The Origins of the Artists: A Lithic Analysis of a Habitation Site Associated with the Jeffers Petroglyphs

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The Origins of the Artists:
A Lithic Analysis of a Habitation Site Associated with the Jeffers Petroglyphs

Kevin Winston Reider

An Honors Thesis
Submitted for partial fulfillment of the requirements
for graduation with honors in Anthropology
from Hamline University

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I would like to express my deep appreciation to Tom Sanders and Chuck Broste for allowing the Hamline Field Schools to excavate at the Gruenig site. Thanks also to Tom Ross for sharing many valuable insight about Jeffers.

Many thanks to Kent Bakken, Ph.D. who shared his expertise of lithic raw materials with me. Additionally, the aid of Dan Wendt and others from the Minnesota Historical Society Lithic Group was very helpful in my research.

The assemblage would not exist without the help of my fellow classmates and peers who excavated, cleaned, and catalogued with me. I will never forget the long hours we spent in the lab. In particular I would like to thank Chelsea Starke, Arianna Elm, Forrest Seaberg-Wood, Ian Bakke, Sarah Lewis, Anna McGraw, and Yvonne Thorpe. I would also like to thank Grant Kvendru for working with me on our experimental project, which was incorporated into this thesis.

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Special thanks to Carol and Jim Reider who provided much needed moral support during my project's final stages.

Finally, thank you to all my friends and family who encouraged me along the way.
The Origins of the Artists: A Lithic Analysis of a Habitation Site Associated with the Jeffers Petroglyphs

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The Jeffers Petroglyphs is one of the most important ancient American Indian rock art sites in the Midwest. The site is unique with over 5,000 individual petroglyphs created over a 9,000-11,000 year span. There have been important studies and interpretations of the petroglyphs, but a large gap of information exists concerning the archaeological sites of those who helped create the petroglyphs. An analysis of the lithic (stone) raw materials found in a habitation site surrounding the Jeffers Petroglyphs was performed in order to help fill in this gap surrounding the origins of the petroglyph creators. The lithic assemblage analyzed was collected from the Gruenig Field site as part of Hamline University's archaeology field school which took place in the summers of 2011 and 2012. Comparison of the Gruenig data with the lithic materials recovered from other southwestern Minnesota sites demonstrates the unusual characteristic of the Jeffers exotic raw materials indicating a wider regional significance.
INTRODUCTION

“The Dakotas viewed every object known to them as having a spirit capable of helping or hurting them, and consequently a proper object of worship. . . . The War God . . . He is called Inyan and Tunkan, both of which mean stone, and it is said by some of the Dakotas to be the greatest of their gods. He is supposed to exist in the numerous boulders scattered over the prairies, and is more worshipped than any of the other Dakota Gods.” (Riggs 1883)

The Jeffers Petroglyphs site is located in Cottonwood County in the southwestern corner of Minnesota. The site sits on top of a large outcrop of Sioux Quartzite and was originally thought to have over 2000 individual petroglyphs (Callahan 2001). These rock engravings were created by American Indians during a time period spanning approximately 5000 years, from 3000 B.C. to A.D. 1650 though some estimates go back as far as 9,000 BP (Callahan 2001; Personal Communication with Sanders 2011). Researchers have suggested many potential purposes for the rock art ranging from a method for remembering dreams to performing sacred ceremonies (Callahan 2001; Lothson 1976).

The Jeffers Petroglyphs site was originally historically documented by travelers, a geologist, and eventually the archaeologist Theodore H. Lewis in 1889 (Callahan 2001). The Jeffers Petroglyphs site has been managed by the Minnesota Historical Society since 1966 after the state of Minnesota bought it from the Jeffers Family (Callahan 2001). Gordon Lothson was among the first to attempt to survey and analyze the individual petroglyphs. He mapped out the site and attempted to interpret the individual petroglyphs. From that time onward many others including American Indians, rock art experts, and other archaeologists have studied the engravings and provided insight into the meaning of the petroglyphs and the context of their creation.
The individual glyphs are varied and have many different interpretations. Gordon Lothson came up with some different possibilities. He thought the site may be a place of sacred ceremony, a place to practice hunting magic, and a place to record events of warriors, shamans, and chiefs (Lothson 1976). Later analysis and ethnographic data from various Minnesota American Indian communities have added to the list of potential uses of the site. The Jeffers Petroglyphs may have been a "house of spirits", a place to record dreams (which were seen as gifts from the spirit world and therefore of great importance), a place to record songs, and a meeting place between the underworld and upperworld (Callahan 2001).

The glyphs are made of many different symbols which represent aspects of American Indian ways of life and religions. "Sun-headed" figures at the site are thought to represent important shamans or possibly the Great Spirit. Atlatls, or spearthrowers, are a common petroglyph at the site. Atlatls would have been very important for the people for hunting and protection purposes. Another symbol which possibly represents shamans at the site is the figure of a person with upraised arms. Thunderbird and thunderbird track symbols are also found at the site. "The thunderbird is one of the oldest, most widespread, and best known spirit beings to be represented on rock, earthworks, and on clothing" (Callahan 2001). This is by no means an exhaustive list of the numerous different symbols and patterns found at the Jeffers Petroglyphs.

American Indians appeared to have started using this site at the beginning of the Middle Prehistoric Period (3000 B.C. - A.D. 900) through the Late Prehistoric Period (A.D. 900 - A.D.1650) (Anfinson 1997). This region had been greatly shaped by glaciers and the hot and dry climate that came after the end of the glacial activity (Callahan 2001). In the Middle Prehistoric Period, the diets of American Indians became more diverse as the environment allowed the growth of more types of edible plants and an expansion of game choices (Anfinson 1997). The
people in this period had "multiseasonal base camps" and "permanent habitations" (Anfinson 1997). When the Middle Prehistoric Period ended, "new subsistence options and technologies fostered population growth and cultural diversity" (Anfinson 1997). Some of the cultural groups of American Indians who lived in the region during this time were the Mountain Lake Phase (3000 B.C. - 200 B.C.), the Fox Lake Phase (200 B.C. - A.D. 700), and the Lake Benton Phase (A.D. 700 - A.D. 1200). The Late Prehistoric Period was characterized by horticultural villages. During the second half of the Late Prehistoric Period, the Prairie Lake Region, where Jeffers is located, had much lower populations than in previous times. Some cultural groups in the Late Prehistoric Period were the Great Oasis Phase (A.D. 900 - A.D. 1200), the Cambria Phase (A.D. 1000 - A.D. 1200), and the Big Stone Phase (A.D. 1100 - A.D. 1300) (Anfinson 1997).

Historic American Indian groups connected to the site are the Iowa, Oto, Oujalespuiton (Wahpeton) and Yankton Dakota (Callahan 2001). Ethnographic data from Sioux, Cheyenne, Mandan, Hidatsa, Arikara, Crow, Pawnee, and Iowa was also used to learn more about the people who lived in this region at the time of the site's creation (Clouse 2004).

During my work on this project, I was fortunate enough to hear both Dakota Elder Tom Ross and Jeffers Site Manager Tom Sanders describe their views of the Jeffers Petroglyphs. They have been conducting their own research which has expanded upon and updated the work of Lothson and Callahan. Tom Ross described the Jeffers area as a meeting place between peoples where different groups could trade with one another or simply share conversations (Personal Communication with Tom Ross 2013). Tom Sanders said that he sees the Jeffers Petroglyphs as an encyclopedia (Personal Communication with Tom Sanders 2012). Like an encyclopedia, the site has many different uses and contains numerous categories of information.
Tom Sanders had spent 15 years as manager of the Jeffers Petroglyphs site. Along with Chuck Broste, Sanders began the painstaking process of eliminating the lichen, a moss-like plant, off of the Sioux Quartzite outcropping where the petroglyphs were found. In this process, the number of documented petroglyphs increased from 2000 to 4500-5000.

Recently there has been a surge in intellectual inquiry concerning the Jeffers Petroglyphs site. Currently, researchers from the University of Minnesota are scanning individual petroglyphs to create electronic 3D images. These scans allow for micro-details including individual peck marks. The results of this meticulous process may enlighten archaeologists about the technology and style used to create the rock engravings; there is also a chance that individual petroglyph creators/artists may even be identifiable through specialized styles or techniques.

The site that I am utilizing for my study is adjacent to the Jeffers Petroglyphs. It is located on a farm field owned by the Gruenig family and was consequently named the Gruenig site. We began investigation on this site over a year and a half ago with the intention of helping the work of Tom Sanders and Tom Ross.

My project contributes to the work of Sanders, Broste, Ross, and Hoffman who had recently started a collaborative multi-year research project. Their goal was to find out anything they could concerning the Jeffers Petroglyphs site including discovering the tools and technique in which the petroglyphs were created, the context of their creation, the timeline of the site's use, and the origins of the creators. The collaboration includes continued excavations by Hamline Field Schools, working closely with Dakota elders, and experiential learning led by Hoffman and Sanders pertaining to the processes and materials involved with the petroglyphs.
RESEARCH QUESTIONS

The aim and focus of my project was led by three overarching research questions: 1) Who created the Jeffers Petroglyphs?; 2) What was the nature of the Gruenig site including information about technology and activities occurring at the location?; 3) When were the Jeffers Petroglyphs created, modified, or visited according to site temporal information based on lithic raw material abundance?

The first research question was to be answered using lithic raw material type as a proxy for spatial distribution of the creators and visitors of sites. Tom Sanders of the Minnesota Historical Society and Site Manager at the Jeffers Petroglyphs site hypothesizes that the Jeffers Petroglyphs was not only an important local destination, but the site also had a much wider regional significance. Sanders hypothesizes that people from throughout the Midwest (and perhaps even more distant places) came to Jeffers to use the rock art site. Through lithic identification, using raw material types with known geological source areas, we attempted to find the areas from where people were likely visiting.

In addition to lithic raw material type, I could have also utilized ceramic and projectile point typologies. Unfortunately, no ceramics were recovered during any of our four excavations at the Gruenig site. As for the projectile points, although some were found in the field, the sample size was never able to reach a satisfactory number. The projectile points that were recovered could tell us little in terms of spatial or temporal origins of the people that left these artifacts behind. I will discuss the information and analysis concerning the projectile points, but it has become much less of a focus of my project than what was initially conceived.
Should Sander's hypothesis be correct concerning the regional significance of the Jeffers Petroglyphs site, certain findings should be present as a result of my analysis and lithic identification. There should be a high relative abundance of exotic materials, at least higher than what is average for other sites in southwestern Minnesota. If there is a wide regional significance, I would expect to find materials from across most of Minnesota, extending into Iowa, Wisconsin, and the Dakotas. Additionally, the debitage of exotic materials should most likely then be at a late stage of production as inhabitants would most likely only bring smaller (and more easily transported) pre-forms or bifaces to the site.

The second major research question in my project involves the activities and nature of the Gruenig site. Using debitage analysis, I attempted to find the most common stages of lithic production occurring at the site. In lithic reduction, certain characteristics are able to express information detailing the average stage of manufacture in an assemblage. As stated earlier, the more exotic materials should most likely give evidence for later stage production, whereas local materials should be represented by flakes of almost all stages of production averaging somewhere in the middle. Certain analyses are better at describing stage of production including those concerning platform type, platform angle, presence of cortex, and weight.

Debitage of exotic materials representing a later stage of production should, on average, have multi-faceted or double-faceted platform types, higher average platform angles, little to no cortex present, and a lighter weight (depending on quality of raw material) than those materials which are thought to be of a local nature. Debitage of local materials representing earlier stage of production should, on average, have single-faceted or cortical platform types, lower average platform angles, a higher presence of cortex, and a heavier weight (depending on raw material quality).
I also focused on the question of when the Gruenig site was occupied, and correspondingly, when were people living adjacent to and most likely using the Jeffers Petroglyph site. This question is hard to answer definitively especially without the presence of diagnostic projectile points, ceramics, or carbon dating methods. I was then forced to use what I had available to me: raw material type relative abundance. In Bakken 2011, a higher usage of Tongue River Silica and Knife River Flint is described for Archaic sites, whereas more local cherts and flints are used during the Woodland periods.

In order to address this question, I found the relative abundance of raw materials for both the Gruenig site surveyed field and the main 1x1 meter unit. Sanders also hypothesized that the Jeffers Petroglyphs site was utilized during both Archaic and Woodland times. An Archaic period site generally has a higher relative abundance of Tongue River Silica and Knife River Flint (Bakken 2011). As the Gruenig site should possibly represent both periods, the abundance of materials should average out more on the field as stratigraphy is lost to the plow, but the 1x1 m unit should have higher amounts of Tongue River Silica and Knife River Flint especially as the unit's levels become deeper.

**GRUENIG FIELDWORK**

The bulk of artifacts researched and analyzed in this project were the result of four separate excavations by Hamline students headed by Professor Brian Hoffman. Two excavations were done as part of Hamline University Archaeological Field Schools in the summers of 2011 and 2012. The other two excavations were also led by Hoffman but were done by the Hamline University Archaeology Group in the fall of 2011 and 2012. All four excavations took place, at least in part, on the Gruenig site.
The first archaeological work done at the Gruenig site took place in the summer of 2011. This was the second archaeological project that the field school had worked on after taking part in an excavation near Lake Roosevelt. The members of the field school included five students and Hoffman. None of the students had any prior experience taking part in archaeological work, though two or three of them had some experience working in the Hamline archaeology lab. We started the project with a meeting led by site manager Tom Sanders and his associate Chuck Broste who then gave us a tour of the petroglyphs as none of the students had experienced them in person.

The landowners, members of the Gruenig family, had given us permission to perform a walking pedestrian survey over his plowed farm fields and dig anywhere on the property as long as the crops were not disturbed or damaged by the work. We had scheduled one week to learn about the Jeffers Petroglyphs site and to start field work. The excavation started with a controlled surface collection with the five students, Hoffman, Sanders, and Broste walking in parallel trajectories spaced out every ten feet. This meant that each individual was responsible for scanning five feet of ground on either side while looking for artifacts. We repeated this process until we had covered the entire field. We were also joined later in the afternoon by Christine Ross and Tom Ross. Upon completion of the field survey we began to open up two 1x1 meter units. One unit location just outside the plowed field was chosen for its relative flatness and logistical ease while the other location was chosen due to a well-defined vegetation change near the plowed field. We were able to excavate a couple levels of each unit with little success before our allotted time had run out, and we were forced to stop work for the time being.

The following fall the Hamline Archaeology Group made the journey back to Jeffers for a weekend excavation. This time there were only four students, including two who had
participated in the field school, along with Hoffman. We were also joined by Dakota Elder Tom Ross who had much experience working with archaeologists at American Indian sites in Minnesota. He contributed in the field work, but he also gave invaluable insight and context about the work we were doing. We had another, shorter tour of the Petroglyphs for the students new to the site. We opened up two more 1x1 meter units directly on the plowed field in areas that we felt were high in artifact density. In addition, we continued to excavate the previously opened units. At the end of the weekend, we decided that continuation of three of the four units was unnecessary as few if any artifacts were produced from them.

The following summer Hoffman taught another field school. This field school included seven students and two more student assistants who had participated in the previous field school. Other than the two assistants, the students had little to no experience in archaeological field work. During this field school, we spent a week re-surveying the plowed field, we continued to work on the one remaining 1x1 meter unit, and we dug three shovel tests. The three shovel tests were a little farther away from the plowed field than the 1x1 meter units. The spots were chosen in locations so that they tested the area between the Little Cottonwood River and Gruenig field to attempt to define the boundaries of the site. Although we felt we were close to finishing the last remaining unit, we decided that we had not gone quite deep enough.

The last excavation that Hamline students took part in was during the fall of 2012. This was only a one day trip so there was not much time to work. This team consisted of seven students, all of whom had previous archaeological experience save one. We divided the group in two with half working to finish the 1x1 meter unit and the other half walking a different, nearby plowed field. Though we felt the day would be sufficient to complete the work on the unit, we were forced to concede that an additional trip would be necessary to finish it at a later time.
making it an unprecedented three season 1x1 m unit. At the time of writing, another excavation tentatively set for the spring of 2013 is being discussed.

**GRUENIG ARCHAEOLOGICAL ASSEMBLAGE**

In this section of my thesis I provide a summary discussion of the entire 2011-2012 catalogue of artifacts collected from the Gruenig field, the shovel tests, and the 1x1 m units.

<table>
<thead>
<tr>
<th>Historical Context</th>
<th>n</th>
</tr>
</thead>
<tbody>
<tr>
<td>Post-Contact</td>
<td>74</td>
</tr>
<tr>
<td>Pre-Contact</td>
<td>372</td>
</tr>
<tr>
<td>Non-cultural</td>
<td>45</td>
</tr>
<tr>
<td>Bone</td>
<td>22</td>
</tr>
</tbody>
</table>

Table 1: Gruenig Total Assemblage

We collected a total of 513 artifacts including 74 Post-Contact artifacts, 372 Pre-Contact artifacts, 45 artifacts of indeterminate chronological origins, and 22 fragments of faunal remains. After bagging the artifacts and adding them to the bag log, we brought them back to the lab to be processed using the Hamline University Archaeology Laboratory Protocol. We sorted the objects in each bag for those that contained more than one artifact. We then cleaned the artifacts using either wet or dry brush depending on the artifact type. Next, we cataloged the assemblage using the Minnesota Historical Society cataloging protocols, slightly adapted for our use. Finally, we added artifact numbers to the objects using the chemical solution B-72.

**Faunal Remains**

The majority (20/22) of bone fragments in the collection were found during our pedestrian surveys in the Gruenig field. The lack of contextual information in addition to the absence of burn or cut marks leads us to believe that these faunal remains were a contemporary contribution to the archaeological assemblage and probably died naturally. The other 2 bone
fragments were found within a 1x1 m unit and were indeed characterized by burn marks. The burned fragments appear to be from before European settlers. The bone pieces are mammalian, but the small size of the fragments makes it very difficult to say anything more about them.

**Historical Artifacts**

<table>
<thead>
<tr>
<th>Object Material</th>
<th>n</th>
</tr>
</thead>
<tbody>
<tr>
<td>Concrete</td>
<td>2</td>
</tr>
<tr>
<td>Coal</td>
<td>2</td>
</tr>
<tr>
<td>Slag</td>
<td>2</td>
</tr>
<tr>
<td>Brick</td>
<td>2</td>
</tr>
<tr>
<td>Metal</td>
<td>12</td>
</tr>
<tr>
<td>Ceramic</td>
<td>18</td>
</tr>
<tr>
<td>Glass Sherds</td>
<td>35</td>
</tr>
</tbody>
</table>

Table 2: Gruenig Historical Assemblage

The Historical component of our assemblage contains 74 artifacts: 1 granite artifact, 2 concrete artifacts, 1 piece of coal, 2 chunks of slag, 2 brick fragments, 12 metal components, 18 ceramic sherds, and 35 glass sherds. These historical artifacts most likely represented a homestead that was once situated on the Gruenig field (Personal Communication with Tom Sanders 2011).

**Non-cultural Samples**

<table>
<thead>
<tr>
<th>Object Type</th>
<th>n</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rock Sample</td>
<td>45</td>
</tr>
</tbody>
</table>

Table 3: Gruenig Non-cultural Samples
Some objects collected were later determined to be non-cultural. These rock samples include cherts for the comparative collection and other natural objects that we concluded to not have been culturally modified once we had a good look at them in the lab.

Pre-Contact Artifacts

The Gruenig assemblage contains 372 pre-contact or pre-historic artifacts. These artifacts can be split up into two categories, Chipped Stone and Cobble Stone.

<table>
<thead>
<tr>
<th>Object Type</th>
<th>n</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anvilstone</td>
<td>1</td>
</tr>
<tr>
<td>Mano</td>
<td>1</td>
</tr>
<tr>
<td>Grinding Stone</td>
<td>3</td>
</tr>
<tr>
<td>Saw Blade</td>
<td>1</td>
</tr>
<tr>
<td>Chopper</td>
<td>2</td>
</tr>
</tbody>
</table>

Table 4: Gruenig Cobble Stone Tools

In the Gruenig assemblage, there are 8 cobble stone tools: 1 anvilstone, 1 mano, 3 grinding stones, 1 saw blade, and 2 choppers. Hammerstones are notable for their absence from this list. The lack of hammerstones may be explained, in part, by an inability to identify them due to the continual plowing of the field which can leave percussion marks on cobbles similar to those created by cultural use.

An artifact of particular importance is one of the two choppers. The raw material of the chopper is Swan River chert. Upon viewing, Sanders felt that it could have potentially been a tool used to peck the petroglyphs. The artifact in question was recovered from Unit 1 at a depth of 36 centimeters. The stone weighs 186 grams and measures 74 mm x 50 mm x 36 mm. Both ends along the potential tools length show signs of percussion. One end has only slight wear while the other end has significant flake removal creating somewhat of a point in the middle.
While Sanders came to visit our Experimental Archaeology class, we attempted to peck into Sioux Quartzite with a Swan River Chert stone of similar form and characteristics. We found that a heavier stone may have been easier to utilize, but it would have been possible to peck images with this artifact. It is impossible, with the current technology at my disposal, to prove one way or another that this artifact had created a petroglyph(s) at Jeffers, but the possibility is intriguing.

The other artifacts from the pre-contact context are chipped stone tools and debitage.

<table>
<thead>
<tr>
<th>Object Name</th>
<th>n</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flake</td>
<td>314</td>
</tr>
<tr>
<td>Core/Core Fragment</td>
<td>17</td>
</tr>
<tr>
<td>Biface/Biface Fragment</td>
<td>11</td>
</tr>
<tr>
<td>Bipolar Core</td>
<td>7</td>
</tr>
<tr>
<td>Projectile Point/Knife</td>
<td>7</td>
</tr>
<tr>
<td>Retouched Flake</td>
<td>7</td>
</tr>
<tr>
<td>Scraper</td>
<td>1</td>
</tr>
</tbody>
</table>

Table 5: Gruenig Chipped Stone Tools

The Gruenig field pedestrian surveys, shovel tests, and 1x1 m units produced 364 chipped stone artifacts. The majority of these artifacts were waste flakes produced during the lithic reduction of cores or preforms. The tools included 17 cores or core fragments, 11 bifaces or biface fragments, 7 bipolar cores, 7 projectile points/knives, 7 retouched flakes, and 1 scraper.

The Gruenig site produced 7 partial or full projectile points. Of these 7 projectile points, 3 are made out of Prairie du Chien Chert, 2 of them are made out of Swan River Chert, 1 was made out of the Iowa Chert Group, and 1 was unidentifiable though it may also fit into the Iowa Chert Group. About half of these projectile points appear to be small triangular points characteristic of the Woodland Period. The larger ones are more fragmentary and harder to pin on the temporal timeline.
The raw material composition of the projectile point assemblage appears to be the most useful characteristic. The amount of Prairie du Chien points is higher than expected. The material appears to have utilized in a similar manner to that of a more local chert which would be consistent with which is consistent with Bakken's description of the material's presence on the eastern border of the region. Another notable presence in the projectile point assemblage is the one (possibly two) Iowa Chert Group projectile point which is characteristic of the exotic nature of the Gruenig assemblage indicating potential regional significance.

<table>
<thead>
<tr>
<th>Cat #</th>
<th>Point Type</th>
<th>Raw Mat</th>
<th>Condition</th>
<th>Flaking Pat</th>
<th>Blade Shape</th>
<th>Max Length</th>
<th>Blade Length</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>EXP ST</td>
<td>Chert</td>
<td>M TIP</td>
<td>A</td>
<td>TRIANGULAR</td>
<td>25.2</td>
<td>16</td>
</tr>
<tr>
<td>2</td>
<td>SIDE</td>
<td>Prairie du Chien Chert</td>
<td>M EAR, M BARB</td>
<td>A</td>
<td>TRIANGULAR</td>
<td>29.5</td>
<td>25.3</td>
</tr>
<tr>
<td>322</td>
<td>OTH</td>
<td>Mississippian Chert</td>
<td>M TIP</td>
<td>A</td>
<td>TRIANGULAR</td>
<td>21.9</td>
<td>21.9</td>
</tr>
<tr>
<td>3</td>
<td>OTH</td>
<td>Prairie du Chien Chert</td>
<td>COMP</td>
<td>A</td>
<td>TRIANGULAR</td>
<td>27.4</td>
<td>27.4</td>
</tr>
<tr>
<td>73</td>
<td>OTH</td>
<td>Prairie du Chien Chert</td>
<td>M TIP</td>
<td>A</td>
<td>TRIANGULAR</td>
<td>20.9</td>
<td>20.9</td>
</tr>
<tr>
<td>247</td>
<td>OTH</td>
<td>Swan River Chert</td>
<td>M TIP</td>
<td>A</td>
<td>TRIANGULAR</td>
<td>10.4</td>
<td>10.4</td>
</tr>
<tr>
<td>399</td>
<td>EXP ST</td>
<td>Swan River Chert</td>
<td>COMP</td>
<td>B</td>
<td>TRIANGULAR</td>
<td>25.9</td>
<td>17.3</td>
</tr>
</tbody>
</table>

Table 6: Gruenig Projectile Point Characteristics (see Projectile Point Protocol)

The other chipped stone tools in the assemblage represent a range of activities at the site. For example the bifaces may have been used for knives, the scrapers may have been used to work hides, and the bipolar core tools may have been used as wedges.

There were 314 flakes recovered from the Gruenig site. These flakes are the result of reductive tool production created from percussion or pressure applied to the raw materials. Some of these flakes are of local origin and found in river gravels. Other flakes are exotic in nature,
transported by humans from areas outside the region. The raw materials and technological attributes of these waste flakes make up the bulk of my analysis and thesis.

**ANALYSIS OF THE GRUENIG ASSEMBLAGE**

The aim of my project was to answer three important research questions about the Gruenig site and the Jeffers Petroglyphs. 1) Who created the Jeffers Petroglyphs? 2) What is the nature of the Gruenig site with technology and raw material as the focus? 3) What is the timeline of the production and use of the Jeffers Petroglyphs using the Gruenig site as a partial proxy?

The first question can be answered by looking at the raw material use and technology at the site. The answer, though somewhat ambiguous, is very intriguing. The high amount of Prairie du Chien Chert artifacts, especially tools, along with the relatively high abundance of exotic raw materials, separates the Gruenig site from other archaeological sites in the area. The second question is answered by the kinds of artifacts found along with their abundance. It seems quite clear that this site was not a short term camping location. A high variation of cobble stone tools and a wide range of stages of production for the chipped stone tools suggest that there were many different activities which occurred at the site including tool production, tool re-sharpening, grinding, and butchering. The third question can be answered from the comparison between the artifacts found in the field and the artifacts found in the 1x1 m unit. The much higher presence of Tongue River Silica, and its higher abundance at lower depths, gives reason to suggest that some components of this site date back to the Archaic Period (Bakken 2011).

**Methodology**

The identification of the raw materials was done with the use of the Hamline University Archaeological Lithic Raw Material Comparative Collection and the Minnesota Historical
Society Comparative collection. My adviser Brian Hoffman, members of the MHS Lithic Group including Kent Bakken and Dan Wendt, and peers at Hamline University assisted me in the process of identification.

Many factors shape the lithic assemblage of archaeological sites including material and technological availability (Hayden et al 1996). In the debitage analysis, both factors were taken into account in order to address the central research questions. The debitage analysis was performed using The Hamline University Archaeology Chipped Stone Debitage Protocol. This protocol was created by Brian Hoffman using his research and materials from his project in Alaska (Hoffman 2002). The first step in my analyses was to test Hoffman’s protocol in order to check its consistency and validity for Minnesota materials.

**PROTOCOL TEST**

In order to test the validity of my claims and arguments concerning the raw material use and technology of the production and maintenance of the stone artifacts in the assemblage, it was necessary to conduct protocol tests using the majority of the flakes produced from Unit 1, a 1x1m pit. The analysis would be performed by measuring and observing certain attributes of the waste flakes. These attributes serve to give insight into areas such as stage of production, the nature of particular raw material usage, and the nature of the site. This process involved determining the relationships between average platform angle and platform type, average platform angle and cortex, platform type and cortex, and average thickness by platform type. The recording of characteristics and measurements was done for the majority of flakes produced by the main 1x1m unit named Unit 1.

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1 I received assistance from my classmates Grant Kvendru, William (Carter) Olsen, David Black and Chelsea Starke.
The measurements recorded involving platform angle and platform type were taken to view stage of production. If the protocol does indeed consistently measure relative stage of production then average platform angle and platform type should hold a steady and predictable relationship. This was indeed determined to be the case, though it was not exactly the same as Hoffman’s Alaska results. While analyzing platform types, six categories were considered: bipolar, cortical, crushed, double-faceted, multiple-faceted, and single-faceted. Hoffman’s protocol predicts that the platform type should have a direct correlation to platform angle on average if successful at determining the stage of production. The flakes with bipolar, crushed, and cortical platform types should generally have lower platform angles while the flakes with single-faceted, double-faceted, and multiple-faceted should have progressively higher platform angles (Hoffman 2002).

The measurements observed from the flakes recovered from Unit 1 involved in platform angle and platform type can be seen in Figure 1. The results are mostly consistent with those of Hoffman (2002) as the multiple-faceted is the highest and the double-faceted/single-faceted seem to represent a gradual decline. The flakes with the lowest platform angles also remained consistent with the previous study as the bipolar/cortical and cortical categories had markedly lower platform angles than then the other groups. The only notable difference between my study and Hoffman’s results was in the category of crushed platform types. This difference is quite understandable as my sample size was only two flakes; one of the flakes had a relatively low platform angle, but the other was unexpectedly high.
The next analysis performed in order to test the validity of the protocol was to view average platform angle by presence of cortex. According to Hoffman (2002), flakes with cortex present are generally understood to be markers of early-stage production and should therefore possess lower platform angles if present. Conversely, flakes with no cortex are generally understood to be markers of later-stage production and should therefore possess higher platform angles. Again, the patterns found matched the patterns expected.
In my analysis of the flakes recovered from Unit 1, the average platform angle of the non-cortical flakes is 116.67 degrees, while the average platform angle of the cortical flakes is 105.5 degrees. The flakes without platforms were not included in this analysis. This analysis also affirms the protocol.

The third analysis to test the protocol was a look at platform type and cortex. According to Hoffman (2002), flakes with the platform types bipolar, double-faceted, and multiple-faceted should have the least amount of dorsal surface cortex present, while flakes with the platform types cortical, single, and crushed should have the highest amount of dorsal surface cortex present. My results were similar although the actual percentages did not ultimately align. The bipolar/cortical category of flakes in my study had a higher percentage than the bipolar category reported by Hoffman. This may only be a sampling size error as the category in my study unfortunately had only one flake. Generally, however, the patterns and continuity between the two studies does additionally indicate the validity of the protocol.

Figure 3: Platform Type by Average Presence of Cortex
The last analysis to test the validity of the protocol involved looking at the relationship between thickness and platform type. For this test, the average thickness for each platform type category was found for those flakes which still contained a visible platform. In Hoffman's study, he found that double-faceted and multiple-faceted platformed flakes were generally thinner than the platform types which represented earlier stages of production. This analysis conducted on the platformed flakes of Unit 1 had mixed results. As expected, the multiple-faceted flakes had the smallest average thickness, while the bipolar/cortical category averaged the largest thickness. In the middle of the graph, however, the results were much less clear. The crushed, cortical, and single-faceted categories were all similar, while double-faceted category had the second-highest average thickness. Again, the sample size of the double-faceted platform category was 2 flakes. Additionally, one of these flakes had a thickness of 7.9 mm. This obviously skewed the data. Without that flake (understanding that the sample size would now be just one) the average thickness of the double-faceted category would be 1.7 mm which would be much more expected. Even though this analysis had results which did not quite align in some areas to Hoffman's study, I think when taking sample size into account, this analysis does indeed help prove the validity of the protocol.
To summarize this section, four analyses were conducted in order to check the validity of the protocol and its conclusions concerning the relationships between measurements and observations including platform angle, platform type, thickness, and presence of cortex and their representation of lithic stage of production. With the accuracy of the protocol verified, the following areas of analysis should be reliable in their ability to convey sound and consistent results.

**RAW MATERIALS AT GRUENIG**

The Gruenig assemblage contains at least 13 unique lithic raw materials that are geologically sourced to at least three states including Minnesota, Iowa, and South Dakota. These raw material types were identified using the Minnesota Historical Society lithic raw material comparative collection, the Hamline University archaeological lithic raw material comparative collection, and Dr. Kent Bakken's dissertation with the assistance of multiple archaeologists.
including Professor Brian Hoffman, Dr. Kent Bakken, and Dan Wendt of the MHS Lithic Group.²

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² Bakken's identification and descriptions were essential in making my project possible.
The most abundant lithic raw materials found at the Gruenig site was Swan River Chert (SRC). This is a common Minnesota material often found in the western and central areas of the state. This material can be a multitude of colors though the typical hues found during our excavation were white, grey, pink, and red. Bakken accurately describes the texture as similar to orange peel. The cortex usually has a rough texture with a grey color. Near the cortex crystalloid fractures may be present as flaws in the material (Bakken 1995). Heat treatment appears to give the rock areas of a more blood red color that fades into a gradually lighter pink.

The second most abundant lithic raw material found at the Gruenig site was Prairie du Chien Chert (PDC). The geological source area for this material spans three states: Minnesota, Wisconsin, and Iowa. Prairie du Chien Chert is often characterized by its oolitic inclusions formed by sand and/or microscopic organisms. Though the closest large resource area appears to be in Mankato, this resource is often considered to be of local importance in Southwestern Minnesota (Bakken 1995). Prairie du Chien Chert is not a very brittle material and therefore is not very efficient at producing tools. To counteract this characteristic, heat treatment is often utilized. Heat treatment seems to turn the color of the oolites into a golden brown color while simultaneously causing the definition of the oolitic borders to increase (Reider and Grant 2013).

The third most common lithic material found during our excavation was Tongue River Silica (TRS). This lithic material is generally found in western Minnesota, eastern South Dakota and North Dakota, and northwestern Iowa. The material seems to be local or relatively local to the Jeffers region. Tongue River Silica is usually a brown or dirty orange color. It seems as if the darker varieties of the material found near Jeffers are heat treated. The material is usually very opaque and relatively smooth. Tongue River Silica from this region tends to be found in smaller
clasts than in the neighboring Pipestone Region of Minnesota as it went through less glacial transport (Bakken 2011).

The Gruenig site also produced numerous flakes from the Red River Chert (RRC) category. The colors of these flakes are generally varying shades of grey and white. In this category I am also including flakes that seemed to have been detached from small pebbles of unidentified chert as they would most likely have been used interchangeably with RRC. Red River Chert is commonly found in northwestern Minnesota through the western and central parts of the state.

Although the number of flakes of Knife River Flint is small, this material is notable in the Gruenig collection for its presence in the later levels of the main 1x1 meter unit as well as its high tool to flake ratio. Knife River flint is occasionally found in western Minnesota including in the Upper Red and Shetek sub-regions and has geological source areas in the Dakotas (Bakken 1995). This material was also used to help create a chronological history to the site area. The presence of this material in the lower levels of our main 1x1 m unit, with the simultaneous presence of TRS, is suggestive of Archaic Period occupation.

For the sake of this project, a category called the ‘Iowa Chert Group’ was created for the majority of probable Iowan and Fusilinid cherts found at the site. I created this group because these cherts difficult to identify precisely and accurately, and the sample sizes were very small. Even though relatively few in number, the Gruenig assemblage appears to have a much higher percentage of Iowa lithic raw materials in comparison to the assemblages produced from sites in

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3 In some of the charts, the term 'Mississippian' is used to represent the Iowa Chert Group as some of these artifacts were identified as being Mississippian Chert.
the same area of Minnesota. This material group is one of the most abundant exotic cherts that was produced from the site.

The remaining lithic raw material types present in the Gruenig assemblage are Bethany Falls Chert, Bijou Hills Quartzite, Burlington Chert Cedar Valley Chert, Chalcedony, Galena Chert, Jasper, Quartz, and Quartzite. The raw materials that were not successfully identified were all simply labeled "unidentified chert" or simply "chert". Many of these cherts are local to Iowa and other parts of the state, therefore adding to the exotic assemblage for Gruenig.

1x1 METER UNIT VS PEDESTRIAN FIELD SURVEY

It is important to take note of the two main techniques used to acquire our collection. The first technique involved pedestrian field surveys conducted by field school teams working together with Tom Sanders and Chuck Broste. The second technique we utilized was a 1x1 m unit excavation dug out at 5 cm levels. Currently, 13 levels have been excavated, and the depth of the unit is 65cm. Approximately 3/4 (n=281) of our lithic assemblage was obtained through pedestrian survey, while the remaining 1/4 (n=91) was produced through our 1x1 m unit excavation. As the lithic debitage analysis was conducted on the waste flakes collected from the 1x1 (n=87), it is important to consider the potential differences between the artifacts collected from both.

The most basic way to determine differences between the two Gruenig collections is to compare relative abundance of raw materials. Looking at the Figure below, one main difference is easy to note. There is an obvious difference between the Tongue River Silica collected in the

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4 Some of these materials are also from Iowa, but we were able to more precisely identify them. Additionally, Bakken had identified some quartz artifacts as Fat Rock Quartz, but the data was lost during the process of cataloging.
field compared to the amount of the material collected in the 1x1 m unit. Another notable difference is the relative amount of Swan River Chert in the 1x1 m unit as compared to the amount found in the field.

![Relative Abundance of Raw Materials in Field vs 1x1 m Unit](image)

Figure 6: Relative Abundance of Raw Materials in Field versus 1x1 meter Unit

There are three potential reasons that could explain the differences within Tongue River Silica and Swan River Chert: 1) The area we placed our 1x1 m unit was not representative of the site as a whole and had an unusually high amount of TRS. 2) The methodologies of the field and of the 1x1 m unit led to differences of collection. 3) The deeper levels of the site contain more Tongue River Silica, and the unit is representative of the Gruenig site’s older components.

The first possible explanation in the different relative amounts of SRC and TRS may simply stem from the section of ground we decided to dig. It is possible that if we had chosen a
spot a meter to the left or right the materials excavated would have been more characteristic of the whole site. Further excavations can help determine if this is the case.

The second possible explanation could come from a multitude of sources of methodological difference. The dirt from the unit was filtered with a 1/4" mesh screen, whereas no dirt was screened from the field. This means that small flakes could be found from the unit while the members of the pedestrian survey would have a much harder time finding flakes in the smaller sizes. The proximity to the ground may have also played a part in finding certain materials. The surveyors may have a hard time walking the field and seeing brown colored Tongue River Chert in the dirt field while unit excavators would have an easier time as they were directly on top of the unit.

The third possible explanation (pertaining to temporally diagnostic changes in raw material use) and its significance will be explored later on in the paper.

In general, the flakes and artifacts found in the field were larger than the flakes and other artifacts found in the 1x1 m unit. This is another expected finding as it is much harder to see small flakes and artifacts while surveying a large field and trying to look five to ten feet away on either side. It is possible that this may help produce an assemblage of artifacts that is more represented by flakes that tend to be detached or break off in large chunks rather than those which shatter into smaller pieces.

While some tools were found in the 1x1 m unit, they were mostly fragmentary. There were no projectile points or complete cores produced. In the field seven projectile points of various lithic raw materials were found. This difference in the presence of tools may be linked to a difference in activities done in this particular area of the site.
RAW MATERIAL OVER TIME

The next series of analysis involves the differences and similarities between the upper and lower sections of the main 1x1 m unit. The division of these two halves was selected at level 6 which produced no artifacts. The upper half represents the waste flakes from levels 1-6 (n=41) while the lower half represents the waste flakes from levels 7-13 (n=46). These analyses were conducted in order to try and understand any temporal change within the unit. The analysis included looking at count by raw material, average platform angle, platform type, and weight by half. It was found that Tongue River Silica becomes a more predominate raw material in the lower levels possibly indicating an Archaic component for the Gruenig site.

The first analysis performed was just a simple count of artifacts by raw material, looking at levels specifically, and halves in general. The results of this analysis were slightly ambiguous. Although the sample size was not as large as one would like, some patterns were still evident. Tongue River Silica represented a much higher percentage of the lower half than the upper half. In the last level excavated, it was the only material found (2 flakes). In a reverse trend, Swan River Chert was one of the most abundant sources in the upper half of excavation, but in the bottom of the lower half the local material was not found.
The opposing trends of Swan River Chert and Tongue River Silica may potentially represent temporal changes of raw material use as described by Bakken. He notes that in earlier, Archaic times materials such as Knife River Flint and Tongue River Silica were more commonly used than the common local materials found in the area. It is possible that these differences in material by half may be the best evidence that this site was at one time occupied by Archaic peoples.

The second analysis performed involved looking at average platform angle by half. While looking solely at platform angles by level, no significant pattern or observance can be
made; however, when looking at both the upper and lower halves of the 1x1 meter unit, a very slight difference is evident. The lower, deeper half of the 1x1 m unit produced flakes that had a small increase in average platform angle. This may possibly mean that the earlier half had more later stage production.

![Figure 8: Average Platform Angle by 1x1 m Unit Half in degrees](image)

The next analysis performed concerning change in depth of the unit and possibly time concerned platform type. This analysis of the two halves did not present many obvious patterns; however, it may be worth noting that the lower half was somewhat dominated by Single-Facet platform types.
The last analysis involving the halves concerned weight differences. When viewing the halves, there appears to be a significant difference between the upper and lower sections. The flakes from the lower section average about 50% more weight than the upper section. The differences in the weights may only arise randomly or due to a small sample size for each section, but they also may indicate a use of worse quality materials in older components of the site or more early stage production. It is hard to make any claims or general statements about the relationship between depth and weight.
In summary of this section, the key result seems to come from the difference of Tongue River Silica and Swan River Chert. The higher amounts of Tongue River Silica and the lower amounts of Swan River Chert may be indicative of an Archaic Period component at the site. This would also be corroborated by the heavier average flake weight as TRS often breaks off into larger chunks. This section of analysis was the most useful in figuring out the answer to the overarching temporal question surrounding the Gruenig site and the Jeffers Petroglyphs.

**RAW MATERIAL AND TECHNOLOGY**

The technological use of raw materials differs due to stage of production, quality of raw materials, and origins of raw materials. In order to better understand the raw material use at the Gruenig site, technological attributes were recorded for the waste flakes found in Unit 1. This approach can yield results which shed light into the use patterns of the material. These attributes serve to describe the nature of the materials found at Gruenig. In order to ensure that the attributes were indeed indicating what they should, I performed the protocol tests earlier described.

**Analysis by Raw Material**

In this next section I will go over the results of analyses performed in order to get a better understanding of the relationship between lithic raw material type and its use and technology. The analyses involved looking at the relationships between platform angle and raw material type, weight and raw material type, and cortex and raw material type. This data will help us understand how each raw material was treated and utilized at the Gruenig site. Additionally, the data may help show cobble or preform size. The findings indicate that Galena Chert, Burlington Chert, and Knife River Flint are generally being utilized in a manner characteristic of exotic
materials, while Tongue River Silica and Swan River Chert are being used in a manner characteristic of local materials. Prairie du Chien Chert is a standout here, with some attributes denoting an exotic nature and others a local nature.

The first analysis was performed in order to better understand the relationship between platform angle and material type. The platform angle can show both the technologies used as well as the type of lithic artifact that the flinknapper(s) may have started with while beginning his reductive process at the site. The results of this analysis were quite interesting. Upon completion, it was clear that there were two distinct groups of lithic raw materials. The first group consisted of the following lithic materials: Swan River Chert, unidentified chert, Red River Chert, and Tongue River Silica, and Burlington Chert. This category of materials all had a relatively lower average platform angle. These results would be consistent with the expectation of local raw materials as all stages of production would be evident creating an average that would fall more in the middle.

The second group in this analysis consists of Prairie du Chien Chert and Galena Chert. These non-local materials are commonly found in southeastern Minnesota and western Wisconsin. The higher average platform angle is in accordance with the non-local source of these materials. It is likely the case that bifacial preforms or finished tools were brought to the Jeffers Area to be worked on using middle or late stage production.

\(^5\) Burlington Chert is included in this category though I suspect that the local nature of its characteristics in this analysis stem from its small sample size.
The next analysis concerning raw material use and technology involves the average weight by raw material type. This analysis also shows the stage of production and availability of raw material at the Gruenig site and the surrounding area. The results produced three distinct groups of materials. The first group had the lowest average flake weight. This group consists of Burlington Chert, Knife River Flint, Quartz, and Galena Chert. The results show and support the non-local and low abundance characteristics of Galena Chert, Burlington Chert, and Knife River Flint. They also suggest that these materials were being utilized at later stages of production at the Gruenig site. The fourth material, Quartz, falls into the low average weight category also; however, the low average weight more likely stems from the low quality of the material and its nature to break off into smaller chunks during bipolar reduction.

The second main group of lithic raw materials in this analysis consists of Swan River Chert, Red River Chert, and Prairie du Chien Chert. Another material type that may fall into this category is Quartzite; however, the sample size is significantly small (1 flake), and it is quite hard to say anything of importance about its placement here as the category is very generic. This
group appears to represent local and abundant resources as the average falls between heavy and light flakes. The commonality of these materials could mean that both early and late stage production of them occurred at the site creating an average between the two. It is important to note here, that Prairie du Chien Chert is behaving like a local material.

The final grouping consists of one material: unidentified chert, which has a much higher Average Flake Weight than the other groupings. The next highest average flake weight (Tongue River Silica) is nearly four times smaller than that of unidentified chert. This characteristic may stem from the act of testing local river cobbles. Upon breaking open these cobbles, the material may be discarded if deemed unusable for lithic production hence the larger, heavier flakes.

![Average Weight by Raw Material (grams)](image)

Figure 12: Average Weight by Raw Material in grams

The final analysis conducted in the raw material technology category concerns the relationship between material type and presence/absence of cortex. The results of this analysis seem to create three distinct categories of raw materials. The first of these groups contains four raw materials consisting of Burlington Chert, Knife River Flint, Quartz, and Quartzite. The materials in this group were not represented by any flakes that contained cortex. The absence of
cortex for Burlington Chert flakes and Knife River Flint flakes is most likely explained by their exotic nature. The absence of cortex for Quartz and Quartzite flakes may stem from their "chunking" characteristic and very small sample size.

The second group of materials in the cortex presence analysis consists of Galena Chert, Prairie du Chien Chert, and Swan River Chert. The fact that Galena Chert has such a high percentage of flakes with cortex is quite surprising as it is an exotic material which does not usually show up in high numbers in the area. One would think that it would fall closer to the first category of no present cortex. One possibility is that the sample size is skewing the data. The remaining lithic raw materials in the grouping, Prairie du Chien Chert and Swan River Chert, are also quite interesting. Prairie du Chien is once again acting as a local material similar to Swan River Chert. As the presence of cortex for these raw materials is between 15%-20%, it appears that both early and late stage production of PDC artifacts was occurring at the Gruenig site.

The third group of lithic raw materials in the cortex presence analysis consists of Tongue River Silica, Red River Chert, and unidentified Chert. These raw materials had much higher presence of cortex than the other two groupings. The Red River Chert and unidentified chert may have a high average presence of cortex as the materials are found in small river pebbles in the nearby Little Cottonwood River. Smaller cobbles or pebbles have a higher surface area to volume ratio which means that there are more cortical flakes per non-cortical flake than is usually found. The high presence of cortex for Tongue River Silica might be explained by its relatively bad quality of material. Again, poor quality tested pebbles would simply be discarded.
Discussion of Select Raw Materials

Prairie du Chien Chert

The Prairie du Chien Chert at Gruenig does appear to be important as Bakken stated, but it appears that the inhabitants of this site utilized this resource heavier than what is the norm for the area. Bakken does note, however that the highest percentage of PDC in a site in the Shetek sub-region is 14.6% which is nearly that of Gruenig (14.8%). The heavier use is particularly evident when looking at the raw materials of the tools. Prairie du Chien Chert accounts for almost 1/4 (23.3%) of all the tools produced from the Gruenig site. This is dramatically higher than most sites in the area. Out of the sites I analyzed, the nearest amount of PDC in tools came from a Redwood County site where the material amounted for 16.7% of the tools.
When looking at the debitage analysis, it is not quite clear how the material is behaving. The average platform angle of the Prairie du Chien flakes is high indicating later stage production; however, the average weight is also on the high side indicating earlier stage production. The presence of cortex falls somewhere in the middle of early and late stage production. The availability of the resource may factor in on this data. If the Prairie du Chien was brought in as preforms or blanks, the higher platform angles would be accounted for. If they also brought river cobbles to the site, the early and middle stage production could be accounted for. Prairie du Chien Chert river cobbles can be difficult if not impossible to break open in a controlled manner without the use of heat treatment (Reider and Kvendru 2013). The role of Prairie du Chien Chert at the site is quite interesting. Further excavation and analysis is suggested to better understand this phenomenon.

**Swan River Chert**

Swan River Chert appears to act very similarly at the Gruenig site as it does commonly throughout sites in the area. Bakken’s dissertation (2011) documents that SRC is a common material in the Shetek sub-region of southwestern Minnesota, and my data correlates with that reported by Bakken. It is clear that Swan River Chert was a very important lithic resource for those who stayed at the Gruenig Site. The only time the material seems to behave uncharacteristically is within the 1x1 m unit. The relative abundance of the material greatly falls as the levels become deeper. This will be further discussed in the Tongue River Silica section.

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6 This January (2013) I attended a class called Experimental Archaeology. My classmate Grant Kvendru and I conducted experiments pertaining to heat treatment and cutting efficiency of lithic materials. For the experiment we heat treated flakes, core-like rocks, and large cobbles of Prairie du Chien Chert and Swan River Chert. All objects were heat treated for one hour at 500 degrees Fahrenheit in a pan covered in sand within an oven. Though the results of cutting efficiency were inconclusive, the specimens were indeed easier to flake after heat treatment.
**Tongue River Silica**

In the debitage analysis, Tongue River Silica had a middle-range platform angle with a relatively high weight and presence of cortex. TRS is a poor quality material (Bakken 2011). It is possible that the lack of quality necessitated more cobbles or larger cobbles than other materials to produce tools. More interesting is the increase in abundance of the material as the levels of the 1x1 m unit increase in depth. This pattern corresponds to the drop in abundance for the Swan River Chert. The relationship seems to indicate that as one material becomes more heavily used, the other becomes less important in tool production.

**Red River Chert / Unidentified Chert**

Red River Chert is commonly found in the area of Jeffers. The RRC artifacts at the Gruenig site appear to be reduced from small pebbles of a relatively good quality material. The unidentified Chert artifacts, most of which were probably also made from locally available pebbles, seem to mimic the characteristics of the Red River Chert counterparts. These materials may have been used interchangeably.

**Iowa Chert Group**

The Iowa Chert Group is an important element in lithic assemblage of Jeffers. Similarly to the Knife River Flint, this category of lithic raw material had a very high tool to flake ratio. The Gruenig assemblage appears to have a much higher percentage of Iowa lithic raw materials in comparison to the assemblages produced from sites elsewhere in southwestern Minnesota. This material is one of the most abundant exotic cherts that was produced from the site. The high presence of materials and tools from this group is one of the best pieces of evidence for the regional significance of the site. If exotic lithic raw materials is a reflection of the frequency of
non-local people, then it appears that people from Iowa and eastern Minnesota were coming to Gruenig (and Jeffers) more frequently than they were going to other areas of southwestern Minnesota.

**RAW MATERIAL ACROSS SHETEK**

![County Map of Minnesota](https://www.digital-topo-maps.com)

Figure 14: County Map of Minnesota (Digital-Topo-Maps.com)

In order to get a more comprehensive understanding of the Gruenig site in context to the region, I obtained the lithic raw material data from twelve other sites along with the aggregate data for the region. The twelve sites in my comparative analysis came from counties in the
surrounding area of Jeffers and Cottonwood County. Additionally, I also included the relative abundance of raw material for the Shetek sub-region of South Agassiz in Minnesota. Most of the lithic raw material identification came directly from Dr. Bakken who was gracious enough to share with me his information and work.

Due to the nature of the data I had at my disposal, I could only analyze two sets of information from the series of assemblages: relative abundance by raw material for all chipped stone lithic artifacts and relative abundance by raw material for all flint tools. For the relative abundance by raw material for all flint tools analysis I was forced to exclude assemblages from two of the sites as I was not able to view the artifact object types.

Three main patterns emerged from my regional analysis in the Shetek sub-region of South Agassiz. The first pattern once again involved the use of Prairie du Chien Chert. Prairie du Chien Chert was the most abundant exotic material in the assemblages included in my study. Secondly, this pattern was exemplified by the Gruenig site which had the highest abundance of PDC, especially when looking at tools. Finally, the amount of exotic materials at Gruenig stands out as having a higher than average amount of non-local cherts.

The following figures are difficult to analyze due to their cluttered nature, but the important patterns are evident. In both figures, the relative amount of Prairie du Chien from Gruenig clearly rises above the amounts of the material from the other sites in the area.

The first set of data looking at raw material of all lithic artifacts produced interesting results. The most notable difference between the Gruenig site and the rest of the assemblages was the relative amount of Prairie du Chien Chert which was considerably higher than all of the other assemblages.
Figure 15: Relative Raw Material Abundance of Sites in the Region
Figure 16: Relative Abundance of Raw Material Types in Tools of Sites in the Region
Similarly, the second data set which looked at the relative abundance of each raw material type of only tools was marked by a much higher presence Prairie du Chien Chert tools, even more so than the previous data set.

I broke down these figures by county in order to better visually represent data. The first group of sites was located in Lyon County. This Minnesota county is located diagonally to the northwest of Cottonwood County, where the Gruenig site is located. I was able to obtain the lithic data from three sites in this county: 21-LY-39, 21-LY-43, and 21-LY-120. There were two main points of difference between the Gruenig site and the three Lyon County sites. The relative abundance Prairie du Chien Chert of the Gruenig site was much higher than the Lyon County site; conversely, the relative abundance of Swan River Chert was much higher in the Lyon County sites than that produced out of the Gruenig site.

Figure 17: Relative Abundance of Raw Materials from Sites in Lyon County
I also compared the relative abundance of raw material type of tools from the sites located in Lyon County to the Gruenig site. Prairie du Chien Chert was again much higher in the Gruenig site than in the sites from this particular county. Grand Meadow Chert is another notable point of differentiation between the two groups. The tools of one individual site is comprised of 1/3 Grand Meadow Chert artifacts. This is in deep contrast with Gruenig as the site has not yet produced any of this material. Lastly, Swan River Chert makes up a lesser amount of the relative abundance of raw material type for tools in the Gruenig site than what seems to be average for sites in Lyon County.

Figure 18: Relative Abundance of Raw Materials in Tools from Sites in Lyon County
Murray County is located directly west of Cottonwood County and the Gruenig site.

Three sites from Murray County were included in my regional analysis: 21-MU-10, 21-MU-39, and 21-MU-83. The relative abundance of Prairie du Chien Chert was once again the most notable difference between the Murray County sites and the Gruenig site.

![Figure 19: Relative Abundance of Raw Materials from Sites in Murray County](image)

In regards to relative abundance of material in the lithic tools assemblage in Murray County, Prairie du Chien Chert represents the widest disparity of any raw material in this county. Neither of the two sites in this county included in this tool analysis contained any lithic tools that were created out of this material. Additionally, one of the sites had a very high amount of Knife
River Flint tools, whereas only about 5% of the tools at the Gruenig site were of the material; however, the other site from Murray County had a slightly smaller relative amount of Knife River Flint tools than the Gruenig assemblage.

**Figure 20: Relative Abundance or Raw Materials in Tools (Murray County)**

Nobles County is located to the southwest of Cottonwood County. The two sites included in my research found in this county are 21-NO-4 and 21-NO45. The relationship between these two sites and the Gruenig site is similar to that of Lyon County: Gruenig had a much higher
relative abundance of Prairie du Chien Chert and the Nobles County sites had a higher relative abundance of Swan River Chert.

Unfortunately, I was not able to utilize any site from Nobles County in my analysis of relative abundance of raw material of tools.

The only other site which I had information for in Cottonwood County besides Gruenig was 21-CO-39. Interestingly, the two sites seem to be of a very similar nature in terms of its lithic relative abundance. Of all the sites in my regional analysis, 21-CO-39 was the most similar to the site near Jeffers including the relative amount of Prairie du Chien Chert.
There were three main distinctions between the two Cottonwood County sites in regards to relative abundance of raw material of tools. Once again, the relative amount of Prairie du Chien Chert was much higher for the Gruenig site. Conversely, the relative amounts of Swan River Chert and Grand Meadow Chert were much higher for 21-CO-39.
Redwood County is located directly north of Cottonwood County and the Gruenig site. I was able to access the lithic information from two sites in this county: 21-RW-53 and 21-RW-57. Compared to these sites, the Gruenig site continued to have a higher relative abundance of Prairie du Chien Chert. Another notable difference pertains to Grand Meadow Chert. This flint was absent from the Gruenig site, while it accumulated to around 20% of one of the Redwood County sites. It may be worth noting that the other Redwood site also contained no Grand Meadow Chert.

Figure 23: Relative Abundance of Raw Materials in Tools from Sites in Cottonwood County
The sample size of the tools in the Redwood County sites was low. It is hard to make out much in this comparison although one of the sites had an amount of Prairie du Chien Chert which is closer to that of Gruenig than almost any other site I used in this study. Additionally, the level of Swan River Chert in the two Redwood County sites appears to be quite low, but again, this may be more a sample size error more than diagnostic data.
The only lithic data from Yellow Medicine County I was able to use in my regional analysis came from the 21-YM-50 site. Yellow Medicine County is located to the northwest of Cottonwood County, just above Lyon County. This site had a higher relative abundance of Knife River Flint, Red River Chert, and Tongue River Silica; it had a lower relative abundance of Prairie du Chien Chert and Swan River Chert when compared to the Gruenig site.
In regards to the comparison between the tools' relative raw material abundance, two main points of contrast are found when viewing the Gruenig site and 21-YM-50. The first concerns Prairie du Chien Chert: the Gruenig site has a much higher relative abundance of the material in its tool assemblage. The second point of difference is the higher amount of Knife River Flint for the Yellow Medicine County site.
The last comparison of assemblages I analyzed was between the Gruenig site and the whole of the Shetek Sub-region of South Agassiz. The aggregate data of this sub-region had a higher relative abundance of Knife River Flint, Quartz, and Swan River chert; the Gruenig site had a higher relative abundance of Prairie du Chien Chert and a slightly higher relative abundance of Red River Chert.
The most notable differences between the Gruenig site and the other sites in the area are quite clear. Prairie du Chien appears to have a unique position in the raw materials of the Gruenig site. Not only is the relative amount of this material higher in the overall assemblage, it dwarfs almost all of the other sites when looking at relative abundance of raw material in tools. The amount of exotic materials, especially in tools, from Gruenig points towards a special position for the site. If the site was used in a similar manner to the other sites in the vicinity, the raw material assemblages should be relatively similar. The results indicate that this was not simply a normal site on the seasonal rotation for American Indian groups in the region.
DISCUSSION

This is the first research project focusing on the Gruenig Field, an archaeological site associated with the Jeffers Petroglyphs. My involvement began about a year and a half ago during my field school. Over the past year and a half, four separate excavation periods were performed and over 500 artifacts have been collected with the majority being lithic debitage. From the beginning of the project, our three main research questions have remained the same: Who created the Jeffers Petroglyphs?; What is the nature of the Gruenig site?; and When were the Jeffers Petroglyphs created, modified, or visited?

To answer the first question, we had originally hoped that the combination of lithic raw material identification and projectile point typology analysis would provide sufficient evidence to get a baseline of understanding. After the first couple series of excavations it became clear that the latter would be much more difficult to utilize as only a small number were found, whereas the former would become the primary focus of analysis to answer this research question. Using the Minnesota Historical Society's and Hamline University's lithic comparative collections the raw material identification began.

As stated earlier, Sanders feels that the Jeffers Petroglyphs had a vast, regional significance. Should this be the case, we would expect to find a large number of exotic artifacts and lithic materials. While the amount of exotic lithics was not incredibly high, it was sufficient to at least partly support Sanders's claim. It seems that Iowa resources played an important role in the lithic production for those staying at the Gruenig field. Prairie du Chien is noted for being an exotic material with a local importance in the southwest corner of the state. This especially rings true for the Gruenig site, where it is on the top tier of utilized lithic raw materials.
My second main research question was: What is the nature of the Gruenig site? We wanted to research how the site was utilized, i.e. habitation site, lithic production site, short-term camping site, etc. The main source of information to answer this question comes from the lithic debitage analysis. It appears that this site was not specifically a lithic production site. Though we found a considerable number of lithic artifacts, the density was not particularly high. The site does not appear to be a short-term camping site as all stages of production are evident. A camping site use for a short period of occupation would also presumably create lithic debitage of mostly late stage production as in the case of re-sharpening tools. Conversely, it could potentially be possible that a short term site would leave behind evidence of early stage production should visitors have come to collect cobbles and leave with bifaces or preforms. The lithic assemblage appears to be that of a habitation site representing all stages of production while still containing a low lithic artifact density. The presence of multiple cobble tool types may reinforce the notion of a medium to long duration habitation site. The cobble tools indicate that the inhabitants were engaged in a number of daily tasks that required chopping and grinding. These tool types are typically more abundant at long duration habitation sites (Anfinson 1997). These findings are by not definitive. A future comparison between the tool types at Gruenig and the tool types at other sites in the area would be beneficial in order test this conclusion.

The final research question involved the chronological history of the site. Originally, projectile point typologies were going to be the central avenue for addressing the question of Gruenig’s temporal history, but the sample size was not sufficient, and other forms of analysis were necessary for its replacement. Therefore, in order to address this question, the 1x1 m unit debitage analysis was performed. As the unit depth increased, so too did the amount of Tongue River Silica and, to a lesser extent, Knife River Flint. According to Bakken (2011) these trends
may be more characteristic of an Archaic Period site than a Woodland site. As the sample size of the unit discussed is not particularly large and a true projectile point analysis was not possible, additional excavations and analysis are necessary in order to further address this question.

CONCLUSION

The analysis of the Gruenig site assemblage has helped address questions regarding the creators of the Jeffers Petroglyphs as well as its significance to the region. The lithic artifacts have told of the exotic nature of the site, pointed towards the use of Gruenig as a habitation site, and have evidenced utilization in at least two Minnesota chronological periods. The analysis of the Gruenig site performed has only touched on the major research questions; there is still much to learn.

Additional excavations at the Gruenig site would be invaluable to the ongoing research project. A larger sample size would help clarify the nature of the Gruenig assemblage. More 1x1 m units would help to better understand the history of the site as there is currently only one unit which has produced a meaningful amount of flakes. Consequent units would determine whether or not the TRS and KRF abundances consistently rise as the depths increase. Furthermore, most of the artifacts have been produced from the plowed field. While plowed fields may be helpful in bringing numerous artifacts to the surface negating the need for actual digging, stratigraphy is almost entirely lost. In order to increase our understanding of the site, I feel that uninterrupted land excavation is essential in order to truly understand this site.

Other research, such as what the University of Minnesota team is doing, will continue to shed light unto the petroglyphs at Jeffers. Further excavations in the area at other sites associated with the Jeffers Petroglyphs and technological studies such as the micro-scanning operations
hopefully continue to move forward. The breathtaking rock art has almost certainly been of the
utmost importance to many people over its long history. We may never completely know the past
meanings and natures of the Jeffers Petroglyphs, but any additional information obtained would
greatly inform our current understanding.

POST-SCRIPT

During the oral defense of my thesis, members of my committee brought up several
questions regarding the nature of my project. Tom Ross made a valid point that my narrative
within the thesis is brief and hidden beneath the numbers and jargon of my analysis. This
critique reflects a problem facing archaeologists of today. How do you create a project that has
sound methodologies and conclusions supported by data, while not leaving out the human side of
archaeology? After all, archaeology is about understanding people. But, in my focus on debitage
analysis and stone raw materials, my thesis spoke too little about the people that created the
archaeology record. I offer this post-script in an attempt to address my committee’s concerns
about narrative and meaning.

During my time at Hamline University, including classes, fieldwork, and conversations
with faculty, I have learned much about the importance of respectful collaboration with
American Indians and descendant communities. In my own research, I have been fortunate
enough to collaborate with many people coming from many different backgrounds. Though this
has been incredibly useful and insightful for me (for both my project and for my professional
development), I still have much to learn. I personally see collaboration as on-going process. It is
a constant dialogue in which everyone brings something different to the table. These differences
help rather than hinder collaboration. They allow for alternative viewpoints to be thought about and discussed. We must stay open-minded, and we must listen.

My thesis contains relatively little about the depth of meaning behind the sites. This is not due to apathy. The goal of my project was simply to learn anything possible about the Gruenig site and the Jeffers Petroglyphs so that we may better understand their stories. So here is how I see the meaning of my work:

The field that we now call Gruenig has been the temporary home of people for thousands of years. These people traveled west from southeastern Minnesota and north from Iowa. From these places they brought along local stone in order to make tools and use them for butchering animals among other things. During their time at the field, conversation would almost certainly focus on the Jeffers Petroglyphs.

Generations of families would have visited the site. I can imagine the importance of the first visit, most likely shared with elder familiar figures. Whether the site's current use was for initiation, medicine, or revering one's ancestors, the noticeable power of the rock carvings on the outcrop must have been immense.

While visiting the Petroglyphs, the sound of the pecking of the rock must have been loud. I would not be surprised if the rock artists would peck in unison or in a pattern in order to create rhythm. These songs would be supplemented at night by the red sparks created when the local hard stone collided with the outcropping. It would be a powerful event for all the senses.

It appears likely that it would be a common occurrence for more than one group of people to visit the Petroglyphs at a given time. When this happened, I imagine that the two or more groups would have shared stories with one another and given their own understanding of what the site meant to them. Strong relations could be formed or reinforced during their visit together.

The Jeffers Petroglyphs has been an important landmark in Minnesota for thousands of years. It has been a site of prayer, a site of ritual, a site of learning, and a site of sharing. The Jeffers Petroglyphs site is a living and striving part of the land. To this day, many people are just experiencing the petroglyphs for the first time. I first visited the site almost two years ago with little to no knowledge of what it all meant. Since then I have traveled there on many more occasions and have never left without learning something new. The site has not stopped being a place for people to come together. I have met many wonderful people at this site. As a group, we worked with one another and will continue to work in order that we may better understand.

"Jeffers is a conversation that started 10,000 years ago."

-Tom Sanders
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University of Minnesota
HAMLINE ARCHAEOLOGICAL LAB

LITHIC WASTE ANALYSIS PROTOCOL

1) FLAKE CLASS

WFC Waste Flake Complete: Platform present, termination intact (enough for length measurement)

WFB Waste Flake Broken: Platform present, termination absent (includes flakes terminating with a snap fracture)

WFF Waste Flake Fragment: Platform absent, identifiable ventral surface

WSH Waste Shatter: Platform absent, unable to identify a ventral surface

2) RAW MATERIAL TYPE

<table>
<thead>
<tr>
<th>Code</th>
<th>Type</th>
<th>Translucence</th>
<th>Crystal-Size</th>
<th>Color</th>
</tr>
</thead>
<tbody>
<tr>
<td>BAS</td>
<td>Basalt phenocrysts</td>
<td>opaque, dull/shiny</td>
<td>micro</td>
<td>black/grey</td>
</tr>
<tr>
<td>IGN</td>
<td>Igneous other poor quality</td>
<td>opaque, dull</td>
<td>macro</td>
<td>dark/light</td>
</tr>
<tr>
<td>RHY</td>
<td>Rhyolite</td>
<td>opaque, dull/shiny</td>
<td>micro</td>
<td>light</td>
</tr>
<tr>
<td>OBS</td>
<td>Obsidian black/grey/green/banded</td>
<td>translucent, glassy</td>
<td>crypto</td>
<td></td>
</tr>
<tr>
<td>CHE</td>
<td>Chert</td>
<td>trans-opaque, dull/glassy</td>
<td>micro-crypto</td>
<td>other</td>
</tr>
<tr>
<td>CHA</td>
<td>Chalcedony clear/white/brown</td>
<td>translucent, glassy</td>
<td>crypto</td>
<td></td>
</tr>
<tr>
<td>QTZ</td>
<td>Quartz</td>
<td>semi-translucent</td>
<td>macro-micro</td>
<td>white</td>
</tr>
<tr>
<td>QTT</td>
<td>Quartzite white/tan/pink/yellow</td>
<td>semi-translucent</td>
<td>macro</td>
<td></td>
</tr>
</tbody>
</table>
SST  Siltstone
    banded
opaque, dull/shiny micro black.grey

3) DORSAL CORTEX (PRECENTAGE)
A  0 %
B  1 % to 50 %
C  51 % to 99 %
D  100 %
E  Platform only

4) CORTEX TYPE

SMOOTH  (mechanical weathering)
    WATER  Water-worn
    POLISH  Polished (sand blasted; desert varnish)

Chemical weathering
    PAT  Patinated
    CHALK  Chalky

Other
    BED  Bedrock cortex
    NOD  Nodule
    STAIN  Stained/Discolored

5) SIZE GRADE: Record size grade of flake to nearest 0.5 cm.

6) LENGTH: WFC, WFB record platform to termination in millimeters (mm). WFF/WSH record maximum dimension in mm.
7) WIDTH: Dimension in mm measured 90° from length.

8) THICKNESS: Maximum thickness of flake in mm.

9) WEIGHT: (recorded to nearest 0.01 g)

10) PLATFORM ANGLE: Measurement of angle between ventral surface and striking platform; recorded to nearest 5°.

11) PLATFORM TYPE

   COR  Cortical
   SGL  Single facet
   DBL  Double facet
   MPL  Multiple facets
   BIP  Bipolar; opposing points of impact
   CRU  Crushed
   IND  Indeterminate

12) PLATFORM GRINDING

   A  Absent
   P  Present
   N  Not Applicable

13) LIP

   A  Absent
P Present
N Not Applicable

14) BULB
A Absent
D Diffuse
P Pronounced
N Not Applicable

15) FLAKE TERMINATION
FTH Feathered (thins to a fragile, fine edge – often edge becomes transparent)
SHP Sharp (terminates rapidly to a sharp, complete edge, thicker edge than feathered)
STP Stepped, snapped, or broken (terminates with an abrupt angle towards the dorsal surface)
HNG Hinged (terminates with an abrupt curve towards the dorsal surface)
PLG Plunged (terminates with an abrupt curve away from dorsal surface – removes biface edge)
FLW Flaw (terminates on an inner flaw)
CTX Terminates by breaking through cortex
BIP Bipolar (force applied to both ends)
IND Indeterminate

16) COMMENTS: Record “edge-damaged flake” or other evidence of utilization, thermal alteration, burning. Record other observations.
Aniakchak Archaeological Project
Chipped Stone Projectile Point Protocol

BAGNO: Bag number

CATNO: Catalog number

**RawMat 1:** (Choose one of the following material types)

- Basalt (dark, fine-grained igneous)
- Chert (translucent to opaque cryptocrystalline silicate)
- Chalcedony (very translucent to transparent cryptocrystalline silicate)
- Other

**RawMat 2:** (Choose from Aniakchak lithic material types sheet)

**COMP:** Artifact completeness

- C – *Complete*; all margins intact
- NC – *Near Complete*; small portion of edge/tip/base missing; most dimensions can still be accurately measured; tool could be reworked into essentially same type and size as “original” tool.
- B – *Broken*; major portion of artifact; “original” shape of still discernible;
- F – *Fragment*; laterally or longitudinally snapped tool; can have multiple fragments of the same “original” tool, but only one broken portion.
**MPORT:** Missing portion of near complete/broken points. Can have more than one MPORT entry. Select from terms below and use Figure 1.

- **TIP** – Point distal end
- **TIP/BLADE** – Use when substantial portion of blade is missing
- **HAFT** – Entire haft element missing
- **BASE** – Portion of haft intact, but missing base
- **SH** – Shoulder (typically missing the corner between blade and haft)
- **EAR** – Basal corner of haft element missing
- **EDG** – Missing a lateral edge segment
- **OTH** – Other portion missing

![Point Parts](image)

Figure 1: Point parts
**Point Class:** (Choose from Figure 2)

*Lanceolate*

- Straight lanceolate point (Base width = Blade width; +/- 1 mm)
- Contracting lanceolate point (Base width < Blade width)
- Expanding lanceolate point (triangular point; Base width > Blade width)
- Bipoint (lanceolate point with ‘pointed base’)

*Stemmed*

- Straight stemmed point (Base width = Neck width; +/- 1 mm)
- Contracting stemmed point (Base width < Neck width)
- Expanding stemmed point (Base width > Neck width)

*Notched*

- Side notched point
- Corner notched point

*Miscellaneous*
Figure 2: Point Class
Point Type: (Choose from Figure 3) (NOTE: I’m still working on this attribute).

*Straight Lanceolate*

Fishtail point

*Contracting Lanceolate*

Izembek point

*Miscellaneous Points*

V-point (see Figure 1)

Shoulder Type: (Choose from Figure 4 – see also Figure 6 for SSA)

Barbed – blade margin extends beyond the top of the stem (SSA < 90°)

Squared – blade margin turns 90° into stem (SSA = 90°)

Sharp – intermediate form between rounded and squared shoulder types

Rounded – blade margin turns gradually towards base (SSA > 90°)

Base Type: (Choose from Figure 4)

Straight

Convex

Pointed

Indented
Figure 6: Angle measurements
Figure 4: Shoulder types and Base types
Metrics:

![Diagram of Measuring Points]

Figure 5: Locations for length and width measurements

**Total length** (A): Tip to base.

**Blade length** (B): Tip to haft. For lanceolate points, the tip/haft division is at the point of maximum blade width.

**Haft length** (C): Base to blade.

**Blade width** (D): Maximum width of blade.

**Neck width** (E): Minimum width of constriction between blade and haft for stemmed and notched points.

**Base width** (F): Maximum width of base. Note this measurement is not necessarily the same as maximum haft width.

**Maximum thickness**: Maximum thickness of tool as measured in any part.
Note on metrics: All measurements are recorded in millimeters (mm). Use an asterisk* to indicate a measurement recorded on an incomplete dimension. Refer to Figure 3 for explanation of point parts.