln for the 2014-2015 Artifact Roadshows. To comment on the 2014 Artifact Roadshows, a small discussion of the unexpected response of the 2013 Artifact Roadshows must be established. A rough framework of methods and goals of the first Artifact Roadshow was communicated to the interpretive rangers, expecting little actual public interest. An unexpected number of participants and interested public arrived during the three-day event which only highlighted the need for a second Artifact Roadshow to occur over Labor Day weekend. During this Artifact Roadshow, archaeological technicians from the Black Hills National Forest offered their experience to conduct the potential identification and discourse with visitors. The need and opportunity of this type of event

was proposed to the University of Nebraska-Lincoln and in the summer of 2014, in which two additional Artifact Roadshows at the HMERC were conducted. Using photogrammetry and three-dimensional scanning, a trial run of participant/archaeologist collaboration was conducted. It was found that photogrammetry was much more suited for the type of public outreach, due to the demonstrative process and quick product that it can produce. Most visitors had one or two artifacts that they were interested in, so the quick turnaround and demonstration was well suited to the attention that the visitors had established early on. Three-dimensional scanning was not well suited due to the length of time that it requires to produce a single scan. There was limited success with the few visitors that produced substantial collections who were interested in spending an equally substantial amount of time discussing the subjects of stewardship and archaeological interpretations.

The NNF&G is fortunate to manage the HMERC and the NVGC which were created for the benefit and enjoyment of the American people. The ‘Artifact Roadshows’ no doubt prompted many participants and visitors to think critically about how they can play roles in the conservation of heritage resources based on the overwhelming visitor response. Participating archaeologists that work in the Great Plains region are continuing to gain insight to archaeological resource distribution located on private land. More importantly, this event allowed professional archaeologists and the interested public to interact in a controlled and safe environment that is created for the benefit of both parties. Moving forward, it is important to discuss and revise techniques used to document collections digitally so that they may be used conduct productive research. While 3D laser scanning proves to be a precise method to document artifacts, it proves to be

extremely time consuming for participants whom do not want to devote that time for documentation. In order to document artifacts with time efficiently and accurately, photogrammetry appears to be the optimal choice to document a variety of artifacts in this type of setting. The addition of high quality scanning of artifacts using a mobile scanner has been tested for future Artifact Roadshow events to expedite the process of documentation as well as create an extremely accessible avenue for responsible collectors to participate in the digital archive. Furthermore, designing a physical platform for the photogrammetric method is currently part of a new method that will utilize the popularity of these events to document artifacts. It is the hope that the photogrammetric approach will be further streamlined as an interpretive tool and an analytical method of documentation.

Additionally, the 2016 season marks the first foray into the 'Traveling Artifact Roadshows' that will be hosted in Wyoming, New Mexico, Oklahoma, Nebraska, and South Dakota. These events will be hosted and sponsored by the various grassland or forest visitor centers or larger museums in the area. Due to the success of the oral history initiative, various interviews will be recorded during these events for the purposes of local documentation and public dissemination. These interviews will focus on historic lifeways as well as personal accounts of the collection of artifacts on private land with perspectives on the archaeological or personal value they hold. Additionally, the digital archive hosted on the Center for Great Plains Studies in Lincoln, Nebraska is data currently nearing a beta testing phase of operation which will be fully functional after the data from the 2016 season is processed and transferred into the archive. Special concerns of data transparency and the masking of specific site locations are at the forefront of the

creation of a publicly accessible digital archive. This database will need to be accessible through varying levels of security regarding these site locations and personal information. However, it is the hope that data gathered from these types of events can be utilized in archaeological research that spans beyond public land and further creates an avenue for the interested public to work cooperatively with public and academic archaeological researchers (Schott 2008).

Conclusion

Archaeology outreach needs to be actively initiating contact and be aware of the many publics of which heritage resources may influence any natural curiosity of the past. Public education and outreach in archaeology seeks to inspire both future and present generations who have not been able to pursue a traditional avenue of archaeological study to become advocates and allies for the resource. In some cases, these publics already have a vested interest in the human past and will work with professional archaeologists to help discover what can be learned from true archaeological research (McManamon, 1991; Molyneaux, 1994; McManamon and Hatton, 1999). However, it is the duty of the archaeologist to initiate productive and ethically based outreach efforts (Peebles, 2014). Performance of archaeological skills and techniques to future avocational archaeologists is the first step in relating the resource's educational value to the public. By digitally documenting these artifacts for the purposes of both analytical research and outreach, the informational value can be shared publicly. The "Artifact Roadshows" are a test and testament of how this may be accomplished for the benefit of the American people and the many publics that exist. The next step is to maintain these relationships through mutual trust and respect for the resource that we both have proven to have a vested

curiosity and passion for. We must meet halfway with responsible and responsive collectors and providing opportunities for mutual collaboration through positive interpretation of the past and the present of archaeology.

CHAPTER 4:

TOWARD THE DEVELOPMENT OF A DIGITAL ARCHIVE: MEETING HALFWAY

Introduction

The development of a digital archive was born out of the "Challenge Cost Share Agreement between USDA/UNL to Create Education Materials about the USDA National Grasslands". Directed by Dr. Matthew Douglass, the educational materials were divided into three distinct applications. First, the development of a digital archive to feature high quality two-dimensional and three-dimensional scans and models of artifacts from United States Forest Service curation and from the public outreach events hosted in

and around USDA National Grasslands. Second, the development of educational and recreational materials based on the 20 National Grasslands throughout the United States. This aspect focuses on the developmental history of the National Grassland, the recreational opportunities within the National Grasslands, the archaeological and ecological aspects of the National Grassland, and the significant restoration or developmental projects that the staff of the National Grassland is implementing. Finally, the development of oral history archives that are collected during and after 'Artifact Roadshow' events featuring generational perspectives of homesteading within the local areas of the National Grasslands. This project is focused on developing a product that provides a promotional and educational perspective to the study of the archaeological record. Additionally, this digital heritage product will strive to provide professional archaeological data from the private collections featured at the USDA/UNL 'Artifact Roadshows'. The development of these initiatives are featured on the grant initiative website "Your United States National Grasslands" hosted on the 'Center for Great Plains Studies' (CGPS) (www.unl.edu/plains/your-united-states-national-grasslands). This paper will specifically focus on the data acquisition and presentation of the digital archives and oral histories.

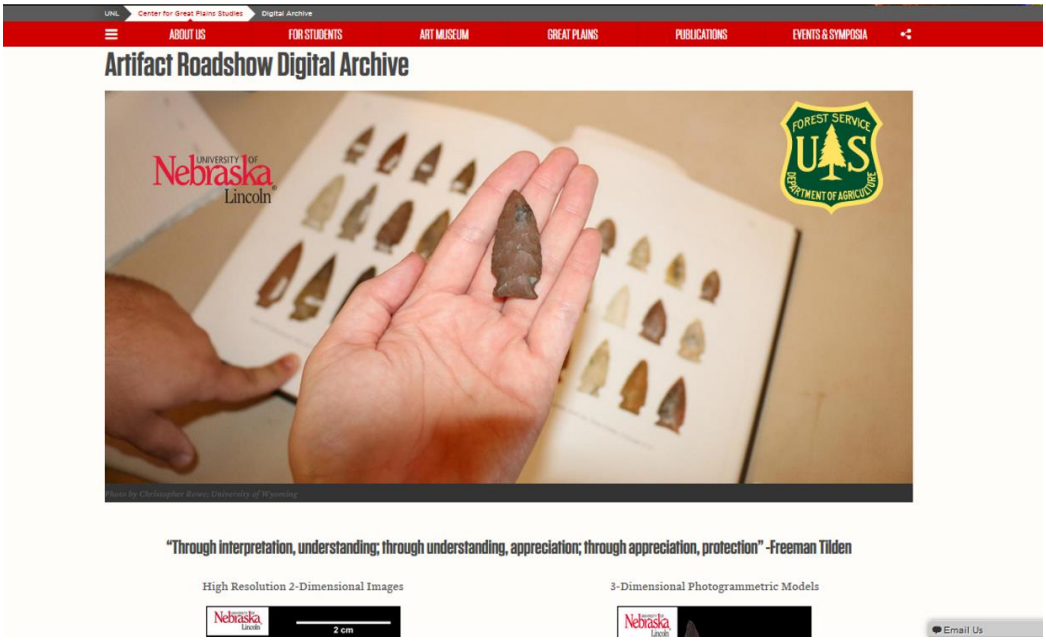

Figure 2: Center for Great Plains Studies Digital Archive Home Page

Description

The integration of the public archaeology initiatives, the 'Artifact Roadshows' are the catalysts for the development of the "Your National Grasslands" web archive. During the summers of 2013-2015, data were acquired from artifact photographs, scans, photogrammetric models, and 3-dimensional scans of artifacts brought in from participants to these events. Additionally, the desire for archaeological data in states with disproportionate amounts of public and private land provides a motivating factor for digitally archiving private collections. Nebraska is especially lacking in sufficient archaeological data from private landholdings partially due to only 1.1% of the total land in Nebraska being held by federal or state entities. With a majority of land in Nebraska being held in private trust, the opportunity for archaeological research done through public grants or federal permits are overwhelmed by the data that potentially exists within

private lands. The public archaeology initiative ‘Artifact Roadshows’ open up the opportunity to explore artifact collections from private landowners. Through a series of interpretive events, private landowners are welcomed with personal collections of artefactual materials to be interpreted and documented by professional archaeologists. Permissions to document these materials for digital curation and subsequent interpretation are granted by the landowners who are credited with discovering the localities where these artifacts once rested. Because the desire for accurate contextual information is important to the scientific interpretation of the archaeological record, data collected from private landowner collections is generalized by county, or USGS quadrangle if applicable, due the inherent inaccuracy of recalled information from memory. The photographed, scanned, or photogrammetric data, from the private landowner is then featured on the ‘Digital Archives’ webpages of the ‘Your National Grasslands’ webpage. Over time, the consolidation of archaeological data derived from the ‘Artifact Roadshow’ events aim to provide a regional sample of artefactual materials for professional archaeologists that access the digital collections.

The Digital Archives

The ‘Your National Grasslands’ digital archives are comprised of two main web archives, ‘3-Dimensional Models’ and ‘2-Dimensional Scans and Photographs’. The ‘3-Dimensional Models’ are captured using a combination of photogrammetry and 3-dimensional laser scanning from the 2014 – 2015 ‘Artifact Roadshows’. Each artifact

featured was selected for 3-diminsional documentation based on the specimen quality and reliability of locational information gathered by the participant. Hosted on Sketchfab, a commercial website dedicated to various 3-dimensional models, each photogrammetric model is then embedded on the webpage utilizing html code provided from Sketchfab. The end-user is then able to access the webpage and stream the web-interface flash player to digitally access the 3-dimensional models and rotate or zoom them using their cursor.

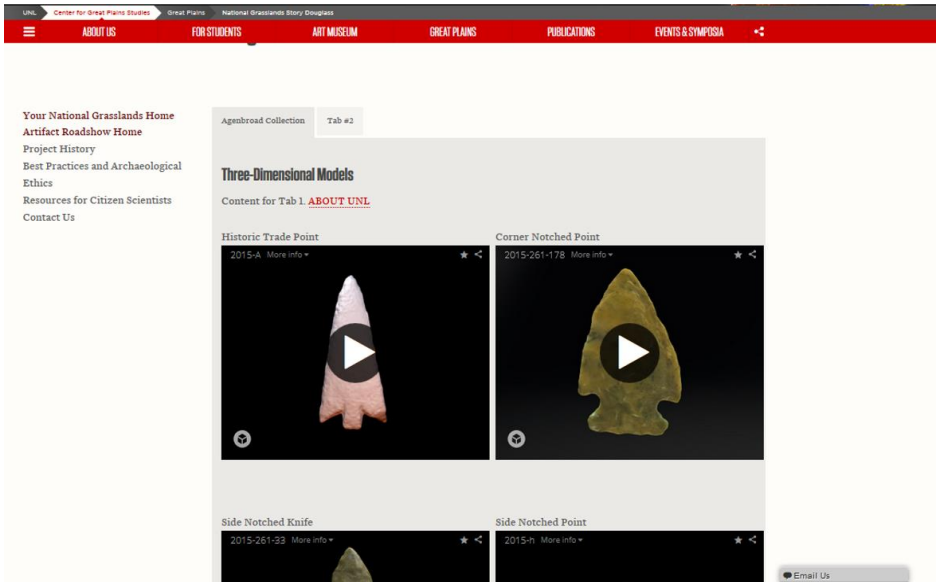

Figure 3: Three Dimensional Digital Archive Web Page

The "2-Dimensional Scans and Photographs" were collected during the 2015 'Artifact Roadshows' utilizing both a table scanner and a 14 megapixel camera. The 2015 photographs were created were placed on a bed of salt with an aligned scale bar and photographed plan-view. These photographs were then corrected for parallax utilizing the open-source GIMP photo manipulation program and batch processed to include a scale bar using ImageJ. The 2015 season also utilized a flatbed scanner which expedited the data collection process as well as eliminated the need for GIMP parallax correction. GIMP was used to rotate, maintain a consistent aspect ratio, and crop the singular artifact

for ImageJ processing. ImageJ was then utilized through batch processing of equivalent aspect ratio .tif files, created by GIMP, to insert a scale bar. Each 2-dimensional scan consists of a dorsal and ventral equivalent and each .tiff file averages 10 megabytes in size. These .tiff files are available for public and professional use by downloading directly through links attached to each image.

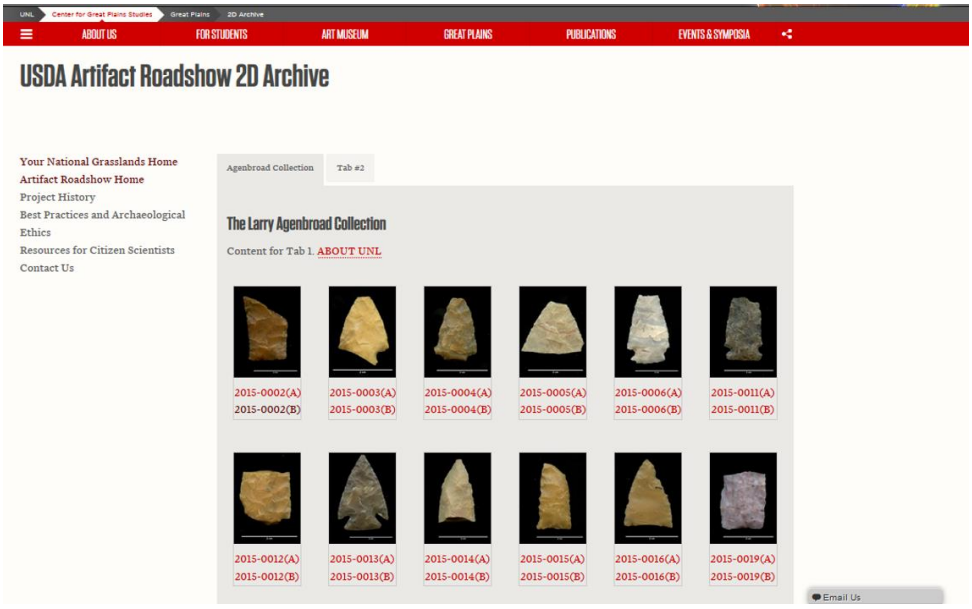

Figure 4: Two Dimensional Digital Archive Web Page

Oral Histories

The 2013 – 2014 'Artifact Roadshows' targeted landowners surrounding the Oglala National Grasslands and aimed to only explore the artefactual materials obtained through private collection on private land. During these seasons, we discovered that one of the most motivating factors for private landowners allowing the USFS and UNL to

observe and document the collections was the desire to obtain some knowledge of the indigenous people who had lived on their land prior to homesteading. This was observed through passing comments and what participants hoped to get out of the 'Artifact Roadshows' and hypothesized through the types of materials that were brought in by these same participants. The selection of only prehistoric lithic artifacts, with the exception of some metal trade points, alludes to the absence of interpretive knowledge held by the private landowners to these artifacts strewn about their property. With this hypothesis in hand, the 2015 'Artifact Roadshows' made an addendum to target individuals, with or without artifact collections, to provide oral histories for the digital archive. Locations for the oral histories in 2015 included the National Grasslands Visitor Center in Wall, South Dakota and the UNL Trailside Museum in Crawford, Nebraska. The oral histories gathered in the 2015 season focus on multi-generational perspectives of living on the Great Plains and include topics such as: Homesteading, the Dust Bowl in South Dakota, working on the National Grasslands as resource managers, and the collection of artifacts. The final topic was asked to each participant in order to gain an insight to the motivation for casual collection so that the educational materials provided on the 'Digital Archive' webpages could be focused and relatable. In 2015, seven oral histories were obtained, transcribed, and edited utilizing the open-source sound editing software Audacity. These audio files were then uploaded to the 'Oral Histories' webpage section of the "Your National Grasslands" website. The 'Oral Histories' website was modeled after the Boulder Oral History Archive and the Wyoming State Historical Society Oral History webpages due to their proximity and their alignment of public outreach. A Google Map with locational information for each oral history was embedded

with each oral history to help the end-user navigate the webpage to find specific oral histories spatially. Additionally, a separate page of metadata summarizing the oral history, the time of the recording, the interviewer/interviewee, and the subject matter is provided and is aimed to be utilized to populate a future search engine or keyword search function.

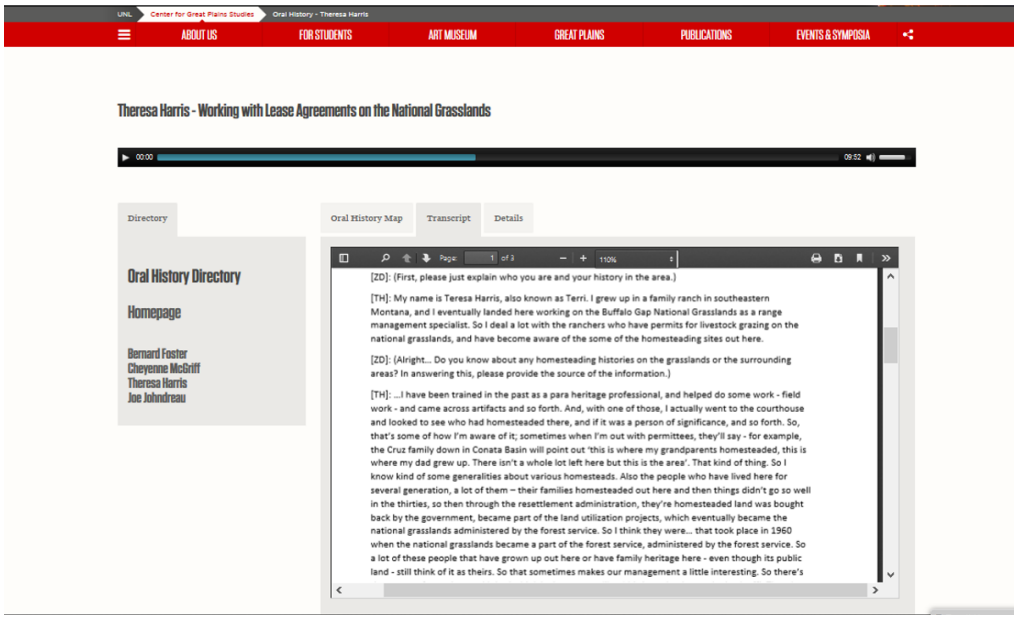

Figure 5: Oral History Digital Archive Webpage

Future Developments and Citizen Science

Both the 'Digital Archive' and the 'Oral Histories' are fully reliant on two main factors for the continuation of webpage function, the participant and the webpage developer. Without either of these two factors, then the webpage and digital archive will absolutely fail. This is why it is exceedingly important to work in direct cooperation with the participants through grassroots public outreach events or within invitations onto

private land for archaeological reconnaissance. Developing a direct end-user input for the recording of pre-existing private collections is an important aspect for the future of data recordation. This direct end-user input would be monitored and reviewed by a heritage resource professional for the quality and honesty of the end-user's data. This aspect provides a platform for motivated participants to move from an interpretive dialogue to a more professional dialogue as the end-user would submit materials for review. The materials would then be either accepted or rejected based on the merits of that particular individual, their prior contributions of pre-existing collections through friends or family, and the physical quality of their data. Much of the 'Digital Archive' webpage is devoted to the practical, ethical, and responsible methodologies of data collection and the archaeological record. While it is important to note that it is explicitly stated that heritage resource professionals should be invited to assist in data collection, it is the reality of some situations where the artifact will be collected disregarding contextual information. It is the belief that by providing a platform where advocates can play a role in the input of data and work directly with professional archaeologists, then there is a greater motivation to conduct data collection methods correctly knowing that there is a review and monitor of this information. There is additional motivating factors for if the data is being utilized in professional, archaeological presentations, manuscripts, theses, or dissertations through specific acknowledgement of the participant. This builds on the foundation of trust, respect, and overall the future of archaeological data recovery. While this webpage and these ideas are still in their infancy at the time of this writing, it is hoped that professional archaeologists and future avocational archaeologists will find common ground by meeting halfway between research and interest.

CHAPTER 5:

CONCLUSION

This thesis contains two regionally related, journal quality articles and the product of a digital heritage and citizen science initiative. The purpose of this thesis is to create a suite of tools and methods for professional archaeologists to utilize. Through the study of ultraviolet fluorescence of the lithic raw materials, White River Group Silicates and Knife River Flint, controlled wavelengths were used as treatments to observe the expressions of the materials. In turn, high quality photographs are now distributable for comparative studies by other researchers to expedite the process of sourcing raw materials. Furthermore, by utilizing the Video Spectral Comparator 6000, the first chapter highlights the elevated level of control through an enclosed observation space, a static magnification, and a method to photograph these expressions of ultraviolet light for subsequent qualitative analysis. Additionally, the use of ImageJ, however inconclusive during this particular study, still should find use in the quantitative analysis of color.

The theme of public outreach is considered the most important aspect of this work. By developing and introducing professional archaeologists to the specific methodology of resource interpretation, it is desired that a new wave of collaborative public outreach reach the levels of accessibility for both academic archaeologists and heritage resource professionals. Using the case-studies of the 2013 – 2015 ‘Artifact Roadshows’, centered on the high plains region, this discussion exemplifies the visitor

response to this type of archaeological research. While professional archaeologists are gaining insight and data of pre-existing private collections for future regional analysis and research, the participant is expanding their interest in the once held curiosities framed to a velvet board.

With the dawn of the digital era of archaeological curation, research, and display, both the ‘Digital Archive’ and ‘Oral Histories’ webpages were developed in conjunction to facilitate the data display and collaboration that was sought after at the 2013 -2015 ‘Artifact Roadshows’. By providing a platform for direct discourse with heritage resource professionals, this archive seeks to expand the relationship between the professional and the avocational by providing platforms for data input and review, based on methodologies that will need to be adhered to on the ‘Digital Archive’ webpage. It is the hope that a citizen science initiative that focuses on the positive efforts of the collaboration between aspiring avocational archaeologists and professionals will be the bridge to a greater collective understanding of the importance of stewardship and the educational value of the archaeological record. We, as professional archaeologists, must meet the future halfway by providing ourselves as a resource in and of itself.

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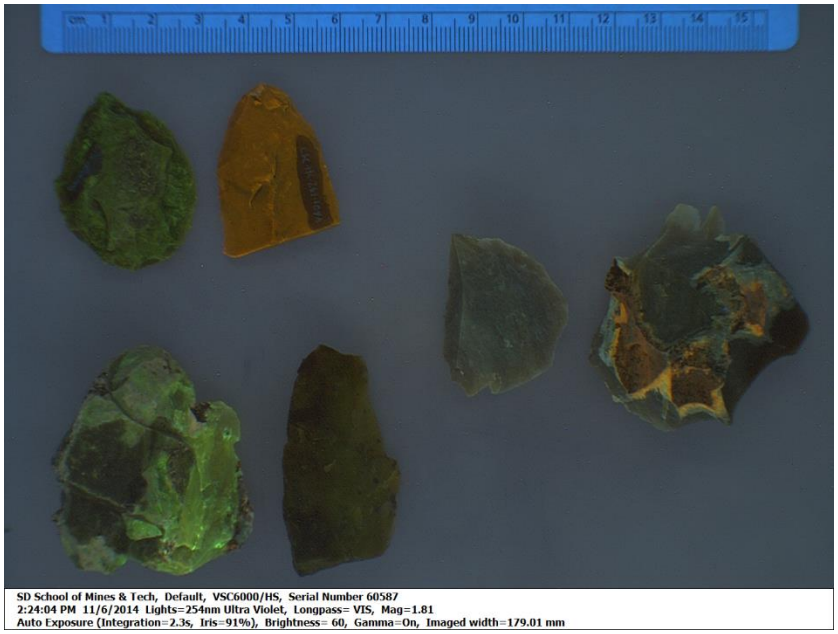
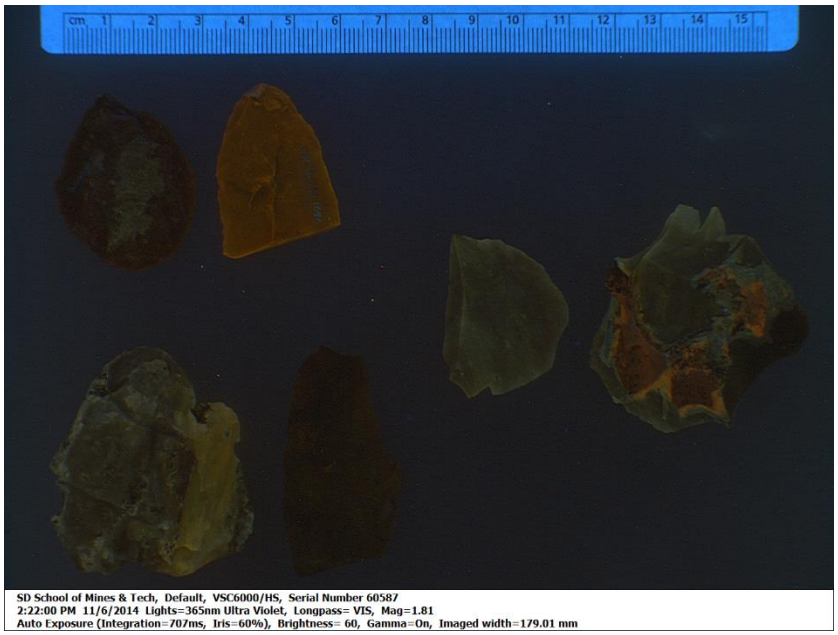
Appendix A: Video Spectral Comparator 6000 Photographs

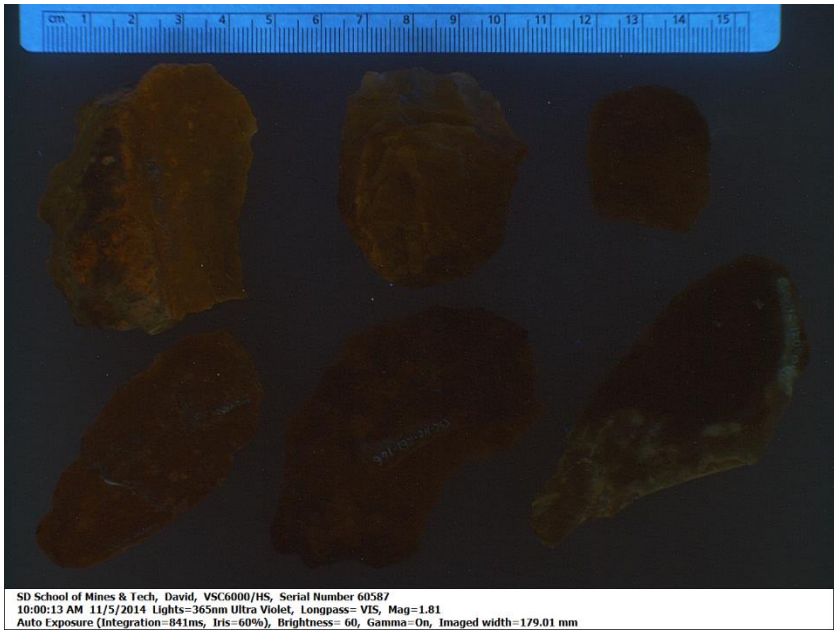
Combined Samples 254 nm



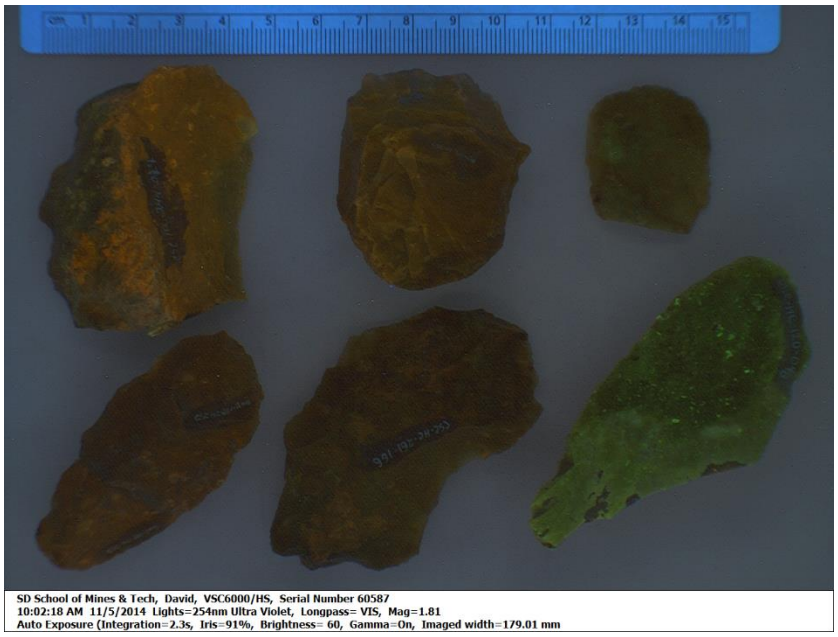
Combined Samples 365 nm



Batch 2 Artifact Samples 365 nm

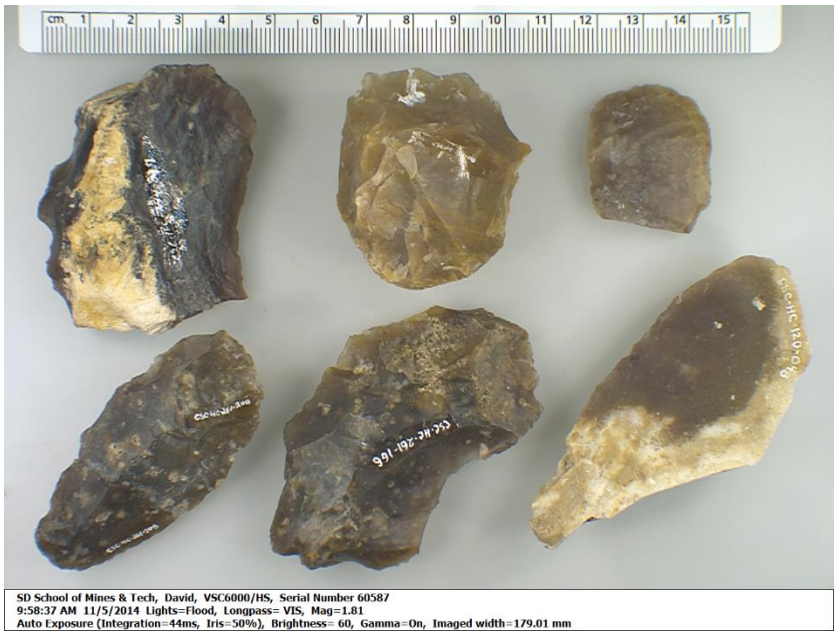


Batch 2 Artifact Samples 254 nm

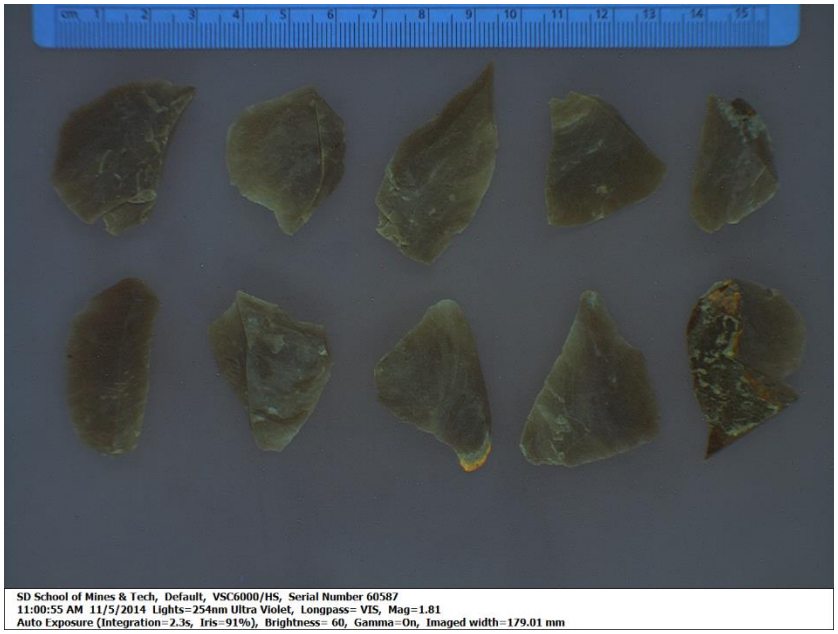


Batch 1 Artifact Samples White Light

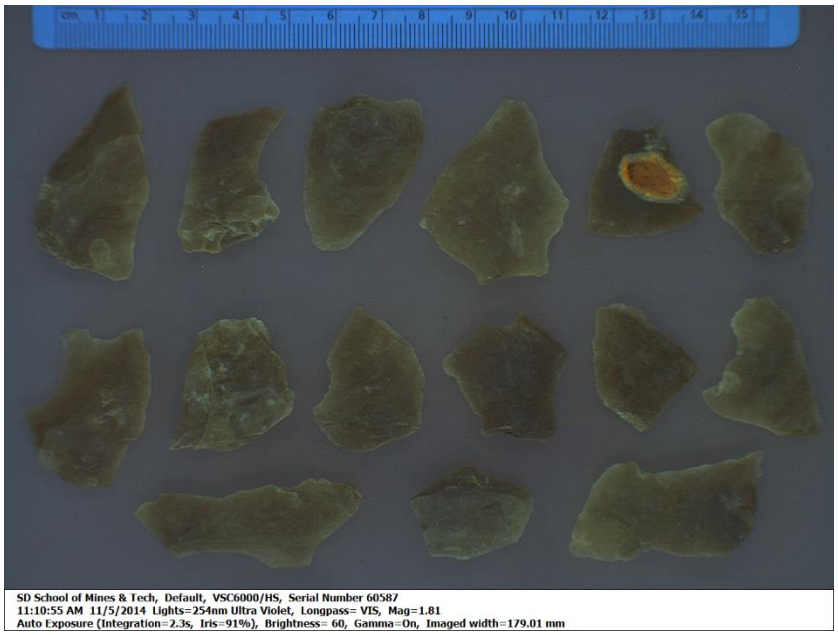
Batch 2 Artifact Samples White Light



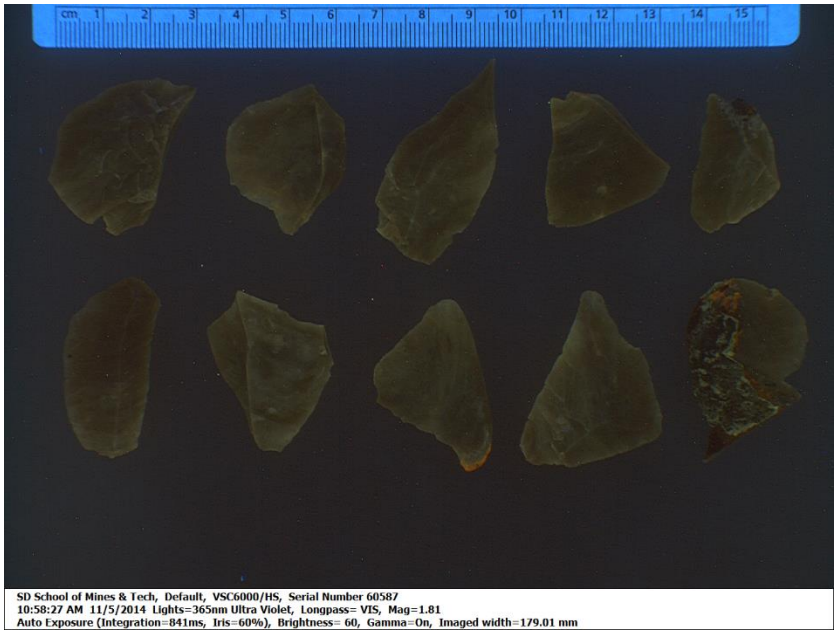
Batch 2 Knife River Flint 254 nm



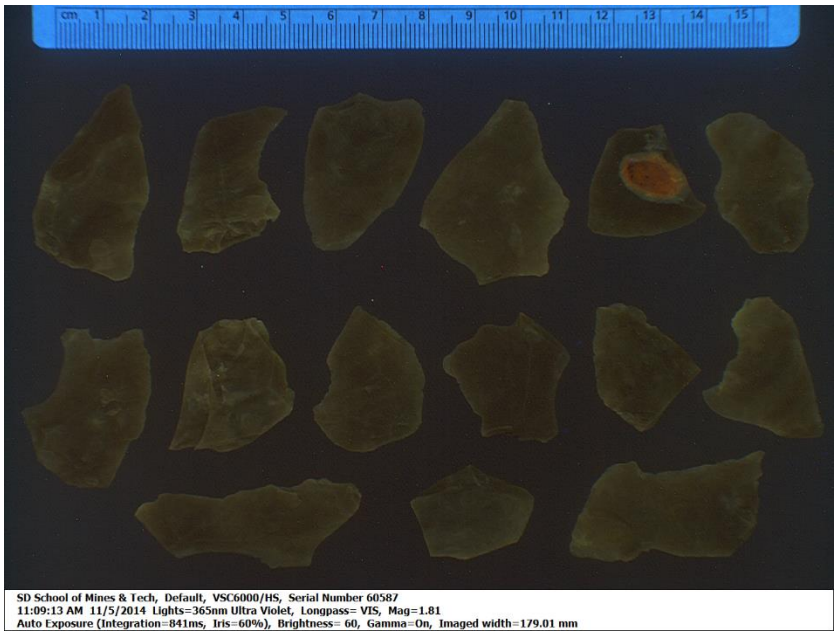
Batch 3 Knife River Flint 254 nm



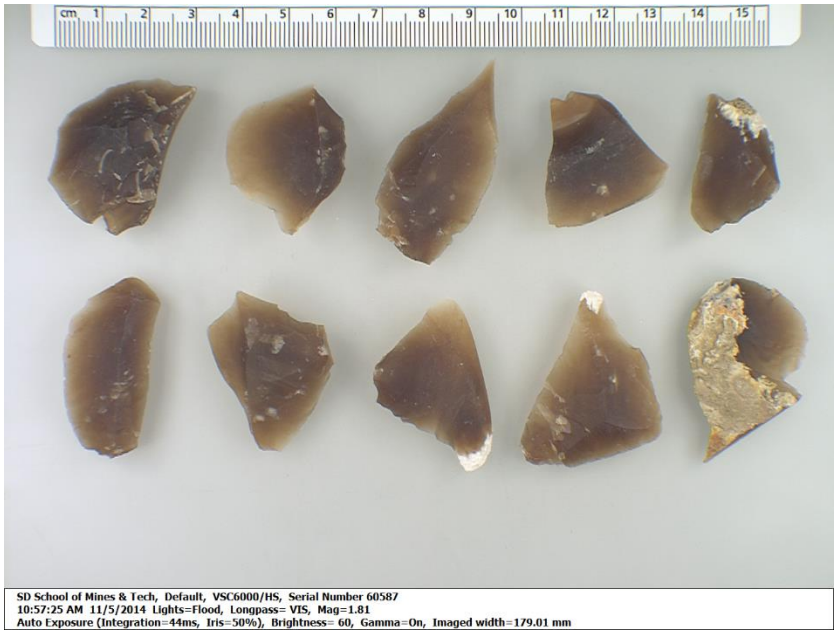
Batch 2 Knife River Flint 365 nm



Batch 3 Knife River Flint 365 nm

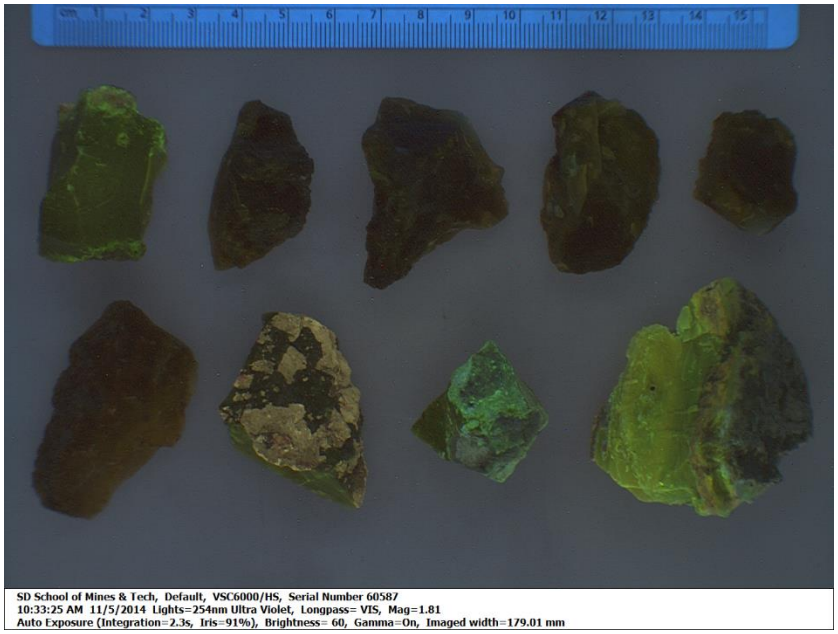


Batch 2 Knife River Flint White Light

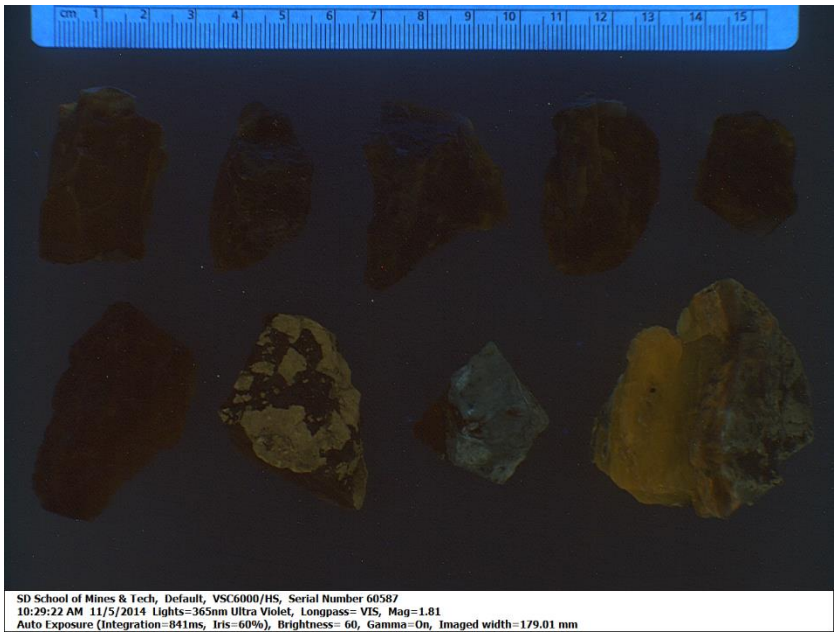


Batch 3 Knife River Flint White Light

Batch 2 White River Group Silicate 254 nm



Batch 1 White River Group Silicate 365 nm



Batch 1 White River Group Silicate White Light

Batch 2 White River Group Silicate White Light

Appendix B: Video Spectral Comparator Raw RGB Data

Knife River Flint VSC Raw Data

KRF365	Red	Green	Blue	KRF254	Red	Green	Blue
KRF1	47.085	43.07	32.947	**KRF1**	59.596	61.926	55.405
KRF2	46.376	41.837	32.436	**KRF2**	55.667	54.918	44.505
KRF3	47.531	44.505	31.489	**KRF3**	63.635	65.033	54.63
KRF4	45.541	40.189	28.736	**KRF4**	65.579	67.703	55.167
KRF5	46.071	42.825	30.358	**KRF5**	62.848	66.172	55.503
KRF6	45.379	40.093	31.511	**KRF6**	52.254	52.219	47.211
KRF7	50.039	45.834	33.199	**KRF7**	65.304	65.908	55.05
KRF8	50.765	46.436	31.353	**KRF8**	65.446	66.543	53.305
KRF9	43.862	37.721	26.286	**KRF9**	53.023	54.076	44.934
KRF10	47.661	44.153	31.021	**KRF10**	58.407	60.017	51.307
KRF11	45.699	36.977	26.832	**KRF11**	51.638	46.534	39.647
KRF12	50.037	45.76	32.998	**KRF12**	63.332	65.545	57.462
KRF13	48.843	44.748	30.865	**KRF13**	62.052	63.411	53.536
KRF14	48.164	43.443	30.627	**KRF14**	62.052	63.411	53.536
KRF15	46.461	41.667	28.471	**KRF15**	57.768	57.815	50.402
KRF16	50.481	44.18	29.608	**KRF16**	52.658	50.926	41.447
KRF17	50.297	44.628	29.332	**KRF17**	64.838	62.977	51.204
KRF18	46.927	41.259	28.139	**KRF18**	63.125	61.126	50.069
KRF19	49.567	43.766	28.592	**KRF19**	63.989	63.323	51.345
KRF20	45.473	39.647	25.553	**KRF20**	68.085	68.088	54.071
KRF21	50.182	45.471	28.332	**KRF21**	62.146	60.193	47.158
KRF22	51.65	44.385	28.691	**KRF22**	64.761	63.66	49.313
KRF23	52.746	47.519	31.378	**KRF23**	63.97	60.376	48.775
KRF24	47.567	40.624	26.537	**KRF24**	63.07	62.203	51.29
KRF25	43.281	35.839	25.171	**KRF25**	62.457	59.512	48.438
KRF26	46.754	40.882	25.553	**KRF26**	55.995	54.569	47.574
KRF27	47.819	42.443	26.632	**KRF27**	57.847	55.043	43.677
KRF28	49.361	42.034	26.437	**KRF28**	59.972	58.726	47.805
KRF29	47.749	43.45	29.814	**KRF29**	66.748	65.147	52.261
KRF30	49.203	43.713	27.321	**KRF30**	65.888	69.732	60.356

White River Group Silicate VSC Raw Data

WRGS365	Red	Green	Blue	**WRGS254**	Red	Green	Blue
WRGS1	37.697	28.238	22.491	**WRGS1**	39.357	38.006	27.531
WRGS2	37.899	27.369	19.989	**WRGS2**	42.105	34.963	23.021
WRGS3	38.039	27.135	17.313	**WRGS3**	42.817	45.625	23.418
WRGS4	44.723	29.912	16.444	**WRGS4**	43.081	43.853	22.436
WRGS5	42.529	29.625	18.866	**WRGS5**	47.325	44.896	24.944
WRGS6	33.962	22.573	18.238	**WRGS6**	37.608	30.722	23.089
WRGS7	40.059	29.716	19.93	**WRGS7**	41.056	34.568	25.89
WRGS8	40.059	29.716	19.93	**WRGS8**	49.284	49.832	26.099
WRGS9	42.239	29.583	17.718	**WRGS9**	45.368	47.407	23.398
WRGS10	53.791	35.404	15.352	**WRGS10**	45.242	47.338	25.899
WRGS11	38.406	26.689	18.936	**WRGS11**	59.241	57.675	21.753
WRGS12	60.048	37.431	12.299	**WRGS12**	60.467	56.92	24.255
WRGS13	61.535	39.077	13.417	**WRGS13**	41.335	43.426	22.697
WRGS14	44.259	31.13	16.416	**WRGS14**	48.81	54.397	28.719
WRGS15	37.814	26.799	19.743	**WRGS15**	38.681	32.405	25.479
WRGS16	33.058	23.655	19.245	**WRGS16**	37.609	31.465	25.468
WRGS17	32.591	23.989	20.396	**WRGS17**	42.352	39.637	25.024
WRGS18	34.354	25.697	19.837	**WRGS18**	35.073	28.386	23.893
WRGS19	30.448	22.526	18.777	**WRGS19**	42.046	32.143	23.629
WRGS20	35.951	23.478	18.193	**WRGS20**	50.791	56.927	34.302

Artifact Samples VSC Raw Data

ART254	Red	Green	Blue	**ART365**	Red	Green	Blue
ART1	40.695	35.281	24.93	**ART1**	32.469	25.137	19.112
ART2	66.698	49.494	16.308	**ART2**	56.707	30.015	9.488
ART3	83.818	57.423	18.059	**ART3**	65.754	38.021	9.748
ART4	68.924	50.211	18.051	**ART4**	46.894	30.915	13.794
ART5	85.06	58.415	14.506	**ART5**	62.267	38.42	9.432
ART6	87.077	60.536	19.761	**ART6**	57.402	37.965	14.404
ART7	68.611	46.718	18.748	**ART7**	73.02	44.039	9.25
ART8	77.268	57.116	24.215	**ART8**	54.403	30.38	10.523
ART9	49.888	58.282	36.555	**ART9**	68.334	41.527	10.848
ART10	69.268	47.461	18.031	**ART10**	34.614	27.539	20.078
ART11	68.039	49.522	17.805	**ART11**	55.305	29.876	9.038
ART12	53.395	39.948	17.938	**ART12**	50.208	32.529	12.98
ART13	44.993	42.035	21.161	**ART13**	42.034	26.998	13.889
ART14	55.126	41.728	25.388	**ART14**	34.017	22.872	15.143
ART15	46	39.772	22.936	**ART15**	38.234	24.16	15.68
ART16	37.206	43.804	21.034	**ART16**	35.198	22.138	14.291