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REASSEMBLING THE QUARRY: QUARTZITE PROCUREMENT AND REDUCTION ALONG THE POTOMAC

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Engineering-Science

ABSTRACT

This article presents the results of a refitting study performed on lithic artifacts from 44LD124, a quartzite quarry in Loudoun County, Virginia. Spatial variation in quarry debris and refits demonstrated differences in intrasite reduction strategies. In one section of the site, where fire-altered quartzite debris occurred, twenty sets of refits were obtained, fifteen of which bore signs of fire-cracking or heating. In another part of the site, eleven groups of debitage were reassembled, reforming cobbles and boulders. To examine the technological and spatial consequences of various reduction techniques, quartzite percussion experiments were conducted. The technological, spatial and experimental analyses suggested that some of the reassembled groups were reduced by anvil and hammerstone percussion, in a high position from the ground, likely employing standing or kneeling stances. The findings derived from analysis of the 44LD124 materials provide information regarding quartzite procurement in the Virginia Piedmont and the Potomac River drainage.

INTRODUCTION

A cultural resources survey was recently performed on the west shore of the Potomac River, in Loudoun County, Virginia. The survey resulted in the identification of a number of prehistoric sites on the floodplain and terraces of the Potomac (Daugherty and Petraglia, 1989; Daugherty et al., 1989; Petraglia et al., 1990). One terrace site, 44LD124, immediately west of Selden Island, was determined to be a quarry based on the presence of natural quartzite cobbles and boulders and associated manufacturing debris (Figure 1). The floodplain sites mainly consisted of secondary stage reduction debris. Savannah River projectile

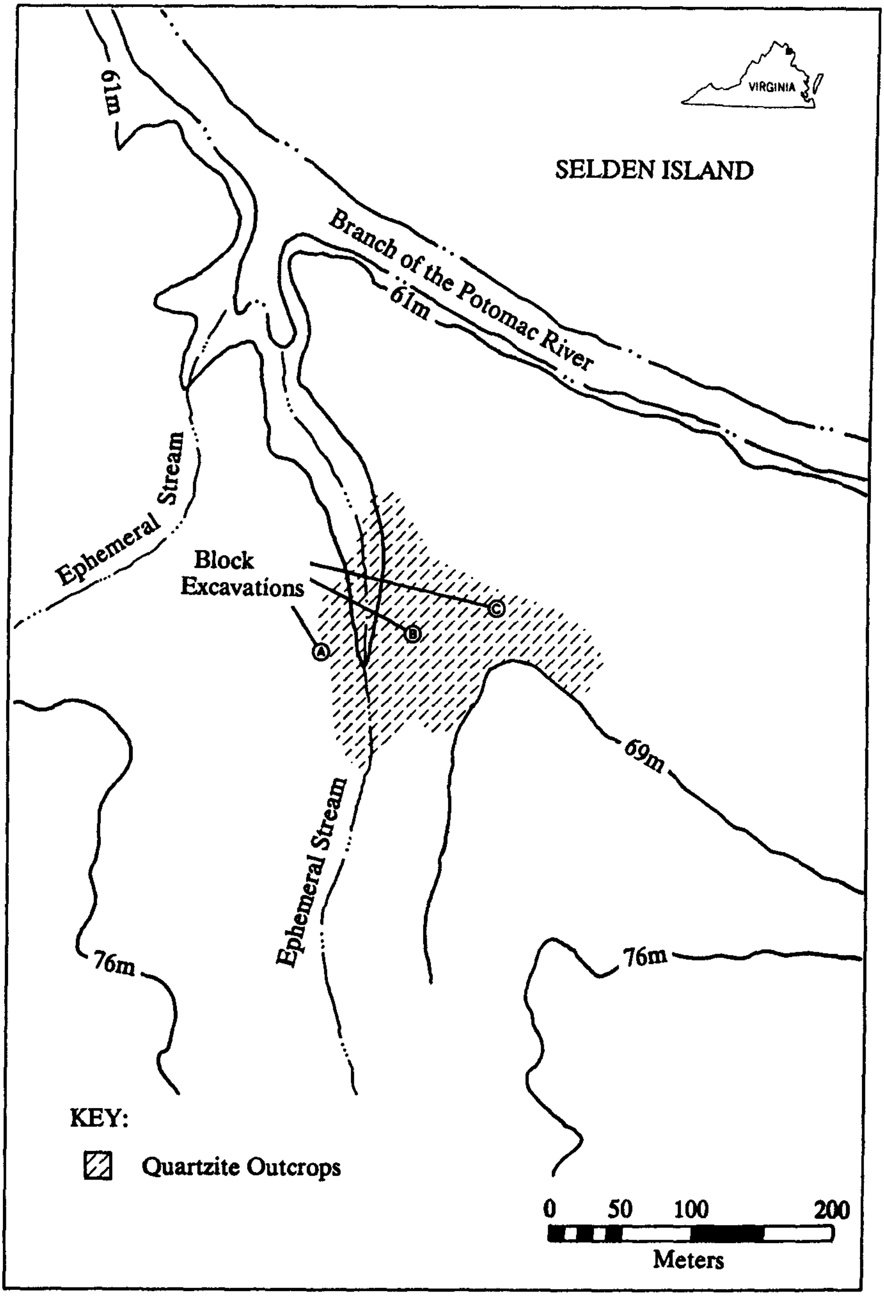

Figure 1. Location map showing quartzite outcrops and block excavations at site 44LD124.

points recovered from the floodplain sites dated occupation to the Late Archaic (Figure 2). The predominant lithic material in the floodplain and terrace sites was the locally available quartzite.

The investigations performed at 44LD124 supplement information derived from over fifty years of archaeological research in the site vicinity. A number of archaeologists have, in fact, paid considerable attention to prehistoric sites on Selden Island and the Potomac River floodplain (e.g., Stearns, 1940; Slattery, 1946; MacCord et al., 1957; McDaniel, 1974, 1979, 1987; Slattery and Woodward, 1992). Most of these earlier archaeological investigations concentrated on the large Woodland villages and associated complexes, rich in features and a wide diversity of artifacts. Surveys and excavations by Rust (1983, 1986) on the terraces of the Potomac are clearly an exception, his investigations concentrating on prehistoric sites of all ages and types.

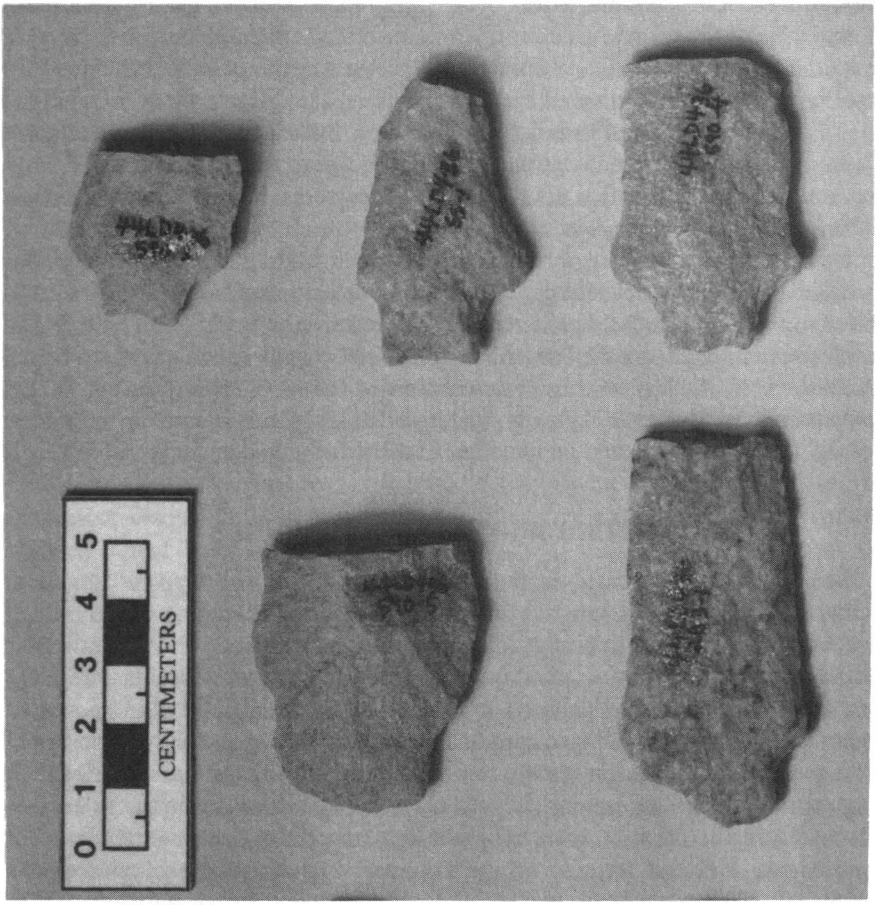

Figure 2. Quartzite Savannah River projectile points from 44LD436.

Among the prehistoric sites located on the terraces overlooking Selden Island, site 44LD124 distinguished itself from most others because of the presence of natural quartzite cobbles and boulders and quarrying debris (Figure 1). Investigations at site 44LD124 were therefore viewed to provide potentially important information about quartzite procurement, reduction and utilization. As most archaeologists are aware, pioneering research on this topic was originally carried out by William H. Holmes (1890, 1987) at the Piney Branch quarry in Washington, D.C. Since these nineteenth-century investigations, archaeologists have learned more about the spatial distribution of quartzite, its variable qualities, and prehistoric mining and manufacturing techniques. For example, Munford (1982) reevaluated the quartzite materials from the Piney Branch quarry, providing a detailed description of the stone tool manufacturing debris. Rust (1983) conducted considerable research on quartzite distribution along the Virginia shoreline of the Potomac River, describing Late Archaic quarrying efforts. Employing petrographic analyses, Ebright (1987) documented the variable qualities of quartzite from a number of quarries in the Middle Atlantic. In a synthesis of the broad material trends in Virginia, McLearen (1991) documented the preference and dominance of quartzite as a lithic material in Late Archaic assemblages. Most recently, Custer (1992) analyzed quartzite industries from several Late Archaic sites in southeastern Pennsylvania, identifying the sequence of biface reduction and projectile manufacture.

Complementing the research carried out at other Middle Atlantic quarries, this article describes the archaeological investigations performed at 44LD124. First, a brief summary of the field procedures and the site stratigraphy is presented. The artifact assemblages are then described, followed by a presentation of the refitting methods and findings, and by a description of the methods and results of the percussion experiments. Finally, interpretations about quartzite reduction methods are presented, and implications of the study are addressed.

SETTING AND FIELD PROCEDURES

Site 44LD124 is located in the northern portion of the Virginia Piedmont Lowlands. The site is situated on an alluvial terrace of the Potomac River, which is Pleistocene in age (Larsen et al., 1980; Rust et al., 1983; Rust, 1986). The Pleistocene terrace deposits overlay Triassic bedrock deposits. Residual deposits on the terrace consist of gravel, cobbles and occasional boulders composed of quartzite, sandstone, and igneous rocks. These residual deposits may be observed along erosional slopes or in alluvium in the vicinity of the site. The residual deposits may represent primary alluvial clast, brought downstream by the ancient river, or may derive from colluvial processes, brought in from the more ancient and higher elevated terraces of the Potomac. Unpublished geological maps showed that the concentration of alluvial deposits in the site had a unique origin; the transported alluvial material came to rest along a siltstone fault, accounting for the increased density of residuum in the site area (C. Scott Southworth, Geologist U.S. Geological Survey, Personal Communication, 1989). The concentration of quartzite cobbles and boulders at 44LD124 therefore set the site apart from most other nearby terrace locations, usually characterized by either a general spread of quartzite material or a lower density of cobbles and boulders. The quartzite materials at site 44LD124 therefore appear to primarily occur as transported clast, deposited during the Pleistocene by the Potomac River. There are no known primary bedrock outcrops of quartzite in the immediate vicinity of the site.

The quartzite outcrops exposed on the surface of the site consist of quartzite cobbles and boulders. The site occurs on an erosional slope, ranging in elevation from 65-69 m. The site was dissected by a small unnamed ephemeral stream, which flows directly into the Potomac. The channel of the stream was 4-5 ft in depth, the bank profile indicating that the residual cobble and boulder deposits lie immediately over Triassic siltstone bedrock. Along the banks and within the channel of the unnamed stream, quartzite boulders and cobbles were also found.

Site 44LD124 was originally identified by William Rust and others during a walkover of a plowed field. During a cultural resources survey of a pipeline corridor, the site was relocated. The previously unrecorded quarry component of site 44LD124 was located in a wooded terrain, on the border of the agricultural field. Archaeological testing at site 44LD124 was subsequently performed within the 50 foot boundaries of the corridor, only representing a sample of the quarry component of the site. Testing included systematic shovel testing on transects at 50 foot intervals, controlled surface collection along an unimproved dirt road, and judgmentally placed test unit excavation. In total, 182 shovel tests were excavated in the corridor, ninety-one of which contained cultural material. The positive shovel test distribution was used to guide test unit and block unit excavations. Following archaeological testing, three excavation blocks, labelled A-C, were placed to examine variability in artifact distributions and to gather information on prehistoric quarrying (Figure 1). A total of fifty-seven excavation units were placed, consisting of four exploratory units, fifteen units in Block A, fifteen units in Block B, and twenty-three units in Block C.

Excavation of the site into three blocks was considered to be an effective strategy for sampling separate areas of the site. The goal of the three excavation blocks was to examine variation in intrasite lithic reduction activity and space use. Block A was placed in the northern part of the site, on a rise overlooking the western side of the unnamed ephemeral stream. During archaeological testing, this area initially produced several unfinished bifaces as well as debitage. Block B was placed in the central part of the site to sample the eastern side of the stream and because of the presence of concentrations of debitage, many of which bore signs of fire-cracking or heating. Block C was placed to test an area with debitage, some of which were large in size.

The subsurface deposits were found to be shallow as there was little Holocene soil accumulation. Typical of the deposits, three main strata were identified

(Figure 3). Strata A-C contained pebbles and cobbles of quartzite, sandstone, vein quartz, and weathered siltstone and diabase. Boulders were present on the surface of the site and in the stratigraphic profiles. The artifact bearing levels in the site measured approximately 20-30 cm in depth. Stratum B, which contained the greatest number of artifacts, was typically 10-15 cm thick. Underlying these strata, at a depth of about a meter or more, was the Triassic siltstone.

In accordance with studies designed to examine natural formation processes (e.g., Butzer, 1982; Schiffer, 1987; Nash and Petraglia, 1987), consideration was given as to whether the sloping topography and the thinness of the soils meant that the artifacts may have been moved by natural processes, especially by water or gravity. While limited postdepositional disturbance of the archaeological materials cannot be ruled out, there was no evidence for the operation of major erosional processes which would transport artifacts. This was based on the lack of any evidence for stratigraphic disturbance, the unsorted nature of the residual rock fragments, and the presence of fine sedimentary elements in the soils, indicating little winnowing. In addition, the presence of fine-screened debitage (<1/16 inch) suggested that natural processes did not remove the smallest artifacts and therefore primary cultural debris was retained in the site (cf. Petraglia et al., 1990). Moreover, the close horizontal evidence derived from the refits, described below, was also evidence for integrity of the deposits. The presence of boulders may have also acted as a stabilizing factor, preventing, or at least slowing, downslope movements of materials (Petraglia, 1987). There was no evidence of plowing or other historic disturbances in the stratigraphic profiles.

During the excavation of Block C, an upright boulder, with battering on the topmost surface, was identified (Figure 4). This boulder was inferred to be an anvil. A large quantity of sizeable cortical debitage was found distributed around the anvil. The anvil and the concentrated debitage was designated as Feature 1. The units in Block C were placed to recover as many of the large pieces of debitage as possible. While large pieces of debitage were located in units near the anvil, especially towards the northeast, these were not concentrated, but were generally dispersed. Shovel tests and a unit placed 1 meter south of Block C did not contain large debitage, thus the debitage scatter was not located in this area. The great majority of the large debitage was therefore recovered upon completion of the excavation in Block C. Because the artifacts in Block C represented potential stone reduction areas, all large artifacts in Feature 1 and in the surrounding units were piece-plotted.

ARTIFACT ASSEMBLAGES

A total of 4,070 artifacts was recovered from site 44LD124. Block B contained the highest density of stone artifacts (167/m^2), followed by Block C (35/m^2), and Block A (22/m^2). The somewhat higher density of material in Block B was due to the presence of fire-cracked and heated quartzite. Although the artifact density

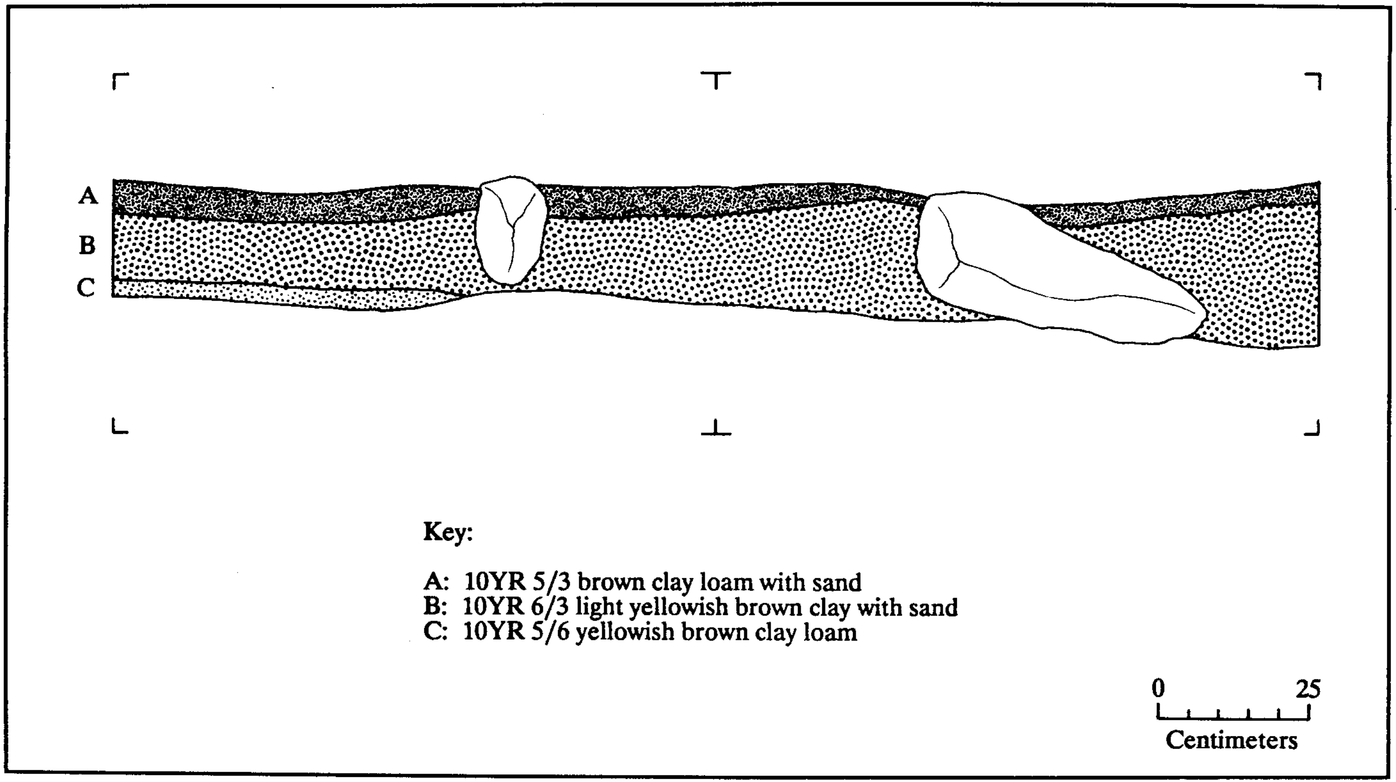

Figure 3. Stratigraphy, Block C.

in 44LD124 was fairly high, the density was not as great as found at other Middle Atlantic quarries (e.g., Holmes, 1890, 1897; Rust et al., 1983; Ebright, 1987), probably indicating that the use of the site was limited, rather than repeatedly used.

Of the eight different raw materials represented, quartzite dominated, and it was over four times more plentiful than quartz (Table 1). Chert, jasper, and four other raw materials made up a low percentage of the total assemblage. The quartzites were fine-grained, vitreous metaquartzites, primarily brown in color, although varying shades and visual qualities existed. Petrographic thin sections showed that the internal crystalline grains were deformed, typical of tectonically strained quartzites in the Piedmont region (Figure 5). As experiments showed (see below), these grades of quartzites were ideal for conchoidal fracture.

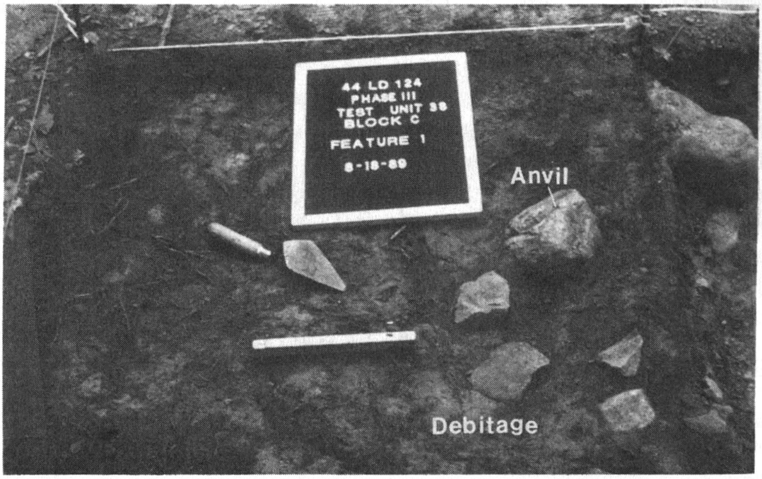

Figure 4. Feature 1, showing anvil and surrounding debitage.

Table 1. Raw Material Types

Material Type	Number	Percent
Quartzite	3233	79.5
Quartz	754	18.5
Chert	35	.9
Jasper	21	.5
Rhyolite	10	.3
Chalcedony	6	.1
Metabasalt	6	.1
Ironstone	5	.1
TOTAL	4070	100.0

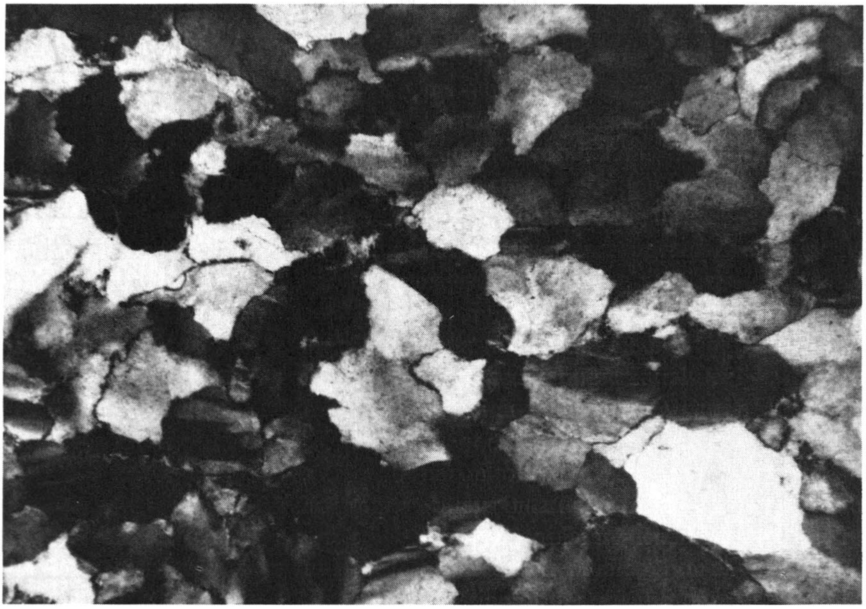

Figure 5. Petrographic thin section of a metaquartzite (40 times magnification). Note deformed appearance of grains.

The great majority of the chipped stone assemblage consisted of flakes (i.e., debitage with characteristic attributes, such as a bulb of percussion), shatter (i.e., debitage which is the product of reduction, but which does not display characteristic percussion attributes), and cores (Table 2). While projectile points, bifaces, hammerstones and other artifact types were recovered, these made up only a small fraction of the total assemblage. Of the seven projectile points, only three were temporally diagnostic, consisting of one Early Archaic LeCroy Point (Block A), one Late Archaic Brewerton Point (surface find), and one Late Woodland Levanna Point (Block C) (Figure 6).

A total of fifty-six cores or core fragments were recovered. The twenty-nine whole cores were large, weighing on average 1.1 kilo each. The largest cores were found in Block C, each averaging 2 kilos. The debitage assemblage was generally large, flakes weighing on average, 11.5 gm, and shatter, 16.5 gm. The mean weight of flakes and shatter and the weight distribution of flakes demonstrated that 44LD124 contained large and heavy debitage (Figures 7 and 8). Block C contained the heaviest debitage. The cortical flake percentages suggested that primary reduction activities were carried out at the site (Figure 9). While Blocks A and C contained similar percentages of decortication flakes, the artifacts found in Block A tended to be smaller, representing bifacial shaping and thinning debris.

Table 2. Artifact Types

Artifact Type	Number	Percent
Flake	2750	67.6
Shatter	1234	30.3
Core	56	1.3
Hammerstone	10	.2
Biface	10	.2
Projectile Point	7	.1
Uniface	1	.1
Anvil	1	.1
Abrader	1	.1
TOTAL	4070	100.0

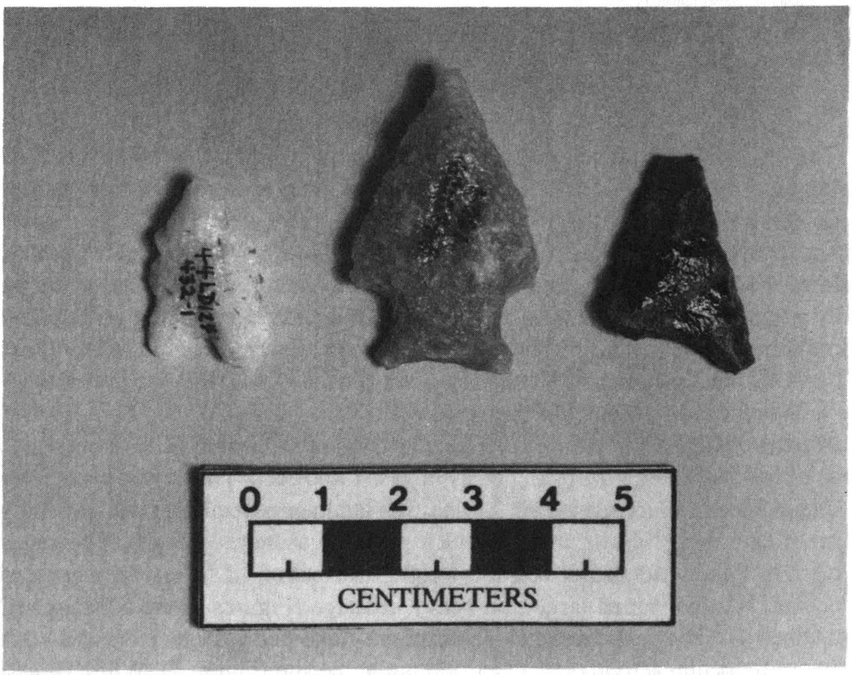

Figure 6. Projectile points from 44LD124.

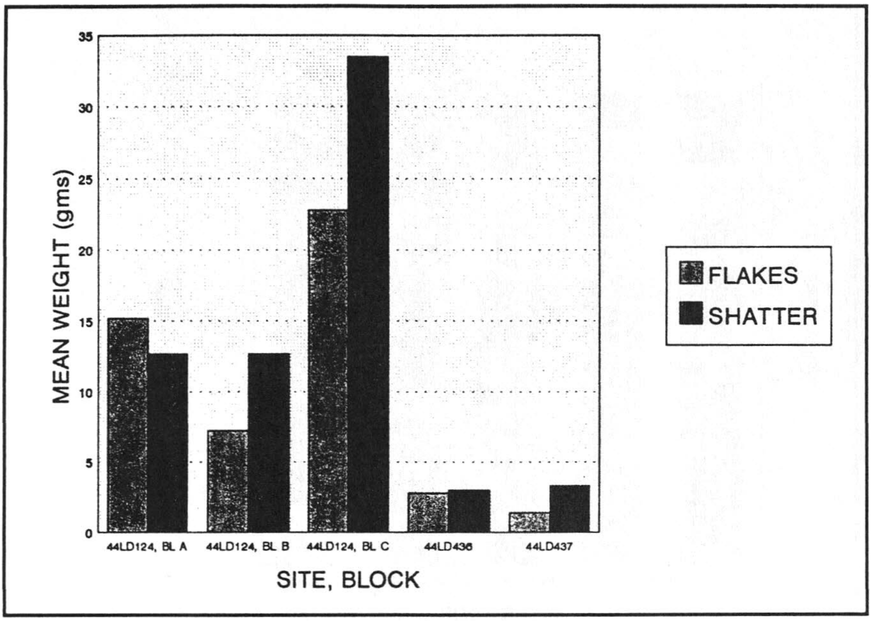

Figure 7. Mean weight of flakes and shatter by site.

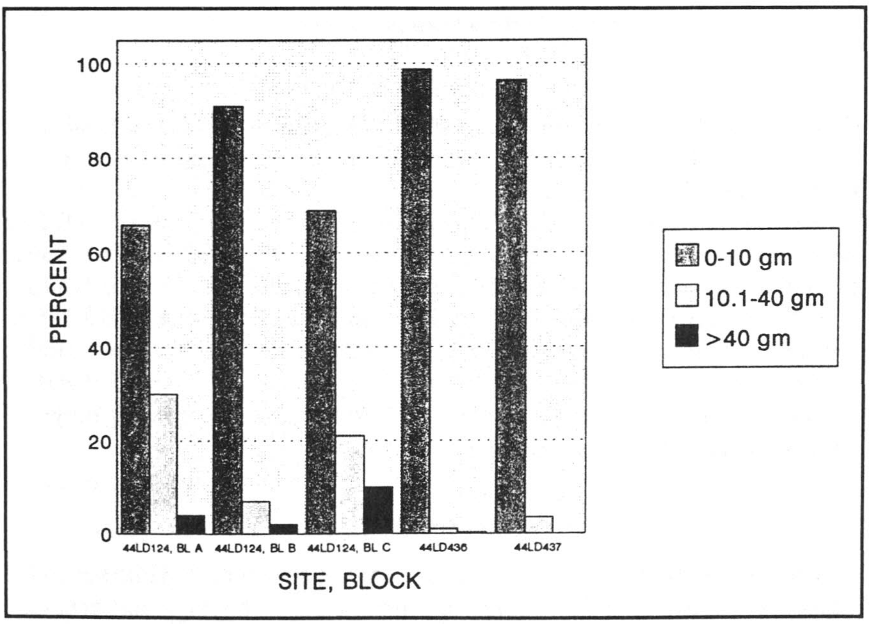

Figure 8. Flake weight distribution by site.

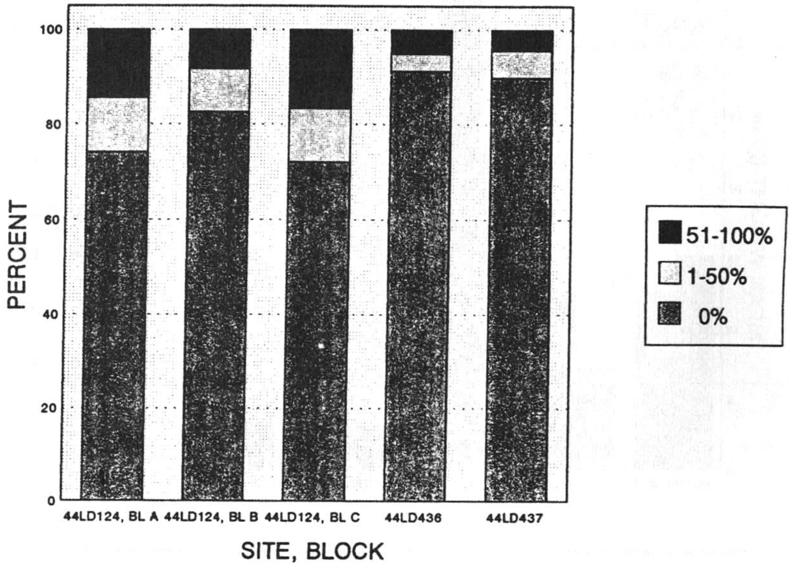

Figure 9. Cortical flake percentages by site.

Compared to two nearby floodplain sites (44LD436 and 44LD437), 44LD124 clearly differed in the size of the artifacts and the percentage of decortication flakes (Figures 7-9).

The width to thickness ratios of seven of the ten bifaces from site 44LD124 were found to be low according to Callahan's (1979) classification scheme (3 were too fragmentary to measure); four fell within the "initial edging" category (1.93 to 2.57), two fell within the "primary thinning" category (3.12 and 3.36), and one fell within the "secondary thinning" (4.50) category. The low width to thickness ratios demonstrated that initial procurement and shaping of bifaces was conducted. One biface was a good example of initial edging, displaying only a few flake removals along the perimeter (Figure 10).

REFITTING STUDY

Artifact refitting has been proven as an important analytical method in archaeology, providing valuable insights into prehistoric technology and behavioral activities (e.g., Cahen et al., 1979; Cziesla et al., 1990; Bergman and Doershuk, 1992; Hofman and Enloe, 1992). Recently refitting has been used in the Middle

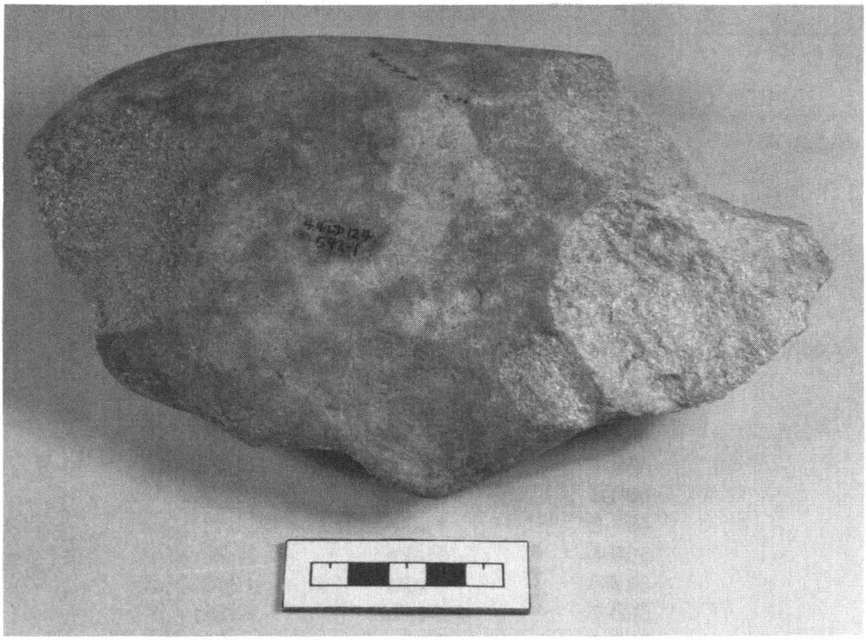

Figure 10. Early stage bifacial cobble showing edge flaking.

Atlantic region providing more refined interpretations of Archaic and Woodland activity (e.g., Whyte, 1985; Custer and Watson, 1985; Carr, 1986; Blanton and Pullins, 1991; Petraglia, 1993). Given the potential of the reassembly of quarry debris, a refitting study was carried out on the 44LD124 assemblage. The goal of the study was twofold, 1) to examine potential stone reduction techniques and, 2) to determine the prehistoric knappers stance from the spatial distributions.

Once the lithic materials from 44LD124 were processed and classified, all artifacts from the site were placed on tables in their respective provenience units so that potential conjoinable pieces could be viewed. Although the majority of the material was quartzite, refitting was aided by observable differences in color and crystalline structure.

Refit Descriptions

Despite attempts, no refits were obtained from Block A. A total of twenty refit sets were gathered from Block B, each consisting of joins of two to five pieces. Of the twenty refit sets, fifteen were fire-cracked or displayed signs of heating (e.g., reddening). The Block B refits did not show clear signs of percussion flaking. A total of eleven groups of quartzite refits were recovered from Block C (Table 3).

Table 3. Refit Groups, Block C

	Artifact Number	Artifact Type	Weight (gm)	Feature
Group A	516-2	Core	1688	1
	517-11	Shatter	459	1
	517-9	Flake	71	1
	517-9	Flake	71	1
	517-9	Flake	71	1
	556-3	Flake	752	—
Group B	476-3	Flake	25	—
	476-4	Flake	23	—
	487-1	Flake	1	—
	487-7	Shatter	3	—
	489-1	Flake	49	—
	489-3	Shatter	338	—
	497-2	Flake	2	—
	509-4	Flake	28	—
	517-5	Flake	245	1
	528-7	Shatter	335	—
	533-5	Flake	53	—
	536-4	Shatter	335	—
	556-2	Flake	19	—
	556-5	Shatter	29	—
	584-4	Shatter	245	—
	584-8	Shatter	372	—
	585-7	Flake	4	—
Group C	497-5	Shatter	72	—
	487-6	Flake	10	—
	533-8	Shatter	1	—
Group D	472-6	Flake	30	—
	497-4	Flake	173	—
Group E	497-4	Flake	173	—
	530-2	Shatter	696	—
	588-1	Shatter	1599	1
Group F	437-1	Core	2921	—
	487-9	Shatter	5	—
	497-2	Flake	4	—
	508-3	Flake	10	—
	508-3	Flake	10	—
	517-9	Flake	71	1

Table 3. (Cont'd.)

	Artifact Number	Artifact Type	Weight (gm)	Feature
	517-9	Flake	71	1
	517-9	Flake	71	1
	517-10	Flake	154	1
	517-10	Flake	154	1
	517-10	Flake	154	1
	544-3	Flake	346	—
	553-5	Flake	29	—
	556-2	Flake	75	—
	574-1	Flake	269	—
	584-6	Shatter	101	—
Group G	497-4	Flake	173	—
	544-1	Core	2319	—
Group H	462-1	Core	1787	—
	476-1	Core	907	—
	528-4	Shatter	62	—
Group I	528-1	Shatter	53	—
	552-1	Flake	29	—
Group J	517-6	Core	545	1
	528-3	Flake	338	—
Group K	476-5	Shatter	242	—
	517-10	Flake	154	1

The Block C refit groups were given alphabetical designations, and labeled A-K. While generally useful for interpretation of Block C refits, only limited technological and spatial information was derived from Groups C, D, E, I, J and K (see Table 3 and Figure 11).

Group A (Figure 12) displayed a mottled brown and white cortex and a white-brown interior with bands of light brown striations of varying texture. This group consisted of one core, four flakes, and one piece of shatter. The weight of the core was 1.7 kilos and the total weight of the group was 3.1 kilos. The weight of the flakes and shatter varied from 71 to 752 gm. A large, cortical piece of shatter was joined to the core, the shattered piece displaying a longitudinal split, along the former center of a rounded boulder. One cortical flake was joined between the core and the piece of shatter, and one large cortical flake was joined to the

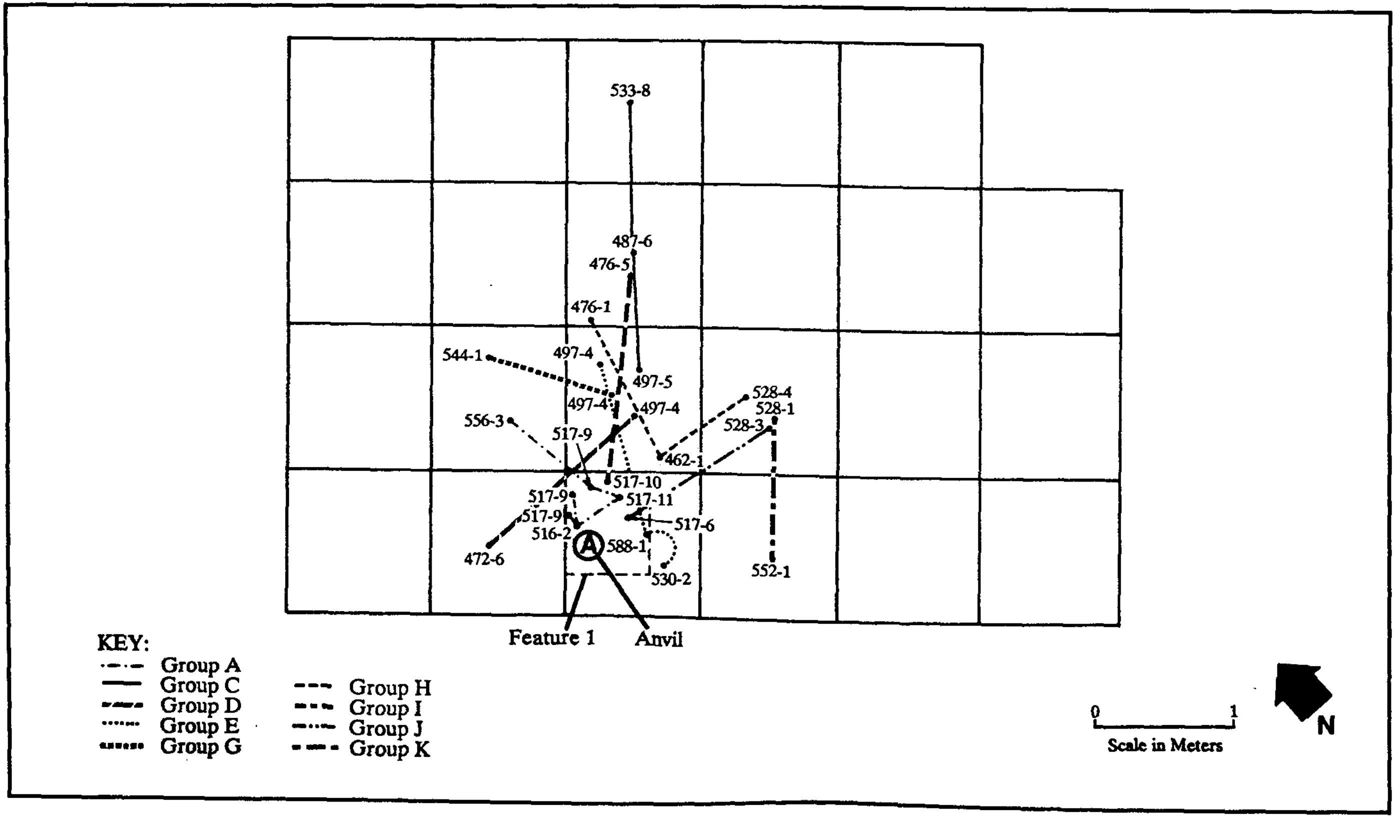

Figure 11. Spatial distribution of refits from Groups A, C-E, and G-K.

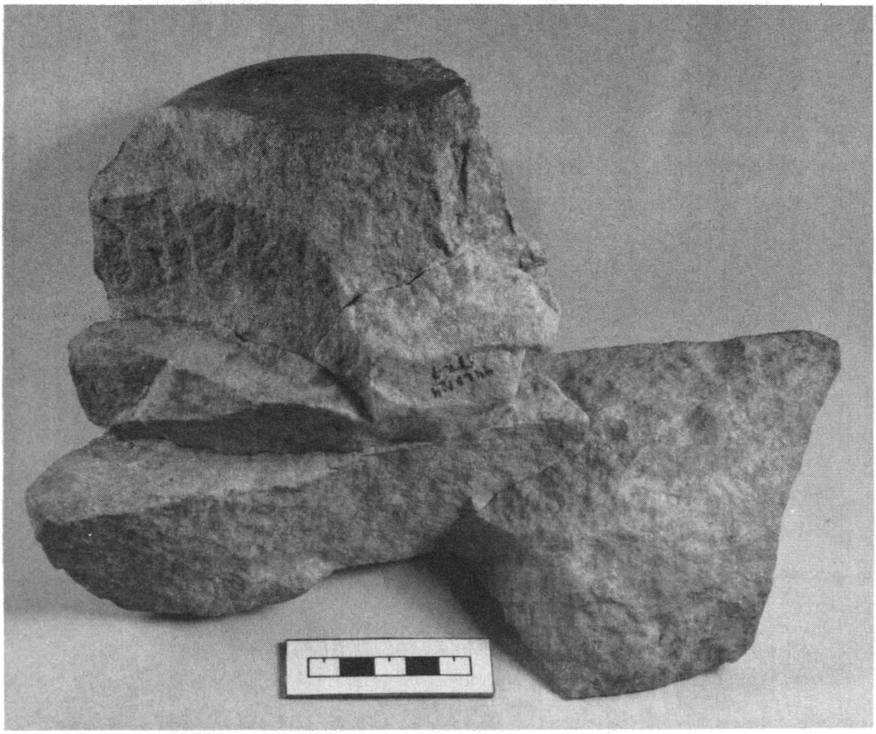

Figure 12. Group A refits.

shattered piece. Two smaller, non-cortical interior flakes were refit onto the shared surface between the split shatter and the core. The original size of this group exceeded 25 cm in length and 15 cm in width. All of the artifacts were found in Feature 1, with the exception of the large cortical flake which was found in an adjacent unit (Figure 11).

Group B (Figure 13) displayed a mottled golden brown and white cortex and a white interior. While the grains were generally well-bonded, some areas exhibited gray and black speckled inclusions and striated bands of finer-grained material. This reassembled group consisted of seventeen artifacts: ten flakes and seven pieces of shatter, all with cortex. The weight of the flakes and shatter varied from 1 to 372 gm, and the total weight of the group was 2.1 kilos. The seventeen artifacts joined to form a sub-rounded cobble, measuring approximately 19 × 18 × 12 cm. The innermost core was missing from the reconstructed cobble. Based upon the size of the cavity, the core would have measured approximately 19 × 10 × 6 cm in maximum size. The refit debitage were found in ten squares; only one flake was found in Feature 1 (Figure 14).

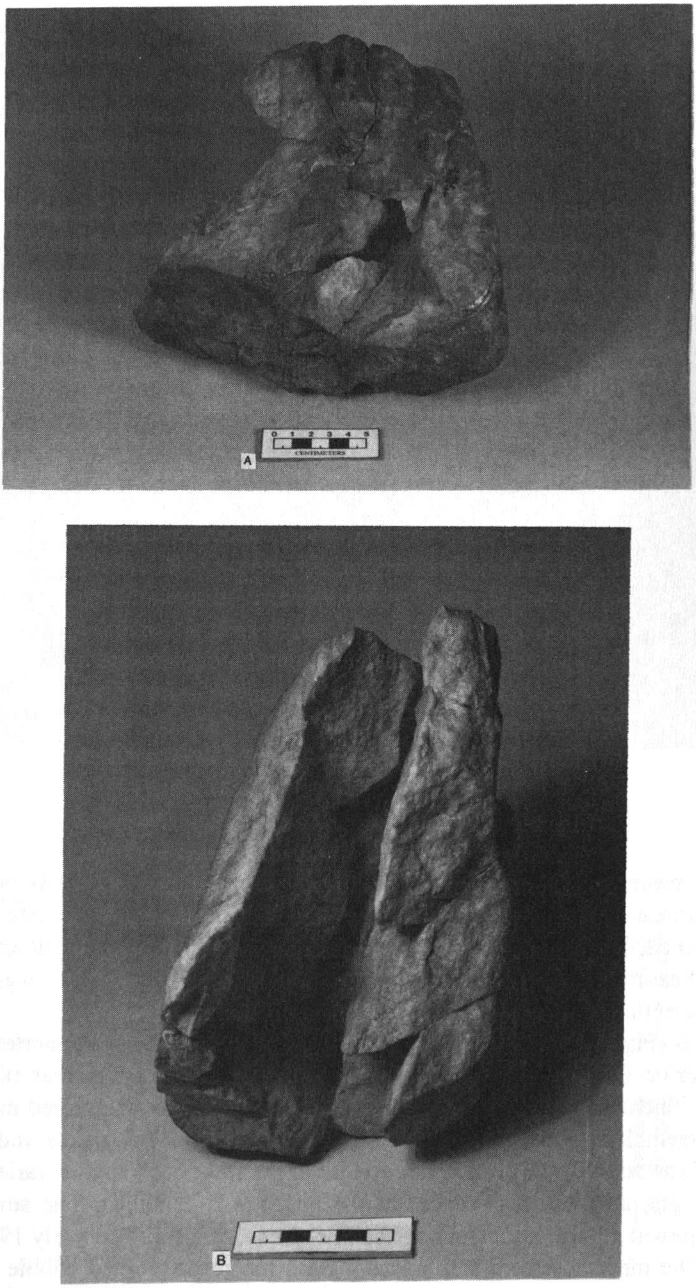

Figure 13. Group B refits, (A) cortical view, (B) interior view showing missing inner core.

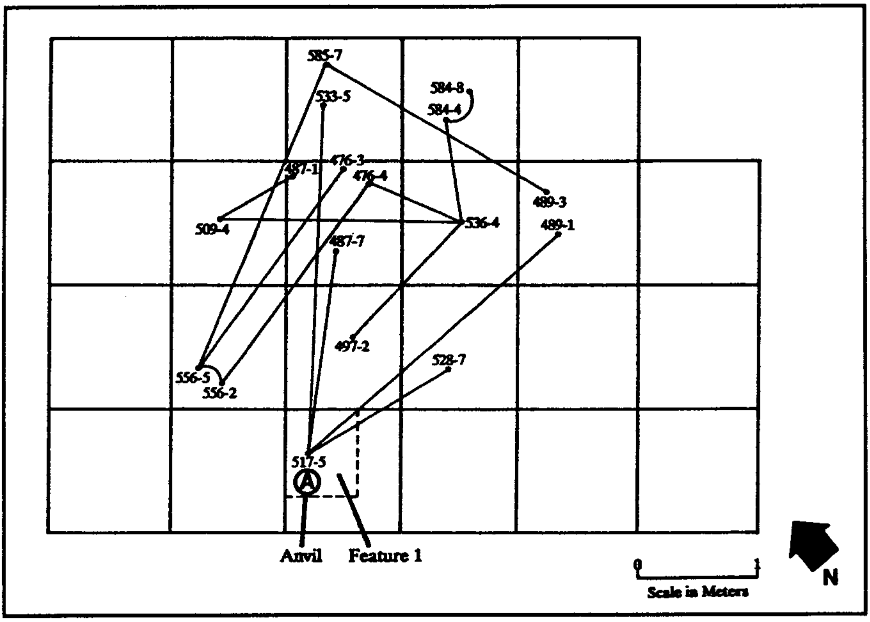

Figure 14. Spatial distribution of Group B refits.

Group F (Figure 15) displayed a brown to light brown cortex and a golden brown to white interior. The set consisted of sixteen artifacts, one large multifacial core, two pieces of shatter, and thirteen flakes. The multifacial core weighted 2.9 kilos and the debitage weighed from 4 to 346 gm, for a total weight of 4.4 kilos. The reassembled group form one section of a round and elongated cobble. The two distal ends of the cobble were missing, the reassembled set consisting of the central portion of the cobble. The size of the original cobble could not be reconstructed due to the absence of the distal ends, but the reassembled set measured 20 × 17 × 13 cm in size, with a maximum circumference of 50 cm. Three-quarters of the debitage was cortical, and the multifacial core retained two small areas of cortex. The sixteen refits were recovered from nine units; six refits were in Feature 1, and ten refits from eight other units (Figure 16). The large multifacial core was found 10 cm outside of Feature 1.

Group G displayed a mottled light brown and white cortex and a light brown interior with small red spots. The group consisted of two refits, one cortical flake attached to a core. The core displayed cortex and multiple flake removals. The weight of the group was 2.5 kilos. The refit pieces were from two adjacent units (Figure 11).

Group H displayed a white-brown and golden brown cortex and a white to golden brown interior. The group consisted of three cortical refits, two core

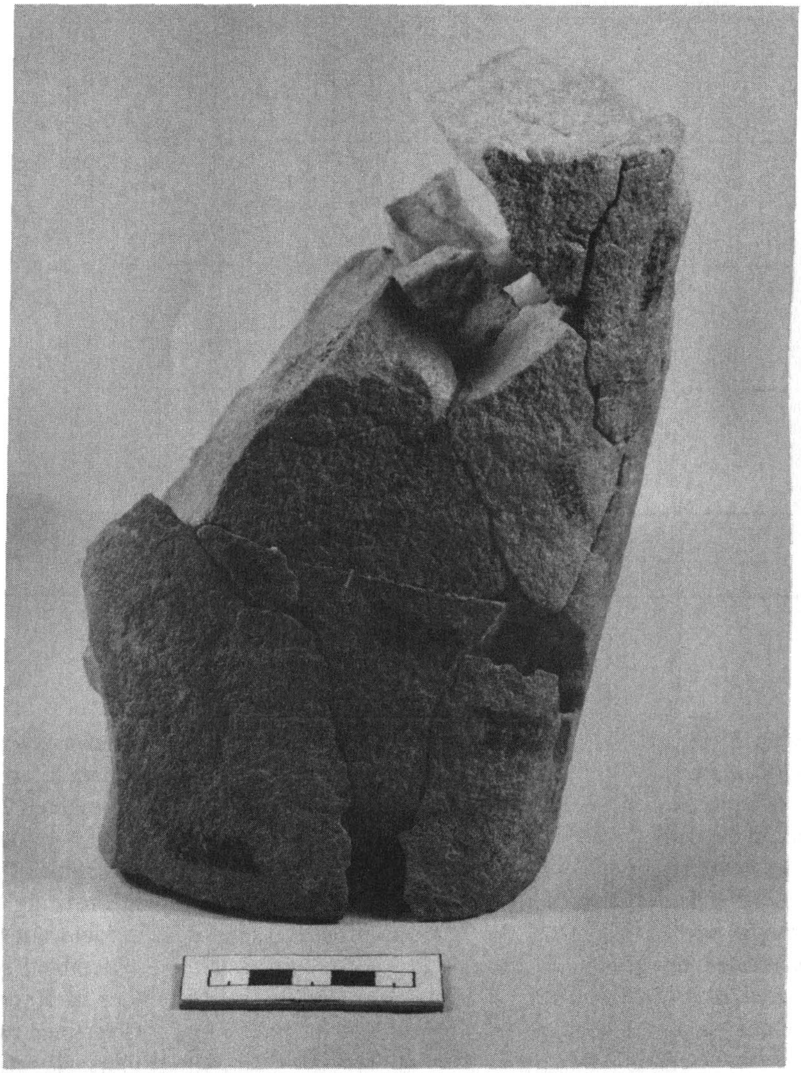

Figure 15. Group F refits.

segments and one piece of shatter, for a total weight of 2.7 kilos. These refits formed segments of a large bifacial core. All three refits were found within 1 meter of each other, although in separate units (Figure 11).

The reassembly of eleven groups of refits in Block C suggested that primary cultural factors were responsible for the artifact distributions. The refit data therefore implied that significant information about prehistoric stone technology

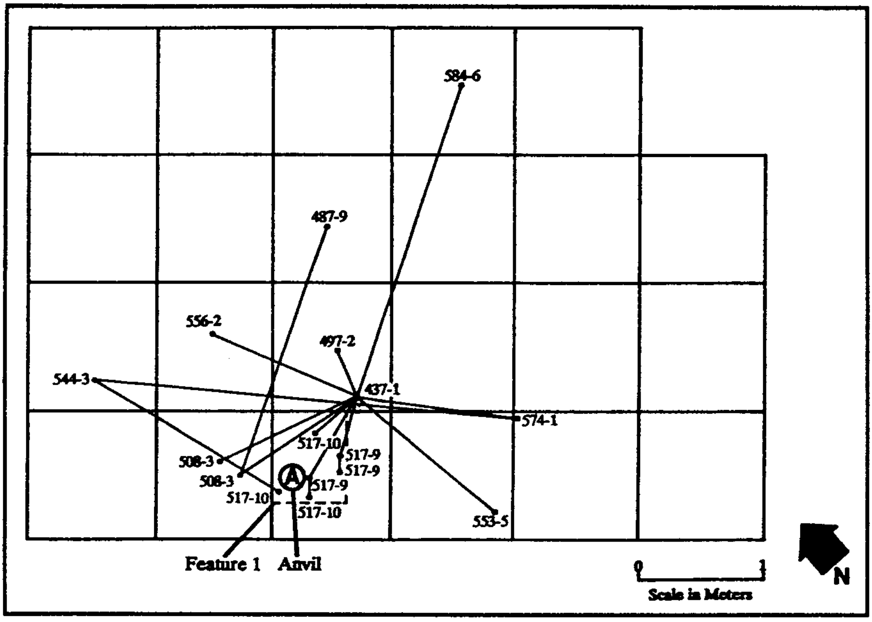

Figure 16. Spatial distribution of Group F refits.

and spatial distributions could be derived. To assist in the interpretation of the technology employed to reduce the refits, and to more accurately infer the reduction techniques which accounted for their spatial distributions, stone reduction experiments were conducted.

STONE REDUCTION EXPERIMENTS

Stone reduction experiments have been initiated to examine the spatial distributions resulting from hard hammer percussion employing different stance positions (Newcomer and Sieveking, 1980; Callahan, 1980; Schick, 1986). While Schick (1986) found that there were spatial overlaps between different stance positions, the standing position produced the most diffuse overall scatter; the kneeling, squatting and sitting positions produced clustering near the knapper with some degree of scatter; and the core-on-ground technique produced the tightest clustering.

Given the reassembly of cobbles and boulders from Block C of 44LD124, four replicative experiments were designed. The experiments were chosen based upon characteristics of the reassembled groups and the inference that percussion techniques, employing heavy hammerstones and anvils, were viable methods for the reduction of large, unwieldy quartzite quarry materials (see Callahan, 1979, Titmus, 1980, and Ebright, 1987 for discussion of boulder reduction). The goal of the experiments was to provide a greater understanding of the technology employed to reduce the material from 44LD124, and to assess potential stance positions from spatial distributions of the archaeological assemblages. The experiments were considered to be instructive in light of the fact that quartzite is rarely studied in detail and replicative quartzite experiments are rarely published (for exceptions see Bottoms, 1968; Behm and Faulkner, 1974; Toll, 1978; Ebright, 1987).

The four experiments were, 1) core-on-ground hammerstone percussion, in a kneeling position, 2) free-hand hammerstone percussion, in a seated position, 3) direct anvil percussion, in a standing and kneeling position, and 4) combined free-hand hammerstone percussion, soft-hammer percussion, and pressure flaking to produce a broad-bladed stemmed projectile point (i.e., similar to a Late Archaic Savannah River point), in a seated position. While the results of the four experiments were useful for comparative purposes, the first and third experiments were designed to replicate the spatial distributions of refit Groups B and F, while the second was considered useful for interpretation of Group H and the edged cobble (Figure 10). Although the refit groups did not consist of flakes refit to bifaces, the soft hammer and pressure flaking phase of the fourth experiment was conducted to provide a contrast to the hard hammer percussion experiments.

While the experiments provided insights into potential prehistoric quarrying techniques, limitations of the study should be addressed. First, it should be realized that only four replicative experiments were carried out, therefore the study did not re-create all possible reduction techniques and resulting spatial distributions. Second, the quantitative results of the experiments (e.g., size distributions, cortical percentages) can not be directly compared to the limited number of refits within groups. That is, the refit groups consisted of limited numbers of debitage, usually the largest cortical pieces, hence direct comparisons with the full range of flaking debris produced experimentally were not possible.

Experiment 1

The goal of the experiment was to detach large flakes from a boulder in order to produce blanks suitable for manufacture of bifaces. A large (27 × 19 × 19 cm), and heavy (10.6 kilos) boulder was chosen. An initial consideration was to stabilize the boulder for hammerstone reduction. The boulder was placed on the ground, and from a kneeling position, the knapper struck the boulder with several strong hammerstone blows. Natural flaws in the boulder were used to the knapper's advantage, allowing removal of several large cortical flakes and shatter. With the inner portion of the boulder exposed, several strong blows were placed on the center of the core, successfully splitting it in half. Both halves of the core had 80-90 degree striking platforms. One half of the core was selected for further flake removal. The core half was placed on the ground and struck along the perimeter, producing a number of cortical and non-cortical flakes potentially useful as bifacial blanks. The manufacturing technique resulted in the production of seventy-seven pieces of debitage (71 flakes, 5 pieces of shatter, and 1 core). The mean weight of the flakes was 26 gm, 18 percent of which were over 40 gm (Figures 17 and 18). A total of 27 percent of the flakes retained cortex (Figure 19). The spatial distribution was tightly clustered, the maximum distance a flake traveled was only a .5 meter from the knapper (Figure 20).

Experiment 2

The goal of the experiment was to detach flakes from a cobble for manufacture of an edged biface. A flat (25 × 17 × 7 cm) cobble weighing 3 kilos was chosen. The knapper was seated on a log 15 cm from the ground, and the cobble was stabilized on the inner thigh for direct hard hammer percussion. The goal was to detach bifacial flakes along the perimeter of the cobble using a hammerstone. The manufacturing technique resulted in the production of forty-three pieces of

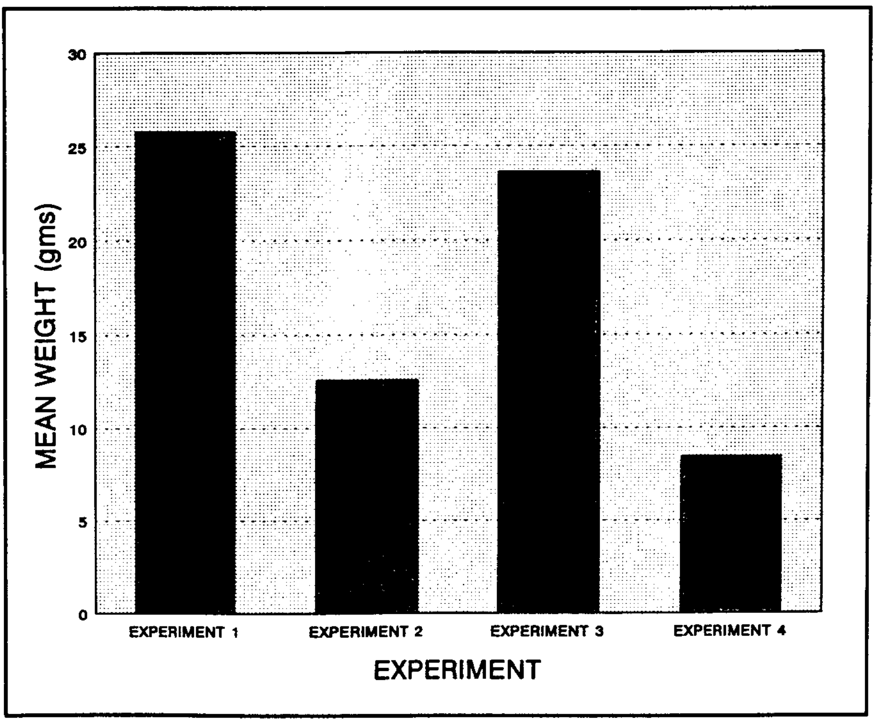

Figure 17. Mean weight of experimental flakes.

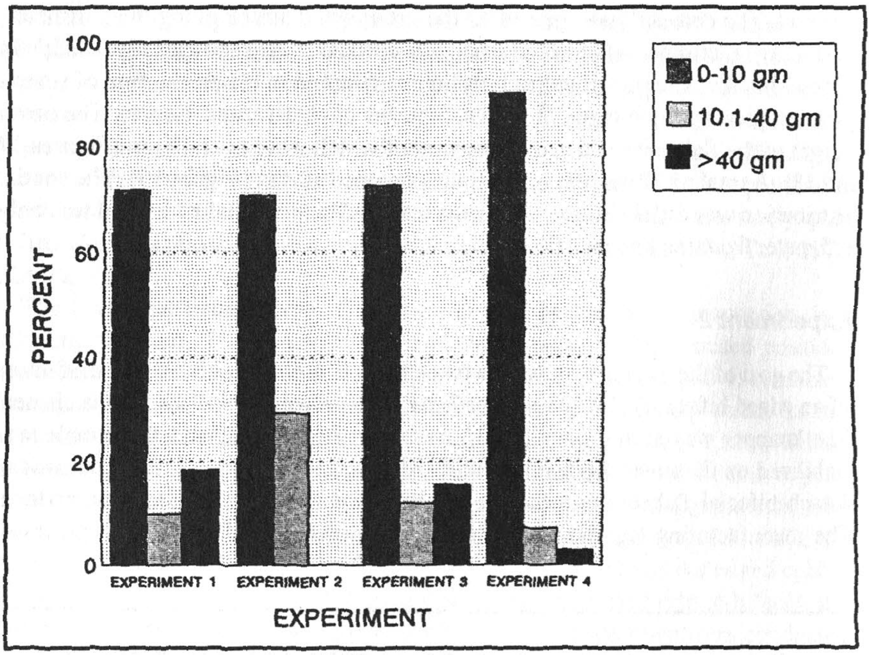

Figure 18. Flake weight distribution by experiment.

debitage (41 flakes, 1 piece of shatter, and 1 core). Small and moderate sized flakes were produced, with a mean weight of 12.5 gm, and one was greater than 40 gm (Figures 17 and 18). A total of 57 percent of the flakes retained cortex (Figure 19). The spatial distribution was clustered between the legs of the knapper, although several examples traveled 2 meters laterally, with an overall spread of 3 meters (Figure 21).

Experiment 3

The goal of the experiment was to detach large flakes from a cobble in order to produce blanks suitable for the manufacture of a biface. A large (23 × 21 × 11 cm), and heavy (6 kilos) boulder was chosen. An anvil weighing 11.6 kilos was set into the ground; the topmost striking surface was projected 20.5 cm in height from the ground. Initially, the knapper stood behind the anvil with legs spread wider than the shoulders. The boulder was held with two hands, brought up as high as the head, and then forcefully struck on top of the anvil while bending down at the waist. Large and heavy cortical flakes were produced. The kneeling position was employed when more controlled and lighter force was required to remove smaller flakes. The experiment was halted when no more suitable blanks could be

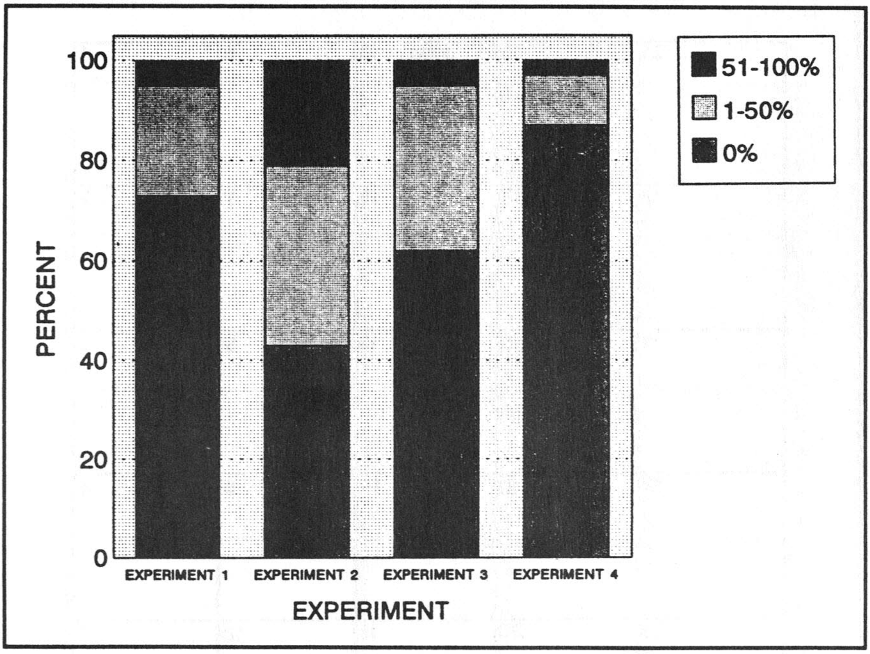

Figure 19. Cortical flake percentages by experiment.

obtained. The reduction technique resulted in the production of eighty-six pieces of debitage (84 flakes, 1 piece of shatter, and 1 core). The mean weight of the flakes was 24.5 gm, 15 percent of which were greater than 40 gm (Figures 17 and 18). A total of 38 percent of the flakes retained cortex (Figure 19). The anvil technique produced the largest and most diffuse spatial scatter of the four experiments, flakes spread in four different 1 meter units (Figure 22). In the standing position, several flakes traveled about 1.5 meters in distance from the anvil. The kneeling position resulted in a clustering of smaller debris in front of the anvil.

Experiment 4

The goal of the experiment was to manufacture a broad-bladed, stemmed projectile point, similar to a Savannah River point. A large (20 × 14 × 9 cm) cobble weighing 2.8 kilos was chosen. The knapper was seated on a log, 15 cm from the ground. The experiment began with the removal of cortical flakes from the cobble, using hammerstone percussion. Once initial flakes were removed, the anvil technique, in a kneeling position, was employed to remove several larger flakes followed again by hammerstone reduction. With the production of suitable blanks, one was selected for initial thinning. A heavy antler billet was used to

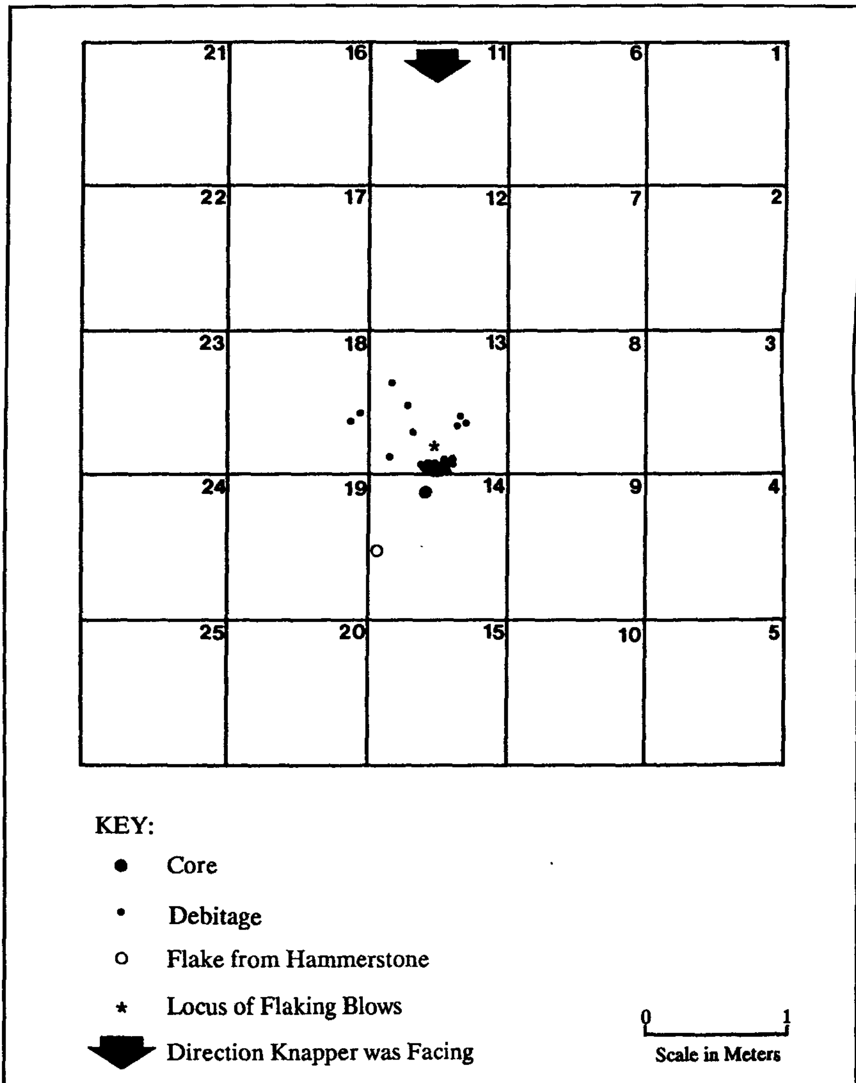

Figure 20. Spatial distribution of Experiment 1.

remove cortex and prominent humps. Once the biface was shaped, a smaller and lighter antler billet was used for further thinning. Pressure flaking with an antler tine was used for notching and completing the point. The manufacturing technique resulted in the production of 457 pieces of debitage (453 flakes, 4 pieces of shatter) and one point. The great majority of the flakes were small, with a mean

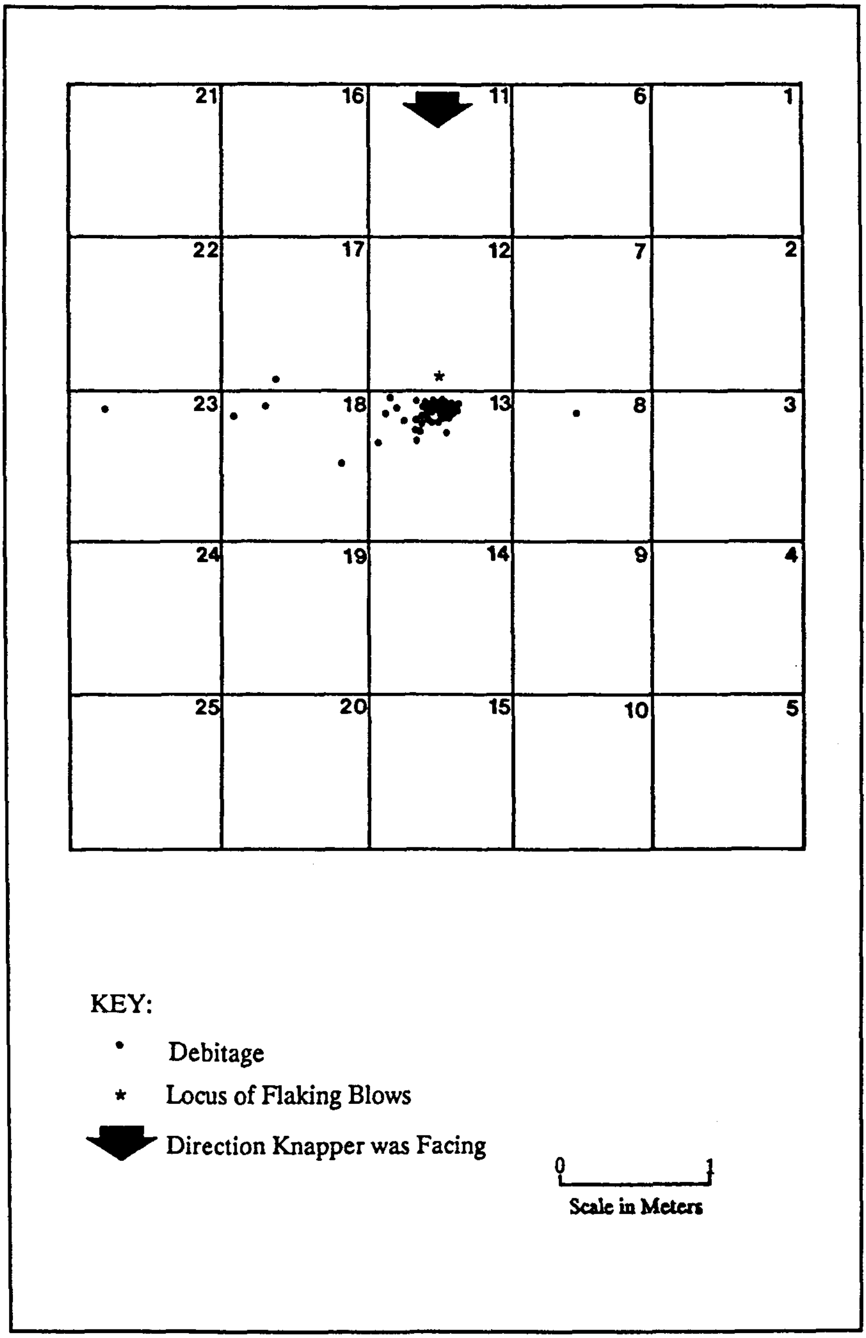

Figure 21. Spatial distribution of Experiment 2.

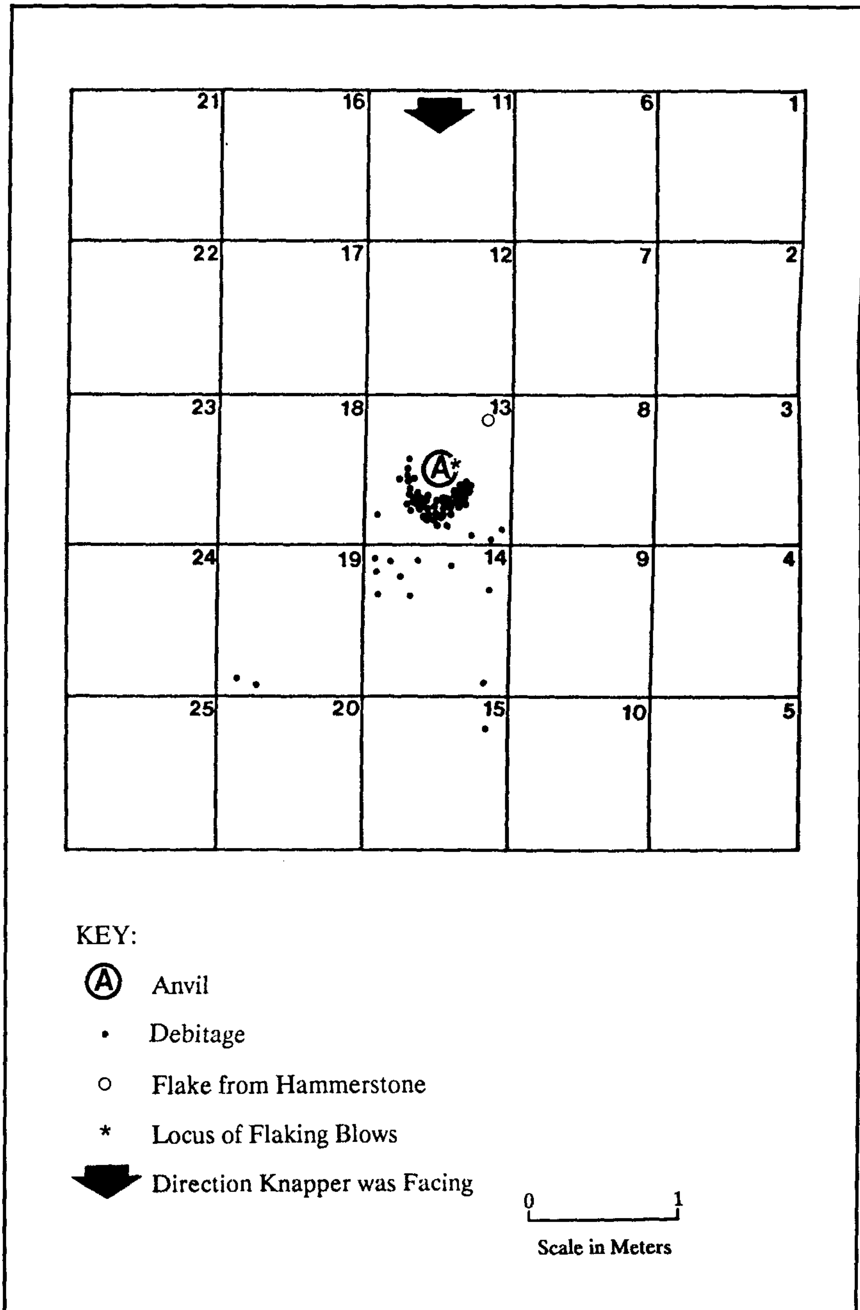

Figure 22. Spatial distribution of Experiment 3.

weight of 8 gm, and 90 percent of which were 10 gm or under (Figures 17 and 18). Only 13 percent of the flakes retained cortex (Figure 19).

TECHNOLOGICAL AND SPATIAL INTERPRETATIONS

The combined results of the joint refitting and experimental project provided the basis to infer certain aspects of prehistoric quartzite quarrying. Technological attributes (i.e., cortex percentages, weight distributions) and the spatial distribution of the refits were used to interpret reduction strategies and potential stance positions.

The absence of refits from Block A was likely due to the predominance of middle stage debitage, characteristic of a quarry workshop. That is, the area primarily contained debitage derived from the shaping of tools which does not lend itself to refitting. Based on the presence of middle stage debitage and the absence of refits, the evidence suggested that blanks were carried into the area, shaped into bifaces, and transported to another site. Fifteen of the refit sets from Block B were fire-cracked or heated, in agreement with the high density of fire altered rock in this area. The high density of heated quartzite suggested the possibility that the material was intentionally fire altered to assist in the reduction of materials.

The eleven refit groups from Block C represented debris associated with the reduction of quartzite cobbles and boulders. A special circumstance was presented due to the presence of the anvil and surrounding debitage. Groups C, D, E, I, J, and K consisted of few refits, hence only limited interpretations about reduction methods can be inferred. The large size of the debitage, their high degree of fracture, and their wide spatial distributions did show, however, that considerable percussive force was used to drive off these cortical pieces.

Among the Group A refits, the large cortical flake appears to have been driven off first. A degree of force would have been required to drive off the flake, indicated by its large dimensions, thick and convex cross section, the prominent bulb of percussion, and its location 1 meter from the anvil. All of the refits join along a split plane, showing that the original boulder was sectioned into two or more parts. A large degree of applied force would have been required to drive off the first large cortical flake and to split the boulder. Anvil or hammerstone percussion could have been used for initial reduction. Judging from the multiple negative flake scars on the core, initial heavy duty percussion flaking was followed by removal of cortical and non-cortical flakes. More controlled application of force from the core was indicated by the smaller dimensions of the flakes, their smaller platform sizes, and less pronounced bulbs of percussion. The flake attributes suggested that reduction was probably accomplished by hammerstone percussion, near the anvil, indicated by location of the majority of the refits in Feature 1.

The seventeen refit pieces from Group B formed a cobble that was reduced with the apparent goal of obtaining an inner core for stone tool manufacture. A biface was likely manufactured from the missing inner core since all of the cortex was removed, and the innermost, best quality material would have remained. The refits demonstrated that reduction was accomplished by first splitting the cobble into fragments, aided by inherent flaws. The force required to initially split the cobble could have been accomplished using an anvil or heavy hammerstones. The morphology and dimensions of the later stage debitage suggested more controlled use of force, probably hammerstone percussion. The large and diffuse scatter of debitage does not clearly resemble any of the spatial patterns produced from the experimental methods. The recovery of the sixteen pieces of refit debitage from ten different test units, with a maximum spread of 3 meters, suggested that the cobble was reduced in a high position from the ground, probably in a standing or kneeling position (Figure 23).

The sixteen refit pieces from Group F formed a large and heavy cobble. The original cobble had to be reduced to manageable proportions since it was probably unsuitable for controlled flaking. The reconstructed cobble showed that splitting occurred at the two distal ends, leaving a central section for further reduction. The force required to split the distal ends off the large, heavy and elongate cobble could have been best achieved by anvil percussion. Once splitting was successfully accomplished, flat distal surfaces were created, with 90 degree striking platforms, ideal for detachment of the multiple cortical flakes. Once the cortical flakes were removed, smaller, non-cortical flakes were detached as shown by the refits and multiple negative flake scars on the inner core. The detachment of the large, cortical flakes and the smaller non-cortical flakes was most likely accomplished by using hammerstones. Approximately one-third of the central section was missing, probably providing the knapper with the needed flakes. Spatially, Group F produced a tight cluster of debitage in Feature 1 and close to the anvil, surrounded by a more diffuse spread of debitage 3 meters from the anvil. The dispersed spatial array of the refits suggested that the set was reduced in a high position from the ground, probably in a standing or kneeling position (Figure 23). The clustering of debitage near the anvil may represent either the fall out of material during reduction in a standing or kneeling position, or it may represent material reduced with less percussive force, and possibly in other stance positions.

Group G consisted of only two refits, forming an object no larger than the size of a cobble. The core exhibited many other smaller flake removals. The detachment of the large cortical flake and multiple smaller flakes from the core, and the separation of the refits by 1 meter, would have been best accomplished by hammerstone percussion.

Group H consisted of three large cortical sections, forming part of a large biface. Three stages of reduction were inferred: first, a flake was removed from an object the size of a boulder, second, the flake was edged to produce a biface, and finally, the biface was sectioned. The method employed to detach the large flake

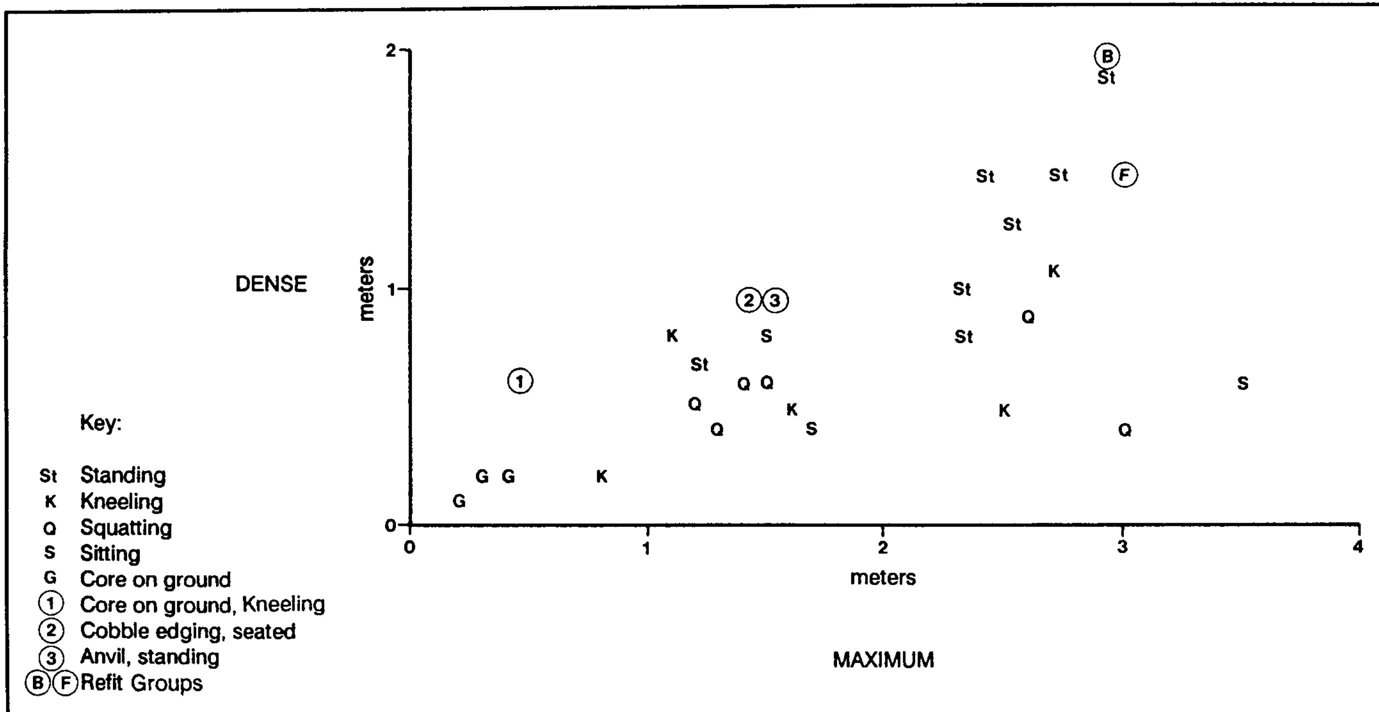

Figure 23. Spatial distribution of Experiments (after Schick 1986: Figure 3.7). The “Dense” axis is defined as the scatter of the closest two-thirds of the debitage. The “Maximum” axis is defined as the maximum distance between two flakes. The uncircled letters represent the data obtained by Schick during a number of percussion experiments. The circled letters and the circled numbers represent the refit groups and the experiments described herein.

from the boulder can not be ascertained, but flake removal would have required application of a high degree of percussive force. The small size and the controlled nature of the edge flaking suggested that a hammerstone was used for biface production. The method used to section the biface was also difficult to infer, but leverage for breakage would have been required, perhaps assisted by use of the anvil.

DISCUSSION AND CONCLUSIONS

Intrasite artifact distributions showed that tool shaping was performed in Block A, indicated by the presence of middle stage debitage. Characteristic of a quarry workshop, the debitage tended to be smaller in size, a high percentage exhibiting some degree of cortex. The high density of thermally altered stone in Block B showed the use of fire, indicating that thermal alteration may have been intentionally used. The use of fire for fracturing and altering quartzite has been witnessed in ethnoarchaeological settings (Binford and O'Connell, 1984) and in other Middle Atlantic quartzite quarries (Ebright, 1987). Although a relationship was not drawn between the high densities of fire-cracked rocks and quarry-related debris in other Potomac terrace sites (Rust, 1983; Rust et al., 1983), circumstantial evidence implies that thermal alteration may have been used to assist in stone reduction.

The reassembly of cobbles and boulders in Block C of 44LD124 indicated that hard hammer percussion was used for reduction. Given the large size of the cobbles and boulders (e.g., Groups A, B and F), anvil and hard hammer percussion were probably employed for decortication and reduction of the large cores. In all three of these cases, large boulders appeared to have been split during initial reduction. Callahan (1979:40) has described a similar technique, in which boulders were quartered into blocks, using heavy hammerstones, in order to break off chunks so that flat surfaces could be created as use for suitable striking platforms. In the case of Group B, the goal was to obtain a core for biface production, while in the case of Group F, the goal was apparently to produce flakes for potential tools. In other cases (e.g., Group H and Figure 10), flat cobbles and flakes were edged along their perimeter, likely employing hammer percussion. All three of these strategies have been noted to occur in other quartzite quarries (e.g., Holmes, 1890, 1897; Ebright, 1987).

The spatial information derived from the refitting project provided an opportunity to assess potential stance positions and episodes of prehistoric activity. The wide spatial distribution of two groups (B and F) appeared to demonstrate that a high stance position was employed, such as standing or kneeling. The association of six groups (A, B, E, F, J, K) with Feature 1 suggested contemporaneous use or reuse of the anvil. The reduction of these cobbles and boulders could have been accomplished in a short period of time by a single individual. Experimental reduction demonstrated that a single cobble or boulder could be reduced in about five to ten minutes.

In terms of chronological evidence, there was no secure nor direct indication of the period of quarrying at 44LD124. Indirect evidence, however, strongly implied an affiliation with the Late Archaic. Surveys performed in the vicinity of Selden Island have shown that Late Archaic sites and Savannah River points were abundant, and the great majority of the points were made from quartzite (see Rust, 1983; Rust et al., 1983; Petraglia et al., 1990). In contrast, projectile points of earlier and later periods were usually manufactured from other materials, mainly quartz and chert. More definitive proof of the temporal context of major quartzite quarrying was obtained from a nearby Potomac terrace site, 44LD284 (Rust, 1983; Rust et al., 1983). That site was found to be a quartzite quarry containing Savannah River points and yielding Late Archaic radiocarbon dates.

Rust (1983) has discussed the variable ways in which quartzite was distributed on the Potomac River terraces in the vicinity of Selden Island. The distribution of quartzite in the region varied greatly owing to circumstances of transportation and deposition of material by the Potomac River. There appeared to be four main ways in which quartzite occurred, likely influencing prehistoric procurement and reduction strategies. In the first situation, quartzite was concentrated in upper Pleistocene terrace deposits. Site 44LD124 represented a situation in which quartzite cobbles and boulders were concentrated because of deposition along a fault in the bedrock. Like 44LD124, a nearby site, 44LD284, contained concentrations of quartzite and 10,000 quarry-related artifacts (Rust, 1983; Rust et al., 1983). In the second and third situations, materials on the Pleistocene terraces of the Potomac and the floodplain may be dispersed, consisting of only occasional cobbles and boulders. In these cases related sites often only contained scatters of quartzite artifacts (Rust, 1983; Petraglia et al., 1990). In the fourth situation, the active floodplain and channel of the Potomac contained gravel bars with quartzite materials. In this case, however, the quartzite was not readily available or the material was only exposed for a short period of time, as it was buried or under water. Although little substantive research has been carried out on the correspondence between quartzite distribution and prehistoric procurement and reduction, preliminary surveys appear to suggest that the location of archaeological sites and their type of contents are related to the distribution and availability of quartzite. In terms of larger regional trends, the Potomac situations contrast markedly with the Piney Branch quarry, which contained different grades of quartzite (i.e., orthoquartzite) and areally extensive and deep deposits of quarrying debris (cf. Holmes, 1890; Munford, 1982; Ebright, 1987).

In sum, the examination of 44LD124 has provided a rare opportunity to examine and address aspects of prehistoric quartzite quarrying. The joint refitting and experimental study has provided information to make more secure inferences about prehistoric reduction strategies and their spatial consequences. While some initial conclusions have been drawn from analysis of site 44LD124, the study suggests that much more information about prehistoric technology and settlement can be learned from examination of quartzite procurement, reduction and utilization in the Potomac Valley.

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