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ANALYSIS OF QUARTZ IN NORTHERN WISCONSIN: DEFICIENCIES, MISCONCEPTIONS AND GOALS

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Abstract: *Quartz is a common mineral found in archaeological lithic assemblages from sites around the globe, however, little analysis and interpretation of these assemblages has been conducted. Quartz debitage can make up nearly the entire lithic assemblage and can total hundreds to thousands of pieces. Valuable information can be attained by studying the debitage in these assemblages, such as the type of reduction technique, stage of reduction, and the relative distance to different lithic sources. Archaeologists have avoided quartz assemblages due to some misconceptions: it is impossible to analyze quartz reduction sequences, it is difficult to work and control and it is used as a last resort raw material. While these misconceptions may hold some truth, the myth has been kept alive because little background research has been done and few quartz assemblages have been analyzed. In order to gather data from quartz assemblages a formal research design must be created and implemented.*

Background

My interest in quartz lithic assemblages began in the fall of 2003, when I was presented an opportunity to analyze a lithic assemblage recovered from the Phase II excavation of the Rodney Clark site (47MR146). The site is located on the Wisconsin River in Marathon County, Wisconsin and was excavated during the summer of 2003 by the Mississippi Valley Archaeological Center (MVAC) as part of a Department of Transportation (DOT) project. The site yielded over 4,000 lithic artifacts from only a few test units, 99% of which were quartz. Analyzing such an assemblage proved to be a daunting task, not only due to the lack of time and project money, but also the significant lack of background research available. As our project progressed, it was obvious that no one before us had the ambition or desire to closely analyze a lithic assemblage made up primarily of quartz.

In the course of the project we strove to detect use-wear patterns macroscopically and microscopically, determine the method of reduction and the stage of production that took place at the site. We formulated eight different lithic categories to organize our data, which included: formal tools, biface thinning flakes, retouch/edge rejuvenation flakes, core reduction flakes, bipolar flakes, shatter, chunks, and cores. The main sources we relied on were Van Dyke (1985), who focused on quartz industries and outcrops in our study area and Barber (1981) who focused on quartz production in New England. In general, there is a lack of literature and research done on this subject, while there is no lack of quartz in archaeological assemblages in northern Wisconsin.

Quartz as a Raw Material

Quartz is a crystalline silicon dioxide mineral that is extraordinarily common and occurs in various types, colors and locations (Gramly 1981: 85). It has a hardness of seven on the Moh's Hardness Scale, which makes it very abrasion resistant, and it is a hexagonal crystal, meaning it has six planes of cleavage to break along. This usually makes flaking difficult and produces flat or linear flakes (Barber 1981b:54). It is difficult to find a high quality form of quartz because it usually contains veins, cracks and other flaws. It is the combination of these variables that makes quartz flake differently than cryptocrystalline materials do (Luedtke 1981: 68). This would then call for a different lithic reduction strategy, which will be presented later in conjunction with the misconceptions of quartz assemblages.

Quartz also occurs in two different types, crystalline and cryptocrystalline. Cryptocrystalline forms include jasper, chalcedony, flints, cherts and agates, which are known to be easily knappable and occur commonly in archaeological sites. Crystalline quartz itself can take on two different forms, crystal and crystalline. Crystalline quartz contains the interior chemical structure of crystal quartz, but does not occur in the crystal form (Boudreau 1981: 22). Crystal quartz takes on its six-sided crystal form and is the more desired form of quartz found in archaeological sites because they occur in large pieces and lack the flaws and impurities that occur in the crystalline forms. The other forms seen in the archaeological record are sugar or milky quartz, rose quartz and amethyst, which range from transparent to nearly opaque (Gramly 1981: 85). These occur more commonly than crystal quartz, but contain impurities and result in more broken or unfinished tools and more debitage.

Quartz Sources

It is difficult to determine the exact location of quartz in northern Wisconsin because there is not a single outcrop or source for it like other materials in the area. Quartz is predominately found in cobbles that occur in glacial outwash and till. Glaciers from the last phase of the Pleistocene, the Wisconsin phase, are responsible for forming the landscape and geology for the state of Wisconsin, save the driftless area, which lies in the southwestern corner of the state. The glaciers eroded the landscape and produced terminal and recessional moraines of glacial till and gravel. Gravels were also deposited by outwash from the glaciers and are the parent material for the soils in the region and consist primarily of quartz, quartzite and rhyolite (Van Dyke 1999: 5).

North-central Wisconsin is not well documented archaeologically and work that has been done there in the past has been limited in frequency and scope (Van Dyke 1999: 8). However, smaller, more specific areas have been well documented such as the Apostle Islands and the St. Croix National Scenic Riverway. While the overall geology of northern Wisconsin plays a large role in the archaeology of the state, the focus will be on the geology of the individual settings of these sites since most of the archaeological data is recovered form these areas.

The St. Croix Scenic Riverway is an area that encompasses the St. Croix River and its main tributary, the Namekagon River in northwestern Wisconsin and northeastern Minnesota. The St. Croix River itself is 197 miles long and forms part of the boundary between Minnesota and Wisconsin before extending further into northwestern Wisconsin (Perry 1986). This was a major river during the recession of the glaciers and was fed predominately by glacial meltwaters. As a result, glacial till deposits made up of mostly of quartz are very common in the river and surrounding areas, which served as a lithic resource for prehistoric people (Perry 1986). Sites in these areas contain strikingly high amounts of quartz in archaeological sites ranging from only forty percent to one hundred percent of the assemblage although other materials such as chert and orthoquartzite are found.

The Apostle Islands is another area where archaeological work and research has really increased recently. This is mostly due to work done by archaeologists such as David Overstreet and Robert Salzer at the Great Lakes Archeological Research Center (GLARC) and others at MVAC, both located in Wisconsin. The Apostle Islands themselves are composed of sandstone and represent hilltops that occurred between preglacial valleys. Glacial erosion deepened the channels between the islands and eroded the hilltops (Salzer and Birmingham 1981: 7). The deposition during glacial outwash left few traces of landforms such as moraines, (although they may be under the current water level in Lake Superior) but did deposit a great deal of till, largely composed of quartz cobbles (Salzer and Birmingham 1981). This background research in the areas geology provides a basis for the abundance of quartz found in archaeological assemblages within the Apostle Islands National Lakeshore.

Lithic Technology

Assessing different lithic reduction techniques is essential to understanding and interpreting a lithic assemblage. This paper will review bifacial and bipolar reduction techniques as well as debitage characteristics and common classification schemes to provide background information. A bifacial reduction sequence involves using percussion flaking, which by definition is the removal of a flake or chip by striking an object with a hammer (Andrefsky 1998: 11). This is typically done by holding the object (piece on is trying to reduce) in one hand (usually left hand for right-handed people) and striking the object with a hammer. Percussion flaking can involve a soft hammer hit, with a billet made out of wood or antler or a hard hammer hit, with a hammerstone, usually granite or other igneous rocks. Hard hammer percussion is usually associated with initial stages of reduction when larger flakes are removed that contain a large, wide platform and thick bulb of percussion. Soft hammer percussion is usually associated with the removal of smaller flakes with narrower platforms and thinner bulbs of percussion later in the reduction sequence. These characteristics are the key to categorizing and eventually examining the debitage. The difference between hard and soft hammers is an example of difference in application load, or the different amounts of force applied to an object to remove flakes or chips (Andrefsky 1998: 11). In quartz assemblages it is very difficult and sometimes nearly impossible to detect hard versus soft hammer hits because quartz shatters so regularly despite application load (Boudreau 1981: 16).

Pressure flaking is another application load that can be used. It is usually associated with bifacial flaking and is the removal of a flake or chip from an object (core) without striking. This is usually done with antler tines and is more accurate than percussion flaking

(Andrefsky 1998:11). While this technique is usually associated with percussion flaking, it can also be done in conjunction with bipolar reduction, as a finishing stage of production.

Bipolar reduction is done by placing the desired object (core) on an anvil and smashing it with hammerstone (Andrefsky 1998: 27). This process creates flakes that are much different in appearance than percussion or bifacial flaking, (which will be discussed next in context with debitage). There are a few hypotheses behind the use of bipolar reduction techniques and it is not quite clear which one is correct. The first theory is that bipolar reduction sequences are used on only low quality materials. However, evidence of bipolar cores or wedges made out of high quality cherts is found in the archaeological record (Perry 1986). A second hypothesis is that a bipolar reduction technique is an adaptation to limited lithic resources, specifically to small cores or cobbles. In northern Wisconsin this is most likely the case because most quartz cobbles retrieved from glacial till deposits are not very large and would be difficult to reduce by percussion flaking.

Tools

There are two main categories for chipped stone lithic tools: formal and informal. Formal or curated tools are tools that were made for long-term use and include such artifacts as: projectile points, knives, scrapers, (end and side) drills, wedges and bifaces. Informal tools, also referred to as expedient tools, are usually used only once for a specific project and include retouched and utilized flakes. These flake tools usually exhibit some retouching, indicating that they have been sharpened for use and pitting or striations, indicating that they had indeed been used for some task (Andrefsky 1998). Some authors choose to leave out this category and simply classify modified flakes as ordinary flakes. While these cannot be classified as formal or curated tools, they are not exactly ordinary flakes because they have been further used or modified. These are important artifact classes and need to be differentiated between when analyzing a lithic assemblage.

Debitage

The debitage, or the waste of core reduction can be difficult to recognize but can provide valuable information about an assemblage. The typology of debitage is usually based on morphology, which allows archaeologists to group debitage into categories to be studied. Very often, general categories used are cores, flakes and chunks/shatter (Andrefsky 1998). Cores are objects from which flakes are removed to either make curated or expedient tools. Flakes are detached pieces of waste from a core that contain certain characteristics such as a platform and bulb of percussion (Andrefsky 1998). These are very specific landmarks on flakes and represent where the flake was struck to remove it (platform) and the direction of force (bulb).

A common system of categorizing flakes is the triple cortex model. Cortex is the outer layer of the rock, which has a different color and texture than the rest of the material, due to chemical or mechanical weathering by exposure to heat and moisture, causing the composition of the rock to change (Andrefsky 1998: 101). The triple cortex model pertains to the amount of cortex left on flakes after they have been removed. Firstly, primary flakes are the initial flakes removed from a core, so their entire dorsal (outer) surface is covered in cortex. Secondary flakes, the second category, exhibit some cortex on the dorsal surface, but is not completely covered, while tertiary flakes, the third category, contain no cortex on the dorsal surface. This model is easily applied to non-quartz assemblages because they very often are made up predominately of flakes. Applying this model to a quartz assemblage may not be as productive as with non-quartz assemblages due to the lack of flakes in a quartz assemblage. However, it is still important to note the cortex present on artifacts in debitage categories, even shatter.

Flakes can also be characterized by their morphology. For example, common flake type categories include bifacial thinning or reduction flakes and bipolar flakes, just to name a couple (Andrefsky 1998). Bifacial thinning or reduction flakes are usually the result of the thinning or reduction of a biface and exhibit flake scars or cortex on their dorsal (outer) surface. If cortex is present, this indicates that the flake is among the first removed from the core, while flakes containing flake scars on their dorsal surface were removed later. Very often the size of the platform and bulb of percussion are studied to determine the stage of reduction. Theoretically, a larger hard hammer is used to remove the first flakes, which are large and contain a wide platforms and thick bulbs of percussion whereas flakes removed later are subsequently smaller and therefore contain narrower platforms and thinner bulbs of percussion. However, the size (length, width and thickness) and weight of these flakes are usually taken into account because they are more reliable characteristics for determining the stage of reduction (Andrefsky 1998: 98). Rather than simply obtaining an artifact count for each type of flake, metric measurements such as size and weight inform the researcher of how many grams or cubic centimeters of material was processed at a site.

Another flake category is bipolar flakes. These flakes are quite unique and are theoretically supposed to have two bulbs of percussion, one from the hammer hit and one from the rebound of force against the anvil (Andrefsky 1998: 27). However, recent experiments with lithic materials and bipolar techniques reveal that this is not always the case and the "bipolar flake" may be just a myth (Jeske & Lurie 1993). If this were indeed the case, it would not always be possible to differentiate between bifacial and bipolar reduction strategies, especially if quartz is the material studied.

Chunks/shatter is a category that very often contains a high number of objects, especially in a quartz assemblage. These pieces do not contain flake characteristics such as a platform and bulb of percussion and are generally flat and blocky. In a non-quartz assemblage, these pieces are usually generated by using a large, heavy hammer and hitting the object very hard, which breaks the platform off of the flake (Andrefsky 1998). While this is also the end result in quartz assemblages it occurs inevitably, despite hammer type or application load.

Quartz Assemblages

Quartz assemblages are unique and are really only comparable to other quartz assemblages. Similar reduction techniques may be used on quartz as on other materials such as flints and cherts, but the end result, and therefore the lithic assemblage, is much different. Typically, in a lithic assemblage dominated by chert, chunks or shatter constitute a mere five to ten percent of a lithic assemblage, while a quartz assemblage will contain up to ninety-five percent (Luedtke 1981: 66). In the past, authors have attempted to create debitage categories in order to make some sense of quartz assemblages.

One example comes from analyzing assemblages from sites in the Apostle Island National Lakeshore in northern Wisconsin on Lake Superior. In this case, Salzer and Overstreet created twelve different flake categories and four other artifact categories in order to interpret their data. These categories were formed on the basis of flake morphology and flake shape, platform morphology and shape, as well as the presence or absence of cortex and retouch. The problem with this approach, however, is that it does not take shatter into account. As was stated earlier, quartz rarely flakes and almost always shatters and to not account for this in an assemblage dominated by quartz is a large oversight.

In 1981, Salzer and Birmingham addressed the issue analyzing a lithic assemblage predominantly made up of quartz when they interpreted data recovered from salvage excavations at the Marina site on Madeline Island within the Apostle Island National Lakeshore. This time, eight tool and six debitage categories were created and the issue of shatter was addressed. These categories were based on flake type and the presence or absence of cortex. A full category was devoted to shatter and classified it as a category "to accommodate a diverse collection of irregular and amorphous items" (Salzer & Birmingham 1981: 258). This category was considered a catchall, but was indeed necessary because the 337 artifacts in the category made up nearly forty percent of the entire site assemblage and could not be classified in any other way. Another important note is that of the 428 waste flakes, 402 (94%) were quartz.

Callanan used a very basic system to analyze a quartz lithic assemblage. He focused on the characteristics of artifacts pertaining to the stage of reduction, such as the triple cortex model, cores and the presence or absence of retouch as well as the weight, length, width and thickness of the debitage (Callanan 1981: 81). This is a very simple method of analysis, but produces large amounts of data to be interpreted. As mentioned earlier, the physical dimensions and properties of debitage can give a good indication for the stage of production the artifacts are from.

Barber conducted another attempt in quartz debitage analysis in 1981 when he had to interpret artifacts recovered from the Sassafras site. He used five categories to successfully classify all the debitage in the assemblage, which include: flat flakes, block flakes, bifacial thinning flakes, pressure/shatter flakes and other/unclassifiable (Barber 1981b). These categories are based on size, shape and the presence or absence of classic flake morphology, such as a platform and bulb of percussion. This approach appears to be the best that has been formulated to date and was the basis of my analysis in the fall of 2003. Flake size, shape and the presence or absence of cortex may seem like a very general way to view a lithic assemblage, but can in fact reveal information about the stage of reduction taking place.

Quartz assemblages are very different from lithic assemblages containing flint and chert. The debitage rendered from quartz assemblages is much different in morphology and cannot easily be compared to other assemblages. It is also difficult to analyze such an assemblage with the same categories, standards and characteristics as chert assemblages. This calls for the analysis of lithic assemblages to be done on the basis of the raw material present in the assemblage, rather than across a spectrum of materials (Luedtke 1981: 66).

Misconceptions

Archaeologists have shied away from quartz assemblages for years due to a few misconceptions. One reason quartz assemblages are rarely analyzed is that they contain a large amount of debitage rather than formal tools, which makes them difficult to study. Typically, when quartz cobbles are reduced, whether a bipolar or a bifacial technique is used, large amounts of waste are produced, most of that being shattered (Gramly 1981: 85). Assemblages recovered from numerous sites, much like the Rodney Clark site, exhibit this characteristic of quartz nicely. Sites such as these produce very few completed or even broken tools and loads of debitage, which make up a majority of the total assemblage (Salzer & Overstreet 1976). However, the fact that bifacial tools are recovered, such as projectile points, indicates that bifacial flaking was taking place at some point, although a bipolar technique may have been used in the initial reduction sequence. The extremely high ratio of debitage to completed tools found at sites lead archaeologists to believe that a large amount of raw material is needed to produce just a few tools. This is a reasonable statement considering the size of raw material specimens present in the environment. Most quartz found in northern Wisconsin is derived from glacial till and only occur as small cobbles, which makes obtaining a blank a difficult task.

Experimental archaeology has also revealed that quartz shatters upon impact regardless of application load or technique utilized. Due to the cleavage planes and flaws that quartz contains, when a cobble is hit, it will not produce flakes, but rather flat or angular chunks called shatter (Boudreau 1981: 18). This is the basis of the first misconception; that quartz debitage (specifically flakes) are difficult to recognize and therefore analyze. While the number of flakes found in a quartz assemblage is usually quite low, when they occur, these pieces can provide very helpful information about the assemblage and the site. For example, if core reduction flakes (thick flakes that contain cortex) were found at a site, it would suggest that an early stage of reduction took place because the cortex on these flakes indicates that they are the result of the initial stage of reduction called cobble smashing. If biface thinning flakes (large, thick flakes taken off of a biface to thin it in order to make a preform) were found at a site, it would indicate an intermediate stage of reduction took place (Andrefsky 1998). Lastly, if edge rejuvenation or retouching flakes, (flakes that result from sharpening or retouching an already finished formal tool) were at a site, it would indicate a late stage of reduction. These flakes are very small and result from finishing and reworking or sharpening a tool, but can also be the result of burination (Andrefsky 1998: 155).

Each of these flake types (these are only a few examples) represents a stage of production in a lithic reduction sequence (Boudreau 1981: 16). If a site were to exhibit only one type, such as edge rejuvenation or retouching flakes, it would signify that the site was probably not near the source of the material and that the initial core and biface reduction took place elsewhere. Typically, the initial stages of lithic reduction are usually completed near the raw material source. This makes sense because it is much easier and lighter to carry a preform or finished tool than a large, bulky core. This situation also shows that tools were being resharpened and reused in order to prolong the use-life of tools. On the other hand, if a site were to contain all types of flakes, including the large core reduction flakes that contain cortex, this would suggest that the site was probably near the lithic source and the initial stage of reduction was done at that site.

Another problem relating to quartz debitage is detecting use-wear patterns. Typically, when expedient tools (flake tools) are used they develop wear patterns such as pitting and striations. However, quartz is a very resistant mineral, so flakes and tools usually do not develop polish, smoothing or striations when used (Barber 1981a: 3). This makes identifying expedient tools such as utilized or retouched flakes very difficult, but as of yet, there is no good way to remedy this. The second misconception about quartz is that it is difficult to process and impossible to make tools out of. While this is true to a degree, it is still possible to make curated tools if adjustments in reduction techniques are made. Quartz is a unique material among those selected for by prehistoric people. It does not flake like other cryptocrystalline materials such as cherts, chalcedony, jasper and flints due to the different chemical makeup quartz. While cryptocrystalline materials are more elastic and bend or ripple (forming a bulb of percussion), quartz breaks because it is brittle. These breaks usually occur along cleavage planes present in the mineral, which takes on the form a hexagonal prism (Boudreau 1981: 22). These characteristics do indeed make knapping very difficult, but not impossible. This is evident by the artifacts found in archaeological assemblages such as projectile points, knives, scrapers and bifaces (Gramly 1981).

A third misconception held is that the same reduction sequences can be applied to quartz and other materials such as chert and flint. While the same techniques can be used, there is a difference in the amount of each type of reduction used. Experiments in knapping have shown that in order to replicate quartz artifacts percussion flaking is mainly used, with only a little pressure flaking (Boudreau 1981: 5). This requires the knapper to obtain a suitable blank or preform and use minute pressure flaking to finish the tool. It is often difficult to discern whether a bipolar or bifacial technique was used to obtain the blank, due to the characteristics, or lack thereof in quartz debitage assemblages. There is a general lack of flakes in a quartz lithic assemblage and it is not possible to know if this is because a bipolar technique was used, (where bulbs are rarely produced) or if the bulbs have broken off of the debitage pieces due to the nature of the material. Despite the difference in initial reduction, there is little processing of the artifact afterwards. According to Boudreau, the most effective way to produce a quartz tool is to use very little pressure flaking or retouch. This is because quartz is a very hard material (compared to cherts and flints) and difficult to pressure flake or retouch successfully and accurately. The most common result in experiments was steeply angled retouch because enough force could not be applied to drive through the mineral in a straight line (Boudreau 1981: 5).

The final misconception is the utilization of quartz in relation to the availability, or lack of, other suitable materials. Quartz is a commonly found material that appears in archaeological assemblages in Asia, Africa, Europe, North America and Australia, and although it is difficult to produce tools out of this material, it is doubtful that it is used as a last resort in so many cases (Rogers 1981: 123). Also, sites that contain quartz as the major component of the assemblage also contain small amounts of debitage and tools made out of other raw materials like cherts, which are usually considered "more suitable" for knapping.

Research Goals

In order to properly analyze and properly understand the data represented in quartz assemblages, a new or a modified research design must be created and implemented. As previously mentioned, quartz is a crystalline material that has distinctive properties not contained in other cryptocrystalline materials and as a result forms an idiosyncratic assemblage. This assemblage contains a very low amount of finished, unbroken, curated tools and flakes, as well as a high amount of shatter, and broken or unfinished tools. This type of assemblage is very different from those of non-quartz materials, which contain finished tools, numerous flakes, (that the triple cortex model is applied to) and very few pieces of shatter. Although it is believed that shatter is a non-diagnostic property of lithics and cannot provide information about a lithic assemblage, this may not be true. The pattern arising in quartz assemblages suggests that a high amount of shatter is a diagnostic trait of these assemblages. Although it has been postulated that an assemblage dominated by shatter and contain few flakes is the result of a bipolar reduction strategy, it is most likely a combination of the two.

Due to these factors, quartz assemblages should be studied differently than other lithic assemblages. I believe the first step is to reexamine the methods of debitage analysis in order to draw worthwhile conclusions from these unique assemblages. First, more experimental projects need to be conducted using quartz. Numerous studies have examined bifacial and bipolar reduction techniques, but very few have incorporated quartz into their experiments. These results then need to be scrutinized and compared to preexisting assemblages in the archaeological record. Once controlled experiments have been completed, the scope and direction of analysis can be determined and finally carried out.

Conclusion

Quartz plays a major role in lithic assemblages found in northern Wisconsin and must be further studied to understand the role in plays in the archaeological record. It is a common mineral that occurs in glacial till and can easily be found along nearly any riverbank or lakeshore in northern Wisconsin and Minnesota. Very little research and analysis has been done on quartz to date, so it remains an elusive topic within archaeology, but cannot remain that way. Numerous site reports and site summaries contain tallies and charts of quartz tools and debris found in the great lakes area and are simply waiting to be studied. Investigating the results of work done in the past twenty years in northern Wisconsin can help us to further understand prehistoric activities that took place in the area. Exploration of quartz assemblages can help to determine site activities as well as the stage of manufacture that took place. Studying the very low quantities of non-quartz materials in the assemblage may also signify movement patterns of people to different lithic sources or possibly exchange patterns.

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