RECONSTRUCTING LATE ARCHAIC TECHNOLOGY:
AN EXPERIMENTAL STUDY OF FLAKED STONE IN THE UPPER PENINSULA OF MICHIGAN

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Trout Point 1 on Grand Island, Michigan has been excavated and analyzed without an adequate explanation of the prehistoric activities at the site. A CONFUSING artifact assemblage of almost entirely lithic material and fire-cracked rock was recovered from this cliff-top site. The final excavation report of Trout Point 1 states that the flaked stone, found in association with fire-cracked rock in the block excavation of the site, showed little if any signs of exposure to fire. The conclusion drawn after the excavation was that the artifact deposit at the site represented a midden where fire-cracked rock was dumped as well as a possible flaking station for stone tools (Benchley et al. 1988). This paper deals with the hypothesis that quartzite cobbles were being heat treated at the Trout Point 1 site on Grand Island, Michigan as a primary stage in stone tool manufacture. The data produced by this study resulted from heating and flintknapping experiments carried out on quartzite material from the same source as the Trout Point 1 lithic assemblage. Experiment results, coupled with archaeological literature used for comparative analysis, demonstrate that Trout Point 1 was a heat-treatment and lithic manufacturing station during the Late Archaic period in the Upper Peninsula of Michigan.

INTRODUCTION

The upper Great Lakes region, specifically Michigan, has been home to human inhabitants for roughly the past 11,000-12,000 years (Shott and Wright 1999:61). Between the estimated dates of 10,000 BC and 8,000 BC glaciers had retreated enough to allow hunter-gatherers, referred to as Paleo-Indians, to live in Michigan along the shorelines of glacial lakes. Between 8,000 and 7,800 BC glaciers had readvanced (Larsen 1999) and water levels in the lake basins began to rise and force them out of their homeland (Fitting 1970:63). Following the Paleo-Indian period, from roughly 8,000 B.C. to 1,000 B.C., Archaic hunter-gatherers occupied Michigan, reaching the height of their occupation between 3,000 BC and 1,000 BC, a period termed the Late Archaic (Fitting 1970:68). Occupations in this time period were widespread, stretching to cover the Lower and Upper Peninsulas of Michigan. This research deals primarily with the Upper Peninsula, particularly focusing on the Trout Point 1 site on Grand Island.

Following an excavation of the site in 1986 by the University of Wisconsin-Milwaukee (UWM) and the Hiawatha National Forest, many questions as to the prehistoric activities at Trout Point 1 remained unanswered. The archaeological record at the site is minimal, including mainly quartzite lithic debitage and a dense deposit of fire-cracked rocks (FCR), referred to as a “pavement” in Franzen’s original report on the site (1981), allowing for minimal conclusions to be drawn as to the nature of the site. Dating techniques employed by the excavation crew yielded a date of roughly 315 BC, which is still considered the Late Terminal Archaic period in this area.

It is my hypothesis that the aboriginal inhabitants of Grand Island were heat-treating quartzite cobbles as a
primary stage in stone tool manufacture. Experimental, as well as archaeological, data will be used to test the validity of this hypothesis in an effort to clearly understand the Late Terminal Archaic activities which took place at Trout Point 1.

GEOGRAPHICAL SETTING

Trout Point 1 is located on Grand Island along the south shore of Lake Superior. The nearest town on the mainland is Munising, in Alger County. The Munising area, being part of the Canadian Biotic Province, has a continental climate rendering cool summertime weather and cold winters that produce considerable amounts of precipitation in the form of snow.

A northern conifer-hardwood forest dominates the landscape, containing maple, beech, yellow birch, hemlock, white pine, balsam fir and spruce trees.

This type of environment supports, both currently and prehistorically, a wide range of animal species, which the occupants of Trout Point 1 in the Late Terminal Archaic period would have been able to exploit as food resources. Mammals prominent in the area are beaver, deer, moose, and black bear, while Lake Superior’s plentiful supply of sturgeon, whitefish and lake trout provide a wealth of food resources (Benchley et al. 1988:3).

The physical setting of Grand Island is unique in that it is actually two separate masses of land that are connected by a tombolo (a low lying sandy spit), which gives it the overall appearance of a large island on the west with a thumb-like projection extending to the east.

The western portion of the island, which contains the majority of the land mass, is roughly seven miles in length from the south tip to the north tip. As well as being larger, the western portion of the island also reaches a higher elevation than the eastern thumb (Benchley et al. 1988:3). It is on this eastern thumb, however, that the Trout Point 1 site can be found.

The site is located on a cliff with a northwestern exposure to Lake Superior. Considerable wave action, 20 meters below the site, has resulted in the erosion of an undetermined area of Trout Point 1 into Lake Superior (Benchley et al. 1988:5) and may render complete understanding of the nature of Trout Point 1 impossible.

To reach the site by land, a forest of beech trees to the south of the site and hemlock trees on and near the site, containing birch and white pine trees, must be crossed (Benchley et al. 1988:5). As the cliff along the edge of the site levels out to the southwest an outcropping of the Munising geological formation has deposited quartzite cobbles in Lake Superior along the shore, creating a cobble beach. These quartzite cobbles are the logical and likely source of the lithic material used in creating the stone tool assemblage at Trout Point 1 in the Late Terminal Archaic period (Benchley et al. 1988:7). Based on the fact that the waters surrounding the site were visited multiple times by a commercial fishing boat during the excavation of Trout Point 1, Benchley et al. have concluded that this area of Lake Superior is a prime fishing spot and likely has been since Archaic times (1988:7).

This conclusion is supported by the name of the site and the adjacent bay both beginning with the word “Trout”, attesting to the abundance of aquatic resources in the area.

EXCAVATION METHODS

To proceed with this current research of Trout Point 1, the original excavation from 1986 must be fully understood. The project was a joint venture between the USDA Forest Service, specifically in the Hiawatha National
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Forest, and the University of Wisconsin-Milwaukee Archaeological Research Laboratory. In 1986, Phase One of the fieldwork was conducted from late in July to late August and involved a crew of six individuals plus volunteers.

Phase Two of fieldwork took place over a span of ten days in mid-September, 1986 and was carried out by a crew of sizes varying from four to nine people.

In both cases the excavation was directed by Dr. Benchley from UWM, a Conservation Archaeologist by profession and the primary author of the final site report from the Trout Point 1 excavations. One member of the crew had a dual function during the project; Derrick Marcucci served as a worker and as a lithic analyst (Benchley et al. 1988). His main objective was to successfully replicate the artifact assemblage of Trout Point 1 using traditional methods and indigenous materials.

Marcucci subsequently authored a chapter on lithics and experimental knapping in the final site report (Marcucci 1988).

The methodological approach to analyzing Trout Point 1 was as follows. John Franzen, the Forest Service Archaeologist for the Hiawatha National Forest, first discovered and tested the site in 1981. He ascertained, from numerous small test pits and two test units, that the site was roughly 600 square meters and contained a “dense ‘pavement’ of fire cracked rocks and flakes” (Franzen 1981) made of almost entirely quartzite at the north end of the site.

No diagnostic tools were recovered from Franzen’s initial testing, however he did believe that some of the flakes of quartzite found were utilized and showed signs of wear (Franzen 1981). The University of Wisconsin-Milwaukee, under contract with the Hiawatha National Forest, led the remainder of the fieldwork conducted at the site.

The crew from UWM proposed the employment of several different investigative methods during their field season: dating landforms associated with the site to establish a date for Trout Point 1, a controlled surface collection, testing the soil matrix by flotation analysis, mapping of the site, test excavations and block excavations to establish the situation of any artifacts recovered. All of the data recovered from these activities, along with Marcucci’s replicative lithic studies (1988), were combined to present a picture of the prehistoric activities at Trout Point 1, based on the comparison of results with other sites in the Lake Superior Basin (Benchley et al. 1988:15-17).

Several additional field studies were conducted to add to the data collected. These studies included the use of a metal detector on the site in attempts to find copper artifacts, as well as the experimental firing of quartzite cobbles from the outcropping to the southwest of the site (Benchley et al. 1988:23).

Artifacts recovered from the site were all in the lithic category, either being debitage, flakes, fire-cracked rock (FCR) or unmodified cobbles of quartzite. Several samples of FCR were removed from the site. The UWM team came to the conclusion, based on the layout of the artifacts at the site, that the deposit of FCR and flakes was the reflection of multiple dumping episodes, in a “midden” (Benchley et al. 1988), at the site as opposed to a single event.

The assemblage was compared to other known sites in the region with the conclusion finally being drawn that Trout Point 1’s lithic assemblage was unlike any other known sites in the region (Benchley et al. 1988:23). Marcucci (1988) represented, in his chapter on the experimental flint-knapping of quartzite on Grand Island, that the purpose of the stone tool manufacturing technology at the site was to produce flakes, not bifaces or other tools.

Flakes of quartzite make very sharp and effective instant, expedient tools when they are chipped from a cobbles.

Tests to establish a date for Trout Point 1 were carried out by the University of Missouri Thermoluminescence Laboratory.

Three separate samples of fire-cracked rock and soil matrix were submitted for analysis, although they were not originally collected for thermoluminescence (TL) testing. The results from the three samples were averaged to establish a more reliable date for the site, since it was a possibility that the TL samples were...
contaminated as a result of improper collection procedures during excavation (Benchley et al. 1988:26). The averaged date of the samples was roughly 315 B.C., leaving it still within the realm of the Late Archaic period in the upper Great Lakes region.

**LATE ARCHAIC HUNTER-GATHERERS**

North America’s Archaic period of prehistory can be characterized as the stage in which hunter-gatherers, living in small mobile groups, diversified their technological and subsistence methods beyond that of their predecessors, the Paleo-Indians, became “‘localized’ and seem to ‘settle in’ to their respective environmental niches” (Emerson and McElrath 1983:219).

There are many different adaptations to the Archaic way of life throughout North America resulting from the diversity of environmental areas that were occupied during this time period. Each group of Archaic hunter-gatherers adapted to the area in which they resided in an attempt to optimize their exploitation of the resources around them.

This study deals specifically with the eastern Woodlands and Great Lakes areas of the United States, focusing intensively on the Upper Peninsula of Michigan.

Emerson and McElrath state that “The trend within the Archaic of the eastern Woodlands is toward increasing cultural complexity within the hunting and gathering milieu. These trends climax in the Late Archaic with the achievement of primary forest efficiency, shellfish exploitation, and nut (especially acorn) collection and processing” (1983).

Dunham and Branstner (1995) state that a low density of Archaic sites in the Upper Peninsula makes drawing conclusions on the subsistence and settlement patterns of Michigan difficult. Models of subsistence posed for this region tend to be less descriptive and detailed than those posed about the Lower Peninsula of Michigan, specifically the Saginaw Valley area.

For these reasons, it is logical to compare the subsistence, settlement, and technological adaptations of Archaic sites found in both the Lower and Upper Peninsulas to the Trout Point 1 site to develop a clearer picture of the Late Archaic way of life in the upper Great Lakes region. Based on a review of the literature concerning Archaic sites in Michigan, it appears that the description of subsistence activities proposed above about the eastern Woodlands, by Emerson and McElrath (1983), can be applied to the Great Lakes region as well.

Archaic hunter-gatherers were people that moved into new, unpopulated areas and began to adapt to a new way of life (Fitting 1970:69).

Variety in site location and environment is a trademark of the Late Archaic in Michigan. Sites are found in numerous ecological areas, from inland sites to lakeshore sites, reflecting a strategy based around the exploitation of as many animal and plant species as possible (Robertson et al. 1999:95). Since diversity is described as a key to the Archaic way of life in North America, it is not unreasonable to compare the sites of this time period from the Lower Peninsula to the Trout Point 1 site. The environmental areas of the Saginaw Valley in lower Michigan and Trout Point 1 are not exactly the same; Trout Point 1 is located on an island and is exposed almost solely to Lake Superior, whereas the Saginaw Valley sites are situated inland near a bay.

However, similarities are quite evident in that both areas consist of a comparable forest habitat and, in the Late Archaic period, both areas were localized around a major body of water. Rising water levels during the post-glacial Nippissing transgression resulted in the formation of a large inland lake fed by numerous tributaries, in the Saginaw Valley, referred to as Shiawasee Bay. It was around this bay that numerous Late Archaic sites were established and utilized by hunter-gatherers (Fitting 1970).

**SEASONAL SITE OCCUPATION:**
LOWER PENINSULA

Excavations in the Saginaw Valley have allowed researchers to formulate plausible foraging-subsistence models for many sites along or near Shiawassee Bay. Sites such as Weber I, 20BY79, Feeheley, Butterfield and Screaming Loon have yielded data that points towards a Late Archaic settlement and subsistence pattern in which hunter-gatherers established base camps where multiple subsistence activities took place, as well as satellite camps for specific activities (Robertson et al. 1999).

Satellite camps often are associated with one specific activity, such as “anticipatory retooling”, as is the case with the 20BY79 site. The archaeological record at this site consists of huge amounts of debitage, complete and fragmentary bifaces, knives and points, along with minimal amounts of subsistence remains. The geographical location of the site is between the Shiawassee Bay area and a local outcropping of chert to the north. It appears that the hunter-gatherers who used the site were replenishing their tool supply in preparation for the late fall and winter months of intensive hunting.

Preforms, as well as projectile points and knives, were produced from chert quarried and brought to the site from the outcropping to the north (Robertson et al. 1999:107). The strategic positioning of 20BY79, between a base camp and a raw material source, reflects a Late Archaic tendency towards efficiency in exploiting local environmental niches.

Seasonality in site utilization appears to be a key trend in the upper Great Lakes region during the Late Archaic period, specifically in Michigan. While the 20BY79 site was utilized primarily in the fall, other sites in the Lower Peninsula were being utilized solely during the late summer/early fall and late winter/early spring seasons. Faunal and botanical remains from the Feeheley site indicate a late summer/fall occupation geared towards hide production. Bifaces, scraping tools and a variety of pit features attest to the hide processing activities at the site (Robertson et al. 1999:107).

The remains from the Butterfield site actually indicate the season of use by what is not present. No turtles, birds, nuts, or shells were recovered from the site, indicating cold weather occupation. There was also a high density of fire-cracked rock and hearths present at the site, possibly used as a heating source. The artifact assemblage consisted of points, knives and a predominant amount of mammal bone, all of which indicates an activity pattern centered around hunting and butchering. The Butterfield site is subsequently referred to as having a late winter/early spring occupation period (Robertson et al. 1999:108).

The Weber I site is another example of a seasonally utilized site type, having been occupied during the late spring/early summer. The conclusion drawn as to the season of use was based on the artifact assemblage recovered in excavation. There was a considerably low frequency of debitage and tools, indicating minimal production activities. Scarce faunal remains coupled with large quantities of floral remains represent a short term residential area with limited activities focusing on collecting and processing plant foods, especially nuts (Robertson et al. 1999:107).

The Screaming Loon site, located in the northern Lower Peninsula, is slightly older than other sites located in the Saginaw Valley. Despite the age difference, the tendency towards specialized, seasonally occupied sites is reflected in the artifact assemblage of Screaming Loon. Faunal and lithic tool remains indicate a warm season occupation focused on butchering and hide processing (Robertson et al. 1999:108).
The recurring theme within these sites appears to be a Late Archaic tendency towards seasonal preparation and exploitation of specific resources in anticipation of upcoming seasonal conditions. This is reflected in the fall use of the 20BY79 site for anticipatory retooling activities. Cold weather and snowfall would have made production of stone tools a difficult activity in the winter months, therefore Late Archaic hunter-gatherers utilized 20BY79 in the fall to replenish their hunting tool kits. As winter was nearing an end, the Butterfield site was utilized by Late Archaic people. High densities of fire-cracked rock and hearths indicate possible prehistoric heating activities to counteract cold weather, while lithic and faunal remains point towards a predominance of hunting and butchering activities (Robertson et al. 1999).

**UPPER PENINSULA**

Though the Late Archaic archaeological record in the Upper Peninsula is minimal, hunter-gatherers in this area appear to have utilized numerous ecological niches. Shoreline sites such as Trout Point 1 and Popper, on Grand Island, attest to a Late Archaic emphasis on coastal resources. Interior Upper Peninsula sites, specifically the 20MQ90 and 20MQ91 sites, demonstrate occupation apart from coastal environments as well, during both warm and cold weather seasons. A reliance on quartzite, quartz and chert is shown through its repeated occurrence in the assemblages of these Upper Peninsula sites (Robertson et al. 1999).

Dunham and Anderton (1999) state that the Popper site on Grand Island is the most notable Late Archaic site in the Upper Peninsula of Michigan. This statement is based on the site’s location, on a datable Nippissing landform, and a hearth feature successfully dated to 4100 +/- 50 B.P. (~2100 B.C.). The archaeological record at Popper consists of primarily a generalized quartzite lithic assemblage, in the form of flakes, cores and expedient tools (Dunham and Anderton 1999).

The lithic assemblage at this site appears to be similar to that of Trout Point 1, which is also characterized by flakes, cores and expedient tools.

Four features were discovered at Popper as well, three of which were in a cluster. The presumption about the Popper site is that it is a strategically located fishing camp. Inhabitants would have been able to exploit resources associated with the Nippissing era embayment (Dunham and Anderton 1999).

**TROUT POINT 1**

Trout Point 1 is potentially “one of the earliest examples of exploitation of fall-spawning fish in the upper Great Lakes” (Robertson et al. 1999:109), based on small quantities of fish bone recovered in excavation. Benchley et al. (1988) suggest that the likelihood of Trout Point 1 serving as a fishing camp is small, due to the site’s location, 20 m above the water on a cliff, and the lack of fishing artifacts. Nonetheless, fall spawning fish bones were recovered from the site, indicating a fall occupation. Artifacts, aside from fish remains, consisted of almost entirely quartzite fire-cracked rock and quartzite lithic material. Based on the abundant lithic material source near Trout Point 1 and the artifactual remains, it appears possible that the site served as a specialized seasonal station for anticipatory retooling, similar to the 20BY79 site in the Lower Peninsula.

The lithic assemblages of these two sites are not comparable, but the situation in which they were used seems to be similar. Both sites are proposed knapping stations near an abundant source of flakeable stones, utilized in the fall, containing minimal subsistence remains in conjunction with large quantities of lithic debris. As the outcropping of the Munising geological formation near Trout Point 1 is the best source for lithic material in the area of Grand Island, it is possible that local inhabitants during the Late Archaic period used the site to replenish their casual quartzite flake toolkits before the cold winter months. According to Kooyman (2000),
“Quartzite is the most important metamorphic rock for flaked stone tools. Quartzite is sandstone altered such that when it is broken, the fracture does not break around the grains (as sandstone does), but rather the fracture passes through the grains”. Quartzite is both sharp and durable when flaked, yet the material is not easily knapped into formal tool types, such as projectile points. Benchley et al. (1988) suggest that “Whatever goods were being processed with casual flake tools and heated rocks may have been brought to the rock sources at the site”. There is little evidence to suggest what activities may have taken place at Trout Point 1, however, Marcucci (1988) suggests several ideas on the lithic manufacturing techniques employed by Late Archaic inhabitants of the site. Based on his own flintknapping experimentation, referred to as replicative systems analysis (RSA), Marcucci (1988) recreated a hand-held, hard hammer percussion reduction system that parallels the site’s assemblage and suggests that the production of flakes was the intent of the Trout Point 1 lithic technology. Although the RSA of Trout Point 1 has yielded two possible methods of reducing quartzite cobbles, referred to as System 1 and System 1A, it is not to be assumed that these were the actual or only way that quartzite could have been worked at the site. Marcucci has produced a viable means of creating flakes and cores similar to those found in excavation, but based on my own experimentation, there appears to be another possibility as to the quartzite reduction methods at the site that is consistent with the artifactual remains. In attempting to present an alternative to the established view of the lithic technology of Trout Point 1, this study has followed, as closely as possible, Marcucci’s scenario as to how quartzite was reduced to usable flake tools, from collection of the material to the actual flintknapping. This study, however, continues beyond Marcucci’s by presenting an alternative to the labor-intensive hard hammer percussion suggested by the Trout Point 1 RSA. Heat-treatment in conjunction with hard hammer percussion, as opposed to the sole use of forceful percussion, appears to be a logical, effective, and plausible way that Late Archaic inhabitants of the site produced sharp flakes of quartzite to use as tools and prepared cores for flintknapping.

Fist sized cobbles of quartzite were the preferred stone type used in lithic reduction, while quartz and chert made up significantly smaller portions of the lithic assemblage. Therefore, it is solely quartzite that both this study and Marcucci’s study retain as a focus. Marcucci attempts to recreate the entire process of stone tool reduction at Trout Point 1, starting with the actual collection and initial quality assessment of the raw material. Marcucci states that:

The aboriginal knapper was constrained by the morphological and physical properties of the stones. The sphericity of the raw material required a degree of knapping to produce usable sharp edges (flakes). In addition, the weathered rind on the cobbles presented two problems. First, it obscured the appearance of the quartzite and required the knapper to flake or break the cobble open to determine the quality or “flakeability” of the material [1988:72].

This statement offers an explanation of the activities at Trout Point 1 in regards to quartzite quality testing and modification, but overlooks important information stated in the site report. The 1986 excavation of the site yielded almost 15,000 pieces (roughly 660 pounds) of quartzite fire-cracked rock (FCR) (Benchley et al. 1988), yet Marcucci does not offer heat-treatment as a possible means of determining the quality of quartzite cobbles. Several experiments carried out for the purposes of this study have indicated that heating quartzite cobbles is a suitable and effective means of fracturing the material to observe its quality. Aside from fracturing a cobble for quality assessment, it was observed during experimentation that usable flakes were actually produced as a result of heating. To fully grasp the importance of this discovery, a detailed description of my experiments along with the commentary of my expert source on flintknapping, Neil Dellinger, are required. Dellinger is used as an
expert source on the subject of stone tool manufacture due to his extensive experience in knapping a variety of lithic materials, as well as his personal experience in teaching informal sessions on flintknapping for Illinois State University students.

**EXPERIMENTAL STUDIES**

**HEAT-TREATMENT**

The experimental portion of this study began on Grand Island, in the summer of 2001, with the collection of roughly twenty-five quartzite cobbles of various colors, sizes and shapes from the beach beneath the outcropping of the Munising geological formation near Trout Point 1. At least two to three pieces of each noticeable different color type of quartzite were collected in an attempt to represent the entire range of possible material types used in the Trout Point 1 assemblage. After the collection of the raw material was complete, the next step was to experiment with the effects of fire on the cobbles themselves. The intention was to observe whether or not the fire would adequately fracture a cobble to check its quality, or knappability, and to observe any other changes that took place as a result of heat-treatment. A cobble of whitish gray quartzite, now labeled and referred to as Fired Quartzite 2 (FQ2), was selected to be placed in a campfire built for the experiment.

The cobble was placed at the bottom of the fire-pit and covered with fuel (wood and kindling) to insure that even after the fire died it would be covered by the hot coals. As coals are the hottest portion of a campfire, it seemed logical that they would be the most effective in fracturing the cobble with heat. I subsequently learned, during my flintknapping research, that covering a cobble with a bed of coals is actually one of the better ways to heat-treat material in a campfire (Neil Dellinger, personal communication, February 20, 2002).

The fire burned intensely for approximately three hours and then decreased to only hot coals until the next morning. Eleven hours after the fire was ignited, and eight hours after the fire died down, FQ2 was still too hot to handle and had produced a flake-like spawl that I will, from here forward, refer to as a *Heat-Treated Flake* (HTF). I am aware that there may be other definitions for a *Heat-Treated Flake*, but for the purposes of this study I believe that this particular terminology is descriptive and appropriate in describing the flakes that are removed from a cobble during the heating process. Dellinger, the expert source on flintknapping used in this study, also agrees that it appropriate to refer to the specific lithic material which I will mention as *Heat-Treated Flakes*, and not just fire-cracked rock (personal communication, February 20, 2002). In addition to the campfire removing a usable flake from the experimental cobble, the fracture also allowed the interior quality of the material to be assessed for knapping purposes. FQ2 and the *Heat-Treated Flake* (HTF1) were removed from the fire-pit, observed, measured and recorded as *First Firing and Initial Ideas* (see Appendix). HTF1 is a flake that can easily be held in the hand and appeared, upon first inspection, to be of good enough quality (not brittle or crumbly) to be called an instant expedient tool. The shape and edges of HTF1 are such that it could be used as a scraping tool or a tool to shave wood/plant material. The data tables included in this study give a full description of each experiment, so in an effort to avoid redundancy I will mention only the most important aspects of each experiment in my written text and will direct any other specific inquiries to the complete Appendix located at the end of the study.

Two days after the first firing experiment and data recording took place, four more cobbles of quartzite were selected to be placed in a campfire.

The cobbles were all different sizes and colors, but each had a relatively spheroid shape; all were recorded under *Second Firing* (see Appendix).
Again, the cobbles were placed at the base of the fire-pit and subsequently covered with kindling and wood. The fire burned for just under four hours before it was reduced to a bed of hot coals. All four cobbles remained in the fire-pit until they were cool enough to extract with bare hands the next day. Two of the four cobbles fractured in this experiment, yielding several Heat-Treated Flakes. The first of the two fractured cobbles is referred to as Fired Quartzite 1 (FQ1) in all of the records, while the second fractured cobble is referred to as Heat-Treated Core 1 (HTC1).

The difference between the two cobbles is in how they were used for this study, hence the different labels. FQ1 was fired in the experimental heat-treating on Grand Island, but was not used in the subsequent flintknapping experiments conducted in Illinois. Therefore, the three Heat-Treated Flakes produced by FQ1 in the campfire were measured, analyzed and recorded in the Appendix, but the remainder of the fired cobble was not experimented on any further. It is important to note that the three Heat-Treated Flakes from FQ1 were durable enough to be considered capable of being used in a scraping or woodworking activity. HTC1, on the other hand, was both fired in the experiment on Grand Island and also flintknapped as part of another experiment in Illinois, along with the two other unfractured cobbles from the second heat-treating experiment (labeled HTC2 and HTC3). HTC1 will be mentioned again in greater detail when I discuss the flintknapping experiments, but for now it is important to note that the campfire produced five Heat-Treated Flakes without any percussive force being applied.

Of the five quartzite cobbles heat-treated during the campfire experiments, three cobbles fractured to produce a total of nine Heat-Treated Flakes. As this study is an attempt to recreate Late Archaic technology from Trout Point 1, I fulfill the role of the flintknapper in this scenario. By placing just five cobbles of quartzite in a campfire, I have managed to produce nine flakes to be used as tools without exerting any of my own energy through flintknapping. In terms of economy, the heat-treatment of cobbles appears to be a conservative way to reduce the amount of energy required to produce quartzite flaked stone tools. This, however, is only one aspect of heat-treatment that I investigated in this study. In addition to the firing experiments just outlined, I conducted several flintknapping experiments to assess the difference between fired and unfired cobbles of quartzite.

**INFORMAL FLINTKNAPPING SESSION S**

All of the knapping experiments, with the exception of two, took place in Illinois on 02/20/02 with the immeasurable assistance of Neil Dellinger. On two separate occasions I conducted loosely structured knapping experiments of my own, using only limited knowledge of stone tool manufacturing techniques. The initial experimental knapping session included the first fired cobble from this study, FQ2, as a core and another cobble of grayish quartzite as a hammerstone, now referred to as Hammerstone 1 (H1). One flake was removed from FQ2 in the campfire in addition to several other fracture lines appearing on the surface. My intent was to test the effects of knapping on a fired and fractured cobble. It required only three blows with H1 to fracture FQ2 into three pieces, then just two more blows to leave the entire cobble in a total of eight pieces. Four pieces of this cobble are labeled and recorded in the appendix as portions A-D of the remaining core, while the other three pieces removed by percussion are referred to as Hard Hammer Flakes. The designation Hard Hammer Flake is only used in reference to flakes removed by percussion from a Heat-Treated Core, in an effort to minimize confusion about the specific results of the knapping experiments. All flakes that were removed from unfired cobbles are referred to as merely Flakes, since there is no other modification besides knapping to describe in their labels. Overall, it was not difficult to fracture FQ2 by percussion, which is most likely due to the fractures already present when the knapping began. Although they are not excessively sharp, the three Hard Hammer Flakes (HHF1-HHF3) removed from FQ2 are durable and of usable quality.
The second loosely structured knapping episode was carried out on an unfired cobble of quartzite, referred to as Q1. The same hammerstone from the first knapping session, H1, was used in this experiment. Q1 was chosen because of its unique shape, which was spheroid on one end with an abrupt cut off at the other end. It appeared as if this cobble had been broken in the conglomerate before it was released from the outcropping near Trout Point 1.

The flat end of the cobble presented numerous potential platforms for removing flakes, even for a knapper with the minimal amount of experience that I have. I intended to test the amount of force that is required in knapping an unfired cobble to compare to the results from the first knapping session.

After I established a comfortable grip on the material, I was able to remove 11 flakes from Q1. There were considerable amounts of shatter and debitage that was produced as well, likely due to my inexperience as a knapper. The core portion of Q1 remains large and is far from being considered “exhausted”. The 11 flakes are all small, each no larger than 46.34 mm, but are very sharp. Considerable force was required to remove these 11 flakes, but I was not sure if that was due to improper knapping techniques or extremely tough material.

The final decision after this experiment was completed, in the sake of fairness and honesty, was that since there was question as to the meanings of the results, they should only be used as a supplement to the formal flintknapping experiments to be carried out with the assistance of Dellinger.

**FORMAL FLINTKNAPPING SESSIONS**

The remainder of this study focuses on the experimental flintknapping carried out in Illinois with Dellinger. The first step in the experiments was to familiarize Dellinger with the lithic material and the background of the site by pointing out the ideas and assumptions made by Marcucci in the original site report (1988). It seemed that the logical place to start with the experiments was to attempt to recreate the hand-held, hard hammer reduction sequence proposed by Marcucci, referred to as System 1. As I was not sure if my own previous knapping techniques were correct, I enlisted the help of Dellinger to recreate, via descriptions and illustrations in the Trout Point 1 site report, the actual reduction sequence outlined by Marcucci (1988). A cobble of yellow quartzite, now referred to as Cobble 1 (C1), was selected as the first core to be knapped. Once again H1 was used as the hammerstone, since it had proven effective in the previous experiments.

System 1, as proposed by Marcucci (1988), requires that the cobble be tested with a solitary flake being removed from one of the “ends”. According to Marcucci (1988), this primary flake scar acted as a means to observe the quality of the quartzite, while also allowing subsequent flakes to be removed without cortex on their distal ends. Numerous cobbles excavated from Trout Point 1 showed signs of just one flake scar, leading to the conclusion that they were “tested” cobbles not knapped beyond the stage of initial quality assessment. Before the descriptions of the knapping experiments continue, I feel it is important to note that the descriptions of these “tested” cobbles are very similar to the description of FQ2. Only one flake was removed from FQ2 as a result of the firing experiment, and it so happens that this flake was removed from one of the “ends” of the cobble. I already mentioned that this flake allowed me to view the quality of the material, following this scenario of the “tested” cobbles, yet no percussive force was required on my part to do so. It is possible that the “tested” cobbles recovered in the 1986 excavation are in fact heat-treated cobbles which only produced one Heat-Treated Flake when they were fired, as was the case with FQ2. It is not my intention to refute the idea that some traditional knapping activities, including the use of hard hammer percussion, were employed at Trout Point 1, but it would be careless to ignore the abundant evidence that supports heat-treatment as an important stage in quartzite reduction at the site. Large quantities of quartzite FCR (roughly 660 pounds) recovered in excavation attest to the quartzite heating activities at Trout Point 1, yet no correlation has been made with the abundant quartzite lithic debris...
This study is intended to bridge that gap between the FCR and the lithic material at Trout Point 1 by showing, through my own experiments, that heat-treatment is a possible, beneficial and plausible explanation for the artifact assemblage at the site.

Now I will return to the description of the First Formal Knapping Experiment (see Appendix) intended to recreate Marcucci’s System 1. Again, an unfired yellow quartzite cobble (C1) was used as the core, while an unfired grayish quartzite cobble (H1) was used as the hammerstone. Each major step in the reduction of C1 was documented with a digital photograph to better explain the reduction process. The first flake (F1) was removed after three hard hits were applied. The cobble was rotated downward so the flake scar was at the bottom of the cobble, as is described in the RSA description of System 1, then a second flake was attempted using the primary flake scar as the distal end of the new flake. This proved unproductive, so under the suggestion of Dellinger we decided to abandon the exact steps diagramed in the Trout Point 1 site report, and instead use Dellinger’s instincts as an expert flintknapper to guide the remainder of the knapping. Four more flakes were removed from C1 following Dellinger’s judgment, yet each flake still required a large quantity of force to separate it from the core. After Flake 5 (F5) was removed, H1 fractured into three pieces. An unfired purplish quartzite cobble (H2) was selected as the replacement for H1. Two more flakes were removed from C1 before H2 fractured into two pieces. A total of 7 good flakes were removed from C1 by the end of knapping using considerable amounts of force and breaking two hammerstones in the process. Overall, the knapping of this unfired quartzite cobble was difficult but effective.

The Second Formal Knapping Experiment (see Appendix) was also conducted using an unfired quartzite cobble (C2), but this time a chert hammerstone (H3) was the percussion tool. C2 is a purple/gray quartzite cobble with a less rounded exterior than is typical in most cobbles, actually appearing to be somewhat rectangular with rounded corners. H3 is a white nodule of glacial till chert from Illinois. Chert was chosen as a hammerstone for this experiment due to the fact that the Trout Point 1 site report states that a chert hammerstone was recovered in excavation (Benchley et al. 1988). It seemed unlikely to me that chert would be effective in knapping quartzite, yet the results of the experiment prove otherwise. Granted, H3 is not the same exact material as the chert hammerstone from Trout Point 1, but Dellinger felt that it was close enough to provide accurate knapping results. Again, all key stages in the reduction of C2 were photographed with a digital camera to aid in the descriptions of the experiment. The first hit applied to C2 with H3 produced a long narrow flake (F1,C2) using considerably less force than in the first knapping experiment. Dellinger commented that he “hardly had to hit it” to produce such a quality flake (personal communication, February 20, 2002). A total of three flakes were removed from C2 before the experiment finished, but they were all of better quality (sharpness, shape) than those removed from C1 with H1 and H2. According to Dellinger, the chert hammerstone requires less force than the quartzite hammerstones and yields better flakes (personal communication, February 20, 2002). It was not clear if the experiment was directly influenced by the non-spheroid shape of C2, or if H3 was actually a superior hammerstone. Therefore, the Third Formal Knapping Experiment (see Appendix) intended to use H3 on a rounded unfired yellow cobble of quartzite (C3) to see if the results from the second experiment could be duplicated. Minimal percussion was applied before H3 fractured into two pieces. This experiment was abandoned after the chert hammerstone fractured so attention could be placed on the true focus of this study, the knapping of heat-treated quartzite cobbles.

The Fourth Formal Knapping Experiment (see Appendix) is where the hypothesis of this paper truly began to be tested. Heat-Treated Core 1 (HTC1)
was the focus of this knapping session as it was the most visibly affected cobble from the heat-treating experiments. As mentioned earlier, \textit{HTC1} fractured during firing yielding five usable flakes and three sections of the core. It is important to note again that \textit{C1}, from the first experiment, required large amounts of repeated percussive force to produce only seven total flakes, while \textit{HTC1} yielded five flakes of equal quality to those from \textit{C1} without the use of any force, just fire.

Immediately, firing appeared to be a beneficial way of reducing the amount of work required to produce usable flakes of quartzite. The remaining core pieces of \textit{HTC1} were knapped using an unfired yellowish quartzite cobble (\textit{H4}) as the hammerstone.

The goal was to observe whether or not heat-treatment of quartzite is beneficial for flintknapping purposes. In other words, Dellinger and I intended to knap \textit{HTC1} to see if firing made quartzite hard hammer percussion an easier task.

Again, the experiment followed Dellinger’s judgment as a flintknapper to guide the percussion sequence. The first \textit{Hard Hammer Flake} was removed with considerable ease. Dellinger commented that less force was required to produce this flake (\textit{HHF1}) than was required to remove the previous flakes from the unfired cobbles (personal communication, February 20, 2002). Two more \textit{Hard Hammer Flakes} were produced with similar amounts of percussive force to what was required for \textit{HHF1}. Knapping ceased following the removal of \textit{HHF3} due to the decreasing size of the knappable core pieces from \textit{HTC1}. Eight total flakes (HTF1-5 and HHF1-3) were removed from \textit{HTC1} by the end of experimentation, but only three of them (HHF1-3) required actual knapping. A key factor that was considered following the knapping of \textit{HTC1} was whether or not the fired and unfired flakes could be distinguished. Flakes from heat-treated and unfired cobbles were examined by both Dellinger and I in an effort to observe any noticeable signs of heat-treating. Dellinger commented that he could not tell the difference between a fired and unfired flake based on color, texture or friability (personal communication, February 20, 2002). In fact, the only way that either of us could be sure which flakes were which was because we had just knapped them ourselves. There was, however, minimal discoloration on the cortex of three of the heat-treated cores due to direct contact with burning logs in the fire, yet it was later discovered that this discoloration could be removed with water and light rubbing. It appears safe to say that if light rinsing with tap water could remove any signs of firing from the flakes, 2,000 years of exposure to the elements on an exposed point overlooking Lake Superior would have affected the lithic remains at Trout Point 1 in \textit{at least} the same fashion. Dellinger’s final thought following Experiment 4 was that heat-treatment appeared to be a logical and beneficial activity in the process of quartzite reduction (personal communication, February 20, 2002).

The \textit{Fifth Formal Knapping Experiment} (see Appendix) was along the same lines as Experiment 4, however with one notable exception; the fired cobble used in this knapping session (\textit{HTC2}) had not been fractured in the initial heat-treating experiments. \textit{HTC2}, a rounded purplish quartzite cobble, was knapped using a rounded yellow quartzite cobble (\textit{H4}) as the hammerstone. Since \textit{HTC2} is a smaller cobble than \textit{HTC1}, I intended to not only observe the effects of heat-treatment, but also to observe if size played a part in the knappability of quartzite cobbles. Only two hits were applied to \textit{HTC2} before \textit{H4} fractured into two pieces, so a rounded replacement hammerstone made of gray quartzite (\textit{H5}) was selected to continue the experiment. Eight more hard hits were applied to \textit{HTC2} with \textit{H5} (10 total hard strikes) with no effect.

Dellinger’s suggestion was to abandon the knapping activities with this particular cobble because it was too difficult to work (personal communication, February 20, 2002). Even heat-treatment did not have an effect on \textit{HTC2}, demonstrating the variety in quality, hardness and knappability among quartzite cobbles. Perhaps once a cobble, such as \textit{HTC2}, demonstrated its low degree of knappability the inhabitants of Trout Point 1 changed its function from core to hammerstone.

In later knapping sessions that are not part of this study I tested this idea by using and noting the ability of \textit{HTC2} as a hammerstone, and was extremely successful in removing flakes.
The Sixth Formal Knapping Experiment (see Appendix) was again focused on the hard hammer percussion of an unfractured heat-treated cobble of pinkish quartzite (HTC3). HTC3 is roughly the same size as HTC2, but is flatter in overall appearance. H5, a gray cobble of quartzite, was used as the hammerstone once again. The percussion activities followed the same succession as with previous cobbles, yielding four small flakes. The flatter shape of HTC3 may have affected the knappability of the cobble, in that it allowed only smaller flakes to be removed. The four Hard Hammer Flakes (HHF1-4) are sharp enough to be used, but are not as easily held in the hand as some of the other flakes produced in this study.

Dellinger commented again that the amount of force needed to remove these flakes, as well as the other Hard Hammer Flakes from Heat-Treated Cores, was still substantially less than the amount of force required to remove flakes from the previous unfired cobbles (personal communication, February 20, 2002).

The Seventh Experiment conducted on 02/20/02 was an additional heat-treatment session involving five more cobbles of quartzite of various colors and shapes (see Appendix). Each cobble was numbered individually and placed in a 55-gallon drum to be fired. The fire consisted of mainly pine logs and had been burning for roughly three hours before the cobbles and several new logs were placed inside the drum. The fire was allowed to burn over night and all of the cobbles were left in place until they were cool enough to remove with bare hands. The results of this experiment have still not been recorded, due to the distance between my residence and Dellinger’s residence. Dellinger, however, informed me that at least one of the cobbles had fractured into several usable flakes and “didn’t even need to be knapped” (personal communication, March 21, 2002).

USE-WEAR ANALYSIS

The overwhelming desire to test the usability of the quartzite flakes produced by this study led me to collect several tree branches and purchase a Lake Superior whitefish to be the subjects of two impromptu use-wear analysis tests. Small amounts of Lake Superior whitefish bone were found in flotation samples recovered during excavation at Trout Point 1, therefore at least that part of these experiments could be considered true to the situation at the site. The tree branches, however, were not positively identified as any one species, so I cannot claim to be replicating the exact type of woodworking activities that the inhabitants of Trout Point 1 may have undertaken. I have not added the exact data tables that were handwritten during experimentation, as they may be the initial experiments for a continuation of this study or an entirely different study. I will, however, present a brief overview of my findings.

The first experiment consisted of attempts to peel, scrape and carve the tree branches that were collected. Two different directions of modification were employed in the woodworking experiments, both a towards and away motion, to maximize the amount of data collected. First, several unfired flakes were selected to be used on the branches. The trend was that the unfired flakes were able to both peel the bark and scrape the wood, but carving was more difficult and less effective overall. According to Whittaker (1994:246), "hard materials like wood, bone and antler are often better worked by scraping and planing if you use stone tools", therefore it appears that the results of these studies are consistent with descriptions of typical stone tool usability in woodworking activities. The next step was to select several fired flakes from both the Heat-Treated Flake and Hard Hammer Flake categories. The trend among the usability of both types of fired flakes was, for all intents and purposes, the same as the trend with the unfired flakes. Fired and unfired flakes of quartzite are adequate, but not exceptional, tools for...
working wood. The flakes can remove the bark, scrape the wood smooth and shape it, but they are not very effective in heavy carving activities.

The edges of both the fired and unfired flakes wore down slightly during use, but only until they reached a point where the edge was thick enough to maintain its form. Typically, the amount of wear on the edges was minimal and did not severely alter the effectiveness of the tools. In all cases, however, it appears that if the tool (fired or unfired) were to be used for an extended period of time it would reach a point of ineffectiveness and would need to be discarded.

Most likely the erosion of working edges on quartzite stone tools was not a problem for the inhabitants of Trout Point 1, since there is an almost unlimited supply of lithic material near the site. Marcucci (1988) states that once the material being knapped or the tool being used became the slightest bit uncomfortable to handle it was discarded and a new piece of quartzite was utilized in its place.

The second use-wear analysis experiment involved choosing several flakes (both fired and unfired) with which I intended to process a Lake Superior whitefish. The fish was purchased at a grocery store, so it had already been cleaned (the internal organs were removed through a slice on the underside). Aside from the incision on the underside of the fish, the body was complete. Two unfired flakes, two Heat-Treated Flakes, and six Hard Hammer Flakes were used to slice and filet the fish. In order to gain a true understanding of the effectiveness of the flakes, both the cortical and fresh edges were utilized. Each of the unfired flakes was quite effective in each of the processing activities; the head was severed and the meat was successfully separated from the scales. One of the two Heat-Treated Flakes wore down quickly and was fairly ineffective, while the other was highly effective in filleting the fish. Of the six Hard Hammer Flakes, three were capable of both slicing through and filleting the fish, while the other three were only suitable for filleting.

The overwhelming trend in this experiment was that both the fired and unfired flakes were effective in processing a Lake Superior whitefish.

The focus of the use-wear experiments is to investigate whether or not flakes from a fired cobble of quartzite are as effective as flakes from an unfired cobble.

The results of both the woodworking and fish processing experiments, although preliminary, support the hypothesis that heat-treating a cobble of quartzite is beneficial and will, in fact, simplify the production of usable flakes.

**CONCLUSIONS**

The current interpretation of the Trout Point 1 lithic assemblage is that hard hammer percussion, in the form of Marcucci’s System 1 and System 1A reduction sequences (1988), was being employed as a means of removing usable flakes of quartzite from cobbles collected at an outcropping near the site. There is, however, substantial evidence, both artifactual and experimental, which indicates that more than just traditional hard hammer percussion was used to process cobbles of quartzite. Large quantities of quartzite fire-cracked rock were excavated in association with the vast majority of the quartzite lithic debris found at Trout Point 1, clearly indicating stone firing activities at the site, yet the final site report states that little to none of the lithic debris showed signs of exposure to fire (Benchley et al. 1988). Experiments carried out for the purposes of this study show, however, that visible signs of heat-treatment on a flake of quartzite can be removed with water and slight rubbing.

The artifacts at Trout Point 1 remained in situ on an exposed point overlooking the world’s largest fresh water lake for over 2,000 years; therefore, it appears well within the realm of possibility that this prolonged exposure to the elements removed any visible traces of heat-treatment activities.

Aside from the physical appearance of the quartzite flakes after heat-treatment, the quality of the flakes and
the amount of effort required to produce them were also in question. Hard hammer percussion of an unfired cobble of quartzite is effective in producing flakes which can be used as expedient tools, however, large amounts of force are required to perform this task. In several cases during experimentation, the amount of force required to knap an unfired quartzite cobble with an unfired quartzite hammerstone resulted in the fracturing of both the core and the hammerstone. Unfired flakes from this study proved effective for woodworking and fish processing activities, but are by no means sophisticated or outstanding tools. The “cost” of using solely hard hammer percussion on an unfired quartzite cobble is that the flintknapper is required to exert substantial amounts of energy in order to produce moderate results. Heat-treatment, however, provides an alternative to the labor-intensive hard hammer percussion employed on unfired cobbles.

Not only did the heat-treatment experiments render the quartzite cobbles more easily knapped, but usable flakes were actually produced as a result of the fire. Both the Heat-Treated Flakes and Hard Hammer Flakes from these experiments were visibly comparable to the unfired flakes, plus they proved to be just as effective as unfired flakes in woodworking and fish processing activities. In terms of economy, the heat-treatment of quartzite cobbles, as a primary stage in stone tool manufacture, is an effective means of conserving energy while still producing favorable results.

The benefit to the aboriginal flintknapper is apparent through the reduction of required energy involved in flake production. This “conserved energy” could have been doubly important to the inhabitants of Trout Point 1, since they were already required to expend substantial amounts of energy in quarrying and transporting the quartzite cobbles up to this cliff-top site.

The reasoning for Trout Point 1’s use as a Late Archaic lithic station remains unclear, however, it is evident that vast quantities of quartzite cobbles were hauled to the site for heating and flintknapping activities. An alternative to the established view of the lithic manufacturing activities at Trout Point 1 has been presented, through this study, in an effort to more clearly understand the Late Archaic way of life in the Upper Peninsula of Michigan. On a large scale, perhaps the results of this experimental study will provide useful information for interpreting other Late Archaic sites in the upper Great Lakes region; on a slightly smaller scale, this reconstruction of Late Archaic technology allows us to gain a more complete understanding of how inhabitants of Grand Island over 2,000 years ago behaved.

**Photos from Flintknapping Experiments with Neil Dellinger**
C1, an unfired quartzite cobble, prior to hard hammer percussion)

(After Neil and I had cracked C1 we decided to reconstruct it for the pictures. This is C1 reconstructed to show where flake 1 (F1) came off the core)
(C1 after F1 has been removed)
(C1 and F1 with tape measure for scale)
(C1, with scar from F1 visible, and hammerstone 1 (H1). H1 is pointing to where percussion will be applied to remove F2. This point did not yield a flake, so C1 was turned over (so scar from F1 is facing down) and F2 was removed from same basic percussion point, not pictured)
(Neil pointing to the percussion point intended to remove F3 from C1)

This attempt yielded a small flake (F3), not pictured)
(Neil pointing to the intended percussion point for removing F4)
(C1 after the removal of F4)
(Neil pointing to the intended percussion point for the removal of F5)
(C1 and the three pieces of F5. The flake broke in transition, but was still measured as a whole)
(Neil pointing to the intended percussion point for the removal of F6)
(After hitting the percussion point from the previous picture, hammerstone 1 (H1) broke into 3 pieces. These are the pieces of H1)
(C1 and the new hammerstone (H2) before percussion)
(Neil holding the 3 individual flakes that comprise flake 6 (F6) in his hands. The flake broke in transition, but was measured as a whole)
(Neil pointing to the intended percussion point for removal of F7)
(After hitting the point from the previous picture, F7 (not pictured) was removed and hammerstone 2 (H2) broke into 2 pieces, as seen in this picture. **THIS IS KEY:** Large amounts of force were applied to remove only 7 total flakes from this unfired core, plus 2 hammerstones were broken in the process.)
(New Cobble and Hammerstone: \textbf{C2} and \textbf{H3}, before percussion.

\textbf{C2} is unfired quartzite and \textbf{H3} is a nodule of glacial till (Chert) )
(Neil holding the 2 pieces of F1,C2 (right side) after initial percussion was applied. F1,C2 is a long thin, almost blade-like, flake. Only 1 hit was applied to remove this flake)
(Neil pointing to the flake scar left from the removal of F1,C2)
(Fuzzy picture indicating the intended percussion point for the removal of F2, C2)
(Neil holding F2,C2 after its removal from the core. F2,C2 is very sharp and knife-like)
(Neil holding F3,C2 after its removal from the core. **F3,C2** is also a nice, sharp flake. This is noteworthy because chert is softer than quartzite, yet the chert was used as the hammerstone and actually required less force to remove these higher quality flakes than when quartzite was used for a hammerstone)
(Neil holding H3 and a new cobble (C3), pointing to the intended percussion point for the removal of F1, C3. H3 actually fractured into 2 pieces at the onset of percussion)
(New cobble: Heat Treated Core 1 (HTC1) as a whole, but after firing had removed several flakes. HTC1 is reconstructed here to give the original cobble some perspective)
(Five flakes were removed from HTC1 as a result of firing. They are labeled Heat Treated Flakes 1-5 (HTC1-HTC5). This picture was intended to show all 5 flakes removed before percussion, but only 3 (plus 2 remaining core pieces) are in clear view)
(Neil holding one of the remaining core sections from HTC1 and H4 before starting hard hammer percussion)
(New Cobble and Hammerstone: **HTC2** and **H5**. **HTC2** had been fired, but was not cracked like **HTC1**. This picture is before any was applied. This cobble was never fractured, too hard)
APPENDIX

First Firing and Initial Ideas

7-27-01 through 7-28-01: Light gray quartzite cobble (Fired Quartzite 2, a.k.a. FQ2)

- The fire was started at 7:45pm CST (on Grand Island). I checked the fire the next morning at 6:30am CST. One cobble (FQ2) was placed in the fire to see what would happen.
- The fire was going until sometime between 10:30pm CST and 11:00pm CST, after that it was just hot coals until the morning.
- The cobble was still too hot to handle at 6:30am CST, however there was a flake-like spawl which was hot, but handleable.
- The flake was 61.09mm in length.

  Other results of the heating were the formation of four different fracture lines on the cobble, at which the stone was subsequently knapped and broken.
- The tensile strength of the stone appears to have been affected by the fire. I can hear slight cracking noises as I try to break the cobble in my hands.
- It appears that, if fired again, the cobble would not crack into as “nice” or opportune flakes as the first to spawl from the rock.
- The color appeared to change only slightly as a result of the fire. It was still well within the color range.
of quartzite collected near Trout Point 1.

- Perhaps the cobbles were placed in fires that served another purpose, other than heating the cobbles, in hopes that they would spawl into “fortuitous” flakes. If they did not then it was no loss, just broken rocks, but a good fracture could be an instant expedient tool.

**FQ2 = A – D (four remaining core portions of Fired Quartzite 2)**

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<th>Core</th>
<th>Length</th>
<th>Width</th>
<th>Thickness</th>
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<tbody>
<tr>
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<tr>
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<tr>
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<td>73.35</td>
<td>39.68</td>
<td>27.20</td>
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</table>

Heat Treated Flakes (HTF): Flakes removed as a result of heating

- HTF1: L = 61.09
  - W = 36.72
  - T = 12.18

Hard Hammer Flakes (HHF): Flakes removed as a result of percussion

- HHF1: L = 39.50
  - W = 36.01
  - T = 10.08
- HHF2: L = 51.95
  - W = 37.48
  - T = 14.35
- HHF3: L = 54.18
  - W = 35.34
  - T = 15.99

**Second Firing**

7-29-01: 4 Cobbles of Quartzite fired on Grand Island

- Same procedure as the first firing, except this time the cobbles were placed in the fire-pit amongst the tinder and kindling, leaving them mostly covered by fuel, prior to lighting it.

- COBBLE 1: Purple colored quartzite = Rounded (9.5cm x 4.9cm x 8cm)
- COBBLE 2: Yellowish colored quartzite = Rounded (12.9cm x 7.5cm x 9.7cm)
- COBBLE 3: Pinkish colored quartzite = Rounded (8.9cm x 4.0cm x 8.7cm)
  - This cobble has a dark line on the cortex similar in shape to the flake that spawled off of (FQ2). I anticipated a flake from this portion of the stone, but after removing it from the fire I observed that there were no fractures at all. This cobble is mentioned and labeled in later experiments.
- COBBLE 4: Gray/Purple colored quartzite = Not rounded (12.9cm x 8.0cm x 9.3cm)
  - This cobble is a different shape than the rest, plus it has a 6.4cm x 4.7cm patch of sandstone stuck to the cortex.
This sandstone is from the outcropping of the conglomerate where I quarried the cobble.

-This cobble is labeled (FQ1) because it was part of my firing experiments, but it was not subsequently knapped. I have measured the remnants of the original cobble and have labeled the individual parts:

** WITH THE EXCEPTION OF THE ROUGH MEASUREMENTS ABOVE FOR COBBLES 1-4, ALL MEASUREMENTS IN THE PROCEEDING DATA ARE IN MILLIMETERS.

FQ1: The remainder of the cobble, which has now become a core

L = 112.05  
W = 82.58  
T = 70.23

Heat Treated Flakes: Flakes removed as a result of heating

HTF1: L = 78.24  
W = 63.28  
T = 29.48

HTF2: L = 68.06  
W = 54.45  
T = 35.91

HTF3: L = 65.54  
W = 62.00  
T = 36.06

First Unstructured Experiment with Knapping Unfired Quartzite

Experiment: Quartzite on Quartzite, Hard Hammer Percussion

- Greenish/Gray Quartzite Cobble (Q1): Not rounded, Unfired
- Grayish Quartzite Hammerstone (H1): Rounded, Unfired

-KNAPPING:

- I used (H1) on (Q1) in an attempt to determine how easily quartzite is knapped. I carried out the knapping with only limited knowledge of knapping techniques.

- A total of 11 sharp flakes (all less than 46.34mm) were removed from (Q1) with the USE OF CONSIDERABLE FORCE.
  By this I mean that I had to hit the cobble with at least 75% of my strength to get the flakes off. This could be due to the material or my inexperience as a flintknapper.

- The core remains large and is not exhausted by any means. It is only slightly smaller than when the knapping began.

Q1: The remaining core of the cobble

L = 93.59
W= 84.98  
T= 59.50  

Hard Hammer Flakes: Flakes removed as a result of percussion

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<th>HHF7:</th>
<th>L= 24.00</th>
<th>HHF8:</th>
<th>L= 21.17</th>
<th>HHF9:</th>
<th>L= 20.30</th>
</tr>
</thead>
<tbody>
<tr>
<td>W= 17.84</td>
<td>W= 13.30</td>
<td>W= 12.22</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T= 2.31</td>
<td>T= 2.98</td>
<td>T= 2.03</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>HHF10:</th>
<th>L= 23.23</th>
<th>HHF11:</th>
<th>L= 23.96</th>
</tr>
</thead>
<tbody>
<tr>
<td>W= 12.55</td>
<td>W= 12.24</td>
<td></td>
<td></td>
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<tr>
<td>T= 3.06</td>
<td>T= 2.27</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**First Formal Knapping Experiment**

**02/20/02**

Experiment: Quartzite on Quartzite, Hard Hammer Percussion

- Yellow Quartzite Cobble (C1): Rounded, Unfired
- Grayish Quartzite Hammerstone (H1): Rounded, Unfired
  
  * Used previously in solo knapping experiments, has dimpling and cortex damage from percussion.

-KNAPPING: Follows the pictures

  - 3 hits, then a large flake came off (F1)
  - Attempts at secondary flakes (with no cortex) were unproductive
  - After Flake 5 (F5) was removed, Hammerstone 1 (H1) fractured into 3 pieces. Two flakes (H1,F1 and H1,F2) and a new core (H1,C) were left over.
  - After Flake 7 (F7) was removed, Hammerstone 2(H2), a purplish quartzite cobble, fractured
into 2 pieces (H2,F1 and H2,C). The fracture produced edges suitable for cutting on (H2,F1).

- Flakes 1-7 were labeled (F1-F7) and were photographed with a digital camera. Percussion points were also noted in the photos.
- All cores and flakes from the same cobble were bagged together after the experiments.

**C1**: The remaining core of the cobble

<table>
<thead>
<tr>
<th>L</th>
<th>W</th>
<th>T</th>
</tr>
</thead>
<tbody>
<tr>
<td>101.78</td>
<td>92.98</td>
<td>66.71</td>
</tr>
</tbody>
</table>

**Hard Hammer Flakes**: Flakes removed as a result of percussion

<table>
<thead>
<tr>
<th>F1</th>
<th>L</th>
<th>W</th>
<th>T</th>
</tr>
</thead>
<tbody>
<tr>
<td>71.65</td>
<td>59.22</td>
<td>15.86</td>
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<table>
<thead>
<tr>
<th>F2</th>
<th>L</th>
<th>W</th>
<th>T</th>
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<tbody>
<tr>
<td>95.77</td>
<td>62.89</td>
<td>17.30</td>
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<table>
<thead>
<tr>
<th>F3</th>
<th>L</th>
<th>W</th>
<th>T</th>
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</thead>
<tbody>
<tr>
<td>30.33</td>
<td>18.76</td>
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</tbody>
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<table>
<thead>
<tr>
<th>F4</th>
<th>L</th>
<th>W</th>
<th>T</th>
</tr>
</thead>
<tbody>
<tr>
<td>68.95</td>
<td>55.68</td>
<td>17.45</td>
<td></td>
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<table>
<thead>
<tr>
<th>F5</th>
<th>L</th>
<th>W</th>
<th>T</th>
</tr>
</thead>
<tbody>
<tr>
<td>39.95</td>
<td>38.66</td>
<td>11.90</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>F6</th>
<th>L</th>
<th>W</th>
<th>T</th>
</tr>
</thead>
<tbody>
<tr>
<td>51.23</td>
<td>35.96</td>
<td>17.52</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>F7</th>
<th>L</th>
<th>W</th>
<th>T</th>
</tr>
</thead>
<tbody>
<tr>
<td>61.09</td>
<td>24.99</td>
<td>10.78</td>
<td></td>
</tr>
</tbody>
</table>

**Second Formal Knapping Experiment**

**02/20/02**

**Experiment**: Chert on Quartzite, Hard Hammer Percussion

- Purple/Gray Quartzite Cobble (C2): Not Rounded, Unfired
- White Chert Hammerstone (H3): Unfired nodule of glacial till from Illinois

**Measurements of this stone will be seen in the proceeding table on Hammerstones.**

**KNAPPING**: Follows the pictures

- 1 hit removed a long thin flake (F1,C2), blade-like in appearance. Neil commented that he hardly had to hit it to remove the flake.
- Second Flake (F2,C2) was also thin flat and sharp.
“Chert Hammerstone requires less force than quartzite hammerstone, and yields better flakes”. –Neil Dellinger

3 total flakes were removed from the cobble before the experiment finished, but they were of better quality (in regards to sharpness and shape) than those removed from (C1) with (H1 and H2)

All flakes required less effort to remove than with quartzite.

C2: The remaining core of the cobble

\[
\begin{align*}
L &= 97.32 \\
W &= 69.93 \\
T &= 60.69
\end{align*}
\]

Hard Hammer Flakes: Flakes removed as a result of percussion

\[
\begin{align*}
F1: & \quad L = 77.85 \text{ (2 pieces)} \\
& \quad W = 27.70 \text{ (measured)} \\
& \quad T = 10.99 \text{ (as1)} \\
F2: & \quad L = 70.78 \\
& \quad W = 38.15 \\
& \quad T = 11.72 \\
F3: & \quad L = 48.02 \\
& \quad W = 38.54 \\
& \quad T = 12.41
\end{align*}
\]

Third Formal Knapping Experiment

02/20/02

Experiment: Chert on Quartzite, Hard Hammer Percussion

- Yellow Quartzite Cobble (C3): Rounded, Unfired
- White Chert Hammerstone (H3): Unfired nodule of glacial till from Illinois

-KNAPPING:

  - Minimal percussion fractured (H3) into 2 pieces (H3,F1 and H3,C)
  - Knapping of this cobble ceased after (H3) broke, so attention could be placed on the knapping of FIRED quartzite cobbles.

C3: The entire cobble, it was never fractured

\[
\begin{align*}
L &= 113.93 \\
W &= 112.84 \\
T &= 53.01
\end{align*}
\]

Fourth Formal Knapping Experiment
02/20/02

Experiment: Quartzite on Quartzite, Hard Hammer Percussion

- Pinkish Quartzite Cobble called Heat Treated Core 1 (HTC1): Rounded, Fired and Cracked from Heat.
- Yellowish Quartzite Hammerstone (H4): Rounded, Unfired

-KNAPPING: Follows the pictures

- 2nd picture is after fire, but before percussion
- The firing yielded 5 “good”, sharp flakes. They are labeled Heat Treated Flakes 1-5 (HTF1-HTF5)
- We had to hit (C1) numerous times, very hard with two hammerstones (H1 and H2) just to yield 7 total flakes. Instantly firing appears to be beneficial, in that it has cut the amount of work at least in half.
- (HTF1-HTF5) are just as strong and durable as the non-fired flakes from (C1 and C2). Firing did not make the flakes more brittle than unfired flakes.

Neil commented that he could not tell the difference between heated and non-heated flakes by appearance or feel.

- 8 total flakes (HTF1-HTF5 and HHF1-HHF3) were removed from (HTC1) by the end of the knapping.
  3 Hard Hammer Flakes were removed from the cores without difficulty, therefore the knapping of the cores ceased because similar results were anticipated from the remainder of the cores.
- Force required to remove these flakes was considerably less than for unfired cobbles. Neil Dellinger agrees and believes that heating of cobbles at Trout Point 1 was logical, plausible and beneficial.

HTC1: 3 remaining core pieces from the cobble

<table>
<thead>
<tr>
<th></th>
<th>L</th>
<th>W</th>
<th>T</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>76.22</td>
<td>46.97</td>
<td>43.27</td>
</tr>
<tr>
<td>2</td>
<td>86.51</td>
<td>59.63</td>
<td>53.17</td>
</tr>
<tr>
<td>3</td>
<td>94.55</td>
<td>88.44</td>
<td>64.63</td>
</tr>
</tbody>
</table>

Heat Treated Flakes: Flakes removed from heating in a fire-pit

<table>
<thead>
<tr>
<th></th>
<th>L</th>
<th>W</th>
<th>T</th>
</tr>
</thead>
<tbody>
<tr>
<td>HTF1</td>
<td>55.57</td>
<td>36.41</td>
<td>6.32</td>
</tr>
<tr>
<td>HTF2</td>
<td>80.47</td>
<td>45.09</td>
<td>17.95</td>
</tr>
<tr>
<td>HTF3</td>
<td>71.11</td>
<td>59.01</td>
<td>19.59</td>
</tr>
</tbody>
</table>
HTF4:  L= 69.64          HTF5:  L= 64.79  
   W= 47.70                   W= 39.60  
   T= 11.09                    T= 10.84  

Hard Hammer Flakes:  Flakes removed as a result of percussion  
HHF1:  L= 53.18         HHF2:  L= 88.53         HHF3:  L= 59.50  
   W= 48.38                   W= 63.27                   W= 30.75  
   T= 19.31                     T= 23.25                     T= 11.46  

Fifth Formal Knapping Experiment  
02/20/02

Experiment:  Quartzite on Quartzite, Hard Hammer Percussion

- Purplish Quartzite Cobble (HTC2): Rounded, Fired but not cracked
- Yellow Quartzite Hammerstone (H4): Semi-rounded tapered at one end, Unfired

-KNAPPING:
   ·  After 2 hits (H4) broke into 2 pieces (H4,F1 and H4,C)
   ·  Hammerstone 5 (H5) was made of gray quartzite and was unfired. (HTC2) was hit 8 times, using ample force, with (H5) without a flake or fracture being produced.
   ·  A total of 10 hard strikes were delivered to the cobble without any result. Knapping ceased after the 10th failed strike.
   ·  Despite heat-treatment, this cobble remained extremely difficult to work. Perhaps cobbles of this sort were switched in function from core to hammerstone, once “hardness” such as this was displayed.

(HTC2): The entire cobble, since no fracture was produced  
L= 94.69  
W= 81.75  
T= 54.02

Sixth Formal Knapping Experiment  
02/20/02
Experiment: Quartzite on Quartzite, Hard Hammer Percussion

- Pinkish Quartzite Cobble (HTC3): Flatter Cobble, Fired
- Gray Quartzite Hammerstone (H5): Rounded, Unfired

-KNAPPING:

  - At least 4 small flakes were removed from the core (HTC3). More force was required to remove these flakes than those from (HTC1), but not as much force was required as when unfired cobbles were knapped.

  - The shape and size of the cobble may have affected the knappability. It would appear that when one is heat-treating quartzite, a larger rounded cobble is more suitable for producing heat-treated flakes.

(HTC3): The remaining core of the cobble

L = 91.54  
W = 77.56  
T = 39.40

Hard Hammer Flakes: Flakes removed as a result of percussion

HHF1:  L = 30.24  W = 28.30  T = 7.75  
HHF2:  L = 38.00  W = 32.81  T = 10.77  
HHF3:  L = 36.45  W = 24.73  T = 9.87  
HHF4:  L = 40.15  W = 30.49  T = 6.38

Seventh Experiment

02/20/02

Experiment: Five quartzite cobbles are to be fired in a 55 gal. drum outside of Neil’s house.

- The drum was used instead of a fire-pit because of wet conditions and high winds. Pine wood was the primary fuel for the fire.
- The fire had been going for several hours before the cobbles were placed in the drum. The cobbles were left in place until the fire had died.
- All of the cobbles were photographed with scale for perspective. Each cobble chosen to be fired was a different color of quartzite to maximize the results of the data.
- THE RESULTS OF THIS PARTICULAR EXPERIMENT HAVE NOT BEEN RECORDED YET.
Neil Dellinger’s Comments and Conclusions Based on the Knapping Experiments

*Neil Dellinger is an experienced flintknapper. He is used as an expert source, due to his extensive knowledge of stone tool manufacturing techniques*

- “A heated, larger, rounded cobbles is the best to use (easiest, most workable) for quartzite reduction”

- “Visible attributes of the heated flakes and cores do not show evidence of heating”

  - Neil picked up a flake of heat-treated quartzite and a flake of unfired quartzite, and he compared them.

  - The only way that Neil knew which flake had been heated was because he had just knapped the stones himself. He believed that it would be difficult, if not impossible, to determine if the quartzite flakes at Trout Point 1 were heat-treated or not.

- “Heat-treated cores do not require as much force during percussion to produce a flake as unfired cores do.”

- “The chert hammerstone yielded fewer flakes, but of higher quality than a quartzite hammerstone. Also, the chert hammerstone required considerably less force than the previous quartzite hammerstone”

  - Chert was used on unfired quartzite only

- “Every good flake has cortex on it.”

  - This is in agreement with Marcucci’s (1988) findings in his chapter of the Trout Point 1 report.

- “Firing of (HTC1) yielded 5 good, sharp flakes before any percussion was applied. Immediately, heat-treatment cut the work in half.”

Hammerstone Measurement Chart

**H1:** Dark gray rounded quartzite cobbles

<table>
<thead>
<tr>
<th>Complete</th>
<th>L = 97.28</th>
<th>Broken</th>
<th>F1: L = 66.65</th>
<th>F2: L = 84.38</th>
</tr>
</thead>
<tbody>
<tr>
<td>W</td>
<td>72.74</td>
<td></td>
<td>W = 46.14</td>
<td>W = 54.96</td>
</tr>
<tr>
<td>T</td>
<td>54.37</td>
<td></td>
<td>T = 23.73</td>
<td>T = 24.03</td>
</tr>
<tr>
<td>C</td>
<td>L = 92.55</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>W = 72.34</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>T = 38.73</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>H2: Dark gray/purplish rounded quartzite cobble</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>-----------------------------------------------</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Complete: L = 111.80</td>
<td>Broken: F1: L = 52.29</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>W = 61.31</td>
<td>C: L = 106.11</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T = 49.21</td>
<td>W = 61.20</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>T = 16.75</td>
<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td>T = 49.32</td>
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</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>H3: Rounded white nodule of Illinois glacial till chert</th>
</tr>
</thead>
<tbody>
<tr>
<td>Complete: L = 70.03</td>
</tr>
<tr>
<td>W = 63.94</td>
</tr>
<tr>
<td>T = 58.25</td>
</tr>
<tr>
<td></td>
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<td></td>
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</table>

<table>
<thead>
<tr>
<th>H4: Light gray/yellowish semi-rounded quartzite cobble, tapered at one end</th>
</tr>
</thead>
<tbody>
<tr>
<td>Complete: L = 114.74</td>
</tr>
<tr>
<td>W = 62.95</td>
</tr>
<tr>
<td>T = 55.16</td>
</tr>
<tr>
<td></td>
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<td></td>
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</table>

<table>
<thead>
<tr>
<th>H5: Light gray rounded quartzite cobble</th>
</tr>
</thead>
<tbody>
<tr>
<td>Complete: L = 87.26</td>
</tr>
<tr>
<td>W = 79.50</td>
</tr>
<tr>
<td>T = 58.81</td>
</tr>
</tbody>
</table>

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