This chapter provides a synthesis and overview of current knowledge concerning lithic raw material resources in Minnesota. A large part of the state is covered with glacial drift, which served as a diffuse source of raw materials. Primary geological sources such as outcrops and lag deposits also served as raw material sources in some parts of the state. Three raw material resource regions are defined and described, each containing a different set of raw materials and types of raw material sources (Figure 6.1). Strategies for conducting a raw material analysis within this context are discussed, including both identifying individual materials and interpreting the significance of a lithic assemblage. A cross-referenced list of raw materials found at regional sites is included.

Stone artifacts are probably the most abundant and certainly the most enduring traces of the prehistoric human presence in Minnesota. In order to glean as much information as we can from these traces, we analyze any number of subtle variations in artifact form and composition. Of the many approaches to analyzing lithic artifacts, one of the most common is the identification of raw material. In Minnesota, however, this approach has been hampered by a scarcity of published information on lithic raw materials and by an advanced state of confusion over nomenclature and terminology. In the following pages, an attempt is made to assemble what is known about lithic raw materials in the state, to organize this information and place it in a broader context, and to provide a common vocabulary for discussing lithic raw materials. Hopefully this will contribute to more productive archaeological analyses.

In many areas, describing the local lithic raw material base consists of identifying geological formations, which contain knappable silicates, describing the silicates, describing the extent of the formations, and so forth. In these cases raw material sources tend to be restricted and relatively well defined. Such situations lend themselves reasonably well to sourcing studies, such as those which compare trace element signatures of archaeological specimens with lithic samples from known sources.
in order to identify probable place of origin. In Minnesota, however, the situation is qualitatively different.

Most of the state is covered by glacial drift, which served as a lithic raw material source. Silicate rocks from various sources are mixed in the drift, and this relatively homogenous mixture is spread over vast areas—sometimes from one end of the state to the other. Traditional sourcing studies are only partially useful in this situation. Although such methods might allow archaeological specimens to be associated with a geological context, there is no assurance that the raw material was quarried from the original context rather than from a drift-related, redeposited context. A different sort of analytical approach is therefore outlined in this chapter. It is based on the gross distribution of various kinds of drift in the state, on the regional distribution of outcropping bedrock, and on the kinds of knappable lithic raw materials contained in both these types of sources. The types and amounts of raw materials represented at any given site may then be studied in comparison to regional patterns of raw material availability.

The information presented comes from a variety of sources. In part it is gleaned from archaeological and geological literature. Some information has been gleaned from conversations with archaeologists.
(both professional and avocational) working in the region. A substantial part comes from well-provenienced comparative samples collected from across the state; I am especially grateful to colleagues at the Minnesota Historical Society for their help in collecting these samples in the course of conducting archaeological surveys. The information on prehistoric use of raw materials comes from examining collections at the Minnesota Historical Society, the University of Minnesota, Moorhead State University, other institutions, and in private collections.

**Terminology.** Discussion of a few important concepts and terms will facilitate this discussion. First is the notion of “focal” versus “diffuse” raw material sources. A focal raw material source is one that has clearly defined limits, and is usually relatively restricted in extent. An example would be the Nora Member of the Shell Rock Formation. This member occurs in discontinuous locations in north central Iowa and possibly in south central Minnesota; surface or near-surface exposures are even more restricted. It contains a fossiliferous chert, which, within Minnesota, is thought to occur only in parts of two south-central Minnesota counties. In contrast, a diffuse raw material source is one that has vaguely defined limits and is relatively extensive. An example would be the Des Moines drift, which covers large areas from Manitoba to the Iowa border, and from the borders of North and South Dakota into east-central Minnesota, and even western Wisconsin. This drift contains a number of knappable raw materials, distributed more or less at random throughout this large region.

Second is the idea of “primary” versus “secondary” geological context. A material in primary geological context is in or in close association with the geological context where it was formed. Examples could include lenses of chert in a limestone bed, lag deposits of chert, which have been left behind as their limestone matrix disintegrated but which have not been otherwise dislocated or transported, or chert in talus deposits at the base of a limestone bluff. In the latter case, although the raw materials have begun to move away from their primary context, the association is still clear and the distance is negligible. A material in secondary geological context is no longer in or in proximity to the geological context where it was formed. In some cases, the primary geological context may no longer even exist. Raw materials in a secondary geological context include, for example, chert in glacial till, chert in reworked glacial sediments such as fossil beaches and outwash fans, or chert in fluvial gravels (whether ancient or modern).

This discussion is also based to some degree on considerations of human scale. Phrases such as “extensive distribution” and “restricted distribution” are meaningful only in reference to human experience, including such factors as how far a person can travel in a day or how widely a person may wander is a season and lifetime. This also relates to factors like the lifespan of a stone tool: will it be used for a day, a season, or longer? On one scale, an outcrop of chert bearing limestone a mile long might seem enormous. In reference to the distance covered during a cycle of seasonal rounds, however, the mile is small. Chert harvested from that outcrop might be abandoned at another location a hundred miles away. This definition of scale is still unfortunately imprecise. Until some meaningful, more objective scale can be articulated, however, the notion of “human scale” allows some calibration of the following discussion.

Regarding the proximity of site to lithic raw material source, three categories are used in this report—local, nonlocal, and exotic. The distinction is based on relative distance from source area and on trade patterns. Local materials are those that are available in the immediate vicinity of the site or in the
surrounding area. For the purposes of this discussion, “surrounding area” includes territory that might be covered during normal seasonal rounds. Although this definition is hardly satisfactory, it must suffice because it is not presently feasible to provide a more specific definition. In contrast, nonlocal and exotic materials are not found in the surrounding area. They may come from neighboring regions or distant sources. The distinction between nonlocal and exotic depends on circulation patterns. Nonlocal materials were traded incidentally and occur only sporadically outside of the source area. In contrast, exotic raw materials were deliberately quarried for trade or export, and were widely circulated. They are also of high quality. The most common examples at sites in Minnesota are Knife River Flint, Hixton Silicified Sandstone, and Burlington Chert.

In the following discussion, some raw material names are abbreviated. This is done not to save space but to acquaint the reader with the abbreviations. These abbreviations are in fairly common use because they have proven convenient in cataloging and discussion. Many of the raw materials discussed are known by more than one name or have a name with multiple spellings. In such cases I have used the name or spelling that seems preferable, with some explanation of my choice.

A few technical terms also require some discussion. Most of the terminology archaeologists use to discuss lithic raw materials is borrowed from the large and finely articulated vocabulary of geology. Generally this works well. But the two disciplines have different goals, and occasionally geological vocabulary does not meet the needs of the archaeologists. In such cases, what was originally a geological term may acquire a specifically archaeological usage.

This is reminiscent of the way archaeologists have borrowed the concepts and vocabulary of stratigraphy from the field of geology. These terms and ideas have been adapted and have acquired specific archaeological connotations. Perhaps this can guide our use of geological terminology in lithic studies also. While it is desirable to maintain a degree of agreement between the two fields, it is not always necessary to strictly follow geological conventions. Rather, we should feel free to make intelligent and well-considered departures from such conventions when this allows us to better meet the needs of the discipline of archaeology. Such adaptation may, in fact, be necessary. Geologists use multiple systems for describing and classifying rocks and minerals, including the kinds of materials discussed in this chapter. I have tried to select a coherent, applicable set of terms to use here. The following discussion will adhere, when practical, to standard geological definitions. Exceptions are noted.

**Types of Silicates.** Most rocks used for flaking consist principally of a material called silica, SiO₂. It is silica that gives these *silicate* rocks their desirable characteristics.¹ They are hard, break in a predictable fashion, and produce a sharp edge. They are brittle enough to flake, yet strong enough to have a durable edge.

The differences between various silicates result principally from differences in how the silica is structured, and partly from the amounts and kinds of other constituents. Both depend largely on how the rock was formed. On the basis of these considerations, silicates may be divided into a few basic groups.
The first and most important group is the *cryptocrystalline* silicates, which consist principally of microscopic silica crystals and only minor traces of other elements or minerals. These materials usually occur in sedimentary formations, and are thought to result from the chemical precipitation of silica from seawater, the gradual replacement of other minerals by silica, or other processes (see Calvert 1983; Hesse 1989). If the crystals are arranged in a fibrous structure, the material is called *chalcedony*. If the crystals have random orientations, somewhat like a felt of silica crystals, the material is called *chert*. These two materials are easily distinguished by petrographic analysis, but not by macroscopic visual inspection. *Agate* is a variety of chalcedony usually having concentric bands of different colors, although other patterns (such as moss agate) do occur. *Jasper* is a variety of chert that is relatively opaque and usually yellow, olive, brown, or red in color as a result of the presence of iron. *Flint* may be used as a synonym for chert, or may refer to varieties of chert that are opaque to translucent and dark grey, dark brown, or black in color. The dark color may come from the inclusion of organic matter.

In practice, archaeologists often use flint, chert, jasper, and chalcedony as mutually exclusive, descriptive terms rather than according to their more technical definitions. In this type of usage, *chalcedony* is a high-quality, translucent to transparent silicate, often with a waxy texture. *Flint* is high-quality, translucent to opaque rock that is dark in color. *Jasper* is good-quality, usually opaque, and sometimes waxy-textured rock that is yellow, brown, red, or olive in color. And *chert* is more opaque, often lighter colored or somewhat coarser cryptocrystalline material that does not look like chalcedony, flint, or jasper. This descriptive usage is acceptable, especially when a petrographic identification is not available.

A second group of silicates consists of indurated, or solidified, sediments. The particles may be fused by temperature and pressure or may be cemented by silica. In some cases silica may have replaced other, nonsilicate minerals. These materials may be classified on the basis of the size of the particles that they contain. When the sediment consisted of sand-sized quartz grains, the resulting material is called *sandstone*. When the grains have been fused by metamorphosis, the material is known as *metaquartzite*. When the grains have been cemented by silica, the material is known as *silicified sandstone* or *orthoquartzite*. The suitability of the material for flaking depends on how strongly the grains are joined. If they are so strongly bonded that the fracture passes through rather than around individual grains, flaking quality is better.

*Siltstone* is a sedimentary rock containing much finer particles. The terms *argillite* and siltstone are both established in archaeological usage, and are generally used synonymously. Geologists use these terms differently, distinguishing a number of fine-grained sedimentary rocks based on subtle distinctions of particle size, trace mineral content, or other characteristics. Such specific distinctions and terminology are not generally useful to archaeologists.

The third group of silicates is *igneous extrusive* rocks, which occur when molten rock rich in silica has cooled at or near the surface. Because the rock was able to solidify quickly, there was little time for crystals to form. When cooling was very rapid, with no crystal formation taking place, the result is *obsidian*. This material is comparable in structure to glass (which also consists of noncrystalline silica). When the cooling takes place more slowly, resulting in the formation of very small crystals, *rhyolite* is produced. If the same molten rock had solidified farther below the surface, slowly enough to produce visible crystals, the result would be granite (which is not flakable). Each of these rocks contains
minerals besides silica, although the silica dominates in the case of flakable rocks. (Molten rock that is low in silica produces other materials, such as diorite and basalt.) Geologists distinguish many varieties of high-silica, igneous-extrusive rock on the basis of which minerals are present and in what proportions. Such subtle distinctions are generally not useful to archaeologists.

In contrast to these other materials, quartz has a large-scale crystal structure. In some cases an individual crystal will be large enough to cut and polish into a sphere, the infamous crystal ball. In most cases quartz consists of a mass of conjoined crystals with different orientations. Quartz is usually less suitable for flaking than other silicates because it tends to breaks along intercrystalline intersections. The fracture is harder to control, and it is more difficult to produce a desired shape. Quartz still provides a useful sharp edge when broken, however, and was widely utilized.

**Descriptive Terms.** A number of descriptive petrographic terms are encountered in discussions of lithic raw materials. A *vug* is a small cavity in a rock. Vugs are often lined with *druse*, a crust of small crystals. Druse may also occur on exterior surfaces. *Ooliths* are small, generally round accretionary bodies that are cemented together in a rock. They are sometimes described as resembling fish eggs. The term is also used in a loose sense for any small, generally round bodies that occur in a contrasting matrix in a rock, although this usage is not recommended. An *oolite* is a rock containing ooliths. Chert and other rocks that contain ooliths are also called *oolitic*. *Phenocrysts* are small, often glassy crystals that are scattered in a finer rock matrix. *Cortex* is the outer, mechanically and chemically weathered surface of a rock. Chert cobbles, for example, often retain a crust of limestone on their *cortical* surface. *Patination* refers to a distinct kind of surface alteration, usually the chemical weathering of a fracture surface; mechanical weathering is less important. Patination is typically very thin, often different in color than the interior of the rock, and sometimes marked by increased porosity.

**Raw Material Names.** A specific raw material is often named for the geological stratum in which it originates. For example, that chert which comes from the Galena Formation is called Galena Chert. In some cases the geological associations are not known, and an arbitrary name is given. One material that has never been found in a bedrock association is especially abundant around the Knife River of western North Dakota, and has come to be known as Knife River Flint.

In a few cases, a nonstratigraphic name has become well established in archaeological usage even though the geological context of the material is known. For example, a distinctive chert that was quarried near the town of Grand Meadow in south-central Minnesota has become known as Grand Meadow Chert (GMC). GMC provides a good example of why a nonstratigraphic name may sometimes be preferable. Trow (1981:102) associated this raw material with the Rapid Member of the Cedar Valley Formation, which suggests that either Cedar Valley Chert or Rapid Chert might be a suitable name for this material. The first name, however, is used to designate a different and quite distinct chert found in the Cedar Valley Formation. Problems also exist with the second name.

Witzke et al. (1988) proposed an extensive revision of Devonian stratigraphy for Iowa and southeastern Minnesota. The Rapid Member was restricted to southeastern Iowa and adjacent areas, the Cedar Valley Formation became the Cedar Valley Group, and several new formations were named (with associated new members). Presently it is not even clear whether Grand Meadow Chert comes
from the Cedar Valley Group or Wapsipinicon Group, much less which formation or member it is associated with. If this material had been called Rapid Chert, it could be argued that the name should be changed to reflect the stratigraphic revisions. While I believe it is generally a good practice to provide stratigraphic names to newly described materials (e.g., “Shell Rock Chert” in Olmanson et al. 1994), I emphatically do not believe it is a good idea to abandon an established name in order to keep current with changing interpretations of geological stratigraphy. Such periodic changes can only serve to introduce more confusion to an already confused situation; they also make older archaeological reports difficult to read and understand. Changes in nomenclature should be made only for very good reason and as infrequently as possible. Established, widespread usage should be given priority over stratigraphic association as a matter of convention.

There has not been a standard regarding capitalization of lithic raw material names. An often-used form is to capitalize the unique part of the name, but leave the generic element uncapitalized (e.g., Swan River chert, Knife River flint). In this chapter I recommend and use another form. The terms for specifically named and described raw materials are proper names, and each element should be capitalized: Knife River Flint, Swan River Chert, Knife Lake Siltstone. This is consistent with some other capitalization conventions in English, for example “a river” but “the Mississippi River.” The names of more general categories of raw materials, however, are not proper names and do not need to be capitalized: flint, chert, silicified wood, siltstone.

**Western Raw Material Region**

The Western Resource Region (Table 6.1) is dominated by glacial drift derived from the northwest and associated with the Des Moines and Wadena Lobes. Because bedrock outcrops are rare to nonexistent, locally procured raw materials must have come from drift. This includes related, reworked sediments such as the sand and gravel ridges that represent fossil beaches of extinct glacial lakes, erosional exposures created by streams or lakes, and concentrations of cobbles in streambeds or along lakeshores. Because the drift and other sediments are well mixed as a result of glacial transport, the same raw materials are spread throughout the region. Availability of raw materials is not uniform, however. In some areas the glacial sediments contain numerous cobbles. In other areas, these sediments consist primarily of sand, clay, or other fine-grained sediments containing little usable rock.

The most notable exception to the homogeneous availability of raw materials is in the northwest corner of the state, where an exceptionally flat clay and silt plain covers all or parts of nine counties. This is the dry bed of Glacial Lake Agassiz, an area also known as the Red River Valley. Rock of any kind is rare or absent in the lake bottom plain. Cobbles are, however, abundant in beaches of the extinct lake. The lake stabilized at different levels during the several thousand years of its existence, and separate beaches were formed at each level. They presently appear as sand and gravel ridges rising above the surrounding clay plain. Some of the beaches are quite massive and may be traced for a hundred or more miles (Fenton et al. 1983). Locally they contain significant quantities of silicate
cobbles, and would have been potentially good lithic raw material sources (e.g., 21RO11, discussed below).

A second exception to the homogeneous availability of raw materials in the Western Resource Region is the apparent lack of Tongue River Silica in the northern part of the region (see Bakken 1985). This distribution is presently hard to explain in terms of geological and glacial history, and needs further examination.

**Table 6.1. Western Lithic Resource Region Raw Materials.**

<table>
<thead>
<tr>
<th>Source Class</th>
<th>Raw Material Type</th>
<th>Abbreviation</th>
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<tbody>
<tr>
<td>Primary Materials</td>
<td>Swan River Chert</td>
<td>SRC</td>
</tr>
<tr>
<td></td>
<td>Red River Chert</td>
<td>RRC</td>
</tr>
<tr>
<td></td>
<td>Quartz</td>
<td>–</td>
</tr>
<tr>
<td>Secondary Materials</td>
<td>Rhyolite</td>
<td>–</td>
</tr>
<tr>
<td></td>
<td>Tongue River Silica</td>
<td>TRS</td>
</tr>
<tr>
<td>Other Materials</td>
<td>Chalcedony</td>
<td>–</td>
</tr>
<tr>
<td></td>
<td>Jasper</td>
<td>–</td>
</tr>
<tr>
<td></td>
<td>Jasper Taconite</td>
<td>JT</td>
</tr>
<tr>
<td></td>
<td>Knife River Flint</td>
<td>KRF</td>
</tr>
<tr>
<td></td>
<td>Quartzite</td>
<td>–</td>
</tr>
<tr>
<td></td>
<td>Silicified wood</td>
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</tr>
</tbody>
</table>

Swan River Chert (SRC) (Figure 6.2) is the most naturally abundant and most commonly used raw material in the Western Resource Region (Campling 1980; Bakken 1985, 1993). SRC is found over a very wide area, from eastern Saskatchewan through southwestern Manitoba, the eastern Dakotas, much of Minnesota and presumably into northern Iowa. This material is extremely variable, especially in color. The “orange peel” texture of fracture surfaces, cloudy yellow color of transmitted light, and microscopic, agate-like banding are normally the most useful diagnostic characteristics. The spongy or ropy texture of the cortex is also distinctive, when cortex is present. SRC is a difficult material to work. Cobbles are extremely tough, and even breaking open a raw cobble can be difficult. At some sites, analysis of lithic debitage suggests that whole SRC cobbles—rather than partly reduced blanks—were heat treated (e.g., Bakken 1995a). Presumably this was a response to the tenacity of the material, which impedes even the earliest stages of reduction. Once SRC was reduced to the form of a tool, however, the tool should also have been tough and durable.
Red River Chert (RRC) (Figure 6.3) is the second most commonly utilized local raw material in the region (Bakken 1985, 1993). Distribution ranges from parts of southern Manitoba through the eastern Dakotas, much of Minnesota and presumably into northern Iowa. In Manitoba, RRC would be identified as either Cathead Chert or Selkirk Chert, both of which are known from bedrock outcrops. In Minnesota, where these materials are known only from glacial drift, they are commonly grouped under the broader category of Red River Chert. RRC is usually light in color, varying from white to light brown or light grey. The color is usually homogenous to broadly mottled. Texture and translucency are somewhat variable. Transmitted light normally shows little color. Some pieces of RRC contain fossils, usually in the form of molds. Segments of crinoid stems are the most common type of fossil. There is little to separate RRC from other fine-grained, light-colored cherts. Happily, no similar materials are known to occur naturally in the Western Resource Region. It appears that RRC is relatively more common in drift than at sites, although relative abundance is difficult to evaluate objectively (see Bakken 1985). This difference may be because many RRC cobbles fracture uncontrollably into small, blocky chunks that are useless for further reduction. Workable RRC cobbles are of variable quality, although there was probably selection for better pieces. These better pieces would be fine grained, homogenous, and generally comparable to the better quality raw materials available in the state.

Quartz (Figure 6.4) is available in glacial drift throughout the state, including the Western Resource Region (Bakken 1985, 1993). It is normally easily identified by the presence of flat fracture plains following the material’s crystalline structure. Although quartz is difficult to work, it was utilized extensively at sites in some parts of the region and is therefore included as a primary raw material (Table 6.1). Based on initial studies, it appears that specialized bipolar reduction techniques were often used with quartz, possibly with the goal of producing expedient flake tools.

Drift-derived quartzite found in the Western Resource Region occurs in two general forms: a white to golden yellow form that tends to have larger crystals, and a dull red to dull purple form that tends to be finer grained. Both forms are very brittle and largely useless for standard lithic reduction. The flakes occasionally found at sites are probably detached from quartzite cobbles used as hammerstones.
Figure 6.5. Lake of the Woods Rhyolite.

Figure 6.6. Tongue River Silica.

Figure 6.7. Silicified wood.
Rhyolite (Figure 6.5) is less common than SRC or RRC, both naturally and at archaeological sites. The
distribution of this material is not well documented. Bedrock sources and associated quarries are
known in parts of northwest Ontario (see Lynch and Lovis 1988), in east-central Saskatchewan
(McDougall 1980), and possibly in intermediate parts of Manitoba. I would expect that this material
occurs sporadically in glacial drift throughout the Western Resource Region. Rhyolite may be identified
by its greenish grey to (less common) grey color; the presence of patches and streaks of brown to
orange brown; and the presence of clear, colorless phenocrysts in a finer-grained matrix. It sometimes
resembles siltstone. The two may be distinguished by relative opacity; siltstone is always opaque, while
rhyolite displays moderate to strong translucency. Rhyolite varies in texture from very fine grained and
almost cherty, to more coarse and granular. Its working characteristics vary from marginal to
moderate.

An initial survey of raw material resources in the northwestern part of the state (Bakken 1985)
described this material but called it argillite (i.e., siltstone). As better information became available, it
became apparent that this identification was incorrect. The availability of siltstone in the Western
Resource Region remains unevaluated, although it seems unlikely that significant quantities would be
available (Bakken 1993). This material is not similar to a brown rhyolite that occurs in northeastern
Minnesota. The brown rhyolite has very poor flaking characteristics, and was only rarely utilized (Tony
Romano, personal communication 1994).

Tongue River Silica (TRS) (Figure 6.6) is found in most of the Western Resource Region although, as
discussed above, it may be absent from the northern parts of the region (Bakken 1985, 1993). TRS has
a relatively narrow range of variation and is easily identified. Its natural color is restricted to a fairly
narrow range of ocher or yellowish brown. Weathering may produce an orange or reddish
discoloration on the surface and along cracks or root molds. Heat treatment is easy to identify because
the color changes to orange-red or red (Anderson 1978). Other diagnostic characteristics include a
fine-grained “sparkle” on fracture surfaces and the presence of hollow root molds. Most TRS is highly
opaque; rare pieces are slightly translucent on thin edges. Although the material does not seem to be as
tough as SRC, it is probably as difficult to reduce because the fracture is irregular. Heat treatment was
regularly used with this material; as with SRC, it was probably applied early in the reduction process.
Related but distinctive forms of grey TRS have been identified in North Dakota (Ahler 1977). These
do not appear to occur naturally in Minnesota, although they may occasionally be found at
archaeological sites in the state.

Pebbles of chalcedony, jasper, and silicified wood occur in the drift but are not common (Bakken
1985, 1993). They rarely occur in cobbles large enough to facilitate standard patterned reduction
techniques. It should be noted that these terms are used here in a descriptive, generic sense.
Chalcedony includes any fine-grained, translucent to transparent, waxy-textured materials that are
usually pale brown, gold, or colorless. Jasper includes fine-grained, waxy-textured material that is
yellow, yellowish brown, olive, brown, or red to reddish brown in color. The color may be solid or
mottled. Silicified wood may be distinguished by its visible wood grain (Figure 6.7). Pieces of this
material often fracture along lines between growth rings. The origin and distribution of these materials
are not well understood. When materials matching these descriptions are found at sites in the region,
some care should be taken in their identification. This is particularly true with chalcedonies and jaspers,
especially if patterned tools made of these materials are found. Such pieces may represent the import of raw material from sources outside the region, especially from sources to the west where larger, better-quality pieces are available. In some cases it may be possible to specifically identify such nonlocal raw materials.

Although Jasper Taconite (JT) is listed as a “local” raw material for this region, local availability is limited (Bakken 1985, 1993). Within the Western Resource Region, this material occurs only in small amounts and in small nodules that are often too friable to flake. Most or all JT found at sites here probably comes from the Eastern Resource Region where it is more common and of much better quality. This material is discussed in further detail in the section describing the Eastern Resource Region.

Locally available quantities of Knife River Flint (KRF) (Figure 6.8) are also negligible; pieces also tend to be small and of poor quality (Bakken 1985, 1993). Most KRF found at sites here probably come from outside the region, specifically from the primary source area in west-central North Dakota (Gregg 1987). An exception may be the reduction of locally procured KRF pebbles by bifacial techniques in order to produce expedient flake tools. KRF is still one of the most abundant raw materials at many archaeological sites in this region. It is not uncommon for up to 30 percent of the lithic debitage at a site to be KRF, especially at sites near the Red River. At Middle Woodland sites, the percentage may be even higher (Clark 1984). KRF is easily identified by its translucency, coffee brown color, and pattern of diffuse inclusions (see Clayton et al. 1970). Occasionally it develops a white patination. Burning makes KRF nearly opaque and pale bluish grey in color. Even when patinated or burned, however, KRF displays the same distinctive brown color of transmitted light and may often be identified by this characteristic.

Other nonlocal and exotic materials will occur in small amounts at sites in the Western Resource Region. They include many raw materials available in other parts of the state, as well as porcellanite, rarely obsidian, grey Tongue River Silica, and probably a few other materials that are usually not specifically recognized and therefore not reported in the literature. It is my impression that the Rainy River and Lake of the Woods may have provided a significant route for the arrival of lithic raw materials from the Eastern Resource Region (i.e., Jasper Taconite, Gunflint Silica, and Hudson Bay Lowland Chert). These materials seem to occur in noticeably higher concentrations near this route, or at least at its western end near Lake of the Woods. This idea needs to be carefully examined, however, before it is given any interpretive significance.

At least one prehistoric “quarry” site has been studied in the Western Resource Region. Actually, it should probably be called a lithic procurement site since it is not a quarry in the narrower sense of the word. The Greenbush Borrow Pit Site, 21RO11 (Peterson 1973), is located on a large Lake Agassiz
beach. Cobbles were apparently being taken from the beach ridge and reduced on the spot. Swan River Chert was the primary material extracted and worked, with Red River Chert processed in smaller amounts. The presence of stemmed projectile points suggests a possible Late Paleoindian date for the site.

**Eastern Raw Material Region**

**Eastern Lithic Resource Region.** The Eastern Resource Region (Table 6.2) presents a somewhat more complex scenario of raw material distribution. The region contains both bedrock and glacial drift sources. The northern part of this region contains areas of drift as well as extensive exposures of bedrock, much of which has been extensively folded and altered. The result is a complex pattern of Precambrian strata, several of which contain knappable silicate rocks. In the southern part of this region, the landscape includes some bedrock outcroppings but is dominated by glacial drift. Because these glacial sediments are derived from rock exposed to the north, the same raw materials are available throughout the region.

The distribution of raw materials in this part of the state has not been adequately studied. If it were possible to survey this large area in detail, specific bedrock sources could no doubt be located and described; the geological literature contains some detailed information of this kind (e.g., Sims and Morey 1972). Theoretically, petrographic and trace element analysis would make it possible to assign specimens (i.e., individual lithic artifacts) to specific sources. But the fact that glaciers spread materials from the same sources over large areas means that such intensive analysis is not likely to provide archaeologically useful information. The analyses would not address the question of whether a piece of raw material was obtained from the signified bedrock source or from a secondary context where it was redeposited.

<table>
<thead>
<tr>
<th>Source Class</th>
<th>Raw Material Type</th>
<th>Abbreviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary Materials</td>
<td>Jasper Taconite</td>
<td>JT</td>
</tr>
<tr>
<td></td>
<td>Siltstone</td>
<td>–</td>
</tr>
<tr>
<td></td>
<td>Quartz</td>
<td>–</td>
</tr>
<tr>
<td>Secondary Materials</td>
<td>Gunflint Silica</td>
<td>GFS</td>
</tr>
<tr>
<td></td>
<td>Lake Superior Agate</td>
<td>LSA</td>
</tr>
<tr>
<td>Other Materials</td>
<td>Hudson Bay Lowland Chert</td>
<td>HBLC</td>
</tr>
<tr>
<td></td>
<td>Jasper</td>
<td>–</td>
</tr>
<tr>
<td></td>
<td>Kakabeka Chert</td>
<td>–</td>
</tr>
<tr>
<td></td>
<td>Quartzite</td>
<td>–</td>
</tr>
<tr>
<td></td>
<td>Possibly other cherts</td>
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</tbody>
</table>
Detailed knowledge of raw material sources in the vicinity of an Eastern Resource Region site is still useful. In addition to a review of geological literature, a first hand, on the ground survey of raw material sources could prove valuable. An adequate raw material analysis may still be conducted without detailed source information, however, by placing the analysis within the context of regional raw material resources.

Siltstone (Figure 6.9) is especially abundant in the Eastern Resource Region, both as a raw material and at archaeological sites (Romano 1991). Because it is usually a marginal-quality material, its utilization may have been based more on availability than desirable characteristics. However, some consideration should be given to the theory that, at least in Paleoindian technological traditions, siltstone was a desirable material for chipped stone adzes and similar implements. This desirability could be based on its relative resiliency; for such intensive uses, it would be better suited than high-quality, more brittle cherts (George Christianson, personal communication 1992).

The term “Knife Lake Siltstone” is commonly applied to any siltstone in the region. This name originates from siltstone quarries found along outcrops at Knife Lake and other locations along the Minnesota and Ontario border. These quarries produce material of apparently better quality than is generally found in the glacial drift (Jon Nelson, personal communication 1992; see also Romano 1991). The drift material probably originates from multiple geological sources, not just to those represented in the Knife Lake vicinity. With some reluctance I suggest that it is better to reserve the term “Knife Lake Siltstone” for siltstone that can be demonstrated to originate from the Knife Lake sources, at least until more is known about the material.

The situation is further complicated by the use of the term “Lake of the Wood Chert.” Lake of the Woods Chert in fact appears to be a finer-grade, green to black siltstone available around Lake of the Woods (Jon Nelson, personal communication 1992). The material does have a cherty appearance and good flaking qualities, and application of the name “Lake of the Woods Chert” to other siltstones does not seem appropriate. To make matters worse, the name “argillite” (or even argillite-quartzite) has also been applied to siltstone. I recommend that “siltstone” is preferable to “argillite,” because it is more widely used, more descriptive and more obviously pronounceable. The relatively subtle petrographic distinction between siltstone and argillite is not important in this context. Perhaps the primary concern in this situation is realizing that these terms all apply to different phases of the same raw material, and realizing also that at least some of this material is widely available in glacial drift.

As mentioned above, quartz appears to be available in glacial drift throughout the state, including the Eastern Resource Region. The extent of its utilization at sites in this region, however, has not been adequately evaluated. It seems to have been extensively utilized in parts of the region during...
certain periods. Quartz is difficult to reduce using standard reduction techniques. Based on initial
studies, it appears that specialized bipolar reduction techniques were used with this material, possibly
with the goal of producing expedient flake tools. Quartz is easily identified by the presence of flat
fracture plains that follow its crystalline structure.

Jasper Taconite (JT), Gunflint Silica (GFS) and Kakabeka Chert are related materials (Romano 1991).
Their common characteristics include a transparent chalcedonic matrix and the presence of distinctive
inclusions within the matrix. Occasionally pieces may be seen that incorporate characteristics of more
than one of these materials, or resemble these materials but cannot be specifically identified as one or
the other material. These ambiguities probably relate to the long and complex geological history of the
region and the rocks it contains. I propose the use of a generic, blanket term for these materials, at
least when a specific identification cannot be made. Any material that exhibits a clear matrix with an
“icy” texture; contains various granular, acicular or other inclusions; and is believed to originate in the
early strata of northeastern Minnesota and surrounding areas, may be referred to as an “Animikie
Silicate.” These silicates appear to come from Middle Precambrian sedimentary strata that form the
Animikie Group (see Morey 1972).

Jasper Taconite (Figure 6.10) is available in drift in the Eastern Resource Region. (As discussed above and
below, JT of inferior quality is also available from drift in the Western and Southern Resource Regions.)
Bedrock quarries are known from northwestern Ontario (Julig et al. 1989; Steinbring 1976) and may
also exist in Minnesota. This good-quality material appears to have been favored for tool production
throughout prehistory. It is easily recognized by its normal, distinctive deep red color and the presence of
small, round inclusions that superficially resemble oolithe. The inclusions dominate the material; the
transparent matrix forms only a small part of the material between the inclusions. The color will vary to
dark green, dark blue, or almost black, but these colors are rare.

In Gunflint Silica (Figure 6.11), the translucent to transparent matrix is dominant. The matrix is usually
translucent and grey to bluish grey, but can vary to colorless and nearly transparent. Working quality is not as
good as Jasper Taconite. Inclusions consist of scattered small black granules resembling pepper grains. Romano
(1991, 1994) reports finding samples of GFS on Gunflint Lake, one of the Ontario border lakes in northeastern
Minnesota, as well as in deep iron mines within Minnesota. The extent of its availability in glacial drift has
not been evaluated, although it is present.
Inclusions also dominate matrix in Kakabeka Chert (Figure 6.12). The inclusions are acicular (needle shaped) and too small to see individually with the naked eye. They give the material a distinctive fine, wood grain appearance. Color is generally a mixture of grey and brown. The availability of Kakabeka Chert in the state has not been evaluated, although small amounts occur in drift (Tony Romano, personal communication 1994).

Lake Superior Agate (LSA) (Figure 6.13) is not uncommon in glacial drift in the Eastern Resource Region (Ojakangas and Matsch 1982:54). It is distinctive and easily identified. The color is light to dark “salmon” or “coral” red, alternating with bands of white. Texture is waxy. The center of the agate is often filled with a mass of colorless quartz crystals. Although LSA usually occurs as relatively small pebbles, it is not uncommon at archaeological site. In many cases, it seems to have been reduced by the same specialized bipolar technique used with quartz. Again, the goal of this technique may have been to produce expedient flake tools.

Hudson Bay Lowland Chert (HBLC) (Figure 6.14) (Julig et al. 1989:297; Romano 1991) remains something of an enigma in regional archaeological studies. Its sources and characteristics are not well documented. Apparently it occurs only as cobbles in secondary deposits. Some authorities speculate that it is actually more than one material, and in fact a “catchall” category. However, comparative samples available to me, as well as occurrences of what appears to be HBLC at archaeological sites in Minnesota, suggest that the category is valid and useful. Until better information is available, it will be considered here as one material. The color of HBLC is variable. Distinguishing characteristics would seem to be an extremely fine texture that preserves remarkably minute details of flake morphology; a thin, buff colored cortex; and a strong red color of transmitted light. Its natural availability in Minnesota is unevaluated. It is conceivable that some pieces might be found in glacial drift, especially in the extreme northern part of the Eastern Resource Region, although this has not been demonstrated. HBLC appears to be a very high-quality material. Flakes very often show signs of
retouch or utilization, a characteristic HBLC shares with KRF.

The archaeological literature contains certain references to “gold chalcedony” or “light brown chalcedony.” Steinbring discusses the occurrence of “a very homogeneous light brown chalcedony” at a number of Old Copper Complex sites, and speculates that it may have a source in Ontario on the north side of Lake Superior (Steinbring 1974:68; cf. Griffin 1961:98). He specifically notes that this material “is not Knife River flint. It is much lighter, more translucent, and completely lacks the common inclusions and impurities of Knife River” (Steinbring 1974:70). In addition, an unattributed, undated note in the site files for Cook County at the Wilford Archaeology Lab, University of Minnesota, reads: “A quarry of amber colored flint said to be on the north side of Gunflint Lake. A point on the Canadian side. Some implements, and in places the chip material is said to be several inches in depth.” Examination of some of the artifacts discussed by Steinbring (at the archaeology laboratory, University of Minnesota, Minneapolis) suggests that this material is Hudson Bay Lowland Chert. The description of this “light brown chalcedony” is within the range of characteristics for HBLC, and no further information has come to light regarding sources or quarries for such a “light brown chalcedony” or “amber colored flint.”

Jasper (not Jasper Taconite) occurs in the Eastern Resource Region. The original association is probably with the iron deposits found in parts of the region. For example, the tailing from the open-pit iron mine in Virginia, Minnesota contain ocher-colored and apparently flakable material that might be called jasper and resembles pieces occasionally found at regional archaeological sites. The occurrence of this and other “jasper” in the region requires further evaluation.

A form of “rhyolite” is also available in the Eastern Resource Region (see Romano 1991). It is not similar to the material of the same name found in the Western Resource Region. The Eastern Resource Region rhyolite is opaque, and available samples indicate that it is brown or reddish brown in color. Phenocrysts of a sort are present, but they are not transparent and colorless as in the western material. This brown rhyolite is reported to occur occasionally at archaeological sites (Tony Romano, personal communication 1994). It is coarse, and flaking quality is generally poor.

Some variety or varieties of quartzite should also be available in this region, based on a reading of the geological literature. Present raw material samples from the region, however, are inadequate to give more specific information.

Hixton Silicified Sandstone (HSS) is a nonlocal raw material that is well represented in archaeological sites in the Eastern Resource Region (Figure 6.15). This material is a Cambrian-age sandstone cemented together with chalcedony and opal derived from a single source known as Silver Mound in Jackson County, Wisconsin. Hixton Silicified Sandstone is commonly white or tan in color, but red,
orange, yellow, lavender, and darker brown colors are also represented. Despite its sugary appearance, Hixton Silicified sandstone is a high-quality raw material with good to excellent flaking qualities. This material does not respond well to heat treatment and is commonly ruined by heating (Jeske et al. 2010). Over the years, several isolated sources of similar silicified sandstones have been identified in west-central Wisconsin, but the material from these minor sources are typically duller, coarser textured, and not near the quality of the higher-grade Hixton.

Other nonlocal raw materials occurring at sites in the Eastern Resource Region include many of the materials available in other parts of the state, plus Knife River Flint and small amounts of obsidian. The quantity of any of these materials can vary considerably from site to site.

There are a number of quarry sites relating to the lithic material resources of this region, although most of them are located in nearby parts of Ontario. Fox (1980:136) reports that outcrops of siltstone along Knife Lake (in this case on the Ontario side of the lake) show evidence of prehistoric quarrying. He suggests that this activity began in the Late Paleoindian period and probably continued into later periods. In recent years, evidence of Knife Lake Siltstone quarrying has been discovered on the Minnesota side of the source area (Clayton and Hoffman 2009). The Cummins Quarry site (Deji-1), near the city of Thunder Bay, Ontario, covers “miles of exposed jasper [Jasper Taconite] deposits” (Steinbring 1976:21). The types of artifacts recovered from the quarry indicate that it was also in use as early as the Paleoindian period.

An example of a known procurement site within the state is Bradbury Brook (21ML42), located a few miles south of Mille Lacs Lake in east-central Minnesota. Here Late Paleoindian inhabitants gathered cobbles of siltstone from a streambed or directly from glacial drift. A partially intact stone workshop at this site was radiocarbon dated to 9220 ± 75 years Before Present (B.P.). The siltstone was used to produce a variety of tools, including a stemmed point, other bifaces, keeled scrapers, blades, and chipped stone adzes. The workshop also contained several fragmented anvil stones and an abundant sample of hammerstones of various sizes (Malik and Bakken 1991, 1993).

**Southern Raw Material Region**

**Southern Lithic Resource Region.** The Southern Resource Region presents a complex pattern of raw material availability (Table 6.3). Glacial drift is an important feature of the landscape. The drift is primarily derived from the northwest, but includes components from the northeast and appears to incorporate material from older tills of uncertain derivation. There are also scattered exposures of older, possibly pre-Wisconsin drift that contain various raw materials. These are, however, a minor component compared to the predominant Wisconsin drift. In addition to glacial sediments, bedrock lies at or near the surface at many locations within the Southern Resource Region. Such potential sources may be as diverse as stream cuts or hilltop lag deposits. The latter are especially important in the southeastern corner of the state where recent, deep glacial sediments are absent (Wright 1972:518).
Table 6.3. Southern Lithic Resource Region Raw Materials.

<table>
<thead>
<tr>
<th>Source Class</th>
<th>Raw Material Type</th>
<th>Abbreviation</th>
</tr>
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<tbody>
<tr>
<td>Primary Materials</td>
<td>Cedar Valley Chert</td>
<td>CVC</td>
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<tr>
<td></td>
<td>Galena Chert</td>
<td>–</td>
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<tr>
<td></td>
<td>Grand Meadow Chert</td>
<td>GMC</td>
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<tr>
<td></td>
<td>Prairie du Chien Chert</td>
<td>PDC</td>
</tr>
<tr>
<td></td>
<td>Swan River Chert</td>
<td>SRC</td>
</tr>
<tr>
<td>Secondary Materials</td>
<td>Quartz</td>
<td>–</td>
</tr>
<tr>
<td></td>
<td>Red River Chert</td>
<td>RRC</td>
</tr>
<tr>
<td></td>
<td>Rhyolite</td>
<td>–</td>
</tr>
<tr>
<td></td>
<td>Shell Rock Chert</td>
<td>–</td>
</tr>
<tr>
<td></td>
<td>Tongue River Silica</td>
<td>TRS</td>
</tr>
<tr>
<td>Other Materials</td>
<td>Chalcedony</td>
<td>–</td>
</tr>
<tr>
<td></td>
<td>Jasper</td>
<td>–</td>
</tr>
<tr>
<td></td>
<td>Knife River Flint</td>
<td>KRF</td>
</tr>
<tr>
<td></td>
<td>Maquoketa Chert</td>
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</tr>
<tr>
<td></td>
<td>Quartzite</td>
<td>–</td>
</tr>
<tr>
<td></td>
<td>Silicified wood</td>
<td>–</td>
</tr>
<tr>
<td></td>
<td>Sioux Quartzite</td>
<td>–</td>
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<tr>
<td></td>
<td>Orthoquartzites related to Hixton Silicified Sandstone</td>
<td>–</td>
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</table>

Bedrock outcrops are relatively more common in the southeastern and southwestern corners of the state. There are significant differences between the rocks exposed in these western and eastern parts of the Southern Resource Region. In the southeastern part of the state, more recent sedimentary rocks are exposed. They consist principally of limestone and other carbonates. Raw materials associated with bedrock in this area include Grand Meadow Chert, Cedar Valley Chert, Galena Chert, and Maquoketa Chert. All of these materials except Maquoketa Chert are relatively important and widely utilized. In the southwest, very old volcanic, metamorphic, and sedimentary rocks are exposed. Bedrock materials in this area include the Sioux Quartzite and the quartz, jasper, and chert that are incorporated in the basal conglomerate of this formation. These raw materials were not widely used for flaking.

In the central part of the Southern Resource Region, outcrops are less common, being confined principally to stream valleys. Glacial drift is again the most important raw material source. Many or most of the raw materials available in the state probably occur naturally in this area. This leads to a great diversity of raw materials at many archaeological sites in the area, and complicates raw material identification somewhat. Among the Southern Resource Region raw materials, Prairie du Chien Chert (Figures 6.16 and 6.17) (PDC) (Withrow 1983:40, 45–50; Gonsior 1992) is one of the most widely utilized. Its distribution includes large parts of south-central and southeastern Minnesota and extends into Wisconsin and Iowa. The widespread utilization of PDC may be due more to availability than quality. The quality of PDC appears to vary considerably, as do its characteristics. In appearance, it sometimes overlaps with such diverse materials as Swan River Chert, Red River Chert or Burlington Chert—all materials that would not usually be mistaken for each other. PDC is most easily identified in its oolitic form. Non-oolitic forms are less common but more difficult to identify. One form has a
grainy appearance; the other may be characterized as “sandy.” It appears that PDC was commonly heat treated, although identification of heat treatment is complicated by the fact that some PDC has a natural reddish tint. Texture may be a better indication of heat treatment in this material.

In some areas, PDC is identified as two separate raw materials—Shakopee Chert and Oneota Chert (e.g., Morrow 1994). These raw materials originate in the Shakopee and Oneota formations of the Prairie du Chien Group. In Minnesota, however, the Shakopee and Oneota formations are not always distinguishable (Austin 1972b:466) and the cherts they contain do not seem to be visually distinguishable. When these raw materials are redistributed in glacial drift, it is not practical to separate them. The inclusive term “Prairie du Chien Chert” provides a category under which they may be grouped.
Grand Meadow Chert (GMC) (Figure 6.19) is a good-quality raw material with a more restricted natural distribution (Gonsior 1992; Trow 1981:102). GMC has a narrow range of variation and therefore is fairly easy to identify. Color ranges from light to medium grey, and may be homogenous or broadly mottled. Transmitted light almost always has a golden tint. Patination, when present, is a distinctive olive color. Cortex, when present, is thin and buff to light brown. Texture is fine. The cobble form is also distinctive, although this is seldom seen on reduced archaeological specimens (occasionally taking the form of fossil casts or exhibiting fossil casts on the exterior). It is helpful to be able to specifically identify this material because it had a fairly wide circulation (although not as widespread as KRF or Burlington Chert). At least one quarry location is known (discussed below). This quarry complex is located near the town of Grand Meadow, from which the raw material takes its name. Outside of this quarry, the natural distribution of GMC is not well known.

Galena Chert (Figure 6.18) occurs in southeastern Minnesota, northeastern Iowa, southwestern Wisconsin, and far-northern Illinois (Withrow 1983:40, 50–54; Stoltman et al. 1984; Gonsior 1992). This raw material has a restricted range of variation and is not hard to identify. The inclusion of scattered, small white flecks (probably crushed fossils) is one of its most distinctive characteristics. It is usually opaque. Texture is normally chalky, although more vitreous textures do occur naturally or as a result of heat treatment. Small, flattened vugs are usually present. Color is normally pale brown, less often pale grey; heat treatment produces reddish tints. This moderate- to good-quality raw material was fairly widely utilized and is common in small amounts at archaeological sites some distance from the source area. Several Galena Chert procurement sites (discussed below) have been documented in southeastern Minnesota.

Cedar Valley Chert (CVC) (Figure 6.20) has a limited distribution in parts of southeastern Minnesota, focused on Fillmore County (Ready 1981; Gonsior 1992). Known quarry sites are discussed below. The material has two distinct forms: opaque and translucent. There seems to be little or no overlap between the two. The opaque form is also called Cedar Valley Jasperoid (Ready 1981). This form has a narrow range of variation. It is very opaque, and varies in color from yellowish brown to ocher and, less commonly, dark brown. Mottling occurs in some pieces. The texture is chalky. Heat treatment turns lighter pieces a distinctive cranberry red, and may deepen or redden the color of dark brown pieces. Heat treatment may also produce a waxy to highly vitreous texture, probably depending on maximum temperature reached. Quality is generally good, with or without heat treatment. This material has also been called “Root River Chert” in some reports.
A similar raw material called Cochrane Chert (Figure 6.21) occurs in nearby parts of Wisconsin (Robert Bozhardt, personal communication 1994). Some cobbles of Cochrane Chert appear to have more distinct grainy patterning, consisting of dark, subparallel lines. The texture may also be naturally more waxy or vitreous in some specimens. Otherwise, the materials are macroscopically nearly identical. Whether they share a common geological origin is unclear.

Translucent Cedar Valley Chert is as variable as the opaque variety is homogenous. In macroscopic appearance, it can resemble colorless and transparent chalcedony, white chert or even Hixton Silicified Sandstone. Any or all of these phases can be found in a single cobble. Identification of this raw material can be challenging. Most pieces of translucent CVC show a distinctive, strong golden color of transmitted light. The pieces that macroscopically resemble quartzite are also easily identified. If these pieces are examined under a microscope, the apparent granular quartzitic texture disappears and the material looks distinctively cherty. Cortex can also help in identification. Heat treatment affects both the color and texture of this variety of CVC. Because of its variability, identification of translucent CVC is best conducted with the use of a reference collection, including whole cobbles and heat-treated samples (available at the Minnesota Historical Society, Fort Snelling). Quality is generally good, sometimes very good. The translucent variety of CVC does not seem to be as widely distributed as the opaque variety at archaeological sites, despite overall better quality. The reasons for the differences in archaeological distribution are not clear.

Swan River Chert (SRC) (Campling 1980; Bakken 1985, 1993) is present in glacial drift in the Southern Resource Region. Although it is found at many archaeological sites in the region, it is probably not as important here as in the Western Resource Region. As discussed above, SRC has a vast distribution to the north and probably also occurs into parts of northern Iowa. Also as discussed above, this material is extremely variable, especially in color. The “orange peel” texture of fracture surfaces, cloudy yellow color of transmitted light, and microscopic, agate-like banding are normally the most useful diagnostic characteristics. The spongy or ropy texture of the cortex is also distinctive, when cortex is present. SRC might be mistaken for Warsaw Chalcedonic Chert (from Iowa) (Morrow 1984, 1994) or certain varieties of Prairie du Chien Chert, although careful examination should serve to distinguish SRC. Neither of these materials seem to exhibit the microscopic, agate-like banding seen in SRC or its distinctive cortex.

SRC is a difficult material to work. Cobbles are extremely tough, and even breaking open a raw cobble can be difficult. At some sites, analysis of lithic debitage suggests that whole SRC cobbles—rather than partly reduced blanks—were heat treated (Bakken 1995a). Presumably this was a response to the tenacity of the material, which impedes even the earliest stages of reduction. Once SRC was reduced to the form of a tool, however, it might be expected that the tool would also be tough and durable.
Tongue River Silica (TRS) occurs in much of the Southern Resource Region, and into north-central and northwestern Iowa (see Anderson 1978) (in addition to its northern distribution). TRS commonly occurs in small amounts at archaeological sites in the region. Because of its generally poor flaking quality, other materials seem to have been preferred whenever available; locally TRS constitutes a minor part of the raw material resource base. As discussed above, this material has a relatively narrow range of variation and is easily identified. Its natural color is restricted to a fairly narrow range of ocher or yellowish brown. Weathering may produce an orange or reddish discoloration on the surface and along cracks or root molds. Heat treatment is easy to identify because the color changes to orange-red or red (Anderson 1978). Other diagnostic characteristics include a fine-grained “sparkle” on fracture surfaces, and the presence of hollow root molds. Most TRS is highly opaque; rare pieces are slightly translucent on thin edges. Related but distinctive forms of grey TRS have been identified in North Dakota (Ahler 1977). These do not appear occur naturally in Minnesota but may occasionally be found at archaeological sites in the state.

Red River Chert (RRC) also occurs in glacial drift in the Southern Resource Region and at regional archaeological sites. It does not seem to be as commonly utilized here, however, as in the Western Resource Region. This may be because of the tendency of RRC to fracture uncontrollably into small, blocky chunks that are useless for further reduction. The relative abundance of other, more reliable raw materials in the Southern Resource Region would minimize the need to rely on utilization of RRC. Specifically identification of RRC at archaeological sites in this region may not be feasible in many cases, unless distinctive mottling patterns or fossils are present. RRC resembles many other light-colored, fine-grain cherts that may occur at sites in the region. Visually separating cherts with these general characteristics is, in my experience, among the most difficult undertakings in raw material identification.

Shell Rock Chert (Figure 6.22) is believed to occur naturally only in a small part of south-central Minnesota and possibly in adjacent parts of north central Iowa. It is probably available in drift rather than from bedrock, even though the distribution would to be quite restricted for a drift source. The archaeological distribution also appears to be limited. So far, this raw material has been identified in small amounts at archaeological sites only in Freeborn, Mower and nearby counties. Shell Rock Chert is highly distinctive. It is near white to light grey in color, and is mottled. In many respects, it resembles Swan River Chert. However, the chert’s most distinctive feature is the presence of easily visible colonial coral fossils, probably a species of *Hexagonaria* (cf. McLean and Sorauf 1988); the entire rock matrix consists of coral fossils. The cortex on unmodified cobbles is chalky and white, although it may be stained yellow or brown. On some pieces the cortex also clearly displays the form of the coral colony (Olmanson et al. 1994; Bakken 1995b).

![Figure 6.22. Shell Rock Chert.](image)
Maquoketa Chert has been found in the vicinity of Cedar Valley Chert outcrops, and is believed to come from the underlying geological stratum (Gonsior 1992). Maquoketa Chert resembles Swan River Chert in its coarse texture and fracture. Maquoketa Chert, however, appears to be limited to a pale grey color. This material seems strongly inclined to fracture along circular layers concentric to the cortex. This characteristic, combined with generally poor flaking characteristics, seems to have ensured that the material was not often utilized.

Sioux Quartzite occurs in the western part of the Southern Resource Region. Although outcrops of the quartzite were used as a substrate for petroglyphs (Lothson 1976), it is unclear whether this material was used to any extent to make flaked stone tools. Sites in this part of the state sometimes contain fractured bits of Sioux Quartzite, but almost all of these pieces lack clear flake morphology. At some locations, the base of the Sioux Quartzite consists of a conglomerate containing pebbles and cobbles of quartz, jasper, and other potentially flakable materials (Austin 1972a:450–453; Sims and Morey 1972:3) that may have occasionally been utilized (Peterson et al. 1989). However, conglomerate outcrops are very limited in extent, and the flakable stone it contains represents a minor raw material source.

Although Knife River Flint is listed as a local raw material (Table 6.3), locally available quantities are negligible. It is likely that most of the KRF found at sites here come from outside the region, specifically from the primary source area in west-central North Dakota (Gregg 1987). As noted above for the Western Resource Region, an exception may be the reduction of locally occurring KRF pebbles by bifacial techniques in order to produce expedient flake tools. KRF is much less common at sites in this region than in the Western Resource Region. KRF is easily identified by its translucency, coffee-brown color, and pattern of diffuse inclusions (see Clayton et al. 1970). Occasionally it develops a white patination. Burning makes KRF nearly opaque and pale bluish grey in color. Even when patinated or burned, however, KRF displays the same distinctive brown color to transmitted light and may usually be identified.

Quartz is available in glacial drift throughout the state, including the Southern Resource Region. It is normally easily identified by the presence of flat fracture plains that follow its crystalline structure. Better-quality raw materials are more abundant in most of the Southern Resource Region than in most other parts of the state; because quartz is relatively difficult to work, these better-quality materials were preferred whenever available. Quartz is therefore less common at archaeological sites here than in areas where good-quality materials were rare. Bipolar techniques were still locally utilized with this raw material, again suggesting the presence of an expedient flake tool technology.

Rhyolite and siltstone probably both occur in small amounts in glacial drift in the Southern Resource Region. They are found at archaeological sites in the region, but generally only in small amounts. These raw materials may be similar in appearance, especially in color. The two may be distinguished by relative opacity; siltstone is opaque, while rhyolite displays moderate to strong translucency. Rhyolite sometimes also has patches and streaks of brown to orange brown, and usually has clear, colorless phenocrysts in a finer-grained matrix; these characteristics are lacking in siltstone. The slightly porous or chalky patina that develops readily on siltstone is not seen on rhyolite.
Pebbles of chalcedony, jasper and silicified wood are occasionally found in drift in this region, and silicified wood is relatively more common here than in other parts of the state. These materials rarely occur in cobbles large enough to facilitate standard patterned reduction techniques. It should be noted that these raw material terms are used here in a descriptive, generic sense. Chalcedony includes fine-grained, translucent to transparent, waxy-textured materials that are usually pale brown, gold, or colorless. Jasper includes fine-grained, waxy-textured materials that are yellow, yellowish brown, olive, brown, or red to reddish brown in color. The color may be solid or mottled. Silicified wood may be distinguished by its visible wood grain. Pieces of this material often fracture along lines between growth rings. The origin and distribution of these materials are not well understood. When materials matching these descriptions are found at regional sites, some care should be taken in their identification. This is particularly true with chalcedonies and jaspers, especially if patterned tools made of these materials are found. Such pieces may indicate import of raw material from sources outside the region, especially to the west where larger, better-quality pieces are available. In some cases it may be possible to specifically identify such nonlocal raw materials.

Quartzites (besides Sioux Quartzite) are found in drift in the Southern Resource Region. In general they resemble the forms found in the Western Resource Region: a white to golden yellow form that tends to have larger crystals, and a dull red to dull purple form that tends to be finer grained. This quartzite is very brittle and largely useless for standard lithic reduction. The flakes occasionally found at sites are probably detached from quartzite cobbles used as hammerstones. It is possible that there are also quartzites of northeastern derivation present in the region, although this has not been specifically documented.

In addition to the drift quartzites, there may be orthoquartzites available from primary geological contexts on the extreme southeastern edge of Minnesota. These would be related to such materials as Alma Quartzite (Penman 1981) and Arcadia Quartzite (Robert Bozhardt, personal communication 1994). To date, however, there is no clear evidence for such sources.

Small amounts of raw materials from Iowa and other areas are found at archaeological sites in southern Minnesota (Figure 6.23). This creates identification problems. The problem is particularly noticeable if you try to separate certain local and southern materials that share elements of geological origin and, therefore, have similar characteristics. In some circumstances, it is sometimes best to avoid specific raw material identification unless clear diagnostic characteristics are present, and group similar raw materials in a generic “chert” category.

Some of these southern materials found at archaeological sites in Minnesota, however, are very distinctive and can be specifically identified. Some of the more often encountered and easily identified include the many varieties of the so-called “Fusulinid Cherts” (e.g., Raytown, Plattsmouth, Winterset, etc.), Moline Chert, Maynes Creek Speckled Chert, Burlington Chert, Croton Tabular Chert, and Cobden Chert. It appears that many of these raw materials, as well as other materials of southern origin, were moving into southern Minnesota along the Mississippi River and some of the major river systems that traverse Iowa. This hypothesis, however, must be studied more carefully.
A very useful key to the identification of these and other Iowa raw materials is provided by Morrow (1994). Remember that this key and any other written descriptions produce better results when used in connection with reference collections. Representative samples of nonlocal lithic raw materials are available at the Minnesota Historical Society (Fort Snelling) and the Iowa Office of the State Archaeologist (University of Iowa).

Burlington Chert is one of the most common exotic raw materials at archaeological sites in the southern part of Minnesota. Hixton Silicified Sandstone (and related orthoquartzites) and Knife River Flint are also found, but are less common. Nonlocal materials that may be encountered (in addition to the materials of southern origin discussed above) include Bijou Hills Silicified Sediment (Church 1994), and possibly raw materials originating in the vicinity of the Black Hills of South Dakota.

Burlington Chert, (Figure 6.24) though highly variable, is generally rather distinctive. This typically high-quality raw material occurs in thick beds and large nodules in an outcrop belt stretching from southeast Iowa, into western Illinois and northeastern, central, and southwestern Missouri. Burlington Chert is most commonly white or off-white in color but can take on a tan color with mineralization.
Some pieces are broadly mottled or irregularly banded and others are more uniform in color. It is slightly to moderately translucent and fine grained. Fossil inclusions are common but may not be present in all pieces. Crinoid columnals, often exceeding 5 mm (0.20 inches) in diameter, are the most common fossils along with fenestrate bryozoa, brachiopods, and solitary corals. Heat treatment changes white Burlington Chert to a snow white to ivory color, or, if traces of iron coloration (tan or brown tinges) are present, pink, red, and maroon color may result. Burlington Chert was rarely (if ever) heat treated prior to the end of the Early Archaic period.

The Maynes Creek Formation is a major raw material source in central Iowa. This material occurs in several modal varieties including cream, speckled, gray, fossiliferous, and green. Maynes Creek Chert tends to be somewhat tough (though still very workable) in its natural state and was commonly heat treated as far back as Dalton times. Maynes Creek Speckled Chert (Figure 6.25) is the most easily recognized variety. It is light gray to cream in color with darker mottled streaks or speckles. It is dull and relatively opaque. Heat treatment induces a satiny to glossy luster and brings out pinkish to maroon colors in the material.

Croton Tabular Chert was formerly attributed erroneously to the Warsaw Formation but is now known to originate in the Croton Member of the “St. Louis” Formation of southeastern Iowa. The Warsaw Formation does contain chert (Warsaw Chalcedonic Chert) and unfortunately some researchers have mistakenly attributed all chert formerly called Warsaw to the Croton source. There is no such thing as Croton Chalcedonic Chert, and there is no longer such a thing as Warsaw Tabular Chert as some have recently reported (Pope et al. 2014). Croton Tabular Chert (Figure 6.26) is a very unusual material that occurs in flat seams typically between 8 and 50 mm (0.31 and 1.97 inches) in thickness. The interior chert matrix is dull, very opaque, and creamy gray to light gray in color with an off-white to yellow-tan cortex on both flat surfaces. When heat treated, the chert matrix commonly turns medium gray and takes on a satiny sheen with the cortex commonly rendered pinkish to brick red in color. Bifaces and points made of this distinctive material often retain a patch of cortex near the
center of one or both faces. Croton Tabular Chert, usually heat treated, was a favorite material of Middle Woodland groups in the upper Mississippi River drainage and was widely traded.

The so-called "Fusulinid Chert" is a blanket term coined to encompass the entire myriad of chert varieties derived from middle and upper Pennsylvanian age sources in southwestern Iowa, northwestern Missouri, southeastern Nebraska, and northeastern Kansas. The name "Fusulinid" is unfortunate in several respects. For one, while the distinctive fusulinid foraminifera fossils are present in some of these cherts, they are completely absent from several Pennsylvanian cherts or are so sparsely represented that they cannot be used as a reliable diagnostic criterion. Further, many Permian cherts from sources in the Flint Hills of eastern Kansas and Oklahoma contain fusulinids (albeit, different species) as well. When present in quantity, however, fusulinids provide a definitive means of distinguishing cherts derived from distinct formations within the Pennsylvanian and Permian strata. Plattsmouth Chert (Figure 6.27), known to rockhounds as "rice agate," is perhaps one of the most unmistakable cherts in the midcontinent.

Moline Chert (Figure 6.28) is a distinctive lower Pennsylvanian age material from a restricted source area in northwestern Illinois. It occurs in beds and seams up to 20 cm (8 inches) thick and ranges from light gray to almost black in color, usually with black steaks or tiny black specks. It is opaque to very slightly translucent and has a dull to satiny luster.

Bijou Hills Silicified Sediment (Figure 6.29) is another raw material derived from sources to the west and southwest. This is a distinctive silicified sediment superficially resembling Hixton Silicified Sandstone. The Bijou Hills material ranges in color from light gray to pale green to a rich olive green. It typically contains a mixture of clear and darker mineral grains, giving it a "salt and pepper" appearance. It is moderately translucent and often takes on a frosty white surface patina.

In the Southern Resource Region, as in the Eastern Resource Region, it is useful to have detailed information on raw material sources in the vicinity of a site that you are studying. Some information of this
sort is available in the geological literature (e.g., “Chapter IV: Paleozoic and Mesozoic,” pages 457–512 in Sims and Morey 1972, specifically Austin 1972b:459–473). A first hand, on the ground inspection of raw material sources would also be valuable. However, an adequate raw material analysis may be conducted without such detailed information by placing the analysis within the context of regional raw material resources.

A few quarry and procurement sites are known in the Southern Resource Region. At the Grand Meadow Site (21MW8), “scores of large pits, up to 3 m deep and 5 m in diameter, were dug through prairie soils and the weathered limestone of the...Cedar Valley Formation” (Trow 1981:102) in order to extract Grand Meadow Chert. The pits still cover several acres, and were previously more extensive. The Archaeological Conservancy has purchased part of the quarry acreage in order to preserve it (see Archaeological Conservancy 1992).

The Hadland Site (21FL60) (Ready 1981) and the nearby Chally/Turbenson Site (21FL71) (Gonsior and Myster 1994) are two known locations where Cedar Valley Chert (CVC) was procured. In both cases, the source appears to be lag deposits. The Chally/Turbenson Site, located in Mower County, southeastern Minnesota, covers an extensive area. Surface collection and excavation at the site to date has not provided clear evidence of site chronology. However, incorporation of artifacts into loess deposits suggests that at least parts of the site may be relatively early. The nearby Hadland Site represents similar procurement patterns.

The St. Croix River Access Site (21 WA 49) is a lithic procurement site where Prairie du Chien Chert (PDC) was gathered either from outcrops or alluvial gravels (Hoffman and Myster 1992). At the LeSueur Site, in the city of LeSueur, PDC was taken from nearby outcrops. Roetzel and Strachan (1992) suggested that it was then heat treated in a kiln built from cobbles.

Gonsior et al. (1994) documented the procurement of Galena Chert from lag deposits at six sites in Fillmore County of southeastern Minnesota. The sites include Kindem (21 FL 65), Tieskotter/Stevens (21 FL 66), Tessum/Lunde (21 FL 67), Evenrud (21 FL 68), Hahn (21 FL 69), and Simonson (21 FL 70). The investigators suggest that raw material was acquired on an opportunistic basis from eroding ravines or other exposures. In addition to procurement, all stages of reduction are represented. Heat treatment was apparently applied to both whole cobbles and partly reduced bifaces.

**Conducting a Raw Material Analysis**

A definition of raw material analysis is required. First it is important to understand that a raw material analysis may be conducted at different levels. The first and most fundamental step is description: identifying the raw materials represented in an assemblage, determining their relative abundance, and determining the relative abundance of such characteristics as heat treatment or the presence of cortex. The second step is establishing raw material context: examining the geographic origin of the raw materials in relation to where the assemblage was found. The next step is establishing archaeological context: comparing the assemblage with other assemblages, whether from nearby or distant sites. The
final step is interpretation based on the above information: discussing how raw materials were procured, circulated, modified, and utilized.

The analysis must include identification of the raw materials represented in an assemblage and their relative abundance; it should also include whenever possible an evaluation of the relative abundance of characteristics such as heat treatment and presence of cortex. Publication of this type of descriptive information in a report provides useful raw data for other investigators, even if no additional interpretation is attempted. However, once this set of descriptive information is in hand, examining raw material context is usually fairly straightforward. This chapter’s initial discussion of raw material resource regions is intended to support such an examination. At the most basic level, establishing raw material context allows the raw materials represented in an assemblage to be characterized as local, nonlocal or exotic (or sometimes indeterminate). The direction and relative distance of sources for nonlocal and exotic raw materials can also be discussed on a basic level. Additional detail can be added to such an evaluation, as appropriate or possible, by considering natural raw material distribution in more detail. This can be accomplished by referring to the publications above or by undertaking additional field research on the natural distribution of one or more raw materials.

The most interesting step is usually establishing archaeological context by comparing your assemblage with other assemblages, whether from nearby or distant sites. This step is not always possible or practical, because it requires collecting a body of comparative data either by literature research or undertaking a descriptive raw material analysis of other assemblages. Both of these options can be time consuming. In addition, it can be difficult to find useful comparative information in published reports because identification and description has not been based on any consistent set of raw material categories. As better information on Minnesota raw materials has become available in the last few years, however, consistency and comparability have improved.

The final step, discussing how raw materials were procured, circulated, modified, and utilized, is beyond the scope of many site reports. In addition, many assemblages do not provide an adequate sample to support this kind of discussion. Such interpretations can, however, be built over a longer course of research with reference to many collections. Among other results, such a research program should allow definition of technological “industries”—patterns of lithic raw materials procurement, circulation, modification, and utilization with specific geographic and chronological limits.

It should be noted that raw material analysis, as discussed here, is limited to chipped stone technology. It does not extend to ground stone, carved stone, or other stone technologies, and does not normally extend to the related but separate issues of technology and typology. It is also distinct from the more specific task of raw material sourcing. Any of these other analyses, however, may serve to complement a raw material analysis.

Methods. The approach I advocate is based on identification of lithic raw materials by macroscopic visual characteristics, supplemented by occasional examination under low power magnification (hand lens or binocular dissection microscope). In part this is a practical consideration. Macroscopic examination is the method available to and utilized by most archaeologists in the course of a regular site analysis. I also believe that this approach can provide substantially accurate results in most cases. This identification technique depends on consideration of multiple characteristics, including apparent
color, color of transmitted light, fracture surface characteristics, color patterning, inclusions, relative
opacity or translucency, cortex characteristics, texture, and alterations produced by heat treatment. The
use of several characteristics provides an adequate “multidimensional” conceptual space within which
most raw materials may be separated. The approach is not unlike that used by geologists to distinguish
various formations and members. And, critically, this approach serves to establish a broad research
framework, within which more explicit (and expensive) identification techniques can be utilized to best
result. Such methods, including trace element analysis and thin section analysis, can provide a valuable
complement. The important consideration, as is always the case in archaeology, is to recognize and
respect the interpretive limits of the resulting information.

I also advocate making distinctions and identifications within the context of regional raw material
availability. Consider where the assemblage was found in relation to the lithic raw material regions
discussed above. Because most sites contain a high percentage of locally available raw materials, this
will give you a good indication of several raw materials you should encounter at the site. For example,
if a site is located in west-central Minnesota (i.e., well within the Western Resource Region), you would
expect to find substantial amounts of Swan River Chert and Red River Chert, together with smaller
amounts of Tongue River Silica, etc. In contrast, if a site is located in central Minnesota (near the
transition between the Western and Eastern Resource Regions), in addition to the materials just
mentioned you might expect to find Jasper Taconite, siltstone, and other eastern materials.

Conducting a raw material analysis in the context of regional raw material availability also helps with
another difficulty commonly encountered in a raw material analysis: distinguishing between similar
materials. For example, Red River Chert (and, for that matter, essentially every other lithic raw
material) has a range of physical characteristics. Occasionally, RRC may resemble some forms of
Prairie du Chien Chert, Galena Chert, Hudson Bay Lowland Chert or possibly other materials. For this
example, we will assume that we are examining the lithic artifacts from a site in northwestern
Minnesota. The site contains Swan River Chert, rhyolite, and Tongue River Silica. There is also a set of
artifacts definitely identified as Red River Chert and another set of artifacts that may be Red River
Chert. Note first that there are not positive identifications of distinctive southern materials. This
suggests that the questionable material is more probably Red River Chert than Prairie du Chien Chert
or Galena Chert. If there had been clearly identified pieces of some southern material (such as oolitic
Prairie du Chien Chert), than the questionable material would require more careful examination to see
if it might be non-oolitic PDC. Stated in another way, if a particular artifact might be plausibly
identified as either a local or nonlocal materials, it is preferable to identify it as a locally available
material. This avoids implying trade networks, long distance travel or other phenomena that cannot be
adequately substantiated.

None of this is meant to imply that sites will normally not contain raw materials from outside the lithic
raw material region in which they are located. In fact, this is very common. But the abundance of a
particular raw material at a site is related to its availability, and therefore “locally” available raw
materials are usually more common as artifacts. In this context, exceptions to the pattern are all the
more remarkable and deserve careful consideration and explanation. They should also be subject to
more rigorous proof.
When conducting a raw material analysis, it is very important to remember that the goal of the analysis is to produce a raw material characterization of an entire assemblage. Even though you are working with individual pieces, your goal is not to produce a list that accurately identifies each piece in terms of raw material. This is not practical; in fact, it is not possible—except in rare cases. Lithic raw materials are too variable in character, and there is too much overlap between the characteristics of various materials. This problem is accentuated as individual pieces become smaller. There is a point where a piece is too small to give an adequate indication of the characteristics of the constituent raw material. At this scale, many raw materials cannot be distinguished from one another with any degree of accuracy.

Thus absolute accuracy is not possible. If, however, you think of your task as characterizing an entire assemblage, you have set an achievable goal. You will be able to produce, first of all, a substantially accurate list of raw materials represented in the assemblage. Second, you will be able to produce a substantially accurate evaluation of the relative proportion of each raw material. This is due in part to the fact that examining many pieces gives you a better idea of the range of characteristics represented; the range of characteristics represented among the pieces compensates in part for the lack of range apparent in individual pieces. It is further due to the fact that a few individual errors of identification will not significantly affect your results. Misidentifying one or two dozen pieces in a collection of several hundred pieces, for example, results in an acceptably small margin of error. As long as most pieces are identified accurately, the misidentification of a few pieces does not significantly change the total characterization.

An assemblage may consist of all the lithics from a site, or of some subset such as all the lithics from a single stratum or feature. When sorting and identifying raw materials, it is best to work with an entire assemblage at once. If you can, dump the entire assemblage—tools, flakes, shatter and other pieces—in a single terrifying heap. Then start sorting. This produces better results than examining pieces individually, in serial, as happens during regular cataloging. Sort by placing materials with similar characteristics together. Having pieces side by side helps in comparing them more effectively. Make the easy identifications first; set aside the difficult pieces. When you come back to them later, you will be more familiar with the characteristics of raw materials present in the assemblage and many of the difficult pieces will no longer seem so mysterious.

As you sort, remember that your decisions are not final. You can easily change your mind. And as you work, think in terms of tentative raw material identifications for each batch you have separated. You can also easily change your mind on these identifications. In making tentative raw material identifications, consider where the site is located. What are the locally available raw materials? In most cases, these will constitute a substantial portion of the material you are examining. This is especially useful in distinguishing similar materials. For example, Galena and Red River may both be opaque, slightly chalky, light-colored cherts. But if you are conducting a raw material analysis of a site in southeastern Minnesota, a chert of this appearance is more likely to be Galena. At a site from northwestern or west-central Minnesota, such a material is more likely to be Red River Chert. Consider the raw material resource context of the site and allow this to guide your identifications.

Also consider which nonlocal raw materials are likely to be found, on the basis of proximity to the sources or on the basis of what has been found and identified at other sites in the region. For example,
Knife River Flint is more common at sites in western Minnesota, Hixton Silicified Sandstone at sites in eastern Minnesota, and Burlington Chert at sites in southern Minnesota. The presence of exotic raw materials is influenced by, although certainly not completely limited by, proximity to the source of the exotic raw material. After all these procedures, it may be that you will still encounter other nonlocal materials. But identification of these materials should be made only on the basis of good evidence, after other more probable identifications have been ruled out.

As you work, compare the texture of fracture surfaces. Many materials have a smooth break, while others have a rough break. These textures can be very distinctive. For example, Knife River Flint usually has a smooth, somewhat satiny fracture surface that shows individual flake scars fracture features quite clearly. Gunflint Silica has a fracture texture not unlike a broken ice cube. Swan River Chert has a fracture surface reminiscent of orange peel, and individual flake scars are distinguished only with difficulty on this raw material.

It is better to view materials in the light from an incandescent lamp than under fluorescent light. The incandescent bulb provides a fuller spectrum of light, thus better approximating natural light and allowing the color of the material to be seen more accurately. Bright, diffuse daylight (not direct sunlight) is better yet.

Try holding each piece up to a bright light so you can see the “transmitted” light coming through the raw material. The color of the light as it comes through the material can be diagnostic. For example, the translucent variety of Cedar Valley Chert usually shows a golden or yellow color. Hudson Bay Lowland Chert shows a distinctive reddish color. Viewing the light coming through an artifact will also help you determine how opaque or translucent the material is, and reveal the presence of inclusions. Diagnostic characteristics such as these are discussed below in the raw material reference list.

Access to a comparative collection of lithic raw material samples is imperative. Even a small collection can be extremely helpful. A large collection with multiple samples of each material is better because it allows you to get a clearer idea of the range of variation for a given raw material. Many of the raw material characteristics that you will observe are rather subtle and difficult to remember with sufficient precision. Refer to the samples periodically.

Remember that overheating, especially burning, can greatly alter the appearance of a raw material, sometimes to the point where it cannot be specifically identified. At many sites a classification such as “burned chert” may be useful.

When your raw material identification is nearly complete, you should still have a few unidentified pieces. Nature is not categorically tidy: there is simply too much variation in each material and too much overlap of characteristics between materials to confidently identify each piece. Do not expect to be able to do this, except in extraordinary cases. Depending on how many unidentified pieces there are and what percentage they constitute of the total assemblage, there are various ways to handle them. If there are just a few unidentified pieces, leave them in a single category. If you have a larger number of unidentified pieces, you may wish to sort them into smaller groups on the basis of observed characteristics. It is preferable to use as few additional categories as possible. The proliferation of nonspecific categories provides little useful information and tends to make an analysis more confusing.
Unidentified pieces may be included in an analysis under general, descriptive terms rather than under specific material names. Use of general terminology allows an unidentified material to still be classified and described in useful fashion. It also provides an alternative to guessing at raw material identifications in order to fit all samples into specific categories. Match the specificity of your terminology to your degree of certainty. Consider using broad terms like “chert,” “fossiliferous chert,” “other silicates,” etc.

When you have separated the various raw materials, you should sort each individual raw material into subcategories according to whether cortex is present or absent and, when possible, whether or not the material has been heat treated. This will produce up to four subcategories for each raw material: no cortex, not heat treated; no cortex, heat treated; cortex, not heat treated; cortex, heat treated. These sub-categorizations can be useful in examining reduction strategies. Examples are discussed below.

Cortex is usually not difficult to identify, even though the appearance of cortex varies from one raw material to another. Cortex refers to the weathered or otherwise distinctive exterior surface of a cobble or other block of raw material. It may be a distinct, separate rind that varies in color, texture, or other characteristics from the chert on the interior of the cobble. It may also be a chemically and mechanically weathered surface on the chert itself. It may even consist of adhering parent material such as limestone. Because of this variability, a reference collection that includes whole cobbles can be helpful. Even without this kind of reference material cortex is usually not difficult to identify. There are exceptions, of course. Siltstone is an example. This raw material tends to develop a heavy patination that may be difficult to distinguish from cortex.

Heat treatment can be more difficult to identify. The effects of heat treatment vary from one raw material to another, and also vary from blatant to subtle to undetectable. Materials like Tongue River Silica and opaque Cedar Valley Chert undergo obvious color changes. Swan River Chert exhibits more subtle but still detectable changes in texture. Siltstone shows no noticeable changes whatsoever. As a rule, some combination of changes in color, texture, or luster results from heat treatment. Many raw materials will redden in color, either subtly or dramatically, although other color changes occur. Mottling or other color patterning may be enhanced or diminished, and fossils or other inclusion may become more or less obvious. Many pieces become waxy or even glassy when they are heated. The degree of change depends partly on the individual raw material and partly on the maximum temperature reached. Changes in luster may be seen by comparing heated and unheated specimens. Sometimes differences can also be seen on a single piece between fracture surfaces created before and after heating. In some cases heating might also produce changes in translucency or other characteristics. Given this kind of variability, I recommend two ways of learning to recognize heat treatment. First, examine the range of variability for each raw material in an assemblage and look for consistent variations in color, texture, luster, or other characteristics. Sometimes the differences between heated and unheated pieces will be obvious. Second, refer to experimentally heat-treated samples. You might even attempt heat treating samples yourself, using a kiln, a fire, or even the kitchen stove. Temperatures of 400˚ to 500˚ F are enough to produce changes in many raw materials.

You will not be able to identify heat treatment on some raw materials. With other raw materials, you will not be able to consistently identify heat treatment. In such cases it is adequate to state in your
descriptive analysis that identification of heat treatment was not attempted for a particular raw material. Also remember that overheating or outright burning can produce radical changes in appearance, often to the point where the raw material cannot be identified. The most obvious signs of overheating or burning are crazing (a network of fine cracks across the surface) or potlid fractures (small round spalls that have popped off the surface).

The results of a raw material analysis are usually expressed in some quantitative way, commonly as a series of counts and weights for each raw material (and subcategory) identified. For example, supposes that when you are done sorting you have a set of heat-treated Swan River Chert flakes that lack cortex. This would be recorded as: 12 SRC flake, heat treated, no cortex, 24.40 grams. In contrast, you might also have: 1 SRC flake, not heat treated, cortex present, 18.20 grams. Count and weight provide complementary means of evaluating the amount of a raw material present. There is a rough correspondence between the number of individual pieces (especially flakes) and the amount of reduction undertaken (i.e., each flake represents an individual blows delivered to a core). Weight, in contrast, gives an approximation of the total amount of a raw material present: a single decortication flake may outweigh a dozen biface trimming flakes. Correlation of count and weight can provide useful information on reduction stage, strategy, etc., especially when further correlated with characteristics of heat treatment and presence or absence of cortex.

Establishing Raw Material Context. With this information obtained by using the procedures described above, you can evaluate the complement of raw materials present in the assemblage and draw conclusions about how raw materials and raw material sources were being utilized. First consider the geographic location of the site. Does it fall within the Western, Eastern or Southern Resource regions? Is it in one region but close to another? Remember that there are no clearly defined boundaries between regions, especially when glacial drift serves as a raw material source. If a site is, for example, within the Western Resource Region but close to the Eastern Resource Region, raw materials characteristic of both regions can be considered locally available.

When you have placed your site in relation to the raw material resource regions, you should be able to evaluate whether individual raw materials are local, nonlocal, or exotic. Remember that exotic refers only to materials that were widely circulated and probably deliberately traded. For example, within the Western Resource Region, KRF qualifies as an exotic raw material; Cedar Valley Chert or Gunflint Silica would be considered exotic.

At many sites there will be raw materials that cannot be characterized as local, nonlocal or exotic. These may include generic categories of raw materials that have not been specifically identified (e.g., “chert,” “burned chert,” “silicate,” etc.) or distinctive but unidentified raw materials. An example of the latter occurs the Gulseth Site in Rock County, southwestern Minnesota (Skaar et al. 1994). At this site, the predominant raw material is a distinctive, translucent grey silicate. Although it can be distinguished from other raw materials at the site, its source and distribution are not known. Thus it is not possible to characterize this raw material as local, nonlocal, or exotic; instead, it is characterized as “indeterminate.”

Next note the directions that nonlocal and exotic raw materials are originating from, and the relative distance for each source area. For example, at some sites you may discover that nonlocal and exotic
raw materials indicate fairly strong ties in a particular direction or with a certain region. At another site the raw materials may indicate connections in several directions but at a much more limited distances. Other sites evidence almost total reliance on immediately available local raw materials.

Site function may also come into consideration. For example, long-term or repeated habitations tend to have a greater mix of raw materials and present a broader general picture or raw material procurement, utilization, and circulation patterns. In contrast, a quarry or procurement site will probably contain one raw material almost exclusively, and offer little information on general patterns of raw material circulation, etc. A single episode, brief period habitation may also offer limited information on general trends, although it may provide other types of valuable information.

In evaluating the complement of raw materials present in an assemblage, also consider the location of your site within the region. For the Western Resource Region, an important distinction is whether the site is located within or outside of the Agassiz lake bottom. Natural supplies of raw material are essentially absent at most locations within the lake bottom; all lithics present were carried in, and exotic raw materials (especially KRF) may be more abundant. For the Eastern Resource Region, sites in the northern part of the region are more likely to be in proximity to bedrock raw material sources. For the Southern Resource Region, relative east and west position is important. Raw materials at sites in the western to central part of this region are more likely to be derived from glacial drift. Sites in the eastern end of the region, however, are more likely to lie in proximity to focal, primary-context raw material sources. Such sites may contain a preponderance of a single local material such as Galena Chert of Cedar Valley Chert.

**Examining Archaeological Context.** Once these characteristics have been examined, your assemblage may be compared with other assemblages, whether from nearby or distant sites. This is often most interesting part of the analysis. This step is not always possible or practical because it requires collecting a body of comparative data either by literature research or undertaking a descriptive raw material analysis of other assemblages. Both of these options can be time consuming. It can also be difficult to find useful comparative information in published reports because identifications and descriptions have not been based on any consistent set of raw material categories. As better information on Minnesota raw materials has become available in the last few years, however, consistency and comparability have improved. The more similar the analyses and raw material characterizations are between two assemblages, the more informative the comparison should be.

On a basic level, such a comparison involves the presence or absence and relative amounts of various raw materials found in the assemblages being compared. Even this simple step is a valuable exercise, because it contributes to building up a large-scale picture of overall utilization and circulation patterns of various raw materials.

Rather than discussing at length the rationale and methods of this type of comparison, two examples will be presented in summary. Both are taken from previous analyses that I have undertaken. These methods and results come from an ongoing research program, one that will be refined based on initial results. The final results will hopefully include an expanded body of comparative information, an elaborated explanation of methods, and discussion of the history of lithic raw material procurement, circulation, modification, and utilization patterns in Minnesota prehistory.
The first example comes from a survey conducted by the Archaeology Department, Minnesota Historical Society in Rock and Pipestone Counties of southwestern Minnesota (Skaar et al. 1994; the following discussion draws heavily on this source). Twelve sites were identified during the course of the survey. Due in part to poor surface visibility, the lithic sample from most of the sites was fewer than 10 lithic artifacts; at many sites, only one or two lithic artifacts were recovered. The largest assemblage, totaling 71 pieces, came from the Gulseth Site. Because of the small size of the assemblages, and because the sites were contained in a limited area of relatively uniform environment, the assemblages from the various sites were grouped for the purpose of analysis. Lithic assemblages from 16 other sites in the region were also examined in order to provide a broader context for evaluating and understanding the limited sample from the survey sites.

Certain interesting characteristics were noted during the analysis. The assemblage from the 12 sites identified by the survey contained an unusual complement of lithic raw materials, including a large sample of a previously undescribed raw material (at the Gulseth Site), fusulinid cherts, Prairie du Chien Chert, Galena Chert, and Knife River Flint. These materials would not be expected to occur locally. Whether this represented a significant trend or a sampling problem could not be determined from the small survey sample. When information from other sites in the region was included in the analysis, however, it seemed clear that this variety was not coincidental. The larger sample contained additional examples of Prairie du Chien Chert, Knife River Flint, Galena Chert, and fusulinid cherts. It was especially significant that at least eight of the other sites also contained pieces of the same unidentified silicate found at the Gulseth Site. In addition, the larger sample contained examples of Grand Meadow Chert, Moline Chert, Burlington Chert, Bijou Hills Silicified Sediment, Hudson Bay Lowland Chert, jaspers that are probably of Black Hills origin, and possibly even Arkansas Novaculite. This included raw materials originating from nearly every direction and from distances of up to several hundred miles. The sample contained several distinctive but unidentifiable raw materials. It is fairly clear that they are not of local origin, but specific identifications were not possible. It is probable that these raw materials also represent exotic materials; that they are unfamiliar suggests that they may originate from relatively distant sources.

The diversity of this sample is unusual and requires some explanation. Two possible factors were considered. First, this small region is located between and in reasonable proximity to three riverine drainage systems. Each of these could represent important transit routes. The region is south of the Minnesota River, near tributaries of the Missouri, and north of major streams leading up from the Middle Mississippi through Iowa. Any of these could have provided gateways to the region—but not reasons for entering the region. Such motivation could have been provided by a second factor.

This part of southwestern Minnesota and adjacent parts of southeast South Dakota contain a unique and valued resource. Pipestone, also known as catlinite, was and continues to be a material of considerable ritual significance to many Native American peoples. Archaeological evidence for the importance of this material comes from a number of sources, one of the most concise and persuasive of which is Sigstad’s (1972) sourcing study involving 193 pipestone artifacts from across the continent. He determined that 60 percent of the artifacts examined were traceable to pipestone sources in southwestern Minnesota or adjacent parts of South Dakota; about 37 percent were made from
pipestone mined at the quarries in the Pipestone National Monument. He was able to establish associations between the pipestone quarries of southwest Minnesota and pipestone artifacts from areas as distant as Anasazi and Hohokam Sites in the desert southwest; Adena and Hopewell Sites in the Ohio area; Fort Ancient Sites in Kentucky; Great Bend Sites in Kansas; Post-Contact Sites in Michigan, Idaho and Quebec; and sites of uncertain chronology as far away as Kentucky and Pennsylvania (Sigstad 1972:42–47). This is in addition to a large number of sites within the Upper Midwest, with various cultural and chronological affiliations. In addition, by carefully consideration of cultural and chronological associations, he showed that the quarries had served as important sources of pipestone as long ago as 5,000 years ago (Sigstad 1972:51).

The distribution of catlinite provides evidence that the southwest Minnesota region was at the focus of a unique, transcontinental resource distribution system. That the archaeological sites of this small region should contain a diversity of widely derived lithic raw materials is perhaps not so surprising. The importance of such exotic lithic raw materials should also not be underestimated in this relatively stone-poor region. Approximately two-thirds of the artifacts examined for this region are locally available raw materials. Of these materials, Swan River Chert is by far the most common. Other local materials represented include Tongue River Silica, Red River Chert, rhyolite, quartz, quartzite derived from glacial drift, and possibly chalcedony derived from glacial drift. These materials are generally of marginal quality. The one-third of the artifacts consisting of nonlocal and exotic raw materials constituted most of the high-quality stone.

This interpretation is based on a limited study and must be considered tentative. The possible associations are intriguing, however, and provide research questions for examining other sites in this part of the state.

A second example comes from excavation of the Roosevelt Lake Narrows Site conducted by Woodward-Clyde Consultants in Cass County, north-central Minnesota (Bakken 1995a). The lithic assemblage from the site (including only chipped stone artifacts) totaled over 4,300 pieces, including tools and debitage. This sample was large enough to support an extensive intrasite analysis. The assemblage was also compared with assemblages from 14 other sites, both within and beyond the region, in order to place it in a broader context. Comparative information was obtained both by first hand examination of collections and from published site reports. The basic comparative analysis was limited to four raw materials: quartz, Knife River Flint, Tongue River Silica, and obsidian. Quartz, KRF, and obsidian were included because they are distinctive, widely recognized, and should have been accurately identified in most cases. Tongue River Silica (TRS) is included because it is also fairly distinctive and because the substantial variation in percentage may be significant. However, TRS is not often specifically identified in reports that are more than a few years old, so information on this material was lacking for some sites.

The analysis showed that the percentages of quartz and KRF at Roosevelt Lake Narrows are comparable to other sites in the region. At most of the sites, quartz is the single most abundant material, often constituting over half of the total lithic assemblage. Most of the sites within the study region also contain a minimal amount of KRF. The comparative information further shows that small amounts of obsidian are not unusual at Woodland sites in the study area. These characteristics seem to be part of a regional raw material utilization pattern.
Assemblages from sites outside the region provide an instructive contrast. (These sites were located to the west; several were in the Red River Valley.) The range of percentages for KRF barely overlaps between regional and extraregional sites. The western (extraregional sites), which are closer to the KRF primary source area, contain significantly higher amounts of KRF. In this respect, it is also interesting that very small amounts of Hixton Silicified Sandstone are found at sites in the region. Hixton is much less common than KRF, even though the Hixton source area is closer. In fact, in Woodland sites even obsidian is more abundant than Hixton, in spite of the fact that the source area is over 800 miles away. The scarcity of Hixton requires some explanation. One possible reason is that some social barrier to trade existed between this part of north central Minnesota and the region where Silver Mound is located. Another potential explanation is that Hixton Silicified Sandstone, for whatever reason, was not as desirable as KRF (or obsidian).

The analysis also shows that the percentage of Tongue River Silica varies widely, especially within the region, with Roosevelt Lake having the highest percentage of any of the sites examined for this study. In contrast, the sample of sites outside the area of study shows much greater consistency in the amounts of TRS present. At this point, the reasons for this variation are not clear. It might be due to the abundance of TRS in the immediate vicinity of the site or to a paucity of other, better-quality raw materials.

The amount of quartz in the sites outside the region is less by an order of magnitude. The abundance of quartz in study area sites requires some explanation. Part of such an explanation may be the flaking characteristics of quartz. Although it could be classified as a marginal-quality raw material, that would ignore some significant characteristics. Quartz does not fracture evenly in any direction; even when it is “homogenous,” it is not isotropic. Fracture is harder to control, which means that quartz is less suitable for making patterned tools. This characteristic is reflected in the relative scarcity of patterned tools made of quartz. It might, however, be well suited to making expedient flake tools—flakes that were used without further modification and discarded when the edge was dulled (cf. Sather 1989).

Hopefully these examples serve to illustrate some of the potential of this kind of comparative analysis, based in large part on the methods of raw material analysis described above. As additional sites are examined and the body of comparative information continues to grow, interpretations should become more secure and elaboration of a contextual overview should become possible.

**NOTES**

1. In archaeological discussions, the word “silicate” is commonly used to signify what geologists might call a “siliceous rock.” In geological usage, the term “silicate” actually covers a broader category of compounds based on the silicon-oxygen tetrahedron.

2. Another approach to raw material identification that I have recently seen applied with promising results is macroscopic examination of samples under ultraviolet light. This technique seems to have especially good potential for distinguishing materials which look similar under visible light, although a systematic evaluation is needed.
CONCLUSION

Lithic raw material studies and raw material analysis are basic tools that can contribute to archaeological analysis on many levels. I hope that the information presented here will contribute to more productive analyses by helping us work together more consistently and productively, sharing a set of ideas on the raw material resource base and on basic approaches to raw material analysis. There will be areas of disagreement; I welcome these, and the chance to debate and revise the ideas that have been presented above.

This chapter presents, within practical limits, the current state of knowledge on the raw material resource base in the state. It also attempts to provide a context for understanding lithic raw material availability and utilization patterns, and suggests certain approaches to lithic raw material analysis that I believe can be productive. Although it represents the work on many people over the course of many years, it should also make obvious the fact that there is more work to be done. This chapter should highlight what we do not know, as well as what we do know. If it contributes to more productive research and discussion, it should lead to its own obsolescence. I hope that, in the course of the next few years, a substantially revised version is required.

ACKNOWLEDGEMENTS

The information presented in this chapter is the product of many years of research by many people. Wherever possible I have acknowledged their contributions by citing their work. However, a great deal of information on the topic of lithic raw materials is not published and is traded in notes, conversations, and other ways that are hard to document. I hope that I have not overlooked any contributions.

I would like to express special appreciation to LeRoy Gonsior and Tony Romano who, with their considerable expertise, helped keep me on the straight and narrow. Thanks also to George Christianson, Dan Higginbottom, Brian Hoffman, Jon Nelson, and Dean Sather for information on lithic raw materials, and to Stacy Allan, Kelly Gragg, Craig Johnson, Donna McMaster, and Jonathon Sellers for reviewing various versions of this chapter and making suggestions. Thanks to Stacy Allan, Pat Emerson, Grant Goltz, LeRoy Gonsior, Mike Justin, Bruce Koenen, Donna McMaster, Les Peterson, Dean Sather, and Doug Welsh for help with collecting samples. And thanks also to my late colleague and friend Riaz Malik, for his help and encouragement.
AUTHOR’S NOTE

A summary of the paper from which this chapter is derived was delivered at the Annual Meeting of the Society for American Archaeology, 3–7 May 1995, in Minneapolis, Minnesota. This chapter is adapted from a paper that is a revision of a draft originally prepared for a workshop on lithic raw materials held at the Institute for Minnesota Archaeology in January of 1992, and initially revised for a similar workshop at Moorhead State University in October 1994. It represents research in progress. Although I have tried to ensure that the information it contains is complete and accurate, some information is still incomplete and parts will be subject to significant revision.
Ground stone, as the term has become common in archaeology, is somewhat of a catchall category (Adams 2002). It includes such a wide range of artifacts made of such a broad suite of raw materials that it is difficult to provide a simple, all-encompassing definition of what is and what is not “ground stone.” At the most elementary level, ground stone artifacts are those tools and other artifacts that were created by processes of pecking, grinding, and polishing. This includes several of the more obvious, familiar, and distinctive stone artifacts found across Minnesota, such as grooved mauls, grooved axes, and ungrooved celts. Other, much scarcer items like smoking pipes, bannerstones, gorgets, and pendants incorporate drilling as an additional part of their manufacture. These are formal tools produced through various combinations of actual manufacturing techniques.

Other artifact types that are commonly thrown into the ground stone category may not fit as well into the definition provided above. Hammerstones, for example, were typically made on selected, naturally formed cobbles and exhibit little or no intentional modification. The only grinding on a hammerstone is that already provided by the forces of nature. Any pecking it exhibits was created by the impact battering induced during use, and polish, if there is any at all, is the incidental result of the sweat and grit from the hand wielding it. There is a world of difference between a lowly hammerstone and a laboriously pecked, drilled, ground, and polished bannerstone.

Still other stone tools seem to straddle the line between the two extremes outlined above. Grinding stones—manos and metates—may, like hammerstones, be simple cobbles and slabs selected from nature and put directly to use. There is a continuum, however, in which more intensively used grinding stones have actually been intentionally shaped for the purpose. The handstones, or manos, very often exhibit a shallow pecked pit on the center of their working surfaces. The grinding surfaces on the larger, stationary metates became smooth and ineffective with prolonged use and were often “freshened up” by pecking. Likewise, abrading tools may simply be unaltered pieces of sandstone exhibiting only use-derived modification, or, in other cases, they may be fully manufactured, formal tools.
Ground stone tools do commonly share one characteristic. That is, they are quite often made of tough, granular rocks that are ill suited to making chipped stone tools. These include materials like granite, diorite, gabbro, and metamorphic quartzite. One might, therefore, get the impression that ground stone tools are anything and everything that is not a chipped stone tool. However, even this broader concept fails to account for the full suite of ground stone tools and the techniques used in their manufacture. Some of the raw materials used to make the more formal ground stone tools can be flaked roughly into shape employing the same percussion techniques used in chipped stone tool manufacture. Some grades of basalt, quartzite, and hematite in particular are quite amenable to the flaking process. There are also examples of technology around the world where tool preforms were made by flaking and then finished by grinding and polishing. These include the polished Neolithic flint axes (celts) of Western Europe, the greenstone axes and adzes made by ethnographically known and contemporary groups of New Guinea, and the Mississippian Chert spuds (flared bit celts) found in and around Cahokia in Illinois (Bostrom 2015).

**MAKING GROUND STONE TOOLS**

Figure 7.1 Reduction sequence of a flaked, pecked, and ground celt. Figure 7.1 Reduction sequence of a flaked, pecked, and ground celt. As with chipped stone tools, the first step in manufacture is finding and selecting a suitable piece of the proper raw material. Tough, fracture-resistant materials are desirable for tools that will have a pounding function. Hammerstones of different grades of material hardness (e.g., quartzite, graywacke, compact limestone) might be selected for a flintknapper’s toolkit. Diorite was a favored material for axe and celt manufacture because it contains a more even mix of moderately hard minerals (orthoclase, plagioclase, and amphibole) with considerably less mica and quartz. Granite and metamorphic quartzite are perfectly acceptable for the manufacture of grooved mauls but were seldom used in the manufacture of ground stone axes and celts. Quartzite is very hard material that does not work easily by either pecking or grinding and the extra work involved in tapering and sharpening a bit edge would have been an arduous task. Granite contains a mixture of medium-sized grains of softer (e.g., mica), medium-hard (e.g., orthoclase and plagioclase), and harder (e.g., quartz) minerals and therefore cannot hold a cutting edge as well as other materials.

Figure 7.1. Reduction sequence of a flaked, pecked, and ground celt.
Rough-textured rock like sandstone would have been chosen for abrading tasks. Materials that do not wear away quickly and add excessive grit would be preferable for food-grinding equipment. Softer, more easily shaped materials like steatite or catlinite were commonly selected for the manufacture of smoking pipes. Aesthetics might play a role in the selection process, such as the use of porphyry or banded slate for things like bannerstones, gorgets, and pendants.

Beyond the characteristics of the raw material, the size and shape of a piece needed to be considered. If a hammerstone is desired, a smooth, rounded-to-ovoid cobble of the suitable hardness, toughness, consistency, and size is chosen. If one were to make a celto or a grooved axe, a cobble or chunk of tough material that will hold an edge and which is also as close as possible in size and overall shape to the desired end product is preferable. This latter consideration of size and shape is especially important in making complex formal ground stone artifacts because the manufacturing processes of pecking and grinding are slow and every excess ounce of material means more manufacturing time from start to finish. If the material is flakable, the size and shape issue is somewhat less critical. Figure 7.1 shows the manufacturing steps for a hypothetical ground stone celto.

**Flaking:** If a chosen piece of material can be flaked by percussion, this can be an expedient first step in the shaping process. The process is similar to that described for making chipped stone tools. However, because the raw materials are typically softer than chert or other siliceous materials, striking platforms have a greater tendency to crush and collapse. Due to the typically coarser texture of materials like basalt, quartzite, and hematite, fracture is not so predictable and flakes often run shorter than in actual flintknapping. Even coarser-grained materials like diorite or graywacke may often be partially shaped by percussion. Regardless, when flaking is an option it provides a means of trimming, shaping, and removing excess material that is much, much faster than either pecking or grinding. It may be possible to flake out a preform for a tool like a celto or adze and move directly to the grinding stage. Other pieces may require further refinement by pecking.

**Pecking:** This process is somewhat analogous to percussion flaking but with a very different goal. Pecking aims to gradually pulverize the surface of a stone, slowly removing excess material and bringing the piece ever closer to its desired final form. Bit by bit, the stone is crumbled away by rapid and repeated shallow blows with a hard hammerstone, or pecking stone (Figure 7.2). The work is tedious, loud, and dusty. The objective is to hit the stone hard enough to crush the surface without cracking or breaking the body of the stone underneath. The pecking stone must be at least as hard as the material being worked and preferably much harder. Tough grades of chert and quartzite were commonly selected for this task. Narrow pecking stones are necessary for pecking in the grooves on an axe or maul. While pecking is slow, grinding is dreadfully slow. Therefore, a tool

![Figure 7.2. Pecking a ground stone axe.](image)
preform is usually made fairly close to its finished form before any grinding commences. Pecked surfaces have a rough appearance with numerous small pits and peaks.

**Grinding:** Whether a tool preform was flaked or pecked into shape or some combination of the two, its surfaces and contours will be somewhat irregular. If a smooth finish is desired on an artifact or if a sharpened edge is required, the next step is grinding. A large stationary block of sandstone is ideal for this process (Figure 7.3), but the grinding can also be done with a handheld chunk of sandstone. Coarse sandstone abrades a rock away slightly faster but leaves a rougher surface. A less abrasive slab of stone can also be used along with the addition of loose sand. Water seems to aid in the process and keeps dust out of the air. Grinding first removes the high points—the small peaks on a pecked surface or the raised arrises (remaining ridges) between flake removals. Sometimes the grinding and subsequent polishing removes all traces of these earlier stages of manufacture. In others, remnants of the low spots—the deeper pecked pits and the hollows of flake scars—remain visible on the finished product. As stated previously, grinding is slower than pecking, removing stone at a rate perhaps five or even as much as ten times more slowly.

**Polishing:** Not all ground stone tools were polished, but some may take on a sheen from continued use. Other stone tools like bannerstones and gorgets were often highly polished. Some stones take a polish quickly while others require more time and effort. The process of polishing involves smoothing the artifact surface until it takes on a reflective sheen. One can accomplish this by switching to a finer grade of sandstone and/or burnishing the surface with a smooth, hard pebble or cobble and water. Finer abrasives like natural silt, powdered hematite, or horsetail (*Equisetum* sp.) can also be applied and rubbed in with piece of soft leather.

**Cutting:** Sometimes cutting was used to remove stone or form a ground stone object. This process was most common with softer stone varieties such as catlinite or steatite. One specialized tool common across the Northern Plains was a matched pair of abraders used to smooth arrow shafts (Figure 7.4). These were usually made from a soft grade of medium-grained sandstone. A block of this material was ground into a symmetrical square to rectangular form. Then a straight flake of
chert or similar material was used to saw a groove all around the piece, bisecting it along the long axis. When the groove was sufficiently deep, the piece could easily be snapped into two equal halves. The rough, snapped surface was then ground flat, after which a shallow, V-shaped groove was sawn lengthwise into both pieces. As the pair of abraders were used, the groove became deeper and U-shaped. When the grooves became worn too deeply to be effective, the opposing faces of the abraders were ground down and thus the groove made shallower and use of the abraders continued.

**Drilling:** Two types of drills were generally used to create holes in ground stone artifacts (Figure 7.5). One is a solid drill that could be chipped stone used with or without abrasive or a wood shaft or stiff grass stem used with abrasive. Tobacco pipes were generally drilled with solid drills, creating a tapered, somewhat cone-shaped bore. Stone gorgets and pendants drilled with a solid drill from both directions have a bi-conical hole. The second type of drill is a hollow, tubular form made out of native bamboo (*Arundaria* sp.), reed (*Phragmites* sp.), or a similar hollow stem. It was used with an abrasive such as sand or fine chert dust and water. The hollow drill cuts a ring rather than drilling a solid hole. Holes were drilled through from one direction or, with care and alignment, from opposing directions. A by-product of the hollow drilling process is a solid, peg-shaped core. Holes made with a hollow drill tend to be rather cylindrical but still taper somewhat. This is probably the predominant way that bannerstones were drilled.

**GROUND STONE IN PERSPECTIVE**

The amount of time it takes to make something like a grooved axe or celt depends on numerous factors, including the overall size of the intended axe, the difference in mass between starting form and finished implement, the relative refinement of the design, and the relative hardness of the material from which it is made. A small, rough, unrefined axe with a shallow groove or a simple celt can often be made in a few hours, but larger, symmetrical, and well-balanced forms may take a day or two. Likewise, a bannerstone might take many hours of pecking, drilling, grinding, and polishing spread out over several weeks or months. It is unsurprising, then, that unfinished, formal ground stone tools are frequently found on archaeological sites (Figure 7.6).

Formal ground stone tools usually take far more time to manufacture than analogous chipped stone tools. A chipped stone adze made of chert or similar material, for example, could generally be manufactured in less than an hour, whereas a fully pecked and ground diorite adze might require a dozen hours or more to make. Shott (1989) examined several variables contributing to the overall
Figure 7.6. Unfinished axe. (MHS Artifact: 1 1-78 928/4592; diorite; Clearwater Co., MN.)
use life of tools. He examined a broad suite of tools and utensils made and used by the !Kung San people of southern Africa and determined that one of the strongest correlates of an artifact’s life expectancy was its manufacturing time. But does the time invested in making an object really determine how long one could expect it to last?

As one might expect, the generally tougher, fracture-resistant nature of the raw materials commonly used for ground stone tools renders them substantially more durable than most comparable chipped stone forms. It is just these properties of ground stone raw materials that determine the time and techniques employed in manufacture. To put it more directly, ground stone tools both take longer to make and are longer lasting because of the nature of the materials from which they are made. In the case of ground stone, manufacturing time is more a consequence of the materials used than a cause for increased tool use life.

Many other aspects determine how long a given artifact will remain useful. Among these is the way an artifact is used. A ground stone grooved axe or celt is primarily a wood-chopping tool. Their ground, sharpened bit edges are subjected to repeated percussive and wedging forces. Even though these tools are comparatively durable, prolonged use may blunt their edges and necessitate resharpening. More catastrophic is any macro damage suffered by the tool’s edge. A chip or dent in the bit of a stone axe or celt creates a catch point—a spot where the edge is weaker and more susceptible to fracture. If the damage is not repaired and the chopping continues, the bit edge can disintegrate in the matter of a few more blows. Each bit repair and resharpening event reduces the length and weight of a stone axe or celt, eventually reducing tool performance and necessitating a replacement. It is worth reiterating here that, as is the case with chipped stone tools, relative size contributes to tool use life. A larger, longer axe or celt would likely undergo more resharpenings and repairs than a smaller example. Larger axes and celts also perform more efficiently with the extra weight, adding more heft to each chop.

Contrast the use life of a ground stone axe or celt with that of something like a bannerstone. Based on the preponderance of archaeological evidence, the most widely accepted function for bannerstones is their use as weights or counterbalances on atlatls or spear throwers (Moorehead 1917; Webb 1946; Glynn 2000). If this were the case, how would someone wear out a spear thrower weight? Barring accidental breakage, which was likely relatively rare, a bannerstone might last more or less indefinitely. A single example of such an artifact might represent a lifetime of hunting activity of one individual or, if such objects were passed down as heirlooms, several lifetimes. Accordingly, objects like bannerstones are among the rarest of North American stone artifacts.

Another thing that contributes to the function and eventual disposition of a stone tool is its size. Ground stone tools, in general, are larger and heavier than typical chipped stone tools. This being the case, portability might have be a factor worthy of consideration. Heavier tools, especially very heavy items like grooved mauls and metates, might have been ill suited to the lifestyles of mobile hunting and gathering groups. Such items would have been more at home in the villages of more sedentary cultures. Alternatively, mobile people who did use larger ground stone tools could have chosen to leave them behind as “site furniture” for future reuse at a favored camping spot.

The above discussion is intended to place ground stone tools in a more understandable context. While chipped stone tools like projectile points, end scrapers, and knives may be prolific on many
archaeological sites, ground stone tools are usually in the minority. Informal cobble tools like hammerstones and anvil stones might be common, but more formal ground stone tools like grooved mauls, grooved axes, and celts tend to be comparatively scarce. These formal ground stone tools are usually larger (and are less easily lost), take more time to make (and therefore are less likely to be casually discarded), and are more durable (and therefore are worn out and discarded less frequently). All of this culminates in circumstances that make archaeological interpretations more difficult and less certain.

Formal ground stone tools are scarce and are only occasionally recovered from archaeological sites. As often as not, archaeological sites are multicomponent—the result of numerous site occupations spread out over several centuries or millennia. If these components are mixed together, as they are on so many near-surface or plowzone sites, drawing conclusions about what artifacts are associated with which occupation is often impossible. Even professionally excavated contexts on such sites are problematic. In those uncommon instances where a formal ground stone tool like a grooved maul, grooved axe, or celt is recovered, the ages and associations of these artifacts might be inferred but can seldom be demonstrated. In a few cases, grooved mauls and celts have been recovered from well-dated and reasonably unmixed contexts on archaeological sites in Minnesota. There are, to the author’s knowledge, no examples of grooved axes being found in similarly secure, unambiguous contexts in the state. Truly rare artifacts like bannerstones have yet to be dated—directly or indirectly—in Minnesota (as is also the case in most nearby states). Chronological and contextual knowledge of things like bannerstones and full-grooved and three-quarter grooved axes in Minnesota, like what is known about similarly rare chipped stone artifacts such as fluted projectile points, is essentially limited to surface-found artifacts (most of which are recovered by avocational collectors) and out of necessity draws heavily on information derived from outside of the state.

Some ground stone tools are time diagnostic while others are less so. Informal ground stone tools like hammerstone and anvil stones can be expected to occur on archaeological sites of all Pre-Contact periods. Formal ground stone tools like grooved axes do not appear in the North American archaeological record until 8,000 to 6,000 years ago. The marked increase in the number and diversity of ground stone tools, especially formal tools, is one of the hallmarks of the Middle Archaic period in the Upper Midwest. The following pages describe and discuss the various ground stone tool categories found across the state of Minnesota. The presentation is organized roughly from the simplest informal tools to the most complex formal types. Chronological ages and notes on regional distribution are given where they are appropriate and available.
TYPES OF GROUND STONE TOOLS

HAMMERSTONES

Hammerstones are common informal tools. They are made on a variety of cobbles of varying sizes and shapes though they are typically round to ovoid in plan view and ellipsoid to spherical in side view. They range widely in size, but most are between the sizes of a golf ball and a softball. The characteristics that identify cobbles as hammerstones relate entirely to their past use as percussion implements. The portion(s) of the cobble used, commonly a rounded end or corner, become pitted and battered through use. The distribution and degree of battering varies from one hammerstone to another. Some specimens exhibit only a small patch or two of scattered pockmarks while others are extensively crushed and battered around their entire periphery. Heavily used specimens also commonly exhibit larger scars where chips and flakes were broken away during use.

Cobbles selected for hammerstones span a wide variety of materials. Virtually any stone hard enough to withstand hammering use and compact and heavy enough to deliver the desired blow could be used. Quartz, quartzite, limestone/dolomite, graywacke, granite, diorite, gabbro, andesite, and basalt were all employed.

Hammerstones were most obviously used for direct percussion flaking in the manufacture of chipped stone tools. Insomuch as hammer hardness influences flaking characteristics, softer cobbles (e.g., limestone/dolomite and graywacke) could be expected to work somewhat differently than those of harder materials (e.g., quartz and quartzite). Hammerstones used to peck in the manufacture of ground stone tools, for example, must be at least as hard, and preferably much harder, than the material being pecked. Hammerstones were also probably used to crush stone temper for making pottery, and some could have been used for pecking in the manufacture of other ground stone tools. Such tools were also undoubtedly used for other purposes like breaking bone to extract marrow, cracking nuts, or pounding dried animal tendons to make sinew. However, considering the range of hammerstone materials and their hardnesses, only the softest stones would be likely to show any readily visible traces of having been used on these non-lithic materials.

Hammerstones are often abundant on raw material procurement sites. There are several in the Minnesota Historical Society collections from the Grand Meadow Quarries in Mower County and the Bradbury Brook Site in Mille Lacs County (Malik and Bakken 1991, 1993, 1999), but they are also frequently found on habitation sites. Their distribution is statewide, and they appear ubiquitous in all Pre-Contact Native American cultures.
Figure 7.7. Selected hammerstones. ([A] UMn Artifact: 664.106; quartzite; 21-ML-9, MN; [B] MHS Artifact: 171-54-3; graywacke; Faribault Co., MN [C] SNF Artifact: 05-270-1/5; granite; Arabesque Site, MN.)
Pitted stones go by a variety of names including anvil stones, nutting stones, and cup stones. In some cases these designations refer to distinct types and forms of tools (e.g., anvil stones versus nutting stones); in others they are basically synonyms (e.g., nutting stones and cup stones). In some of the literature, these are all simply called pitted stones, without regard to their form or function. Those that are most common in Minnesota appear to have been used as anvils in flintknapping.

Anvil stones are a type of common informal ground stone tool. The most frequently seen kind of anvil stone, referred to here as the common anvil stone, typically ranges from 10 to 25 cm (3.9 to 9.8 inches) across but can be even larger. These are often somewhat tabular to ovoid in side view but can be of nearly any shape in plan view. The more common anvil stones are identified by the diagnostic battering and pitting they exhibit, usually near the center of their broadest face. The roughness and irregularity of this pitted area distinguishes these anvil stones from other pitted stones. Some anvil stones exhibit pitting on two opposing faces, and it is not unusual for these tools to also show the battering typical of hammerstone usage on one or both ends or at various locations.

Anvils used as nutting stones characteristically exhibit hemispherical, intentionally pecked depressions, but these should not be confused with naturally occurring omarolluks. These depressions may occur singly but are often seen in groups of three or more. True nutting stones can be large or small, some being made on broad slabs up to a meter (3.3 feet) across.

Cobbles selected for common anvil stones are much the same as those used for hammerstones. Quartzite, graywacke, and a host of various igneous and metamorphic rocks were used for anvils employed in flintknapping. These same materials in addition to limestone/dolomite slabs and even sandstone were used for nutting stones.

Anvil stones were used, as their name implies, as a stationary platform against which an object was placed while it was being struck from an opposing direction with a hammerstone. Considering the severity of the battering exhibited by many common variety anvil stones, these were most likely used in the flintknapping process. Such anvils were certainly used in bipolar percussion, as previously discussed in the chipped stone section. Some of these common anvils were multipurpose tools that had an alternate hammerstone function.

Nutting stones were most likely used to crack various nuts like hickory, walnut, butternut, and hazelnut. The occurrence of multiple nutting depressions on many of the larger slab nutting stones implies that several people could work together. True nutting stones appear to be rare or absent over most of Minnesota.

Common-variety anvil stones are present on raw material procurement sites and are in the Minnesota Historical Society collections from the Grand Meadow Quarries in Mower County, and several are reported from the Bradbury Brook Site in Mille Lacs County (Malik and Bakken 1991, 1993, 1999), but they may be found on nearly any site. Their association with procurement sites where large masses of material were being worked demonstrates that anvil stones were not relegated solely to the salvaging of smaller pieces of raw material through bipolar percussion. They may be common to all Pre-Contact Native American cultures. Nutting stones, in comparison, are comparatively rare.
Figure 7.8. Selected anvil stone. (MHS Artifact: 199-9-1-14; graywacke; 21-MW-8, Mower Co., MN.)
Figure 7.9. Large anvil stone. (MHS Artifact: 199-9-1-15; graywacke; 21-MW-8, Mower Co., MN.)
MANOS

Manos are common grinding implements. These are the handheld stones that were used in conjunction with larger, stationary metates. Manos can vary in shape, but most are ovoid to circular in plan view with one broader surface, or both, being flattened or slightly convex. Specific features related to their use distinguish manos from similarly shaped, natural stones. The broad grinding surfaces are notably smoother than other portions of the stone, a difference that can be seen and felt. Most manos have a shallow-pitted area near the center of the grinding surface. In addition, many manos exhibit battering wear, like that seen on hammerstones and pecking stones, around part or all of the circumference. Most manos are between 6 and 12 cm (2.4 and 4.7 inches) across.

Cobbles suitable for use as manos were commonly selected from nature and put to use without much further modification. Quartzite, graywacke, and a variety of compact igneous and metamorphic rocks were used.

Manos were used principally in grinding foodstuffs, especially seeds and grains. The peripheral battering many exhibit could be related to the pounding and crushing of these foodstuffs or could be the result of use in pecking and refreshing the grinding surfaces of a worn metate. Alternative use as a hammerstone in flintknapping is another possibility.

Manos have been found on sites as old as the Late Paleoindian and Early Archaic periods, but they do not appear to be common until Middle and Late Archaic times. They are quite frequently found on later Woodland and Late Prehistoric sites as well as on Proto-historic sites. Their distribution is likely statewide.
Figure 7.10. Selected mano. (UMn Artifact: 763.45.4; diorite; Wilford Site, 21-ML-12, Mille Lacs Co., MN.)
Figure 7.11. Selected mano. (MBISP Artifact: 10516; granite; Albert Lea Lake, MN.)
Figure 7.12. Selected mano. (SHM Artifact: 83.85.8; granodiorite; Meeker Co., MN.)
**METATES**

Metates are the larger, stationary component of the grinding ensemble known as a mano and metate. Metates are generally larger, usually much larger, than manos and typically have a slab-like appearance. They can be as small as 10 or 20 cm (3.9 or 7.9 inches) wide to as large as a meter (3.3 feet) across. A metate’s appearance varies, depending on the degree to which it has been used and maintained. Minimally used specimens may only exhibit light smoothing on the high spots of the flattish grinding surface. More intensively used metates stereotypically show a wide, deepened, pecked trough or broad, pecked depression that has been worn smooth and polished from use.

The same materials used for manos are suitable for making metates. Flat slabs of resilient Sioux quartzite appear to have been a favored material in southwestern Minnesota and adjacent parts of the neighboring states.

Metates were used in conjunction with manos in processing foodstuffs. They are comparatively uncommon artifacts on most archaeological sites whereas the hand stones or manos used with them are more frequently found. Simple and typically smaller metates are sometimes found on Archaic and Woodland period sites. Larger, more intensively used and maintained examples appear to be associated with Late Prehistoric village sites.

Figure 7.13. Large metate. (MBISP; granite; Glenville, MN.)
Figure 7.14. Mano and metate in one. Note the concavity on one side used as a metate, with the convex side used as a mano. (MBISP Artifact: 31014; pink quartzite; unknown provenience.)
PESTLES

Pestles are elongated stone forms with a blunt working end. Bell-shaped forms and cylindrical types occur across the southeastern United States. The few specimens seen in Minnesota were cylindrical and of a type commonly called a “roller pestle.” These tend to be somewhat large artifacts, often 15 to 20 cm (5.9 to 7.9 inches) long, but some examples are over 30 cm (11.8 inches) long. Most measure about 5 to 7 cm (2.0 to 2.8 inches) in diameter. These artifacts usually show traces of pecking across any or all of their surfaces. These pecking scars are usually partially obscured by grinding and/or polish resulting from intention or use. The ends of many have rough, pecked surfaces that show no traces of use.

Pestles appear to have been made from a variety of stone types including limestone, slate, schist, graywacke, and basalt.

While pestles by definition are the implements used to grind and pulverize materials in a concave, often bowl-shaped mortar, such stone mortars appear almost nonexistent in the Upper Midwest. The absence of wear on the blunted ends of many pieces suggests that they were not used in the stereotypical pestle fashion. Rather, it seems most likely that these artifacts were used to crush grains and other foodstuffs by rolling against the flat surface of a metate. Therefore these artifacts might better be called “rollers” rather than pestles.

Roller pestles are found so infrequently in the Midwest that little is known about their age or affiliations. They appear to be a rather intensively fashioned piece of food-processing equipment, and based on this, they are probably a later rather than earlier artifact type. Late Woodland and Late Prehistoric periods are the most likely ages for these tools.
Figure 7.15. Cylindrical pestles. ([A] Ulep Collection, Calkins Nature Center; schist; International Falls vicinity; [B] MHS Artifact: 4593; schist; unknown provenience.)
Abraders are a varied group of informal and formal ground stone tools that can divided into two broad categories: surface abraders and grooved abraders. Surface abraders are often little more than an abrasive stone, large or small, that exhibits a worn face or faces. These tools were used to grind down broad surfaces. Grooved abraders come in many shapes and sizes and with various groove configurations. These grooves are commonly worn into a piece and take on the configurations of the piece being ground. Some grooves a broad and semicircular, others are narrower and U-shaped, and still others are narrow and V-shaped. A specialized form of abrader, largely limited to the Plains region is the paired shaft abrader consisting of two elongated, loaf-shaped pieces, each with a groove running lengthwise on one flattened side. Some abraders exhibit multiple uses and had complex use lives.

The materials most commonly used for abraders in Minnesota are the softer, medium-grained sandstones that could be obtained from Cambrian, Ordovician, and Cretaceous sources across the southern half of the state. “Clinkers,” the cinders created from naturally burned and vitrified lignite (coal), may have been used locally in southwestern Minnesota.

Abraders were obviously used for a variety of manufacturing tasks. Sandstone surface abraders would have been useful in the manufacture and maintenance of ground stone axes and celts or the sharpening of the vertebral border of a bison scapula to be used as a hoe. Abraders with wide, rounded grooves could have been used to smooth wooden spear throwers, bows, or handles for larger tools. Abraders with narrow, V-shaped grooves are generally attributed to the manufacture and sharpening of bone needles and awls. The paired abraders with U-shaped grooves were employed in making arrow shafts.

Abraders of one form or another are found on a variety of sites of a variety of ages. They appear to be most abundant in and around areas where suitable sandstone is accessible. The aforementioned paired shaft abraders were an important component in making arrows and therefore are probably solely confined to the later Pre-Contact and historic period following the introduction of the bow and arrow.
Figure 7.16. Large surface abrader. (UMn Artifact: 714.37; sandstone; Vash Site, 21-PN-8, Pine Co., MN.)
Figure 7.17. Arrow shaft abraders. ([A] MHS Artifact: 17-22a, b; sandstone; Goodhue Co., MN; [B] MHS Artifact: 17.268; Bijou Hills Sandstone; Goodhue Co., MN.)
Figure 7.18. Heavily used shaft abraders. ([A] MHS Artifact: 17.234; sandstone; Goodhue Co., MN; [B] MHS Artifact: 17-22d; sandstone; Goodhue Co., MN; [C] MHS Artifact: 17-22c; sandstone; Goodhue Co., MN.)
WHETSTONES

Whetstones are relatively uncommon artifacts. They typically occur in two forms, a tabular bar form and long, cylindrical form. The bar-shaped form is illustrated here. These are roughly elongated rectangles about 3 to 5 cm (1.2 to 2.0 inches) wide, 10 cm (3.9 inches) or more long, and a bit less than 1 cm (0.4 inches) thick. The surfaces take on a soft sheen from use and are very smooth to the touch. Whetstones gradually become worn down and thinner with continued use. Likewise, the corners and edges tend to become worn down. Whetstones made of materials like mica schist can be brittle and are often found broken.

A variety of materials have been used for the commercial manufacture of whetstones including mica schist from New Hampshire and Vermont; sandstone from Indiana, Ohio, and New York; and novaculite from Arkansas (Tarr 1898:428–429).

Whetstones or hone stones are used to put a fine edge on steel knives and other sharp-edged metal implements, with oil or water as a lubricant. The tool edge is held against the stone at a low angle and stroked across going one direction.

Whetstones such as those discussed here date back to Roman and Medieval times in Europe. Whetstones made of mica schist were manufactured in Norway during the Viking Age (Hansen 2009) and were made domestically in New Hampshire and Vermont at least as early as the 1820s (WK Fine Tools 2013). By the turn of the twentieth century, novaculite whetstones from Arkansas (so-called “Washita stones”) started to dominate the market.
Figure 7.19. Whetstones. ([A] MHS Artifact: 359.359.9; mica schist; 21-RW-11, Lower Sioux Agency, Redwood Co., MN; [B] MBISP Artifact: 31021; mica schist; unknown provenience.)
**NET WEIGHTS**

Net weights occur in several different forms and appear to be an uncommon, or at least little-recognized, artifact type in Minnesota. Regardless of form, net weights are generally not large implements, rarely exceeding 10 or 15 cm (3.9 or 5.9 inches) in maximum dimension. Two general forms are most prevalent across the midcontinent. There are rounded examples made on ovoid cobbles encircled by a pecked or, more rarely, cut groove. These grooved net sinkers somewhat resemble miniature grooved mauls but do not show any modifications or use wear associated with hammering. The other, apparently more common form consists of simply flattened pebbles or tabular chunks of rock with two opposing rough notches. Specimens recently recovered from a site on Gull Lake appear to be the crude, notched type. These caused quite a stir in the media, underscoring the apparent scarcity of these kinds of artifacts in Minnesota.

Cobbles of the appropriate size and shape of materials that would be easily pecked or cut were used to make grooved net weights. Rocks that tend to separate into tabular masses, such as limestone, schist, and slate, seem to have been favored for the notched forms.

As their name implies, net weights were used to hold down fishing nets. The weights were tied to the bottom of a gill net, for example, and wooden floats were attached to the top of the net (Prowse 2010). Some ethnographic accounts also mention larger stones being used as net anchors.

Babbitt (1884) discusses an account of stone net weights used by the historically known Ojibwa of the Red Lake area of northern Minnesota. He describes these weights as “small, manageable pebbles or rough bits of rock” that he explicitly states were not notched or otherwise modified. Perhaps one reason that stone net weights appear to be so uncommon in Minnesota is because so many are essentially indistinguishable from natural stones. Even with modification, net weights are not eye-catching objects and might easily be overlooked. They have been found on sites with Woodland pottery and may date back at least to Woodland times.

A cache of notched net weights was recovered along Gull Lake in Cass County, MN, possibly dating to the Middle Archaic (Florin Cultural Resource Services 2016).
Figure 7.21. Selected notched net weights. ([A] UMn Artifact: 615.28; graywacke; 21-PN-8, Vach, Pine Co., MN; [B] MBISP Artifact: 21; schist; unknown provenience.)
**Full-Grooved Axes**

Full-grooved axes are formal ground stone tools. They are identified, as their name implies, by the presence of a pecked groove that completely encircles the body of the axe. One end of the axe is the ground and sharpened chopping bit, and the other is a blunt poll. The groove is typically placed closer to the poll end but can be nearer the midway point, especially if the axe bit has been resharpened several times or has undergone a major repair. These axes are generally about one-third to one-half as thick as they are wide. Overall plan view outline shape is variable, ranging from ovate to somewhat rectangular to somewhat irregular. The bit portion may be nearly as wide as the rest of the axe or may be considerably narrower. Among the ground stone axes of the Midwest, full-grooved axes tend to be the crudest, many being notably asymmetrical and often retaining large, unmodified patches of the original cobble. The grooves may be shallow or moderately deep and are usually pecked but unground. On some specimens, the grinding is functionally restricted to the bit end and the remainder of the axe is left rough. Other axes were more completely finished and show more extensive grinding. Full-grooved axes range considerably in size and weight. Most specimens are between 8 and 20 cm (3.1 and 7.9 inches) in length.

Moderately hard rocks that can hold a chopping edge were preferentially selected for making ground stone axes. In the Upper Midwest, most of these tools were made out of darker-colored materials that often have a grayish, bluish, or greenish cast, including rocks like diorite, andesite, gabbro, basalt, graywacke, or greenstone. Rare examples were made of dense hematite.

Full-grooved axes were principally woodworking tools used to fell trees, break up firewood, and the like. These axes were most likely hafted to wooden handles that were wrapped around the groove and bound with rawhide, leather, or fiber lashings. The blunt poll ends were sometimes used as hammers and show impact damage.

These are among the earliest formal pecked and ground stone tools made in the Midwest. Though none have been recovered from dated contexts in Minnesota, they are known from several well-dated Middle Archaic contexts in Iowa (Frankforter and Agogino 1960; Pope 2015) and Illinois (Cook 1976). Full-grooved axes first appear around 7500 B.P., and they remained common until about five millennia ago. Full-grooved axes appear to have largely replaced the chipped stone adzes of the Early Archaic and Late Paleoindian period as the favored wood-chopping tool. After circa 5000 B.P., three-quarter grooved axes predominate (Cook 1976).
Figure 7.23. Full-grooved axe with battering on poll. (MHS Artifact: A2839; diorite/diabase; Clearwater Co., MN.)
Figure 7.24. Full-grooved axe. (SHM Artifact: 72.10.1; indeterminate greenstone; Yellow Bank Township, Lac qui Parle Co., MN.)
Figure 7.25. Full-grooved axe. (UMn Artifact: 39.15; hematite; Ottertail Co., MN.)
THREE-QUARTER GROOVED AXES

Three-quarter grooved axes are identified as such by the presence of a hafting groove pecked into only three of the four surfaces of the axe. The bottom is left ungrooved. Three-quarter grooved axes with rounded bottoms tend to otherwise closely resemble full-grooved axes. The shallow to moderately deep groove is usually set closer to the poll end, and the overall size and proportions of these axes are similar. Other three-quarter grooved axes have flat bottoms. This latter variety often exhibits deeper, more pronounced grooves. While full-grooved axes might trend toward being somewhat crude, three-quarter grooved axes are usually more refined. This is especially true of the rectangular, flat-bottomed variety. The latter style often exhibits a well-balanced symmetrical design with considerable grinding and polishing. Three-quarter grooved axes have the same size and weight range seen among full-grooved axes, most ranging between 8 and 20 cm (3.1 and 7.9 inches) long.

The same range of rocks used to make full-grooved axes were used for three-quarter grooved axes. These include moderately hard rocks like diorite, andesite, gabbro, basalt, graywacke, and greenstone with an occasional example made of hematite.

Like full-grooved axes, three-quarter grooved axes were also principally woodworking tools. Round-bottomed three-quarter grooved axes could have been hafted in exactly the same way as a full-grooved axe. Flat-bottomed three-quarter grooved axes were certainly hafted differently. The flat bottom (and it is the bottom, not the top) is a very intentional design feature most likely related directly to how the axes were attached to their handles. One very plausible method was strapping the axe onto a flat-ended, T-shaped handle with wrappings of rawhide or strong cord. As was the case with full-grooved axes, the poll ends of three-quarter grooved axes were also occasionally used as hammers.

Three-quarter grooved axes first appear in the Midwest circa 6,000 years ago. By 5,000 years ago, three-quarter grooved axes had largely supplanted earlier full-grooved forms. Axes from dated contexts in Iowa and Illinois (Nolan and Fishel 2009) also suggest a temporal trend in three-quarter grooved axes. Earlier three-quarter grooved forms have rounded bottoms and are in most attributes quite similar to full-grooved axes. Around 4,000 years ago, the refined, flat-bottomed, rectangular three-quarter grooved axes appear (Benn 1983; Benn and Thompson 2009; Nolan and Fishel 2009; Wiant et al. 2009). Interestingly, it is at about this same time during the Late Archaic period that small, rectangular, ungrooved celts came on the scene (Benn and Thompson 2009; Nolan and Fishel 2009; Wiant et al. 2009). These ungrooved axes all but completely replaced grooved forms during the following Woodland and Late Prehistoric periods.
Figure 7.27. Three-quarter grooved axe (rounded). (SNF Artifact: 1-49/5; graywacke; Lake Co., MN.)
Figure 7.28. Four views of a three-quarter grooved axe. (SHM Artifact 86.24.1; graywacke; Stearns Co., MN.)
Figure 7.29. Unfinished three-quarter grooved axe. (SHM Artifact: 54.1.1; basalt; Benton Co., MN.)
Figure 7.30. Three-quarter grooved axe. (MHS Artifact: 1984-41-22-1; graywacke; unknown provenience.)
Notched Axes

Notched axes are not common in Minnesota. They are similar at first glance to full-grooved axes but generally do not have a clear, encircling groove. Rather, the hafting area is demarcated by distinct notches chipped and/or pecked into the top and bottom. These are usually extremely crude axes with little pecking or grinding; in fact, some would probably more rightly be categorized as chipped stone tools. The latter would be the obvious classification were it not for the materials that the few specimens in the Minnesota Historical Society collections are made from—igneous and metamorphic rocks rather than chert or similar material. In some ways, notched axes resemble notched net weights, but notched axes are larger and net weights do not have chipped and shaped bit ends.

The same range of materials used to make grooved axes appear to have been used for crude, notched axe forms. Less desirable materials for axe manufacture like schist may also have been used.

Rough notched axes were probably hafted and used in much the same way that full-grooved axes were. These may, in fact, have been *ad hoc*, temporary replacements when a grooved axe was broken or no longer serviceable (Lurie 1989).

Notched axes are, in all likelihood, the same age as full-grooved and ovate three-quarter grooved axes, that is, Middle Archaic into the early Late Archaic.
Figure 7.31. Notched axe. (MHS Artifact: 4541; basalt; unknown provenience.)
Celts

Celts are ungrooved axes. They exhibit relatively simple designs with few elaborations. Celts are usually widest toward the bit end and from that point gradually taper back to the poll. The poll ends may be flat, rounded, or somewhat pointed. Most have an ovoid cross section, some being rounder than others. In uncommon examples, the top and bottom surfaces are flattened and the celt has a roughly rectangular cross section. Celts having outwardly flaring bits are often called spuds. Overall, celts tend to be fairly well made, symmetrical, and fully ground with some polish. Celts typically range between 5 and 20 cm (2.0 and 7.9 inches) in length, but on rare occasions, larger examples do occur.

Celts have the same functional requirements as grooved axes, so the same range of raw materials also applies here: diorite, andesite, gabbro, basalt, graywacke, and greenstone with an occasional example made of hematite. Hematite specimens are almost always much smaller than celts made out of other materials.

Like grooved axes, celts were also wood-chopping tools, but they were hafted in a completely different way. A club-shaped handle of hard wood was made with a tapered socket chiseled and scraped into the thicker distal portion. This prepared hole normally goes completely through. The socket is tooled and adjusted to fit the taper and contours of the poll portion of the celt. The stone blade is placed firmly into the socket, and with a few solid blows, the celt is securely wedged into the handle. One advantage of this hafting design is that the celt blade can be quickly removed by reversing the handle and tapping the poll end. This would be very convenient if a stone celt needed resharpening or broke and had to be replaced. Another advantage of the socketed/wedge style haft is that there are no lashings that loosen and need retightening.

Small, rectangular celts appear across the Upper Midwest during the Late Archaic period, circa 4,000 years ago (Benn 1983; Benn and Thompson 2009; Nolan and Fishel 2009; Wiant et al. 2009). Within a thousand years or so, ungrooved celts large and small had completely taken over as the predominant wood-chopping tool. Their popularity continued up to around the time of Euro-American contact when steel trade axes became available, thus completing the chipped stone adze–full-grooved axe–three-quarter grooved axe–ungrooved celt sequence that represents some 10,000 years of wood-chopping technology.
Figure 7.33. Selected ground stone celts. ([A] MHS Artifact: 17.273; diorite; Goodhue Co., MN; [B] MHS Artifact: 17.266; possibly basalt; Goodhue Co., MN.)
Figure 7.34. Selected ground stone celts. ([A] MHS Artifact: 1984.41.22.2; diorite; [B] SCH: 81.52.1; diorite; Eden Valley, MN.)
Figure 7.35. Selected ground stone hematite celts. Note the unground chipped edge on specimen B. ([A] MHS Artifact: 17-25-1309; hematite; Goodhue Co., MN; [B] MHS Artifact: 12-140; hematite; Crow Wing Co., MN; [C] MHS Artifact: 17-25-1307; hematite; Goodhue Co., MN.)
SPUDS

Celts with flared bits, or “spuds” as they are commonly called, are an unusual and uncommon class of ground stone artifact. In their most basic form, spuds are celts with a markedly expanding bit end. The bit contour may be markedly or only slightly convex. The body portion of the celt is generally oval-shaped to semicircular. This form of spud, designated “Type B” by Brown (1902) is the one observed in Minnesota.

There are two seemingly related spatulate-ended ground stone forms that Brown (1902) designated “Type A” and “Type C” spuds. Type A spuds have a rounded bit with notched and barbed corners carved at the end of a long, slender, cylindrical body. Type C spuds are flattened, squat forms with a wide, flaring bit attached to a rectangular or tapering body. Many Type C spuds exhibit a single drilled hole and some vaguely resemble oversize pendants. While these latter two varieties of spuds are found across the southeastern and eastern states, they do not appear to be represented at all in Minnesota.

The Type B spud variety observed in Minnesota appears to be a Mississippian-inspired artifact design. In and around Cahokia are examples made out of diorite and similar materials by pecking and grinding as well as specimens made out of Kaolin or Mill Creek Chert by flaking, grinding, and polishing (Bostrom 2015).

Many researchers have commented on the absence of wear or damage on the bit ends of these flared bit celts, suggesting that they were never intended for hard use. Based on this, many have suggested that spuds were “ceremonial” axes for display and expressing status. That could be; however, consider what might happen if a Type A spud were mounted in a handle and used like any other celt. Any resulting damage to the bit would most likely be promptly repaired. It certainly would not take too many resharpenings to remove all traces of the original flaring bit, and the resulting tool would look like almost any other celt. Brown (1902) notes that the bits on many Wisconsin specimens do “exhibit nicks and fractures and other unmistakable signs of use.”
Figure 7.36. Stone spud. (MBISP Artifact: 07280; possibly schist; Washington Lake, MN.)
ADZES AND GOUGES

Ground stone adzes and gouges, particularly the latter, are fairly uncommon artifacts in Minnesota. They typically have a vague resemblance to celts but can be distinguished by the offset bevel of the bit edge and a flattened, often plano-convex cross section. Adzes typically have the cutting edge beveled on the underside. Gouges are identified by having a troughed-out area underneath and a bit edge that forms a curved arc. These tools range considerably in size, from large, elongated examples over 20 cm (7.9 inches) long to small ones only 5 cm (2.0 inches) or less in length. Ground stone adzes and gouges are often quite well-made symmetrical tools. In rare instances, haft modifications like partial pecked grooves are incorporated into the design.

Ground stone adzes and gouges were made from the much the same materials used to manufacture celts, that is, diorite, andesite, gabbro, basalt, graywacke, and greenstone. Small specimens were most frequently made of hematite.

Adzes and gouges were woodworking tools; however, they were hafted differently from celts. These tools are mounted such that their working edges are perpendicular to the handle (like a hoe) rather than inline with the handle (like an axe). The handles were either vaguely shaped like the letter T or the number 7. The adze or gouge was strapped down onto a flattened surface on the end of the handle with rawhide or some other strong cord.

Ground stone adzes and gouges are so uncommon in the Midwest that there do not appear to be any recovered from reliable, secure contexts. As such, their age is rather conjectural. Essentially identical tools are much more common to the north and east. In Canada, ground stone adzes and gouges appear to be firmly associated with the Middle and Late Archaic periods (Ellis et al. 1990).
Figure 7.37. Broken gouge (A) and adze (B). ([A] MBISP Artifact: 06949; diorite; Albert Lea Lake; [B] MBISP Artifact: 06950; hematite; Freeborn Co., MN.)
Figure 7.38. Adze. (UMn Artifact: 49.6; slate; Koochiching Co., MN.)

Figure 7.39 (Opposite page). Atypical adze. (MBISP Artifact: 31019; greenstone; Freeborn Co., MN.)
GROOVED MAULS

Grooved mauls are one of the most common formal pecked and ground stone tools found in Minnesota. These artifacts generally consist of a rounded to ovoid stone with a pecked groove encircling its middle. They typically range from around 8 to 15 cm (3.1 to 5.9) in diameter and may weigh up to 4.5 to 9.0 kilograms (10 to 20 pounds). Grooved mauls were usually made on a selected cobble that already had much of the desired spherical to ovoid shape. Some specimens are rather asymmetrical. The actual shaping done to the tool is often limited to the pecked groove. More symmetrical and refined examples may show some selective pecking about their circumference and thoroughly pecked and flattened working ends. There is almost never any grinding imparted on these tools. The great majority of these mauls are full grooved with the pecked groove completely encircling the form. A smaller percentage of them are three-quarter grooved, in a fashion very reminiscent of an ovate, round-bottomed, three-quarter grooved axe.

A wide range of igneous and metamorphic rocks were used in making grooved mauls. Unlike axes, a substantial percentage of these tools were made from granite cobbles. Diorite, gabbro, basalt, greenstone, graywacke, and quartzite were also used.

Grooved mauls were essentially the sledgehammers of their day. Many ethnographic examples with handles are in Native American collections gathered from across the Northern Plains. They were hafted in a wraparound fashion with the wood secured by rawhide lashing or jackets. Especially large and oblong grooved mauls may actually have been used as canoe anchors, net anchors, or horse tethers.

There seems to be some confusion over the temporal range of grooved mauls. Some accounts state that these artifacts date back to Archaic times; however, little support for this could be found in Midwestern or Plains archaeological site reports. There are many passing references to grooved mauls being found in some abundance among the copper mining debris about Lake Superior (Whittlesey 1863), and these (quite unjustifiably) conjure up an image of the Old Copper Archaic. It is difficult to find images of these grooved mauls found at copper mines, and, of course, the use of copper persisted well past the Archaic era. Perhaps it is the grooves on grooved mauls—full-grooved and three-quarter grooved—that inspire an analogy to the similarly grooved axes of the Middle and Late Archaic periods.

By and large, grooved mauls appear to be associated with the later part of the Native American occupation of the region. Where they have been found in archaeological investigations they are almost always associated with Late Prehistoric and Proto-historic sites. A temporal range of Late Woodland to Historic seems most likely.
Figure 7.41. Three-quarter grooved maul (A) and full-grooved maul (B). ([A] SHM Artifact: 38.163.1; granite; Stearns Co., MN; [B] SHM Artifact: 83.85.6; diorite; Meeker Co., MN.)
Figures 7.42. Three-quarter grooved maul. (SHM Artifact: 85.23.3; diorite; Stearns Co., MN.)
Figure 7.43. (Opposite page) Three-quarter grooved maul. (UMn Artifact: 39.29; granite; Ottertail Co., MN.)
PENDANTS

Stone pendants are an uncommon but widespread artifact type. Generally, there are two types, one being a simple pebble pendant and the other being a symmetrical, well-shaped, and polished form. Simple pebble pendants are generally small, usually 3 to 5 cm (1.2 to 2.0 inches) across. Most are made on relatively thin pebbles of 4 to 5 mm (0.15 to 0.20 inches) thick that are already roughly circular, ovate, or teardrop shaped. They typically have a single bi-conical, drilled hole near one end. The more elaborate and symmetrical gorgets are also larger, tabular, and most commonly rectilinear or wedge shaped. These were intentionally shaped by extensive grinding and usually some polishing and have a smooth surface finish. They have one hole, usually bi-conical, drilled through toward one end.

Simple pebble pendants may be made of nearly any kind of pebble with the right natural shape. The more elaborate, symmetrical pendants are made of a more restricted range of materials like slate, greenstone, and catlinite.

The smaller, simple pebble pendants were probably ornaments used as personal jewelry or as decorations on clothing, bags, baskets, etc. Some of the smaller intentionally shaped catlinite pendants probably had a similar use. The larger, symmetrical polished stone pendants closely resemble two-hole gorgets in materials and form and may have been similarly used as atlatl weights.

Simple pendants of one form or another appear to be present in all temporal periods from the Archaic forward. The polished examples that resemble gorgets most likely date to the Late Archaic, Early Woodland, or Middle Woodland periods.

Figure 7.44. Ground stone pendants. ([A] SNF Artifact: 02-633 Lot 24; greenstone; Gordon Site, MN; [B] UMa Artifact: 637-161; greenstone; 21ML16, Mille Lacs Co., MN; repatriated through NAGPRA.)


**GORGETS**

Ground stone gorgets are typically tabular and symmetrical. Most are rectilinear in shape with somewhat tapered ends. Variations in shape occur and some forms have flaring ends, giving them a bowtie or double-bitted axe plan view. They are typically fairly flat on both faces, but some have a distinct plano-convex cross section. These artifacts usually show extensive grinding and polish. Size ranges considerably with most examples being between 7 and 13 cm (2.8 and 5.1 inches) long, but specimens up to 20 cm (7.9 inches) long are known. Ground stone gorgets usually have two drilled biconical holes. These holes are usually symmetrically arranged, some having the holes placed closer to opposite ends and others having the holes drilled somewhat nearer the center. It is not unusual for gorgets to exhibit more than two holes. Vertical cuts or “tally marks” are seen on the ends or side edges of many of these artifacts.

Ground stone gorgets are made of a range of materials like slate, greenstone, and schist. The materials selected often have aesthetically appealing banding or color.

The term “gorget” implies that these finely made artifacts were worn as an ornament around the throat. However, the size, weight, and configuration of most ground stone gorgets seem incompatible with this. Two-hole ground stone gorgets appear to show up in the archaeological record around the time that bannerstones are disappearing from the cultural inventory. The materials from which they are made, especially banded slate and greenstone and catlinite, mimics the kinds of visually attractive stones that were used to make bannerstones. Their plan view shapes—bar, bowtie, and double-bitted forms—are also reminiscent of bannerstones. All of this converges on the idea that finely made two-hole gorgets were also probably used as a kind of atlatl weight.

Ground stone gorgets seem to appear toward the end of the Middle Archaic period, proliferate during Late Archaic times and continue into the following Early and Middle Woodland periods.
Figure 7.45. Single-hole (A) and double-hole (B) gorgets. ([A] MHS Artifact: 1984.41.19.11; possibly slate; unknown provenience; [B] UMn Artifact: 253-37; unknown material; Houston Co., MN; repatriated through NAGPRA.)
Figure 7.46. Broken gorgets. Note: B had been broken and recycled. D is a broken bowtie style. ([A] MBISP Artifact: 07265; diabase/greenstone; Pickeral Lake, MN; [B] MBISP Artifact: 07264; diabase/greenstone; Pickeral Lake, MN; [C] MBISP Artifact: 07255; brownish soapstone or siltstone; Union Lake, MN; [D] MBISP Artifact: 07254; slate; Albert Lea Lake, MN.)
BANNERSTONES

Bannerstones come in a wide variety of forms, including prismoidal, rectangular, bar-shaped, pick, curved pick, crescent, double-crescent, bowtie, and butterfly varieties. The majority of the very few known Minnesota specimens, including all of them from the Bannerstone Hill Site in Rice County (Glynn 2000) are of the rectangular type. There is a single example of a pick-style bannerstone made of banded slate from the Owen Johnson collection. What all bannerstones have in common is an elongated, cylindrical hole usually measuring between 8 and 12 mm (0.31 and 0.47 inches) in diameter drilled through the central portion. Most specimens are 6 to 12 cm (2.4 to 4.7 inches) across and 2 to 3 cm (0.8 to 1.2 inches) thick. Finished bannerstones almost invariably exhibit a degree of refinement and symmetry that sets them apart from most other ground stone artifacts. Their surfaces have usually been smoothed and polished such that there are no traces of the earlier pecking used to rough out their forms.

A rather restricted range of materials was typically selected for the manufacture of bannerstones. Throughout Michigan, Indiana, and Ohio in the eastern Midwest a distinctive greenish-banded slate was widely used, and objects of this material occasionally made it farther afield, one being found in Minnesota. Other Minnesota specimens were made out of speckled diorite, granodiorite, and porphyry with one made of red catlinite.

The function of bannerstones and other “problematic” stones has been a matter of discussion and debate ever since these items were first noted in the 1800s. Antiquarians, prehistorians, and archaeologists alike have a long-standing tradition of interpreting any objects they do not understand as “ceremonial” and coming up with imaginative and fanciful explanations for them. As the name bannerstones implies, the favored theory early on was that these were ornamental stones placed on staffs signifying the wealth and status of their owners (e.g., Moorehead 1917). To one degree or another, this idea lives on in some professionals and artifact collectors even today.

The best interpretation of bannerstones, and the one that actually has some direct evidence supporting it, is that these were weights or counterbalances attached to atlatls. This was first proposed by Webb (1946) based on the frequent co-occurrences of bannerstones with antler hooks and antler handles in human burials at the Indian Knoll Site in Kentucky. Since that time, similar associations have been occasionally noted on other sites. Minnesota provides its own interesting contribution to this argument. At the Jeffers Petroglyphs in Cottonwood County there are several pecked representations of shafts with hooked ends, handles, and finger loops with rectangular to ovoid weights attached (Lothson 1976). A reconstruction of an atlatl with a bannerstone is shown in Figure 7.47.

Bannerstones are uncommon items wherever they are found. They are largely restricted to the eastern United States and become increasingly rare toward the Mississippi River and further west. Only a handful of them are known from Minnesota. Where bannerstones have been found in context on Midwestern sites, they are usually attributed to the Middle Archaic period and are typically associated with side-notched point forms like Godar, Matanzas, and Raddatz.

Figure 7.47. Illustration of an atlatl with a bannerstone.
Figure 7.48. Rectangular (A) and pick-style (B) bannerstones. ([A] MHS Artifact: 2013.27.1; diorite; Anoka Co., MN; [B] MBISP Artifact: 07269; banded slate; Pickeral Lake, MN.)
Figure 7.49. Rectangular bannerstones from Bannerstone Hill. (Dennis and Mark Glynn Private Collections; [A] catlinite, [B] granodiorite, and [C and D] diorite; Bannerstone Hill, Rice Co., MN.)
**OTHER ATLATL WEIGHTS**

In addition to bannerstone and gorgets, there are other ground stone forms that were used to balance spear throwers. Two types seen in the Minnesota collections examined for this book are included here. One is a simple elliptical form, tapered toward both ends with a plano-convex cross section. This type closely resembles some of the ground stone gorgets described previously but lacks the drilled holes. The specimen illustrated here is made of a greenstone or schist.

The other atlatl weight type is analogous to the bar amulet style that is found across the Eastern Woodlands. Bar amulets are thick, elongated forms with one flat side. Their profile gently tapers away from the thickest middle portion, then flairs at both ends. The ends are flattened and may be nearly vertical or somewhat angled. In the typical eastern form, bar amulets exhibit drilled holes at both ends. The individual holes are formed by two drillings, one from the bottom and one from the end, that meet at nearly 90 degrees. The similarities between bar amulets and birdstones are undeniable—bar amulets resemble two-tailed birdstones. The Minnesota specimen shown here, made from catlinite, lacks the drilled holes but does have a cut groove about its middle.

While one might still hold some reservations about bannerstones and polished gorgets being used as atlatl weights, there is little doubt as to the function of the two Minnesota pieces shown in here. The elliptical specimen is virtually identical to simple stone weights that are found over a wide area of the western United States. The perpendicular groove cut around the bar amulet form is a common feature seen on atlatl weights from the American Southwest. The discovery of preserved wooden atlats in the Southwest and Great Basin, some with their stone weights still attached, clearly demonstrates how these artifacts were used (Guernsey and Kidder 1921; Guernsey 1931; Hester and Mildner 1974).

The simple elliptical form of atlatl weights is so generally similar to drilled gorgets that they may also be of approximately the same age, Late Archaic through Middle Woodland. Like birdstones, bar amulet–style atlatl weights appear to be firmly associated with the Late Archaic/Early Woodland timeframe. A classic bar amulet of banded slate was recovered from a Red Ochre–affiliated grave at the Turkey River Mounds in Clayton County, Iowa (McKusick 1964; Alex 2000).
Figure 7.50. Elliptical (A) and bar-amulet (B) atlatl weights. ([A] MHS Artifact: 11-9; possibly schist or greenstone; Clearwater Co., MN; [B] MBISP Artifact: 07266; catlinite; Madison Lake, MN.)
**DISCOIDALS**

Ground stone discoidals, commonly known as chunkey stones, are an uncommon artifact. In plan view, these are rounded stones that are usually perfectly circular. These are fully pecked, ground, and often polished objects ranging from around 5 to 20 cm (2.0 to 7.9 inches) in diameter and 2 to 6 cm (0.8 to 2.4 inches) thick. The rims of most discoidals are symmetrical, but some were beveled to one side. There are three general types of discoidals. The simplest, and often the smaller, forms are biscuit shaped with slightly convex sides. A more elaborate style has symmetrical concave depressions on both faces. In the rarest form, the concavities meet to form a round perforation in the center of the discoidal.

A variety of hard stones such as quartzite, basalt, diorite, and granite were used to make discoidals. These materials often appear to have been selected for their color and aesthetic appeal. More mundane ones were sometimes made of limestone and sandstone.

Based on numerous writings of early explorers and ethnologists, discoidals were used in a game called chunkey. There appear to have been several variations, but in most, the discoidal, or chunkey stone, was rolled down a flat playing field where two players would each cast a wooden spear, trying to land theirs closer to where the discoidal would stop. By most accounts of the day, this game was wildly popular and the players were fiercely competitive (e.g., Hudson 1976; Fleming 2009:242–250).

The earliest discoidals appear to show up in the Late Woodland period in western Illinois. With efflorescence of the Mississippian Culture and its influence beyond the Cahokia region, the chunkey game spread far and wide. Ground stone discoidals have been recovered from archaeological sites throughout the southeastern United States and from the northern Plains to the New England coast. In the Upper Midwest, discoidals seem to be associated with Late Prehistoric sites exhibiting some connections to the Mississippian world to south. Several examples have been found in the Oneota/Mississippian complex in the Red Wing locality in Goodhue County, Minnesota, and Pierce County, Wisconsin, but most appear to have been recovered on the Wisconsin side (Gibbon and Dobbs 1991).
Figure 7.51. Asymmetrical discoidal. (MHS Artifact: 37.5; possibly slate; Ramsey Co., MN.)
Pipes

Carved stone smoking pipes hold a special place in Minnesota history. The prized red pipestone, commonly called catlinite, was extracted from ancient quarries near Pipestone in the southwest corner of Minnesota. Though this is not the only source for red pipestone—similar stone can be found in Kansas and Wisconsin—it is certainly the most legendary. Bannerstones and atlatl weights made of catlinite evince the use of this material as early as the Middle and Late Archaic periods. Smoking pipes made of catlinite first appear during Middle and Late Woodland times. The most intensive use of the Minnesota quarries was during the Late Prehistoric and Proto-historic periods. During these times, pipes and other items made of Minnesota catlinite circulated widely across much of North America east of the Rocky Mountains. Today, Pipestone National Monument is a very sacred and revered place to many Native Americans.

While the great majority of stone pipes in Minnesota were made of catlinite, other materials also occur. Dark gray, greenish, or black steatite (soapstone), possibly from the eastern United States, was also widely used. The gray to greenish pipestone from near Sterling, Illinois, may be represented in the Minnesota specimens. Limestone was sometimes employed. West (1905) provides an extensive overview of carved stone pipes found in Wisconsin.

The earliest stone pipes in the Eastern Woodlands appear to be straight, tubular pipes associated with the Early Woodland period. A few tubular pipes have been found in Minnesota, but these appear to be much younger and are associated with the Late Woodland Blackduck Culture in northern Minnesota. The examples illustrated here are made of steatite and catlinite.

Platform pipes, where the pipe bowl sits centered atop a curved tabular platform, are another early pipe form. The erect bowls may be roughly cylindrical, slightly tapered, or recurved. The bases range from nearly flat in side view to markedly arched. Platform pipes, some with their bowls carved into elaborate effigies of various animals, are a signature artifact of the Middle Woodland Hopewell Interaction Sphere and are found throughout eastern North America. Most examples appear to be made of tannish, greenish, or gray pipestone from sources in Illinois and Ohio. A minority were made of catlinite.

Simple elbow pipes are widespread and probably the most common form of pipe throughout the Upper Midwest. These consist of a bowl and base connected at a roughly 90-degree angle. The cross section is usually circular or semicircular. In plan view, the pipe may have smooth, curving contours or it may be more angular. The relative proportions of the bowl and body of the pipe are highly variable. These generally plain pipes appear to date from Late Woodland to Late Prehistoric times.

Calumet-style pipes are the stereotypical form most people imagine when they think of the proverbial “peace pipe.” These typically consist of a tall, cylindrical bowl carved perpendicular to an elongated cylindrical base. Some examples have a more rectangular cross section. The base of the pipe is usually considerably longer than bowl is high. In this style of pipe, the elongated base projects noticeably beyond the bowl/base juncture. These pipes can be quite large, up to 15 or 20 cm (5.9 or 7.9 inches) long, but most are around 10 to 12 cm (3.9 to 4.7 inches) in length. Some elaborate examples have incised designs inlaid with lead. Calumet-style pipes appear to date mostly from Proto-historic times.
Figure 7.52. Steatite (A) and catlinite (B) tubular pipes and platform pipe (C). ([A] UMn Artifact: 33.39; steatite; 21-BL-1, Beltrami Co., MN; [B] UMn Artifact: 716.220; catlinite; 21-ML-12, Mille Lacs Co., MN; [C] UMn Artifact: 111-125, possibly Illinois pipestone, Site 21-TR-01, MN; repatriated through NAGPRA.)
Figure 7.53. Elbow pipes (A and B) and a calumet pipe (C). ([A] UMn Artifact: 247-120; catlinite; Wilsey Site, MN; repatriated through NAGPRA [B] UMn Artifact: 637-127; catlinite; Cooper Mounds, MN; repatriated through NAGPRA [C] UMn Artifact: 269-111; catlinite; Site 21-CP-02, MN; repatriated through NAGPRA.)
Figure 7.54. Disk pipe. (UMn Artifact: 334-6; catlinite; Houston Co., MN; repatriated through NAGPRA.)
Figure 7.55. Stemless pipe. (UMn Artifact: No accession number; steatite; Lake Winnibigoshish, MN; repatriated through NAGPRA.)

Figure 7.56. Mismac pipe. (Ulch collection, Calkins Nature Center; steatite; International Falls vicinity.)
8

FUTURE DIRECTIONS

Toby A. Morrow

I hope you have read through the previous chapters of this book (or at least looked at the pictures!) rather than skipping ahead to read its exciting conclusion. It should come as no surprise to the attentive reader that understanding and analyzing stone tools is complicated. Lithic analysis is every bit the specialty that floral, faunal, and ceramic analyses are. The days of sorting one’s projectile points into side-notched and corner-notched varieties and determining how many of each are made of white chert, pink chert, gray chert, etc. are a thing of the past. Nowadays we speak of a Pelican Lake point made of heat-treated Swan River Chert with an impact fracture on its tip and light cutting use wear along one blade edge. In Minnesota, as elsewhere, lithic analysis has matured into a demanding and diverse field of study. Used in conjunction with the results of other specialty studies, lithic analysis will create a fuller and more robust understanding of the past.

Over a decade and a half ago, I suggested several directions for future lithic studies in the Great Lakes region (Morrow 1999). I think these recommendations are still relevant, not because they have not been heeded, because they have and then some, but because they are ideas still worth considering. Here, I touch upon some of those suggestions again, elaborate more on others, and draw attention to a few new issues.

CONTINUED COOPERATION

There are three groups of people who have a deep and personal interest in stone tools: Native Americans, archaeologists, and artifact collectors. These three groups have not always seen eye to eye, but the situation has improved. Presently in Minnesota, the relationships among Native Americans, professional archaeologists, and collectors are remarkably amicable.

There are eleven federally recognized tribes presently living in Minnesota. They are the Bois Fort Band of the Chippewa, the Fond du Lac Band of the Lake Superior Chippewa, the Grand Portage Band of the Chippewa, the Leech Lake Band of the Ojibwe, the Lower Sioux Indian Community, the Mille Lacs Band of the Ojibwe, the Prairie Island Indian Community, the Red Lake Band of the Chippewa, the Shakopee Mdewakanton Sioux (Dakota) Community, the Upper Sioux Community, and the White Earth Band of the Chippewa. These tribes have a long and rich history in Minnesota, and
their members have a vested interest in their ancestors’ artifacts and archaeological sites, including sacred sites.

There was a time, not so long ago, that people (predominantly people of white Euro-American ancestry) freely and openly dug into Native American mounds and cemeteries. Some of these people called themselves archaeologists, but in the earlier days especially, they were antiquarians, collectors, and curiosity seekers. Untold thousands of Native American graves were dug up from the late eighteenth century to the middle of the twentieth century. This, along with the long and deplorable history of Euro-American deception, exploitation, and annihilation of Native American people, has left an understandably bitter taste in the mouths of the latter group’s descendants. Archaeologists today must continue to work with and develop a relationship with the people whose ancestors created the very artifacts and archaeological sites that they study.

Today, Native American burial sites are protected by both federal and state law, and other laws bear directly on Native American sites, artifacts, and archaeology. The National Historic Preservation Act of 1966, as Amended, 54 U.S.C. § 307103 was a major piece of legislation that compelled federal agencies to responsibly manage archaeological and historical resources, profoundly influencing archaeological research in the United States today. All construction projects with federal involvement require consideration of cultural resources prior to execution as a result of this legislation. Most of the archaeological research conducted in the United States today is driven by this federal law.

The Archaeological Resources Protection Act, 54 U.S.C. § 100707, enacted in 1979, gives protection to all archaeological resources on federal and Native American lands. Under ARPA, it is illegal to disturb or vandalize Native American archaeological sites or remove archaeological artifacts from these places and to sell, purchase, or trade such illegally procured artifacts. Any archaeological investigations on federal land must be completed under a permit issued by the managing agency.

Perhaps even more significant is the Native American Graves Protection and Repatriation Act of 1990, 25 U.S.C. § 3001(2009), also known as NAGPRA. This law calls for the repatriation of human remains and cultural items located in museums that receive federal funding and the repatriation of any newly discovered human remains and associated burial items from federal lands as well providing legal restrictions on the trafficking of human remains and culturally sensitive objects. As a result of NAGPRA, many archaeologists at museums and universities across the nation have since 1990 worked to identify such items in institutional collections, return them to their relevant tribes, and begin to set right at least some of the wrongs of archaeology’s checkered past. In addition, NAGPRA protects Native American burial sites on federal and tribal land.

The Minnesota State Historical Society and the Science Museum of Minnesota have both issued policy statements regarding their recognition of culturally sensitive items and compliance with NAGPRA, and these are posted online. Even before NAGPRA, many individual states enacted their own legislation, giving enhanced protections to Native American graves. The Minnesota Private Cemeteries Act (MS 307.08) was amended in 1976, giving the State Archaeologist the duty of documenting and authenticating all unrecorded burial sites over 50 years of age. This amendment includes any Native American graves in the state and allows for consultation with the Minnesota Indian Affairs Council.
(MIAC) on behalf of various tribes. Most importantly, the law protects all burial sites in the state, whether they are located on private or public property.

Now let us turn to archaeologists, who are a mixed lot. Nowadays, archaeologists tend to have research specialties. Some focus on animal remains in the forms of the bones and teeth found on archaeological sites. Others use microscopes to study carbonized (burnt to charcoal) plant remains like wood fragments or seeds. Some are most interested in theorizing about the social order and the meaning of archaeological findings. Archaeologists also typically will have expertise in the archaeology of a particular region or regions (e.g., the American Southwest, Peru, the Middle East). Archaeologists are not all equally experienced with stone artifacts, and some are unfamiliar with this part of the country. There are some archaeologists who are simply not interested in stone tools.

Within the professional archaeological community a wide range of attitudes exists toward artifacts and the people who collect them on a nonprofessional basis (see Shott and Pitblado 2015). It is an undeniable fact that some professionals view avocational artifact collectors with complete disdain. In a very recent statement, Goebel (2015:29), for example, writes, “I cringe whenever I must deal with artifact collecting,” and advocates that professionals should interact with collectors as little as possible. This attitude has been fueled by the destruction of archaeological sites by the indiscriminate digging of looters and pothunters (Davis 1972). While all responsible professional archaeologists stand against the pillaging of sites, some professionals use this sentiment to condemn all private artifact collecting. In their view, collecting creates a market for artifacts that makes the looting of archaeological sites attractive and profitable (e.g., Shane 1999:149). Mallouf (1996) even seems to imply that surface collecting artifacts escalates into full-blown looting, pot hunting, and archaeological site destruction, as if finding an arrowhead in a plowed field is some sort of “gateway drug.” To be fair, these extreme attitudes are most common among archaeologists who work in archaeologically rich parts of the world like the American Southwest, Central America, or the Middle East, in other words, places where archaeological looting is especially rampant.

Taken to its extreme, the attitude that all artifact collectors are damaging the archaeological record is unfair, unrealistic, and harmful in and of itself. Such professional hostility toward the collecting community serves to alienate artifact collectors and instills in them a sense of indignation and even paranoia. They can come to see professionals as greedy, arrogant, privileged bullies who are out to spoil their hobby. Many artifact collectors think that professional archaeologists will confiscate their collections and go excavate their favorite hunting spots for themselves. This, too, is an unfair characterization.

Fortunately, a growing number of professional archaeologists recognize the past contributions that nonprofessionals have made to archaeology and understand the potential scientific value of artifacts in private collections (e.g., LaBelle 2003; Kinnear 2008; Pitblado 2014). Paleoindian archaeology as we know it today would not exist without the discoveries of nonprofessionals. In fact, most of the artifacts illustrated in this book presently reside in private collections or were donated by individuals to the institutions where they now are. If we had to rely exclusively on artifacts found by professional archaeologists, we surely would not have many Paleoindian projectile points, three-quarter grooved axes, or bannerstones to show you.
Like archaeologists, artifact collectors are not all alike. All people who collect Native American artifacts have a great interest in these things, not all of them for the same reasons. Some people appreciate the beauty and craftsmanship of ancient Native American creations, some find their undeniable connection to a long-ago time irresistibly fascinating, and a few mostly just see dollar signs. There is no denying that Native American artifacts have monetary value in today’s world. So long as it is legal, projectile points, axes, clay pots, beaded moccasins, and woven baskets will be bought, traded, and sold. If an object was obtained legally from private property with the landowner’s permission, was not removed from federal or other public property or the lands of a federally recognized Native American tribe, and is not a human bone or a culturally sensitive object like a funerary offering, there is nothing legally preventing its sale on the open market. Modern professional archaeologists abhor the buying, selling, and trading of artifacts, mostly because of the great loss in scientifically useful information that almost inevitably occurs when these objects change hands and sometimes ship off to places unknown.

Collectors of Native American artifacts are a diverse group that cannot be painted with a single brush. There are many who are, in every sense of the term, avocational archaeologists. These collectors interact and work with professional archaeologists, share information, and record archaeological site locations within the Office of the State Archaeologist’s system, and encourage the study, not just the admiration, of artifacts.

Then there are enthusiastic local collectors who may engage in their hobby on an independent basis or perhaps with a family member or close friend. These collectors often hunt for artifacts in a restricted home territory but are often uneasy about divulging archaeological site locations for fear that others will usurp their favorite fields. These people might never dream of selling an artifact that they found—the artifacts mean too much to them—and they can usually remember where and when they found most of the pieces in their collections. These collections can be extremely useful to archaeologists conducting regional archaeological studies.

Other collectors are fascinated by artifacts and actively buy relics at auctions and online venues. They do this because they may not have the time or predilection to hunt for artifacts themselves or because they are motivated to acquire more and better pieces than they might find themselves. These collections can become quite problematic, and unfortunately, many of the large old-time artifact collections were accumulated largely through purchases and trades. If a collector neglects to keep track of which artifacts were personal finds, which were purchased, and where they were found, the individual pieces, as lovely as they might be, have little scientific value. This is especially true if artifacts have been acquired from a wide geographic area and are mixed together without respect to their places of origin, be it at the level of a county, state, or even country. Such collections also inevitably attract a lot of forgeries, and no number of paper certificates can guarantee authenticity. These collections are often hopelessly mixed, untrustworthy, and unable to contribute much of anything to the field of archaeology.

Then there are those who primarily seek artifacts for financial gain. Their activity openly promotes buying, selling, and trading artifacts and presents financial opportunities for both those who fake artifacts and those who loot archaeological sites. Some individuals hunt for artifacts, dig for them, or do both exclusively to sell them. Professional archaeologists, even those who are otherwise pro-
collector, often see these financially motivated individuals as the most reprehensible of the lot. Fortunately, looting and pot hunting do not appear to be quite as problematic in Minnesota as in other parts of the country and across the world, but that does not mean Minnesota is free of those issues.

If you own a collection of Native American artifacts, I urge you to consider two things:

(1) These objects have scientific and historical value and are a part of the history of some place at some time. They lose that scientific and historical value when their provenience is unknown. Please, keep track of where your artifacts were found in a computer catalog or a logbook—the more specific the locational information, the better. Discretely mark your artifacts with a number or code or keep track of them with photos that can be referenced back to your records.

(2) These artifacts, many of them thousands of years old, will still be around long after you are gone. What will happen to your collection? Will it be split up among your heirs and taken to their homes in different parts of the country? Will it be sold piecemeal at an auction and scattered to the four winds? Will it be thrown out with the trash because there is no one left who cares about those stupid rocks? If your collection is at least somewhat well documented (see No. 1 above), consider donating it to your state historical society, a local nature center, or a county history museum where the artifacts can continue to tell their stories.

Consider working with a professional archaeologist and having your find locations officially recorded as archaeological sites. The Office of the State Archaeologist keeps these records confidential, so there is little chance that your main collecting competitor who lives down the street will find out your secret spots. And, barring unusual circumstances (say, a site is eroding into the river or will be destroyed by a shopping mall) a professional archaeologist will probably never dig your site; they usually have plenty of sites and projects of their own to keep them busy.

Consider the following example of an artifact orphaned from its place of origin and provenance information. Fluted projectile points of the Early Paleoindian period are scarce throughout Minnesota and especially in the far-western portions of the state. There is one remarkable piece that is variously attributed to being found in Rock or Pipestone County or somewhere else. It was acquired from an artifact collector sometime in the 1930s by Albert Jenks for the University of Minnesota’s archaeology collections. What makes this point stand out is that it is huge in comparison to nearly all other fluted points known from Minnesota and that it appears to be a classic example of a fluted point type known as Cumberland (Shane n.d.; Higginbottom 1996; Buhta et al. 2011:29–30). The recovery of such a point in southwestern Minnesota would be, to say the least, bizarre. Cumberland points are largely limited to a core area of Kentucky, Tennessee, Alabama, southern Indiana, and southern Ohio; they are rare or absent beyond this range. The “Cumberland” point illustrated in Morrow (1984:14) has been reinterpreted as being a heavily reworked Gainey-style fluted point. Cumberland points are not a normal find in the Upper Midwest. Shane (n.d.) describes the raw material as an unidentified gray chert, but Higginbottom (1996) states that it is made of Grand Meadow Chert. It should be noted that there are various gray cherts that occur in the Cumberland point core area that might be mistaken for Grand Meadow. A note on a photograph in the OSA’s collection bears a cryptic message reading, “Jackson Co. Clovis/U of M/Nobles Co.” Does that mean it comes from Jackson County or the Jackson Collection? Or is it from Nobles County, or was it obtained from the collection of a man...
named Nobles? Is it really from Jackson County, Minnesota, or could it be from Jackson County, Kentucky; Jackson County, Ohio; or Jackson County, Tennessee? Or is it from Noble County, Ohio, or Noble County, Indiana, instead of Nobles County, Minnesota? We will probably never know what this point could have told us.

**Rock On**

The Minnesota Historical Society houses a marvelous comparative collection of lithic raw materials from all over Minnesota and beyond. This is thanks to the efforts of a few passionate individuals, especially LeRoy Gonsior who started the collection, as well as Kent Bakken, Bruce Koenen, and Dan Wendt. Some of the lithic raw materials found on Minnesota archaeological sites are visually distinctive, but others are not. Continued research into these sources and alternative ways of identifying the raw materials from them is surely welcome. Portable and non-destructive (as well as inexpensive) means of trace element and chemical characterization would obviously be preferable. Knowledge of lithic raw material sources has opened the door to investigating past cultures on a regional and interregional scale—a task that was the exclusive domain of ceramicists not so long ago. More research on lithic raw material use patterns across the state and over time will continue to flesh out our understanding of regional prehistory. Kent Bakken’s dissertation (Bakken 2011) provides an excellent springboard for applying this information to future lithic studies in Minnesota.

**These are Diagnostic, Too?**

I think it would be very useful to expand our understanding of what constitutes a diagnostic artifact. Some projectile point types, such as Snyders points, are particularly diagnostic, in this case of the Middle Woodland period in the Upper Midwest. Other artifacts, while perhaps not as time specific, are nonetheless temporally sensitive. Some artifacts that seem to be diagnostic may not actually be, so caution should be exercised. One will not have to read much of the recent literature on Clovis stone tool technology to encounter a discussion of outré passé, or overshot, flakes (e.g., Huckell and Kilby 2014; Smallwood and Jennings 2014). While overshot flakes are characteristic of Clovis biface technology, they are not necessarily unique to that period (Eren et al. 2014).

People who made large projectile points (like Paleoindians) also made large bifaces and large biface-thinning flakes. These should be considered for their diagnostic potential. Paleoindians also made some rather impressive flake tools (e.g., Ellis and Deller 1988). We commonly disregard artifacts like end scrapers and retouched flakes, assuming that these tool forms are ubiquitous and not diagnostic, but are they? In Illinois and Wisconsin where end scrapers appear to be more restricted to specific time periods, there have been some efforts made to distinguish end scrapers of different time periods (e.g., J. Morrow 1997; Swader 2009). This might be a worthwhile topic to investigate in Minnesota. In addition to marked variation in the use of specific raw materials over time, the frequency of intentional heat treatment is also temporally sensitive. If (in the Upper Mississippi Valley, at least) one sees a
substantial quantity of heat-treated chert on a site where several Thebes, St. Charles, or Hardin hafted biface types have been found, it is almost certainly a multicomponent site with later occupations.

Though we have not said much about it in these pages, fire-cracked rock (or, more correctly, its absence) is also potentially diagnostic. Across most of mid-continental North America, fire-cracked rock is essentially unheard of on Early Paleoindian sites and rare or absent on most Late Paleoindian and Early Archaic sites (see Jackson 1998; Thoms 2009). The absence of fire-cracked rock, in concert with other lithic evidence, might be useful for locating early archaeological sites.

THE TYRANNY OF TYPOLOGY

There is a seemingly never-ending debate on the nature of archaeological typology—did these types really exist in the minds of their makers, or are they merely a contrivance imposed by archaeologists (e.g., Whallon and Brown 1982)? I would say that some of the artifact types we recognize are quite real. Though they co-occur in the same contexts, Thebes knives and St. Charles points are morphologically, technologically, and functionally distinct. In fact, most Paleoindian and Early Archaic point types are fairly distinctive and, with care and experience, easy to identify. This trend of readily recognizable uniformity in projectile points seems to have started changing around 9,000 to 8,000 years ago. Interestingly, this is about the same time that there is a decrease in the frequency of regionally exotic stone sources like Knife River Flint or Hixton Silicified Sandstone and a greater reliance on more locally available, but often less desirable, raw materials. Did the limitations imposed by these second-rate raw materials lead to conditions that loosened technological standards (e.g., Bakken 2011:316)?

While many early projectile point forms are easily recognized, certain point types are far more nebulous and may simply be chimeras. This in particular applies to the varied, medium to large, side-notched points of the Archaic period. These are found over a huge part of the United States and go by a plethora of local and regional names—Big Sandy, Brannon, Cache River, Godar, Graham Cave, Hawken, Hickory Ridge, Kessell, Little Sioux, Logan Creek, Long Creek, Lookingbill, Madison Side-Notched, Matanzas, Osceola, Otter Creek, Raddatz, Reigh, Robinson, Tama, Turin, and Wolf Creek, to name a few. When they are found intact and exhibit their classic, stereotypical forms, some of these side-notched types present little difficulty in identification—Graham Cave and Osceola points are both large, side-notched points with concave bases, but they differ in flaking style, edge retouch, and certain aspects of the base and notch configuration. One would expect that Graham Cave (Early Archaic) and Osceola (Late Archaic) points should be distinguishable—they are, after all, some 4,000 to 5,000 years apart in age. When it comes to the medium-sized, side-notched points of the Midwestern Middle Archaic period, it is probably safe to say that many of our type names are arbitrary and meaningless. This is most evident when one sees whole assemblages of these points recovered from buried, single-component contexts (e.g., Cook 1976; Pope et al. 2014). Clearly, Godar, Raddatz, and Matanzas points are found together, and it would not take much imagination to split out a few more examples that fit additional named types. Here we are almost certainly seeing a single generic form with a wide range of morphological variation. The contracting stem points of the Early Woodland period—Adena, Dickson, and Waubesa—present a somewhat similar situation (e.g., Boszhhardt 2002). In
particular, it might even be a bit silly of us to try to distinguish Adena and Waubesa points in the Upper Midwest.

**Mountains, Molehills, and Agendas**

There appear to be two widely divergent schools of thought regarding the significance of projectile points and their differences. First, there are evolutionary archaeologists who focus on the functionality of design differences. The coalescence of this idea in the Midwest can be traced back to Ahler (1971), who, using the assemblage from Rodgers Shelter in the Missouri Ozarks, correlated projectile point/knife (PPK) morphology with the results of experimentation and use-wear studies. Taken to its extreme, this approach attributes changes in projectile point design to the goal of achieving ever-increasing efficiency, i.e., projectile point designs just got better and better over time (e.g., Musil 1988; O’Brien and Lyman 2002). Most of these studies assume rather than demonstrate that small differences in projectile point shape (side notches, edge serration, barbed shoulders, etc.) affect projectile performance (e.g., Christenson 1986; Musil 1988; Darwent and O’Brien 2006; Vierra 2013). “Common sense” is often the only defense offered for such functional interpretations. Musil (1988:382) argues that side-notched points will tend to break between the notches, leaving a proportionately larger distal fragment that can easily be repaired and reused. His idea that side-notched points make more efficient use of raw material than lanceolate points is pure armchair speculation. It is commonly assumed that barbed shoulders increase the killing power of projectile points (e.g., Darwent and O’Brien 2006:207), although to what degree this may or may not be true has never really been evaluated.

As noted above, there is a palpable assumption in many of these evolutionary analyses that differences in projectile point shapes were directly related to projectile performance and/or killing efficiency (e.g., Christenson 1986; Darwent and O’Brien 2006). Competing explanations regarding differences in morphology such as projectile point maintenance or alternate use as a hafted knife are either discounted or ignored altogether (e.g., O’Brien and Wood 1998). Projectile point resharpening and repair and the potential multi-functionality of projectile points to serve as both hafted cutting/sawing tools and weapon tips are clearly at odds with this functional efficiency perspective. In a recent resurrection of an old and long-abandoned idea, Lipo and several co-authors (Lipo et al. 2012) demonstrated that large, alternately beveled projectile points would rotate in a wind tunnel and argued that Early Archaic points were so beveled because the concept of fletching had not yet been invented. Alternate beveling has long been understood as a resharpening strategy (Sollberger 1971), and this trait is not limited to the Early Archaic but also occurs on some Early/Middle Woodland Dickson point/knives and Late Prehistoric four-bevel Harahay knives. Pettigrew and co-authors (Pettigrew et. al 2015) conducted flight experiments with replicated beveled projectile points mounted to atlatl darts and published a resounding rebuttal to the age-old “spinner” hypothesis.

If one considers the myriad of projectile point shapes that were used through prehistory and acknowledges that these varieties were made and used over large areas for considerable spans of time, it is difficult not to question the whole concept of design efficiency. The people who made these widely varying projectile point forms seemed to get along just fine; even if their projectile points may
not have been perfectly attuned to maximum lethality, they worked anyway. To be sure, there were broad changes in weaponry systems, such as the shift from the atlatl and dart to the bow and arrow. But even within the class “arrowhead,” we see unnotched triangular and lanceolate, side-notched, corner-notched, and stemmed forms. Are these variations really the result of fine-tuning point designs to reach maximum killing efficiency? Furthermore, if a strictly evolutionary approach to projectile point design is viable, why then, did people apparently never find that “perfect” point design and commit to it? If climate and ecological changes are the ultimate cause of these differences in projectile point design, as some might suggest, then how specifically does this dictate a shift from side notching to corner notching or from lanceolate to stemmed points?

At virtually the opposite end of archaeological interpretation is the concept of style. Some archaeologists prefer to analyze artifacts in terms of symbolic rather than functional value. The very question, “Do stone projectile points even make a difference?” was addressed on an episode of the Discovery Channel’s MythBusters. Waguespack and colleagues (Waguespack et al. 2009) measured the penetration depths of arrows with sharpened wooden tips and arrows with stone tips when fired at a stationary ballistic gel target. They concluded that the stone projectile points only increased penetration effectiveness by about 10 percent. This, they suggested, was not a sufficient reason for going to the extra trouble of making and hafting a chipped stone tip. Rather, Waguespack et al. (2009:797) proposed that the primary purpose for stone projectile points may have been symbolic: “Because they require greater effort and skill to produce, hafted projectiles provide a medium for expressing self and/or group identity, essentially a form of costly signaling.” The idea that styles of projectile points convey some form of social information is not a new one (see Wiessner 1983). Unlike the functional arguments, the costly signaling proposition is essentially untestable.

The idea that stone projectile points add little to the performance of projectiles can be questioned on many grounds. If that 10 percent increase in penetration noted by Waguespack et al. (2009) meant the difference between eating or going hungry, the 10-, 15-, or 20-minute investment in making the stone point was probably more than worth it. Furthermore, stone projectile points do not just penetrate but carve a wider wound path and can continue to tear at and agitate soft tissues in an escaping animal after impact (see Knecht 1997). Projectile points, particularly ones with barbs, may also have helped the weapon stay lodged in the animal. Thus the whole idea that stone projectile points were luxury items made predominantly for social display purposes is not supported. If one recalls that the biggest and most obvious differences in projectile point forms tend to occur in the hafting area—that portion of the point that was essentially covered and hidden from view once it was mounted—it is difficult to see how most point styles would convey sameness or difference to onlookers.

Clearly, there are faults with both the evolutionary/functional and the stylistic/expressive explanations for projectile point design. I would suggest that archaeologists have a tendency to over-interpret things and make mountains out of molehills. Why does the variation we see in projectile points have to imply something profound? People may do certain things in a particular way out of habit and familiarity, or simply because that is how they were taught (see Tehrani and Riede 2008 for a discussion of the cultural transmission of traditional crafts). This could easily result in the distribution of the same or similar artifact styles over large geographic areas within an interacting and interconnected human population. Changes in projectile point designs over time might result from
copying error, stylistic drift, or the emulation of novel forms without any noticeable difference in point performance and with no overt symbolic or social intentions.

**THE PROBLEM WITH PIGEONHOLES**

Archaeologists are fond of clean, discrete categories, perhaps overly so. We sort the materials recovered from archaeological sites into defined categories like hammerstone, mano, projectile point, knife, core, preform, etc. The problem with this pigeonhole mindset is that the world is not always black and white. A case in point is an edited volume entitled *Tools versus Cores: Alternative Approaches to Stone Tool Analysis* (McPherron 2007). The book’s title immediately implies that a single object cannot be both a core and a tool. Its chapters, most of them concerning Old World lithic assemblages, overstate the distinctions between thick unifacial scrapers and microblade cores as well as how to classify flakes. This is not just an Old World problem. There is no denying that North American Paleoindian people made large bifacial tools and that they routinely used the flakes they derived from them as tools. Kelly (1988) was perhaps the first to articulate the potential efficiency of such a technology. Large bifacial cores have been experimentally shown to be as good a source for flake tools as is a blade core, but unlike a blade core, the large biface can readily be converted into a tool in its own right (Morrow 1997; Jennings et al. 2010). Unfortunately, this notion—that a biface can simultaneously be a core for flake tools and a blank/preform for the production of a separate bifacial tool, and that this is the whole point—is sometimes underappreciated (e.g., Carper 2005; Prasciunas 2007).

Another problem arises when it is assumed that seemingly similar concepts are interchangeable and synonymous. Take, for example, the polar dichotomies of formal/informal and curated/expedient. People often think of formal tools as being equivalent to curated tools and informal tools being the same as expedient ones, but it is not necessarily that simple. A carefully made side-notched arrow point might be good for one shot. Little effort would probably be expended to find or repair such a point once it is lost or broken in field, especially if it has separated from its arrow shaft. In contrast, I have a red quartzite cobble hammerstone that has been part of my flintknapping kit for over twenty years (see Whittaker 1994:87). Which of these two tools is curated, and which is expedient?

The archaeological literature is replete with polarized dichotomies: curated/expedient (Binford 1979), maintainable/reliable (Bleed 1986), logistical/residential (Binford 1980). In most cases, these dichotomies represent opposite ends of what in reality is a continuum. Consider, for example, the concepts curated and expedient. The essential element in this continuum is artifact use life, as might be quantified in terms of minutes, hours, days, months, or years. Understanding this attribute on a continuous scale would open doors for analysis and comparison that are closed by simply categorizing things as being either curated or expedient (see Bamforth 1986).

A particularly sensitive reader may have noticed how I seem to discourage an overtly non-utilitarian approach to the study of stone artifacts. For example, my arguments that bannerstones were functional components of Middle and Late Archaic spear throwers. I do not think that otherwise
functional artifacts could not or did not have more esoteric and symbolic meanings. I am merely
distancing myself from the historical catchall that “ceremonial” has become.

THE VITAL ROLE OF EXPERIMENTAL ARCHAEOLOGY

Ethnoarchaeological studies only represent a fraction of the range of stone tools and technologies that
existed in the more remote past. There simply are no people in the Western Desert of Australia, the
New Guinea Highlands, or the rural villages of Ethiopia who are cranking out Clovis points or ripple-
flaked Danish daggers. Therefore, understanding much of the stone tool technology of the past relies
out of necessity on insights that can be teased out of the archaeological record and experimental
archaeology (see Toth and Schick 2009).

An experiment is a controlled study designed to test an idea. We should acknowledge the difference
between experimental archaeology and experiential archaeology (see Callahan 1999). Experiential
archaeology entails learning something for oneself by giving an activity a try. Learning to flintknap,
making a few throws with an atlatl, or trying to fire a hand-built clay pot in your Weber grill will not
generate much information that can be used to interpret the archaeological record. These are
experiences, not experiments. On your first attempt, you will not determine how long it takes to make
a projectile point, you will not determine the typical range at which an atlatl is an accurate weapon, and
you will not determine how firing temperatures were controlled and manipulated in a Stone Age
pottery kiln.

Some of the classic experiments in stone tool studies border on the experiential. An example is
Carneiro’s (1979) “Tree Felling with a Stone Axe: An Experiment Carried out Among the Yanomamo
Indians of Southern Venezuela.” Carneiro’s goal was to determine how long it would take to fell a
large tree with a stone axe. He acquired an example of an authentic ground stone axe head that was
found in the forest. It is unknown whether this axe was in pristine working condition or was
previously discarded because it was worn out. He gave the stone axe to an indigenous teenage boy
who proceeded to tie it to a stick and then use it as Carneiro requested to chop down a tree. His
Yanomamo participant, unfortunately, had only ever used steel axes and seemed to have little or no
familiarity with stone implements (see also Hodder 1982:79). The flimsy hafting of the axe failed in
short order, and eventually the Yanomamo boy lost interest and abandoned the task, long before the
tree was ready to fall. Despite all of these methodological problems, Carneiro went on in the same
1979 publication to devise a formula for calculating Stone Age tree-felling times that is still widely cited
today. One must wonder whether the results might have been somewhat different if Carneiro had
been working with a motivated participant who actually knew much about the task in question (see
also Mann 2005:464).

Many archaeologists can say that they have made a stone tool or two, but this hands-on experience
might be limited to a few minutes in the afternoon lab for an undergraduate Introduction to
Archaeology course. All lithic analysts are wholeheartedly encouraged to persevere to gain at least a
practical level of competence in flintknapping.
In the United States at least, modern flintknappers tend to be very much focused on making beautiful projectile points (Whittaker and Stafford 1999; Whittaker 2004). Because their products are largely intended for show and the tool makers are not relying on stone tools to perform day-to-day activities, their approach to flintknapping might be a little skewed. For example, they might be interested in recreating the broad overshot flake scars seen on many large Clovis points, but they are not very concerned with the flakes that come off. Some modern flintknappers have developed a technique of using a small antler rocker punch to accomplish this via indirect percussion. Their flake scars may resemble those seen on Clovis points, but the flakes so removed are quite different, usually being thinner and having poorly isolated striking platforms. Focusing on replicating the flakes rather than the flake scars in this case would greatly improve their experimental relevance.

A large number of replication studies have focused on the manufacture of Folsom points (e.g., Crabtree 1966; Flenniken 1978; Frison and Bradley 1981; Sollberger 1985; Gryba 1986). Most of these studies follow a reverse-engineering approach, taking a finished fluted Folsom point as the production goal and trying to duplicate it. These experiments inevitably give a lot of attention to the process of fluting and have focused on determining the technique that was used to detach the channel flake. These experiments have demonstrated that direct soft hammer percussion, indirect percussion, hand pressure flaking, and lever-assisted pressure flaking can all result in flutes and also that a substantial percentage of preforms are broken in the fluting process. These studies have required a great deal of trial and error (and shattered preforms). A close study of actual Folsom preforms and channel flakes can contribute greatly to the accuracy of such experiments and even cut down on the failures.

At the second Folsom Workshop held in Austin, Texas, in 1999, Tony Baker displayed a Riker mount full of Folsom channel flakes collected from one of his New Mexico Folsom sites, proclaiming that we (the flintknappers in attendance) were all doing it incorrectly. Sure enough, heeding the lessons of fracture mechanics, we were setting up our isolated fluting platforms with a stout, steep angle in order to get the longest flutes. But Baker’s channel flakes had very acute striking platform angles. Applying what I had seen, that afternoon I successfully fluted one Folsom preform on both sides and one long obsidian preform on one side, and I made a Gainey-style fluted point—all without breaking a single preform! It turned out that the steeper, incorrect striking platforms required so much more force to initiate a flake removal that they were putting the preform under undue stress, leading to greater failure rates. The interplay between a flintknapper and the actual artifacts one is trying to reproduce can be a truly enlightening thing.

Beyond flintknapping per se, the factors affecting tool performance, tool use life, and potential alternate functions are all incompletely understood. These can also be investigated using experimental archaeology. Yes, in addition to cajoling you into learning how to break rocks, now I am urging you to take the time to gain some expertise in making wooden handles, butchering game, scraping hides, chopping down trees, and any and all Stone Age living skills that inspire you to research or simply strike your fancy. Just how much more durable is a ground stone adze compared to one of chipped stone, and does that justify the added manufacturing time? At what point does a stone tool need resharpening? How does raw material scarcity or abundance affect the design and discard of stone tools? What might we be able to say about people’s lives and economies if we knew how many end scrapers were typically used up preparing one bison hide? If we knew more about the functions of
stone tools and how they really worked, we would be in a much better position to understand what a site assemblage with 32 end scrapers, 15 projectile points, two drills, and one-and-a-half celts means.

**MORE SITES, MORE RADIOCARBON DATES, MORE DATA**

Archaeologists who study the pottery or plant remains from Late Prehistoric village sites might have more than enough securely dated material to keep them busy, but the same cannot be said of those who study lithics, particularly those researching the earlier Pre-Contact periods. We need to see more assemblages, preferably from single-component or predominantly single-component sites. There are several comparatively rich Paleoindian sites in neighboring Wisconsin (e.g., Hensel et al. 1999; Loebel 2009), and there are hints that there might be some localized concentrations of these in Minnesota (Florin 1996; Buhta et al. 2011). We should seek out locations where the diagnostic points of this era are found and also be on the lookout for places where unusual lithic raw material signatures (Bakken 2011) and artifact characteristics, like large bifaces and large biface thinning flakes, might indicate an early site. Surface collections are a low-cost way of building a potential database. Test excavations at selected sites might prove fruitful. Cooperation with local artifact collectors is a given in Paleoindian research. Archaic sites in the state are poorly known as well, but lacking the overt characteristics of Paleoindian lithic technology, these might prove a bit more difficult to identify.

Over the years there have been substantial advances made in archaeological dating methods. Radiocarbon dating remains the single most straightforward and reliable method that can be widely applied—dendrochronology and counting lake varves are both a bit constrained by their situations. Many sites dated by radiocarbon years ago have excessively large standard errors. If additional dates on available carbon samples were run from these sites (as has been undertaken in a recent legacy-funded project) the results would surely improve our understanding of regional prehistory. Care should also be exercised in selection of the material submitted for dating—charcoal is usually preferable to bone while charred annual plant remains (e.g., corn, rice, and beans) may give more reliable and precise dates than wood charcoal.

**EPILOGUE**

These are challenging times in archaeology. Many earlier ideas are being reexamined and reevaluated. Stone tools are sometimes in the middle of these debates. Scientific and popular views of the initial peopling of the New World have largely shifted from the earlier Clovis First model to one that envisions a substantial human presence in North and South America long before Clovis. Many candidates for the oldest New World sites are being announced in the press where they undergo a trial in a court of public opinion. I hope that after reading this book you will be in a better position to judge for yourself the next time you read about a new Pre-Clovis site. In any case, the next time you look down and see an oddly shaped rock, you will have a better idea of what it is.
**Glossary**

**Abrader:** A tool of abrasive, grainy stone, especially sandstone, used to grind and smooth other objects. Abraders may exhibit broad, smoothed surfaces or V-shaped or U-shaped grooves depending on their respective uses.

**Adze:** A woodworking tool with the chopping bit mounted perpendicular to the axis of the tool handle, much like a hoe. Both chipped stone and ground stone adzes are found in Minnesota.

**Agate:** A form of chalcedony, often considered to be a semiprecious gemstone. Banded Lake Superior Agates were officially recognized as Minnesota’s state gemstone in 1969.

**Alternate Bevel:** A pattern of unifacial retouch resulting from creating a distinct bevel on one side of the blade, flipping the blade, and repeating the process on the other side. The end result is a rhomboidal cross section. Alternate beveling was a common resharpening strategy on Early Archaic knives and projectile point/knives but was also used later in prehistory as on Dickson point/knives of the Middle Woodland period and Harahey knives of the Late Prehistoric era. The stems on some Early Woodland points like Kramer and Adena were sometimes made by alternate beveling.

**Andesite:** A fine-grained (intrusive) igneous rock with a composition intermediate between rhyolite and basalt.

**Anterior:** The front or beginning portion of an object.

**Anvil Stone:** The stationary rest upon which a core is placed. Though commonly associated with bipolar cores and the reduction of small pieces of raw material, anvil stones also occur at quarry sites where they were used to steady larger masses of material. Anvil stone will exhibit central pitting and battering from use.

**Arrow:** A slender, comparatively small projectile fired with a bow. These are typically made of wood, though cane shafts were widely used where they were available. They are notched, or nocked, on one end to accept the bowstring. Most, but not all, were fletched near the nock end with two, three or four feathers. Light thin chipped stone points were widely used to tip arrows but some arrow points were made out of bone or antler and other arrows simply had pointed or blunted wooden ends.

**Atlatl:** A device used to propel spears or darts consisting of a shaft or board with a handle on one end and a hook on the other. The atlatl serves as a lever, adding considerable force to the throwing arc when compared to a hand-thrown spear or javelin. Some, but not all, atlatls had stone weights affixed to them. Known or suspected atlatl weights in Minnesota include bannerstones, stone gorgets, and bar amulets.

**Awl:** A pointed instrument used to make holes in fabric, hide, or leather. Typically made of bone, which performs far better in this role than stone.
Axe: A woodworking tool with the chopping bit mounted inline with the axis of the tool handle. Full-grooved, three-quarter grooved, notched, and ungrooved celts are all varieties of stone axes found in Minnesota.

Bannerstone: A typically symmetrical ground and polished artifact with a hole drilled through its central axis. Evidence strongly suggests that bannerstones were used as atlatl weights during the Middle and Late Archaic periods in the Eastern Woodlands.

Bar Amulet: A distinctive form of atlatl weight that resembles a two-tailed birdstone.

Barb: A sharp, rearward projection as on the barbed shoulders of a corner-notched projectile point.

Basalt: A dark-colored, fine-grained (intrusive) igneous rock with a predominantly mafic composition.

Base: Commonly used as another name for the haft element of a hafted projectile point or knife; the proximal portion of a tool.

Bedded: Occurring within distinct layers or strata. Some cherts are exposed limestone and dolomite outcrops as more or less continuous bands of coalesced nodules. Catlinite occurs in beds or seams between layers of Sioux Quartzite.

Bending Fracture: The failure and breakage of a flake or tool undergoing a bending force.

Bending Initiation: A flake whose separation from the core begins as a wider zone of contact rather than a specific point of impact.

Bifacial: Flaked or chipped on two opposing surfaces.

Bifurcated: Forked or split. With reference to projectile points, typically used to refer to varieties of stemmed and notched points with a distinctly notched basal edge.

Bipolar Percussion: A core-reduction practice, commonly involving small piece of material, wherein the core is placed atop and anvil stone and split and flaked by percussion. The resulting bipolar core is commonly wedge shaped and exhibits crushing on both ends.

Birch Tar: A natural waterproofing agent and adhesive made by extracting the oils out of birch tree bark and simmering this material down to a gooey consistency; similar to pine pitch.

Birdstone: An elaborate form of probable atlatl weight having the stylized form of a sitting bird. These were made during the Late Archaic/Early Woodland period in the Eastern Woodlands.

Bit: The chopping edge of an axe or adze.
Blade (flake): To many, a blade is a flake that is more than twice as long as it is wide. This definition is far too simplistic. The definition stressed here is that a blade is one of several elongated flakes removed serially from a specially prepared polyhedral core. That is, blades are the result of a true blade core technology. Identifying an isolated long flake as a true blade may be difficult.

Blade (portion of knife or projectile point): Typically, the term blade refers to the portion of a projectile point or hafted knife other than the haft portion, in other words, the main body of the point or knife. The term blade is also sometimes used to refer to an unhafted knife in its entirety. This can lead to confusion when it is not clear whether someone is referring to a bifacial knife or an elongated flake from a specially prepared blade core.

Blank: A roughed-out piece of material representing the early stages in the manufacture of an object.

Borer: A tool, usually of chipped stone, with a sharp corner or spur used to expediently bore holes into material such as hide, wood, or antler.

Bow: A weapon most commonly made of wood, bent, and stretched taut with a strong cord or bowstring that stores kinetic energy that is released to propel an arrow.

Breaking (hide): The vigorous working of an animal hide to breakdown the fibers to convert rawhide into soft leather.

Breccia: A coarse-textured sedimentary rock made of angular rock fragments suspended in a finer-textured matrix.

Brittle: Having a condition of fragility, a tendency to fail and fracture under stress.

Bulb of Percussion: A swelled, convex area adjacent to the striking platform on the ventral face of a flake. Bulbs can be quite pronounced or subtle, and they are not present on all flakes.

Burin: In the Old World Upper Paleolithic, a chipped stone tool with a chisel-shaped end created by removing a flat flake down the edge of a flake. Burins were likely used as scoring and slotting tools. True burins, in the Old World sense, are rare to nonexistent in most North American assemblages.

Cache: A stash of objects or material. Caches may be large, consisting of hundreds of pieces, or small with only three or four items. Some probably served a utilitarian function such as storing usable equipment and/or raw material at a place for future use. Other caches are found in special and mortuary contexts that may have served a more esoteric function. The Schumann Cache, from Olmstead County, Minnesota, is a Late Paleoindian cache of large bifacial blanks, preforms and flakes made of Hixton Silicified Sandstone.

Cache Blank: A large, roughed-out biface; essentially synonymous with quarry blank and trade blank.

Catlinite: The name reserved for the distinctive red pipestone derived from quarries near Pipestone, Minnesota.
**Celt:** A tapered stone axe blade with no groove or notches.

**Ceramic:** Of or pertaining to fired clay.

**Chain e d’Operatoire:** A conceptual framework for understanding the step-by-step production, use, and eventual discard of an object.

**Chalcedony:** A form of microcrystalline or cryptocrystalline quartz with a fibrous grain orientation. Agate is a commonly banded form of chalcedony.

**Chert:** A common form of microcrystalline or cryptocrystalline quartz with some impurities. Commonly found in beds or nodules in limestone and dolomite outcrops. Chert is hard and brittle and has conchoidal fracture, making it an ideal material for chipped stone tool manufacture. Chert and flint are essentially synonymous.

**Chipped Stone:** A tool technology involving the manufacture of implements by flaking. Techniques include hard hammer percussion, soft hammer percussion, indirect percussion, and pressure flaking. Chipped stone tools were made from a variety of raw materials including chert (including flint and jasper), chalcedony, silicified sandstone, quartzite, obsidian, and a range of fine-grained igneous and metamorphic rocks.

**Chopper:** A name often applied to generally large and crude implements believed to have been used as expedient chopping tools. Various forms of cores and rough blanks could have been used in such a way but should not be automatically identified as scrapers without a careful consideration of use wear and edge damage.

**Chunkey:** The common name used to refer to a game played by many historically known tribes across the eastern and central United States involving a round stone disc or ring and two players with spears.

**Cleavage:** In a mineral, predetermined planes of weakness that determine how a material will break. Materials with pronounced cleavage tendencies are not suitable for chipped stone tool manufacture.

**Cock:** In a flintlock mechanism, the hammer that holds the gunflint in its screw-tightened jaws.

**Collateral:** A flaking pattern in which horizontally oriented pressure flakes are paired from opposite sides meeting at or close to the midline. Well-controlled collateral pressure flaking is characteristic of some very well-made Agate Basin, Scottsbluff, and Eden points of the Late Paleoindian period.

**Conchoidal:** Having a shell-like break resembling the growth lines on a mussel. Conchoidal fracture is the basis for chipped stone tool technology.

**Concretion:** A solid mass resulting from the accumulation of material. Chert nodules are a form of concretion as are Lake Superior Agates and the calcium carbonate spheres that weather out of Omarolluk cobbles.
**Cone Initiation:** A fracture propagation beginning at a specific point of impact or force, forming an expanding cone that develops into a flake. A partial cone resembling a Hertzian cone is sometimes visible at the proximal end of a bulb of percussion.

**Conglomerate:** A coarse-textured sedimentary rock made up of rounded cobbles and pebbles suspended in a finer-grained matrix.

**Core:** The parent mass from which flakes are removed.

**Cortex:** The unaltered, natural exterior of a piece of material. When freshly separated from their host bedrock, chert nodules are commonly surrounded by a softer, chalky or limey rind. This is called a primary cortex. Chert cobbles long separated from their primary sources often develop a discolored, weathered skin that is very different in appearance from the interior of the piece. This is called a secondary cortex.

**Crystal:** In minerals, a natural geometrically regular form exhibiting patterned arrangements of planes and faces. Most minerals have their own particular crystal habit or habits.

**Curated:** In stone tool technology, used to refer to tools that are used over long periods of time that are repeatedly maintained through resharpening and repair.

**Cutting:** The act of separating an object into two or more pieces using a knife or similar tool in a slicing or sawing motion.

**Dart:** A projectile thrown with an atlatl. The term dart is a bit misleading as atlatl projectile range from small, light projectiles not much larger than an arrow to heavier spears that may be six to eight feet long. Archaeologically and ethnographically known darts were commonly equipped with a detachable foreshaft, and many were fletched.

**Decortication:** Removing the outside of a piece of material. Sometimes erroneously assumed to be a necessary first step in making a chipped stone tool.

**Debitage:** Any and all flaking debris resulting from the reduction, manufacture, or maintenance of a chipped stone tool. Includes flakes and shatter.

**Diagnostic:** An object or material that is distinctive to a particular time period, region, or culture. Projectile points and decorated pottery rim sherds are commonly diagnostic.

**Diorite:** A coarse-grained (intrusive) igneous rock with a composition intermediate to granite and gabbro.

**Discoidal:** A round, disc-shaped stone, often highly polished. Believed to have been used in a Native American game called chunkey.

**Distal:** The portion of a tool that is farthest from the hand or handle. The pointed tip is the distal portion of a projectile point.
**Dolomite:** A mineral similar to calcite but containing magnesium in addition to the calcium carbonate. Limestone units that have been altered into dolomite are also referred to by this name, for example, the Prairie du Chien Dolomite.

**Dorsal:** The back or exterior surface of a flake.

**Drill:** A symmetrical, narrow, elongated chipped stone tool with a pointed end for drilling holes. Most drills are bifacial, and many were made by repurposing projectile points. Drills were probably hafted to a straight shaft and used in a rotary action.

**Drilling:** Creating a hole with a sharp tip used in a rotary, or spinning, fashion. Solid stone drills make conical holes while hollow cane drills used with a fine abrasive cut a ring making a more cylindrical hole.

**Ductile:** Able to be deformed without losing its toughness. Pliable rather than brittle.

**Eccentric:** In chipped stone technology, an elaborate, often intricately shaped, and flaked piece with imaginative shapes and abstract forms. Some eccentrics are actual prehistoric artifacts, but many have been fashioned by modern people reworking authentic broken pieces.

**Effigy:** An object made to emulate the form of something else, typically a human or animal.

**End Scraper:** A chipped stone tool, commonly completely or predominantly unifacial, with a steep scraping edge retouched onto one, sometimes both, ends of a flake.

**Eolith:** A stone with chipped edges and surfaces resulting from natural tumbling, compression, trampling, and fracturing. Not an artifact made by people.

**Eraillure:** A shallow, negative scar that forms on the convex percussion bulb on the ventral surface of a flake. Eraillures will not be present on all flakes exhibiting percussion bulbs.

**Ethnoarchaeology:** A field that studies existing people from an archaeological perspective, paying particular attention to the relationships between people’s actions and the resulting material residues and products.

**Ethnography:** A field of study involving the description and interpretation of various cultures in their native settings.

**Expedient:** In stone tool technology, generally used to refer to simple tools that are used briefly and then discarded.

**Experimental Archaeology:** A field of study that attempts to reproduce actions and activities performed by past people in order to better understand the archaeological record. Experimental archaeology often employs scientific controls and methodologies in answering specific questions about artifacts and past lifeways.
**Feather:** In chipped stone technology, the termination of a flake that evenly tapers away from the core, leaving behind a relatively smooth surface.

**Felsite:** A term commonly used by geologists to describe a fine-grained igneous rock whose composition cannot readily be determined in the field.

**Fire-Cracked Rock:** Typically, angular fragments of cobbles that have resulted from various hot rock cooking activities such as pit roasting or stone boiling.

**Flake:** A piece of material that has been removed from a core. flakes commonly exhibit several characteristics including a clear interior (ventral) and exterior (dorsal) surface, a striking platform at one end, and on the ventral surface ripples or undulations radiating away from the point of applied force. See also: Bending Initiation, Bulb of Percussion, Cone Initiation, Eraillure, Feather, Step, Hinge, Outre Passé.

**Flaking:** The process of making a chipped stone tool or an important step in the early stages of making some ground stone tools.

**Flash Pan:** The compartment at the base of the frizzen on a flintlock mechanism that holds the gunpowder charge that ignites the gunpowder behind the projectile in the gun barrel.

**Fletching:** The feathers placed near the proximal end of a dart or arrow to stabilize its flight.

**Flint:** To some, a darker, purer variety of chert. For most, essentially synonymous with chert.

**Flintknapping:** The activity of making chipped stone artifacts.

**Flintlock:** A firing mechanism for firearms developed in the eighteenth century and widely used through the first half of the nineteenth century employing a prepared gunflint. See also: Cock, Flash Pan, Frizzen, Gunflint, Patch.

**Foreshaft:** A separate haft unit at the distal end of a spear, dart, or arrow. Oftentimes this is a detachable solid wood shaft four to eight inches long with a stone point. Large and medium-sized stone points mounted in such a way can perform double duty as projectile tips and hafted knives.

**Formal:** A tool extensively modified from its parent blank into a patterned shape.

**Fossil:** The preserved remains or impression of a prehistoric organism (body fossils) or preserved traces of the organism’s activity such as burrows or tracks (trace fossils). Both categories of fossils are represented in Midwestern cherts.

**Fracture:** In minerals, a property used to refer to the manner in which materials that do not exhibit cleavage planes break.

**Fracture Mechanics:** A field of physics focusing on the manner in which brittle solids fail and break.
Frison Effect: A concept describing the continual attrition of a stone tool through use and maintenance.

Frizzen: The vertical steel plate that is struck by the gunflint in the flintlock mechanism.

Full-Grooved: Having a groove that fully encircles an object as in a full-grooved axe or a full-grooved maul.

Gabbro: A coarse-grained (intrusive) igneous rock with a mafic composition.

Geofact: A stone object created by nature that might be mistaken for a humanly made artifact.

Glacial Till: The sediment and rock material carried and deposited by a glacier.

Gneiss: A coarse-grained metamorphic rock with extensive foliation that is derived from the metamorphism of granite or some sedimentary rocks like shale.

Gouge: A form of ground stone adze with a hollowed-out or trough-shaped bit.

Gorget: A tabular piece of ground stone, often very symmetrical usually with two drilled holes. Stone gorgets (as well as similar-shaped “pendants” with only one hole) were probably a form of atlatl weight. Stone gorgets are probably completely unrelated to the elaborate carved and incised gorgets made of marine shell during Mississippian times.

Granite: A coarse-grained (intrusive) igneous rock with a felsic composition.

Graver: A tool often made on a flake, but sometimes on a repurposed projectile point or knife, with a sharp spur or tip used to score, incise, or engrave.

Gray Ghost: The common slang term for a series of often very large, flat spearhead and knife reproductions. These are commonly attributed to Bryan Reinhardt of Gustine, Texas. These modern-made artifacts are named for the gray Edwards Plateau Chert usually used for their manufacture.

Graywacke: A sedimentary rock made up of sand-size grains of quartz and feldspar in a clay-like matrix.

Greenstone: A common field term for metamorphosed and/or weathered basalt.

Grinding: In ground stone tool manufacture, the process of shaping through abrasion.

Grooved: Having a linear indentation.

Ground Stone: A general category of stone tools including informal cobble tools and artifacts fully shaped by flaking, pecking, grinding, polishing, cutting and/or drilling.
**Gunflint:** A square, rectangular or heel shaped piece of flint or similar material that is used in a flintlock mechanism. The gunflint is clamped into the jaws of the cock or hammer and strikes the steel frizzen plate sending a shower of sparks into the flash pan below.

**Hackles:** Rough linear scars, typically seen along the sides of the interior or ventral surface of a flake. They are perpendicular to the ripples or undulations and are oriented directly toward the origin of the impact. Hackles may be some form of stress fractures as the flake spreads and thins out towards its edges.

**Haft:** Either the portion of an object designed for insertion or attachment to a handle or the handle itself.

**Haft Grinding:** Grinding and dulling of the edges of the area of a chipped stone tool where lashings or sinew will be applied. Haft grinding is a routine feature on Paleoindian and many Archaic projectile points and knives, but this decreases later in time during the Woodland and Late Prehistoric periods. The edges of the haft region of a Dalton adze were similarly dulled.

**Half-Grooved:** Only having grooves around one-half of the periphery of an object, usually on two opposing sides. Keokuk axes of southeastern Iowa and adjacent areas are half-grooved axes.

**Hammerstone:** A cobble used as a hammer for a variety of purposes, among them direct percussion in flintknapping.

**Hard Hammer Percussion:** Flaking by direct percussion using a hammer made of stone.

**Hardness:** The degree to which a material resists cutting or abrasion. Typically measured on the Mohs Scale. A very different property than tenacity/brittleness.

**Heat Treatment:** The intentional thermal alteration of a knappable raw material like chert through the gradual and controlled application of heat. Heat-treated material is often more colorful than raw stone, typically has a finer-grained texture and a glossier luster and is more brittle and more easily flaked. It is important to distinguish intentional heat treatment from incidental heating and burning.

**Hematite:** A common iron mineral consisting largely of iron oxide.

**Hertzian Cone:** A characteristic fracture created by a sharp impact on a flat surface of a brittle material like glass. From a small point of impact, the fracture expands through the glass, forming a broad cone-shaped piece that is ejected from the opposite side. Old storefront windows commonly exhibit this type of fracture.

**Hide Glue:** A natural adhesive made by boiling down hooves and hide scrapings.

**Hinge:** A termination on a flake wherein the fracture front rolls outward, leaving a lipped “hinge” on the surface of the core. Generally, a very undesirable type of flake termination.
Hoe: A bladed tool used to work soil in horticulture and agriculture. Traditionally, most hoes in prehistoric Minnesota were made of the shoulder blades of bison or elk. Most of the hoes used in the Mississippian world around Cahokia were of chipped stone, particularly out of Mill Creek Chert.

Horizontal: A flaking pattern in which long pressure flake scars are oriented horizontally across the blade of a projectile point and may or may not terminate at or near the midline.

Hornstone: A colloquial term sometimes used for the high-quality gray to blue-gray cherts of the middle and lower Ohio River drainage in Indiana, Kentucky, and Illinois.

Igneous: A large group of rocks formed of molten rock material deep inside the earth or near the surface in volcanic contexts.

Impact Fracture: The failure and fracture of a projectile point upon impact. In a classic impact fracture, the break snips off part of the point’s tip and drives an elongated, flute-like flake down the face of the blade. Impacts can also remove elongated flakes down the bifacial edge of a point, leaving them with a flattened “burinated” edge. Projectile points can also buckle and bend in half upon impact, snap between the notches, or suffer crushing and compression at the center of the basal edge.

Incidental Heating/Burning: Occurs when an object is exposed to unintentional heat alteration, as in when a campfire is built over unseen debris under the surface of the ground, a flake is accidentally scuffed into a fire, a dwelling burns or a wildfire sweeps across an archaeological site. It is important that these instances of heat exposure are not confused with heat treatment, which is an actual technological practice.

Indirect Percussion: A means of removing a flake using a bone or antler tool between the core and the hammer much like using a hammer and chisel.

Informal: A tool of simple form, minimally modified from its parent blank, such as a flake or cobblestone.

Interior (flake): The essential equivalent of a tertiary flake in the primary-secondary-tertiary cortex model of debitage typology.

Jasper: A colloquial name commonly applied to colorful varieties of chert that usually contain considerable traces of iron. Most jaspers are yellow-tan, brown, red, or sometimes green.

Knife: A bifacial, or sometimes unifacial cutting tool.

Lanceolate: Elongated and leaf shaped.

Leather: Treated animal hide that is softer and more pliable than rawhide.

Limestone: A sedimentary rock made predominantly of the mineral calcite. May contain abundant marine fossils.
Lithic: Of or pertaining to stone.

Lithification: The process whereby loose mineral material is compressed and/or cemented into stone.

Llano: A name applied long ago to distinguish the Early Paleoindian fluted points complexes for the subsequent unfluted lanceolate point styles of the Late Paleoindian period.

Mano: The commonly flat, circular, to rectangular-shaped handstone that is used in conjunction with a metate in grinding grains and other foodstuffs.

Marble: Metamorphosed limestone

Mass Analysis: A method developed in debitage analysis that examines the collective count and weight characteristics of flaking debris separated into various size grades.

Maul: Name commonly used for grooved stone hammers. They may be full-grooved or three-quarter grooved.

McCormick Folsom: Replica Folsom points made by a prolific modern flintknapper named Marvin McCormick in southeastern Colorado. While McCormick’s replicas have the general appearance of an authentic Folsom point, they are typically thicker than and have narrower flutes than the real artifacts.

Medial: The middle portion of an object.

Metamorphic: A broad category of rocks formed from other pre-existing rocks through heat and/or pressure. Metamorphic rocks formed from igneous parent material are referred to as metavolcanic rocks. Those derived from sedimentary rocks are called metasedimentary.

Metate: Typically a flat or trough-shaped slab of stone that is the stationary grinding surface used in conjunction with a handheld mano.

Mineral: In geology, a naturally occurring, inorganic, and crystalline solid with a fixed structure and chemical composition.

Mohs Scale: A widely used system for characterizing the relative hardmesses of various minerals. Numbered 1 (softest) through 10 (hardest).

Mortar: An object of stone or wood with a round or cylindrical depression that is used to pound and pulverize grains and other foodstuffs. Used in conjunction with a pestle, which may also be of wood or stone.

Mortuary: Related to funeral and burial practices.

Net Weight: A stone, often very crude, that is tied to a net. Grooved and notched net weights are found in Minnesota.
Nodule: A typically somewhat rounded mass of a particular material, such as chert. Nodules come in many shapes ranging from spherical to lozenge shaped to irregular and amoebic. They can be up to a meter or more in diameter or be as small as a pea. Chert nodules typically occur in concentrated bands within several Midwestern limestone and dolomite outcrops.

Notched: Having distinct indentations, usually for the purpose of hafting to a handle or attaching to cord.

Novaculite: A name sometimes used to refer to massive silica formations as in the case of the Arkansas Novaculite of the Ouachita Mountains.

Nutting Stone: A cobblestone or slab with one or more rounded depressions that are used to hold nuts while cracking them with a hammerstone.

Obsidian: A natural volcanic glass, typically black in color but sometimes also clear, greenish, or reddish, formed by the quick cooling of felsic, or granitic, magma.

Omarolluk: The name of a graywacke formation in eastern Hudson Bay, Canada, that contains distinctive spherical concretions of calcium carbonate. The concretions weather out, leaving often remarkably round holes that people commonly mistake for the handiwork of people. Commonly called omars, cobbles of this material are widely distributed in glacial till throughout south-central Canada and the north-central United States.

Oolitic: Containing small rounded concretions formed in highly agitated, shallow ocean environments. In southeastern Minnesota and adjacent parts of neighboring states, much of the chert derived from the Prairie du Chien Group is characteristically partially or completely filled with ooliths.

Outre Passé: The French term for a flake that passes completely across the surface of a core, clipping off a bit of the opposite side. Basically equivalent to an overshot flake. An overshot or outre passé flake may or may not severely disrupt the further reduction of a core or biface. If the overshot is slight, and only a sliver of the opposite margin of the parent mass is lost the end result may be nearly ideal. If the overshot is severe and clips the piece into two halves, further reduction may be impossible.

Overshot: See Outre Passé.

Pareidolia: The process by which one’s mind organizes random visual stimuli and reinterprets them as familiar objects, like a human face.

Parallel-Oblique: A flaking pattern in which parallel pressure flakes are directed across the surface of a piece at a diagonal, or oblique, angle. This type of flaking is often seen on very Late (Terminal) Paleoindian projectile points on the High Plains.

Patch: A small sheet of lead or a square of leather used to help seat a gunflint in the jaws of the hammer or cock in a flintlock.
Patination: The chemical and or physical weathering of the surface of a cobble or artifact that can look drastically different from the appearance of the original and interior of the stone. For example, originally dark brown, translucent Knife River Flint commonly exhibits an opaque, whitish to bluish surface patina.

Pecking: The process of battering away the surface of a tough, usually granular, stone in the manufacture of a pecked and ground stone tool.

Pecking Stone: A hammerstone, typically of very hard material like chert, quartz, or quartzite, used in the process of pecking in the manufacture of pecked and ground stone tools.

Pendant: An ornament typically with one hole drilled for suspension.

Perforator: A pointed tool used to make holes. Drills, borers, and awls are all forms of perforators.

Pestle: A cylindrical tool of stone or wood used to pound and pulverize grains and other foodstuffs in a mortar.

Phytolith: Rigid microscopic structures made of silica that are present in many plant tissues that can survive after the decay of the plant. These are useful in identifying the types of plants that were present in the environment around an archaeological site as well as the specific types of plants that were being used by people.

Piece Esquillée: From the French, a “scaly piece.” These are typically lozenge- or wedge-shaped flaked stone pieces with battered edges. They have been interpreted as specialized wedges by some, but many are probably the remnants of bipolar cores.

Pine Pitch: A natural adhesive made from the sap of pine trees mixed with crushed wood charcoal.

Pipe: A carved and drilled stone artifact used for smoking tobacco and similar substances.

Pipestone: A soft stone commonly used in the manufacture of pipes. Catlinite from southwestern Minnesota is but one type of pipestone.

Pitted Stone: A stone with battering or pitting on one or both sides. A pitted stone may be an anvil stone, a nutting stone, or a mano with a small divot pecked into the center of the grinding surface.

Plane: A steep-edged tool used at a low angle to shave and remove material in the working of wood, bone, or antler.

Plano: A name applied long ago to distinguish the unfluted lanceolate point styles of the Late Paleoindian period that follow after the Early Paleoindian fluted points.

Plummet: A ground and typically polished, teardrop-shaped stone with a knob, groove, or drilled hole on the narrow end. These are found throughout much of Eastern North America and may occur in Minnesota.
Polishing: Bringing the surface of a material to a smooth finish with a high gloss.

Poll: The butt end of an axe, celt, adze, or gouge.

Potlid: A rounded half dome of material popped off a piece of chert as a result of either frost fracture or uneven heating of the interior and exterior of the mass. These superficially may resemble Hertzian cones but they exhibit no point of impact.

Preform: An unfinished artifact whose final form is beginning to take shape. A later, more advanced stage of manufacture than a blank.

Pressure Flaking: The process of removing controlled flakes by the application of pressure, typically with a bone or antler tipped tool. Modern flintknappers commonly use copper tipped pressure flakers out of convenience and durability.

Primary (flake): Within the primary-secondary-tertiary cortex model of flake classification, primary flakes are flakes whose exterior or dorsal surface are mostly or completely covered with cortex, theoretically indicating that these flakes were the first flakes removed in the reduction of a core.

Primary (source): A source of material that is at or not far removed from its point of origin, as in an actual bedrock outcrop of chert bearing limestone or a residual layer atop an outcrop.

Projectile Point: A bilaterally symmetrical, pointed object deigned to tip a projectile such as a spear, dart, or arrow. While the most common and familiar projectile points were made of chipped stone, around North America, tips were also made of ground slate, antler tine tips, bone, and even large gar scales.

Proximal: The portion of an object closest to its haft or handle.

Quarry Blank: A generally large, roughed-out biface. Essentially synonymous with cache blank and trade blank.

Quartz: A mineral with the chemical composition SiO₂. Quartz occurs in many forms and forms the basis of many of the raw materials used in chipped stone tool manufacture.

Quartzite: Metamorphosed sandstone.

Radial Fracture: A means of sectioning or smashing a chipped stone piece, commonly a flat flake or a biface, into triangular or rectangular fragments that may in turn be used as other tools like splitting wedges or scraper-planes.
**Radiocarbon Dating:** A method of measuring the gradual loss of the radioactive carbon-14 isotope from the carbon atoms within a once-living organic material since the organism has died. This is the most reliable and commonly used method of absolute dating in archaeology. Note that radiocarbon dating requires organic material such as wood or bone for dating. Establishing the age of a stone projectile point using this method relies on the strength of its association with the dated organic substance.

**Raphide:** Needle shaped crystals of calcium oxalate found in many different plant families. Useful for identifying the types of plants that were present and/or being used at an archaeological site.

**Rawhide:** Animal skin that has had the hair, flesh, and fat removed but has not yet been chemically or physically processed to create pliable leather. Rawhide is soft and pliable when wet but hardens into a stiff, strong material when it dries, making it a useful material for bindings and lashings.

**Recycling:** Converting an object that is no longer useful for its original or intended purpose into something else. In extreme conditions of raw material scarcity, formal tools like end scrapers or projectile point fragments may be recycled into bipolar cores for the creation of a few more small, sharp flakes.

**Red Ocher:** A red pigment that is the powdered form of the mineral hematite.

**Reduction Sequence:** The steps, stages, or procedures followed in the production of a stone artifact. A thorough understanding of a reduction sequence allows for the identification of complete and fragmentary unfinished forms that might otherwise be considered as finished tools.

**Refitting:** The process of reassembling fragments of a once larger object. Pieces of a broken tool can be conjoined, flakes can be fitted onto cores, and flakes can be matched to other flakes creating a mold, or ghost image, of the object that was manufactured. Refitting not only results in more complete artifacts such as a reconstructed pot or a reassembled broken projectile point but also allows for the investigation of the spatial relationships across a site where these fragments were found and for the assessment of the degree of stratigraphic integrity or mixing represented in an archaeological site.

**Relative Dating:** A situation in which the relative age of an artifact type is known but not its absolute age. A projectile point type found in a stratum above a separate stratum is younger than the points found deeper in the site even thought the actual age of the stratum might not be known. In some cases, it is possible to chain together enough evidence to narrow down the probable absolute age of artifacts. This is how, for example, we can propose that the age of Hardin points is between about 7000 and 6500 B.C.E.

**Repairing:** Fixing damage resulting from use. Creating a fresh tip on a projectile point damaged by impact fracture is an example or repair as is making a new base on a point snapped between the notches. Grinding out a major nick on the bit of a ground stone axe or celt is a form of repair on a ground stone tool.

**Replica:** A modern-made copy of an object. Some replicas are readily distinguished from authentic artifacts, but others are more difficult to identify.
**Repurposing:** Altering the form of an object so that it can be used for a purpose other than that was originally intended. Note that this is not necessarily the same thing as recycling. A perfectly usable projectile point might be converted into a long drill, for example, if the need arose.

**Resharpening:** Rejuvenating the dulled edges of a tool. Alternate beveling was a standard means of resharpening in Early Archaic times.

**Residue Analysis:** The microscopic and chemical analysis of traces of plants and animals that might be left on stone tools.

**Residuum:** A layer of material accumulated from the gradual decomposition of bedrock. Chert, which commonly occurs in limestone and dolomite formations, is chemically resistant to such decay. With the encasing limestone or dolomite degenerated into a gritty, clayey marl, chert nodules and fragments become concentrated. This creates conditions where actual quarrying through excavation can be desirable.

**Retouched Flake:** A flake on which one or more edges have been modified by pressure or percussion flaking. This modification may be unifacial or bifacial. While end scrapers and side scrapers are technically retouched flakes, the term is most commonly used for flake tools that do not correspond to an established form.

**Reworking:** A more general term referring to the intentional alteration of a tool, especially of chipped stone, from its original form. Includes resharpening, repairing, repurposing, and recycling.

**Rhyolite:** A fine-grained (extrusive) igneous rock with a felsic composition.

**Rock:** In geology, a solid made up of an aggregate of one mineral or, commonly, multiple minerals.

**Sandstone:** A sedimentary rock consisting of cemented sand grains.

**Saw:** A stone tool, often with a retouched and serrated edge, used in a sawing motion.

**Scavenging (lithic material):** Collecting and reusing cores, flakes or tools left at an archaeological site by previous inhabitants. This was likely a common practice in raw material poor areas and could severely complicate our understanding of trends of tool technology and raw material use through time.

**Schist:** A medium-textured, extensively foliated metamorphic rock derived from the metamorphism of shale or similar material.

**Scraper:** Typically, a unifacial tool with a steep working edge.

**Secondary (flake):** Within the primary-secondary-tertiary cortex model of flake classification, secondary flakes are flakes whose exterior or dorsal surfaces a partially covered with cortex, theoretically indicating that these flakes were removed after most of the cortex had been trimmed away but before the final stages of reduction.
Secondary (source): A source of raw material far removed from its place of parent origin. Glacial till and river gravel are examples of secondary sources.

Sedimentary: A broad class of rocks formed from the lithification of sediments deposited by water, wind, or gravity.

Serrated: Having a saw-toothed edge.

Shale: A sedimentary rock composed of lithified clay and silt-sized particles.

Shatter: A fragment of chipped stone debitage that does not have the attributes of a flake. Shatter typically does not have a distinct interior or exterior side, lacks concentric rings or undulations, lacks a striking platform, and cannot be oriented with the respect to the direction it broke. Shatter can be tabular or blocky, irregular, or angular.

Side Scraper: A unifacial chipped stone tool with a steeply retouched edge down one or both lateral sides of a flake blank. Side scrapers could have been used in a planing or drawknife-like manner but also function well as knives for cutting and sawing.

Silica: A shortened name commonly used to refer to silicon dioxide, basically quartz.

Silicified: A lithic material converted into or impregnated by silica.

Siltstone: A sedimentary rock made predominantly of silt-sized particles.

Sinew: Fine, strong strips of muscle tendons from the legs or back of a large mammal. Sinew is an ideal material for lashing artifacts like projectile points to their hafts. When wet it is soft and pliable, but when it dries it shrinks, tightens, and becomes rigid.

Slate: A hard, fine-grained, foliated rock derived from the metamorphism of shale or similar material.

Soft Hammer Percussion: Direct percussion flaking with a hammer of a material other than stone, especially bone or antler.

Spade: A name commonly used to refer to large, elongated chipped stone hoe blades.

Spear: A generally large weapon that could be used as a hand-thrown javelin or in a thrusting motion. Often visualized as the earliest and simplest projectile weapon equipped with comparatively large stone projectile points. Insomuch as there is evidence that Paleoindians used the atlatl or spear thrower, the view that these earliest human occupants of North America routinely killed large mammals with hand-thrown or thrusting spears may be unrealistic.

Spear Thrower: Another name for Atlatl.

Specific Gravity: The relative weight of a volume of material compared to the weight of an equivalent volume of water. Lead, for example, has a specific gravity of 11.35, meaning that it is 11.35 times denser than water.
**Spokeshave:** The name commonly used to refer to a concave edged unifacial scraper.

**Spud:** The common archaeological term for a ground stone celt with a markedly flaring bit.

**Starch:** A carbohydrate substance produced by most green plants as a means of storing energy.

**Steatite:** A more formal name for material commonly known as soapstone. Commonly used in the manufacture of pipes.

**Stemmed:** Having a projection at one end, typically forming the haft element of a point or knife. Stems may flare or expand, be straight-sided, or taper and contract.

**Step:** An abrupt, near-ninety-degree fracture at the end of a flake, leaving a shelf or step on the core or biface. Generally, a step fracture is an undesirable type of flake termination. If multiple step fractures build up, which often happens if the step fracture is not promptly eliminated, the end result is a thick lump of leftover material called a stack that may be nearly impossible to remove.

**Stone:** For most of us, essentially a synonym of rock.

**Stratigraphy:** The layering within an archaeological site, typically with the oldest strata at the bottom and progressively younger strata above. An important tool for discerning the ages of the various occupations on a multicomponent site. Note that not all archaeological sites are stratified. On some sites, the tools and debris left behind over thousands of years of sporadic occupation are comingled within a single stratum.

**Streak:** The color of a streak of powdered mineral left on a streak plate, typically a flat piece of unglazed porcelain. A useful characteristic for identifying some minerals, such as hematite, which always has a red or reddish streak regardless of its color as a solid.

**Striking Platform:** The portion of the edge or surface of a core that is the place where percussion or pressure force is applied in order to remove a flake. A portion of the striking platform is broken away with the flake, forming the proximal end of the flake. The striking platform may be simple or intricately prepared and ground. The striking platform will be absent from many broken flakes and may be removed by retouch on modified flakes.

**Tertiary (flake):** Within the primary-secondary-tertiary cortex model of flake classification, tertiary flakes are flakes that exhibit no cortex on their exterior or dorsal surfaces, theoretically indicating that these flakes were removed after the cortex on a piece had all been trimmed away.

**Thermal Crazing:** A series of small cracks and fractures that develop in a material like chert or chalcedony when it is heated or cooled too rapidly, essentially ruining its potential for making chipped stone tools. A common result of incidental burning.
Thermoluminescence Dating: A means of measuring the radiation dose that has accumulated since an object has been heated beyond a certain temperature. This method can be used to date materials like fire-cracked rock or fired ceramics. It is generally a secondary dating method in archaeology due to its typically higher cost and greater margin of error compared to radiocarbon dating.

Three-Quarter Grooved: An object having a groove that encircles most, or three-fourths, of the circumference of an object, as in a three-quarter grooved axe or maul.

Trace Element: Minute quantities of a particular chemical element within a material that may be useful for identifying its regional or geographic source.

Trade Blank: A typically large roughed out biface. Essentially the same as a cache blank or quarry blank but implying a trade function.

Triangular: A shape having three relatively straight sides as in a triangular point.

Trihedral: An object having three surfaces or sides.

Type: A category of object, often very specific, distinguished from other categories by a combination of traits and features. Types can be chronological, morphological or functional in nature or all three at once.

Type Cluster: A grouping of similar or related types.

Typology: A system of dividing a group of objects into smaller groups sharing particular features that distinguish them from objects in other groups.

Unifacial: Flaked on only one side or face, from one direction.

Undulations: Ripples, or wavelike features radiating away from the point of applied force on the ventral surface of a flake.

Use Life: The duration of time that a tool is in use that can range from minutes to days, months, or even years. Generally, this is the span of time between the completed manufacture and final discard of the tool.

Use Wear: Physical damage, abrasion, polish, or striations resulting from the use of an object.

Utilitarian: Having a common, everyday function.

Utilized Flake: A flake that has been used for a task with little or no intentional modification. A utilized flake will exhibit use damage and microwear traces along its used edges and surfaces.

Ventral: The belly or interior surface of a flake.

Whetstone: A stone with a flat surface that is used to hone and sharpen the edges of metal tools.

X-Ray Fluorescence: An analytical technique used to identify and quantify specific elements and compounds within a substance.
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