6.0 ARCHAEOLOGICAL FINDINGS

The following section of the report presents the results of the archaeological investigations conducted at the Black Diamond site. Descriptive and interpretive analyses of the findings are detailed, beginning with a review of the archaeological evaluation of the site. The location of the site within the surrounding landscape is reviewed, and a general evaluation of stratigraphic contexts and the cultural materials that were contained in the deposits is presented. The end result of the evaluation was an assessment that the site retained sufficient integrity and research potential to meet eligibility Criterion D for listing in the NRHP, providing important information regarding American Indian prehistory in Delaware based on research priorities established by the DESHPO.

Following the evaluation, the results of the mitigation study are presented. In-depth analysis of site contexts includes a detailed description of sediment stratigraphy, a review of the results of absolute dating, and a summary of an analysis of stratigraphic integrity. The Late Archaic temporal component at the site is then defined using artifact assemblage characteristics and analysis of horizontal spatial patterning, which established the boundaries of the occupation and supported the interpretation that the site was single-component in nature. Finally, detailed description and analyses of the constituent artifact assemblage are presented.

6.1 Site Evaluation (Phase II): Summary and Analysis

The archaeological evaluation of the Black Diamond site described in this report was undertaken as a result of recommendations of the initial site survey conducted by LBA in 1997 (Bedell and Jacoby 1998). That survey entailed the excavation of four parallel transects of shovel tests on a 20-m interval within the proposed right-of-way. The archaeological site was identified on the basis of seven contiguous and two outlying positive shovel tests on the survey grid. The tests yielded a total of 17 pieces of flaking debris—characterized as quartz, quartzite, and jasper—and a single fragment of fire-cracked rock. Historical artifacts were also recovered, but in low frequency; they were not considered to represent an archaeological site component. The dimensions of the prehistoric site were estimated as 45-x-75 m. Based on the recovery of a small sample of artifacts from below the plow zone, the LBA investigators concluded that potential existed for intact subsurface contexts at the site. Consequently, the prehistoric site component was recommended for formal evaluation to determine NRHP eligibility. The CR Division was later contracted to formally review management recommendations for all of the archaeological sites identified in previous surveys of the Smyrna-to-Pine Tree Corners segment of the SR1 right-of-way, including the Black Diamond site (Parsons 1999). The CR Division agreed with the LBA conclusions and again recommended evaluative testing of the prehistoric component of the site. Concurrence with the recommendation was granted by DESHPO in November 1999.

Fieldwork was conducted by the CR Division in June 1999. The work consisted of a series of shovel tests systematically excavated on-grid to relocate the site and refine horizontal boundaries. In addition, 1-m^2 test units were used to investigate details of stratigraphy and more closely examine areas of artifact concentration.

6.1.1 Shovel Testing

At the time of the evaluation study, the site area was in second-growth forest and ground surface visibility was poor. Shovel tests were excavated on a 5-m grid oriented with the centerline of the proposed right-of-way. In total, 185 shovel tests were excavated on the grid. Of these, 56 tests yielded prehistoric artifacts, and 23 yielded historical artifacts. Shovel test data were plotted on a scaled map to provide preliminary analysis of artifact distribution across the site (Figure 6-1). The prehistoric site component appeared to be represented by a dense and spatially discrete concentration of lithic debitage (flaking debris) centered near the crest of the low ridge northeast of the bay/basin. The concentration covered an area approximately 400 m^2. Artifact counts within the concentration ranged as high as 49 per shovel test. Artifacts occurred below the plow zone mainly in an area corresponding with the highest part of the landform on the ridge. While no thermally altered stone was found within the main artifact concentration, individual fragments were recorded in five peripheral shovel tests. The separation of artifact types thus recorded in the shovel test results suggested that discrete activity areas or occupation components might be present.

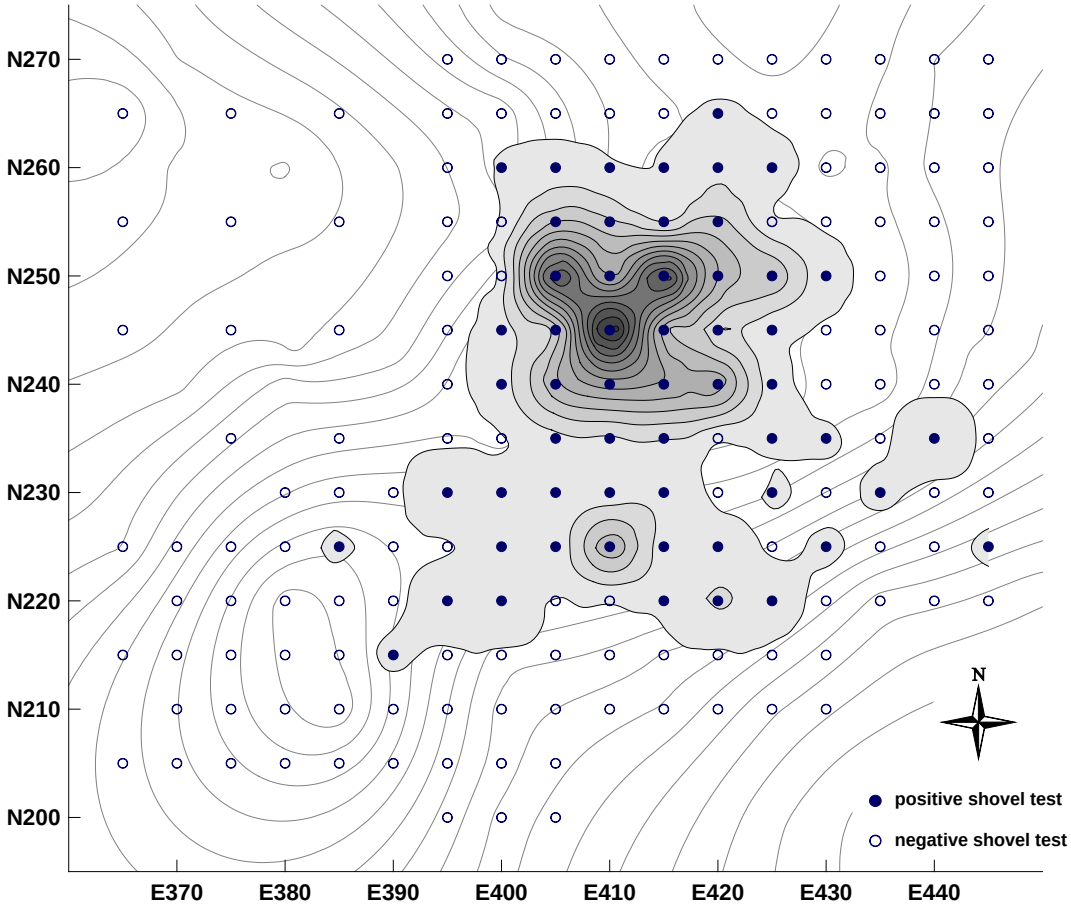


Figure 6-1. Spatial Analysis of Prehistoric Artifact Distribution Based on Site Evaluation Shovel Testing.

Historical artifacts recovered during this testing were widely dispersed across the site and were wholly contained within the plow zone. The recovery of historical artifacts was anticipated, and while analysis of the material was not included in the formal site evaluation

study, the artifacts were documented as found. Advance consultation with DelDOT and DESHPO resulted in a treatment strategy in which the artifacts were analyzed and reported in an appendix to the report on the prehistoric component of the site. For the sake of completeness in reporting the site evaluation results, the mapped distribution of historical artifacts from the study is presented here (Figure 6-2), while the remainder of the analysis of historical data from both the evaluation and mitigation investigations is included in Appendix B.

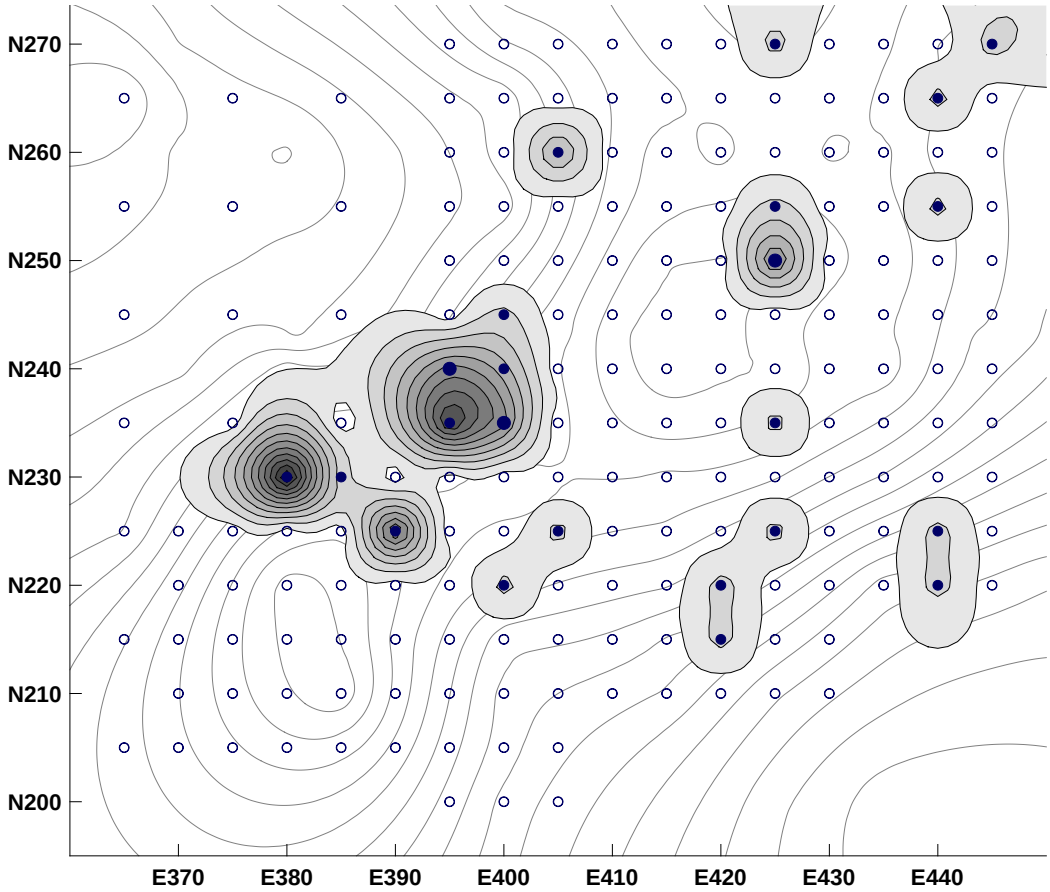


Figure 6-2. Spatial Analysis of Historical Artifact Distribution Based on Site Evaluation Shovel Testing.

6.1.2 Test Units and Stratigraphy

Following shovel testing, sixteen 1-m^2 test units were placed on a 10-m grid within the prehistoric artifact concentration representing the apparent center of the site. Prehistoric and historical artifacts were recovered from six of the test units. One additional test unit was placed off the grid interval to the southwest, at N231/E394, to test a scatter of brick fragments discovered in that location and determine whether a small historical component might be present that had been missed by earlier survey and testing—no such component was found.

Two distinct soil profiles were recorded in units within the central part of the site. Units to the south and southeast, lying slightly down slope from the ridge crest, contained a shallow,

gravelly plow zone overlying gravels that represented an eroded Columbia Formation surface. Artifacts from this portion of the site were limited to plow zone contexts. Unit N232/E429 typified this sequence:

Unit N232/E429

0-20 cm	10YR 5/3 sandy loam with gravel (plow zone)
20-40 cm+	10YR 6/4 sandy loam with gravel

Near the crest of the ridge, loamy medium-fine sands that appeared to be aeolian in origin capped the soil profile. The upper part of this deposit had been plowed, but artifacts occurred in the first 20 cm below the plow zone, indicating that sediment accretion had been sufficient to partially shield the cultural deposits from the disturbance. The third stratum comprised redder, coarser textured sand that was culturally sterile. Unit N242/E409 typified this sequence:

Unit N242/E409

0-28 cm	10YR 5/4 loamy sand (plow zone)
28-50 cm	10YR 5/6 loamy sand
50-60 cm+	7.5YR 5/6 loamy coarse sand

6.1.3 Features

Two features were identified below the plow zone during test unit excavation, both consisting of shallow pits of undetermined origin. Feature 3 was recorded in the eastern half of the test unit at N242/E428 (feature numbers are not necessarily sequential since soil anomalies determined on further investigation to be non-cultural were disregarded yet their numbers were maintained in field logs for bookkeeping purposes). Feature 3 was first recognized at the base of the second stratum, at a depth of approximately 40 cm below surface grade. The portion of the feature exposed in the test unit had gently sloping sides that extended 20 cm in depth and ended in a flat bottom. Two fragments of thermally altered stone were recovered from the feature. The second pit, Feature 4, was recorded in the southwest corner of the test unit at N261/E410, beginning at the base of the second stratum and extending into the underlying coarse sand. Relatively little of the pit was exposed, but it appeared to have moderately sloping sides and to extend at least 30 cm in depth. One quartzite flake was recovered from the feature fill.

6.1.4 Artifacts

In total, 1,313 artifacts were recovered during the site evaluation study, including 1,203 prehistoric, 93 historical, and 17 fragments of culturally modified floral or faunal material (Table 6-1). A complete artifact inventory is included in Appendix G.

Table 6-1. Artifact Frequency Totals from Site Evaluation Testing.

group	*count*
prehistoric	1,203
historical	93
floral/faunal	17
total	1,313

Approximately 98 percent of the prehistoric artifacts consisted of flaking debris (Table 6-2). The frequency of occurrence of quartzite was approximately 93 percent, and most of this material consisted of a distinctive, coarse-grained, gray and red quartzite. A contracting stemmed argillite point was recovered that was thought to be generally diagnostic of the Late Archaic-to-Early Woodland period. In addition, six bifaces were recovered, all made from the distinctive gray and red quartzite. Included in the assemblage was a thin, finely flaked blade, a stemmed biface broken in production, a distinctive "turtleback" tool with the appearance of a bifacial core with cutting edges flaked along its sides, and two smaller biface fragments.

Table 6-2. Prehistoric Artifact Frequency by Type from Site Evaluation Testing.

artifact type	*count*
biface	6
chip	24
core	1
flake	1,148
point	1
potlid	1
thermally altered stone	22
total	1,203

Historical artifacts consisted mainly of fragments of brick and coal. For completeness in reporting the site evaluation results, Table 6-3 summarizes the findings. The remainder of the analysis of historical data is included in Appendix B. Historical ceramics included pearlware, whiteware, and ironstone, typical of the early-to-middle nineteenth century. Machine-made bottle glass, from the twentieth century, was also present.

Floral material consisted of seven fragments of charcoal. Faunal material consisted of eight fragments of non-calcined animal bone and one fragment each of oyster and snail shell.

Table 6-3. Historical Artifact Frequency Totals from Site Evaluation Testing.

group	*material*	*count*
domestic	glass vessel sherd	2
	coarse redware vessel sherd	6
	refined redware vessel sherd	4
	refined earthenware	1
	pearlware vessel sherd	2
	whiteware vessel sherd	8
personal	pipestem	1
architectural	brick fragment	48
	iron fragment	1
fuel	coal/clinker/slag fragment	20
	total	93

6.1.5 Vertical Artifact Distributions

Although most of the prehistoric artifacts were recovered from the plow zone, artifact-bearing deposits were documented in sub-plow zone contexts. The frequency distribution by stratum of artifacts from test units in the 10-m grid is displayed in Figure 6-3. The sixteen units contained a total of 774 prehistoric artifacts, 69 percent from the plow zone and 31 percent from proveniences below the plow zone. Broad calculations of artifact type and lithic material type frequencies suggested similarities between the deposits suggesting that they were directly related: the frequency of flakes in the plow zone was 96 percent, below the plow zone 95 percent; the frequency of quartzite in the plow zone was 94 percent, below the plow zone 89 percent.

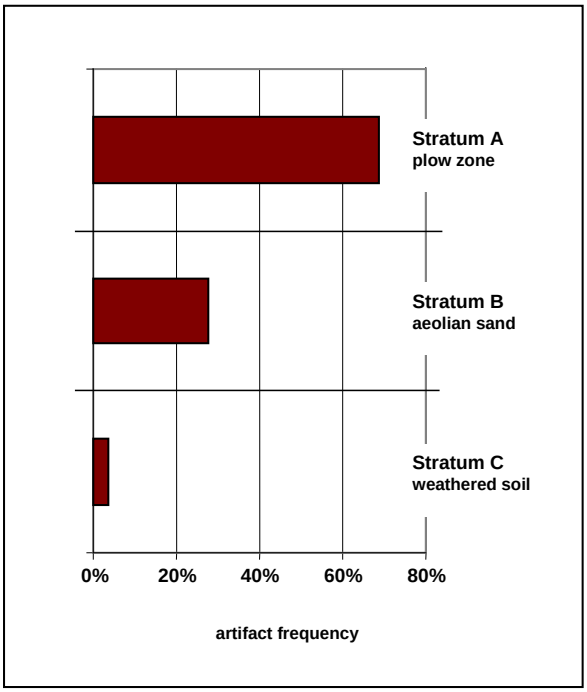


Figure 6-3. Prehistoric Artifact Frequency Distribution by Stratum.

6.1.6 Site Evaluation Summary and NRHP Recommendations

Following the completion of site evaluation fieldwork and data analysis, recommendations were made with regard to the eligibility of the site for inclusion in the NRHP. While the historical component at the Black Diamond site was not formally under evaluation, additional historical artifacts were discovered during testing of the prehistoric component. The artifacts were widely dispersed and fully contained within the plow zone. As detailed in Appendix B, the Black Diamond site was located on land owned by the prominent Reynolds family. However, nineteenth-century maps show no structures in the vicinity of the archaeological site. No sub-plow zone contexts were identified. Most of the artifacts recovered consisted of fragments of brick and coal. Overall, the limited quantity and variety of artifacts along with the lack of features or structural remains suggested that the historical component at the Black Diamond site comprised a typical field scatter representing little additional research potential. No further recommendations were made concerning the component.

The prehistoric artifacts recovered from the evaluation study at the Black Diamond site suggested that the site functioned primarily as a lithic reduction and tool manufacturing location. The uniformity of the site assemblage in terms of artifact type and lithic material contained in plow zone and sub-plow zone proveniences, together with the highly discrete spatial distributions defining the site limits, suggested that the occupation was likely single component, an unusual occurrence in the region. The exact temporal association of the component remained undetermined. However, based on the morphology of the single point that was recovered from test unit excavation and an apparently strong focus on quartzite utilization, a Late Archaic association was assumed. Similarities between plow zone and

sub-plow zone artifact assemblages further suggested that the cultural material was not stratified, but consisted of a single, shallowly buried deposit the upper portion of which had been disturbed by plowing. Two features were present below the plow disturbance indicating the potential for additional intact features, such as individual chipping clusters or datable contexts such as pits or rock-lined hearths.

Based on the results of the site evaluation, the CR Division concluded that the prehistoric component at the Black Diamond site (7NC-J-225) retained sufficient integrity and information potential to meet eligibility criterion D for listing in the NRHP. The site contained sub-plow zone deposits, clear site boundaries, high artifact density, and chronologically and functionally diagnostic artifacts. The site was thus recommended eligible for nomination to the NRHP. Further, in accordance with the MOA of 1987, data recovery investigations were recommended to mitigate the adverse effects to the site resulting from construction of the Smyrna-to-Pine Tree Corners segment of SR1. It was anticipated that the resulting study would contribute to prehistoric research priorities established for Delaware, including lithic technology, intra-site patterning, and paleoenvironmental studies, as well as refining current understanding of occupation and settlement in the state during the Late Archaic and subsequent periods. Moreover, the data recovery investigations were expected to provide valuable information for inter-site comparison regarding site occupation chronology; the relationship between sedimentation, soil formation, and site burial; subsistence practices; and lithic tool technology and raw material procurement.

6.2 Data Recovery (Phase III): Description and Analysis

Following DESHPO concurrence with recommendations for archaeological site mitigation, data recovery investigations were conducted. Field work, carried out in December 1999, entailed excavation of twenty-two 1-m^2 units on a transect across the main artifact concentration and scattered across the landform, to refine the view of artifact distributions and stratigraphic contexts. In addition, two excavation blocks totaling 146 m^2 (including three of the site evaluation units) were employed to investigate occupation components in the central part of the site.

The analyses that follow assess the archaeological contexts of the site to provide support for the definition of the main component occupation. The analyses include a detailed description of sediment stratigraphy, a review of the results of absolute dating, a summary of feature analyses, and finally, a discussion of artifacts.

6.2.1 Site Stratigraphy

Studies were conducted to address site formation issues from the perspective of stratigraphy. The primary aim of the analyses was to assess the physical context of the archaeological deposits as a guide to interpreting occupation sequences and on-site behavior—when and how people lived at the site. A secondary objective was to investigate local paleoenvironmental conditions as reflected in the sediment matrices across the site area. Specifically, a detailed record was developed of localized aeolian activity and other geomorphological processes associated with the bay/basin setting within which the site occurred, with the aim of yielding information pertinent to both local environmental

reconstruction and a more complete understanding of the archaeological contexts present at the site.

The landscape in the vicinity of the Black Diamond site was dominated by the presence numerous bay/basin features associated with a series of dune-like ridges. The origin of these ridges is presumed to have been related to the formation or modification of bay/basins themselves, probably through the localized aeolian transport of sediments out of the basins during Pleistocene times (Versar 2011a). The bay/basin adjacent to the Black Diamond site was small in comparison to many such features in the area. It measured approximately 100 m in greatest dimension, with a depth of 2.8 m from the bottom of the basin to the crest of the northeast ridge. Geoarchaeological analysis suggested that it had been ponded at some time in the past.

Topographic relief was relatively minor across the site, although mapping on a 20-cm interval revealed subtle variations in the surface contour of the ridge crest (Figure 6-4). In essence, the ridge, referred in the geoarchaeological analysis as the *central dune segment* or *aeolian/hummock terrain*, consisted of two distinct knolls separated by a minor saddle. Southeast of the ridge, in an area referred to in the geoarchaeological analysis as the *slope/basin terrain*, the landform dropped towards a broad swale that was weakly expressed in surface contours. Soils in the swale were moist, suggesting that the area may have been the location of a seasonal spring.

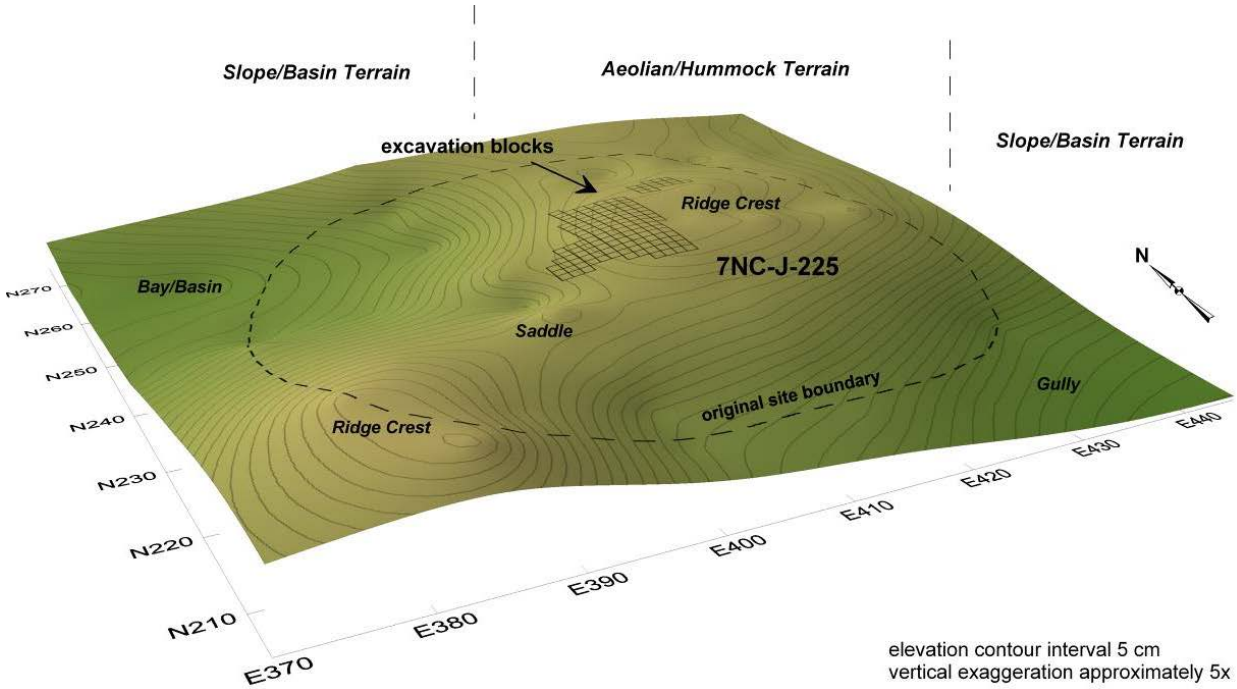


Figure 6-4. Three-Dimensional Rendering of the Topographic Setting of the Black Diamond Site on the Ridge East of the Bay/Basin.

As is typical of the Delaware Coastal Plain, the entire site area was underlain by Columbia Formation sands and gravels, consisting of unconsolidated and heavily reworked material of Pleistocene age (Groot and Jordan 1999). Surface soils along the higher portion of the site

area consisted of the Sassafras Series sandy loam, while the adjacent bay/basin soils consisted of Fallingston Series sandy loam (Mathews and Lavoie 1970).

Stratigraphic evidence as described in the archaeological excavations suggested that the site had been plowed in late historical or modern times. A plow zone, identified as archaeological Stratum A, consisting of brown (10YR 4/3) loamy sand, occurred across the area with a nearly uniform thickness of approximately 20 cm. The second layer of sediment at the site (Stratum B) consisted of a yellowish brown (10YR 5/6) loamy medium sand. Sand grains within this layer appeared to be well sorted and showed little or no evidence of soil development. While Stratum A had been disturbed by agricultural activity, it was thought to be genetically equivalent to and derived from Stratum B. Both sediment layers appeared to be largely aeolian in origin. A weak-to-moderately developed B horizon (Stratum C) was present below Stratum B. Soil development was expressed primarily as a color shift to a strong brown (7.5YR 5/6), with no major increase in fines or other textural differences noted. Within the main excavation block, near the crest of the ridge, dense gravel lenses were encountered below Stratum C, at depths beginning around 100 cm. These gravels comprised the initial levels of a C horizon, corresponding with the upper portions of the Columbia Formation, which also contained beds of strong brown (7.5YR 5/8) sand.

The following soil profile typified core area of the site:

Depth	Stratum	Horizon	Color and Texture
0-20 cm	A	Ap	10YR 4/3 brown loamy sand
20-45 cm	B	EB	10YR 5/6 yellowish brown loamy sand
45-70 cm	C	Bw	7.5YR 5/8 strong brown loamy sand
70 cm* +	D	C	7.5YR 5/8 strong brown loamy sand/gravel

* variable depth and gradational boundaries

This profile was based on a long profile section recorded east-west across the Main Block along N243 (Figure 6-5). The sediment layers within the profile became shallower and more compressed moving west-to-east toward the crest of the ridge. The section showed the upper limits of the Columbia Formation rising near the eastern edge of the block. This uplift in C-horizon material was likewise recorded in a profile section extending north-south along E417 (Figure 6-6). Site evaluation units demonstrated that the upper layers of the profile continued to thin moving eastward, down the backside of the crest and away from the bay/basin. In the unit at N232/E429, southeast of the main excavation block, the profile was essentially collapsed into two stratigraphic units, with Columbia Formation sand and gravel occurring at or just below the base of the plow zone.

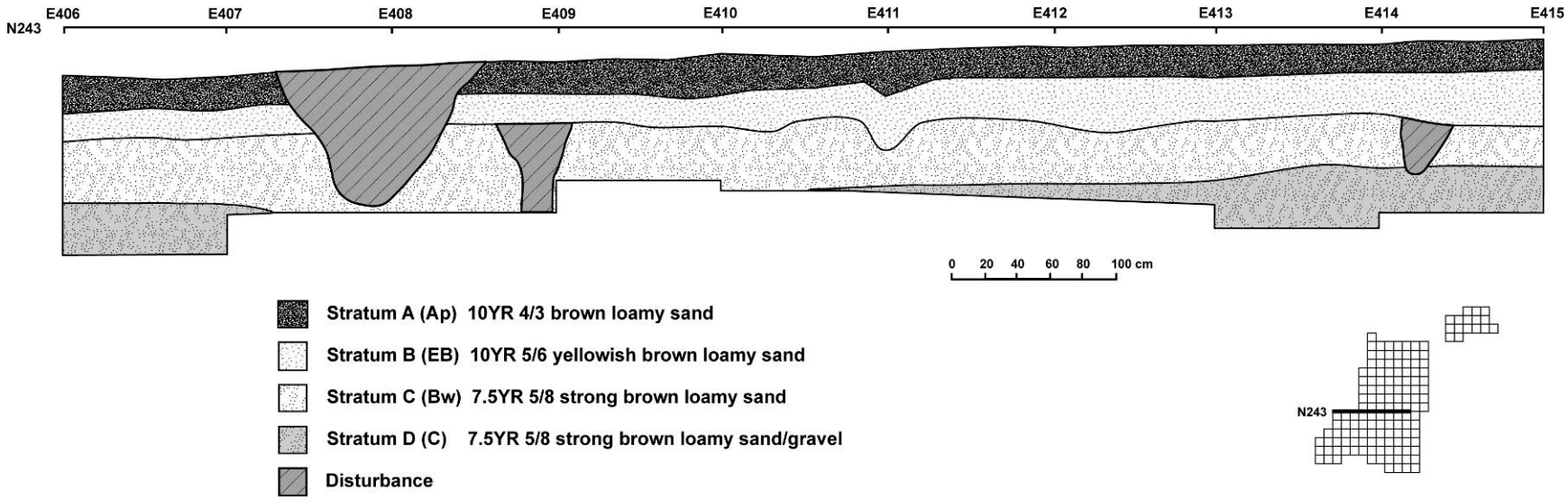


Figure 6-5. East-West Profile Section along N243.
(disturbances include tree roots or animal burrows)

Geoarchaeology

Geoarchaeological interpretations tended to corroborate archaeological descriptions of the sediments, as the following excerpts from the consultant's report suggest. To accommodate the subtleties observed in the cultural and natural horizonation, the geoarchaeological analysis used an *allostratigraphic* system as its organizing framework. Geologists typically map sedimentary rocks on the basis of lithology or physical characteristics such as color and texture. Allostratigraphy maps rock layers by the processes and timing of their deposition: for example, recognizing old erosion surfaces as boundaries. The boundaries are often referred to as bounding discontinuities (NACSN 1983; Birkeland 1984), referring to limits or borders that are marked by changes in how the rock accumulated. Allostratigraphy tends to describe a stratigraphic sequence at finer resolution than does lithostratigraphy, and thus it defines more detail relevant to archaeological interpretation in the sedimentary classification. It is especially appropriate for linking sets of grouped archaeological, soil, and depositional units, and is particularly flexible for situations in which breaks in deposition are inconsistent across a site and across segments of landforms, such as the *aeolian/hummock* and *slope/basin terrains* at the Black Diamond site. Since the allostratigraphic units are defined by boundaries rather than by their contents, they allow explanation of the mechanisms that produced changes in stratigraphic ordering (Ferring 2001).

At Black Diamond, two transects registered the range of stratigraphic variability. Archaeological information was provided for the key excavation blocks and deep testing units (Figure 6-7). Sedimentological profiles were integrated within the sequence to highlight contemporary occupation and landscape successions.

Based on field relations and stratigraphy, the allostratigraphic units (AU) may be grouped and identified by soils and by landform segment as follows (oldest to youngest):

- **AU-1**
  Unweathered to weathered gravels and sands (with lag deposits) of the Columbia Formation (C horizon [aeolian-hummock]; 2BC/2C horizons [slope basin]);
- **AU-2**
  Weathered aeolian with some colluvial sediment of Holocene age; unit is split within the solum and includes horizon interface (EB-Bw) since this is an overthickened soil. Archaeological materials of Late Archaic through Woodland are present (EB-Bw horizons [aeolian-hummock]; EB-BC-2C horizons [slope basin]);
- **AU-3**
  Historical soil represented by plow zone but irregularly underlain by thin aeolian or colluvial sediment; includes upper solum (Ap/EB horizons [entire landscape])

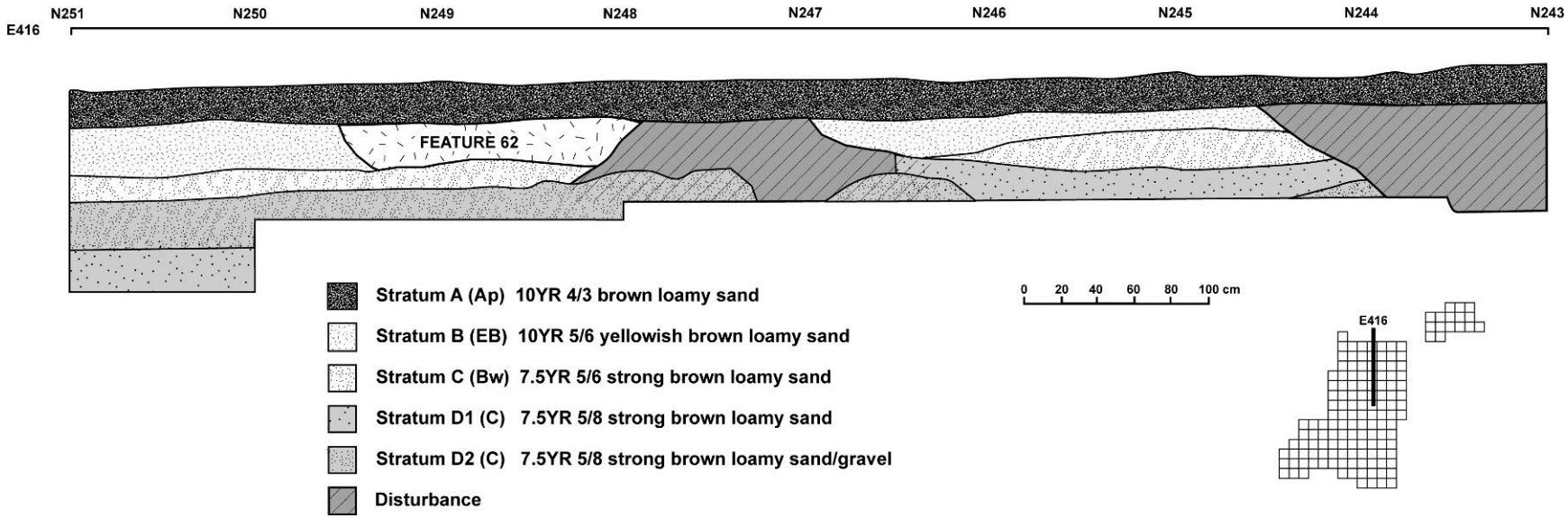


Figure 6-6. North-South Profile Section along E416.

(disturbances include areas identified in the geoarchaeological analysis as soil formation anomalies)

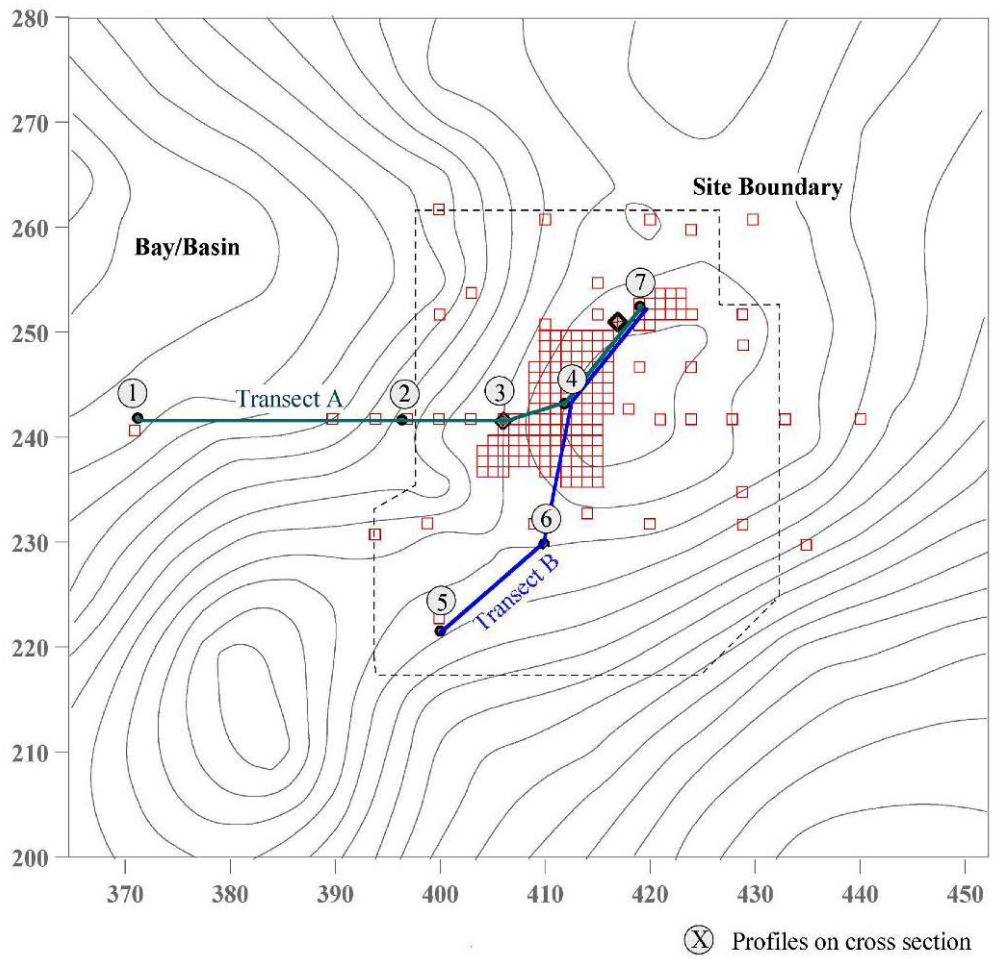


Figure 6-7. Geoarchaeological Transects.

It is emphasized that only slight changes in parent material and slope distinguish the two landscape segments. For this reason the AU units are contemporaneous across both landscape segments while the soil profiles are unique to the individual segments.

The archaeological field horizons generally articulate with the following AU subdivisions: Stratum A conformed to AU-3; Stratum B was equivalent to AU-3 (lower) and AU-2 (upper); Stratum C represented AU-2 (lower) and AU-1 (upper); and Stratum D is the weathered Columbia gravels, AU-1. Archaeological features were generally sampled in Stratum C, which is within the Bw or upper Columbia gravels (Bw/C interface). In terms of the allostratigraphy, these should be considered AU-2. It is also noted that the EB-Bw succession was often considered a Bw-Bt sequence by excavators. However, since the geoarchaeological investigations identified an overthickened podzol, the field observations were variously adjusted to reflect the continuous pedogenic sequence.

Figure 6-8 shows the geoarchaeological transects and the ordering of the major allostratigraphic units. Principal observation and sampling locations are illustrated for the transects. The sections underscore the subtle differences in the sequences for the two landform segments. Variability is chiefly a function of the unique sedimentation in the slope

basin. Colluviation is a more prominent depositional process, as is the oscillating water table which accounts for permeability of fines through the sandy gravel matrices of the Columbia Gravels in AU-1. It also explains the preservation of a 2Bw horizon in Transect A while the equivalent soil horizon in Transect B is 2AB. Local reworking of basin gravels also explains the succession of coarse grained sands and gravels above the weathered horizons (2AB and 2Bw) in the basin settings. While AU-1 is of Pleistocene age, there are Holocene veneers of aeolian, colluvial and basin edge sediment (the latter from the slope basin) that cap the unit locally.

AU-2 is the most archaeologically sensitive unit in the sense that it represents the unit that is time equivalent with human occupation. As discussed, post-occupational disturbances (pedoturbation, soil formation, plowing, land clearance) have resulted in vertical and lateral translocation of artifacts; high densities of cultural materials are therefore preserved in the Ap (plow zone) horizon within AU-3.

In the aeolian/hummock landform, AU-2 registers a Holocene soil that has weathered on a slightly silty sand parent material. Archaeological materials are either embedded in the firmer Bw silts (as features) or as artifact clusters within the lower EB. The general soil forming sequence extends to the slope basin, albeit on a coarser parent material. It is not possible to establish the chronology of soil formation with great specificity, but available radiocarbon dates and the presence of sealed archaeological features in the Bw indicate that the soil is at least 5,000 years old and, further, that the upbuilding of the Late Holocene soil was slow. Within the rubefied clay-silt matrix (7.5 YR hues) of the lower Bw determinations are no younger that 1000 BP, suggesting that the active weathering front, which would normally be defined at the E-Bw interface, is rising slowly and that enrichments of aeolian sands are in equilibrium with the soil forming sequence to the present day.

As depicted in Figure 6-8, the top of the Bw is offset as an eroded/mineralized surface. In pedogenic terms this is simply a sharp soil boundary to the zone of weathering (EB/Bw transition). However, there are independent indications of a depositional break here, most notably the additions of silts to the otherwise sandy matrix; these are not the product of weathering but appear to be of depositional origin. Further, the dates and the archaeology are suggestive of 500-1,000 years of landform stability, after which more podsolization proceeded in conjunction with incremental additions of aeolian material. This homeostasis obscures the evidence of the former disruption to landform buildup sometime in the later Holocene. In finer grained sediments the pedogenic record would disclose the break in the form of a bisequal soil (Buol et al. 1997), but weathering profiles are considerably more subtle in the sandier parent materials of the Black Diamond site.

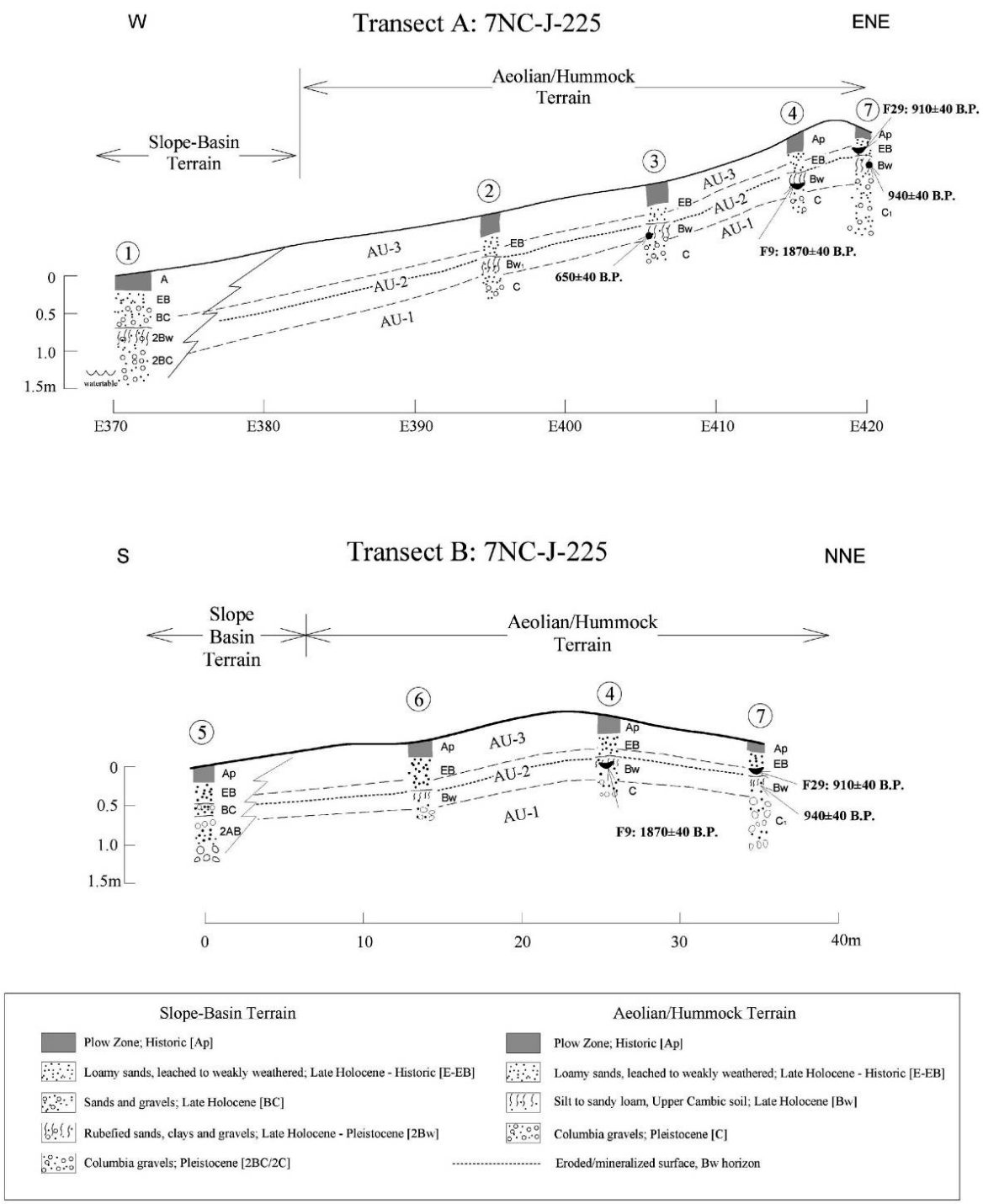


Figure 6-8. Allostratigraphic Units as Constructed in the Geoarchaeological Transects.

AU-3 represents the plow zone and upper solum (top of EB horizon). It is generally <0.5 m thick. The horizon contains historical debris and prehistoric deposits, irrespective of the landform segment, and it can therefore be difficult to isolate. Prehistoric materials within the upper EB are typically clustered, and in some loci the highest artifact densities are within the leached zone (E horizon) immediately underlying the Ap. The soil boundary is represented

by the passage from 10YR 3/6 loamy sands to 7.5YR 4/6 silt to clay-loam sands with structures moving from granular to weak-subangular blocky. Widespread plowing, variable forest cover, and longer-term erosion account for the diverse distributions of artifacts in that soil-sediment package. It is tempting to link this portion of the sequence to the Woodland-historic succession, but the shallowness of the deposit, its loose consistence and exposure are consistent with active sedimentation and redeposition. The principal archaeological component at the site is Late Archaic, such that AU-3 represents a post-occupation unit and records the upper weathering sequence extending to the historical period. Beneath the present soil cap artifacts are variously turned over from originally sealed contexts.

Sand Grain Morphology

Landform morphology, the uniformity of the sand grain population, and the continuity of the weathering profile offered initial indications of the dominance of aeolian process in fashioning the landscapes at the Black Diamond site. The prominence of aeolian activity was tested through a quantitative analysis of quartz-grain micromorphology on representative samples of the parent material underlying the aeolian/hummock terrain. The isolation of aeolian sedimentation was the key to understanding the formation history of the site.

The central procedure in the study was the differentiation between fluvial and aeolian transport processes. Both processes fashioned the Pleistocene landscape and subsequent Holocene sedimentation reflects reworking of basal sediments together with some allochthonous regional sediment contributions (Jordan 1964). Typically, the sediments underlying the Black Diamond site are quartz-rich, fine-to-coarse sands that vary from well to poorly sorted, per their derivation from the Columbia Formation. The homogeneous composition and identifiable texture of these deposits permit morphological analysis on the scale of the individual grain (Butzer and Gladfelter 1968; Holliday 1992; Waters 1992). Analysis of the depositional history of these sediments focuses on characteristics of the sediment grains themselves, including grain shape and surface features.

Ideally, grains from an aeolian sedimentary context would be similarly-sized, well-sorted, well-rounded sands exhibiting a high degree of sphericity and composed primarily of frosted surfaces. In contrast, alluvial or colluvial contexts exhibit moderate to poor sorting, subangular to angular grains, low sphericity and a low percentage of surface frosting. Based on these assumptions, the following assessment isolates the features in sand samples that distinguish between two ends of the transport spectrum: aeolian and fluvial. Colluvial contexts are mixed by definition and would be difficult to differentiate microscopically.

Sediments were taken from 40 samples of fine-to-coarse sands at 23 localities across the site. Two sets of additional samples from modern alluvial (3 samples) and aeolian settings (7 samples) were taken for control. These controls were acquired from the vicinity of the Frederick Lodge Site Complex as well as a study location in North Carolina. Only sands from the C horizons in any of the stratigraphic exposures were analyzed. Feature samples and sands from the A, B or E horizons were eliminated in order to limit the physical or chemical influence of human or pedogenic factors on the micromorphology of the sands.

Details of the quantitative assessment of sand grain morphology are contained in Appendix G. In summary, comparisons including roundness indices (Figure 6-9) and amount of frosting (Figure 6-10) suggest a landscape that is dominantly of aeolian origin, the most prevalent transport mechanism being wind action moving sand grains both up and down the slopes. Specimens from the various parent materials sampled in this experimental study indicated an environment influenced by conditions favorable to mobilization of sand-size sediment by wind action.

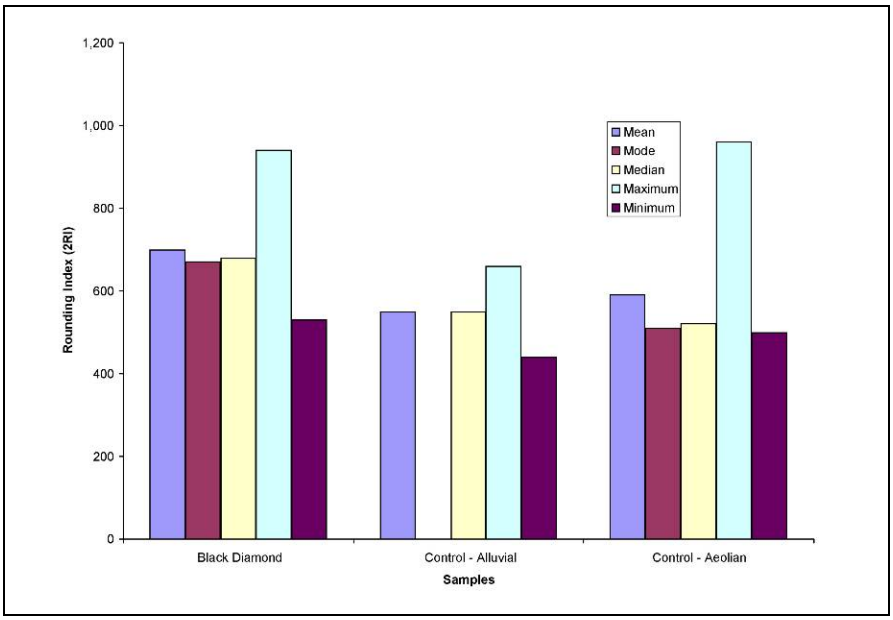


Figure 6-9. Rounding Index Implying Similarity between Black Diamond Sediments and Aeolian Control Samples.

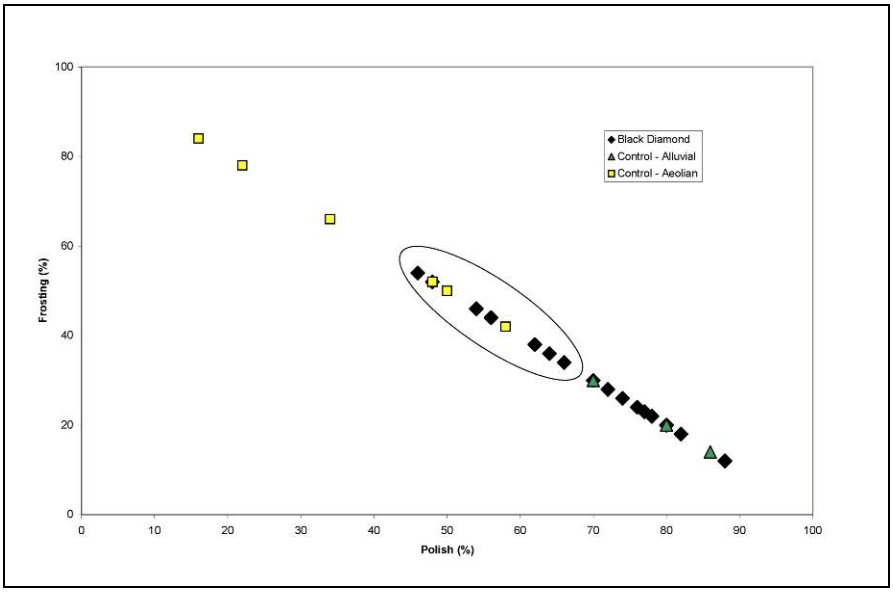


Figure 6-10. Frosting Percentage Implying Similarity between Black Diamond Sediments and Aeolian Control Samples.

Cultural Stratigraphy: Vertical Artifact Distributions

Vertical artifact distributions indicated that most artifacts occurred in the first 10-cm level below the plow zone. With some variation by unit, approximately one-half of the artifacts occurred in the first two levels of Stratum B (Figure 6-11). The single peak in the frequency distributions implied one depositional level or period of occupation, the duration of which was not immediately clear. Notably, this finding differed from analysis of site evaluation data that suggested fewer artifacts below the plow zone (Figure 6-3).

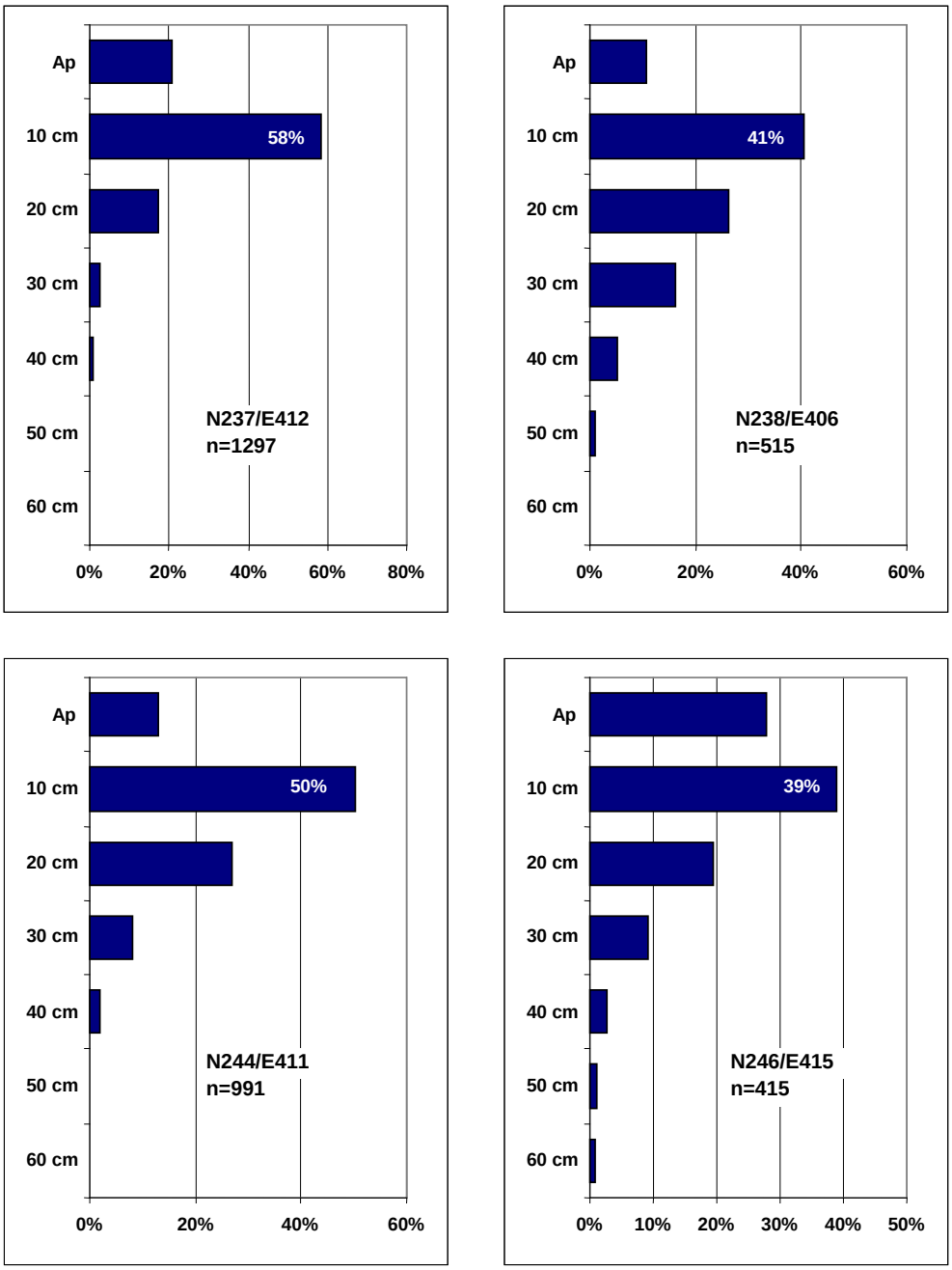


Figure 6-11. Vertical Frequency Distributions of Artifacts in Units Across the Main Excavation Block.

Sedimentological information documented in the archaeological excavations suggested that two landscape formation trends were ongoing at the Black Diamond site during the Late Holocene. The first consisted of the infilling of the bay/basin bottom and toe slopes, presumably by colluvial action reworking soils along the bay/basin rim. The second trend was the minor addition of aeolian soils on the attendant ridge landform. Accretion appeared to have been modest and to have occurred mostly on the side of the ridge crest facing the bay/basin. The source location for these sediments is likely to have been the bay/basin bottom. Geoarchaeological analysis reported soft sediment accumulations within the basin to depths of approximately three meters, representing mixtures of reworked slopewash and slackwater clays. While a significant portion of the aeolian accretion noted on the ridge crest appears to have predated the site occupation, the process continued after the site occupation, partially shielding the archaeological deposits from the effects of modern plowing.

6.2.2 Absolute Dating

Absolute temporal data were derived from accelerator mass spectronomy (AMS) analysis of organic material recovered via flotation from feature contexts selected in the field. AMS dating was also undertaken on bulk soil samples in conjunction with geoachaeological investigations. The results of the analyses are shown in Table 6-4 (data sheets are included in Appendix E).

The dates returned on the samples generally did not align well with the cultural chronology implied by artifacts recovered from the site. While the dates ranged from the latter part of the Woodland period onward, diagnostic artifacts suggested that the site occupation was likely single component, probably dated to the latter end of the Late Archaic period.

6.2.3 Features

The presence and characteristics of features on an archaeological site—whether pit features or artifact concentrations such as chipping clusters or surface hearths—can be used to infer the degree of stratigraphic integrity of depositional contexts. The maintenance of feature outlines, for example, may imply that little disturbance to the soil profile has occurred, while the occurrence of a series of features on a common stratigraphic level can delineate surviving depositional surfaces and imply the contemporaneity of non-diagnostic artifacts contained in the associated deposits.

During the course of the current data recovery investigations, 78 soil anomalies were identified with characteristics suggesting that they were cultural features (Figure 6-12). The anomalies were assigned feature numbers and were further investigated by means of sectioning, using procedures described in Section 5.2. Feature fill in most cases was only slightly different in color and texture from the surrounding soil matrix. Many of the features were almost imperceptible in plan, and field archaeologists reported that they excavated some primarily on the basis of the consistency of the fill. Upon excavation, many of the features proved to be natural in origin—root channels, tree molds, or geomorphological features such as areas of differential soil weathering or the upward displacement of sands and gravels. Ultimately, half of the features, 34 in total, were determined to have been natural in origin. The remaining 34 were cataloged in the field as potentially cultural (Figure 6-13).

Table 6-4. AMS Dates from the Black Diamond Site.

Provenience	***Sample Material***	***Conventional Radiocarbon Age***	***Calibrated Results (2 sigma)***	***Probability***	**13C/12C ratio (o/oo)**	***Excavation Sample No.***	***Laboratory Sample No.***
N248/E414-415, Feature 11, Str. I-1	charcoal (unidentified)	250+/-40 BP	AD 1514 to 1600 AD 1617 to 1683 AD 1735 to 1805 AD 1933 to 1951*	25.4% 44.2% 24.6% 5.7%		5020	Beta-149980
N245/E410, Feature 46, Str. I-2	charcoal (amorphous carbon)	270+/-40 BP	AD 1486 to 1604 AD 1607 to 1675 AD 1769 to 1770 AD 1777 to 1799 AD 1941 to 1951*	50.2% 40.1% <.01% 8.1% 1.5%		5003	Beta-149976
N294/E412, Feature 24, Str. I-1	charcoal (deciduous taxa)	680+/-40 BP	AD 1263 to 1325 AD 1344 to 1394	59.2% 40.8%		5058	Beta-149977
N253/E421, Feature 29, Str. I-2	charcoal (unidentified)	910+/-40 BP	AD 1032 to 1210	100%		5023	Beta-149975
N245/E412-413, Feature 9, Str. I-3	charcoal (deciduous taxa)	1870+/-40 BP	AD 60 to 238	100%		5004	Beta-149979
Trench C, 2AB, 250-300 cm bs.	bulk soil sample	370+/-40 BP	AD 1446 to 1530 AD 1539 to 1635	52.7% 47.2%		5063	Beta-150341
N242/E406, 50-60 cm bs.	bulk soil sample	650+/-40 BP	AD 1278 to 1332 AD 1337 to 1398	46.4% 53.6%		5065	Beta-150343
N251/E417, 45-55 cm bs.	bulk soil sample	940+/-40 BP	AD 1019 to 1185	100%		5064	Beta-150342

*range suspect—impinges on the end of the calibration data set.

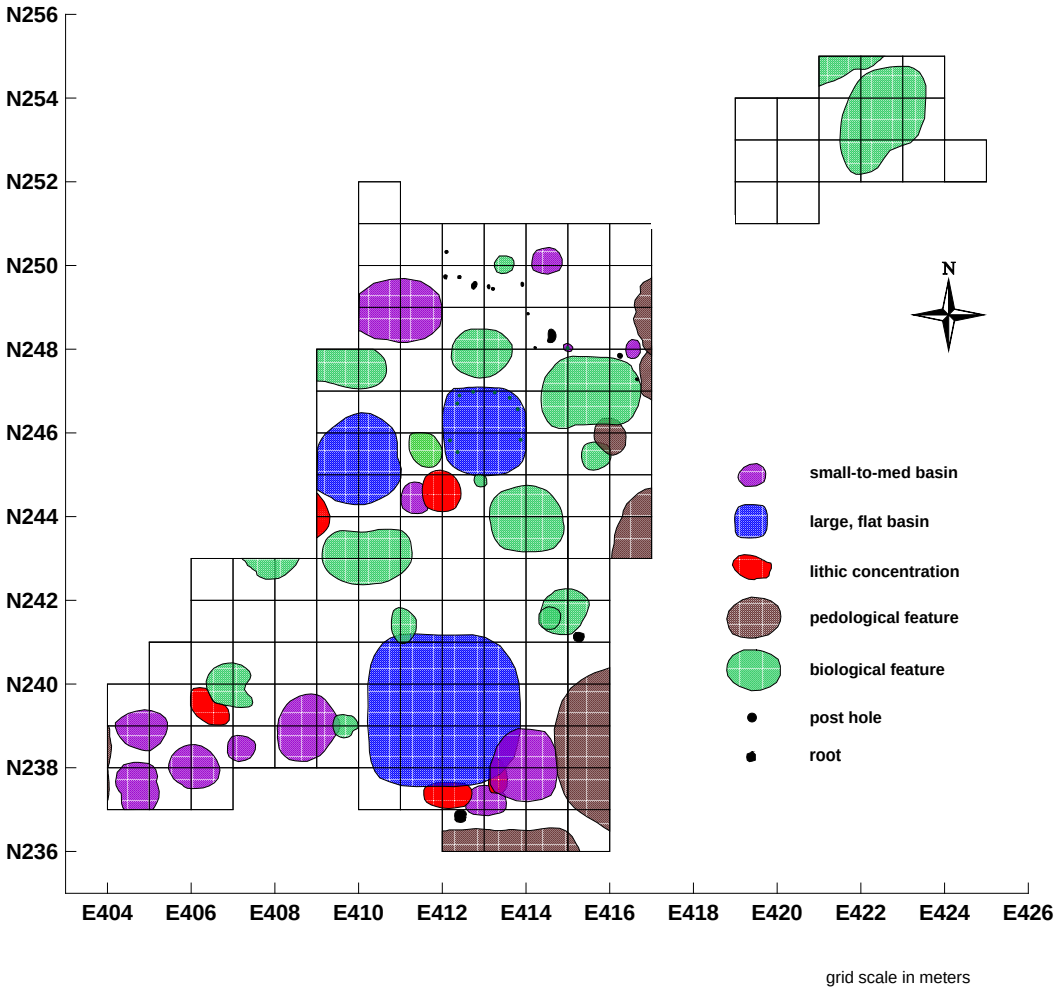


Figure 6-12. Distribution of Feature-Like Anomalies in the Excavation Blocks at Black Diamond.

These features were fully documented, and the data recovered from them was subjected to extensive analysis.

The cultural features fell into three general categories: artifact clusters and two types of pit feature. The latter included small pits, defined for this analysis as measuring approximately one to one-and-one-half meters or less in greatest horizontal dimension; and large, shallow pits greater than two meters in horizontal dimension. The attributes of the features are described in full in Appendix C. In an effort to more completely assess feature formation processes and thereby reach confident conclusions as to the origins and functions of the features, three sources of information were employed where possible:

- absolute dating, to determine temporal associations
- chemical analysis, to determine whether chemical signatures of human use were present
- analysis of artifact distributions, to determine whether artifacts in nearby, non-feature contexts were associated with the features

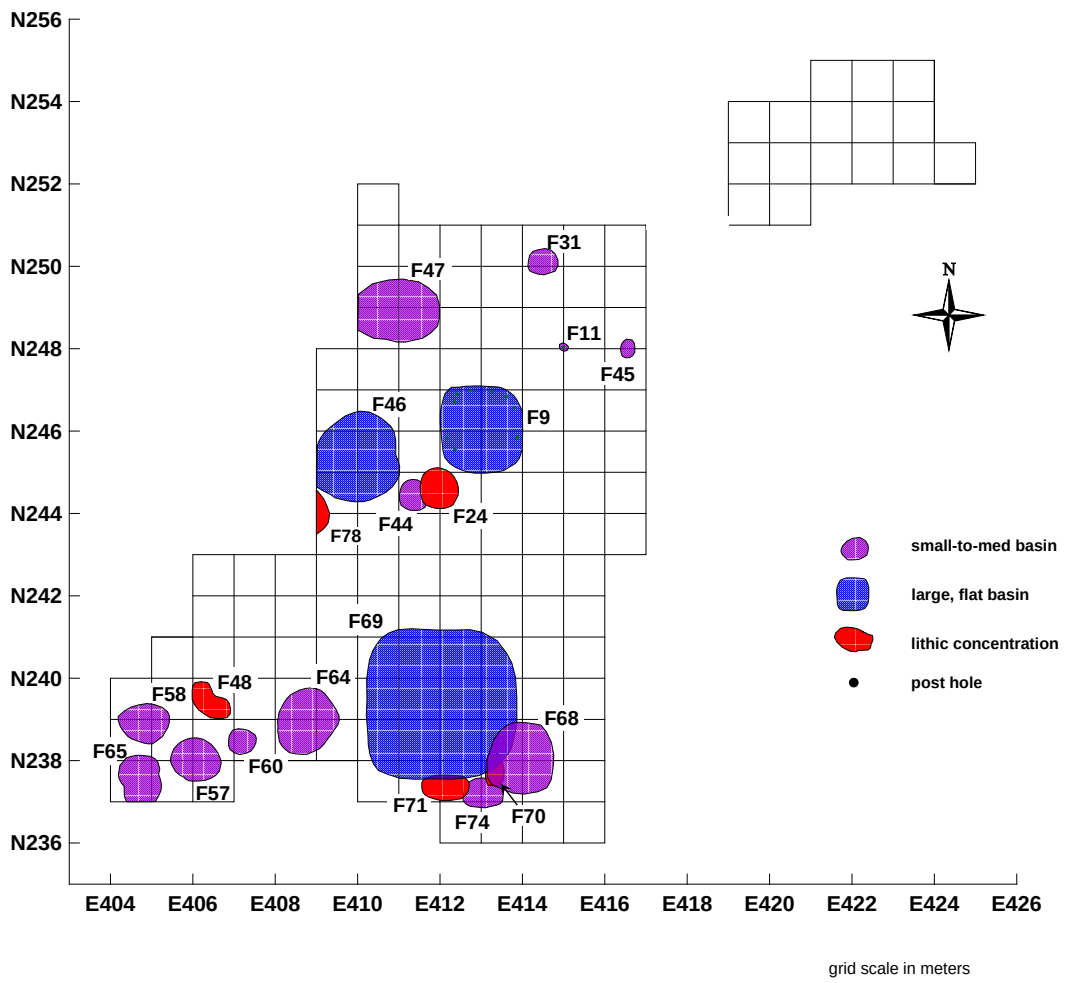


Figure 6-13. Distribution of Features Assessed in the Field as Potentially Cultural.

Dates

As outlined above, the results of AMS dating were inconsistent with the general temporal parameters of the site occupation as implied by diagnostic artifact assemblages. The range of dates reported from pit feature contexts corresponded with the second half of the Woodland period and the historical period, while artifacts from the site suggested a considerably more limited range of occupation in the Late Archaic. Consequently, no clear temporal links could be established between the features and cultural occupations.

Chemical Analysis

Geochemical analysis of feature fills measured concentrations of inorganic phosphates and assessed fractionation patterns following a methodology initially outlined by Eidt (1984) for phosphate fractionation and subsequently refined by Schuldenrein (1995) for North American hunter-gatherer sites. Phosphate fractionation studies were performed on Features 9, 11, 17, 24, 29, 46, 60, 67, 69, and 71 (Figure 6-14). The results did not provide clear evidence regarding the cultural origin of the features. Phosphorous is a typical anthropogenic addition to a soil profile (Cook and Heizer 1965; Kolb et al. 1990), yet low concentrations of total phosphorous were documented in samples from the Black Diamond site features. While this finding might suggest that a limited series of activity patterns characteristic of single or

short-term occupation was represented at the site, the chemical signatures more likely implied simply that the features did not represent cultural activity.

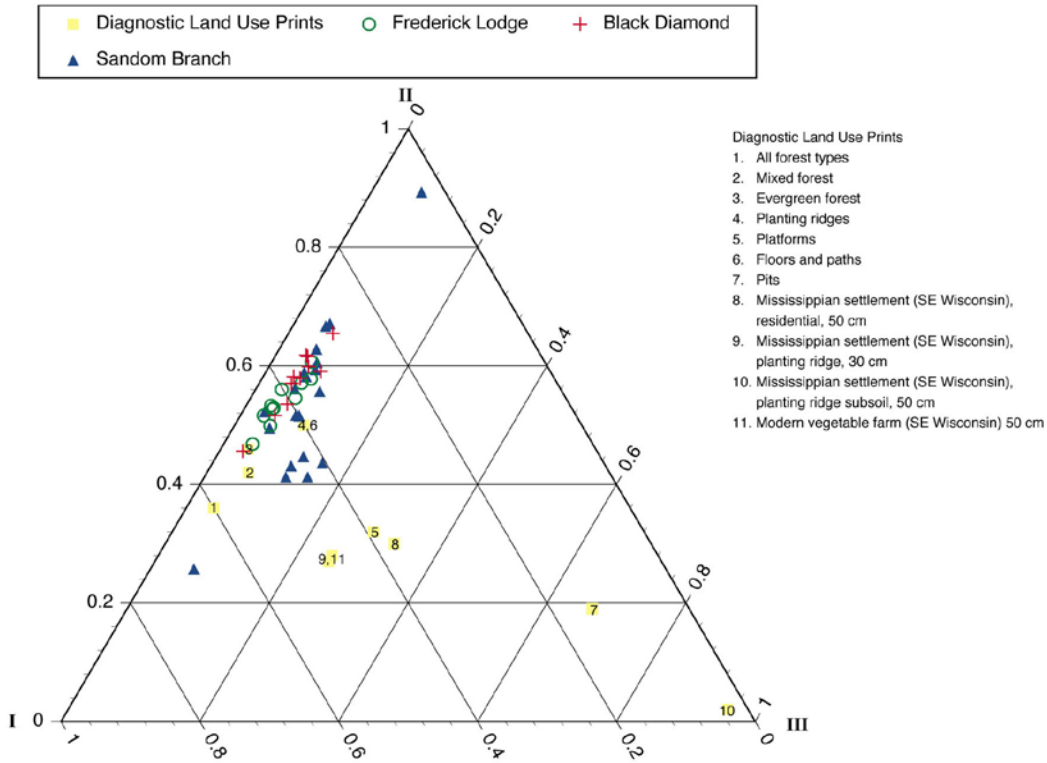
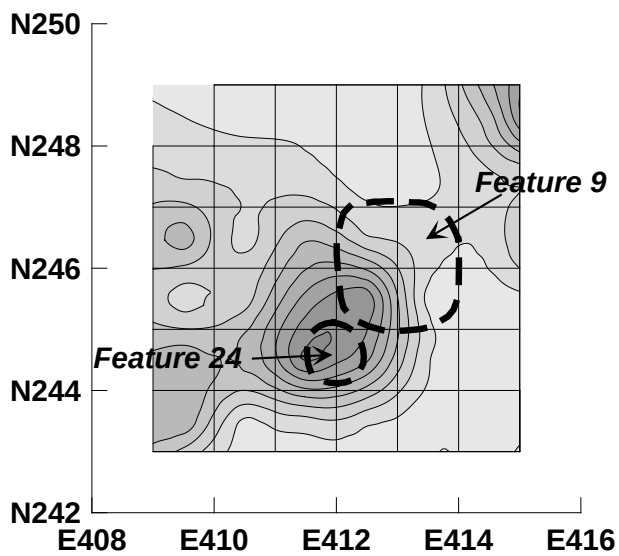


Figure 6.14. Phosphate Fractionation Results for Black Diamond and nearby Sites.

Context: Artifact Distributions

During field excavation, some features appeared to contain significantly greater artifact frequencies than did the sediments surrounding them. The actual degree of contrast between artifact frequencies in adjacent features or between features and background deposits was often not clear due to the relative lack of precision implied by the 1-m^2 horizontal and 10 cm vertical proveniencing protocol employed in the excavations, and due to problems with defining feature boundaries in leached sandy sediments. For example, Feature 24 was defined as a small, shallow basin containing more than 1,000 pieces of quartzite debitage. The feature lay adjacent to a wide, shallow pit, designated Feature 9 (Figure 6-15). Spatial analysis of artifact distributions in the excavation units containing the two features suggested that the artifacts comprising Feature 24 were distributed well across the mapped boundary of the larger basin. Statistical analysis of the physical and technological attributes of the material in the two features indicated close similarities (Table 6-5). Together, the spatial and attribute analyses implied that the artifacts in the two features probably represented a single concentration and that Feature 9 either pre-dated Feature 24 or was a natural occurrence related to soil formation that developed after the artifacts were deposited.



artifact density contour interval = 50

Figure 6-15. Spatial Analysis of Artifact Distributions Relative to the Locations of Feature 24 and Feature 9.

Table 6-5. Sample of Attribute Statistics for Artifacts from Feature 24 and Feature 9.

	Feature 24		Feature 9	
	Level 1	Level 2	Level 1	Level 2
flake	568	416	172	112
chip	7	3	1	1
biface	2	--	1	--
core	2	--	--	--
thermally altered stone	1	1	--	--
flake frequency, level 1 vs. 2	58%	42%	61%	39%

	flake frequency		frequency of cortical flakes	
size grade	Feature 24	Feature 9	Feature 24	Feature 9
1	11%	10%	4%	0%
2	59%	57%	6%	6%
3	19%	19%	10%	10%
4	6%	8%	18%	11%
5	4%	4%	29%	25%
6	2%	1%	17%	25%

In two other parts of the site, a system of piece-plotting was adopted with the aim of more precisely quantifying spatial distributions and the relationships of artifacts and feature boundaries. Analysis of the distributions indicated that the features investigated did not contain substantially higher artifact counts than non-feature contexts, implying that they were not necessarily pit or basin features filled with site debris. Figure 6-16 shows the piece-plotted data from excavation units containing a concentration of artifacts designated Feature

71, at the southern end of the excavation block. The artifacts appeared to overrun the boundary of Feature 69, a wide and shallow, flat-bottomed basin to the north, while the upper levels of the basin contained more artifacts than the lower levels, both characteristics suggesting that the artifact distribution was not necessarily related to the feature contexts. Similarly, Feature 78 was a concentration of artifacts adjacent to a wide, shallow basin, Feature 46. In profile section, the artifacts in the concentration appeared to continue in a thinner distribution across Feature 46 and into Feature 54, a natural, pit-like feature related to tree growth that occurred north of Feature 46 (Figure 6-17). The data implied that the artifact cluster (Feature 78) and the shallow pit features may not have been temporally related. In both examples, it appeared that either the features had been partially filled in by the time that the artifacts were deposited, or the features were not purposefully excavated basins but were natural phenomena related to soil formation that had arisen independently from the artifact deposits.

During the field excavations, it was proposed that the large flat-bottom basin features represented shelter locations, prepared domestic floors, or living spaces, and further that the shallow, quartzite-debris-filled basins adjacent to the large features were hearth locations functionally associated with the shelters. Yet, the preceding analyses of occupation-period organic material (via AMS dating) and feature contents in terms of artifacts and anthropogenically related chemicals did not support such an interpretation. Nor, in fact, did the data provide clear evidence of the cultural formation of the large pit features. In the end, distinguishing between cultural and natural origins for most of the features was impractical, and individual interpretations were inconclusive. Consequently, in approaching the analysis of the site findings as a whole, the functional role of the shallow basin features has been de-emphasized. While it is acknowledged that the features were identified archaeologically, the primary information potential of the site was deemed to lie in its artifact content. Ultimately, the single-component nature of the Black Diamond site occupation allowed all of the contexts to be viewed collectively as elements of site structure. Thus, the basin features were taken into analytical consideration in the same manner as unit data and, with the exception of several deep pit features in the southwest part of the site, functional interpretations of most of the features were not attempted.

In the southwest part of the excavation block, several pit features including Features 58, 60, 64 and 65, were documented that were not associated with artifact concentrations. The features varied in horizontal dimensions between 80 and 150 cm and depth between 30 and 50 cm. They contained varying amounts of flaking debris but insufficient carbon for dating purposes. While no archaeobotanical samples were recovered from the features and geochemical analyses were inconclusive, the features were presumed to have been the bases of storage or processing pits.

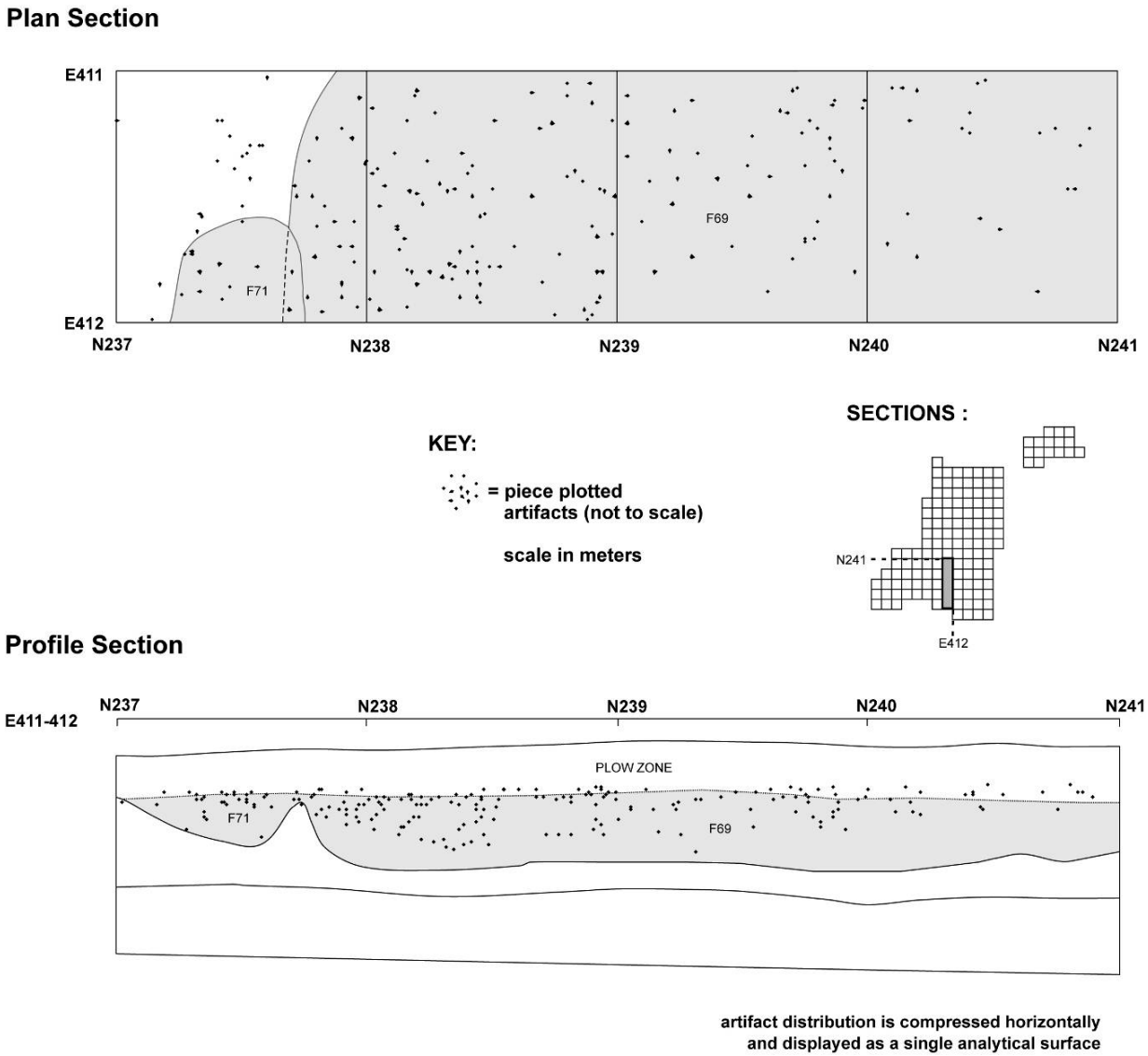


Figure 6-16. Piece-Plotted Artifacts in Relation to Features 69 and 71.

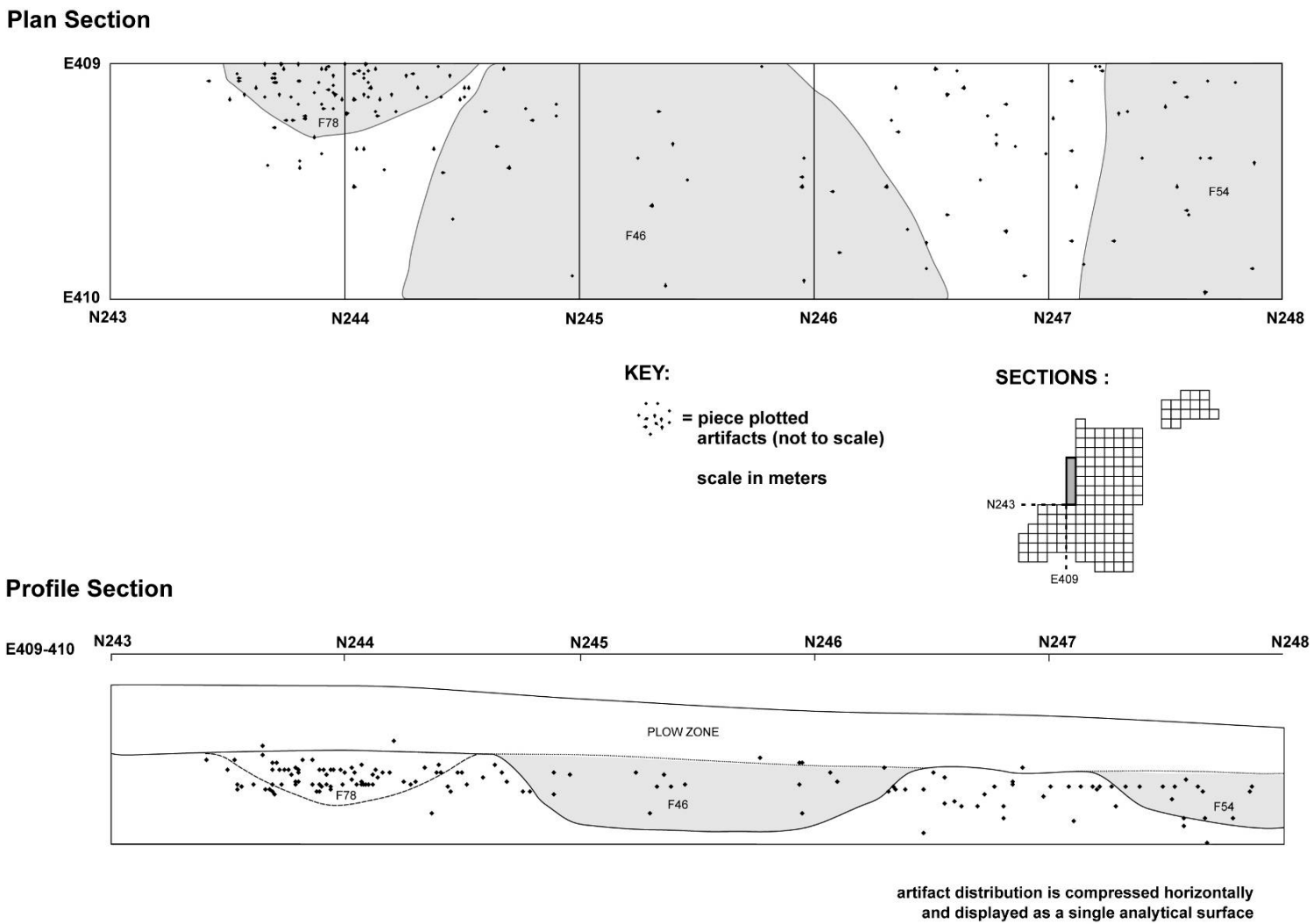


Figure 6-17. Piece-Plotted Artifacts in Relation to Features 78, 46, and 54.

6.2.4 Site Component Analysis

To review, occupation debris from the Black Diamond site appeared to represent a single cultural component that dated to the latter part of the Late Archaic period. This conclusion was largely based on evidence, detailed below, consisting of a single form of stemmed point that was present throughout the deposits, as well as artifact distributions that implied a single occupation. Additional patterns of material culture were documented that are associated with the Late Archaic period in the Middle Atlantic, including artifact style characteristics and the extensive use of hard, coarse-grained lithic raw material for stone tool manufacture.

The main occupation at the site was represented almost exclusively by chipped stone artifacts. Although dominated by lithic debitage, various tools types and artifact classes unrelated to lithic reduction activities were also present. Descriptive analyses of the artifact assemblage are presented below, beginning with a discussion of bifacial tools, which were the focus of the lithic industry at the site, followed by miscellaneous forms including unifaces, drills, hammerstones, and a pendant. The largest portion of the artifact assemblage by count—flaking debris—is then characterized, and finally, thermally altered stone fragments are described.

Artifacts

Slightly in excess of 37,000 prehistoric artifacts were recovered from the excavations at the Black Diamond site. Typical of prehistoric archaeological sites in eastern North America, the artifact type distribution was dominated by chipped stone (Table 6-6). Also typical was the predominance of flaking debris, although at over 99 percent of the artifact assemblage, the frequency of flaking debris at the Black Diamond site was unusually high.

Also unusual was the overwhelming predominance of a single lithic raw material type, quartzite, and specifically, a distinctive variety of quartzite referred to in this study as Type I quartzite. This material was distinguished by its color—gray to light brown—and by the appearance of separate quartz grains cemented in a chert-like matrix. This particular form of quartzite accounted for almost 90 percent of the chipped stone raw material in the artifact assemblage (Table 6-7).

Points

Fifteen points or point fragments were identified in the Black Diamond site artifact assemblage. Among them were two main forms—wide-bladed/short-stemmed and narrow-bladed/long-stemmed—along with several miscellaneous fragments that did not conform to specific types.

Table 6-6. Artifact Type Distribution, Black Diamond Site.

artifact type	count	
chipped stone		
flake	36,417	flaking debris comprised 99.1% of total
chip	331	
core	55	
early stage biface	94	
middle stage biface	29	
late stage biface	5	
point	15	
drill	1	
uniface	5	
ground or pecked stone		
hammerstone	11	
pendant	1	
thermally altered stone	135	
	37,099	

Table 6-7. Lithic Raw Material Distribution, Black Diamond Site.

material	count	frequency
Type I quartzite	32,877	89.0%
quartzite	2,105	5.7%
quartz	796	2.2%
jasper	716	1.9%
chert	278	0.8%
rhyolite	146	0.4%
argillite	11	<0.1%
siltstone	9	<0.1%
greenstone	6	<0.1%
basalt	5	<0.1%
ironstone	2	<0.1%
schist	1	<0.1%
	36,952	

Type I – Wide Blade, Short Stem

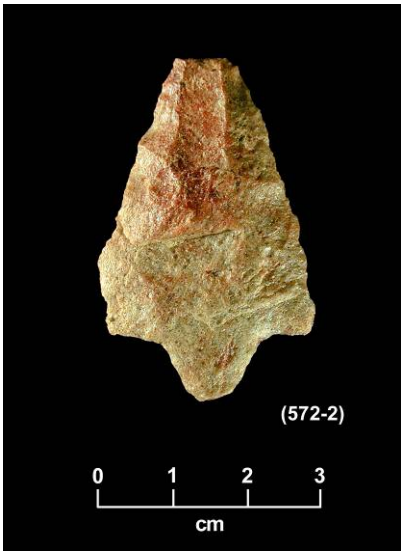
The most prevalent point form at the site was a wide-bladed, contracting stemmed point, typically manufactured on the site's distinctive form of quartzite. As will be discussed below, the points appeared to have been related to a technological tradition associated with the latter end of the Late Archaic, such as Savannah River or Koens-Crispin. They have not been placed in an existing formal type, nor has it been considered appropriate to coin a new type name for them, since the full implications of their chronological and typological position are incompletely understood. Therefore, in the discussion and analyses that follow the points are identified by a generic term, Type I.

The blades of Type I points were wide, symmetrical, and triangular in shape, and the blade edges straight-to-slightly convex and very well-flaked. Shoulders ranged from prominent (at nearly right angles to the main axes of the points) to rounded (slightly obtuse angles). Stems were typically wide, short, and contracting slightly to a rounded base. The base, stem, shoulders, and proximal blade edges exhibited edgewear in the form of rounding that appeared to represent either direct haft wear or intentional grinding to facilitate hafting.

Almost all of the points showed signs of use, both along blade edges and at the distal ends. The edges of several were asymmetrically formed, and most of the blades were inflected slightly part-way along the edge: that is, the line of the blade edge extending from the shoulder was interrupted and re-oriented slightly. This inflection also tended to coincide with the extent of grinding along the proximal end of the blade. Together, these characteristics suggested that most of the points had been hafted, with the binding extending approximately one-quarter of the distance along the blade from the shoulder. This relatively extensive binding, which required a degree of effort and material to construct, further suggested that the points would probably not have been removed from the haft unless necessary. Resharpening of the artifacts would have been accomplished with the point still hafted, from the tip to the start of the binding resulting in the inflected blade edge.

Distal use wear was generally noted in the form of impact fractures or minor transverse breaks. In only one example (#859-1) was there evidence of an extensive break—an oblique snap above the hafting element corresponding with the inferred position of the binding. Most of the points appeared to have been made on flakes. While the points were typically bi-convex in cross section, many had distinctly plano-convex cross sections or retained a portion of the original flake curvature.

Descriptions and images of the individual points follow.



artifact #572-2

raw material: Type I quartzite

dimensions: length 47 mm, width 30 mm, thickness 9 mm
haft length 8.5 mm, neck width 12 mm,
shoulder width 28 mm

comments: triangular blade with straight edges; wide, prominent shoulders perpendicular to the main axis of the blade; short and narrow contracting stem; thin, well-flaked blade with even, bi-convex cross section, although several large and small hinge fractures were present on both faces; base, stem, and shoulders ground; blade inset slightly above shoulders, indicating resharpening; a long, flute-like impact fracture at the distal end; minor damage to one shoulder, accounting for the difference between shoulder and maximum width measurements

artifact #616-1

raw material: Type I quartzite

dimensions: length 47 mm, width 29 mm, thickness 10.5 mm
haft length 11 mm, neck width 17 mm,
shoulder width 29 mm

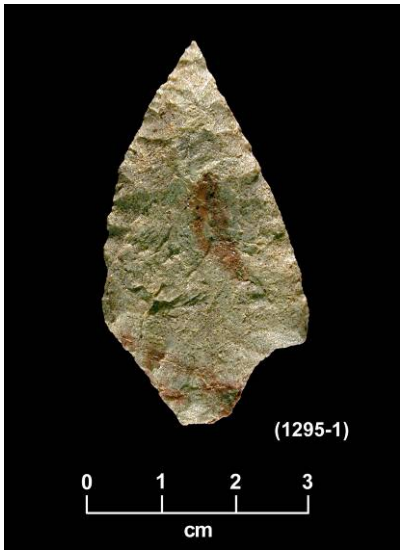
comments: slightly convex blade edges; prominent-to-rounded shoulders; well-flaked blade with bi-convex cross section; short, wide contracting stem; base, stem and shoulders ground; one blade edge ground almost half the distance from the shoulder to the distal end; opposite blade edge less heavily ground; minor oblique snap at distal end, with some rounding of snap break suggesting possible reuse following break

artifact #1429-2

raw material: Type I quartzite

dimensions: length 49 mm, width 26 mm, thickness 8.5 mm
haft length 11.5 mm, neck width 16 mm,
shoulder width 24 mm

comments: slightly convex blade edges, with prominent-to-slightly rounded shoulders that were slightly asymmetrical; well-flaked, thin and bi-convex in cross section; wide and short contracting stem with a rounded base; stem, base, shoulders, and a section of blade edge ground; an inflection apparent along both blade edges corresponded with the extent of grinding on blade edges, which was more extensive than on most examples of the type; impact fracture at distal end consisting of a flute-like flake with an oblique termination

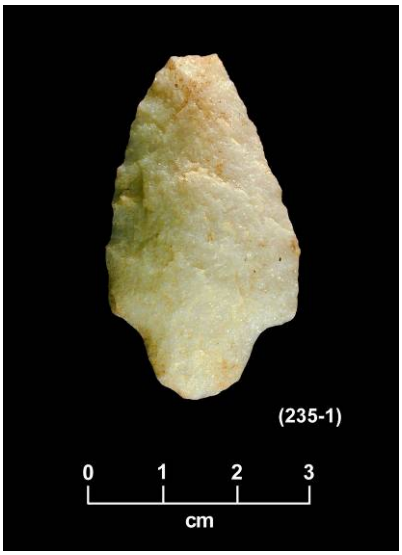


artifact #1295-1

raw material: Type I quartzite

dimensions: length 61.5 mm, width 28 mm, thickness 8.5 mm
haft length 9.5 mm, neck width 14 mm,
shoulder width 27.5 mm

comments: straight-to-slightly convex blade edges, with prominent shoulders; blade plano-convex in cross section; short and distinctly contracting stem; stem, base, shoulders, and a short section of blade edge ground; minor damage to base and one shoulder—that shoulder and corresponding blade edge reworked, showing a more clearly convex blade edge and producing an asymmetrical blade shape; the reworked shoulder was also ground, indicating the artifact had been reused in its original function; minor beveling produced by pressure-flaked reworking of the distal end

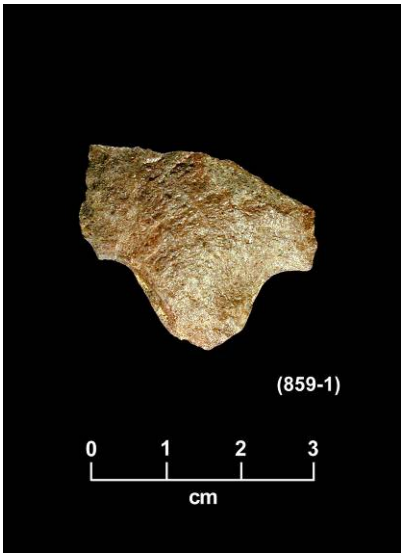


artifact #235-1

raw material: quartzite

dimensions: length 46 mm, width 26 mm, thickness 9 mm
haft length 11 mm, neck width 16 mm,
shoulder width 25 mm

comments: white quartzite, made on a flake, with the original curvature still visible; one blade edge convex, the other straight but inset asymmetrically a short distance from the shoulder resulting from unifacial, beveled pressure flaking along the blade edge; both shoulders prominent and set at slightly oblique angles to the axis of the blade, although slightly unbalanced; base, stem, and shoulders ground, as were the proximal sections of the blade edges; inflections on both edges corresponded with the extent of grinding; impact fracture at distal end

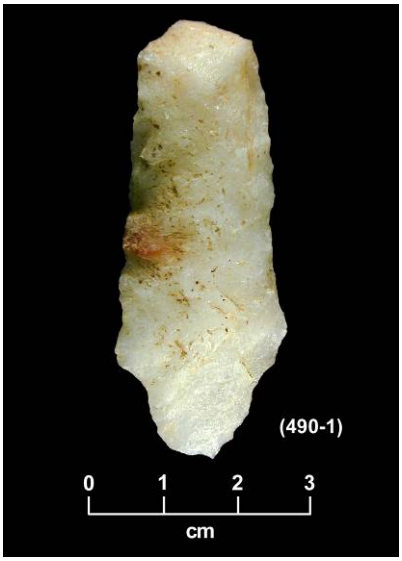


artifact #859-1

raw material: ironstone

dimensions: length 27 mm, width 32 mm, thickness 10 mm
haft length 11 mm, neck width 16 mm,
shoulder width 32 mm

comments: a large segment of the blade missing at a wide, oblique snap break, yet from the surviving sections, the blade edges appeared to have been straight-to-slightly convex; shoulders slightly rounded and obliquely angled relative to the blade axis; short and wide stem, contracting to a rounded base; minor damage on one edge of the stem and the tip of the corresponding shoulder; the base, stem, and shoulders heavily ground

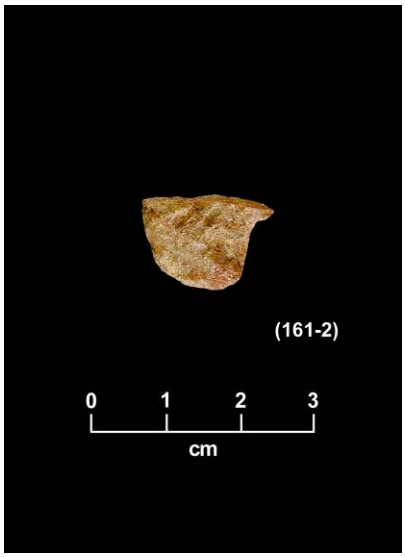


artifact #490-1

raw material: quartz

dimensions: length 60 mm, width 24 mm, thickness 13 mm
haft length 13 mm, neck width 15 mm,
shoulder width 22 mm

comments: slightly variant form exhibiting a longer blade than was typical on quartzite examples; extensive reworking of the blade evident from its narrow width, with edges inset from shoulders and symmetrical beveling accomplished with percussion flaking that produced distinct medial ridges on both faces of the blade; shoulders prominent, with one slightly damaged; base and stem unground, but no wear or grinding on blade edges; minor oblique snap break at distal end; if proportional, the artifact's original length would have approached 65 mm, its width 35 mm



artifact #161-2
raw material: Type I quartzite
dimensions: length incomplete, width incomplete, thickness 7 mm (stem only), haft length 12 mm, neck width 15 mm

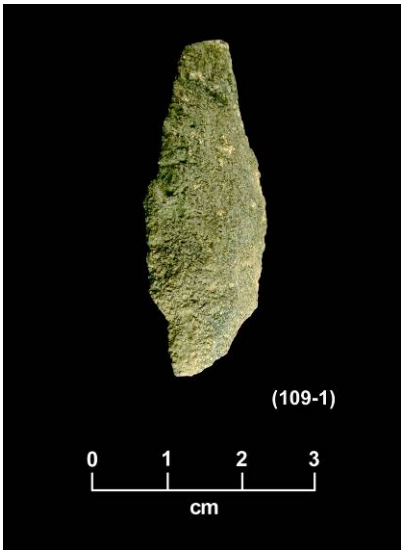
comments: a proximal fragment, consisting of a short, contracting stem with a rounded base; both the base and the edges of the stem ground; considering the similar shape and size of the fragment in comparison with the other contracting stemmed quartzite points, along with the similar variety of quartzite material, the fragment was confidently placed in the same point type; the stem had snapped transversely at the neck, leaving a small part of one shoulder

The points described above appeared to bear the greatest similarity to certain variants of the Savannah River form as recognized on the Middle Atlantic Coastal Plain (Custer 1996; McLearen 1991; Geier 1996; Stuck et al. 1997; Jones 2000). Although not conforming to the classic Savannah River type, as defined by Claflin (1931) and Coe (1964), their blade shape, relatively large size (in comparison with Early and Middle Woodland points from the area that are typically made from locally available pebble material), production characteristics, and the common use of quartzite in their manufacture, suggest a connection to the greater Savannah River tradition. Derived from an area in the southeastern U.S., this broad-bladed tradition spread rapidly up the East Coast during the Late Archaic and is often viewed as an indication of population movement of some scale (Dent 1995). McLearen (1991) illustrates the morphological range the Savannah River type in Virginia, recognizing three forms: the classic wide-bladed form; a narrow variant (also referred to regionally Holmes [Handsman and McNett 1974]); and a third variant with a short, strongly contracting stem. A small Savannah River variant has also been reported from central Virginia (Oliver 1981, 1985; Gleach 1987). Stuck (et al. 1997) proposed that these the short variants represent a late manifestation of the Savannah River type, while remarking on morphological similarities with Koens-Crispin points more commonly found in the Delaware Valley. Similar forms were studied by Custer (1992) at a series of sites in southeastern Pennsylvania, including the Long site (36LE4) and several sites in eastern Lancaster County. There, Custer detailed evidence indicating a Late Archaic, quartzite-based lithic reduction industry supporting the manufacture of broad-bladed points related to the Leigh/Koens-Crispin, Snook Kill, and Savannah River traditions. The research dated activity at the Long site to end of the Late Archaic period.

Type II – Narrow Blade, Long Stem

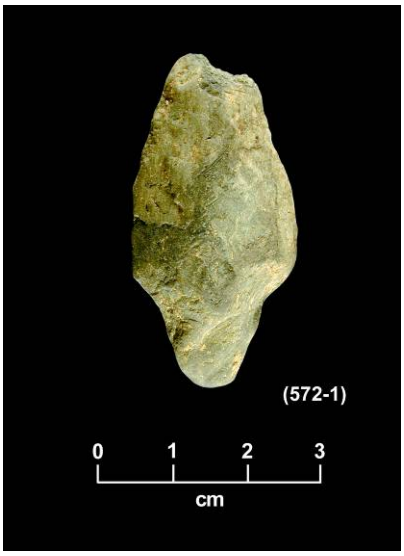
The second point form in the assemblage was a narrow-bladed form with a longer stem than was typical in the Type I points. The blade edges on these points were straight-to-slightly convex, the shoulders rounded, and in at least one case the base was convex. Two points were placed in this group, both manufactured from argillite. Both artifacts were heavily weathered, to the extent that much of the original flake scar patterning was no longer visible.

Due to the weathering, the recorded measurements probably underestimate the original dimensions somewhat. The points generally conform to morphological characteristics of the Lackawaxen type, yet their exact relationship to that type or to the Type I points from the site is unclear, and so they are identified for present analytical purposes with the generic term Type II.



artifact #109-1
raw material: argillite
dimensions: length 46 mm, width 17 mm, thickness 7 mm
haft length 10 mm, neck width 10 mm,
shoulder width 15 mm

comments: severe weathering rendered technological information difficult to observe; blade edges appeared straight, and shoulders rounded; bi-convex cross section; blade edges inset at distal end and alternately beveled, possibly indicating use as a drilling tool; oblique snap break at distal tip; one side of stem and base damaged

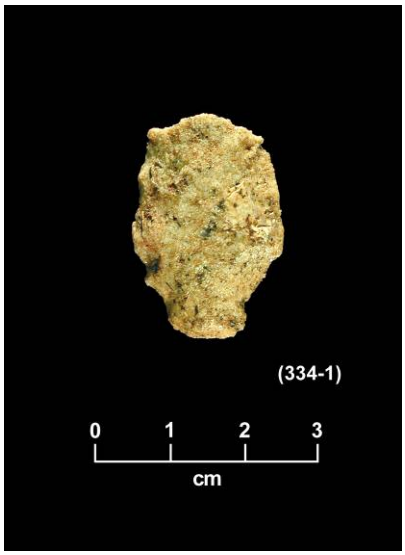


artifact #572-1
raw material: argillite
dimensions: length 46 mm, width 23 mm, thickness 9.5 mm
haft length 16 mm, neck width 14.5 mm,
shoulder width 23 mm

comments: straight-to-slightly convex blade edges, with prominent-to-rounded and slightly asymmetrical shoulders; plano-convex in cross section, suggesting manufacture on a large flake; a medial ridge on one face resulting from edge beveling and stacks; long and narrow contracting stem (accounting for over one-quarter of the overall length); inflections along both blade edges and asymmetrical blade shape suggest resharpening; perverse fracture at distal end

Miscellaneous Point Fragments

Among the remaining points from the site was a proximal fragment (#334-1) and a distal fragment (#274-1), both made from the distinctive Type I quartzite that typified the lithic reduction activity at the site. While neither artifact was complete or bore sufficient attributes for confident typological placement with the Type I points in the assemblage, they appeared to be a closely related part of the technological assemblage. The proximal fragment (#334-1) may have been a failed attempt at producing a point of the typical form from a small flake, while the distal tip (#274-1) appeared to have been a production error. Both artifacts were considered manufacturing rejects.

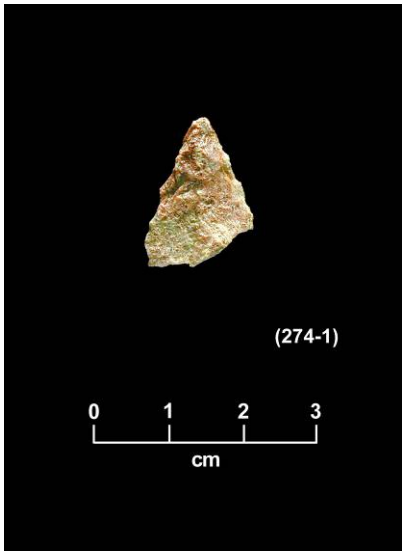


artifact #334-1

raw material: Type I quartzite

dimensions: length 30 mm (incomplete), width 20 mm, thickness 9.5 mm, haft length 11 mm, neck width 12 mm, shoulder width 20 mm

comments: small, stemmed point made on the same form of quartzite as the main contracting stem form at the site; plano-convex cross section with original flake curvature apparent; straight-to-convex blade edges; shoulders rounded and irregular; stem slightly contracting, base slightly rounded and thick, suggesting that it was originally the proximal end of the flake



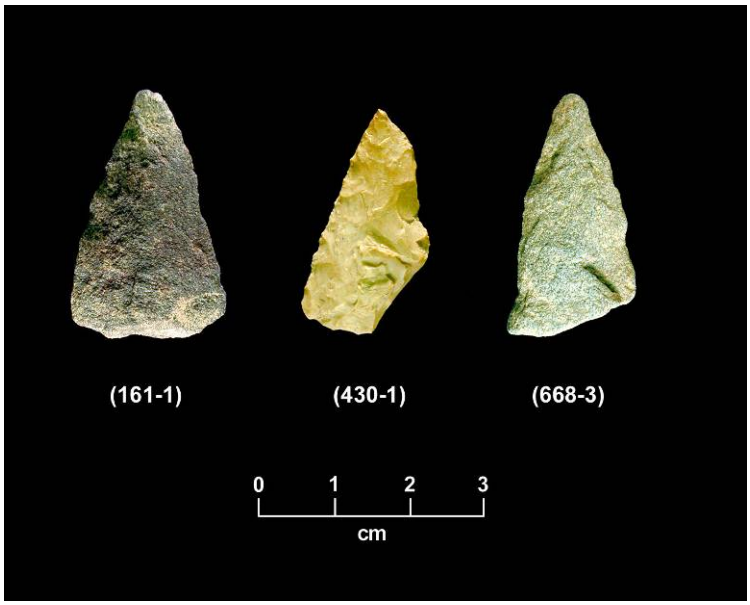
artifact #274-1

raw material: Type I quartzite

dimensions: length 20 mm (incomplete), width 16 mm (incomplete), thickness 7 mm (incomplete)

comments: distal tip, straight blade edges and sharp tip with no evidence of edgewear, stack developing at proximal end of the fragment at an oblique snap break, attempts at removing the stack may have led to the break; manufacturing reject

The final three artifacts in this group consisted of distal fragments. The ironstone and schist fragments were weathered, but appeared to have been broken during use. The break on the jasper fragment was more extensive and could not be absolutely attributed to either manufacture or use; given the finished appearance of the piece it may have been the latter.



#161-1 ironstone; blade and shoulders of a small, possibly stemmed point snapped transversely at the neck; blade edges straight, shoulders prominent; low medial ridges; large, deep percussion flake scar on one face, possibly occurring after initial failure and discard

#430-1 jasper; distal tip; plano-convex cross section with slight flake curvature visible in profile; fine pressure flaking along straight blade edges; no edgewear; wide, bending snap at proximal end and perverse fracture along one blade edge, suggesting failure during use

#668-3 schist, distal blade fragment of a long, narrow-bladed point; plano-convex cross section with flat segment of original ventral flake surface still apparent; large and small step fractures visible despite heavy weathering; oblique snap break at proximal end

Bifaces

In total, 128 bifaces or biface fragments were recovered at the site. The raw material distribution among the bifaces differed from the assemblage totals for each material, as shown in the far right-hand column in Table 6-8. Notably, the frequency of Type I quartzite bifaces was lower than the total artifact frequency for that material. In contrast, the frequencies of quartzite and quartz bifaces were higher than their respective material totals and there were no cryptocrystalline bifaces to correspond with the cryptocrystalline debitage. The variations in frequencies may have been in part a function of the emphasis placed on the reduction of Type I quartzite at the site, which resulted in the production of a large amount of flaking debris of that material.

Table 6-8. Lithic Material Distribution among Bifaces and Total Assemblage.

material	*count*	*freq.*	*assemblage total*
Type I quartzite	107	84%	89.0%
quartzite	15	12%	5.7%
quartz	6	5%	2.2%
cryptocrystalline	0	0%	2.7%
total	128		

As noted earlier, bifaces were categorized on the basis of the stage they represented in a theoretical sequence of reduction leading from an unworked fragment of stone to a finished point. To review, three stages were recognized: early (the result of initial edging), middle (the result of primary thinning), and late (the result of secondary thinning). A cross-tabulation of the stages and raw materials is presented in Table 6-9, showing the prevalence of artifacts from early reduction stages in each material type.

Table 6-9. Bifaces by Reduction Stage and Material.

reduction stage	*Type I quartzite*	*quartzite*	*quartz*	*total*
early stage biface	77	13	4	94
middle stage biface	25	2	2	29
late stage biface	5	--	--	5
total	107	15	6	128

Descriptive statistics for each group are presented below along with images of a representative sample of artifacts from each category. The statistics were derived from dimensional measurements of complete specimens only.

Early Stage (n=94)

Of the 94 early stage bifaces in the assemblage, 22 were complete: 15 Type I quartzite, 4 quartzite, and 3 quartz. Dimensional attributes are summarized below (Table 6-10), along with illustrations of sample artifacts (Figure 6-18). The characteristics of the minority raw material types, quartzite and quartz, were difficult to assess in comparison with Type I quartzite due the small samples that were present. Nonetheless, the minority types did not appear appreciably different in terms of overall dimensions. Most of the bifaces of all materials had been cleared of cortex. Three of the whole Type I quartzite specimens and six fragments retained patches of cortex, as did one whole quartzite specimen and two fragments. The relative absence of cortex on the artifacts may be an indication of the form in which the material was introduced to the site—i.e., as partially reduced bifaces—rather than evidence that complete removal of cortex was a specific step executed early in the reduction process.

Most of the bifaces displayed random or unpatterned flaking intended to produce a bifacial edge around the circumference of the artifact. Yet, proximal and distal ends appeared to have been formed on at least two examples (#202-3/501-1 [mended]; #491-3/491-4 [mended]), suggesting that shaping was not always undertaken during the middle or latter

part of the sequence. Evidence of bipolar reduction was noted in the form of several high-backed bifaces with remnant cortex. Among the biface fragments, breaks included 48 perverse fractures, 20 unrecovered hinge fractures, 12 breaks due to incipient fracture planes, and 5 lateral snaps. All of the failures appeared to have been related to production error—either incorrectly applied percussion or due to raw material flaws or other variability that could not be overcome by the artisan.

Table 6-10. Dimensional Attributes of Early Stage Bifaces.

	length	*width*	*thickness*	*w:th*
Type I quartzite, n=15				
range	48-101 mm	31-72 mm	14-45 mm	1.4-2.8
mean	66.2	46.3	24.1	2.9
standard deviation	15.9	11.5	9.5	0.4
coefficient of variation	0.24	0.25	0.39	0.15
quartzite, n=4				
range	70-106 mm	40-59 mm	19-31 mm	1.5-2.2
mean	88.3	50.8	26.3	2.0
standard deviation	14.8	8.9	5.1	0.3
coefficient of variation	0.17	0.18	0.20	0.15
quartz, n=3				
range	69-78 mm	37-50 mm	15-22 mm	2.1-3.3
mean	56.3	34.5	14.5	2.6
standard deviation	4.6	7.0	3.5	0.7
coefficient of variation	0.08	0.20	0.24	0.27

A measure of the relative thickness of each artifact was calculated in the width:thickness ratio, where small numbers indicate greater apparent thickness. Among the complete bifaces, mean ratios ranged from 2.0-2.9, indicating that the artifacts were relatively thick. In comparison, Andrefsky's (1998) estimates, based in large part on Callahan (1979), suggest an expected range of 2.0-4.0 for the width:thickness ratios of early stage bifaces. Among the early stage biface fragments, representative measurements could be made on 12 additional artifacts. Ratios ranged from 1.6-3.6 (mean 2.2), which appeared to be within the range for complete bifaces. The low ratios overall, indicating thick artifacts, exemplified the fact that most of the bifaces had been rejected because they could not be adequately thinned. The ratios did provide an indication of the form in which the lithic material had been brought to the site—reduced cobbles rather than partially reduced flake blanks, since cobble forms tend to be thicker than flake blanks in their initial shapes.

Dulled edges were observed on nearly 25 percent of the early stage bifaces in the assemblage. The dulling did not appear to have been associated with platform preparation, such as trimming to properly locate and isolate the platform or grinding to roughen hard or smooth surfaces. In some cases, the dulling was obviously related to the crushing of platforms that accompanies hard-hammer percussion, and in several particular instances, the wear appeared to result from unsuccessful attempts to split thick bifaces (or cores) by means of bipolar percussion. The wear may also have been an indication that the artifacts had been

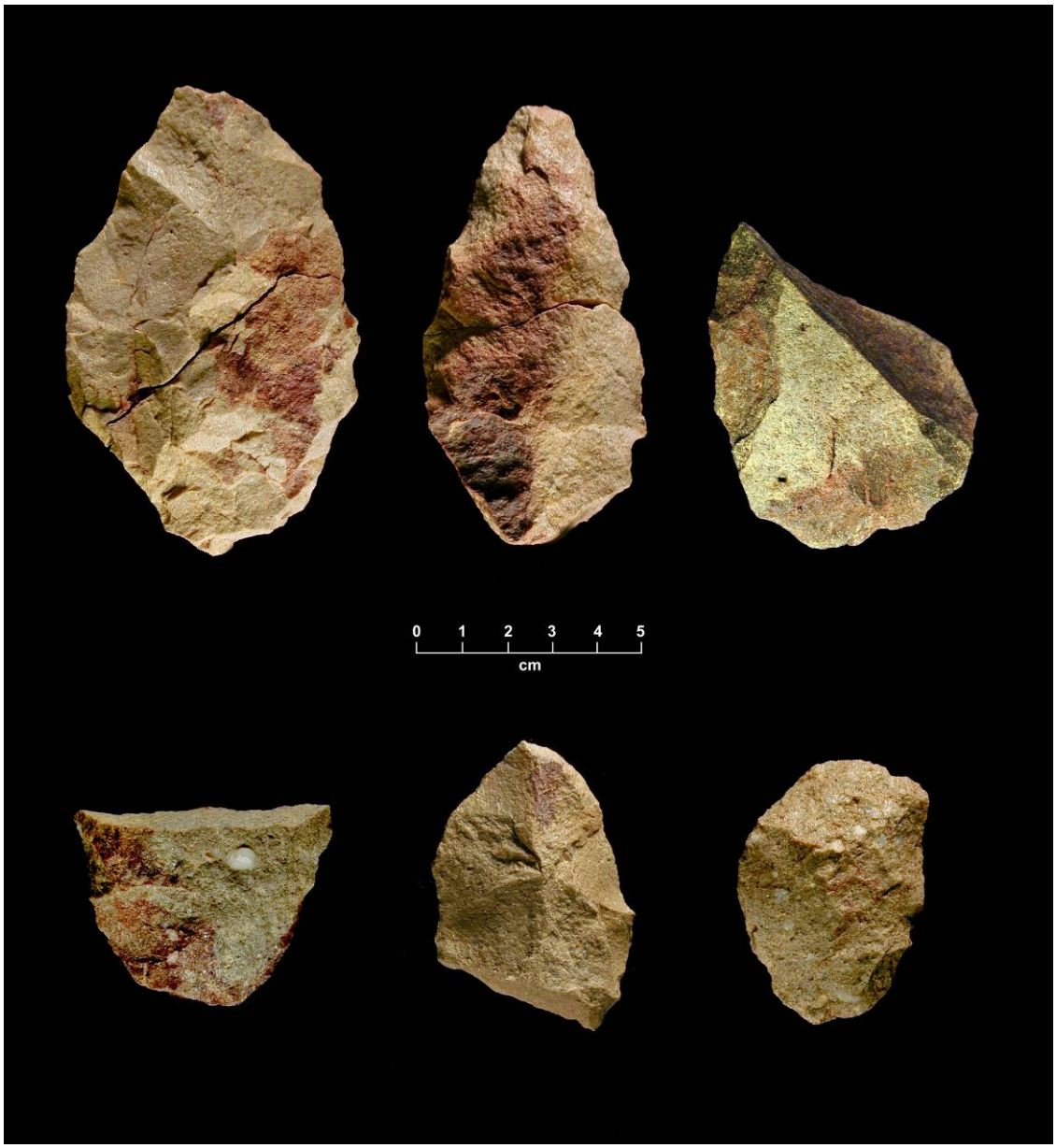


Figure 6-18. Early Stage Bifaces.

(top: 491-4/491-3 [refit]; 501-3/202-3 [refit]; 521-1;
bottom: 1142-1; 376-1; 1295-2; all Type I quartzite)

used as *ad hoc* tools following discard or abandonment (Crabtree 1977), since the rounded or dulled edges tended to occur on isolated, often protruding portions of an edge, such as the end of a biface. Yet, the wear patterns were not extensive or systematic on any of the artifacts, implying that the bifaces were not end-products, reduced to this stage for use as chopping tools or mauls. They appeared to have been manufacturing rejects that had been used in an expedient fashion, rather than heavily utilized and discarded tools.

Middle Stage Bifaces (n=29)

Only three of 29 middle stage bifaces in the assemblage were complete. Two of the complete bifaces were Type I quartzite and one was quartz. Two additional bifaces of Type I quartzite were refitted from fragments. Because they were recovered from widely separated proveniences (2-3 m), the fragments were tallied in the database as individual artifacts; but their dimensions as refitted bifaces were recorded for the current analysis, bringing the total of complete bifaces to five. The dimensions are detailed below (Table 6-11); a sample of the artifacts is illustrated in Figure 6-19.

Table 6-11. Dimensional Attributes of Complete Middle Stage Bifaces.

	length	*width*	*thickness*	*w:th*
Type I quartzite, n=4				
range	49-80 mm	33-49 mm	12-21 mm	1.94-3.08
mean	52.5	39.8	27.5	2.34
standard deviation	9.5	4.5	7.4	0.44
coefficient of variation	0.18	0.11	0.27	0.19
quartz, n=1	55 mm	37 mm	12 mm	3.08

One of the complete Type I quartzite bifaces retained a patch of cortex on one face, as did four fragments, also of Type I quartzite. The use of soft-hammer percussion flaking was apparent in the wide and occasionally shallow flake scars on the artifacts in this group. The patterning of flake removals was more systematic than on early stage examples, indicating increased planning toward thinning and shaping the pieces. Width:thickness ratios were slightly higher than for early stage bifaces, indicating thinner artifacts and reflecting the later position of the middle stage bifaces within the reduction continuum (although the nature of the artifacts as presumably rejected items implied that they were thicker than would be typical of ideal examples at this level of reduction). Representative width and thickness measurements could be made on six of the middle stage biface fragments. When added to the width:thickness ratios from the complete artifacts, the sample size rose to 11, with the ratio ranging from 1.7-3.1 (mean 2.3, standard deviation 0.49, coefficient of variation 0.21). In two cases (#888-1, #1435-1/337-1), the shape of the stem had been roughed out by percussion flaking.

Breaks consisted of 12 perverse fractures, 10 lateral snaps, and 5 unrecovered hinge fractures. All of the fractures appeared to have been manufacturing errors. The overall frequency of middle stage bifaces was lower than that of early stage bifaces, but the proportion of broken examples was greater. The lower overall frequency probably reflected the fact that poor quality material had been culled out through observation and breakage during the preceding stage. Thus, primary and secondary thinning was more often successful in producing later stage artifacts (late stage bifaces and points), and so resulted in fewer failed pieces at this intermediate stage. Edgewear similar to that observed on early stage bifaces was noted on middle stage bifaces. The wear, which consisted of rounding or dulling on isolated, protruding edges, was recorded on fewer than 25 percent of the artifacts. It was interpreted as a combination of platform crushing during percussion and, possibly, expedient use of the artifacts as tools following their removal from the reduction sequence.

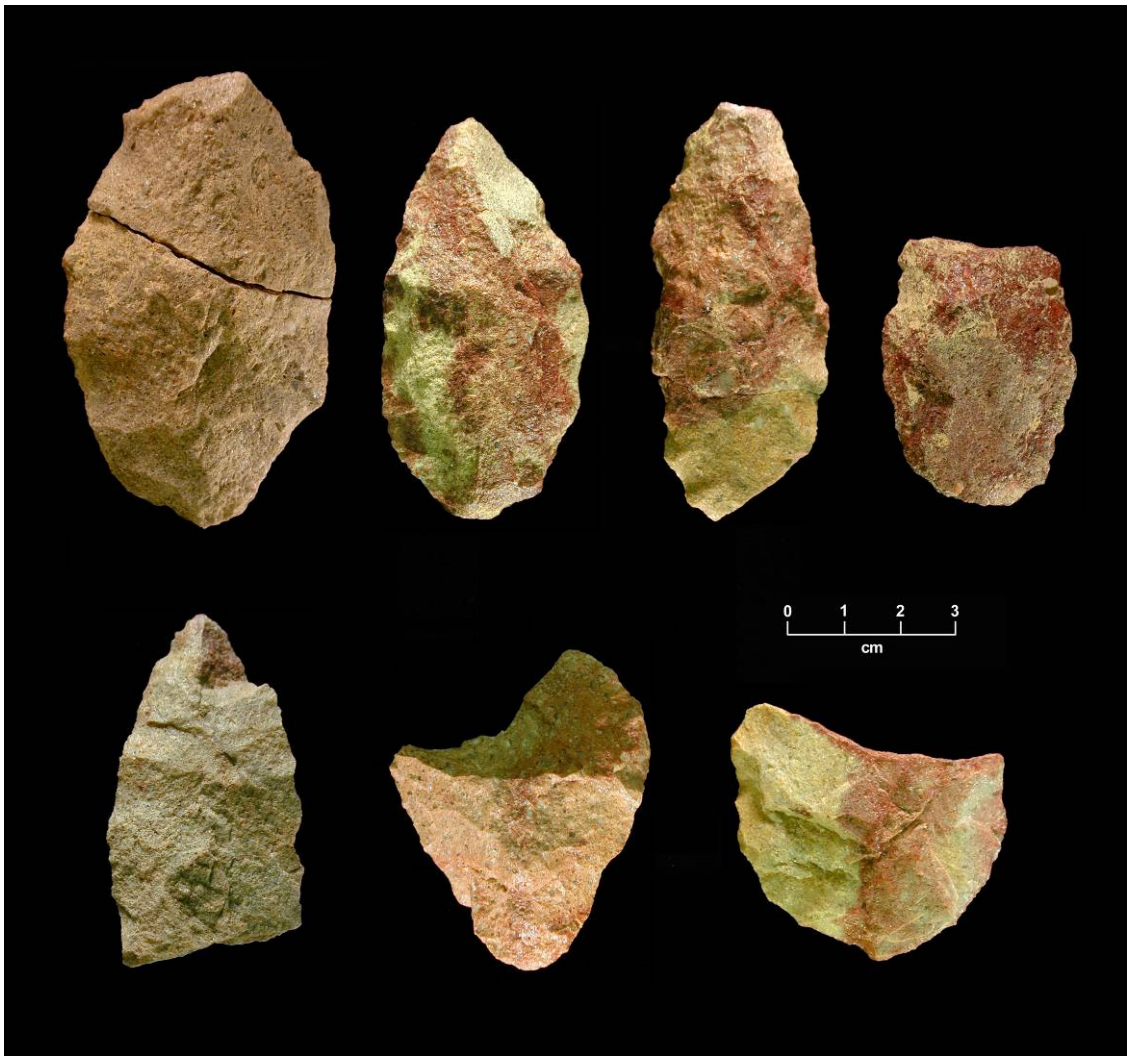


Figure 6-19. Middle Stage Bifaces.

(top: 337-1/1435-1 [refit];111-2; 1412-1/166-3 [refit]; 266-1;
bottom: 354-3; 888-1; 586-2; all Type I quartzite)

Late Stage Bifaces (n=5)

All five of the late stage bifaces were of Type I quartzite, and all were fragmentary (Figure 6-20). None bore remnant cortex. Little evidence of pressure flaking was observed on the edges of the artifacts, indicating that thinning and shaping in the later, secondary stages of reduction were carried out using percussion. Three fragments exhibited transverse or slightly oblique lateral snap breaks, while two bore perverse fractures. All of the breaks appeared to have resulted from repeated stress on the material during preceding stages of reduction that had led to cracks and eventually to failure along one or more minor fracture lines.

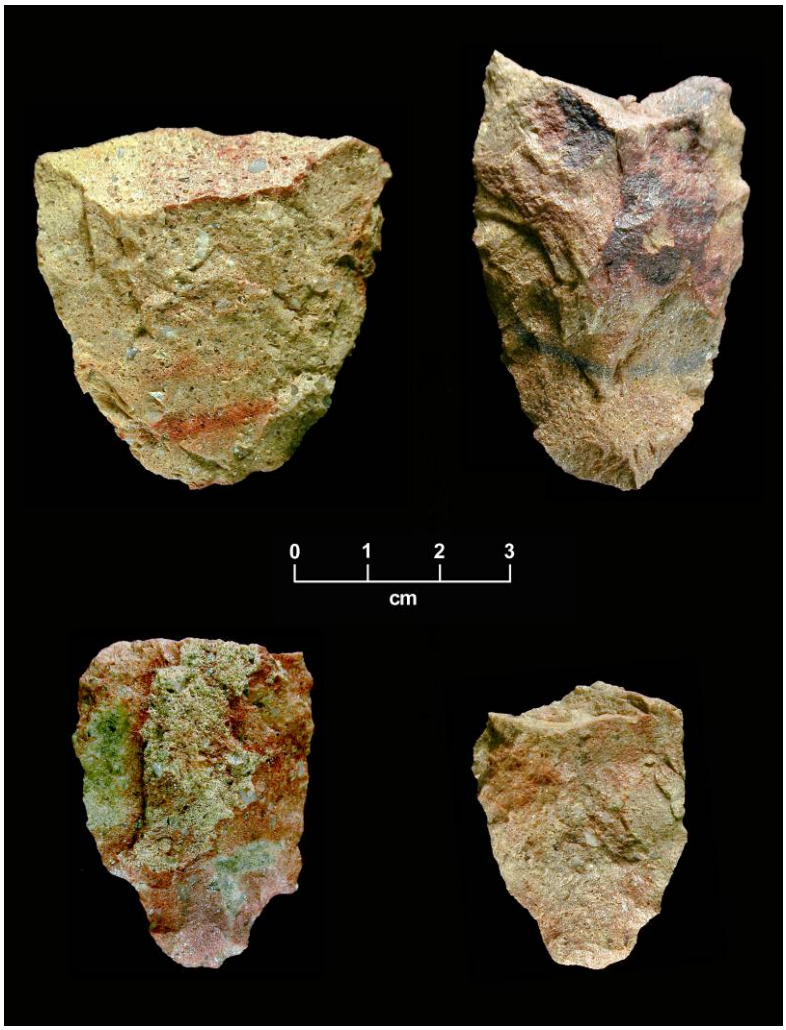


Figure 6-20. Late Stage Bifaces.
(all Type I Quartzite, top: 1346-2; 564-1;
bottom: 150-5; 855-1; all Type I quartzite)

Representative width and thickness measurements could be made on two of the artifacts: width:thickness ratios were calculated as 2.44 and 2.94. These figures indicated artifacts that were not much thinner that the biface fragments from earlier stages. The finding further emphasized that the artifacts were rejects and that relative thickness (or breakage during attempts to reduce the thickness) would have been one of the criteria resulting in the lack of further attempts to reduce the pieces.

Cores

An additional form of lithic reduction that lies outside the biface reduction sequence consists of the generation of flakes from cores. In individual cases, cores may often be difficult to distinguish from early stage bifaces, particularly when bifacial flaking is non-systematic or not well controlled. In the current analysis, cores also include tested cobbles, from which one or two flakes have been removed to allow assessment of the knapping quality of the material. The debris resulting from core reduction would be similar to that produced during early stage biface reduction, being dominated by large, thick, cortical flakes with simple

platforms. Exhausted cores and tested cobbles or pebbles, the latter often split using bipolar techniques, would be among the large debris expected.

Fifty-five cores were recovered as part of the Black Diamond site artifact assemblage. Raw material types were distributed differently from flaking debris (Table 6-12). Almost 90 percent of the flakes in the assemblage overall consisted of Type I quartzite, while only 78 percent of the cores were of that material. In contrast, slightly more than 2 percent of the flaking debris consisted of cryptocrystalline materials, compared with 9 percent of the cores. The variation suggested that less emphasis was placed on the use of Type I quartzite for flake-core production than for biface reduction. Cores were subdivided for descriptive purposes by flaking technique: multi-directional or random; bipolar; and tested. A sample of is illustrated in Figure 6-21.

Figure 6-21. Cores.

(top: 493-1 [multi-directional]; 330-5 [multi-directional];
bottom: 660-1 [multi-directional]; 230-3 [bipolar]; 1192-2 [bipolar]; all Type I quartzite)

Table 6-12. Cross-Tabulation of Core Types and Raw Materials.

	multi-directional	*bipolar*	*tested*	*totals*	*material freq.*
Type I quartzite	40	2	1	43	78%
quartzite	1	1	1	3	5%
quartz	1	1	--	2	4%
cryptocrystalline	1	4	--	5	9%
argillite	--	--	1	1	2%
greenstone	1	--	--	1	2%
total	44	8	3	55	

Multi-Directional Cores (n=44)

Multi-directional cores were struck freehand from a variety of angles, showing little evidence of patterned flake removals or planned reduction. Thirty-six of the multi-directional cores of Type I quartzite were complete, and their dimensions are listed below (Table 6-13). Relatively few—a little more than one-third—retained cortex, indicating the extensive amount of flaking that had been carried out.

Table 6-13. Dimensional Attributes of Multi-Directional Cores, Type I Quartzite.

Type I quartzite, n=36	*length*	*width*	*thickness*	*weight*
range	37-103 mm	27-72 mm	15-61 mm	20-299 gm
mean	71.9	54.0	36.4	153.8
standard deviation	16.5	11.4	9.0	66.6
coefficient of variation	0.23	0.21	0.25	0.43

Multi-directional cores from minority materials were typically larger than Type I quartzite cores (Table 6-14), suggesting that they may have been intended for the production of different tool types. There was some supporting evidence, from the relative frequencies of utilized flakes within each material type (see below), that the minority materials were more often used for flake tool production overall rather than biface manufacture.

Table 6-14. Dimensional Attributes of Multi-Directional Cores, Other Materials.

material	*length*	*width*	*thickness*	*weight*
quartzite	82 mm	70 mm	54 mm	417 gm
quartz	95 mm	83 mm	68 mm	568 gm
jasper	82 mm	49 mm	46 mm	240 gm
greenstone	128 mm	105 mm	77 mm	1023 gm

Bipolar Cores (n=8)

Little evidence was recorded of the bipolar reduction of Type I quartzite, which may reflect the fact that the cobbles comprising the material were large enough to allow freehand reduction, which is a more controlled reduction technique than bipolar percussion. In terms of relative frequency, most of the bipolar cores in the assemblage were cryptocrystalline, either jasper or chert, and they were derived from pebble-sized clasts (Table 6-15).

Table 6-15. Dimensional Attributes of Bipolar Cores, Cryptocrystalline.

cryptocrystalline, n=4	*length*	*width*	*thickness*	*weight*
range	43-63 mm	36-45 mm	19-37 mm	37-54 gm
mean	52.5	39.8	27.5	45.8
standard deviation	9.5	4.5	7.4	7.3
coefficient of variation	0.18	0.11	0.27	0.16

Yet, in some cases, bipolar reduction was undertaken on small cobbles of non-cryptocrystalline stone that was brought to the site (Table 6-16). Bipolar percussion may also have been used as a recovery technique on freehand cores that had become too thick for various reasons but were perceived as worth splitting in an attempt at salvaging the piece. For example, #798-1 was a steep-sided, almost spherical biface on which extensive crushing on opposing edges indicated unsuccessful bipolar blows.

Table 6-16. Dimensional Attributes of Bipolar Cores, Other Materials.

material	*length*	*width*	*thickness*	*weight*
Type I quartzite	36 mm	44 mm	17 mm	31 gm
Type I quartzite	107 mm	78 mm	41 mm	332 gm
quartzite	65 mm	31 mm	27 mm	63 gm
quartz	101 mm	45 mm	34 mm	202 gm

Tested Cores (n=3)

This category consisted of cores with evidence of a minimal amount of reduction, suggesting that they had been flaked in order to examine the quality of the stone. In each case the stone exhibited poor knapping characteristics, such as coarse or irregular grain, inclusions, or bedded fracture planes, which led to rejection of the piece. Tested cores were larger than the mean dimensions of multi-dimensional cores (Table 6-17), reflecting in part the lesser amount of reduction to which they had been subjected.

Table 6-17. Dimensional Attributes of Tested Cores.

material	*length*	*width*	*thickness*	*weight*
Type I quartzite	83 mm	59 mm	28 mm	138 gm
argillite	118 mm	83 mm	72 mm	848 gm
quartzite	81 mm	67 mm	34 mm	183 gm

Drill

A single, distal fragment from a drill or awl-like tool was present in the assemblage (Figure 6-22). Made on a biface of quartz, the proximal end was missing at a transverse snap break. The surviving portion of the blade was 50 mm in length and was generally straight-sided, measuring 15 mm in width for most of its length. The blade had been beveled by percussion flaking to an average edge angle of 53 degrees. The bevel was not heavily altered, but enough to suggest use of the artifact as a drill or router-like implement.

No evidence of grinding or dulling was observed at the proximal end of the tool. Minor scalar flaking was noted along the edges of the blade that may have resulted from the original shaping of the bit or from subsequent sharpening. Minor damage at the distal end consisted of a step fracture that may have resulted from impact—whether directly related to use or to post depositional damage was not clear.

Figure 6-22. Drill.
(174-1, quartz)

Unifaces

Of the five unifaces in the assemblage, four were of Type I quartzite, while the fifth was chert (Figure 6-23). The dimensions of the Type I quartzite artifacts are summarized in Table 6-18. The chert specimen was 28 mm long, 27 mm wide, 17 mm thick, with a bit angle of 69 degrees. Two of the unifaces, one of Type I quartzite specimens (#292-2) and the chert specimen (#302-1), were typical thumbnail-type endscrapers. Both had rounded bits formed on the dorsal face of a thick flake. Bit angles measured 69 degrees in both cases. The chert artifact bore unifacial microflaking on the ventral surface, along with polish and rounding, suggesting extensive use against a slightly yielding material, such as hide, wood, or green bone. The quartzite bit showed no wear, possibly indicating that the artifact had been not been used, or had been resharpened and not re-used.

Table 6-18. Dimensional Attributes of Unifaces, Type I Quartzite.

Type I quartzite, n=4	*length*	*width*	*thickness*	*bit angle*
range	30-63 mm	29-42 mm	8-24 mm	53-69 deg.
mean	49.8	35.5	17.5	60.3
standard deviation	15.8	5.7	7.0	6.6
coefficient of variation	0.32	0.16	0.40	0.11

The remaining three unifaces, all of Type I quartzite, had less regular shapes, exhibiting lateral or diagonally formed bits with angles ranging between 50 and 60 degrees. Usewear could not be confidently identified on any of these tools, either because the use was not extensive or because evidence did not register well on the hard, coarse-grained material.

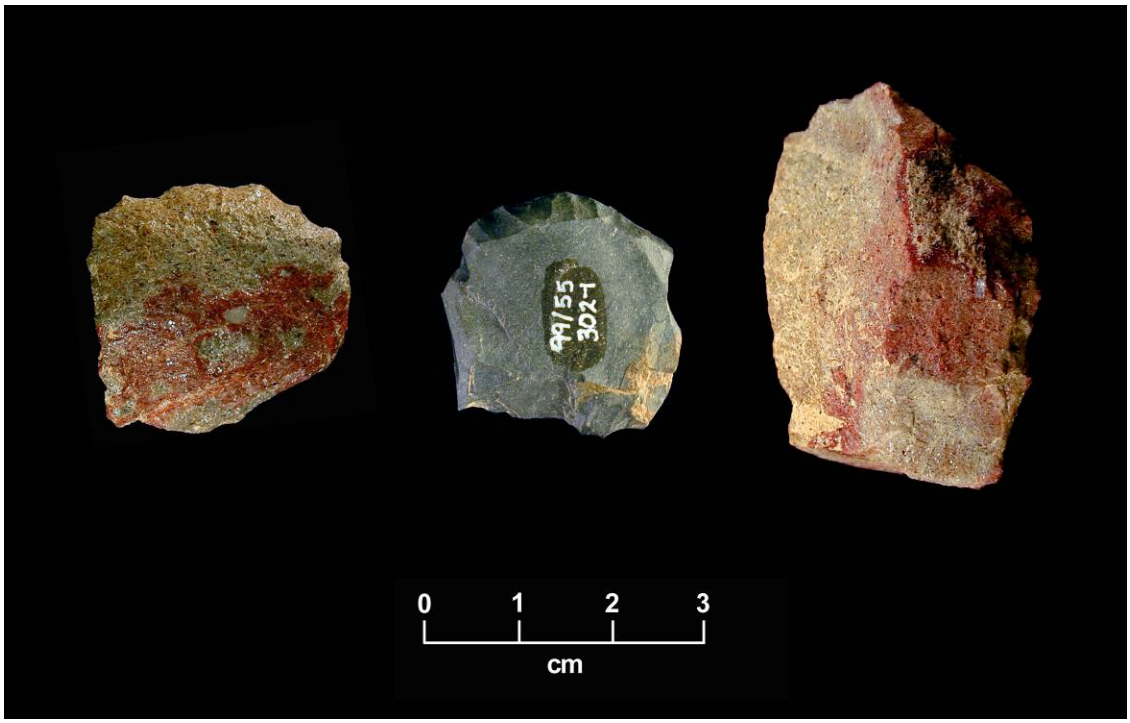


Figure 6-23. Unifaces.
(592-21, Type I quartzite; 302-1, chert; 520-1, Type I quartzite)

Flake Tools

Flake tools were infrequent in the artifact assemblage, considering the high overall artifact counts that were registered. Flakes with evidence of use or retouch occurred among quartzite (including Type I quartzite), quartz, and cryptocrystalline materials (Table 6-19). While most of the artifacts appeared to have been *ad hoc* tools, some were retouched, suggesting a degree of purposeful edge modification directed toward a specific task. In total, nine of eleven Type I quartzite and all seven of the quartz tools bore evidence of retouch.

Table 6-19. Relative Frequencies of Flake Tools and All Flaking Debris by Material Type.

	flake tools	*freq.*	*all flakes*	*freq.*
cryptocrystalline	3	14%	965	3%
quartzite	1	5%	2,079	6%
Type I quartzite	11	50%	32,448	89%
quartz	7	32%	752	2%
totals	22		36,244	

Type I quartzite accounted for 90 percent of the flakes in the artifact assemblage but only 50 percent of the flake tools. In contrast, quartz comprised two percent of the flakes in the assemblage, but 32 percent of the flake tools, while cryptocrystalline flakes accounted for three percent of the flake total and 14 percent of the flake tools. These proportions may have been in part a function of recognition during analysis, in that usewear is often easier to distinguish confidently on cryptocrystalline and microcrystalline materials than on coarse-

grained stone, such as quartzite. Thus, while usewear on quartzite may have been somewhat under-represented in the analysis, the study did demonstrate that flakes were regularly used as tools at the site.

Hammerstones

Ten complete hammerstones and one fragment were present in the assemblage. Most of the hammerstones consisted of cobble-sized clasts of dense quartzite (Table 6-20, Figure 6-24). Quartz specimens were smaller on average and occurred within a tighter range of sizes. Wear on all hammerstone examples typically consisted of pecking and battering on the ends, edges, or on flat areas, the latter implying use in bipolar reduction either as hammerstones or anvils.

Table 6-20. Dimensional Attributes of Complete Hammerstones.

	length	*width*	*thickness*	*weight*
quartzite, n=7				
range	53-130 mm	44-92 mm	30-80 mm	88-1,078 gm
mean	98.6	70.1	56.7	617
standard deviation	26.7	19.2	18.8	400
coefficient of variation	0.27	0.27	0.33	0.65
other				
quartz	70 mm	50 mm	49 mm	504 gm
quartz	83 mm	67 mm	45 mm	306 gm
sandstone	115 mm	95 mm	46 mm	626 gm

Hammerstones represent an artifact type typically found in low frequencies in lithic artifact assemblages. They are associated with a specific form of reduction—heavy, early stage percussion—which is not necessarily carried out extensively at all sites. Hammerstones may also have been viewed as expedient tools that were selected from local gravels, used for a particular task, and discarded. Curation of hammerstones does not seem to have been a common practice, particularly among mobile groups, since the items were heavy and were easily procured in regions with widespread pebble and cobble deposits. Because they are typically harder than the stone against which they were used, and often were not used extensively before discard, archaeological examples frequently do not show clear evidence of use. Yet, a number of hammerstones were identified in the Black Diamond site artifact assemblage. All of the artifacts were dense, and most bore extensive evidence of use. These characteristics were probably related to the hardness of the Type I quartzite that was the main focus of lithic manufacture at the site, and the need to find and keep good, dense percussors that were harder material than the quartzite that was being flaked. The amount of wear on the hammerstones left at the site indicated the degree of use to which they had been subject, implying that they were maintained and reused rather than being replaced frequently. To illustrate the variety and extent of wear patterns on the artifacts, several of the examples are described in some detail.

Figure 6-24. Hammerstones.
(top: 640-1, quartzite; 997-1, quartz; 376-4, quartz;
middle: 467-3, quartzite; 423-17, quartz;
bottom: 717-1, quartzite; 773-1, quartzite; 541-1, quartzite)

Artifact #773-1 (Figure 6-25) was an irregular, tabular cobble with several flat facets and protruding angles. Extensive battering was observed along most of the edges. The material was less dense than many of the other hammerstones, and several deep, angular flake scars emanating from the ends and battered edges reflected incidental flaking of the stone during use as a percussor. Two protruding corners had been struck repeatedly and had become slightly concave, suggesting use in a vertical motion, such as occurs in bipolar reduction. Two of the largest flat surfaces on the artifact also bore pits. One was roughly oval in shape, measuring 16-x-25 mm (a small, deep pit next to the pecked area appeared to have been the result of natural weathering). The second pit was wider, measuring 22-x-32 mm. Both pits were 4-5 mm deep, and neither exhibited evidence of systematic abrasion or grinding.

Adjacent to the wider pit was a third depression, situated along an edge the cobble. The pitting on the stone was consistent with use in bipolar percussion. Due to the shape of the cobble, none of the major depressions would have been horizontal if the stone had rested normally on a flat surface. The implication drawn from this, as well as from the relatively low density of the material, was that the artifact had been used in part as a bipolar hammerstone rather than as an anvil.

Figure 6-25. Detail of Hammerstone.
(left: reverse view; right: obverse view; quartzite, 773-1)

Artifact #997-1 (Figure 6-26) was a round cobble of very dense quartzite with one flat facet. Extensive battering was present around the circumference of the cobble, while minor, randomly located damage was noted on the flat face. On the opposite, rounded surface of the specimen, heavy battering was present. The wear formed the beginnings of a small depression approximately 25 mm in diameter that suggested the artifact had been used as an anvil, resting on the flat surface, or as a bipolar hammerstone.

Figure 6-26. Detail of Hammerstone.
(left: reverse view; right: obverse view; quartz, 997-1)

Artifact #717-1 (Figure 6-27) exhibited variety of wear patterns. It appeared to have been a multi-functional cobble tool, rather than simply a hammerstone or anvil. The artifact exhibited battering at both ends that was sufficiently extensive to have blunted the ends slightly. One face contained a deep recess or pit, measuring 25 mm in diameter and 7-8 mm in depth. The interior surface of the pit exhibited a degree of smoothing that suggested use in grinding activity. Extensive pecking was present across a wide portion of the cobble surrounding the pit that further suggested use as an anvil. The opposite face of the cobble bore a flat area that was the remains of a natural spall. The resulting surface measured approximately 60-x-95 mm. The exposed quartzite grains at one end were smoothed, suggesting the area had been used as an abrader. Lastly, additional pecking was present in a band, 25-30 mm in width, connecting the two utilized faces of the cobble across a convex edge. The band was slightly convex in form, and thus did not appear to have been the result of use in a rolling or milling action. Rather, it appeared to have been deliberately applied by hammering or pecking. In form, the band resembled hafting grooves seen on groundstone axes and similar implements. However, given its presence on one side of the tool only, hafting seemed unlikely. Alternatively, this portion of the artifact may have been used in a specialized task such as suppling leather straps or cordage.

Figure 6-27. Detail of Hammerstone.
(bottom: obverse view; top: lateral view; quartzite, 717-1)

Pendant *(n=1)*

Artifact #536-3 was a small, slate pendant (Figure 6-28). Originally oval in shape, one end was damaged along an irregular diagonal break that paralleled the bedding grain of the material. The surviving portion of the pendant measured 62 mm in length (which is estimated to be at least 90 percent of the original length), 38 mm in width, and 6 mm in maximum thickness. A hole had been drilled in one end. The hole was conical in form, bored from one side only and oriented at a slight angle to the face of the artifact. The opening was oval in shape, measuring 4-x-8 mm, while the diameter of the hole on the

opposite face was 2 mm. The edges of the pendant had been worn smooth, as had the damaged edge. A small indentation, possibly the remains of a second drilled hole was present at the upper limits of the damaged edge. The pendant was manufactured on bluish gray slate (Munsell gley-2 4/1), with plate striae clearly evident in several areas. One face of the artifact was polished smooth while the other appeared unfinished, showing imperfections and irregularities in the form of plate ridges.

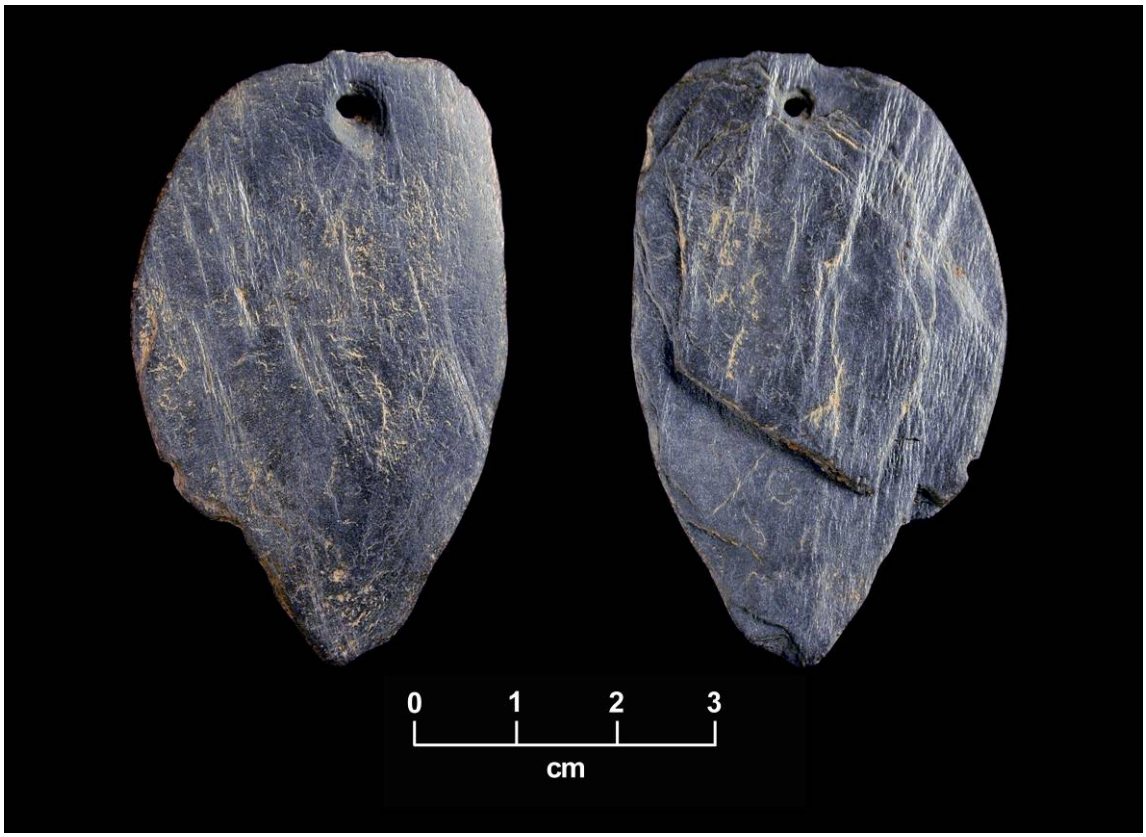


Figure 6-28. Pendant.
(slate, #536-3)

Flaking Debris

Of the more than 37,000 prehistoric artifacts in the Black Diamond assemblage, 98 percent were flakes. Almost 90 percent of the flakes consisted of Type I quartzite (Table 6-21), the rest consisting of other forms of quartzite, and of quartz, jasper and chert (combined in the table under the term cryptocrystalline), and coarse-grained stone such as rhyolite and argillite. Five of the materials represented large enough samples to support statistical analyses, and the descriptions that follow are focused on those materials.

Table 6-21. Distribution of Raw Material Types among Flakes.

material	*count*	*freq.*
Type I quartzite	32,448	89%
quartzite	2,079	6%
quartz	752	2%

cryptocrystalline	965	3%
rhyolite	146	0.4%
siltstone	9	<.01%
argillite	8	<.01%
basalt	5	<.01%
greenstone	5	<.01%
total	36,417	

The large number of flakes in the assemblage posed difficulties in terms of efficient analysis, and so, as indicated in the introductory section describing analytical methods (Section 5.3), a form of aggregate or mass analysis was used to characterize the artifacts. One of the primary attributes recorded in this form of analysis is size, measured on an interval scale—one centimeter in this case. The smallest interval, size-grade 1, consisted of flakes less than 1 cm in maximum dimension. Since the opening of the ¼-inch mesh used in data recovery was effectively larger than 1 cm, many of the flakes in size-grade 1 may have passed through the field screens and remained uncollected. Because it was not systematically recovered, the sample at this interval was incomplete and thus was not used in the analysis. The size-grade distributions above size-grade 1 for each of the five material types in the analysis are listed in Table 6-22.

Table 6-22. Flake Size Distributions by Material Type.

	Type I quartzite	*quartzite*	*quartz*	*crypto-crystalline*	*rhyolite*
size grade	n=28,954	n=1,880	n=642	n=855	n=125
2	67%	65%	70%	73%	76%
3	22%	22%	20%	21%	22%
4	7%	9%	5%	4%	2%
5	2%	3%	2%	2%	--
6	1%	1%	3%	1%	--

The most striking aspect of the distributions was the marked similarity between the groups—65 and 75 percent of the flakes of each material occurred in size-grade 2 (<2 cm in maximum dimension), while approximately 20 percent occurred in the next largest grade. Because of the uniformity of the proportions, minor differences in frequency were potentially significant, and indeed, several of the variations appeared to follow a discernible pattern. For example, the frequencies of non-quartzite materials—quartz, cryptocrystalline materials, and rhyolite—were between 5 and 10 percent higher in the smallest size grade. In addition, slightly more quartzite and Type I quartzite flakes occurred in larger grades, particularly size-grade 4. The variation in the larger size grades is graphically illustrated in Figure 6-29, where the lines for quartzites lie distinctly above those of the other materials at size-grade 4. Greater frequencies observed among small flakes combined with lower frequencies of large flakes may reflect different forms in which the raw materials occurred. Sampling studies of gravel deposits in the vicinity of the Black Diamond site indicated that quartz and cryptocrystalline materials occurred in small, pebble form in contrast to quartzite—both Type I quartzite and more general forms of the material—which tended to occur as larger clasts, often of cobble size (Versar 2011a, 2011b). Smaller clasts will, of course, tend to produce smaller debris on average, suggesting that the higher relative frequency of small quartz and

cryptocrystalline flakes reflected the fact that the materials had been collected in pebble form. Moreover, pebbles may often require bipolar percussion to initiate fractures from which to produce bifacial edges. Bipolar percussion is a relatively uncontrolled flaking technique in comparison to freehand reduction, and can result in the propagation of a greater amount of small, incidental flaking debris (Honea 1965; Kobayashi 1975; Cotterell and Kamminga 1990). In a slightly different interpretation, the distribution of small rhyolite flakes appeared to indicate that little if any manufacturing reduction took place using this material. No large rhyolite flakes typical of the earlier stages of reduction were present, implying that the small flakes in the assemblage were more likely the result of tool maintenance rather than the by-products of manufacturing.

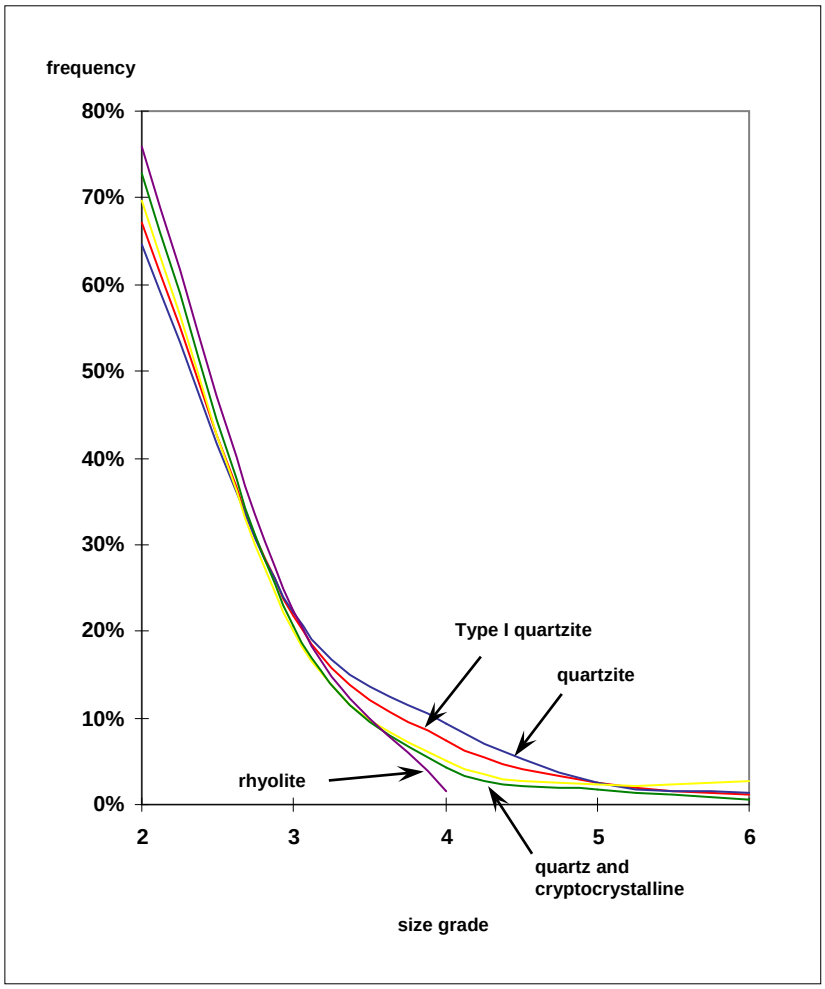


Figure 6-29. Size-Grade Distribution of Flakes by Material Type.

Mean flake weights calculated for each size grade indicated that the relative thickness of flakes of most of the materials was similar (Table 6-23). Quartz flakes tended to be slightly larger in some size intervals, which may have been a function of fracture mechanics, since the crystalline structure of quartz typically contains internal irregularities that can lead to uneven or uncontrolled flaking and can often result in broken or shattered flakes that are relatively thick (Boudreau 1981). Mean weights of rhyolite flakes were consistently lower,

indicating that the flakes were thinner, and again implying that the debris resulted from retooling or resharpening.

Table 6-23. Mean Flake Weight per Size Grade.

size grade	Type I quartzite	quartzite	quartz	crypto-crystalline	rhyolite
1	0.12	0.12	0.13	0.12	0.09
2	0.45	0.45	0.44	0.43	0.36
3	2.04	1.89	2.23	1.88	1.31
4	5.79	5.36	6.82	5.23	3.25
5	13.01	11.95	12.71	10.81	--
6	36.71	40.28	35.21	32.14	--

Perhaps the most informative statistic was the frequency of occurrence of cortical flakes within each size interval (Table 6-24). The cortical frequencies for all material types increased predictably with each larger grade, reflecting the fact that larger flakes are more likely to be produced during primary reduction or decortication, and that some activity of this type was carried out at the site. Yet the degree to which decortication was represented varied by material. Cortical frequencies were higher for quartz than for either of the two quartzite varieties, while frequencies among cryptocrystalline materials were substantially higher yet.

Table 6-24. Frequency of Cortical Flakes per Size Grade.

size grade	Type I quartzite	quartzite	quartz	crypto-crystalline	rhyolite
1	2%	2%	5%	20%	0%
2	4%	4%	12%	25%	1%
3	10%	11%	29%	45%	7%
4	15%	16%	36%	56%	--
5	24%	27%	47%	60%	--
6	32%	40%	61%	100%	--

The distributions highlighted the apparent difference in original clast form among the material types, the quartzites being derived from cobbles, quartz and cryptocrystalline materials from pebbles. Due to their size, pebbles contain a higher proportion of cortex per mass than cobbles, and thus their reduction will tend to produce a greater proportion of cortical debris. Implicit in this interpretation is the notion that the primary reduction of quartz and cryptocrystalline pebbles was undertaken on-site along with the working of partially reduced quartzite cobbles or blanks. A last observation pertains to the low frequency of cortex on rhyolite flakes: this finding again reflected the exotic or non-local nature of the stone and the fact that it was brought to the site in reduced form, probably as finished bifacial tools.

Thermally Altered Stone

Thermally altered stone was a problematic artifact category within the assemblage. Few artifacts were identified in the database with unambiguous evidence of heat alteration. The characteristics that typically indicate heating include a change in color or surface luster; irregular fractures not associated with knapping; spalling, or the generation of relatively thin

fragments that follow surface contours rather than cutting into the stone; potlidding, a particular form of spalling that results in small, basin-like scars; or crazing, minor stress fractures on the surface of the artifact that do not result in material separation. Combinations of these attributes were identified on 117 of the total of the more than 37,000 artifacts in the assemblage. Most of the artifacts that were identified as thermally altered consisted of small fragments of jasper, quartz, sandstone, or quartzite; most of these fragments were less than 5 cm in diameter and weighed less than 15 gm. They were widely and evenly distributed across the excavation block. In general, therefore, the data suggested that stone was not intensively or systematically used in fire-related activities such as cooking, residential heating, or ceremonial activities such as a sweatlodge.

Another widely documented use of fire by Native American populations was related to stone tool manufacture. Data from studies at locales across Delaware and other regions of North America suggest that heat was occasionally used to improve the knapping quality of some chipped stone materials (Mounier 2008; Johnson 1981; Purdy 1981; Waston and Riley 1994). To further investigate evidence of this form of thermal alteration in the Black Diamond assemblage the majority raw material, Type I quartzite, was examined in detail. Artifacts in each of the large chipped stone artifact types—cores, and early, middle, and late stage bifaces—were analyzed. The evidence was neither clear nor conclusive. Various combinations of potlidding, spalling, and reddening were noted within each artifact type. The frequency of occurrence of one or more of these characteristics was highest among cores, at over 50 percent (Table 6-25), but considerably lower for bifaces (note that the frequency calculation for late stage bifaces was based on a small sample—five artifacts—and thus may not be representative). No sure evidence of thermal alteration was observed on the finished points from the site.

Table 6-25. Large Artifacts of Type I Quartzite with Attributes Characteristic of Heat Alteration.

artifact type	*evidence of heating*	*total*	*freq.*
core	31	55	56%
esb	10	94	11%
msb	4	29	14%
lsb	2	5	40%
point	0	15	0%

Color change is one of the most common variables associated with the heat alteration of lithic artifacts (Schindler et al. 1982). Ebright's (1987) experiments with heating quartzite indicated that the material tends to change color from the inside out. While no additional experimentation was conducted in association with the Black Diamond site investigations, research suggested that evidence of heat treatment should be expected to be in the form of uniformly reddish hues throughout an artifact. The interpretation of color alteration in Type I quartzite was complicated by the fact that the material was iron-rich and dense. Like the ferruginous quartzite that is referred to in the Delmarva region as ironstone (Ward and Doms 1984; Ward 1985), rubefication, or reddening, was common in the Type I quartzite debris at the Black Diamond site and was present in a large proportion of the artifacts made from the material. But in most cases the color could be readily attributed to chemical weathering of

the constituent iron. For example, red coloration was frequently noted on the exterior of fragments in the form of a thin rind beneath the cortex or along cracks or flaw planes that indicated the seepage of moisture into the rock. Many artifacts had broken or split along mineralized flaw planes, either during the manufacturing process or postdepositionally. These surfaces appeared as platy, dark red or black patches, and were often associated with other areas within an artifact that were red and well-oxidized. Luster, a gloss or sheen often imparted by heating, was generally not observed on the artifacts. The inference from these observations was that the reddening noted in most of the artifacts of Type I quartzite was chemical in nature rather than induced by heat.

However, some of the Type I quartzite artifacts did appear to have been heated, many of them classified as such on the basis of more uniform coloration. Homogeneous color change was identified on all of the artifacts noted as thermally altered in the assemblage. Color was the only characteristic of heating observed on middle and late stage bifaces, and the only characteristic on all but two of the 10 thermally altered early stage bifaces. Other characteristics of heat alteration such as potlidding and spalling were present on cores but not bifaces, and always occurred in combination with reddened coloration. Among cores, these characteristics also correlated with lithic material that displayed poor qualities for knapping, such as a coarse or tightly packed grain, extensive inclusions, or the near absence of the distinct, cherty matrix that characterized the quartzite. While not quantified, this correlation appeared to be consistent within the quartzites from the site, implying that the stone that was most often heated was the least suitable for chipped stone reduction.

Several researchers have observed that systematic heat treatment of lithic raw material was typically conducted on partially reduced bifaces, not on unworked cobbles or bifaces in the earliest stages of reduction. Schindler (et al. 1982) describes the details of chemical modifications to jasper resulting from heating, reporting that in the archaeological samples they studied, evidence of heat treatment occurred at considerably lower frequencies on primary thinning flakes than on flakes from later stage thinning, implying that heat treatment was undertaken only after the initial edging and thinning had occurred. Purdy (1981:110) similarly observed that heating commonly occurs “fairly late in the manufacturing process.” In the Black Diamond site assemblage, in contrast, the frequencies of heat-alteration characteristics followed a trend implying that artifacts from early in the reduction sequence had been heated, suggesting that it was not an intentional part of the manufacturing process.

While bifaces did not appear to have been methodically heated, most of the cores with attributes suggesting thermal alteration also appeared to have been flaked to some degree. The flaking was usually not systematic and was often limited in extent. Multiple levels of patination could be seen on several of the cores. The first level consisted of cortex, which as noted earlier was smooth, gray, and seemed to have resulted from chemical and physical weathering. A second level of patina occurred on interior surfaces, seen in relation to unpatinated areas as a slight dulling of the surface of the stone, similar to the dulling or crazing that occurs as a result of intense heating. Flake scars present on many of the cores indicated that they may have been tested for knapping quality. Step-fracturing was common on these cores, reflecting the poor flaking characteristics of the stone. Because the poor

quality of the material in its initial state, it seemed unlikely that the stone had been heated specifically to improve its knapping characteristics.

Following the identification of thermal alteration on large artifacts in the assemblage, attempts to re-assess the entire database for evidence of heat alteration were considered, but the process was determined to be impractical. Differentiating between flakes and heat spalls or potlids was problematic in many cases because of the coarseness of some of the material, which varied in quality, both between and within cobbles. The coarser material appeared to break unevenly, not producing clear ventral or dorsal flake surfaces. And so, discriminating between small pieces of flaked debris and spalls resulting from heating was in most cases unfeasible. Given the large amount of clearly definable flaking debris in the assemblage, along with the low frequency of equally distinct thermally altered stone fragments, it seemed reasonable to assume that most of the ill-defined pieces of debris had resulted from flaking, not from heat spalling.

Boulder

A single, essentially unmodified quartzite boulder was documented at the site (Figure 6-30). The material differed from the Type I quartzite that dominated the artifact assemblage in that it was a tightly grained orthoquartzite that did not feature individual quartz grains suspended in a smooth matrix, and was light brown in color rather than gray and reddish. The boulder was roughly tabular in form, weighing 24.9 kilograms (kg). Cortex was uniformly present on all faces, suggesting that it had not been worked in any way. The boulder was encountered in the main artifact bearing cultural horizon, lying within the basin forming Feature 71. It was substantially larger than the naturally occurring stone in the area, including items from the underlying Columbia Formation which typically consisted of pebbles and small cobbles. Although the quartzite appeared to be fine-grained, it is unlikely to have been suited for tool production. The boulder exhibited what appeared to be laminate planes throughout its mass which would likely have rendered controlled flaking of the material difficult. No evidence was noted that the piece had been tested: the only observed modification was minor cortex attrition that could have resulted from hammering, although the wear was very limited in extent suggesting that the boulder had not been extensively used as a formal anvil or mortar stone.

Figure 6-30. Unmodified Quartzite Boulder.
(scale bar 1 m with 10-cm increments)