1987

Michaud, a Paleoindian Site in the New England-Maritimes Region

Arthur E. Spiess

Deborah Brush Wilson

Maine Archaeological Society

Maine Historic Preservation Commission

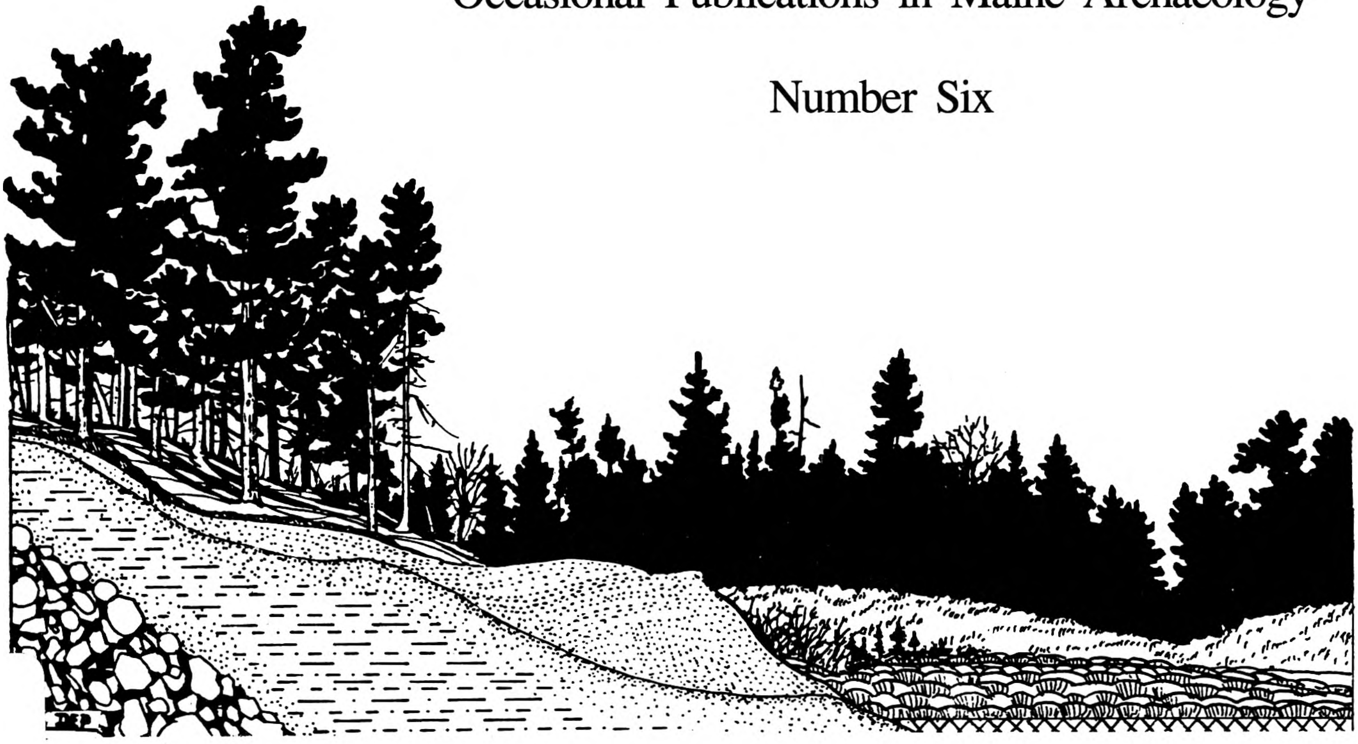
MICHAUD
A PALEOINDIAN SITE
IN THE NEW ENGLAND-MARITIMES REGION

by

Arthur E. Spiess and Deborah Brush Wilson

Occasional Publications in Maine Archaeology

Number Six



MICHAUD

A PALEOINDIAN SITE

IN THE NEW ENGLAND-MARITIMES REGION

by

Arthur E. Spiess and Deborah Brush Wilson

Occasional Publications in Maine Archaeology
Number Six

The Maine Historic Preservation Commission
and
The Maine Archaeological Society Inc

Augusta, Maine
1987

Occasional Publications in Maine Archaeology
Number Six
Series Editor: Arthur E. Spiess
The Maine Historic Preservation Commission
Augusta, Maine

ISBN 0-935447-04-0

TABLE OF CONTENTS

ACKNOWLEDGEMENTS

It has been two years now since the fateful day in the spring of 1985 when George Eaton's sharp eyes first discovered the Michaud site. Since that time, many people have contributed to the Michaud site investigations, advertantly or inadvertantly.

Particular thanks go to the M.D.O.T. materials geologists, George Eaton, Rebecca Hewitt, Sylvia Michaud and Ray Woodman, who first surface collected the site during the course of their survey work, and later located their finds on maps and in the field for us. Sylvia Michaud brought the site to our attention, for which we are particularly grateful. The late George Eaton displayed a great interest in the site, spending hours checking the progress of the excavations, lending a hand on the screens, and helping to record the surficial geology of the site.

Henry Lamoreau provided help, expertise, insight, and the keenest Paleo-indian nose available. He volunteered, with Dennis Edmondson in the hot June sun, for the initial test excavations. Later, he participated in the major excavation effort, displaying his dedication by locating the Lamoreau site while everyone else ate lunch and stretched out in the welcome shade of a tent. Later, Henry worked in the lab, sorting raw materials and refitting broken items. It was Henry whose keen eyes refitted two channel flake fragments to a broken biface preform. Henry contributed ideas on mammoth and mastodon hunting, tried out a survey strategy to locate other Paleoindian sites, contacted collectors who might have other Paleoindian artifacts. In short, Henry Lamoreau provided assistance in many ways during the project.

The field crew consisted of John Abruzzi, Deborah Brush (Wilson), Arne Carlson, Lanita Collette, Ellen Cowie, Charles D. Cox, Edna Duffy, Dennis Edmondson, Lynn Fitz-Patrick, Mark Hedden, John Holland, Robert Kelley, Laureen LaBar (Kidd), Eric Lahti, Shelley Lahti, Henry Lamoreau, and Alexandra Morss, some of whom worked a seven day week. David Skinas, as fieldcrew chief, provided steady leadership when Spiess was not there, and provided able assistance when Spiess was there. Mark Hedden was indispensable during the initiation of fieldwork, acted as quartermaster in charge of dig supplies during the excavation in addition to regular work as a fieldcrew member, and oversaw the transition from fieldwork to laboratory work. Lanita Collette helped with much of the cataloguing and initial analysis.

The following colleagues deserve hearty thanks for providing advice during the planning and early fieldwork stage of the project: Bruce Bourque, Steven Cox, Richard Michael Gramly, John Grimes and Brian Robinson. Steven Cox was especially helpful during the analysis.

Steven Cox, Chris Ellis, James B. Petersen, John Grimes, and Dennis Stanford did the yeoman task of reviewing the manuscript with completeness and frankness. Such advice represents the most altruistic level of professional and personal friendship, which is deeply appreciated.

Steve Bicknell, University of Maine at Orono, Department of Anthropology, is to be thanked for the excellent artifact photographs in Chapters 3 and 6.

CHAPTER ONE:
PROJECT BACKGROUND

During the fall of 1984 an archaeological survey was undertaken by Maine Historic Preservation Commission personnel (Arthur Spiess and Mark Hedden) along the low-slope portions of a proposed right-of-way for a new connector road from the Maine Turnpike to the Auburn-Lewiston Industrial Park (Figure 1-1). Initial examination of the right-of-way was unproductive and the survey remained inconclusive. Early the following spring, however, several stone tools and a number of lithic flakes from stone tool reworking or manufacture were recovered from several sandy "blow-outs" in the unsurveyed right-of-way area by four materials geologists from the Maine Department of Transportation (George Eaton, Sylvia Michaud, Ray Woodman and Rebecca Hewitt). These artifacts were brought to the attention of Spiess, who attributed them to the Paleoindian period, ca. 11,000 to 10,000 B.P. in Maine, particularly on the basis of a diagnostic fluted point base and a channel flake. All four of the M.D.O.T. materials geologists were able to locate most of the finds they had made, either on 1"-100' scale aerial photographs, or in the field. An extensive survey of the find area described by the M.D.O.T. personnel, as well as the surrounding vicinity, was begun on May 30, 1985. It was evident that the recovered artifacts represented only a sample from an extensive site, which was named after Sylvia Michaud, the first of the observant geologists to bring this significant site to our attention.

At the time the Michaud site was discovered, access to the site was by a gravel work road which converged with the southerly end of the North-South Runway (Runway 4-22) at the Auburn-Lewiston Airport (Figure 1-2). Standing at the end of the runway facing south (220° magnetic), one looked downslope across an irregular, undulating surface alternately covered with grasses, weeds, and exposed patches of sand, best described as dune fields, an area which is now traversed by a road. Patchy vegetational cover still extends for about 200 meters to the west of the runway centerline, where it is bordered by a mature pine forest. Railroad tracks run perpendicular to the runway across the view to the southward. To the far south, across the tracks, a bedrock-controlled outcrop known locally as Christian Hill dominates the landscape. Below Christian Hill, and slightly to the west of the runway approach centerline, is a modest bog which is fed and drained by Moose Brook. A small stream runs along the southern border of the nearest dune field perpendicular to the runway center line, meandering in a generally east to west direction before finally turning south across the valley to join Moose Brook below Christian Hill. Looking in a northeasterly direction, the land rises to form a low, till-covered hill.

The dune fields which provide the current surface at the Michaud site are built upon a fine sand base in which rocks or cobbles larger than 1 cm. in diameter are extremely rare. This sandy base is part of the regional, terminal depositional unit of a marine transgression which reached a maximum in Maine ca. 13,000 B.P. Selective logging ca. 1968 apparently exposed substantial areas of substrate in this area for the first time since it was originally vegetated, although it was probably not until after 1970 that the dune field was reactivated. In 1970, according to Mr. Fernand Giguere, long-time maintenance foreman at the Airport, a variety of ground-disturbing activities took place in

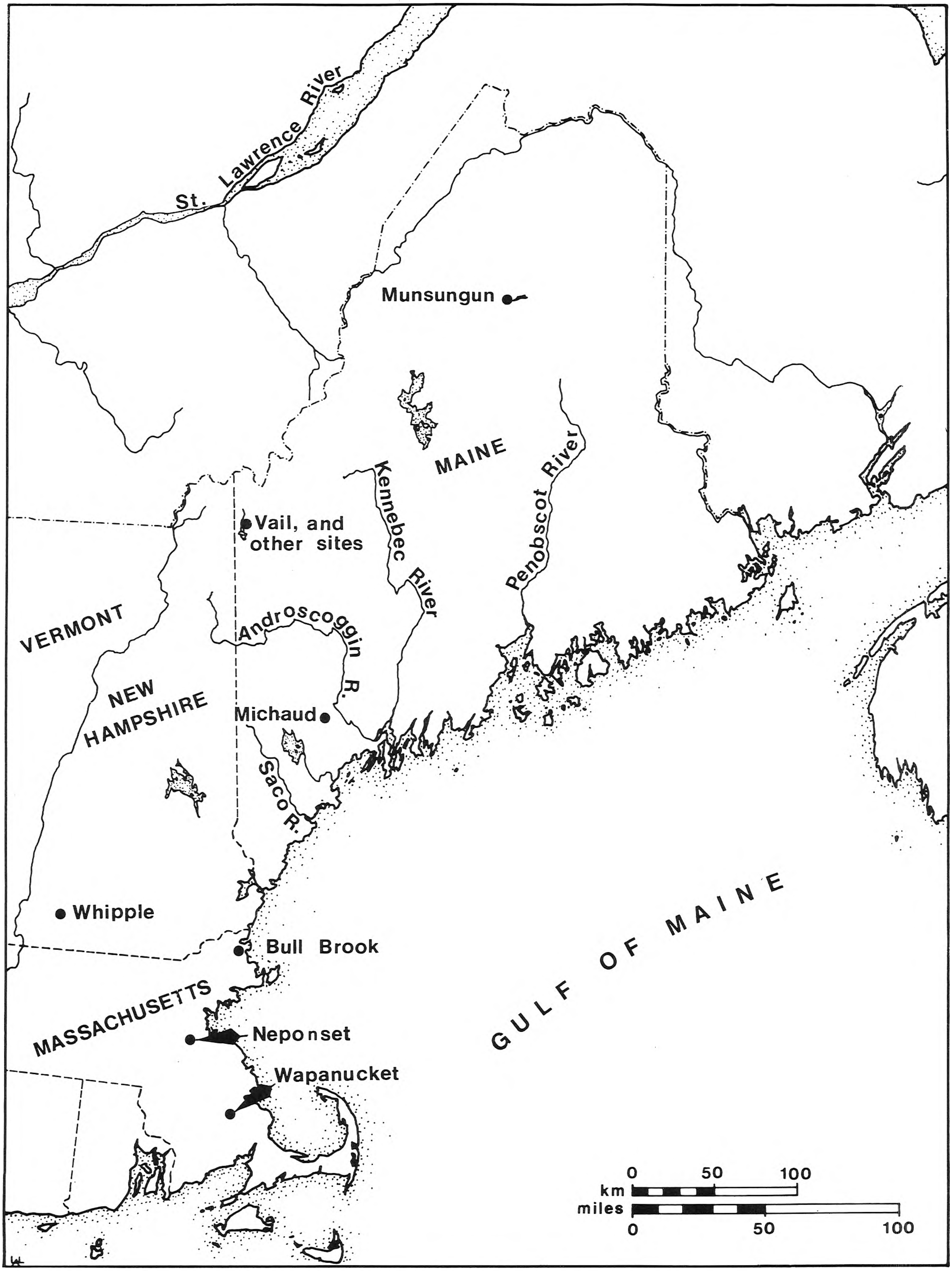


Figure 1-1. Location of the Michaud site at Auburn, Maine, in relation to selected Paleoindian sites in New England.

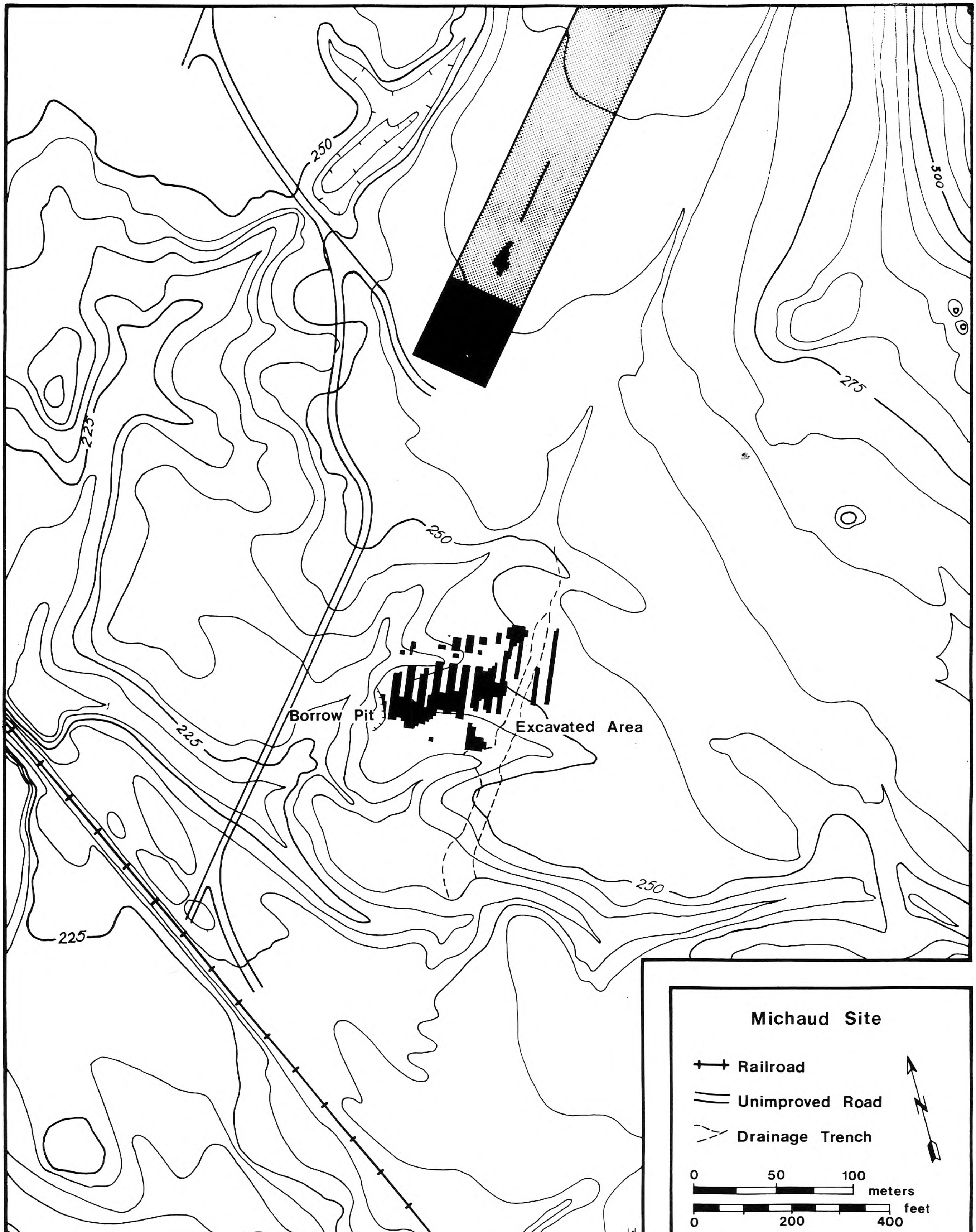


Figure 1-2. Topography of the Moose Brook Valley and Michaud site area south of Runway 4-22, and the excavated area of the Michaud site.

order to clear and level the ground at the end of the runway for an expanded clearzone. As part of this activity, an intermittent drainage that ran diagonally (NE to SW) across the runway clearzone was filled by pushing in adjacent sand, soil and vegetation; and a new north-south drainage trench was dug parallel with the runway centerline, to the east. Coincident levelling of low dune tops to increase the ease of mowing low vegetation added to the disturbance which reactivated dune movement. Discussions with Mr. Giguere were invaluable in reconstructing patterns of soil disturbance. Although the dune fields had been active for more than 15 years, soils analyses, initially by Spiess and subsequently by Balogh and Gordon (Appendix One), showed that much of the area preserved intact older forest soil below the eolian deposits of the last decade. These intact soils consisted of developmental soil horizons beginning with an A/E horizon overlying a deeply orange B_1 horizon. A slightly less orange B_2 horizon and C horizon, respectively, underlay the B_1 horizon.

All of the artifacts recovered by the M.D.O.T. personnel had been collected in the devegetated, deflated areas southeast of the end of the runway. The survey by Spiess and Hedden at the end of May, 1985, included both an extensive surface collection over much of the area south of the runway and the digging of several test squares in the vicinity of the original finds. At this time, Hedden and Spiess laid out initial transects across the impact area, including the probable Paleoindian site location, in order to assign consistent provenience designations to subsequent artifact finds.

A north-south base-line was laid out with a handheld compass which was within one or two degrees of true north. A transit and 100 meter tape were used to control straight lines and horizontal distance, and red plastic flags attached to wire stakes were set along major north--southand east-west base-lines every ten meters. The M.D.O.T. survey centerline marker No. 47.00 was arbitrarily designated North 50 East 50 on the metric grid for the archaeological site (Figure 1-3). The east-west base-line was extended eastward across the drainage ditch which had its western edge at approximately North 50 East 100, and this was considered the probable eastern margin of the site.

For all subsequent work the site was divided into two-by-two meter squares which were each named by the coordinates of the southwest corner of the square. Each two-by-two meter unit was subdivided into four one-meter square quadrants which were designated Northeast (NEq), Southeast (SEq), etc. More precise horizontal control was obtained by further subdividing each quadrant into one-quarter quads of 50 x 50 centimeter dimensions, which were designated Northeast one-quarter quad (NE 1/4) of the SE quad, etc., or by taking provenience information which was exact to the centimeter. Generally, careful trowelling by quarter--quad was employed in those areas which possessed both intact soils and two or more flakes per quad, allowing exact provenience for flakes and artifacts discovered in-situ, and a resolution of quarter-quad for materials recovered in the screen. R. M. Gramly (personal communication) suggested the use of 1/8" screens to aid in the recovery of concentrations of small flakes in various activity areas. As a necessary compromise to the likelihood that we would be excavating much "sterile" ground in order to clear the construction area, we decided to utilize 1/4" mesh screen until we exceeded a count of one flake or tool per square meter in any given 2 m square, after which 1/8" screen would be used to sieve the sediment from that square and those adjacent to it. Upon advice from Steven Cox and Bruce Bourque of the Maine State Museum in mid June, 1985, the following excavation strategy decisions were made. (1) We would maintain a 2 m grid divided into 1 m quads over the whole site regardless of the site's ultimate size. This grid system would enable us to record point provenience of material as found in-situ, or to get a minimum resolution of 1 m square on

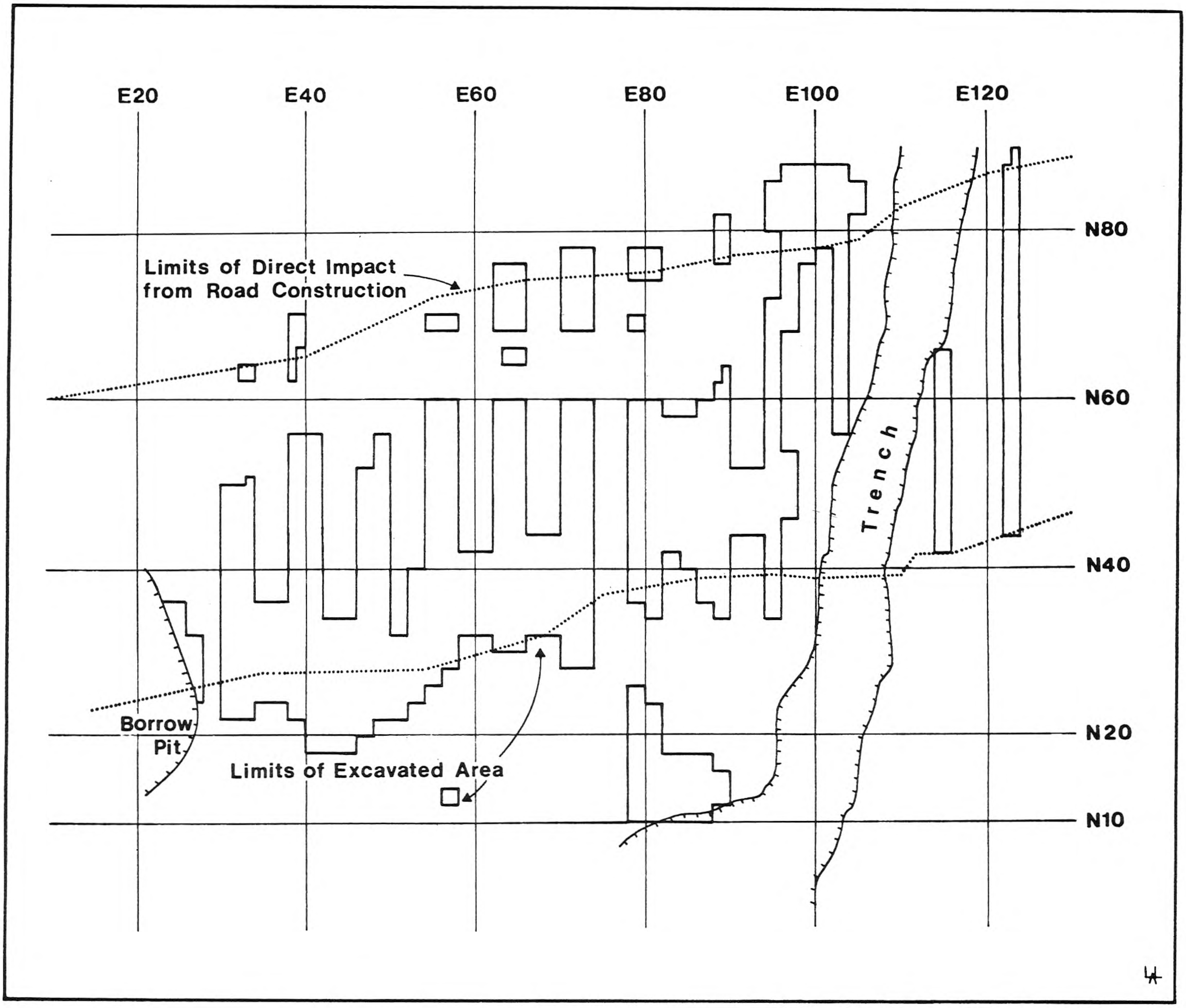


Figure 1-3. Metric grid and final limits of archaeological excavation imposed on plan for road construction and pre-existing drainage trench and borrow pit.

Plate 1-1. General view of 1985 excavation at the Michaud site. Foreground: excavation in the N30E60 vicinity, left to right: A. Spiess, C. D. Cox, D. Skinas. Background: view south to Moose Brook, M. Hedden left, L. Collette right. Photo courtesy of Gregory Hart.

material recovered from screening or surface collection. (2) We would excavate the site within the right-of-way in linear groups of excavation squares called "trenches" that would be 4 m wide from east to west, and would extend across the whole width of the right-of-way from north to south. (3) We would excavate alternate 4 m wide trenches completely across the entire width of the right-of-way and then excavate additional units in areas where artifacts or flakes were found. Thus, the maximum distance between excavated points would be 4 meters. (4) We would dig some deeper testpits, up to 2 m deep, to test the hypothesis that Paleoindian cultural material was primarily associated with B horizon orange soils, and that no other deeply buried soils existed.

As test excavation progressed through June, ongoing area survey during lunch hours revealed a second Paleoindian site closer to Moose Brook, but well outside the impact area. Surface collection on small patches of exposed sand suggested that the site, which we designated the Lamoreau site

Plate 1-2. Excavation inside a lithic concentration at the Michaud site. Foreground: A. Morss. Background left and right: L. LaBar Kidd and E. Cowie. Photo courtesy of Gregory Hart.

(Maine Archaeological Survey Site #23.13) after Henry Lamoreau, our dedicated crew-member who made the discovery, covered an area of at least 60 meters in length. The Paleoindian tools and flakes recovered from the Lamoreau site were of the same range of raw materials as those we found at the Michaud site. Like the Michaud site, the Lamoreau site provides an excellent view of the Moose Brook Valley. We suggest, based on the proximity of these two Paleoindian sites to the Moose Brook Valley, that the valley was a primary focus of Paleoindian attention, perhaps for big game animals sought by Paleoindian hunters.

Although time and funds were not available for excavation of the Lamoreau site, it has been nominated to the National Register of Historic Places and is now protected by the Maine Antiquities Law.

The information recovered from the Michaud site through June 21, 1985 was used to predict rates of excavation and to prepare an estimate of site integrity. These figures were used to develop a plan of work for mitigation of adverse impact to the site. Approximately seven weeks passed while the paperwork establishing permission for the excavation and transfer of funds was finalized. Ownership of the artifacts was transferred to the State of Maine during this period.

Excavation began on August 15, 1985, and continued until October 23, 1985, generally with a crew of between 10 and 15 people (Plates 1-1 through 1-4). David Skinas, a graduate student at the University of Maine, acted as fieldcrew chief and

Plate 1-3. View southeast from N40E60 area, field office and lunch area.

Spiess served as overall project director.

Ultimately, nearly 150 flaked stone tools, over 2,500 flakes and several fragments of calcined bone were recovered during the excavations at the Michaud site. A great many of the artifacts were found in intact soils, indicating that most of the site was little disturbed. With such a thin scatter of artifacts, specific activity areas could be delineated and artifact associations clearly defined.

Based upon the distribution pattern of material from excavated portions of the Michaud site, surface inspection of deflated areas, and limited shovel testing, all in-situ material was recovered by our excavation. An unknown portion of the ex-situ material was not recovered. Some material certainly slumped over the bank of the new drainage ditch at the southern margins of Concentration VII (Figure 5-1), although much of the volume of slumped sand was screened. We also estimate that a small number of flakes, and perhaps a few tools, went unrecovered in the disturbed area labeled Concentration VIII (Figure 5-1), and in the fill pushed into the old drainage ditch. As an estimate based on comparison of the shapes of intact artifact clusters, we might have lost 20% of Concentration VII. We estimate that a score or two of flakes and possibly several tools were not recovered from Concentration VIII and the fill in the drainage ditch.

Road construction followed the close of our excavations (Plate 1-5).

Plate 1-4. General view of Michaud site area behind truck in sand in the middle distance, facing southeast. Note: runway at left. Photograph taken at an elevation of 500 feet by Spiess.

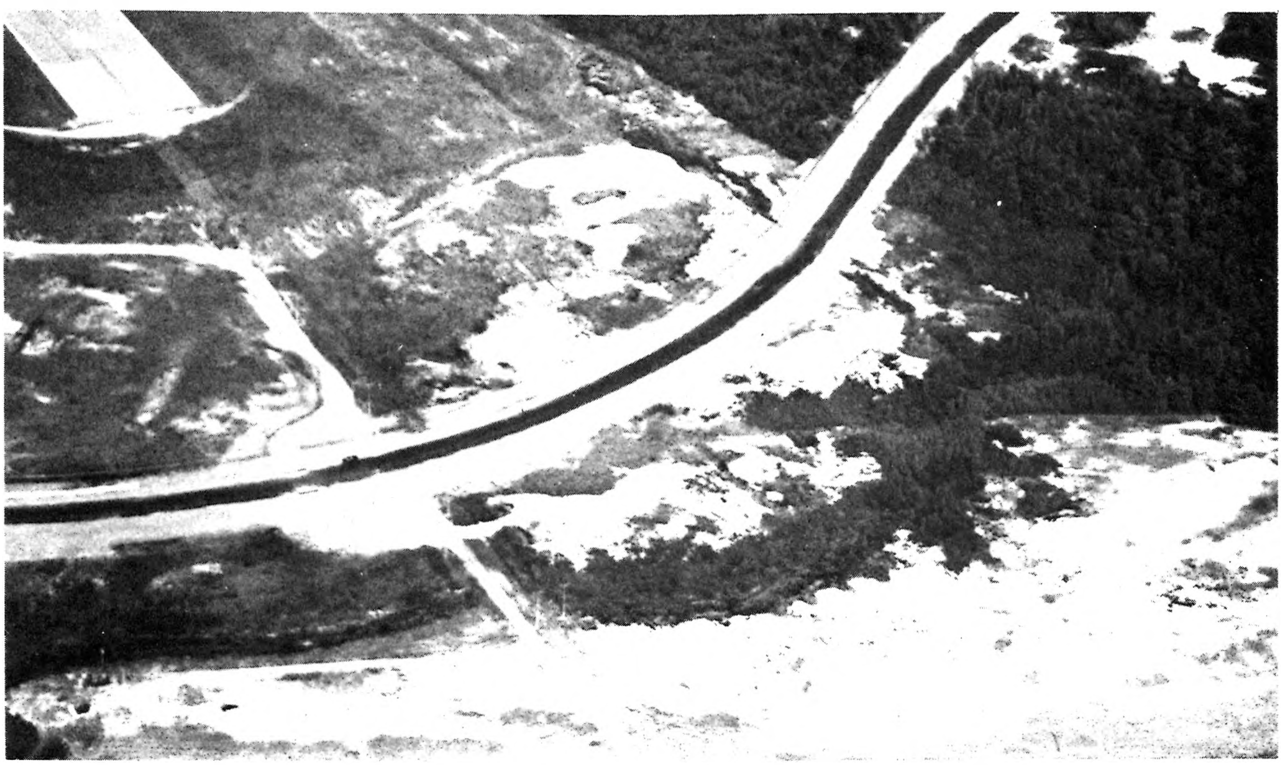


Plate 1-5. The Michaud site vicinity following road construction, August, 1986.

CHAPTER TWO

GEOLOGICAL CONSIDERATIONS

LANDFORMS

The Michaud site is located just south of the Androscoggin River drainage and slightly southwest of Lewiston, Maine (Figure 2-1) at an elevation of about 245 feet above mean sea level (m.s.l.). The site is separated from the Little Androscoggin River, which lies one kilometer to the north, by a divide which reaches an elevation of approximately 280 feet above m.s.l. (Figure 2-2). The site lies just to the north of, and within sight of Moose Brook, which is a northwest-southeast flowing minor tributary of the Royal River. For approximately 20 km west of this area, the topography consists of a mixed sand and gravel "peneplain" with an average elevation of about 250 feet above mean sea level. Moose Brook has its origins in small streams and channels which dissect this terrain, and which finally join to form Moose Brook about 2 km west of the airport.

At present, the Moose Brook Valley, adjacent to the Michaud site, contains an extensive beaver bog. Sediment cores taken in February, 1986 (see Chapter 4), indicate the presence of long term bog conditions there. Moose Brook flows southeastward to join the Royal River 1 1/2 km from the site. The contemporary Royal River is an underfit stream meandering across the flat bottom of a broad, steep-walled valley. The steepness of the valley walls is particularly pronounced for some kilometers downstream from the Moose Brook-Royal River junction.

The Royal River flows nearly due south from its confluence with Moose Brook to the present coast at Casco Bay (Figure 2-1). At the time when Paleoindians were present, the Royal River would have continued its flow across what is now Casco Bay to an ancient coastline below the modern shore, as relative sea level in the Gulf of Maine was lower than at present (Oldale 1985).

On a New England regional scale, the present shores of Casco Bay between Portland and Freeport represent the northernmost terminus of the New England coastal plain. The Royal River Valley is a north-trending, low elevation access to the interior from the coastal plain between two areas of near-coastal highland which extend between Portland and Gray, and Freeport and Lewiston. We suspect that even with the sea-level lower ca. 10,500 B.P., the Royal River would have still been the northernmost interior access from the New England coastal plain. The north-south trending bedrock ridges that create the topographic highs east of Casco Bay currently extend seaward under water, partially visible as peninsular and island chains. Thus, we hypothesize that the Paleoindian sites in Auburn were purposefully placed within a major topographic corridor that extended from the coastal lowlands into the interior.

SURFICIAL GEOLOGICAL RECONSTRUCTION

Geologists Thomas Lowell, Robert Oldale and Woodward Thompson each visited the site vicinity independently in an effort to decipher the sequence of events that placed the glacial till, clay and sand in the area of the Auburn Airport, and later reworked these deposits into the current landforms. Our reconstruction of the landform features in the vicinity of the Michaud site is as follows (see also Figure 2-3), based on the geologists' comments, and the known glacial history of Maine (Borns et al 1985b).

Landform features linked solely to glacial advance and subsequent retreat are evident in abundance in the Michaud site vicinity. Two sets of glacial striations, scratches on bedrock created by the passage of the rock encrusted ice sheet, were noted by Lowell, trending in a south-southeasterly direction. A possible meltwater channel was noted by Lowell flowing across the top of Christian Hill, dividing it into NW and SE peaks. Such a meltwater channel could have flowed at any time during ice retreat, when the hill was covered with ice, for instance.

Two superimposed till units have been recognized for some time in southern New England, and more recently in northern New England (Koteff and Pessl 1985). Diamicton is the generic term for an unsorted deposit of material often containing a wide particle size range. Lowell noted that the drumlin in the southeast corner of the airport, just northwest of the Michaud site, was composed of two units of diamicton. The lower unit contains more clay and rocks that are well-rounded and thus are suggestive of long distance transport. In contrast, the upper unit contains less clay and more angular rocks of apparently local origin. A fist-sized cobble of dark red Munsungun-like chert was recovered from the lower diamicton unit on the south side of the drumlin. However, extensive walk-over of the lower unit and visual inspection of thousands of cobbles and boulders failed to reveal any more cherts. Moreover, the Michaud site inventory does not contain any chert cobble cortex flakes, making it extremely unlikely that the till was used as a cobble chert source by the inhabitants of the Michaud site. This lower till unit was probably emplaced by ice advance from a northwesterly direction (Tom Lowell personal communication). It is not likely

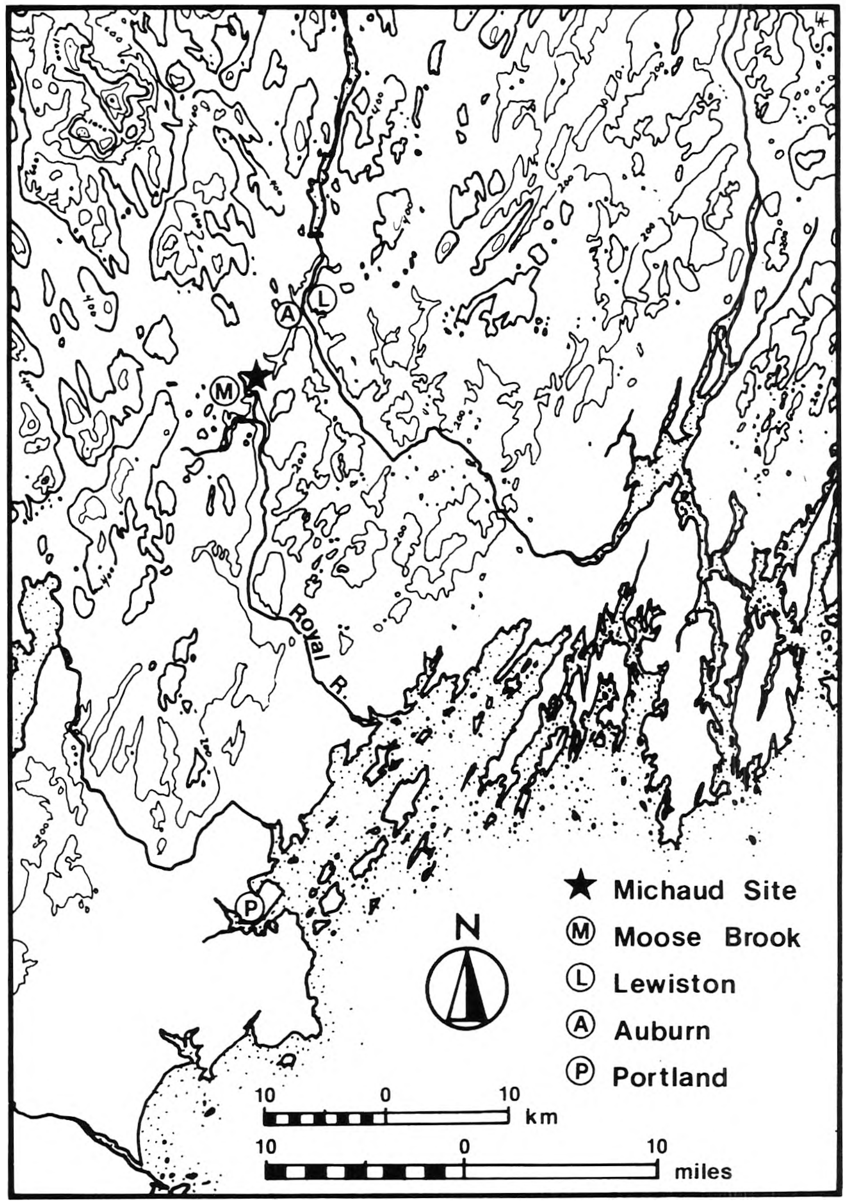


Figure 2-1. Location of the Michaud site relative to major topographic features in central Maine. Contour lines are at 200 foot intervals. The Royal River corridor trending northward from the coastal plain is evident.

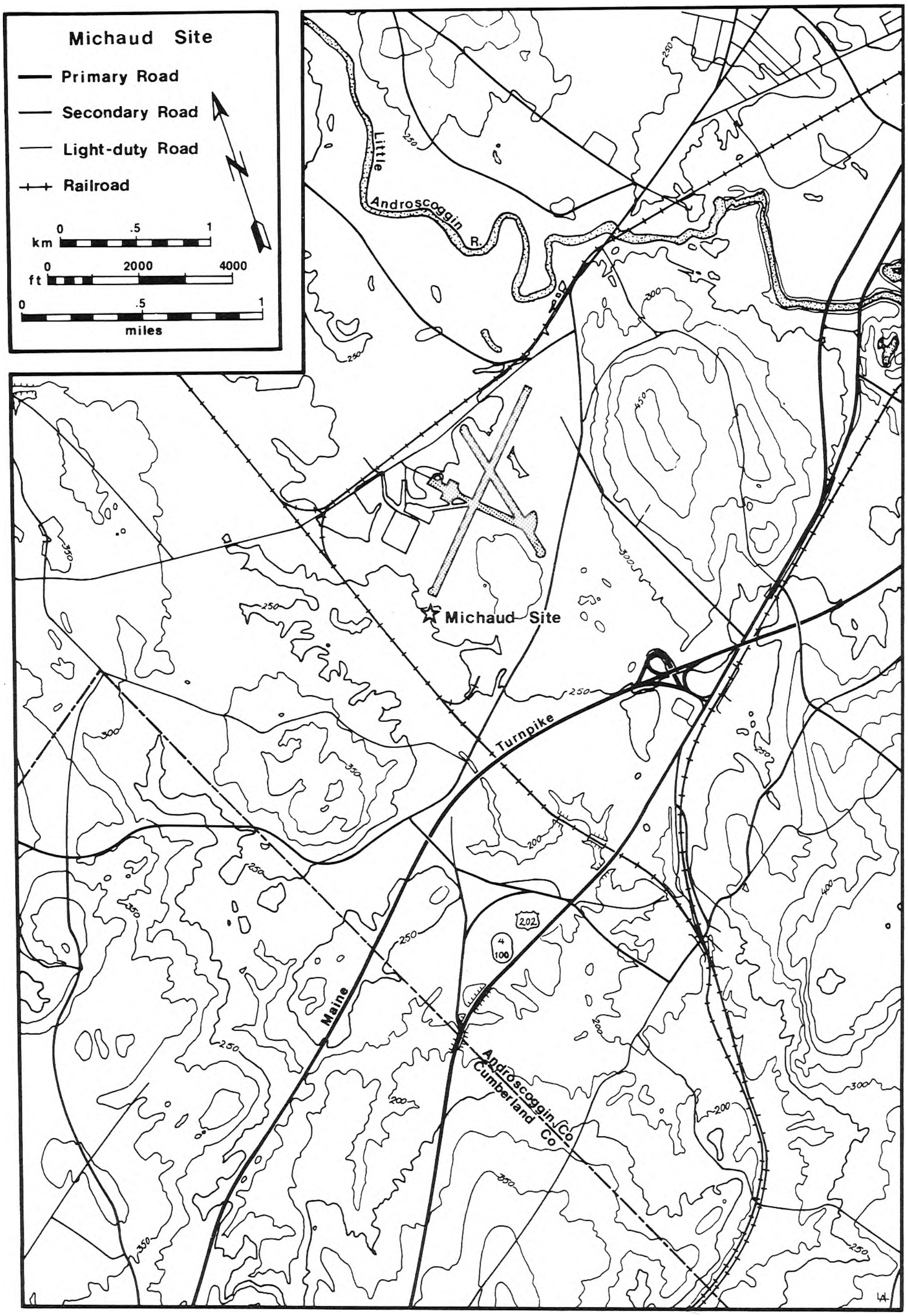


Figure 2-2. Topography around the Auburn-Lewiston Airport and the Michaud site. The large hill reaching 400 feet elevation across the railroad tracks from the site is Christian Hill.

that a Munsungun chert cobble arrived from the northwest without multiple generations of glacial movement.

The marine transgression subsequent to glacial retreat (Smith 1985) was responsible for other major depositional events in the area of the Michaud site, at times in conjunction with sediments emplaced by glacial melt. A surficial examination of soils in the Airport vicinity revealed a sand-based planar topography, thought to be marine deltaic in origin. This type of topography is characterized by a relatively flat or gently sloped sandy surface. Sand ridge/-mound topography, or wind-generated dunes (Lowell personal communication), occur in certain areas of the sand plain.

Examinations of the dunes were conducted with the various geologists who visited the site. It was important to understand the temporal context of their formation in order to assess the possibility that portions of the site were obscured in hidden soil horizons or disturbed by recent soil deflation and

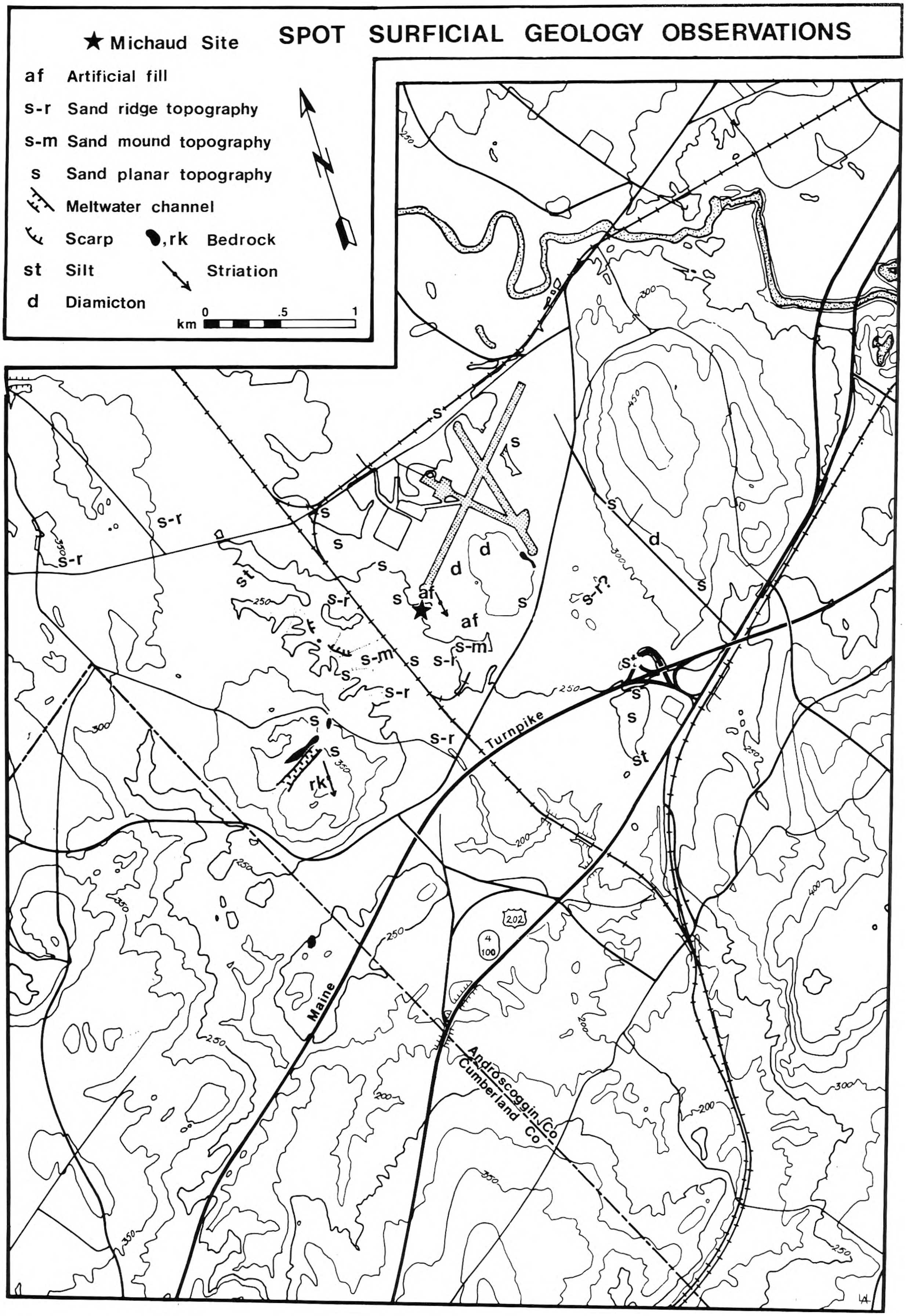
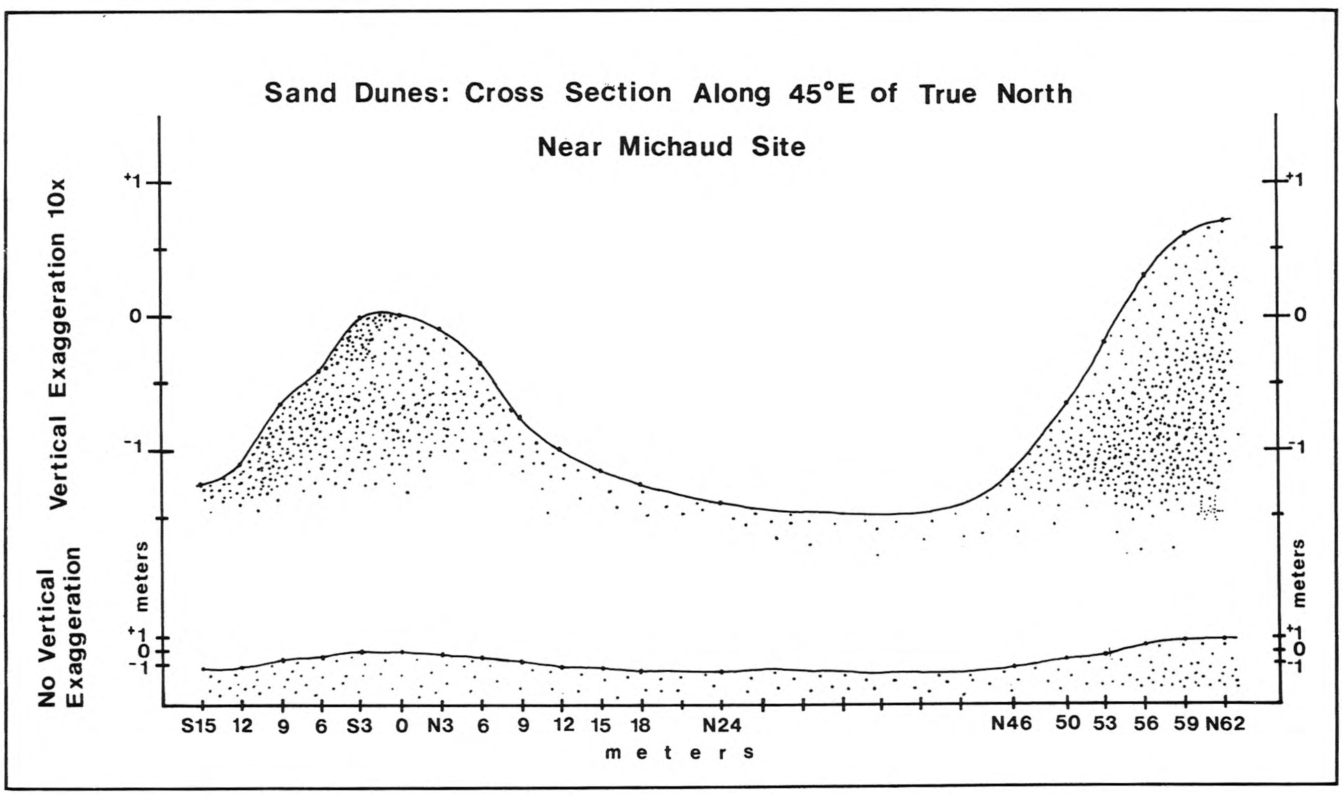


Figure 2-3. Surficial geological observations made by Thomas Lowell in the vicinity of the Michaud site.

re-deposition. One such examination was conducted by Spiess and Lowell, who measured several dune features in undisturbed pine woodland approximately 600 meters east-southeast of the Michaud site (Figure 2-3). Cross-sections seemed typical of low dune forms with shallow troughs between them. The dune center shown in the cross-section at the left of Figure 2-4 trends northwest-southeast (145° true -325° true), probably perpendicular to the wind that formed it (McKeon 1972). From its northwest rise to its southeast terminus it is 77 m in length. Soil development within the dune includes a strong B_1 horizon of 36 cm depth, above a lighter orange B_2 horizon which graded into a yellow C horizon at about 53 cm. This soil development sequence appears to be the same as that observed at the Michaud site, suggesting that the age of the soil development may be similar. Realizing that the deep orange B horizon soils of the vicinity could form in as little as 1,000 years (Oldale personal communication 1985), more evidence was sought to determine temporal placement for the dunes. A sand dune located near a gravel pit 2 km west of the site, just inside the headwaters valley of Moose Brook, and lying on glacial till, provided an opportunity to test dating possibilities. The till-dune contact at the base of the dune exhibited no sign of soil formation on the till, while the top of the sand dune displayed the common, well-developed, rich orange B horizon soil. Thus, not much time had passed between emplacement of the till (or its exposure to the air ca. 12,000 years ago), and the formation of the dune on top of it (Oldale personal communication).

Interestingly, areas of somewhat greater slope at slightly lower elevation, such as the Michaud site, appear to have been more susceptible to dune formation than areas which are more level but are located at

Figure 2-4. Sand dune topography 600 meters east-southeast of the Michaud site. The upper profile displays a vertically exaggerated scale.



higher elevation on the deltaic sand plain. Lowell provides the following opinions on the origin and reworking of the sand in the Michaud site vicinity (personal communication October 4, 1984): *A preliminary examination of the sediments suggests that the sands have a bimodal origin. The sands rest upon silts commonly described as marine clay. The contact between these units appears to be gradational over an interval of some 50 cm (Presumpscot Formation), with the upper portion of the marine unit containing couplets of sand and silt. The lower portion of the sand displays extensive horizontal bedding that most likely formed in a sub-aqueous environment. The simplest model would be for deposition of the sands during the final stages of marine submergence. At some time subsequent to the withdrawal of water, wind activity appears to have mobilized the upper-most portions of the sand. Locally this sediment forms long, low, linear ridges and irregular mounds.*

Regression of the water is thought to have occurred by approximately 11,800 years B.P. (Smith 1985: 38). This is the same time frame that McKeon (1972) suggested for the formation of wind deposits in the Anson area of the Kennebec Valley. Here McKeon suggested that wind transport acted for a period of time less than 500 years.

No evidence observed during the field visit suggested that the wind deposits had become re-activated between the original deposition and historic times. However, the possibility that small areas had at some time been re-activated cannot be ruled out.

Thus, it appears that primary dune formation occurred subsequent to the marine transgression but prior to vegetational cover, probably during a period of less than 1,000 years.

Concurrent with depositional events, it appears (Lowell personal communication 1985) that the broader Moose Brook watershed valley may have been cut either sub-aerially or sub-aqueously by run-off from the sand plain west of the Airport either just before, during, or just after the sea was retreating (as the land rose) about 12,000 years ago. During the last 10,000 years, headwall erosion of the gullies along Moose Brook have steepened the valley walls, dumped sand and silts into the bottom of the Moose Brook Valley, and possibly eroded some of the original dune edges perched along the right bank (southwest side) of the Moose Brook Valley.

Evidence from deep testing at the Michaud site failed to reveal any deeply buried Paleoindian artifacts (beside those disturbed recently by machinery), nor were any deeply buried soils found. Thus, the dune surfaces in the vicinity of the site, with possibly localized exceptions, apparently have been stabilized by vegetation since before the Paleoindian occupation.

Thus, we construct the following chronological background for the landforms around the Michaud site:

1) Around 15,000 to 14,000 years ago, the glacial till deposits reached their final thicknesses, and local ice began to stagnate (Smith 1985).

2) Between 13,000 and 12,800 years ago, the glacial ice edge retreated inland past the locality, to be replaced immediately by the ocean, flooding the depressed land surface.

3) Between 12,800 and 11,800 years ago, the locality was submerged, a series of marine sediments were deposited which became coarser and coarser as the land rose, the sea retreated, and the water shallowed as the the coastline approached from further "inland". The last unit in this sedimentary sequence was a thick layer of fine sand.

4) At about 11,800 years ago, the sand deposits were left exposed by the retreating ocean. Being unvegetated, they began to move before the wind into dune forms. Perhaps at the same time, or just before in shallow water, a broad channel was cut by run-off from higher elevation that would later become the headwaters of Moose Brook.

5) Soon, the sand dunes acquired a vegetational cover and stopped moving. Perhaps initially a grassland, the dunes were later covered with trees, although the presence of a closed forest most likely postdates the Paleoindian occupation.

6) Around 10,500 years ago, give-or-take a few hundred years, (a) Paleoindian group(s) camped once or a few times on the vegetated surface of the dunes.

7) With the exception of tree falls and perhaps localized forest-fire denudation, the sand dune surfaces were not again disturbed until woodcutting and Airport maintenance activities in the late 1960's and early 1970's A.D. The absence of a plowzone suggests that the land was never farmed.

8) Subsequent to that disturbance, minor sand movement and dune formation were reinitiated.

SOILS IN THE MICHAUD SITE VICINITY

An initial assessment of the soils in the Michaud site vicinity was made on May 30, 1985, by Arthur Spiess, as part of the overall site definition following discovery by the M.D.O.T materials geologists. The site was located on a relatively flat dune top, with large bowl-shaped "blow-outs" and dune ridges scattered among areas vegetated by grasses and occasional scrubby bushes. Spiess made an initial soil description based on a stratigraphic cut in the 1970 drainage ditch at S10E70.

A more formal soils analysis was undertaken by James Balogh and Geoffrey Gordon of Resource Assessment Service Inc., Orono, Maine. Their work included an examination of several deep testpits within the confines of the site, and excavation of two off-site testpits (Off-site North and Off-site West, see Figure 2-5). The soil sequence observed by Balogh and Gordon is described in Appendix One and summarized below (see also Figure 2-6 and Table 2-1).

The site surface is a mosaic composed of "blown-out" areas with exposed lower horizon soils, small raised dunes in the form of small ridges, and areas covered by low vegetation. The sand which forms this surface, herein described as a dune field, is a recently reactivated windblown sand. Prior to the de-stabilizing effects of land clearing ca. 1970, the uppermost unit was an A horizon of brownish-black humus, as is currently preserved in rare patches across the site. Immediately underlying the A horizon soil is an E horizon, a thin, grey podzol. This podzol layer was apparently discontinuous in the pre-1970 forest soil. Upon initiation of the recent erosion, areas around podzol lenses were deflated, leaving raised podzol remnants surrounded by deflated sand. Immediately underlying the podzol was a B_1 horizon orange subsoil containing an occasional concentration of iron concretions. Iron concretions as seen at the Michaud site were generally lumps of sand which were lightly cemented with iron oxide. The B_1 horizon graded downward into a lighter orange layer, designated the B_2 horizon. This layer in turn graded into a yellow to olive brown C horizon sand. The A horizon, when present, ranged from 1-5 cm in depth, and the E horizon, again when present, ranged from 9-10 cm in depth. The combined depth range for the B_1 and B_2 horizons was from 14 to 51 cm. The C horizon averaged approximately 125 cm in depth before mixing with gray particles of silt or clay. Underlying the C horizon sand was a gray layer which had a high clay content and often included many small, light orange, tightly cemented sand concretions. Where it was exposed in the wall of the drainage trench, this gray layer was approximately 20 cm thick; it was exposed on the surface of the site in the bases of the deepest "blow-out".

Dr. Woodward Thompson, quaternary geologist for the State of Maine, identified the gray layer underlying the C horizon as the uppermost clay rich layer in a stratified series which alternated between depositional units composed of predominantly clay or predominantly sand. This depositional sequence apparently formed during the Presumpscot Marine Transgression, thus both the clay-rich and sandy units appear to have marine origins. This sequence is best exposed at the south end of the site in the artificial drainage ditch.

SOIL FEATURES

Throughout the first three weeks of the dig, frequent and puzzling soil stains were encountered in areas where the rich

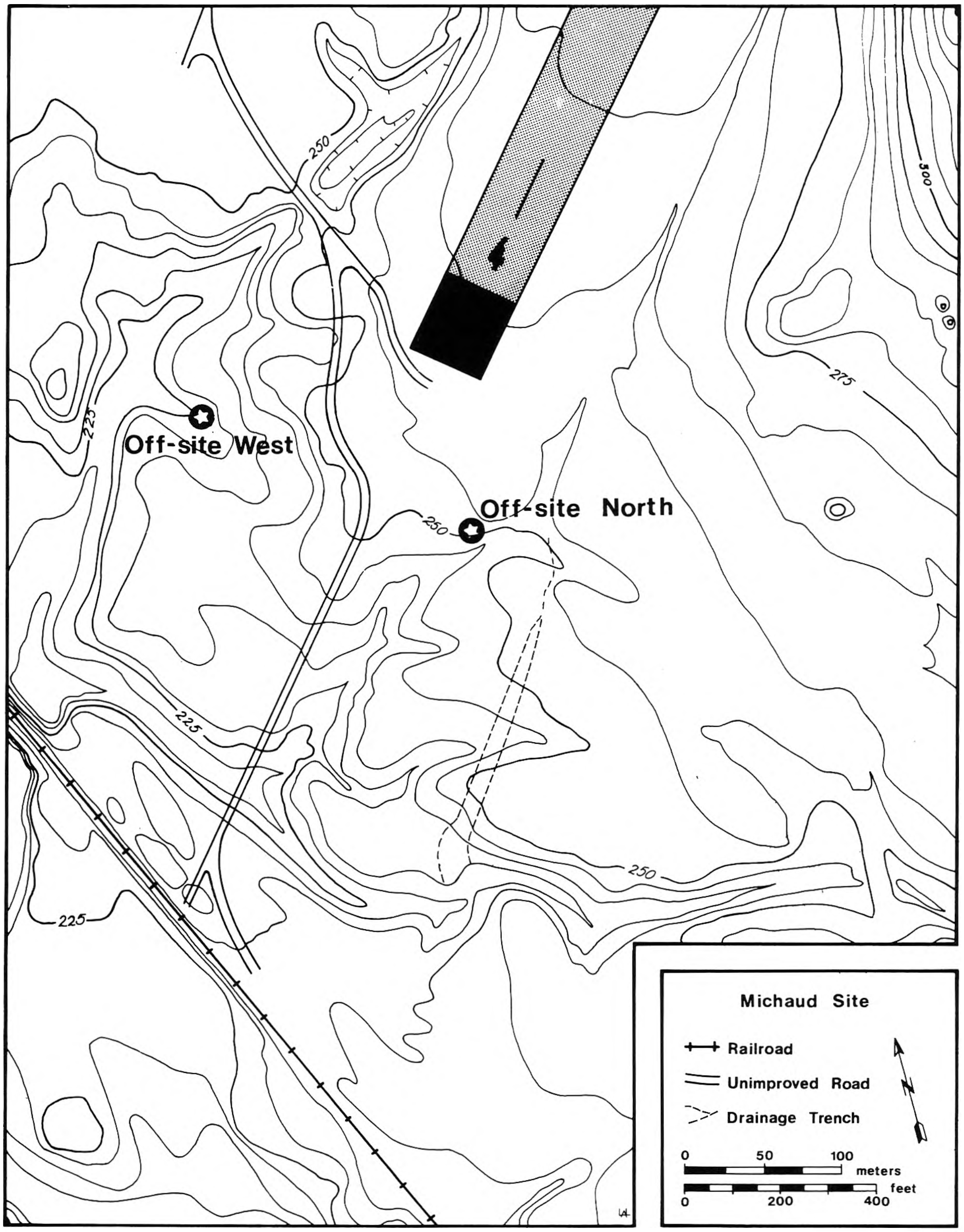


Figure 2-5. Location of the Off-site North and Off-site West soil testpits.

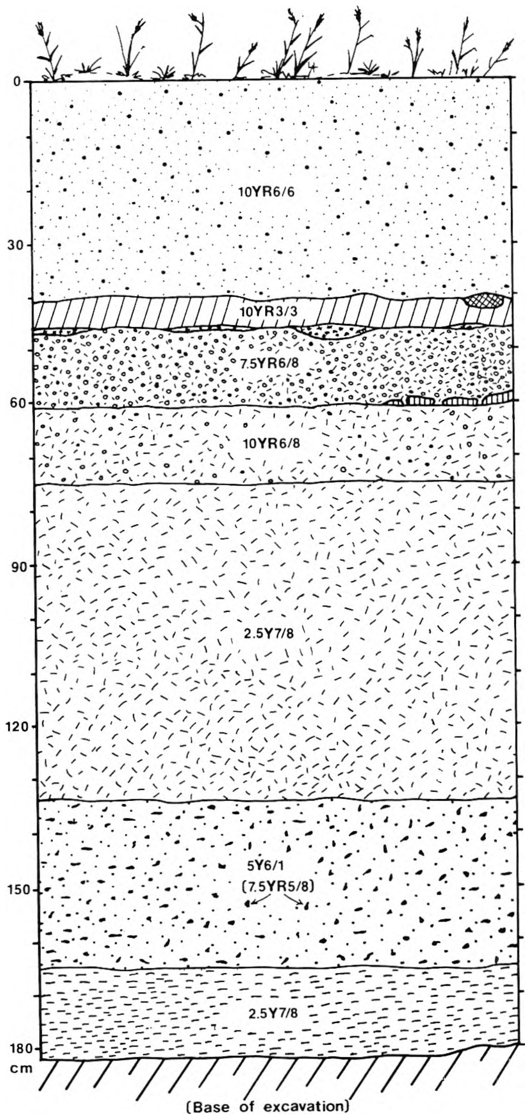


Figure 2-6. Generalized soil sequence in the S10E70 area of the Michaud site. See also description in Table 2-1.

orange B_1 soil horizon was intact. Characteristically, these "features" were recognized as localized patches exhibiting a thick white E horizon soil, from which the soil chemicals had been leached, surrounded by a very deep orange-red, intensified B_1 horizon soil halo, probably created through chemical precipitation. Many of these "features" were lobate or elliptical in shape (Figure 2-7), about the same size as cultural hearths. The vast majority, however, were round and about 20 cm in diameter in horizontal plan, thinning to a blunt or pointed end some 15 to 25 cm deeper in the sandy soil. These soil discoloration features were interpreted as the chemical "shadows" of wooden or organic objects that rotted in place, changed the local soil pH, and intensified soil chemical movements. Thus, the 20 cm diameter, blunt or tapered base "features" mimicked exactly the shape archaeologists recognize as the "shadow" of a former structural post (a "post-mold" or "post-hole").

After a number of these features had been recorded, a perfect "post-hole"-shaped soil discoloration was observed in square N30E26, displaying slightly less intense colors than normal for these "features". Importantly, the circumference of the eluviated soil horizon still retained partially rotted fragments of poplar root bark. Double-checking the root form on some of the small poplar trees growing adjacent to the site showed that, indeed, their main root extended a short distance into the soil before breaking into finer roots with much thinner bark. Evidently, rotting of the main tap root produces enough organic acid to cause the local, post-hole shaped soil discoloration.

Balogh and Gordon, while digging off-site soil testpits, located three more of these post-hole like features in a poplar wooded area. Such features appear to be common in the off-site soil; thus, we suggest that they were not associated with the Paleoindian occupation in any way. The larger, irregular soil colorations were associated in a few cases with rotting root structures of larger trees.

Three features which are attributed to the Paleoindian occupation of the site are discussed in Chapter 4.

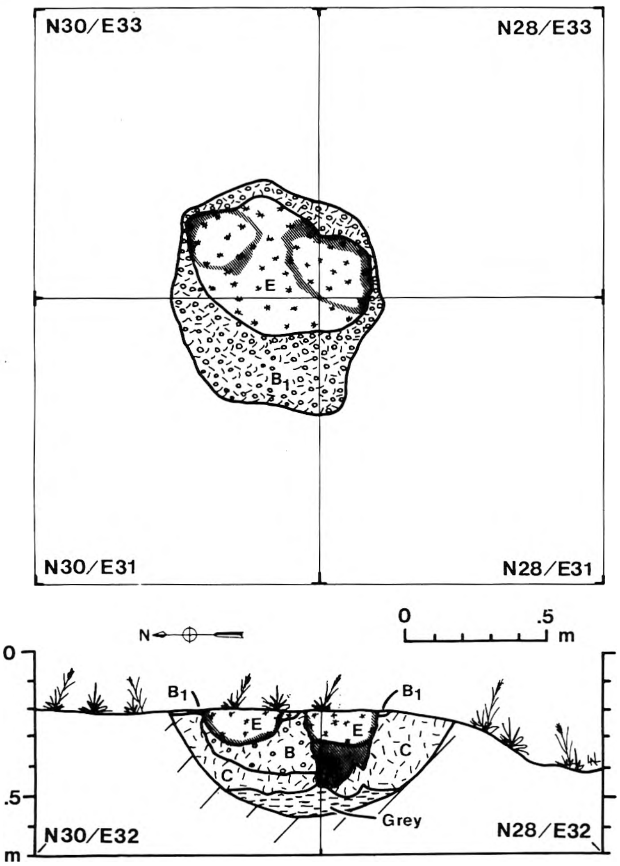
MODERN DISTURBANCE AND ARTIFACT CONTEXT

The land in the area of the Michaud site has never been farmed. Long-time local residents who have known the area since the early 20th century could not

Table 2-1. S10 E70 Soil Profile with Munsell Colors

	Depth	Description
Layer 1	Above 0 cm	Grass and loose, dry windblown sand (10YR6/6, brownish yellow)
Layer 2	0-41 cm	Light wind-blown sand with grass roots, minor textured bedding evident. Recent wind-blown material, (10YR6/6, brownish yellow)
Layer 3	41-46 cm	A1 and A2 soil horizons of original forest podzol. Black and dark brown with lump charcoal from forest burning. (10YR3/3 and 10YR2).
Layer 4	46-48 cm	Discontinuous, 0-2 cm thick E horizon (10YR7/1, light gray).
Layer 5	46-61 cm	B1 horizon. Deep orange, with some sand particles lightly cemented into large chunks by iron oxide. (7.5YR6/8, reddish yellow and 7.5YR5/8, strong brown).
Layer 6	61-75 cm	B2 horizon. Gradual transition from above B1 horizon to a very light "orange" (10YR6/8, brownish yellow).
Layer 7	75-134 cm	C1 horizon. Tan sand, gradual transition from B2 level (2.5YR7/8, yellow).
Layer 8	134-165 cm	Gray soil. Abrupt upper and lower boundaries. Contains some small, hard iron (?) concretions in localized bands (5YR6/1, gray and 7.5YR5/8, strong brown).
Layer 9	165-182+ cm	C2 horizon (bottom of section). Buff sand (2.5YR7/8).

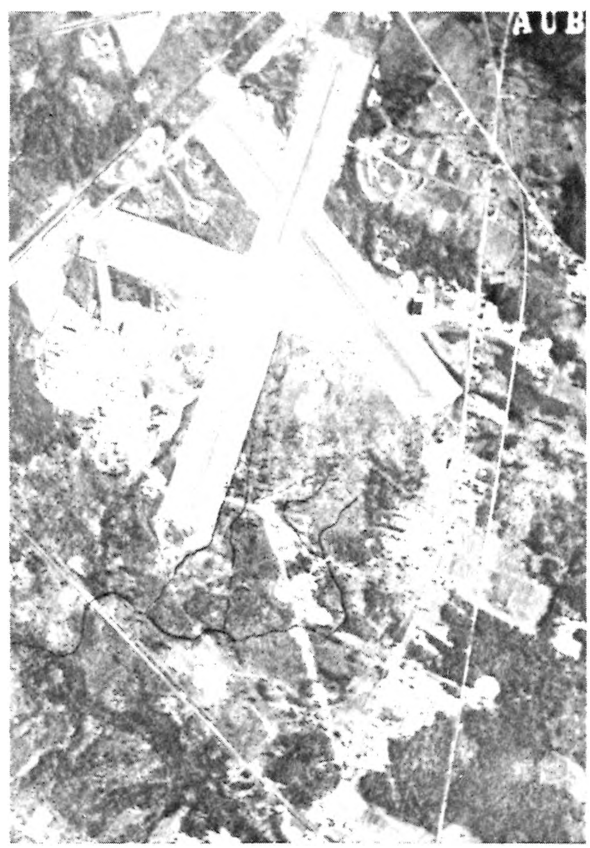
Figure 2-7. A false "feature" caused by localized chemical movement associated with tree root decomposition, originally designated as "Feature 12." Shown in plan (upper) and section (lower) views.



recall a farm there. Pine trees in the vicinity of the site, outside the clear zone, are in excess of 100 years old, indicating that they would have germinated at about the time of the Civil War, long before Maine's agricultural decline that left abandoned fields commonly available for forest re-growth. Moreover, the soils on the Michaud site itself, when not disturbed by a bulldozer or the wind, were intact and not plowed. Thus, the historic land use history of the site itself can be associated solely with possible logging activity and the Airport development. The following is a detailed description of the recent disturbances to the site surface, extrapolated from air photos, discussions with airport maintenance personnel and local residents, and observations made by the excavation crew, information which we use to determine the integrity of artifact context.

Circa 1951, the site area was covered with a brushy woods, probably dominated by pine and poplar (Plate 2-1). An intermittent stream drainage pattern (Plate 2-2) cut across the site area before a new drainage ditch was cut in the late 1970's. An airphoto dated 1969 shows that the site area had been logged. Visible soil disturbance was limited to short, narrow skidder-blade scrapes at random angles, widely scattered across the site.

Plate 2-1. Airphoto of the airport vicinity taken April 29, 1951.



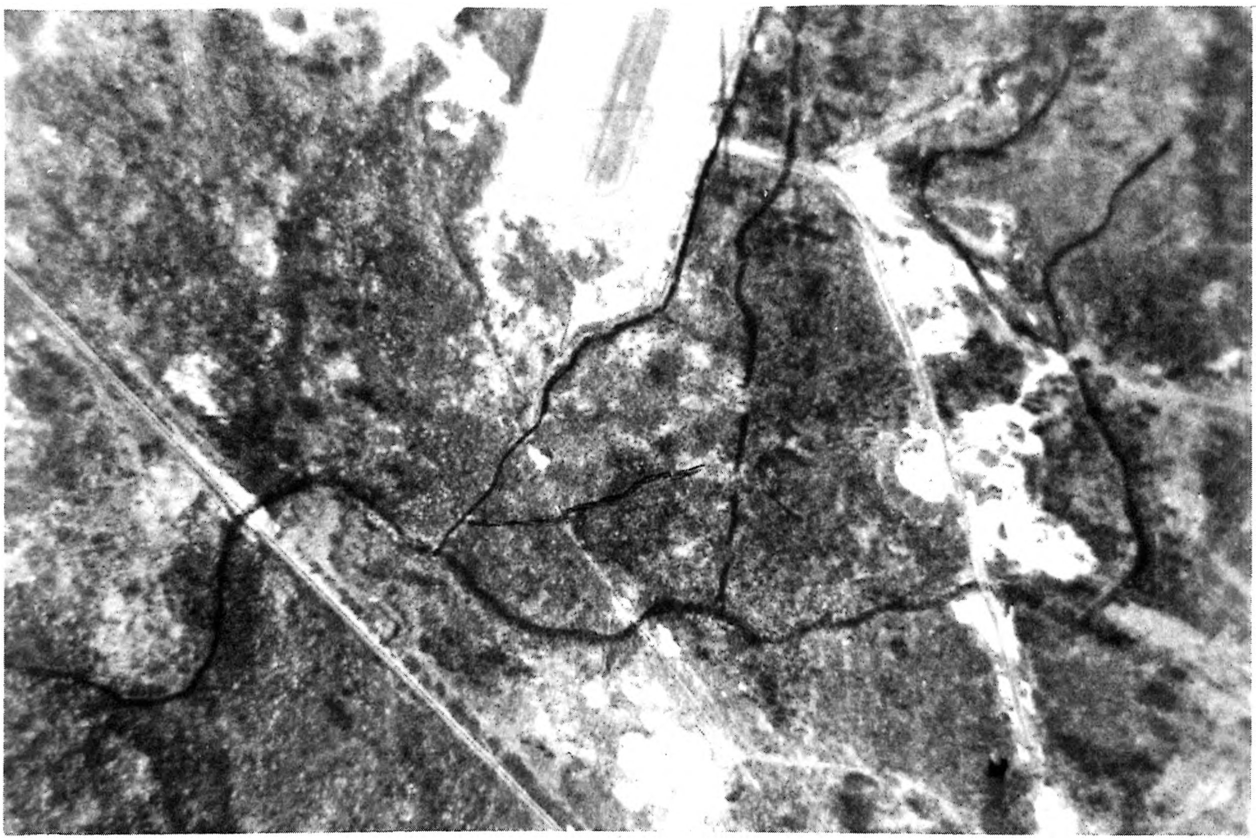


Plate 2-2. Closeup of Michaud site area in Plate 2-1, with drainage patterns highlighted. Courtesy of Ray Woodman, Maine Department of Transportation.

A 1979 airphoto clearly shows the extent of disturbance of recent activity in the clear zone (Plate 2-3). This work included the construction of a new north--south drainage ditch paralleling the runway. The intermittent streams that had previously run northeast to southwest across the site area (Plate 2-2) were cut off by the new drainage ditch, and their channels filled with sand and brush scraped from the surrounding surface by a bulldozer. Most of the Michaud site area remained vegetated and undamaged.

Sand-covered areas appear as light patches (due to a thin cover of snow?) in a November 1983 view (Plate 2-4). The southern (downstream) end of the new drainage ditch had begun to form a semi-circular erosion feature. The northern edge of this feature cut into the N10E80 site area. Due west of this erosion feature, a semi-circular borrow pit is visible at the western limit of the site (N20E30).

The record of soil horizon distribution observed during excavation and from soil coring along transects on grid lines was used to produce a map of the site which shows areas where wind erosion deflated the surface down into the C horizon sand or, further, to gray horizon sand (Figure 2-8). These areas should have yielded surface-exposed artifacts or flakes, had any been originally present in the soil layers above the C horizon. Also shown in the same figure is the pre-excavation distribution of wind-blown sand cover, in most cases protecting intact soil horizons.

Much of the excavated area contained a relatively intact soil sequence (Figure 2-9). Only the A and E horizons proved

discontinuous and patchy under the recent windblown sand. B horizon soils covered the majority of the excavated area. Wherever B horizon soils were intact, either on the surface or under A and E soil layers, we would expect to have found Paleoindian flaked stone material had any been dropped on the spot by the site's inhabitants. Thus, "negative" evidence in these areas was considered conclusive.

The data derived from mapping of recent disturbances to the site and intact soil sequences have been used to reconstruct the pre-1960's topography of the Michaud site (Figure 2-10). The extent of bulldozer disturbance, and correspondingly of soils left intact, can be seen on the profiles that follow (Figs. 2-11 to 15).

Plate 2-3. Clearzone improvement activities and soil disturbance evident in a 1979 airphoto.

ARTIFACT VERTICAL PROVENIENCE

Cultural material was found overwhelmingly in B_1 or B_2 horizon soils, or in disturbed soils derived from B horizon soils. Thus, the artifacts were associated with one shallow soil development series on a surface that had not seen substantial subaerial deposition (see above) from the time of site occupation (ca. 10,500 B.P.) until it was disturbed in the 1970's. The vertical distribution of artifacts throughout the B horizon may be a product of millennia of soil particle movements within the active soil layer

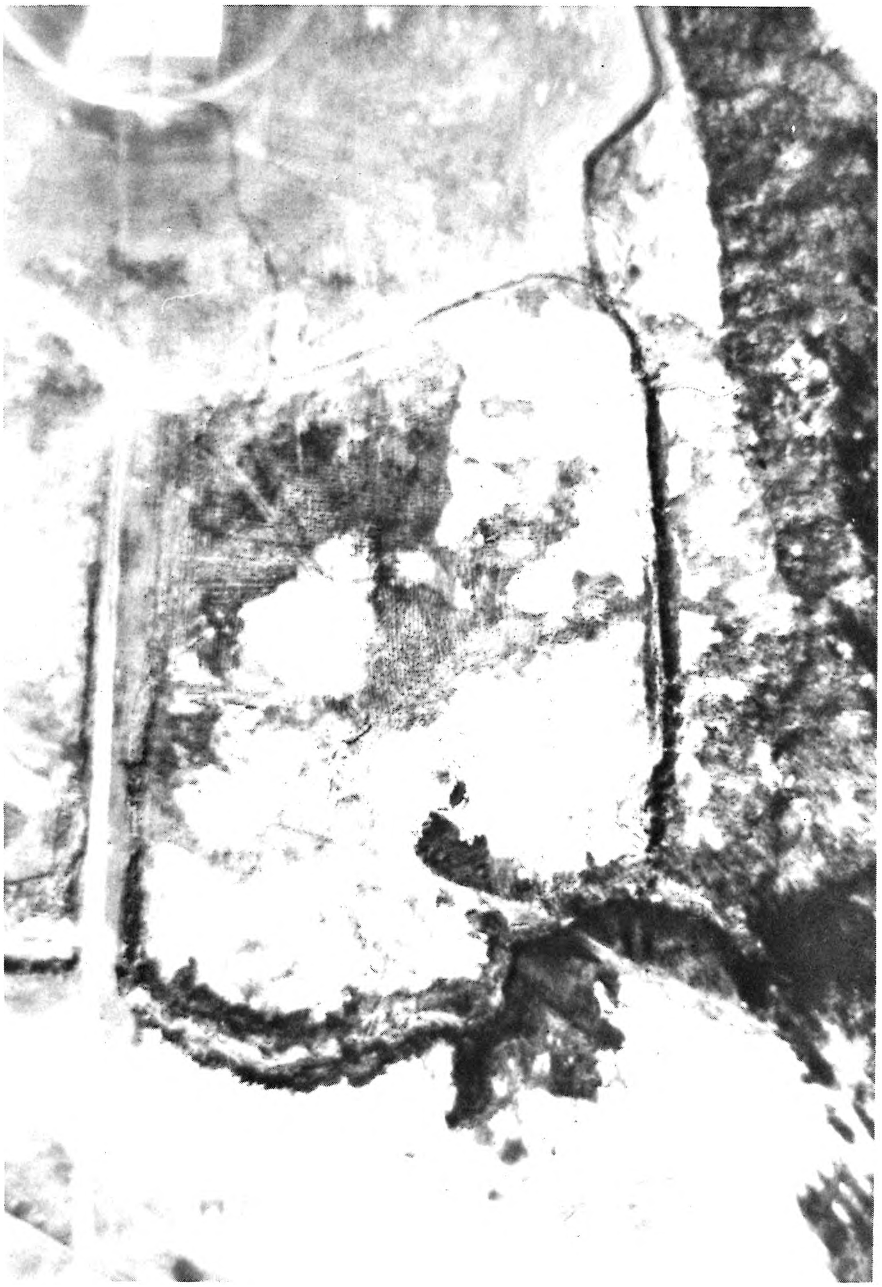


Plate 2-4. Airphoto taken November 19, 1983.

(Thomas and Robinson n.d.). Freeze-thaw cycles tend to push soil particles that are larger than median size upward relative to surrounding soil particles. At the same time, soil particle transport by some soil fauna (ants, for example) tends to extrude smaller soil particles onto the ground surface. Given constant conditions over centuries, some sort of equilibrium will be reached, with particles of different sizes spread through a variety of soil depths.

There were 219 pieces of chert debitage, chert tools, and flaked diabase recovered from squares N24E50, N26E50, and N26E52 (profile, Figure 2-14). The vast majority of the cultural material in these squares came from the B_1 and B^2 soils horizons (Table 2-2). Where present, the patchy A and E soil horizons yielded a few pieces, while the wind-blown and disturbed soil layers yielded nothing. Indeed, all of the cultural material from these squares was apparently in-situ horizontally in intact soil levels, with tools more common in the B_1 horizon than in the B_2 horizon, and microflakes more common in the B_2 horizon than in the B_1 horizon. In one localized area in the NE and SE quads of N26E50, a few flakes (n=7) and microflakes (N=11) were found in the upper C horizon.

Most of the materials

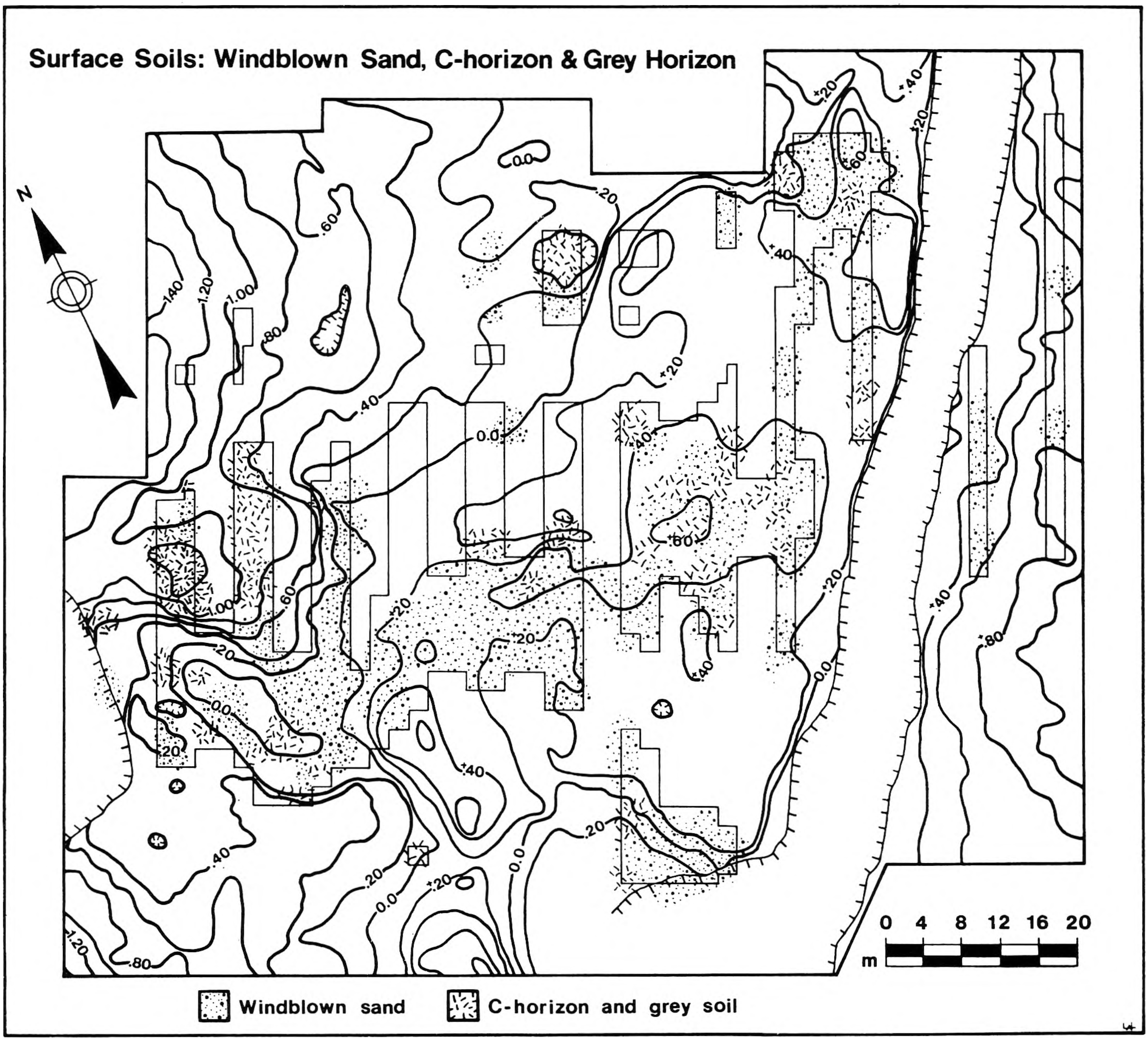


Figure 2-8. Topography of the Michaud site (20 cm contour intervals) in Fall, 1985, showing areas of deflation (C horizon or grey soil) and deposition (wind-blown sand).

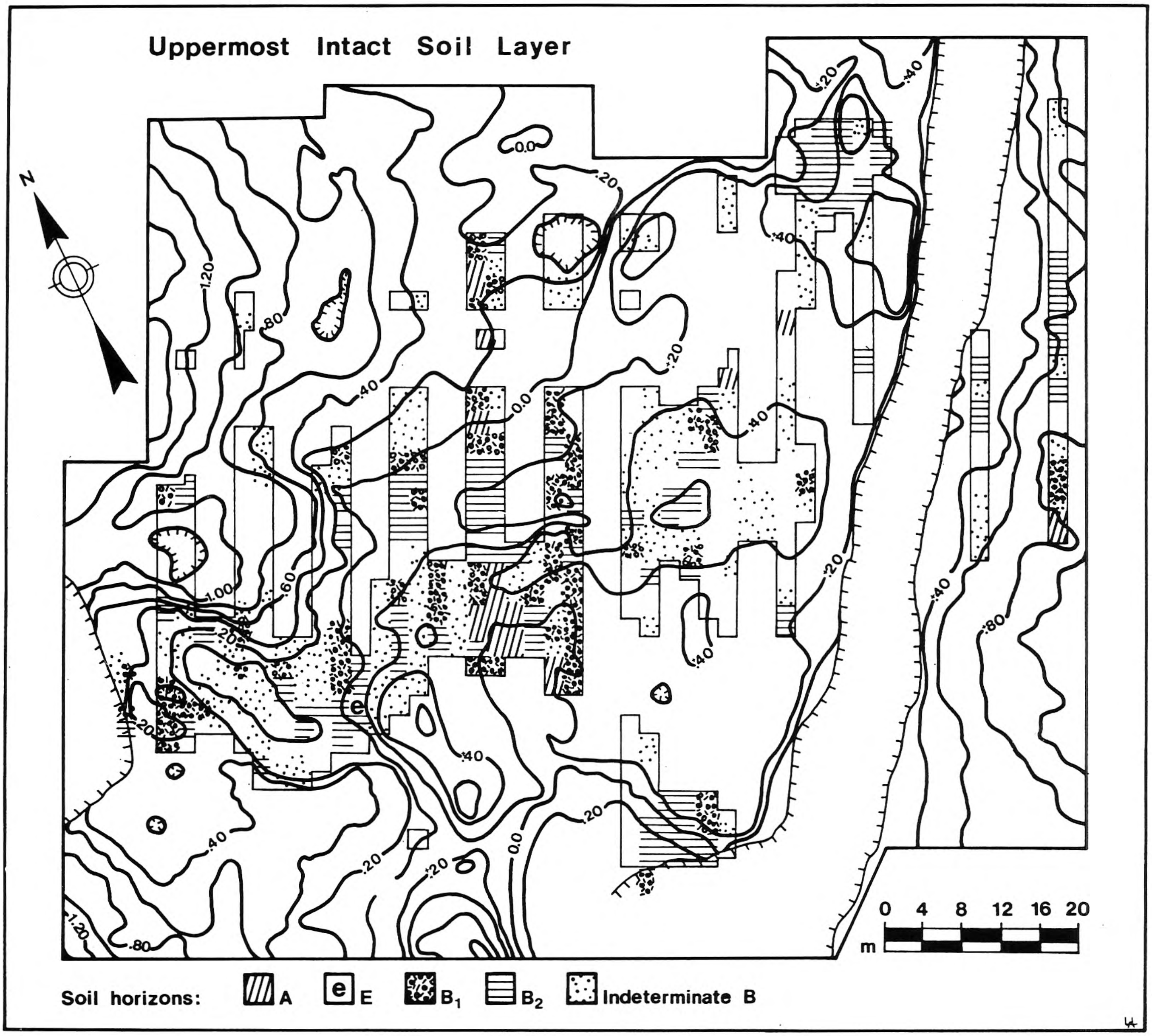


Figure 2-9. Uppermost intact soil layers on the Michaud site. Only the blank areas within the limits of excavation were totally deflated.

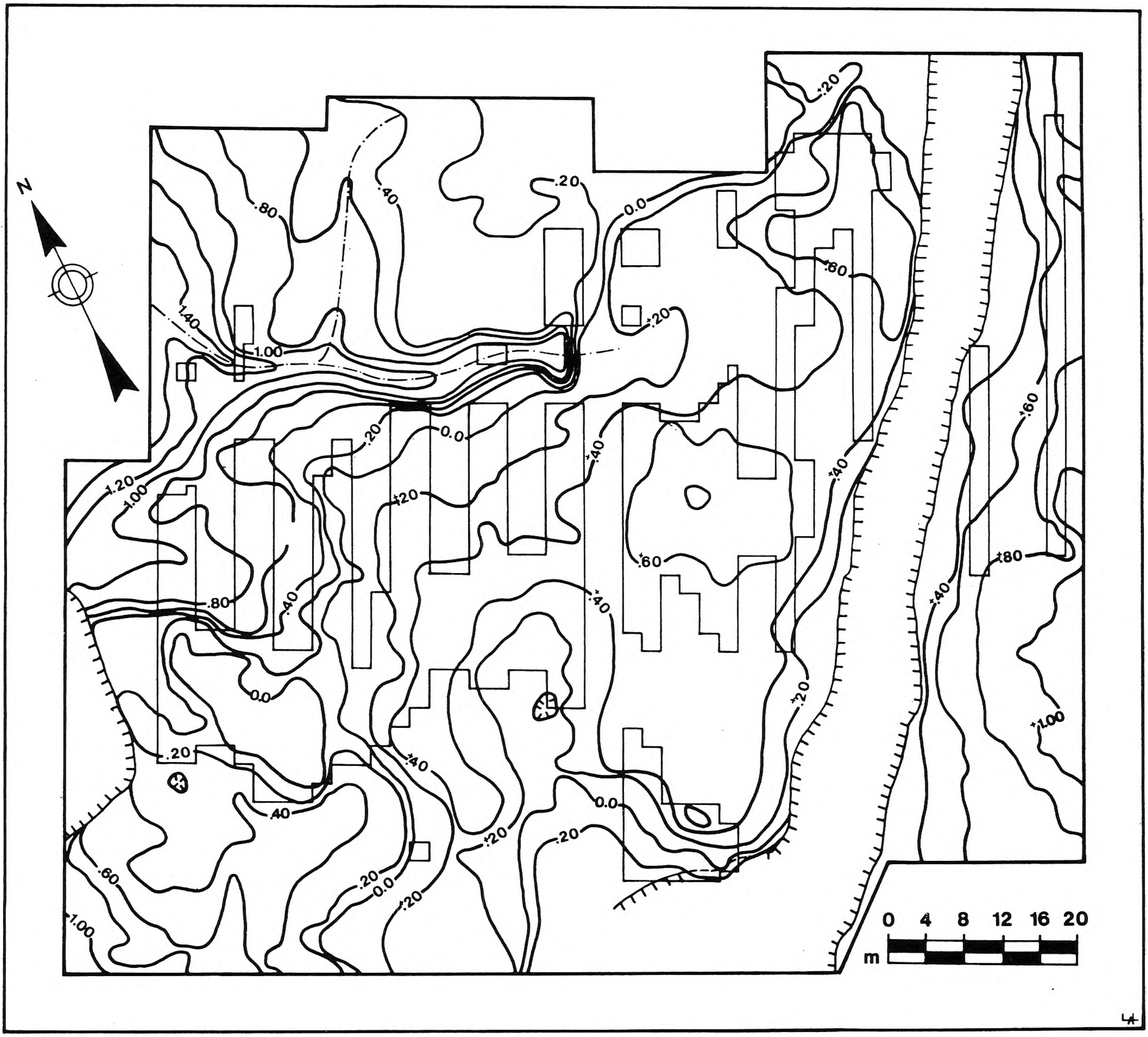


Figure 2-10. A reconstruction of the Michaud site surface topography before extensive disturbance circa 1969, based on pre-excavation topography, intact soils and average soil depths. Note the drainage ditch with head-wall erosion in upper left.

Table 2-2. Provenance of cultural material from various soil development levels from the N24-28 E50-54 area. Number of artifacts (A)(= tools), flakes (f) and microflakes (mf).

Square	N26 E50	N26 E52
Soil Horizon		
Windblown	0	0
A	0	1A
E	0	2f, 4mf
Disturbed/ B1 interface	2f, 5mf	1mf
B1	1A, 15f, 37mf	1A, 6f, 64mf
B1/B2 interface	10f, 8mf	0
B2	1A, 35f, 38mf	9A, 28f, 172mf
B2/C interface	0	1f
C (upper 10-15 cm.)	7f, 11mf	1mf

in the N24-28 E50-54 area were chert fragments. In the N34-38 E58-62 area (Figure 2-15) many more of the materials were made of Neponset rhyolite (Rfnp), larger flakes were more common compared with microflakes, and the B_1 soil level had been disturbed to a greater extent than in the N24-28 E50-54 area. The windblown sand yielded only one flake. The disturbed soil in this area consisted of A and B horizon soils that had been churned by bulldozer passage (left-hand edge of profile). The intact B_1 and B_2 soils again yielded the vast majority of cultural material, with a very few pieces found in the upper C horizon. Again, the count of artifacts (=tools) is slightly higher in the B_1 horizon than the B_2, while microflakes are slightly more numerous in the B_2 than the B_1 horizon.

In both areas of the site, one dominated by chert and the other by Neponset rhyolite, there is a slight tendency for larger pieces (tools) to be found higher in the soil column, with a higher proportion of the smallest pieces (microflakes) deeper in the soil column. Thus, there appears to be a mild tendency for vertical sorting by size within a 30 to 50 cm deep active soil zone. Based upon a number of lines of evidence, primarily the horizontal distribution patterns, lack of evidence for buried soil horizons, and reconstructed geological history of the site, the Michaud site assemblage was deposited upon a single soil surface by one or a few short-term occupations very close in time. The observed vertical distribution pattern, therefore, we hypothesize, is the result of the last 10,000 years or more of soil processes on site.

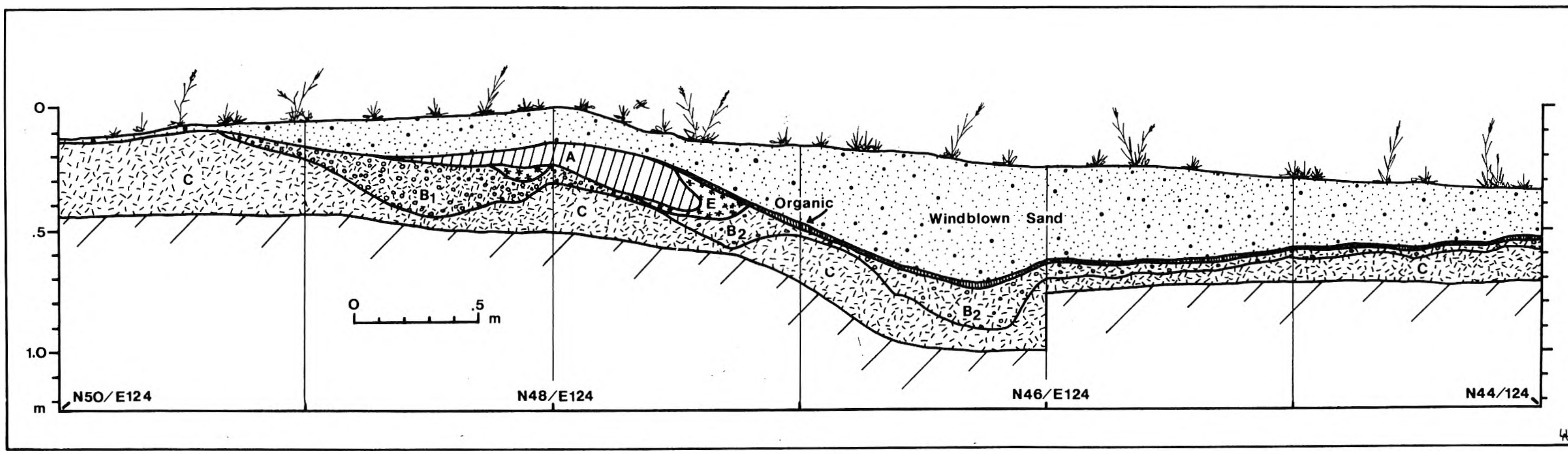


Figure 2-11. This figure shows the truncation of the original soil surface as it rose to the northward in a sterile portion of the site (N44-N50, E124). The effect of the bulldozer scrapes in piling up the A horizon soils was observable at N48, and the former natural depression was covered with wind-blown and bulldozed soil.

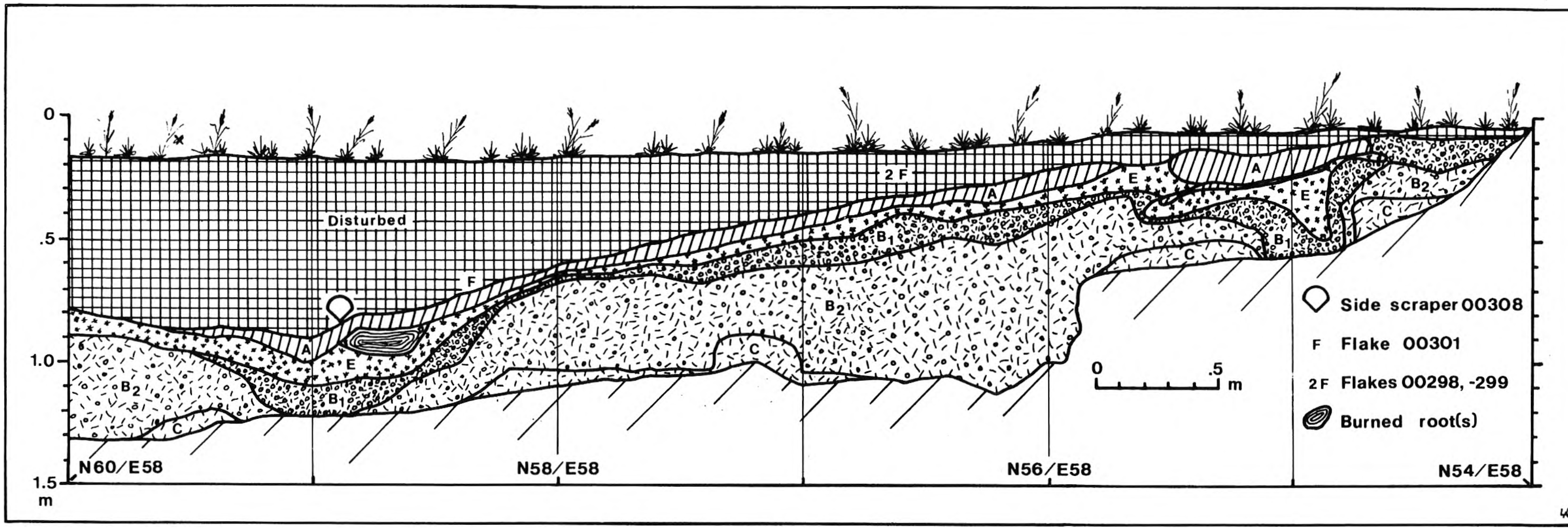


Figure 2-12. This profile reveals the slope of the south side and center of the natural drainage ditch that formerly ran across the N60 area of the site. An intense soil anomaly from a rotting/burned tree stump could be seen in the depth of the E horizon soils at about N55. The approximate depths of three flakes a one tool (23.12.00308, a sidescraper) from adjacent squares have been "projected" onto this profile. In the deep part of the drainage trench, the flake and sidescraper were apparently in the first fill to be pushed the ditch, because they ended up near the bottom just above the intact A horizon. It should be noted that no Paleoindian cultural material was found in any of the intact soils on the sloping sides of the drainage trench.

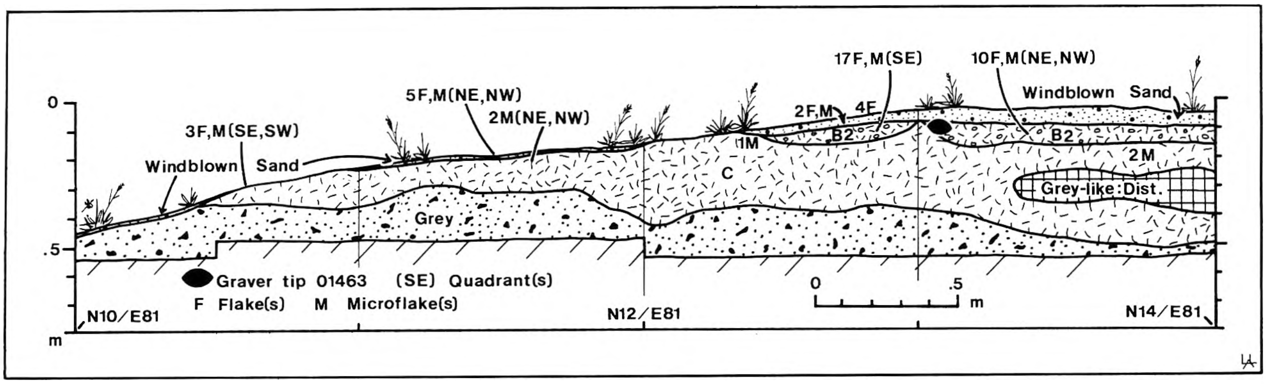


Figure 2-13. A profile along the E81 line from N10 to N14 reveals the slumping and surface erosion on the lip of the 1970's north-south drainage ditch. Flakes and microflakes were commonly found on the surface or in wind-blown sand, or in the top 5 cm of C horizon sand in the N10 to N13 area. In square N12E80, twenty-seven flakes or microflakes and one artifact (23.12.01463) were recovered in the B horizon sand. Two microflakes had worked their way down into C horizon sand.

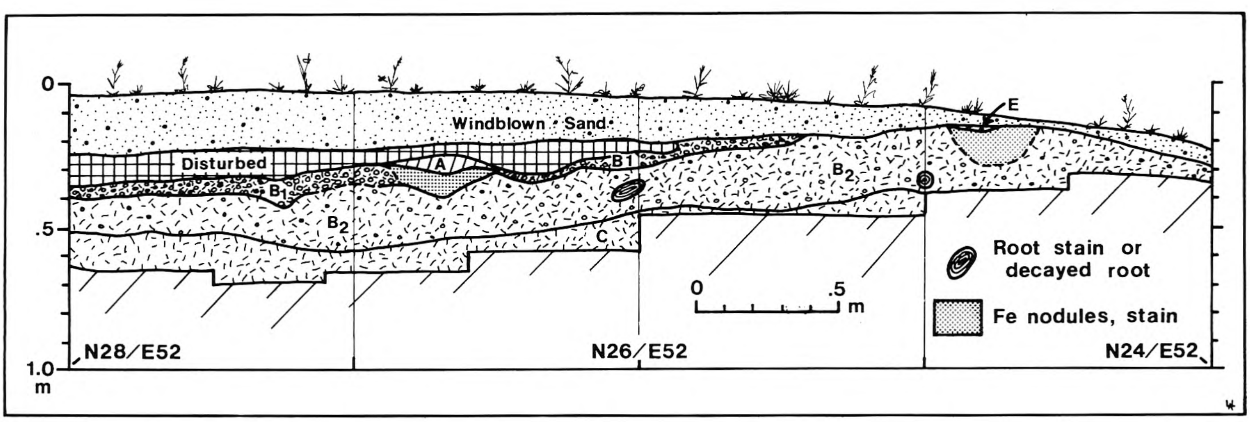


Figure 2-14. This profile comes from one of the most intact areas of the site: N24 to N28 along E52. On the surface in this area were B1 horizon soils covered in some places with A and E horizon soil patches that had escaped bulldozing. At the northern end of the profile was a thin layer of disturbed soil composed of a mixture of A and B horizon soils. The whole sequence had been capped by a wind-blown dune deposit, thickening toward the north end of the area.

Figure 2-15. Soil profile in the N34 to N38 E60 area, covered with windblown sand.

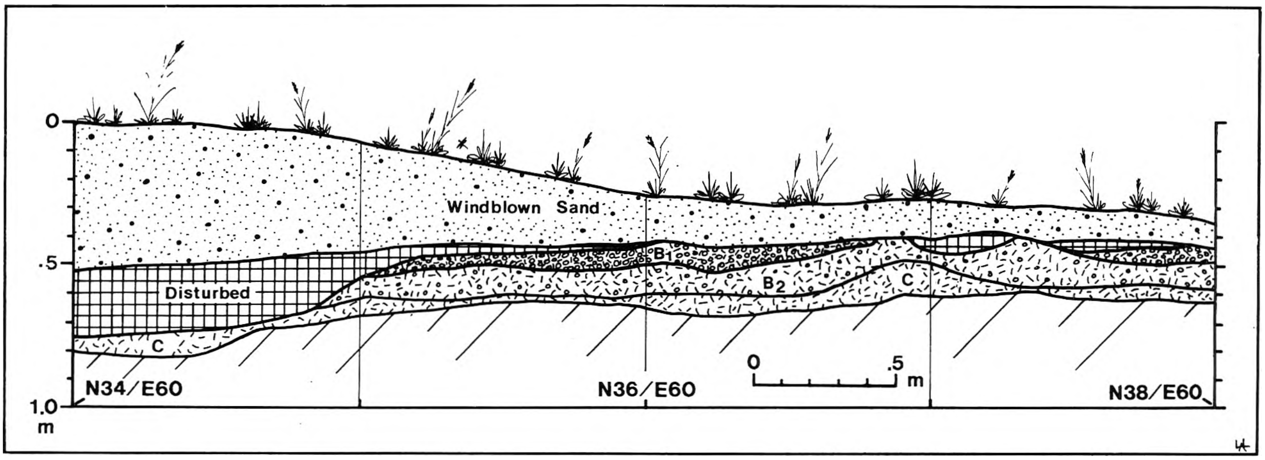


Table 2-3. Provenance of flakes and artifacts (=tools) from the N34-38 E58-62 area.

Square	N34 E58	N36 E58	N34 E60	N36 E60
Soil Horizon				
Windblown	0	1f,3mf	0	0
Disturbed	4A	2f,3mf	0	1f
B1	4A,10f,15mf	9A,65f,120mf	1A,16f,6mf	4A,36f,23mf
B1/B2 interface	2A	0	0	1f
B2	1A,1f,13mf	4A,87f,162mf	0	9f,7mf
B2/C interface	0	1f,5mf	0	0
C	0	5mf	0	0

CHAPTER THREE

TOOLS AND DEBITAGE: DESCRIPTION, ATTRIBUTES AND TYPOLOGY

Excavation and surface collection at the Michaud site resulted in the recovery of approximately 150 tools and preforms and 2,300 flakes and microflakes which can be attributed solely to the Paleoindian period. Represented in the collection are all of the tool types generally characteristic of Paleoindian assemblages in the New England-Maritimes region (Table 3-1), with the exception of drills, pieces esquillees, and the snapped and multi-spurred gravers or cutters seen at the Vail (Gramly 1982) and Debert (MacDonald 1985) sites. Overall artifact to flake ratio is 1:16, though proportions vary considerably by material (Table 3-2). The diagnostic flaked stone artifacts from the site are made from a variety of cherts and a glassy rhyolite whose sources lie at great distance from the site. There is also a large "flake and core" component made on diabase of local origin. This chapter presents descriptive data dealing with the stone tool assemblage from the Michaud site, integrated with a literature review of the lithic industries of comparable Paleoindian sites.

ANALYSIS METHODOLOGY

Once the excavated material had been returned to the laboratory, field provenience data were checked, and the collection was catalogued by artifact type. Separate categories were created for flakes and microflakes: "microflakes" were defined as chert or glassy rhyolite flakes of less than 6 mm maximum dimension and less than 0.1 gr in weight, i.e., those objects which might pass through a 1/4" mesh screen. "Flakes" were defined as unmodified specimens of any dimension larger than microflakes. All objects except microflakes received an individual catalogue number written on the piece in India ink. Groups of microflakes from each provenience unit (1/4 quad and depth level) were sorted visually into raw material groups, and each of these groups was assigned a catalogue number.

As catalogue numbers were assigned, all objects were passed to a person doing computer data entry. A preliminary description (i.e., flake, microflake, fluted point) was assigned, a weight was taken on an electronic digital balance, and data were entered into a KNOWLEDGEMAN database file on an IBM-compatible microcomputer.

A visual catalogue of about 200 tools and preforms was made using a Mita photocopier. Resolution of the flaking patterns and other details was good enough for laboratory notation. Spiess then proceeded with a preliminary microscopic examination of these pieces, using a binocular dissecting scope with magnifications from 5X to 40X. Notes were taken on flaking and possible use-wear patterns along tool edges, and a search was made for blood stains or other organic residues on the artifacts. In fact, perhaps a half-dozen orange-brown stains were discovered on the artifact surfaces, but subsequent testing for hemoglobin (Downs, written communication) proved negative. Analysis further included an examination of the lithic materials present at the site and a search for their sources (Appendix 4), attempts at refitting broken pieces, a limited use-wear study (Appendix 2), and an analysis of the biface manufacturing sequence as practiced at the Michaud site together with an artifact analysis by tool type. Flakes were also examined for type (i.e. biface thinning, uniface sharpening, etc.), and limited attempts were made at refitting flakes to tools and preforms.

Table 3-1 Tool Counts and Percentages

TYPE	N	%
Fluted Points	9	6.5
Biface Preforms	6	4.3
Channel Flakes	17	12.2
Sidescrapers	16	11.5
Endscrapers	9	6.5
Concave Scrapers	5	3.6
Limaces	2	1.4
Gravers/Perforators	5	3.6
Utilized Flakes	70	50.4
Totals	139	100.0

Table 3-2 Artifact to Flake Ratios by Raw Material

MATERIAL	# ARTIFACTS	#FLAKES	RATIO
Cr1	34	219	1:6.5
Cr05	23	76	1:3.3
Cb01	10	49	1:5
Ceg1	15	356	1:24
Ct01	4	29	1:7
Rfnp	43	733	1:17

Coincidentally with the collection examination, a literature search was conducted by Spiess and Brush for appropriate tool typologies and attribute measuring systems in the North American Paleoindian literature, and for comparative information on specific Paleoindian tool attributes in the Northeast.

RAW MATERIALS

Two distinct lithic industries were noted in the Michaud collection, one based on cryptocrystalline materials of exotic origin and the other based on coarse-grained stone of local origin (Table 3-3). The major industry, including approximately 2500 specimens, was comprised of a variety of cherts and a glassy rhyolite or tuff. A smaller component (221 specimens), and one which might easily have been overlooked had the sandy soil matrix contained any indigenous rocks, included a number of cores and flakes of what we termed "Christian Hill diabase", as well as a green volcanic river cobble and several pieces of granitic rock.

Inevitably in northeast Paleoindian research the question of the ultimate origin of the lithics arises, as we use their transportation patterns to help elucidate Paleoindian settlement patterns (e.g., Storck 1982). Despite groundwork on lithic characterization (Lavin and Prothero 1981; Pollock 1982, 1987) much more laboratory work remains to be accomplished. Such work has only begun with the Michaud collection (Appendix 4). We will thus make source suggestions for the raw materials from the Michaud site based on extensive visual examination of quarry specimens from suspected sources, limited thin section results, and comparison with artifacts from known lithic sources from other Paleoindian assemblages in the Northeast. In fact, extensive observations of extant Paleoindian assemblages from the New England area by

Table 3-3. Lithic raw materials used at the Michaud site. Where they differ in detail, these hand specimen descriptions are superceded by those in Appendix 4. Code in parentheses following the chert designation is a computer code assigned to the project artifact catalogue.

CHERT RED 01 (Cr01) Ground mass: dusky red 5R3/4. This is a brick red to crimson chert with minor lateral shade variation groundmass color. Lustre varies from waxy toward waxy/matte. Some pieces display parallel bedding/banding on the 1 to 20 mm scale. Bands appear to contain larger-grained material, which patinates yellow-red, with slightly darker purple on either side of a yellow-red band. Variable frequency of small yellow (patinated) vesicles (0.1 mm diameter approximately), possibly microfossils. Mineral inclusions include dark flecks and silvery flecks of similar scale.

CHERT RED 02 (Cr02). 10R4/2 grayish-red ground mass, solid color, no inclusions or visible bedding. Very dull lustre.

CHERT RED 03 (Cr03). Color of groundmass is intermediate between 10R4/2 (grayish-red) and 5R3/2 (grayish brown). No visible evidence of inclusions or bedding. Lustre very dull, and ground mass particle size apparently larger than the other cherts. Fine clay particles from the soil appear to adhere tenaciously to the surface, in contrast with more lustrous materials from this site.

CHERT RED 04 (Cr04). Color of groundmass is 10R3/4, dark reddish-brown, with dull lustre. A marbled red chert in overall appearance, with nearly 50% inclusion of translucent brown silica inclusions in 1 cm diameter blobs and swirls of like thickness. When patinated, the inclusion appear white and opaque.

CHERT RED 05 (Cr05). Ground mass color 5R3/4. Waxy lustre dark red groundmass with linear banded or cobwebbed geometry bifurcating and joining at random inclusions of 1-5 mm thickness. Unpatinated, the inclusion bands are either translucent dark grey or dark brownish or greenish-grey silica. They patinate to a dark tan.

CHERT TAN 01 (Ct01). Ground mass is 5Y7/2 yellowish-grey. This rock is characterized by a very light colored or cream colored groundmass, with widely spaced (5-10 mm) small (0.1-1 mm) inclusions that appear to be rust colored.

CHERT GREY-GREEN 01 (Ceg1). Ground mass is 5Y5/2 light olive-grey, with a patina of slight waxy lustre. This is a chert without visible bedding, but it exhibits mottling: lighter and darker greenish-tan diffusely bordered discolorations. Some pieces with an iron(?) stain derived from the soil, or with more patina(?) vary to 5Y6/4 dusky-yellow. Inclusion of a light-reflecting and dark reflecting mineral present, about 0.1 mm diameter. Occasional oxidized-iron mineral inclusions present, 1-3 mm diameter.

CHERT BLACK 01 (Cb01). This designation is used to describe a chert which displays rapid color, texture and inclusion variation over distances on the order of centimeters. Most notably, 3 facies of this chert appear on one fluted point: 23.12.0008/0112. One facies is a bluish-black with semi-waxy lustre to very waxy lustre. Ground mass color is near 5B2/1. Some of this facies is opaque, some is marginally translucent, appearing slightly bluer in color. A second facies is a dark grey-green color, with black silica fracture filling. A third facies is a black opaque chert with a high proportion of vesicles on the 0.1 to 0.3 mm diameter size range. These may be gas bubbles or dissolved inclusions. The latter two facies contain rare oxidized iron stains identical to the iron stains in Ceg1.

RHYOLITE FINE-GRAINED, NEPONSET (Rfnp). This is a visually heterogeneous groups of speckled glassy rhyolites with a light grey ground mass. All but one piece are heavily patinated. In patinated specimens the light grey ground mass

Table 3-3 con't.
contains many nearly regularly spaced, darker grey, tubular discolorations that appear as speckles or as pencil-like lines depending on the angle of fracture. There is some variability in iron content or in iron oxide staining of the patina, which adds an orange tinge to some pieces. Ground mass is N7 light grey, patinated discolorations are medium gray. Fragments still exhibiting heavily patinated joint fracture surfaces of the original bedrock quarry blanks are present for this material (and this material alone). There is one piece (23.12.0029) which seems to be an unpatinated example of the same or related material. It is a very glassy, very finely flow-banded(?) rhyolite(?) of dark grey ground mass (5Y2/1). The flowbanding is barely discernable, but is of the same scale as the pencil-line discolorations in the patinated material.

CHERT BROWN 1 (Cbr1). Ground mass color 5YR5/2. This is a banded chert or fine glassy flow-banded rhyolite with 1-2 mm thick banding. Material is represented by a single utilized flake (23.12.1992).

QUARTZITE 1 (Qtz1). This is a fine grained quartzite(?) with 10R3/4 dark reddish-brown ground mass. It is represented by a single concave scraper, 23.12.0321.

CHERT GREY BLACK SPOTS (Cbst). Ground mass 5YR3/1 dark brownish-gray with 1 to 2 mm diameter black blotches exhibiting indistinct edges. This material is represented by a single specimen, 23.12.01804, a channel flake which has been reworked into a perforator-graver.

SILICIFIED SILTSTONE (Sslt). One piece may be a silicified siltstone or mudstone that has patinated deeply to a very chalky surface. It is doubtful whether any of the original material remains unaltered within the piece, which is unique. The specimen is a fluted point mid-section.

CHERT, BANDED TAN BLUE (Cbtb). This is a tan groundmass, waxy lustre chert with blue silica fracture filling. Ground mass color is 5Y5/2 light olive gray. It is represented by a single uniface fragment (23.12.2186).

FELSITE, MAINE (Fme). A Kineo-Traveler-like felsite, which dominated Archaic and Woodland Period collections from Maine, is represented by only two flakes, one exhibiting a flat quarry clast cortex, NOT a rounded river cobble cortex. These specimens are 23.12.0095 and .00298.

CHERT GREY (Ce). A light grey, dull lustre groundmass chert or silicified mudstone represented by two flakes too small for further characterization (23.12.0653 and .0525).

CHERT BLUE GREEN (Cbgr). This chert is a light greenish-tan-grey, of dull lustre, nearly translucent around the thin flake edges. The material is a visual match with pieces in the Vail site collection, and visually matches hand specimens from both Ledge Ridge near the Vail site and outcrops near Munsungun Lake. the material is represented only by two microflakes.

DIABASE (Rc01). This material is a tough, mafic material that patinates to a rusty brown, coarse-textured surface, with small vesicles or mineral crystals that appear to be high in iron content. Patinated material matching exactly the site specimens was discovered in bedrock dikes on the top of Christian Hill, off the end of the airport runway. Newly flaked surfaces of the Christian Hill material are a dark grey, of granular appearance. Fracture is subconcoidal.

RHYOLITE, FINE GREEN (Rfg). This material appears to be a fine-grained military-green rhyolite with small phenocrysts. It exhibits very poor flaking qualities (much poorer than the diabase). Flakes of this material have ben refitted to artifact 23.12.0225, a battered river cobble.

the authors suggest that a limited number of lithic sources were utilized by Paleoindians throughout this region (see Chapter 7). Interestingly, although these sources are widely distributed across the entire region, the frequency of lithic materials in any given regional Paleoindian site does not appear to be consistently dependent on proximity to source.

Although cobble cherts were used extensively at several mid-Atlantic Paleoindian sites (Meltzer 1984; Moeller 1980), this pattern has not been observed in New England-Maritimes region Paleoindian assemblages (e.g., Curran 1984; Gramly 1982; Grimes et al. 1984; MacDonald 1985). Cobble cortex was not present on any of the cherts or on the Neponset rhyolite (glassy tuff) from the Michaud site. However, numerous examples of bedding plane surfaces, characteristic of blanks obtained from outcrop formations, were noted on rhyolite specimens, indicating that the material had been obtained from bedrock outcrops. Having concluded that none of the cryptocrystalline rocks utilized by inhabitants of the Michaud site were obtained locally, bedrock sources were sought for the major raw materials components.

Several visually distinct varieties of red and red and green cherts (Cr1 through Cr05 in Table 3-3) comprise 30% of the tools and debitage from the Michaud site (Table 3-4). The entire range of these cherts has been correlated through macroscopic and microscopic examination with cherts from the Munsungun Lake formation (Appendix 4).

A second major raw material at the Michaud site (36%) is a rhyolite or glassy felsic tuff (Appendix 4) which was designated Rfnp, after "rhyolite, fine, Neponset". All but one specimen were heavily patinated, but all specimens retained a distinctive dot and dash pattern which we had not previously observed in other prehistoric assemblages in Maine. Several Maine geologists could not recognize the material as native to Maine. John Grimes recognized it as a minority component in the Bull Brook collection. At the recently discovered Neponset site (Carty 1986), the Paleoindian assemblage is dominated by a heavily patinated rhyolite. Visual comparison of the Neponset and Michaud site rhyolites leaves little doubt that they are the same material. Carty (1985) has identified a likely source area within the Boston Basin Mattapan volcanic series for this rhyolite, within 10 miles of the Neponset site. We use the designation Neponset rhyolite, however, based on the dominance of this material in the Neponset site assemblage, rather than inferring a source. Pollock (Appendix 4) has examined thin sections of Neponset rhyolite and describes it as a felsic tuff displaying welded glassy fabric and distinctive circular or elongated coalesced grains.

Fully 30% of the Michaud stone assemblage consists of an often heavily patinated black, grading to olive green, chert (Chert grey-green [our code Cegl] and chert black [our code Cb01] in Table 3-3). John Grimes (personal communication) has identified visually similar chert within the Bull Brook collection, including a representative group of about twenty fluted points and fluted point preforms, that exhibit two or more color grades of this chert on each specimen. They can be seriated to demonstrate a continuous grade from the patinated olive green to black color variants. The Bull Brook and Bull Brook II collections are dominated (80-90%) by this chert (Grimes et al., 1984). Grimes has suggested (personal communication) that the bedrock source for this material ("Bull Brook chert") might be found in the chert quarries near Burlington, Vermont, based on hand specimen samples from the area (vide Hawley 1967; Peterson and Power 1983). Grimes, Spiess, and Brush examined quarry samples and lithic assemblages from both the Reagen site and from later sites whose inhabitants had used the Ordovician cherts from the Mt. Independence, St. Albans or related quarries in northwestern Vermont. Exact macroscopic matches for all color variants within the Bull Brook chert range were found among specimens from quarries near the eastern Lake Champlain shore. Although the Michaud site specimens

Table 3-4 Raw Materials by Tool Class, Cryptocrystalline Industry

	MATERIAL							
TYPE	Cr1	Cr05	Ceg1	Cbo1	Ct01	Rfnp	Sslt	Qtz1
Fluted Point	3	1		2		2	1	
Biface Preform			4	2				
Channel Flake	6	3	4			4		
Endscraper	1	3			2	3		
Sidescraper	8	3	2		1	2		
Concave Scraper	1	2				1		1
Limace		1		1				
Graver/Perforator	1		2	1		3		
Utilized Flakes	17	9	3	4	1	29		
Total	37	22	15	10	4	44	1	1

note: Two tools, 23.12.1534 and 23.12.1843, are counted both with sidescrapers and graver/perforators. The utilized flake category includes utilized flakes, retouched flakes and small uniface fragments of unknown type. For raw materials key, see Table 3-3.

suspected to have originated from this source area were highly weathered, they appear to cluster with eastern Champlain shore quarry specimens, Vermont artifacts that visually match Bull Brook chert, and macroscopically similar chert from the Vail site (Pollack, Appendix 4). The basic characteristics of this material include some silt-sized particles in a biogenic chert, with varying percentages of microfossils (sponge spicules and radiolaria). Some of the variability in microfossil content appears to have been caused by passage of the precursor matrix through the digestive tract of a worm or other invertebrate scavenger, which has produced macroscopically visible burrow structures and fecal pellets.

Up to 40% of the lithic material from the Vail site collection (Spiess, Brush and Grimes personal observation) visually matches the Bull Brook-Cegl/Cb01 chert series just described. Gramly, (1985: 76-77) however, postulates sources for the raw materials from the Vail site as follows (translated from the French): "the cherts of Vail can be separated into three categories: the yellow or caramel colored cherts (jaspers), the cherts of a pure blue-grey with often a lustrous appearance, and the cherts of Ledge Ridge." (Ledge Ridge is near the Vail site in northwestern Maine.) The pure blue-grey lustrous chert is one of the series of color facies of Bull Brook chert. It patinates to an olive green in the same manner as the black color variant. Gramly favors the hypothesis that Ledge Ridge chert dominates the Vail collection (personal communication). The exact nature and variability of Ledge Ridge chert, however, is not currently well defined.

Gramly's x-ray fluorescence data (1985: Figure 8) show variability in trace element content among three Ledge Ridge quarry hand specimens, as well as within the archaeological samples from Vail (including one of the blue-grey lustrous pieces). Two pairs of samples each cut from individual Vail site flakes (Gramly 1985: items a and b; h and i) show variance in trace mineral content within the same flake. These cherts are chemically variable on a very small scale (millimeters), suggesting that criteria other than those derived from x-ray fluorescence should be employed to identify the source of the Vail lithics.

Pollock (Appendix 4) examined thin sections from Ledge Ridge quarry hand specimens. One specimen was identified as

a metavolcanic or hornfels, rather than chert. A second specimen was identified as a thinly laminated chert which had undergone low-grade metamorphism, eliminating any radiolaria or biogenic structures, if any such fossils had originally been present. Visible inclusions of pyrite were abundant in both the hornfels specimen and the chert.

Flakes from the Vail site collection, identified by Gramly as Ledge Ridge chert, were also thin sectioned (Appendix 4). These specimens contained from 5 to 40% radiolaria. They appear to be related to hand specimens of the eastern Champlain lowlands cherts, similar to the black patinating to green cherts from the Michaud site (Cegl/Cb01).

Although we believe that the source of all the grades of black to gray-green chert from the Michaud site is on the eastern shore of Lake Champlain, we have retained the separate designations of Cb01 for black chert and Cegl for the patinated gray--green chert. This has been done in an effort to trace individual pieces of raw material across the site.

Exact sources of the minority materials present in the Michaud collection have not as yet been identified. Most are represented by only a few flakes or a single tool. A tan chert, however, makes up over 3% of the sample and includes over 60 flakes and two endscrapers. Brush and Spiess identified this material as a minority component in the Vail site collection. Visual macroscopic examination suggests that it may be a Munsungun chert variant.

Most of the rough stone assemblage from the Michaud site, including cores, large flakes and chopper-like implements, are made of a coarse aphanitic volcanic material (our computer code: Rc01), probably a diabase, which is visually identical with weathered surfaces observed in bedrock dikes on the top of Christian Hill, immediately south of the Lewiston--Auburn Airport. Lamoreau and Spiess both recovered specimens from the hilltop which visually match Michaud site specimens. Casual flaking of a piece recovered from Christian Hill produced large flakes with irregular edges. Flaked coarse granitic rock, as well as a dense green volcanic river cobble, are also included within this rough stone category.

TOOLS

Fluted points as a marker of early human presence in North America were first recognized in 1926 or 1927, with the discovery of the bones of extinct Bison in association with fluted points near Folsom, New Mexico (Jordan 1960). By 1934 the distribution of fluted points all across the United States to the East Coast had been acknowledged. In 1936, excavations at Clovis, New Mexico associated a dozen fluted point specimens with mammoth remains and with two bone implements thought to be foreshafts. In 1934, Frank H. H. Roberts began seven seasons of excavation at the Lindenmeier site, a major Paleoindian habitation site in Colorado. All preceding excavations had been at kill sites, so that the range of stone tools associated with fluted points was poorly known. Lindenmeier, however, produced a major assemblage with a large range of tool types (Wilmsen and Roberts 1978).

The Shoop site in Pennsylvania produced the first reported Paleoindian habitation site assemblage in eastern North America (Witthoft 1952), followed by the Reagen site in Vermont (Ritchie 1953) and Bull Brook in Massachusetts (Byers 1954; Jordan 1960).

As late as 1970, Irwin and Wormington were analyzing and comparing Paleoindian assemblages by quantifying the number of tools in rather arbitrarily defined artifact types (Irwin and Wormington 1970). Their article closely followed (without citation) the typological approach to French Middle and Upper Paleolithic assemblages pioneered by Francois Bordes and Denise de Sonneville Bordes, complete with cumulative frequency graphs. As a reaction to the Bordian school of typological assemblage quantification, American Paleolithic archaeologists had been exploring the use of artifact attributes well before the Irwin and Wormington article (e.g., Movius et al. 1968). Attribute analysis seems to have

represented the "wave of the future" in Paleoindian assemblage study, although with a less exclusive reliance on metric attributes than had been suggested by the pioneering study by Movius. Jordan (1960) was the first of the latter studies, with Cox's (1972) restudy of the Shoop material being a notably cogent example. The Michaud site artifact analysis presented below mostly follows in the tradition of the latter.

The Michaud site assemblage was initially divided into bifacial and unifacial specimens. Further sorting involved identifying specimens with known Paleoindian analogues. Measurement and attribute systems were adopted or devised on a tool by tool basis, generally after Cox (1972), although MacDonald (1985), Gramly (1982), Moeller (1980), and Fitting, Devisscher, and Wahla (1966) were also extensively reviewed. Specific attributes and measurements were incorporated to facilitate intra-assemblage comparisons as well as to provide information on the Michaud artifacts which would be most comparable with other northeastern Paleoindian assemblages.

Throughout the artifact descriptions, an orientation standard was applied which is illustrated in Figure 3-1. For fluted points, the dorsal side was considered to be that side displaying the longest flute scar. In contrast to fluted points, designations of obverse and reverse sides for bifaces were usually assigned on an arbitrary basis, following an unsuccessful attempt to discern the ventral side as that side having been connected to the core and therefore often less convex than the dorsal side. Unifaces were always oriented with the dorsal side up and the proximal end (that end displaying a striking platform and/or a bulb of percussion) held toward the observer.

Bifaces

Judged strictly by the number of stone tools recovered archaeologically from Paleoindian sites, the Paleoindian lithic industry could be characterized as uniface--dominated. The minority bifacial industry

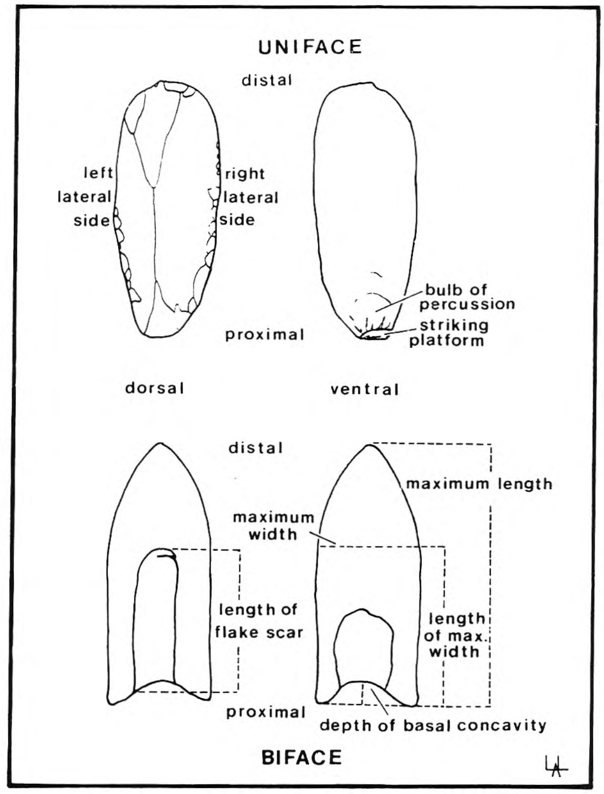


Figure 3-1. Biface and uniface measurements and orientation landmarks.

seems to have been focused on a production pathway leading from trimmed quarry blanks to the diagnostic weapon tip, the fluted point. To be sure, sharp- edged final stage preforms might have been hafted and used as multi-purpose knives, and a large proportion of fluted points ended up being used for work other than as weapons: being reworked, broken or not, into some other tool class (40% or more in one sample, Lepper 1984).

Most descriptive effort dealing with the Paleoindian biface industry has concentrated on the final stages of production and the final steps of fluted point manufacture. However, Fitting has described a biface reduction sequence for the Holcombe site (Fitting, Devisscher, and Wahla 1966: 39-42) by dividing the unfinished bifaces into Types A and B and comparing their attributes. The Type A preforms are described as larger and cruder than other bifacial artifacts, with heavy edge grinding, mean thickness of 11.3 mm and large,

expanding flake removals. The type B preforms are smaller and lighter, more standardized in form, and edges on complete specimens lack grinding. Mean medial thickness is 8.1 mm. Fitting implies that the Type B preforms are worked-down Type A preforms, and states that the edges are not reground before the final pressure retouch.

MacDonald (1985: 73) describes preform reduction, noting that two markedly different types of preforms were used for reduction at the Debert site: some starting as "bifacial core nuclei" and some as very large flakes. He observed that flake-originated preforms were the most common, some being especially long. Whatever their origin, preforms were "trimmed by soft hammer percussion to the desired point outline before preparation was made for fluting".

McGary (1975: 57) notes that bifacial cores at the Williamson site were reduced to rough preforms by both transverse and longitudinal flaking. Longitudinal flake scars often resemble flutes. They most often originate at the proximal end, although sometimes at the distal end. Similar longitudinal flake removal, designated as "medial thinning", has been observed on the Munsungun Lake area Paleoindian bifaces which are being investigated by James Payne (personal communication).

By far the most detailed biface reduction sequence description is Callahan's (1979). Although modelled after some eastern fluted point production, the model may not apply to all eastern fluted point industries. It is a nine part sequence of fluted point production including an initial four stages called preform reduction. Stages one through three are accomplished at the quarry, while stage four may be "dressed out later". After stage three, the biface should be without humps, irregularities, hinge terminations, or step-fractures. Callahan's stage three or four involves longitudinal flaking to thin if necessary (Payne's medial thinning), otherwise stage four involves secondary thinning (1979: 116). Attributes of stage four bifaces include a width/thickness ratio of 4.0 to 5.0 or more, and aligned, centered edge-angles of between 25 and 45 degrees. The edges are ground for platform preparation as stage four begins. Stage five involves retouching the final point outline in preparation for the first flute, while stages six through nine finish the fluted point.

A total of six biface fragments were recovered at the Michaud site. Three specimens (23.12.0082, 23.12.1330, 23.12.660/.661; Plates 3-1 and 3-2) display attributes which are consistent with expected characteristics for fluted points in various stages of production. Three other fragments are present, all of which are too small to assign to a particular phase in the manufacturing sequence. All, however, exhibit large, irregular flake removals and lack secondary retouch. Microscopic examination of the edges reveals occasional grinding for platform preparation, but no evidence of utilization.

The preforms whole enough to assess are all symmetrical in outline and display a fairly uniform thickness, despite the fact that at least one specimen (23.12.0330) represents a very early stage in the manufacturing sequence. Individual descriptions of these preforms follow, with special emphasis on their place in the manufacturing sequence as outlined by Callahan (1979).

First to be described is a proximal portion of a biface (23.12.0330), which is roughly equivalent to Callahan's stage 2-3 preform (Callahan 1979: 9). The ventral face is original flake surface with retouch confined to the lateral margins. Edge angle for both left and right lateral sides averages 62 degrees. Callahan states that the optimum edge angle for bifaces at Stage 3 in the reduction sequence is 50 degrees, although the acceptable range is from 40 to 60 degrees. Thus, the edge angle for platform preparation was barely at acceptable limits for this stage of production in Callahan's estimation. The dorsal surface displays an irregular pattern of flake scars, suggesting that the flakes had most likely been removed prior to the flake-preform's detachment from a core. On the ventral

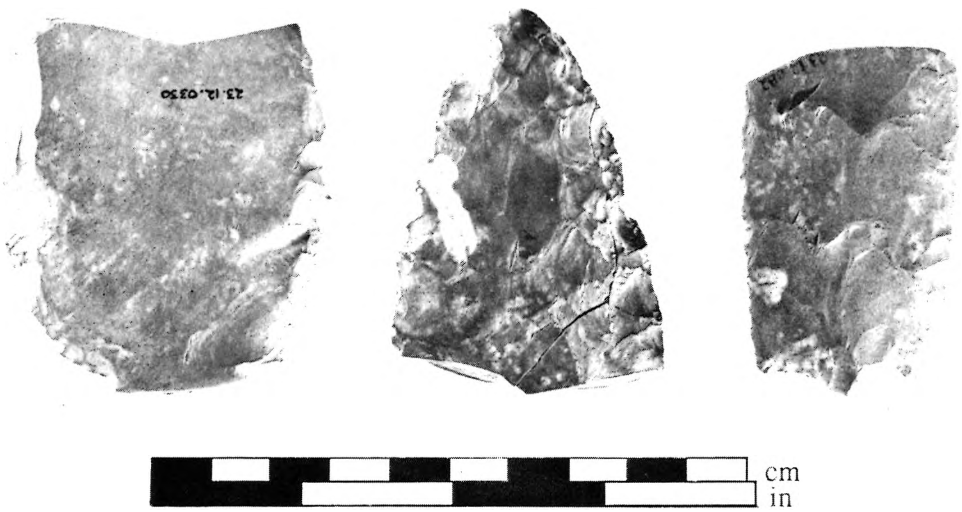


Plate 3-1. Biface specimens from left to right illustrating biface preform production sequence (l. to r. 23.12.0330, .0660/.0661, .0082).

side, edge retouch extends along the length of the right lateral side, but only 50% of the left lateral side has been flaked. The preform has been snapped at mid-section, a break which does not appear to have been caused by a material flaw or manufacture error but rather by pressure applied to the dorsal surface, as if the artifact had been stepped on.

Second, a distal biface fragment (23.12.0660/.0661) was recovered in two pieces split horizontally along the plane of the artifact, a feature evidently due to a material flaw. Lateral thinning is evident on both faces of the artifact. Edge angle average for both sides is 37 degrees. Edge angle, (within the 25 to 45 degree range which Callahan equates with a Stage 4 biface), regular outline, and shallow and more even flake scar removal indicate that this biface had reached Stage 4 in Callahan's reduction sequence (1979: 9). Bevelling of the tip on this specimen may have been intended to provide a broader surface to dissipate force when the flutes were removed. Light grinding is noted on the flake ridges on both lateral sides, apparently to provide an improved striking platform for subsequent flaking (Plates A2-10 and A2-11).

The third specimen (23.12.0082) provides an example of a stage six preform (Callahan 1979:36). It is a proximal portion, complete with a basal fluting nipple. A transverse break (outre passe fracture, e.g., Bradley 1982: 189) occurred at an estimated one-third of the length of the completed point during the fluting process.

Plate 3-2. Reverse of specimens in Plate 3.1. Note the outre passe termination of the channel flake removal attempt on .0082, right.

The channel flake must have been mis--struck. With the fortunate recovery and subsequent refit of two portions of the channel flake, one the basal portion including the tip of the fluting nipple, fluting preparation may be assessed (Plates 3-3 and 3-4). The point is nearly plano-convex in cross-section; the ventral surface displays large, moderately irregular flake removals creating a nearly flat surface, upon which retouch is limited to the outer margins of the lateral edges. An accentuated convexity has been created on the dorsal face by the regular (average spacing 5.2mm) removal of thinning flakes from the lateral sides which terminate before reaching the longitudinal axis of the artifact. The fluting nipple on the basal end has been sharply bevelled from the ventral side and extends 5 mm below slight concavities which have been flaked on either side of the fluting nipple, again from the ventral side. The end of the fluting nipple is heavily ground at the top of the bevel to provide a striking platform.

At this point it seems appropriate to describe a preform (23.13.0008) from the Lamoreau site (see Chapter 6) which "hinged-out" during the removal of the second flute, in order to complete the production sequence as probably practiced by the inhabitants of the Michaud site. The removal of the second channel flake brings the point to Stage 8 in Callahan's reduction sequence (Callahan 1979:36). Having successfully removed the first channel flake, the ventral side was then prepared for fluting. The lateral edges on

Plate 3-3. Biface preform 23.12.0082 with two pieces of the channel flake shown adjacent.

Plate 3-4. Biface preform 23.12.0082 with channel flake fragments refit in place.

the ventral side were regularly flaked to create a convexity along the longitudinal axis. The striking nipple was then reworked and bevelled toward the ventral face, again bordered by slight concavities. The basal nipple on this specimen entirely disappeared with the removal of the second channel flake, leaving a straight base. As in the preceding specimen, the channel flake must have been mis-struck, causing the flute to expand to the point margins and to "hinge out" at approximately one-half of the length of the point.

We suggest that on an unbroken final stage preform, the lateral sides would have been finely retouched following the removal of the second channel flake. Such retouch may have extended far enough to obscure the lateral margins of the flute scar. A basal concavity would then have been created, either by basal retouch and/or secondary fluting. Finishing touches appear to include the grinding of the lateral sides, generally for the length of the longest flute scar, and occasional light basal grinding.

Measurements of the biface preforms (see Table 3-5 and Figure 3-1 for a description of the measurements taken and Tables 3-6 and 3-7 for the measurement values for preforms and fluted points respectively) provide an opportunity to assess decreasing dimensions as preforms were worked into finished points and consequently, to project the size range for finished, unretouched fluted points at the Michaud site. Length is the most difficult attribute to project because all specimens are medially broken. However, maximum width and maximum thickness are available for all specimens. Table 3-8 presents selected dimensions for biface preforms

Table 3-5. Definition of Biface Measurements

Catalogue Number: The site number, 23.12, and the individual artifact number were recorded. All artifact numbers are given when broken pieces were conjoined.
Category: The portion of the artifact was recorded. Categories include distal fragment, proximal fragment, whole, tip missing, etc.
Material: See the lithic material descriptions in Table 3-3.
Maximum length: This was a measurement of the maximum length of the artifact, regardless of orientation. Lengths of broken artifacts are given in brackets.
Maximum width: The point of maximum width was measured. When an artifact was broken, and the point of maximum width was unknown, the measurement was enclosed in brackets.
Length of Maximum Width: The distance from the proximal end to the place of maximum width was measured.
Length/Width Ratio: A ratio of maximum width to maximum length was obtained.
Thickness: This was a measurement of the maximum thickness of the artifact, wherever it occurred.
Basal Width: This measurement was taken from the outside edge of one basal ear to the other for fluted points. On preforms, the basal width was measured only if there was a nearly complete proximal end approaching the form of a finished fluted point.
Flute Width: A maximum and minimum width were taken. Measurements are given for both dorsal and ventral sides where applicable.
Flute Length: Flute length was measured from the top of the basal concavity to the distal end of the flute scar. A length is given for both dorsal and ventral flutes as they occur. The dorsal side has been defined as that side having the longest flute scar.
Ratio Flute Width/Length: The ratio of flute length to width was calculated for both dorsal and ventral sides.
Number of Flutes: The number of flutes removed from each side was noted, whether they were removed in the manufacturing process as a thinning technique prior to final fluting, as guides for the final channel flake removal, or as a new flute removal in conjunction with resharpening.
Depth of Basal Concavity: Depth was measured by orienting the point on its longitudinal axis and measuring from a line perpendicular to the longitudinal axis at the tip of the longest ear. This method was also used by MacDonald (1985:71), though Gramly (1982:27) measured maximum depth from a line connecting basal ears, regardless of point orientation.
Basal Grinding: Grinding on the inside edge of the basal concavity was noted as 1=absent, 2=light, or 3=heavy.
Lateral Grinding: Presence or absence of lateral grinding was noted. When present, length of grinding from the base toward the tip was taken for both right and left sides.
Edge Angle (Right): Two measurement were taken, one at 1/4 of the distance from the tip back toward the base, and the other 1/4 of the distance from the base toward the tip. All angles were measured with a standard goniometer.
Edge Angle (Left): Same definition as above.
Basal Retouch: Presence or absence of basal retouch was noted. This retouch may be described as the removal of thinning flakes from the basal concavity after the removal of the channel flakes.
Wear Type: This is a verbal description of use-wear seen on the artifact other than purposeful grinding of an edge. Tip damage was noted, as well as wear

Table 3-5 con't.
associated with functions other than use as a projectile point.
<u>Outline Form</u>: General outline shape was noted, which in this collection took the form of "triangular" or "lanceolate" for fluted points.

Table 3-6 Michaud site biface measurements, artifact numbers at top.

	109	88/112	321/433	643	1974	1568	377	330	660/661	82
Category	whole	whole	whole	prox.	dist.	midsec.	dist.	prox.	dist.	prox.
				tip missing						
Type	fp	fp	fp	fp	fp	fp	biface	preform	preform	
Material	Cb01	Cb01	Cr1	Cr1	Rfnp	Sst	Ceg1	Ceg1	Ceg1	
Length	44.4	65.5	61.9	[47.6]	[33.5]	[23.2]	[35.0]	[63.1]	[63.7]	[59.6]
Width	21.5	23.1	26.04	26.2	[11.9]	[18.5]	[26.0]	[54.2]	[44.3]	[36.0]
LMW	1.5	3.3	22.9	27.5						
L/WR	2:1	2.8:1								
Thickness	5.6	5.8	5.5	5.2	5.5	4.1	5.5	9.9	8.3	7.0
Basal W	21.5	[23.1]	24.7	[27.5]						31.0
Fl. W-D	6.7- 12.3	7.2- 15.0	14.0- 21.0	12.6- 18.5	8.6	7.5- 10.0				13.0- 25.0
Fl. W-V	8.7- 13.5	4.5- 19.8	19.0 28.2							
Fl. Length D	34.0	48.0	21.0	[40.0]						[58.8]
Length V	19.0	38.0	30.4	28.0						
Fl. W/LD	2.6:1	3:1	3							
Fl. W/LV	1.4:1	1.8:1	1:1	1.4:1						
# Flutes-D	1	1	1	1	1	1				1
# Flutes-V	1	2	2?	1		1				
Depth BC	3.4	4.0	5.0	7.0						
B. Grind	yes	yes	yes	yes						
L. Grind-L	23.0	50.0	28.2	26.0						
L. Grind-R	28.0	43.0	24.1	21.2						
Edge A-R	55-57	39-45	45-50	40-43	36	47	43			
Edge A-L	55-57	44-46	47-55	38-46	38	42	43			
Basal Ret.	yes	no	yes	yes						

Table 3-7. Summary statistics for fluted points.

	Number	Mean	Minimum	Maximum
Length	3	57.3	44.4	65.5
Width	4	24.2	26.2	21.5
Thickness	6	5.2	4.1	5.8
Depth, Basal Concavity	4	4.8	3.4	7.0
Length Flute Scar	8	31.2	19.0	48.0

Material Cr1:4, Cbo1:2, Sst:1, Rfnp:2.
Portion Whole:3, Distal:1, Proximal:1, Ear:1, Mid-section:2.

Table 3-8 Dimensions of Biface Preforms from the Michaud and Lamoreau Sites

Specimen #	23.12.0330	23.12.0660/.0661	23.12.0082	23.13.0008
Stage	2-3	4	6	8
Max. Thick.	9.9	8.3	7.0	5.7
Max. Width	54.2	44.3	36.0	32.5
Thick/Width ratio	1:5	1:5	1:5	
Average Lateral Edge Angle	62	37	37	32

from the Michaud and Lamoreau sites and their suggested stage in Callahan's manufacturing sequence.

There is a surprising consistency in the relationship of thickness to width and of overall proportions among the biface preforms from the Michaud site, as stone was removed in the metamorphosis from rough preform to finished point. Interestingly, all three of the Michaud site preforms (23.12.0330, 23.12.0660/.0661, 23.13.0082) are associated with Concentration I (see Chapter 5), and all three display a thickness to width ratio of 1:5. The two whole fluted points (23.12.0643, 23.12.0321/.0433) from this concentration also have a 1:5 thickness to width ratio, while the two whole fluted points from other areas of the site display a 1:4 thickness to width ratio. Based on a comparison with the measurements of the former, we suggest that a freshly finished fluted point made on one of the previously mentioned preforms would have had a length in the vicinity of 90 mm.

Chronology and Typology of Fluted Points

The Michaud site contributes little information relevant to the fine scale chronology of the fluted point making Paleoindian period in the Northeast. However, it appears more closely related to some assemblages in the Northeast than to others. The literature on the Paleoindian period in the Northeast (in a broad geographical sense, including the Great Lakes and the mid-Atlantic states) as we interpret it, can be used to seriate a loosely defined sequence of fluted point forms for the region. That this sequence may be region-wide in its broadest outlines is suggested by the occurrence of cognate forms in the Mid-Atlantic states, the Great Lakes, and the New England-Maritimes region, although in each region they may be joined by locally developed variations. At present, there appears to be no clear boundary between Paleoindian and Late Paleoindian forms. Forms generally accepted as Late Paleoindian in age may show more qualities of regional specialization, although certain forms (i.e. "plano", Northeast parallel flaked, and Hell Gap-like points) are distributed across the broad region. We first present a review of northeast Paleoindian chronological sequences based on fluted point form as proposed by other authors, followed by a discussion of a chronological sequence which we propose based on a review of the current data.

Witthoft (1952 reviewed by Cox 1972:5-7) was the first to propose a chronological sequence for eastern fluted points. Witthoft noted similarities between the Shoop material and material from the Williamson and Hardaway sites. He grouped them into what he termed the Enterline Chert Industry, with fluted points hypothetically characterized by multiple fluting involving the removal of two preliminary lateral channel flakes from a blunted base. These two lateral channel flakes served to isolate the striking platform and guide the main channel flake. In his re-analysis of the Shoop site, Cox (1972:25-27) observed

that a number of the Shoop biface preforms appeared to be basally or longitudinally thinned ("medial thinning", as previously noted), the occurrence of which directly correlated with the thickness of the original flake base (cf. Grimes 1979). Moreover, several instances of lateral flute scars overlying, and thus subsequent to, the central flute scar removal were noted. Besides the Enterline fluting process, Witthoft based his thesis that the Shoop site was the earliest fluted point site in the East on the apparent presence of a core-and-blade technology, "which seemed closest to possible Old World Paleolithic ancestral cultures" (Cox 1972:2), and on the limited number of tool types represented at the site. He proposed that it was followed by the Parrish Industry (including the Parrish, Wilhelm, and Reagen sites) which was, he said, roughly equivalent to Clovis in the West. He proposed that the Parrish Industry was followed by an equivalent of western Folsom in the area east of the Mississippi.

At the time of Cox's 1972 review, Witthoft's own views on this chronological scheme had been modified only by dropping the Hardaway site from the Enterline complex, as work at the site had continued and had produced later (Early Archaic) assemblages. Cox comments that few archaeologists accepted the Enterline Industry and the chronological scheme of which it was originally part as of 1972, and the literature since has continued to reflect that view. However, the concept of the "Enterline" fluting technique based on multiple channel flake removals with the central and largest removal being last still affects current thought, despite the apparent discontent with the chronological framework that Witthoft had proposed.

More relevant than Witthoft's currently unacceptable sequence is a Paleoindian chronological sequence that has been developed for the eastern Great Lakes area based on Roosa's (1965) ideas. Archaeologists working there have taken the opportunity to use the association of Paleoindian sites with strandlines of glacial lakes dating roughly between 12,000 and 10,000 B.P. to produce a convincing chronological sequence for the later portion of the Paleoindian period. (Fluted points do not occur below Lake Algonquin levels, whereas Holcombe points and "Plano" points do.) Earlier Paleoindian assemblages are seriated on the basis of internally consistent changes in several categories of attributes. Recent relevant references to this work include Storck (1982,1983), Roberts (1985), and Deller and Ellis (1984, 1986a, 1986b). Gainey points, and associated assemblages, are postulated to be first in the chronological sequence. The second fluted point manifestation is characterized by Barnes points, as at the Fisher, Parkhill, and Barnes sites. Points like those of the Crowfield site are third, while points like those from the Holcombe site are fourth chronologically. The series continues with sites containing Hi-Lo points, which some authors consider to be transitional to the Early Archaic.

The assemblage from the Gainey site, Michigan (Simons et al. 1984; Payne 1982; Payne personal communication 1986) and similar fluted points from Michigan, Ohio, and southwestern Ontario, are separated from the Barnes-Parkhill complex. "Because it has a simpler assemblage and simpler fluting techniques, Gainey is thought to antedate these sites, placing its occupations at some point before 10,500 B.P." (Simons et al. 1984:266). The relevant attributes of Gainey fluted points are as follows (Simons et al. 1984: 268-9; Deller and Ellis 1986b): 1) a basal striking platform beveled for the production of guide flakes followed by further retouch to produce a central nipple for a striking platform, 2) parallel sides, the face angle (which is "formed by the juncture of the lateral edges of a tool with its base") having a modal value of 91 degrees. Points from the Parkhill and Barnes assemblages display modes of 94 and 98 degrees (more convex than parallel sided). Gainey points are rarely or never "fish-tailed", while Parkhill-Barnes points often exhibit this trait. Ellis (personal communication 1987) suggests that Gainey points, in fact, are a heterogeneous form contrasting with the clearly defined Barnes

point. Interestingly, the Gainey site assemblage is dominated by cherts from central Ohio, a fact used to hypothesize a northward immigration (Payne 1982), followed by the use of more local chert sources later in time.

Storck states that Barnes points are characterized by preparation of a basal nipple during the final fluting stage, followed by removal of thinning flakes from the margins of the point. Barnes points are smaller, on average, than Gainey points, and their lateral edges expand moderately from a narrow point above the base, which is often fishtailed. They tend to be fully fluted on at least one face (Deller and Ellis 1986b). Succeeding Crowfield points are characterized as "pumpkin seed" in form (noticeably widest at or above mid-point), very thin and wide, often with multiple flutes originating from a prepared nipple platform (Ellis personal communication 1987). Some Holcombe points may resemble Crowfield points, but they are usually characterized by less convex sides, and display shorter and less prominent fluting, or basal thinning in place of fluting. Holcombe points are usually much narrower than Crowfield points, but seem to be logically derived from them. Differentiation of the distinctive Crowfield-like, Holcombe--like, and Hi-Lo points appears relatively easy when compared with the Gainey and Parkhill complex groups.

As part of the history of development of a Great Lakes Paleoindian sequence, Roosa (1965) produced a discussion of the parallels between Great Lakes fluted point manufacture techniques and the western Folsom and Clovis techniques. He suggested that points from the Bull Brook, Barnes and Parrish sites seem to form their own typological cluster, and that there were at the time several Bull Brook style points known from the research area. He characterizes Bull Brook points as having a deep basal concavity, the prepared channel--flake striking platform (nipple) having been removed after it was used to strike the flute. He also states that their fluting scars often terminate in hinge fractures. Thus, Roosa established a geographically--bounded point style characterized by a group of shared attributes that covered the Northeast. He later (Roosa 1977: 353) added the Parkhill (Ontario) site to the Bull Brook group, and proposed that the group be called the Parkhill Complex, with analogies in the Folsom style of point manufacture.

Roosa's statement that the Parkhill complex fluting technique is "Folsom-like" is, in his view, based both on the presence of a "well-prepared, centrally-located basal nipple" as the platform for fluting, and on the tendency to remove a single flute from each face. In Storck's opinion (1982:82-88), there are many differences between Folsom and Parkhill Complex points, notably the extensive use of points broken by outre--passe flute terminations and then reworked into smaller finished points in the Folsom assemblages, and the extensive use of tip bevelling before fluting in Folsom. Recent analysis of Thedford II and Parkhill site materials (Deller and Ellis 1986a) indicate that tip bevelling did not occur at these sites, but that reworking of outre-passe broken points did occur at Parkhill Complex sites.

Deller and Ellis (1986b) suggest associations based upon stylistic similarity between Gainey points and points from the Shawnee-Minisink, Bull Brook, and Whipple sites. They suggest that isolated Barnes points exist in southern New England. In fact, the points from the Neponset site in Massachusetts (Carty 1986) exhibit many of the same attributes as do Barnes points i.e., particularly long flutes and narrow waists above fish-tailed bases (Ellis, personal communication 1987).

There were no analogues known to Deller and Ellis from the Great Lakes for the distinctive Vail and Debert site assemblages, which suggests to them the possibility of contemporaneity and allopatry between the Parkhill Complex and Vail--Debert like material. The recent discovery of the Lamb site in western New York, with fluted points exhibiting deeply indented bases very reminiscent of the Vail site, may complicate this neat geographic subdivision (Gramly 1986). However, we

caution against the use of a single attribute to suggest relatedness, because the Lamb points exhibit longer (20-55mm) flute scars (Gramly personal communication 1988), in contrast to shorter flute scars on average among Vail site fluted points.

In the Mid-Atlantic states, Gardner (1983; Gardner and Verrey 1979) has proposed a chronological sequence of "Clovis, Mid-Paleo, and Dalton." At the stratified Thunderbird site, the earliest (lowest) points are "virtually identical" to western Clovis points according to Gardner, a sharp contrast with the statements of Midwestern workers reviewed above that Clovis points are absent from their area. The subdivision into Clovis and Mid-Paleo as proposed by Gardner and Verrey (1979) is based upon a sample of 14 "Clovis" points, of which three are middle-stage preforms judging by the published illustrations (Gardner and Verrey 1979: 22-23). The Mid-Paleo stage is based on 12 points, of which two are mid-stage preforms, three are heavily resharpened to some specialized pointed (drill?) form, and all the rest are broken basal fragments (Gardner and Verrey 1979: 26). The metric comparison between these two types is unconvincing to us because the preform and heavily resharpened pieces are calculated in most of the metrics, including some multivariate analyses (Gardner and Verrey 1979: 33-39). The Mid-Paleo preforms are shorter than the "Clovis" complete points, and the basal fragments of finished Mid-Paleo points are narrower than the basal fragments of "Clovis" points. Thus, there is hard evidence in Gardner's data that his "Mid-Paleo" points are smaller than his "Clovis" points, but we question his reliance on the length/width and other ratios for differentiation, because of the nature of the sample which includes preforms and broken pieces. Subjectively, based solely on the illustrations of Gardner and Verrey (1979: 26), the Mid-Paleo material seems often to be multiply basally thinned, at least on the dorsal face. This attribute, plus the general delicacy of the point bases, seems reminiscent of the Crowfield point in the Great Lakes sequence. Based mostly on a metric comparison, Gardner and Verrey state that Shoop site points (Witthoft's Enterline point) fall in their "Clovis" category.

Gardner considers the Shawnee--Minisink and Debert Paleoindian material to be a cognate with his "Mid-Paleo" (1983: 49). However, based on the illustrated Shawnee-Minisink point (McNett et al. 1977: 294, Figure 5r; McNett 1985:89) and the illustration of points from Debert (MacDonald 1985: Plates III-VII), we strongly disagree. Again, we suggest that the closest parallels for Gardner's "Mid-Paleo", and any similar materials from the Mid--Atlantic states, is with Crowfield-like material from the Great Lakes. This statement has appropriate implications for a region-wide chronology of Paleoindian. In Gardner's use of the term "Clovis", therefore, we have a generic term for early northeastern fluted points that subsumes the Parkhill Complex, Bull Brook and related sites, Vail, and Debert. The immediate implication of (unproven) contemporaneity with western Clovis makes use of the term "Clovis" unwise.

The Shoop site fluted points, however, seem to lack the centrally located basal nipple as part of the fluting sequence (Cox personal communication) as has been noted for western Clovis. Shoop points, however, often display multiple fluting. In fact, multiple flute removals can occur throughout the chronological sequence of northeast fluted points: for example, occasionally on Parkhill Complex points, occasionally on Gainey-like and Bull Brook-like points, and usually on Crowfield-like points. Multiple fluting is also seen on Vail site points and those from the Michaud site. It is apparent that a distinction must be made between lateral guide flutes (if this technique was indeed employed to isolate a striking platform and longitudinal ridge), medial thinning flake removals as part of preform reduction, multiple flute scars superimposed during the resharpening process or during the removal of the basal nipple and creation of the concave basal concavity, and as a basal thinning technique in its own right. Thus, attributes other than the

presence of multiple flute scars must be considered when determining whether a site is "early". It is possible that the Shoop site, with its "simpler" assemblage and "core and blade" component, may be early in the chronological sequence. Further analysis of this assemblage in light of the many northeastern Paleoindian sites recorded subsequent to its examination by Witthoft (1952) and Cox (1972) will help place it within a greater context for comparison.

Loring (1980:25) reports on isolated fluted points from sites in Vermont. He divides the fluted points (n = 33) into two types: one type has "straight parallel sides and a single deep fluting spall on each face." The second group is shorter, exhibiting at their base a "slightly concave lateral edge which turns to form a broad convex blade edge." The second type may exhibit multiple sequential flutes. It is unclear whether Loring means to imply any chronological significance for this typology, for which there is no independent evidence similar to the beach ridge series in the Great Lakes or Gardner's stratigraphic series. However, Loring's second type may be a northern New England parallel with the "Mid-Paleo" and Crowfield material in the Mid-Atlantic and Great Lakes.

Ritchie (1980: 6) recognizes six types among Northeast fluted points. "There exist some regional typological differences in all the traits [of fluted points]". In the context of his discussion, he clearly implies that the variant forms of fluted points have chronological significance; however, the only site assemblage which Ritchie clearly designates as "late" in the Paleoindian sequence from the New England area is the Reagen site. Our recent (July 1986) examination of the extant Reagen site collection in the Bixby Library, Vergennes, Vermont, and the University of Vermont collections, indicates that the Reagen material may be most closely comparable with the Holcombe site in the Great Lakes sequence. There are, however, other point styles from the collection, notably Crowfield-like points and at least one point base (Ritchie 1953) similar to the parallel-flaked lanceolate point bases from site 154.7 at Munsungun Lake (Bonnichsen et al. 1982) and elsewhere in Maine and the broader northeast (Doyle et al. 1985). Thus, the Reagen site appears to be a multi-component Paleoindian site later in date than the Gainey, Bull Brook-like, Parkhill complex, Debert and Vail groups of "classic" fluted point assemblages.

Based on an extensive literature review of Northeastern Paleoindian site reports and personal observation of many Paleoindian assemblages in the New England region, we propose the following chronological scheme for the broad Northeast. The first portion of this Paleoindian sequence is characterized by fluted points with a variety of outline and basal attributes which do not clearly fall in one of the later groups. Importantly, there is little independently supported evidence of chronological sequence within the first three portions of this sequence, which we designate together as "Classic" fluted points. In fact, there is no consensus on the meaning of the variability within this group. Based primarily upon fluted point attributes, but also on other tool forms in the assemblages, we suggest the following chronological scheme for "classic" fluted points in the broad Northeast:

1) an early form, loosely analagous to western Clovis, for which the Shoop points provide the type model. These points are characterized by the lack of a fluting nipple, less regular lateral flake removals than exhibited later, a shallow basal concavity, a relatively thick cross-section, and short flute scars. This type appears to be thinly distributed across the broad region;

2) a middle form, characterized by a prepared fluting nipple, somewhat thinner cross-sections, longer flute scars, and deeper basal concavities than the previous group, and a variety of outline forms from parallel sided to slightly convex-sided. This is, in fact, the heterogeneous group defined by Deller and Ellis (1986a), and includes Gainey-like points from the Great Lakes area, Bull Brook-like points from New England, and points like those from the Shawnee-Minisink site in the mid-Atlantic

states. Thus, this form appears to have been widely distributed across the broad region, indeed, is probably the most frequent fluted point form recovered in the Northeast;

3) the third group of "classic" fluted points must again be subdivided. In the Great Lakes area, the "Barnes" point follows, as a well-defined type, the earlier heterogeneous fluted point style. These points are thinly distributed elsewhere across the greater Northeast, but sites containing them do not appear in the consistency and density that they do in the Great Lakes area. We agree with Deller and Ellis (1986) that the Vail/Debert points may be contemporaneous and allopatric with Barnes points. As with Barnes points, points displaying attributes analagous to Vail/Debert points appear to be thinly distributed across the broad region, but the focal point of this type stretches from northwestern Maine to Nova Scotia. Currently, we are not aware of a form apparently contemporaneous and allopatric from the mid-Atlantic states.

The foregoing chronological sequence for "classic" fluted points applies to the broad Northeast. In the eastern Great Lakes area, this sequence is followed by Crowfield, Holcombe and Hi-Lo points. The tendency in these later forms is for smaller, thinner points which are often multiply basally thinned rather than fluted. Cognate forms are found in New England and the mid-Atlantic region, particularly at the Reagen site in Vermont and in Gardner's "mid-Paleo" sequence. Distibution of Crowfield, Holcombe and Hi-Lo forms, however, is not uniform across the broad Northeast, so it would be an error to suggest a generalized cultural sequence for the entire Paleoindian time period. It appears that the earliest forms may indeed have been widespread, but the lack of uniform distribution and presence of local variation suggests an early regionalization, with perhaps frequent interregional contact, during the Paleoindian period.

There are no stratigraphic or other independent means of controlling chronological separation or sequence within the group of "classic" Paleoindian assemblages from the Great Lakes, New England, and the Maritimes Provinces. Radiocarbon dates do not seem to have enough resolution at this time to help resolve the situation (Byers 1959: 628; Gramly 1982; Haynes et al. 1984; McNett et al. 1977; Moeller 1980: 31; Stuckenrath 1966: 77). The only date of relative precision is the average date of 10,585 from Debert, which can be accepted as an average only if we assume that the Debert site was occupied for a few years, an assumption which some might accept (e.g., Spiess 1983), but which others reject.

Place of the Michaud Site

The Michaud site is clearly more closely related to our undifferentiated construct of "classic" fluted point assemblages that might include Gainey-like points, Bull Brook, Parkhill Complex, Vail and Debert points than they are to Crowfield, Holcombe, and Hi-Lo point styles. The Michaud site collection is also clearly differentiable from manifestations such as Gardner's Mid-Paleo material. When compared with the Great Lakes sequence, Michaud points tend to be closer to Gainey-like material than to the Parkhill complex, but some Michaud specimens do exhibit traits (fishtail base) that may place them intermediate between these two constructs. Below we focus in greater detail on the New England-Maritimes region.

Seriation of the "classic" northeastern fluted point assemblages is indeed difficult. We have above reviewed the Great Lakes scheme which separates Gainey material from Parkhill Complex material. In New England, Grimes and others (1984: 172) propose the "Bull Brook Phase" to include the Bull Brook I and Bull Brook II sites, Wapanucket 8 and the Whipple site, because of a similarity in lithic raw material usage at these four sites, and because of perceived typological correspondences. For example, "finished projectile points and fragments display virtually identical basal configurations, finishing and fluting, particularly between the Bull Brook localities and Whipple (Grimes et al.1984)."

Gramly (1982: 70-72) focuses on the depth of the basal concavity on fluted points from the Vail and Debert sites, and proposes a developmental sequence from less-deeply indented points, such as the Bull Brook point, to Vail and Debert. Gramly (1982: 71) cites a number of fluted points with deep basal concavities from across the Northeast in implying that this attribute is a style with chronological or "developmental" significance, a position he believes is strengthened by his work at the Lamb site (Gramly 1986). Gramly (1984:111) also states that he had once thought the deep concavity "might be considered cultural", ie. an expression of style by the stone knapper, possibly indicating ethnic relationship between Vail and Debert. However, the distribution of such points across the countryside "cautions us against accepting the explanation of style or cultural whim (Gramly 1984: 111)". Alternatively, Gramly proposes that the deeply indented bases may be an adaptive trait that would tend to increase over time.

In attempting subdivisions of the "classic" fluted point group in the New England-Maritimes region, we think it instructive to contemplate the variability in fluted point form among eight fluted points associated with the kill of one mammoth at Naco in Arizona (Haury 1953). We may assume that these eight points existed in the armament supply of several hunters who lived contemporaneously. It is probable that they came from one "band", however defined, but not a certainty. In any case, whatever variability exists in the Naco assemblage can not be chronological in nature. The points vary in length from moderate to long, in outline from parallel sided to convex sided. The basal corners vary from no ears to moderate ears, and the depth of basal concavity varies from near nil to moderate compared with "classic" Northeast fluted points.

Interestingly, six of the points come in three pairs, with both examples in each pair made of the same material as its counterpart. At a visual level only, based on Haury's published figures, the basal concavity depth and ear form appear to be more similar between members of a pair than they do among the group as a whole. We might assume that paired points made of the same material, with similar basal treatment, might have come from the same hunter's production. In any case, the Naco assemblage indicates that some of the variability we see in fluted point assemblages may be ascribed to individual preference without overriding chronological or social group meaning. This variability suggests the need for greater use of the concept of polythetic types and greater attention to detailed attribute studies in working with Paleoindian material (following Deller and Ellis 1986a).

At this state in our analysis and inspection of "classic" fluted points from the New England-Maritimes region, we think that certain fluted point attributes (where data are available) cluster within a site and between certain sites (Table 3-9). However, close examination of these assemblages indicates that there are certainly overlapping attribute ranges. For instance, although flaring basal ears are not a majority attribute at any of these sites, they are most common at Bull Brook and the Michaud site. Several examples of slightly flaring basal ears are present at both Debert and Vail, though it is such an uncommon attribute as to be considered absent for the present purpose. Although the average depth of the basal concavity is greater at Vail and Debert, the minimum depth overlaps with specimens from Bull Brook, Bull Brook II, and the Michaud site. Clearly, both localized affiliations and individual maker's differences, as well as attributes created through resharpening, are reflected in fluted point form attributes within this "classic" group of material. Much more work is necessary before this variation can be said to be stylistic marking for ethnic or band groups, or to be surely temporally indicative.

We can, however, begin to place the Michaud site specimens within the variability of New England-Maritimes "classic" fluted points. First, there appear to be two stylistic clusters of points at the Michaud site (see below). In all, however,

Table 3-9. Selected attributes of fluted points from Paleoindian sites in the Northeast.

	Bull Brook	Bull Brook II	Vail	Debert	Michaud
Depth Basal Concavity (mm)					
min.		3.75	5.5	2.0	3.4
max.		6.8	12.6	15.0	7.0
ave.	shallow	5.2	8.6	9.4	4.8
Average Length Flute Scar Compared to Total Length	> 1/2 (some full length)	>1/2	<1/2	<1/2	>1/2
Flaring Basal Ears	present	absent	absent	absent	present

Note: "Average length of the flute scar compared to total length" is given in relation to the distance from the proximal end of the basal ears to the point tip.

the Michaud points are closer to the Bull Brook Phase proposed by Grimes et al. (1984) than to points from the Vail or Debert sites (although not identical with the Bull Brook Phase). There are enough differences between the Michaud site assemblage and the Vail site assemblage to demonstrate the lack of a close stylistic similarity.

Michaud Site Fluted Points

Nine fluted points and fragments were recovered at the Michaud site (Plates 3-5 and 3-6). Of these, only four specimens were complete enough to examine a range of diagnostic details, including depth of basal concavity, shape of the basal ears, and flute scar characteristics. Interestingly, the points clustered into two categories based not only on provenience data and raw material, but on stylistic characteristics.

Two specimens (23.12.0109, 23.12.0088/.0112) were made of black chert. Although these points differ in length, their form is surprisingly similar. Both display a shallow basal concavity bounded by thick, squared basal ears. The single flute scar on the dorsal side of each specimen extends nearly to the distal end of the point. The ventral side of specimen 23.12.0109 displays a single flute scar which extends for half of the length of the point, while a double flute scar is present on the ventral side of specimen 23.12.0088/.0112 which extends to just beyond the mid-section of the point. The thickness to width ratio for both specimens is 1:4. Both specimens show a convex longitudinal ridge beyond the flute scars defined by regular collateral flaking. Although resharpening may have accentuated this characteristic on specimen 23.12.0109, it is apparent that a thick longitudinal ridge near the tip was an original feature of both of these points.

Two fluted points, one with the distal end missing and the other with the tip missing, were recovered from Concentration I (Chapter 5). Further, a tip section and a basal ear (which do not fit the preceding specimens) were also recovered from this concentration (making a minimum of four points). All of these specimens are made from red Munsungun chert. The two fragments (23.12.0377, 23.12.0451) which are not whole enough to reveal many

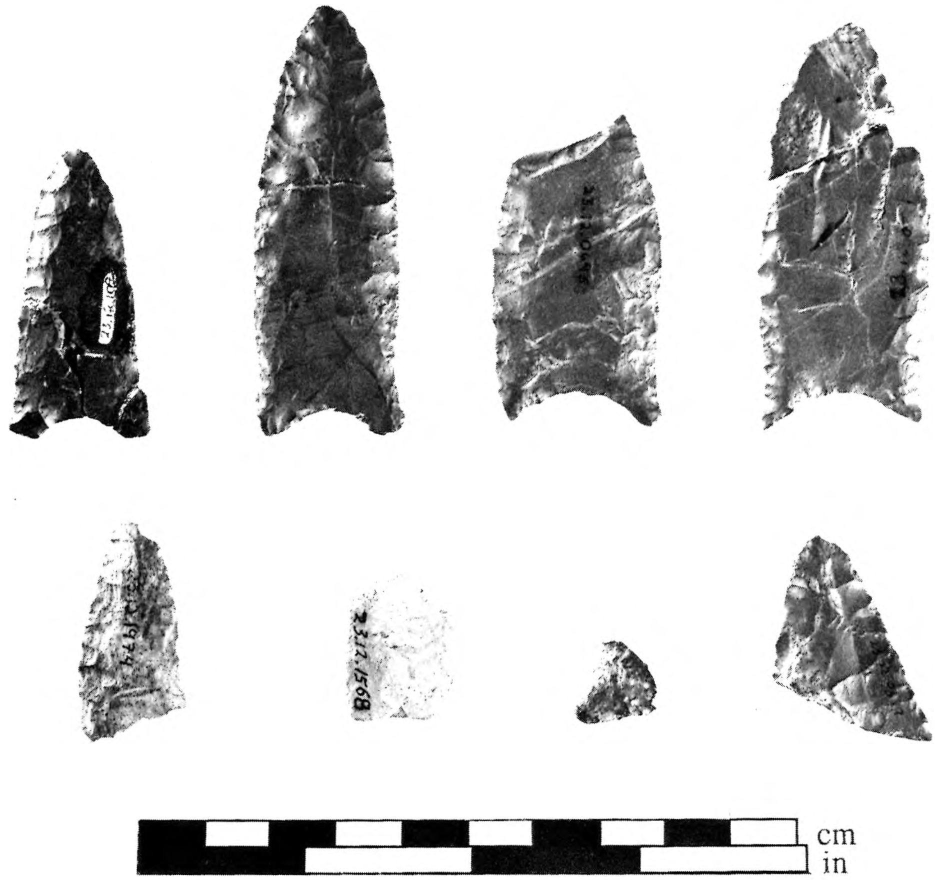


Plate 3-5. Fluted point fragments from the Michaud site. Upper row, left to right: 23.12.0109, .0088/.0112, .0643, .0321/.0451.

diagnostic characteristics nonetheless support the stylistic configurations which will now be examined in the other two specimens (23.12.0643, 23.12.0321/.0433). Both of these specimens exhibit relatively shallow basal concavities, although both are somewhat deeper than those of the previously described black chert specimens (see Table 3-6). The basal concavities are symmetrically arcuate and are bounded by fine, pointed, heavily ground "fish-tailed" basal ears. The points are lanceolate in outline, with the length of maximum width occurring just proximal of the mid-section of the point, in contrast to the preceding specimens, whose length of maximum width occurred near the base. The thickness to width ratio for specimens 23.12.0643 and 23.12.0321/.0451 is 1:5, the same ratio exhibited by the preforms from Concentration I. Flute scars in general are not as long as on the preceding specimens, although the terminus for the dorsal flute scar on specimen 23.12.0643 is indeterminable as the proximal portion of the tool is missing.

Three other fluted point fragments were recovered from elsewhere on the site during our excavations. One (23.12.1974) is an asymmetric, very narrow tip fragment displaying the remnant of a flute scar apparent just beyond a transverse break. It is made from Neponset rhyolite. A very thin, narrow biface mid-section (23.12.1568) exhibiting a flute scar is also present. Finally, a very small fragment of a basal ear of Neponset rhyolite was recovered. The fragments just described

Plate 3-6. Reverse side of points shown in Plate 3-5.

were too fragmentary to contribute any information to the above discussion. In fact, the mid-section (23.12.1568) and tip (23.12.1974) fragments appear to come from points which would have been considerably smaller than the whole fluted points described above.

Channel Flakes

Twenty-one channel flakes and fragments were recovered at the Michaud site. They appear to vary in size and shape as a function of both raw material (Table 3-10; Plate 3-7) and preparation techniques. Channel flakes made from Neponset rhyolite tend generally to be narrow and less well defined than those made of chert. The width of these Neponset rhyolite channel flakes is similar to the small width of the flute scar present on the extant fluted point of Neponset rhyolite (23.12.1974). On channel flakes made of chert, there appears to be an equation between the extent of symmetrical convexity achieved by lateral flake removals and the production of the desired parallel-sided long channel flakes. Two red chert channel flakes (23.12.0087, 23.12.1398) are excellent examples: they are narrow--13 mm and 15 mm average widths, parallel-sided, and, although both are broken, their extant lengths are 55 mm and 47 mm, respectively. Both are plano--convex in cross-section with a well-defined longitudinal ridge on the dorsal side. Specimens that do not display this well--defined convex longitudinal ridge are asymmetric and tend to detach as dictated by the irregular pattern of lateral flake

Table 3-10. Raw materials distributions for channel flakes.

Material	Number	Percent
Cr1	5	30
Cr05	3	17
Ceg1	5	30
Rfnp	4	23
TOTAL	17	100

Plate 3-7. Channel flakes from the Michaud site.

scars. The fluted points in this collection (and many of those observed in the Vail collection) tend to have one long flute removal on what we call the dorsal side, and one or more shorter and less well--defined flute scars on the ventral side. This effect may be due to the careful production of a medial longitudinal ridge by lateral flaking on the dorsal surface of the preform, with somewhat less attention paid to such production on the ventral side. This pattern may also have been dictated by the original flake from which the point was manufactured, and may therefore indicate that the observed fluted points were made on flakes rather than bifacial cores. Alternatively, it may simply have been standard procedure to work the dorsal and ventral faces in slightly different ways.

Of the twenty-one channel flakes and fragments present, nine have been utilized. Two of these have been worked into gravers or perforators, and are discussed below. Three channel flake fragments (23.12.1139, 23.12.0932, 23.12.0817) are present which preserve the top of the fluting nipple and the ground striking platform.

Sidescrapers

Sidescrapers are perhaps the most morphologically diverse Paleoindian tool type. As the name implies, the primary

working surface generally occurs on the lateral side(s) of a medium or large flake, although the distal end may be utilized as well. Quite often sidescrapers take the general shape of the flake on which they were made, and we suspect that large, primary flakes of several standard types were employed in their manufacture. Of particular note, sidescrapers are a tool form confined almost exclusively to the Paleoindian time period in the Northeast (Steven Cox personal communication), and therefore represent a diagnostic form paralleling that of fluted points.

Various authors (Cox 1972; Gramly 1982; Funk 1976; Irwin and Wormington 1970; MacDonald 1985) have suggested a number of sub-types for the sidescraper class, and also have recognized the relationship of these forms to other tool classes. Funk, for instance, suggests a relationship between sidescrapers, flake knives, and retouched flakes. "These artifacts are here grouped in one category, partly because of a fundamental morphological similarity: all are based on flakes retouched on one or more long edges...(1976: 215)." Funk's distinction between knives and sidescrapers is arbitrary, as it is based on the steepness or shallowness of the bevel on the retouched edge(s). There is even less of a distinction from a functional viewpoint: Funk records the same pattern of wear consisting of "edge-crushing, or the removal of tiny hinge-flakes from the working edge (Funk 1976: 215)" on both knives and scrapers.

The Holcombe Beach site uniface collection was divided into three categories: standardized scrapers, gravers, and unique or irregular tools (Fitting et al. 1966: 48-51). This approach seems to have been conceived as a typological exercise, but summary attributes for each type are discussed. Most recent discussions of eastern Paleoindian assemblages have followed a similar approach, except for Eisenberg (1978), who has attempted a purely attribute-based approach to subdividing unifacial tools. MacDonald says the typology of the sidescraper class is difficult to establish because "variations in form are myriad. A major technological difference occurs between those that are true unifacials -- that is, trimmed over the entire face of one side--and those that are retouched only marginally (MacDonald 1985)." Actually, MacDonald (1985: 395-98) subdivides the sidescraper group into eight types, such as "sidescrapers on expanding flake with unilateral retouch, sidescrapers with steep retouch opposite the bulb of percussion". Most of the types seem to be based on flake shape, but one type is the "sidescraper with graver spur".

"At first glance sidescrapers appear to be a variable lot defying classification. Actually, the tool class is easily analyzed (Gramly 1982:36)." Gramly divides the sidescraper tool class into two types: those that converge distally and those that expand distally. Gramly further comments that sidescrapers are the largest tools in the assemblage, and that their function is unknown. He favors the idea that sidescrapers were used on wood.

Alexander (1973) presents an extreme case of the typological subdivision of this artifact class, creating fifteen scraper types. Likewise, Irwin and Wormington (1970: 28-9) devise approximately twelve sidescraper types.

Jordan (1960:85, 102-3) perceptively comments that the largest pieces of raw material in the Bull Brook assemblage seem to have been used to make sidescrapers or retouched flakes. The largest in the Bull Brook collection is a retouched flake weighing 94.5 gr, and measuring 107x74x15 mm. "It is also my belief that slabs of raw material were transported from their sources (wherever they were) in the form of these sidescrapers." "Being carried as a large tool instead of merely as dead weight would help 'pay the freight' of the material."

It is possible that sidescrapers were indeed a handy carrying form for raw materials, although evidence thus far is only suggestive. However, the substantial number of relatively large sidescrapers found discarded in archaeological contexts would seem to place limits on such a probability, since they would tend to be

Table 3-11. Uniface attributes used in Michaud site analysis, described in detail where they differ from those defined for bifaces.

Catalogue Number
Category: whole or fragment
Type: sidescraper, endscraper, etc.
Material
Length: maximum on the longitudinal axis
Width: maximum
Length of maximum width: taken from the proximal end forward
Length//Width Ratio
Thickness: maximum, independent of location
Length/Thickness Ratio
Description: a description of the outline of the tool
Edge Angle, Distal: an average of several when variation occurs
Edge Angle, right Lateral: same
Edge Angle, Left Lateral: same
Platform Angle: an angle of the striking platform in relation to the ventral side of the artifact
Platform Preparation: flat, retouched, grinding or crushing
Concavity(ies): number and position
Spurs: number and position
Wear position
Wear type
Cutting Edge Contour: (for endscrapers only) convex, pointed, irregular, flat, or asymmetric

Table 3-12. Summary statistics for sidescrapers. Measurements are in millimeters and degrees.

Attribute	Number	Mean	Std. Error	Minimum	Maximum
Length	9	66.9	15.59	44.9	85.0
Width	9	37.7	15.7	20.3	74.3
Thickness	10	8.6	2.78	5.0	13.3
Length of Maximum Width	9	38.0	18.07	6.0	61.0
Length of Maximum Thickness	8	28.9	12.58	10.2	44.0
Edge Angle, r lateral	10	48.9	9.13	41.0	65.0
Edge Angle, l lateral	10	55.3	7.98	41.0	69.0
Edge angle-distal avg	10	54.5	13.13	26.0	65

re-utilized for other tools if they were intended as primary raw materials sources.

Just as other authors have been faced with making typological decisions about the sidescraper class, so also does the Michaud site's small sidescraper collection include a diversity of forms suggesting a number of types. Whether these be functional types, or simply original flake morphological variation, remains an unanswered question at this time. Sidescrapers from the Michaud site, as well as other standard

form unifacial tools (e.g., endscrapers, concave scrapers, (but not utilized/-retouched flakes) were measured and described using a common set of measurements (Table 3-11). Summary statistics for the sidescraper class are presented in Table 3-12.

The term "backing" is used frequently throughout this section, and a definition should precede its use. Intentional "backing" i.e., the creation of a rounded or smoothed tool edge to prevent abrasion either to the hands or to a haft, has been noted in two forms at the Michaud site. One, in the form of intentional medial snapping, has been noted elsewhere (Cox 1972: 44; MacDonald 1985: 97). The second form of "backing" is seen either on a distal end or a lateral side which has not been regularly retouched. These often ragged margins have been either lightly and irregularly retouched, "nibbled"by regular light retouch, or ground, or a combination of these features. Approximately half of the sidescrapers in the Michaud collection display at least one of these varieties of "backing".

The most numerous type of sidescraper recovered at the Michaud site is parallel--sided or expanding. Five specimens are represented, three of which display hinge fractures or are snapped at one end (Plate 3-8). Two of these are retouched on all other margins (23.12.1700, 23.12.2301), while one (23.12.2323) is "backed" by slight retouch and edge "nibbling" on the left lateral side.

Two other specimens (23.12.2293, 23.12.2053) have been created on large, expanding flakes (Plate 3-9). The left lateral side on each of these specimens has been steeply retouched, while the right lateral sides show "nibbling" and light retouch. The distal end of specimen 23.12.2053 is a jagged edge which displays light retouch and possible grinding as "backing".

A second type, represented by three specimens, may be described as distally convergent. Two specimens (23.12.1477, 23.12.0308) are relatively small, with regular retouch confined to the right lateral sides, while irregular retouch and edge "nibbling" are present on the left lateral sides (Plate 3-8). The third specimen (23.12.0289) appears to be a preform. The left lateral side is crescentic in outline and has been bifacially flaked, while the right lateral side is straight and steeply retouched.

Three specimens (23.12.2218, 23.12.0090, 23.12.0488) represent a smaller variety in the sidescraper class (see Plate 3-10 lower left for 23.12.0090, Plate 3-16 upper right for 23.12.0488). They are made on thin, small flakes which have an average thickness of 4.6 mm, compared to the average thickness of 9.1 mm for the larger sidescrapers in the collection. Moderately steep retouch is seen on both lateral edges. The distal end of specimen 23.12.0090 is convex in outline, and may have served an endscraper function. A second specimen (23.12.0488) is unmodified on the distal end.

Numerous specimens which are too fragmentary to be assigned to a particular type have simply been catalogued as uniface fragments.

Endscrapers

The form "endscraper" as generally observed in Paleoindian site reviews refers to uniface tools whose primary working surface occurs opposite the bulb of percussion i.e., on the distal end. End-scraper "bits" are usually mildly to strongly convex with edge angles which vary greatly, although they most often fall within the 55-75 degree range. It has been suggested (Wilmsen 1970) that edge angle may have functional significance in that certain edge angles are more effective for some tasks than for others. It seems likely that the measured edge angle of an endscraper which has been retrieved from an archaeological context may reflect not only the edge angle purposefully napped to an appropriate angle, but also both the effect on edge angle of resharpening and of use.

Besides exhibiting a usual flake orientation and distal end form, Paleoindian endscrapers may vary considerably in size and in the number and type of additional features which each specimen may display.

Plate 3-8. Sidescrapers. l. to r. 23.12.1700, .2323, .0308, .1477.

Other authors describing Paleoindian assemblages have found it useful to define a number of types for this class, based both on morphological characteristics and, presumably, functional attributes.

The extreme typological approach to this class is exemplified by Irwin and Wormington (1970: 28-9) who identify eleven types of endscraper on the basis of overlapping and not mutually exclusive attributes. One group is distinguished by the shape of the bit, another by the presence of a graving spur or angle where the retouched edge intersects the side of the flake, another by ventral as opposed to dorsal retouch, and so forth.

MacDonald (1985: 90-92) defines six types of endscraper in a sample of 1,587 specimens from the Debert site. Of these, 425 were too fragmentary to assign to type, leaving a typeable sample of 1,162. Over 50% of the sample were "characterized by a tapering stem, by extensive retouch often tending to diminish the lateral margins, and by a steeply chipped working edge." "Their most striking feature is the presence of hook-like projections or 'spurs' at the corners of the bit." Another 30% of the intact endscrapers, called rounded bit endscrapers by MacDonald, are identical to the spurred endscraper in size, material, and manufacturing details, but lack the spurs. The remaining types described exhibit variation in flake shape, preform--to-tool orientation, and the amount of retouch occurring on lateral sides.

In contrast to the typological approach exemplified above, the Holcombe site yielded eight tools which were simply classified as endscrapers and described as follows (Fitting et al. 1966: 48): "They are marked by a convex working edge, a series of parallel flakes forming a steep retouch and a series of small flakes, ending in hinge fractures, directly on the working edge. The entire series is marked by a slight constriction back of the working edge. In several examples an

Plate 3-9. Large sidescrapers. l. to r. 23.12.2293, .2361,.2053/.2051.

actual 'spur' is present". Funk (1976: 214-15) also simply describes the type "endscraper" without further subdivision. He states that they are invariably made on preforms which are "oval or expanding, flat to ridge-backed flakes, retouched at the broad end opposite the striking platform".

Of particular interest, Gramly (1982: 34) notes that at the Vail site endscrapers are but one stage in the useful life of the stone on which they are made. "The usual transformation for a trianguloid endscraper was first to become a cutter with a spur flaked at the corner of its working edge or proximal end. Next, the former scraper was tipped on edge and beaten with a hammer, perhaps one made of stone. This use as a wedge (piece esquillee) resulted in heavy crushing and stepflakes on the piece." Gramly here presents the hypothesis that endscrapers would not have had graving spurs flaked on their lateral margins until after they had ended their useful life as endscrapers, having been finally resharpened and used to a dulled edge.

Only nine endscrapers were recovered at the Michaud site (Plate 3-10) and they do not sort easily into well-defined types. Flake size and other flake "preform" characteristics, raw material selection (Table 3-13) and extent of resharpening appear to be the attributes responsible for most of the variation. Variation in form (Table 3-14) is also likely the result of adaptation for different hafting arrangements. Rule and Evans (1985: 216) suggest that this is the case at the Shawnee

Plate 3-10. Endscrapers from the Michaud site. Upper row, l. to r.: 23.12.2193, .0022, .2214, .2109, .2396. Lower row, l. to r.: 23.12.0090, .0151, .0586, .0110. Object .0090 at lower left is classed as a sidescraper. Endscraper .1528 is not shown.

Table 3-13. Endscrapers, raw materials.

Raw material	Number	Percentage
Cr1	1	11.1
Cr05	3	33.3
Ct01	2	22.2
Rfnp	3	33.3
TOTAL	9	99.9

Minisink site: "The patterning and consistency of hafting dimensions within the Shawnee Minisink sample leaves little doubt that endscrapers were tailored to fit specific hafts and suggests that variations in the type and placement of hafting modifications were closely related to accommodating the particular group of hafts in use at the site." The Michaud endscrapers exhibit two patterns of dorsal face, lateral side, and proximal end form suggesting that each type may have been hafted differently. Certain attributes cluster in different areas of the site (see Chapter 5), and thus, may represent either "stylistic" characteristics attributable to an individual maker or functional attributes specific to tasks accomplished within a particular tool concentration.

Three endscrapers (23.12.0151, 23.12.2193, 23.12.2214) recovered from two nearby, and apparently related, tool concentrations (Concentration I and Concentration III) and a fourth specimen (23.12.0022), which was surface collected, are all small and made from red chert (Cr05 and Cr1). Moreover, each has been made on a flake which appears to have been

Table 3-14. Summary statistics for Endscrapers, measurements in millimeters

Attribute	Number	Mean	Std. Error	Minimum	Maximum
Length	10	30.3	8.09	22.8	48.2
Width	10	22.5	4.33	16.5	28.3
Thickness	11	5.8	1.6	4.6	9.2
Length Max. Width	10	22.5	7.0	14.6	35.0
Length Max. Thick.	10	21.7	8.88	13.0	45.0
Distal Edge Angle	11	56.0	8.97	41.0	68.0
R Lat. Edge Angle	11	51.4	14.15	39.0	78.0
L Lat. Edge Angle	11	51.18	14.28	27.0	73.0
Platform Angle	4	112.5	18.69	98.0	138.0

chosen and worked so that the dorsal surface centers between flake ridges, leaving a medial dorsal facet. Two of these specimens have been bilaterally notched, while all of the specimens have retouched lateral edges which do not appear to have been utilized. These scrapers could have been hafted in either a composite haft which was lashed, something similar to the proposed composite hafts for Folsom points (Frison and Craig 1982), or in an open--socketed haft, as are similar specimens in Neo-eskimo collections (Fitzhugh and Kaplan 1985). When resharpening brought the scraper bit too close to the haft, the endscraper would then have reached the end of its useful life and would have been discarded. Thus, some spurs or sharp angles at the intersection of a lateral side with the scraper bit may have been created during resharpening. Particularly as the scraper bit receded toward the haft, it would have been increasingly difficult to round the distal lateral corner. This situation would have been accentuated in the cases where hafting concavities had been flaked into the lateral sides (concept developed with John Grimes; see also Deller and Ellis 1986: 65).

Two endscrapers of Neponset Rhyolite (23.12.2396, 23.12.2109) exhibit both trianguloid outlines and slightly convex bits; both were recovered within several meters of each other. Hafting modification is suggested on these specimens as flakes, not unlike small, rough channel flakes, have been removed from the proximal dorsal surfaces of the tools. In contrast to the red chert specimens, the dorsal surfaces of these endscrapers exhibit a random distribution of flake scars with the exception of the medial thinning flakes on the proximal ends. The lack of a smooth dorsal surface suggests that these endscrapers were hafted in a socket-type haft which did not require prepared dorsal and ventral sides on which to bind a flat piece of wood or bone. The lateral sides on these specimens have not been steeply retouched, in fact, only slight retouch is present. An open-socket type haft, where the tool was wedged, perhaps with a piece of leather and some mastic, would not be subject to abrasion from the relatively sharp lateral sides as would a bound, composite haft.

Two specimens (23.12.1528, 23.12.0586) made from tan chert (Ct01) have a greater length to width ratio than other endscrapers in the Michaud collection, and both-display a central dorsal ridge. One of these specimens (23.12.1528) is large and has a heavily resharpened bit which is asymmetric. Several thinning flakes were removed from the proximal, dorsal end, suggesting that the tool was hafted. It seems likely that specimens displaying a central dorsal ridge would also have been hafted in an open-socket haft, which could accommodate irregularities in outline form more easily than a wood or bone composite haft.

In summary, the red chert endscrapers recovered principally in Area A (see Chapter 5) are consistently made on flakes which were chosen or modified to have a smooth dorsal surface. Two of these specimens display bilateral concavities, while the lateral edges on the others are steeply retouched, possibly to reduce abrasion in a lashed haft. These specimens could either have been hafted in a composite or open-socket haft. All of these specimens are quite small. Endscrapers from Area B either have dorsal surfaces displaying prominent flake scars or dorsal ridges, suggesting that an open-socketed haft would have been most accommodating for these specimens.

Limaces

The tool form named "flakeshaver" in a recent functional/morphological study (Grimes and Grimes 1985) has a long history of poor recognition in Paleoindian studies. Jordan (1960: 104-5) called them "groovers", stating that specimens from the Bull Brook site were between 30 and 50 mm in length and up to 10 mm in width. According to Jordan, Byers called the specimens from Bull Brook "keeled scrapers", while the Beverly group of avocational archaeologists who excavated at Bull Brook called them "rowboats or canoes", which was an apt morphological rather than functional designation. Witthoft (1952) called this tool form "flint bars", and was apparently the first to differentiate it from the mass of other Paleoindian tools. MacDonald (1985) classified tools of this form as "stone awls" under "perforating tools". Gramly (1982: 37-8) called these tools "limaces" based on an Old World (French, Upper Paleolithic) analogue.

Just as the form has had a poor history of recognition, so has their function been open to considerable speculation. Though he does not ascribe direct function, MacDonald (1985: 98-99) notes of the "stone awls" at Debert: the "wear is greatest at the tip, and the removal of small flakes from the ventral side of the tip and occasionally from the tip itself indicates that considerable pressure was exerted on this point through the length of the tool. These awls show superficial resemblance to drill bits but are completely unifacial and show no signs of rotary use."

Cox (1972 48-49) describes six specimens in the Shoop collection as "perforators" which may, instead, belong in the "limace" category. Several of the Shoop specimens were made on blades or blade-like flakes. The tips in half of the specimens are bifacially flaked and sharp, while the remaining specimens have a fairly blunt tip. Cox makes note of this difference: "In view of the near identity otherwise in tool shape and execution, I doubt that this is a significant difference-in all cases the tip has been carefully shaped and probably represents the main working portion of the tool."

By far the most detailed analysis has been prepared by Grimes and Grimes (1985), who derive several lines of evidence strongly suggesting that these objects were hafted in more-or-less standard depth sockets, and sequentially re-set and re-used if they snapped. At each snap the proximal fragment was extracted from the haft and discarded, and the distal portion re-hafted until it was too short to re-haft. The distal end was used as a push-plane and scraper, leaving use-wear as scalar flake removals from the ventral side of the distal end or from the distal end on the lateral sides. Grimes and Grimes (1985) suggest that a "flakeshaver" is a "hafted whittling or shaving tool applied to hard materials such as bone, ivory, wood, or antler."

Two of these tools were recovered from the Michaud site excavation, and a third was found by George Eaton while surveying for the Maine Department of Transportation airport road and subsequently lost. The latter specimen was described as being whole, long and fairly narrow, and made from gray-green chert (Cegl).

A single whole specimen (23.12.1342) of red and green mottled chert (Cr05) was recovered during our excavation (Plates 3-11 and 3-12). It is long and narrow, measuring 61.8 x 9.8 x 4.0 mm, and appears to have been made on a blade, although the

Plate 3-11. Limaces, dorsal view. 23.12.1342 above, .0634 below.

Plate 3-12. Lateral view of limaces in Plate 3-11, exhibiting longitudinal blade curvature.

striking platform is absent. The lateral sides have been steeply retouched, although it is not clear whether the sides were used for a scraping function or were only retouched to strengthen the tool and shape it for hafting. Both the distal and proximal ends have use microflakes removed from the ventral side. Microflakes have also been removed by force from the dorsal side along the dorsal arris at the top of the retouched left lateral distal end. It therefore appears that the tip was either pushed into a hard substance and/or inserted into a hole in a semi-hard substance.

The second specimen (23.12.0634) is made from black chert and is a proximal or distal fragment. It also was made on a blade-like flake. The specimen, though broken, is narrow (9.5 mm) and relatively thin (5.0 mm). Flaking from both lateral sides meets on the longitudinal axis of the tool to form a central ridge. Again, slight microflaking is present at the tip on the ventral side.

The two extant limaces and the one described by George Eaton are more long and narrow than those generally found in Paleoindian assemblages in the Northeast. At present we hesitate to ascribe a temporal or functional significance to this difference. As all three are finely formed and come from the same tool concentration (Concentration I), it is possible that we are again viewing an individual's stylistic preferences, in parallel with other tool forms in this concentration (see Chapter 5).

Pieces Esquillees and Drills

The Michaud site assemblage lacks piece esquillees and drills, but, since their absence may be significant in a seasonal/-functional or chronological sense, we here discuss each tool as it is described in the literature.

Jordan (1960: 95-96) was apparently the first to report the tool type that has come to be called a "wedge" or "piece esquillee" (translation: scaled piece). He calls them lozenges: rectangular, or diamond-shaped bifacial implements, coarsely

and crudely chipped, with flake scars reminiscent of bipolar flaking. They have a vague similarity to cores "but the flaking is too irregular, and a small number of definite cores have been found at the site which are quite different. I feel that these do constitute a new tool type, but can offer no suggestion as to their function." "P.E.L. Smith has recently called my attention to a somewhat similar artifact from the Upper Paleolithic in France, interpreted there as a wedge (Jordan 1960: 95-96)."

At Debert pieces esquillees account for up to 20% of the total tool sample (MacDonald 1985: 85-86). "In form they are generally rectangular and exhibit bipolar flaking from paired, crushed and battered surfaces. Primary flakes driven from both faces by direct hard percussion exhibit extreme concentric ripples emanating from the point of percussion." "Several paired edges are observed on many specimens which have been rotated one or more times during use (MacDonald 1985: 85-86)." MacDonald surmises that these tools were used as wedges on unstated substances and as slotting tools for the removal of a sliver of antler from its parent piece.

Wedges or pieces esquillees are present in the Shoop assemblage, for which Cox (1972: 51-52) generally follows MacDonald's description and functional interpretation. MacDonald (1985: 89) states that pieces esquillees are present in the Holcombe assemblage, although Fitting et al. (1966) do not describe them.

Pieces esquillees constitute the third most common tool at the Vail site, where Gramly (1982: 41-42) and Lothrop and Gramly (1982) clearly feel they were used as wedges. Importantly, up to 20% of these tools show clear evidence that they had been other tool types prior to being used as pieces esquillees. None of the hard--hammer flakes struck from pieces esquillees at the Vail site seem to have been utilized.

Recent analyses (Goodyear 1982) have suggested that pieces esquillees are exhausted bipolar cores rather than tools, an argument based primarily on presumed lithic conservation strategies. Goodyear hypothesizes that Paleoindian sites in which the lithic supply appears to be in a state of exhaustion (i.e. displaying highly resharpened tools and few preforms) would exhibit the highest incidence of pieces esquillees. Sites near quarries would, conversely, contain the fewest number of pieces esquillees, for there would be no need to conserve raw material when much was available. As examples for this argument, Goodyear uses the Debert and Vail sites, both of which contain high numbers of pieces esquillees, many of which were made on other tool forms, particularly endscrapers. In fact, however, both the Debert and Vail sites are located relatively close to chert quarries utilized by the site's inhabitants (40 miles and 15 miles, respectively). Even supposing, as Goodyear suggests, that the site's inhabitants were occupied with primary pursuits of a different nature (i.e. obtaining game), such activities would not preclude the acquisition of raw materials if the need were great, by several members of a band, for instance.

MacDonald (1985: 88-89) argues convincingly for their use as wedges, citing possible analogues in Upper Paleolithic (following Jordan 1960) and Mesolithic European industries, as well as possible examples from Siberian Paleolithic sites. Interestingly, when endscrapers at Debert were used as pieces esquillees, MacDonald notes (1985: 89-90): "In a predominant number of examples, it is significant to note that the secondary bulb, or the point of contact between the scraper and the material acting as the anvil, was the spur of the scraper. One interpretation of this phenomenon would be that the spur was first employed to slot the material and that in the event that a wedge was not available it was also used to dislodge it by hammering the scraper itself into the slot."

The general size of pieces esquillees as they are found discarded in archaeological contexts negates their use as cores. If these specimens represent exhausted bipolar core nuclei, then the desired flakes would be somewhat larger than those which could be removed from the discarded core. At

the Debert and Vail sites, endscrapers were often used as the precursors of pieces esquillees. These endscrapers are the same size or just slightly larger than pieces esquillees. This fact suggests that, if usable flakes were the desired product, very small flakes would do. At both the Vail and Debert sites, there is sufficient waste from biface reduction to fill a need for small waste flakes. And there is nothing noteworthy about flakes from bipolar reduction to recommend their use over that of biface thinning flakes. Rather, if anything, they are more irregular in shape and less predictable in manufacture.

The fact that pieces esquillees occur frequently in some sites and not in others may reflect seasonal or economic differences in site use rather than raw material shortage, or possibly chronological placement. Two possible "wedges" were reconstructed from debitage in the Folsom level bone beds at Agate Basin (Frison and Stanford 1982: 122). They are also present at Lindenmeier and the Clovis level at Blackwater Draw (MacDonald 1985: 144). Pieces esquillees have been recorded at "Gainey" sites in the Great Lakes area, but are notably absent from the later "Parkhill" complex sites from southern Ontario (Deller and Ellis 1986b: 8). Piece esquillee incidence is low in many sites in the Northeast (8 at Bull Brook II [Grimes et al. 1984], 22 at the Potts site [Gramly and Lothrop 1984], 2 at the Whipple site [Curran 1984], 5 at West Athens Hill [Funk 1976]), and seemingly disproportionately high at other sites (295 at Vail [Gramly 1982], 1,046 at Debert [MacDonald 1985], 70+ at Shoop [Cox 1972]).

In conclusion, biface thinning flakes were available at all of the Paleoindian sites where pieces esquillees were found, suggesting that flake removal from bipolar cores was not necessary to produce expedient flake tools.

Basally fluted twist drills were first described by MacDonald (1985: 81-85) who identified four specimens in the Debert collection, where there is considerable variety of form in the tip. The Vail site assemblage contains 56 drills (Gramly 1982: 30-31), of which 35% are unfluted, 24% are fluted on one face only, and the rest are bifacially fluted. Gramly also notes variability in distal end form. Although neither author states so, the implication of such a high percentage of fluting on the drills is that they were often thinned for hafting, perhaps in conjunction with a bow drill.

Byers (unpublished: 21-24), in his preliminary analysis of the Bull Brook assemblage, suggests that the bit ends of Debert drills (and under this definition Vail drills, Brush and Spiess personal observation) do not qualify as "twist drills" in the sense that the form from Bull Brook does in terms of tip morphology. A number of Bull Brook drills examined by Byers exhibited flake removals which had been detached from opposing sides of a flat, broad bit end, thereby creating an end analogous to a modern low-speed twist drill. Despite the variability of distal end form noted by both MacDonald and Gramly, neither site produced a drill bit with this particular twist bit configuration. Debert and Vail drill bit ends, without the alternate beveling, are more analagous to modern high-speed wood drills.

Concave Scrapers (Spokeshaves)

Concavities of varying size and of probable functional diversity are found on tools in most Paleoindian assemblages. Two distinct categories seem to emerge: those small concavities found generally in association with another tool form (e.g., endscraper), and most often assumed to be a hafting modification, and larger concavities (over 1/2 cm in width) which occur singly or on opposing sides of a modified flake. Concave scrapers, as defined here, refer to the latter description.

Functionally these tools, as the oft used term "spokeshave" describes, are thought to be woodworking tools (Funk 1976: 216; MacDonald 1985:102). McDonald suggests that the concavities on the spokeshave "were probably used to remove material from wooden shafts by cutting as well as scraping with the concave edge."

Concave scrapers make up 11% of the formal tools (formal tools including all types except utilized/retouched flakes and minute unifacial tool fragments) at the Michaud site. This is a significant proportion when compared to their frequency in other Paleoindian assemblages. Fifty concave scrapers were present at Debert, representing 1.5% of the formal tools. Gramly does not mention either concave scrapers or spokeshaves at the Vail site, although marked concavities occur on some endscrapers at Vail (Brush and Spiess personal observation). These were often unilateral rather than bilateral, and occurred proximal to a graver spur that was on the distal lateral corner. One specimen was designated as a "spokeshave" at 6LF21 (Moeller 1980: 68-69), because of the presence of a semi-circular concavity on the distal end of a flake tool. The concavity, however, was not intentionally created, and the tool has spurs (three) which were isolated as the primary working surfaces. Spokeshaves were not noted in the Bull Brook or Bull Brook II assemblages, although their lack of description may be a function of the incomplete data available from at least the Bull Brook collection to date. Only one "spokeshave" was noted for the Potts site (Gramly and Lothrop 1984: 137), although concavities occur on other tools.

So, the type concave scraper or "spokeshave" appears to be another Paleoindian tool type which varies in distribution both spatially and perhaps temporally, along with drills, pieces esquillees, and limaces. Another possibility, however, is that many of the concave scrapers are flake tools and consequently were not given a formal description by other authors.

Five concave scrapers were recovered at the Michaud site (see Table 3-15 for individual measurements; Plate 3-13). Three are made from chert (1-Cr1, 2-Cr05), one is made from Neponset rhyolite, and one from quartzite. Four are made from thin flakes on which only the concavity significantly alters the basic outline of the flake. Minimal retouch or edge "nibbling", perhaps to provide backing for these probably hand-held tools, occurs on flake margins opposite from and adjacent to the concavity. The concavities are all located on a side adjacent to the bulb of percussion.

One specimen (23.12.0086) is unique and deserves individual description. Its proximal end has been bifacially retouched to remove the bulb of percussion and thin the end. The left lateral side diverges from the base for 13 mm and is retouched on the ventral side. A concavity of 21.7 mm in length and 4 mm in depth extends along the mid-portion of the left lateral side, which is dorsally flaked. Distal to the concavity, the edge converges slightly, still retouched on the dorsal margin. The distal end is snapped. The right lateral side of the tool is slightly convex. The proximal half is retouched from the dorsal side, a large expanding flake was removed from the ventral side at mid-section, and the remaining length of the right lateral side is ventrally retouched. This opposing pattern of edge retouch, both laterally and transversely, is a functional enigma.

Gravers and Perforators

This is a loosely defined class at the Michaud site. The Michaud assemblage contains multiple examples of tools with utilized tips, as do many other Paleoindian collections. However, the tipped specimens do not appear to be a functionally cohesive group. Gramly (various) has chosen to include any specimen with a tip, whether snapped, flaked, or naturally occurring, multiply or singly spurred or associated with another tool (e.g., endscraper, generally) under the functional rubric of "cutter."

Tipped specimens at the Michaud site do not appear to have performed cutting tasks. Some may have served to puncture or perforate a soft material, presumably hide. Other specimens appear to have been utilized on harder substances, possibly wood, bone or antler. "The suggestion that (fine tips) were used to cut the eyes in bone needles is plausible in light of the fact that eyed needles have been reported

Table 3-15. Individual concave scraper measurements in millimeters and degrees

Catalogue #	Length	Width	Thickness	Length of Concavity	Depth of Concavity	Edge
23.12.1319	37.5	43.2	7.3	28.2	7.7	52
23.12.0335	49.0	36.4	6.2	30.8	4.1	52
23.12.1591	41.2	23.6	6.5	22.4	2.2	65
23.12.0032	[36.4]	[18.7]	4.4	[20.3]	[1.8]	45
23.12.0086	51.8	27	6.2	21.7	4.0	57

Plate 3-13. Concave scrapers. Upper row, l. to r.: 23.12. 0032, .1591; lower row, l. to r.: 23.12.0086, .1314, .0335.

from the Lindenmeier site" (Roberts 1941: 71). "They are much too delicate to have been used for extensive work on bone or antler other than for scratching surface designs" (MacDonald 1985: 100).

As in other Paleoindian assemblages, the graver/perforators at the Michaud site are flake tools, generally made on irregularly shaped flakes exhibiting little retouch except occasionally for tip definition. Backing, however, in the form of edge "nibbling" or irregular, light retouch is common on the margins of many specimens.

Three specimens (23.12. 1843, 23.12.1534, 23.12.1592) from the Michaud site have expanding tips centered on a

Plate 3-14. Graver 23.12.1534 at left.

dorsal flake ridge (Plate 3-14). Of these, two (23.12.1534, 23.12.1843) have a steeply retouched lateral edge identical to a sidescraper edge, suggesting that they were multi-purpose tools.

A single specimen (23.12.1818), made on a strongly concavo-convex flake displaying edge "nibbling" for backing on the lateral sides, has a sharp, fine, slightly expanding tip on the distal end which has been created by fine retouch. A small flake has been removed from the tip from the ventral side, probably for resharpening the tip.

Two specimens are made on channel flakes (23.12.0215, 23.12.1804). The former has a spur on the left lateral side defined by a transverse break on the channel flake and a concavity on the left lateral side which isolated the tip. The latter specimen has a tip which has been finely flaked on the distal end of the channel flake on the longitudinal axis of the tool. Both lateral edges of this specimen have been nibbled, and a concavity has been flaked on the left lateral proximal end from the ventral side of the flake. The tip has a flake removed from the ventral side, as does specimen 23.12.1818, presumably for resharpening the tip.

Utilized and Retouched Flakes

Retouched flakes will be discussed with utilized flakes because, in all cases, modification has not significantly altered the basic outline of the flake. Usually light retouch and/or wear in the form of edge damage occurs on one or more margins of the flake. Functional shapes such as concavities are, often, accentuated naturally occurring characteristics of the original flake. Whole specimens are generally of moderate size; the range for length is from 28.5 mm to 69.2 mm, the range for width is from 20.9 mm to 36.5 mm, and the range for thickness is from 2.7 mm to 17.5 mm. Their distribution by raw material is presented in Table 3-16. See Plate 3-16 for examples.

The form in which the raw material arrived at the site and the purpose for which the flake was removed from its parent rock influenced the size and retouch/utilization characteristics observed on the retrieved specimen. For example, the utilized flakes of black chert are all thin, fairly large, biface thinning flakes whose distribution (see chapter 5) suggests that they were generated on the site from one episode of biface reduction. The finely feathered edges on these specimens show edge damage from use rather than intentional retouch, indicating that they were expedient tools which were utilized and discarded probably close to where they had been originally removed. The same pattern of edge use-wear rather than retouch holds true for the utilized/retouched flakes of Neponset rhyolite (Rfnp). The high frequency of these forms in close association with large amounts of Rfnp debitage again suggests that they were an expedient tool, perhaps a handy-sized or shaped flake which was picked up from among a number of flakes and utilized in the vicinity for any number of tasks before being discarded.

The utilized/retouched flakes of the various red cherts, on the other hand, exhibit a high proportion of retouch. With the exception of several examples (23.12.0150, 23.12.2322, 23.12.1158), all are fragmentary. It seems possible to suggest

Table 3-16. Utilized or retouched flake and uniface fragments, materials.

Material	Number	Percent
Cr1	17	24.3
Cr02	1	1.4
Cr03	2	2.8
Cr04	1	1.4
Cr05	10	14.3
Ceg1	3	5.7
Cb01	4	5.7
Ct01	1	1.4
Rfnp	30	42.9
Rc01	1	1.4
TOTAL	70	100.0

that some retouched flakes were "curated" or carried for some time before being discarded.

Rough Stone

A rough stone industry, including hammerstones, anvils, a variety of abrading stones, chopping and crushing tools, and perhaps large, coarse scraping planes (MacDonald 1985: 105) has now been noted for many Paleoindian sites. However, there does not appear to be a universal inclusion of these tools in Paleoindian site reports. A variety of factors may account for this non-uniform reporting, as well as for the identification of only limited types of rough stone tools in specific sites. In contexts where other stones are present within the soil matrix, the entire range of large, coarse stone may be missed, especially in sites already disturbed. Additionally, these rough stone tools do not often look convincing as tool types and may thus be ignored, unless the context indicates human importation of all large, rough stone. Alternatively, this lack of their mention may reflect a functional difference from site to site.

Almost all rough stone tools found at Paleoindian sites are made from locally available material, most often in cobble form, but occasionally from a bedrock source. At larger sites, such as Lindenmeier (Wilmsen and Roberts 1984), Agate Basin (Frison and Stanford 1982), Debert (MacDonald 1985) and Bull Brook I (Grimes personal communication), greater numbers and varieties of rough stone tools occur. At smaller sites, including Bull Brook II (Grimes personal communication), 6LF21 (Moeller 1980) and the Whipple site (Curran 1984), as might be expected, the few rough stone tools present often seem specific to a single task. For example, a single hammerstone completes the coarse tool inventory at both Bull Brook II (Grimes personal communication) and 6LF21 (Moeller 1980).

It has been suggested (Funk 1973: 31) that rough stone tools such as "abrading stones, anvil stones and other rough stone tools, because such traits are extremely rare in Paleoindian contexts, (are) rather (more) characteristic of Archaic complexes." Since a range of rough stone tools is present at many Paleoindian sites, it seems more likely that a rough stone component more regularly had some place in the Paleoindian manufacturing kit.

As previously noted, rough stone tools appear in a number of categories. For instance, several types of abrading stones have been identified, which are most often made from sandstone. One type, which has a flat surface and was possibly used to smooth bone or wood (Wilmsen and Roberts 1984), was found at Lindenmeier, Debert (MacDonald 1985), and West Athens

Plate 3-15. Four utilized flakes, with sidescraper fragment (23.12.0488) in upper right.

Hill (Funk 1973). Another type, recovered at both Debert and West Athens Hill, had one or more grooves worn into the surface; this pattern of wear suggests use for the smoothing and rounding of bone and/or wood, as in the shaping of hafts or manufacture of bone needles.

Abrading stones with shallow concavities are associated with pigment grinding at the Lindenmeier site (Wilmsen and Roberts 1984). Although no analogous association has been confirmed in the Northeast, the presence of pigments at Debert (MacDonald 1985), Bull Brook I, Bull Brook II (Grimes personal communication) and the Michaud site, as well as abrading stones at Debert, Bull Brook I and possibly the Michaud site, suggest a possible similar association.

Choppers are defined (Goodyear 1974; MacDonald 1985) as cobble tools. Generally the surface is removed from one side of the cobble, although occasional bifacial flaking is seen on the chopping edge. When wear is evident, it is generally in the form of crushing on the working edge (MacDonald 1985), or rounding and polish as at the Brand site (Goodyear 1974).

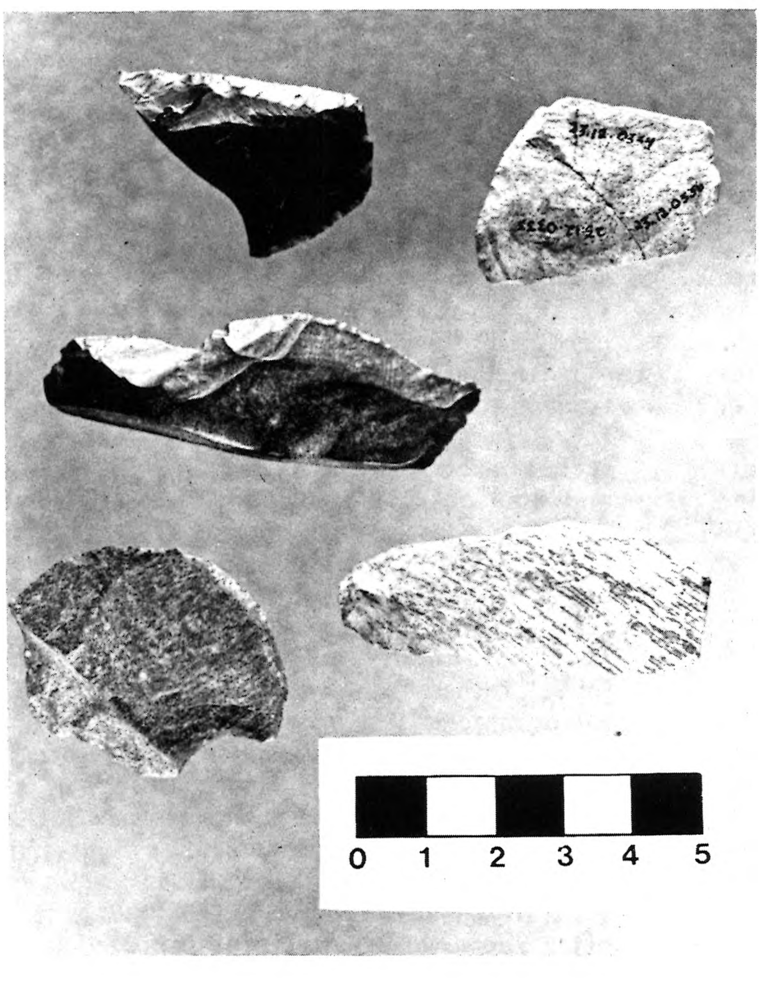
In the Folsom level at the Agate Basin site, granite and quartzite choppers were found in good context with well preserved skeletal remains of several bison (Frison and Stanford 1982: 60). One "was recovered in direct context with several disarticulated and butchered skeletal parts of a bison calf.... The general appearance of working edge damage suggests that these specimens have been used for breaking or crushing [bone] rather than for chopping [meat or softer materials]."

Hammerstones show characteristic patterns of battering and crushing in all Paleoindian assemblages, and are most often made from "hard" stones such as quartzite and granite. Anvil stones as well are generally made from "hard" stones and often show wear patterns of indented lines, such as might be expected from contact

with the base of a piece esquillee. Indeed, a significant spatial correlation was noted between pieces esquillees and anvil stones at Debert (MacDonald 1985).

A significant proportion of the cultural material retrieved from the Michaud site (about 400 pieces) was rough stone, either in the form of debitage or as possible tools. The majority (55% by count) of the rough stone from the Michaud site was Christian Hill diabase. Another 17.5% was a somewhat finer grained and harder volcanic, represented by one utilized river cobble and a sizeable amount of debitage, demonstrably from the same cobble. A final 27.5% of the rough stone was classified as "other", and included a variety of coarse-grained, relatively hard, purposefully broken cobbles. Importantly, none of these stones displayed fire-reddened surfaces characteristic of "fire-cracked rock", nor was this coarse stone distributed in such a way as to suggest that it was associated with (a) hearth(s).

Plate 3-16. Four utilized flakes, with sidescraper fragment (23.12.0488) in upper right.



Eighteen cobble chunks were present which weighed over 300 grams each. Another 37 flakes ranged in size from 25 grams to 300 grams, while 345 pieces were in flake or "shatter" form, weighing less than 25 grams each. Virtually all of the large specimens (those weighing more than 300 grams) exhibit flake removals or appear to have been modified by being broken in some way (Plates 3-17 through 3-19). In this sense they may be considered "cores". However, it is not apparent by macroscopic or microscopic examination if these large "cores" were utilized. For example, they show no consistent pattern of shaping to suggest particular functions. Additionally, obvious wear patterns on all but one specimen are totally lacking. This may be, in part, due to the heavily weathered surfaces of all of the diabase specimens, on which the great degree of weathering would obscure all but the most deeply inscribed patterns of wear. The coarser-grained specimens, belonging to the "other" category, seem unlikely to show wear patterns except for perhaps heavy crushing. A small number of the medium-sized flakes (approximately 25 gr) show some evidence of grinding or smoothing, indicating an abrading function of some sort. Most likely, however, is that a combination of weathering and short use-life (an assumption based on the apparent brief occupation of the site and local origin of these tools), as well as type of use, have rendered these cobbles and flakes "unreadable".

None of the rough stone at the Michaud site shows wear patterns characteristic of hammer or anvil

Plate 3-17. Christian Hill diabase "core" tool.

stones, nor edge crushing as would be expected from chopping onto an anvil stone. It seems most likely, based on the relative hardness of most of the rocks in the rough stone category, and the lack of deeply inscribed wear patterns, that tasks of an abrading or smoothing nature were carried out with these stones, or that chopping or breaking of bone was accomplished without use of a stone anvil underneath the bone.

One specimen (23.12.0225) deserves an individual description (Plate 3-20). It is a cobble of green felsite probably related to the Kineo Traveler series but lighter in color and displaying fewer phenocrysts. Flakes have been removed from both ends and two sides. Deeply inscribed lines as would, for example, be expected from grinding a biface edge to prepare a striking platform are evident along a ridge between the original cobble surface and the rough area where a flake has been removed. Polish is evident on the "high spots" along the length of this roughened area. Two shallow, highly polished grooves are evident on one end of the cobble, while another slight depression on the surface on the side above the incised lines also shows high polish. It is evident that this piece was used for a variety of abrading tasks.

A range of grit sizes is available among the different abrading stone specimens (Plate 3-21), suitable for a sequence of abrading tasks from rough to fine or, alternatively for tasks requiring different rates of abrasion.

Pigment

Mineral substances which are assumed to have been used as pigment have been recovered from a number of Paleoindian sites, notably the Lindenmeier site (Wilmsen and Roberts 1984), Agate Basin (Frison and Stanford 1982), the Debert site (MacDonald 1985), Bull Brook and Bull Brook II (Grimes et al. 1984).

A total of 61 pieces of hematite and 8 pieces of ocher were recovered at Lindenmeier. Although the ocher was in a "crumbly state" (Wilmsen and Roberts 1984: 126), all of the pieces of hematite showed evidence of grinding. Of particular interest, coarse grinding stones of sandstone were recovered in association with these minerals, with pigment residues retained on many specimens.

The Debert site yielded 690 grams of pyrolusite, a soft gray-black mineral commonly found in the Minas Basin area (MacDonald 1985:107). The occurrence of this substance in one isolated locus supports the assumption that its presence is cultural. None of the nodules showed evidence of abrasion; however, MacDonald notes that the mineral has a tendency to decompose in acidic soils like those in the Debert site vicinity.

Nodules of graphite, a mineral similar to pyrolusite, were present at both Bull Brook and Bull Brook II (Grimes et al. 1984). Grimes notes that although the nodules from Bull Brook II were "somewhat eroded, several bear indication of direct abrasion against another substance". In the same reference Grimes mentions that a

number of the graphite nodules at Bull Brook are clearly faceted.

A total of 4.9 grams of small (0.1 grams to 1.6 grams) nodules of red ocher were collected at the Michaud site. As most were recovered in-situ from one locus, it seems plausible that these nodules were used as a source of pigment.

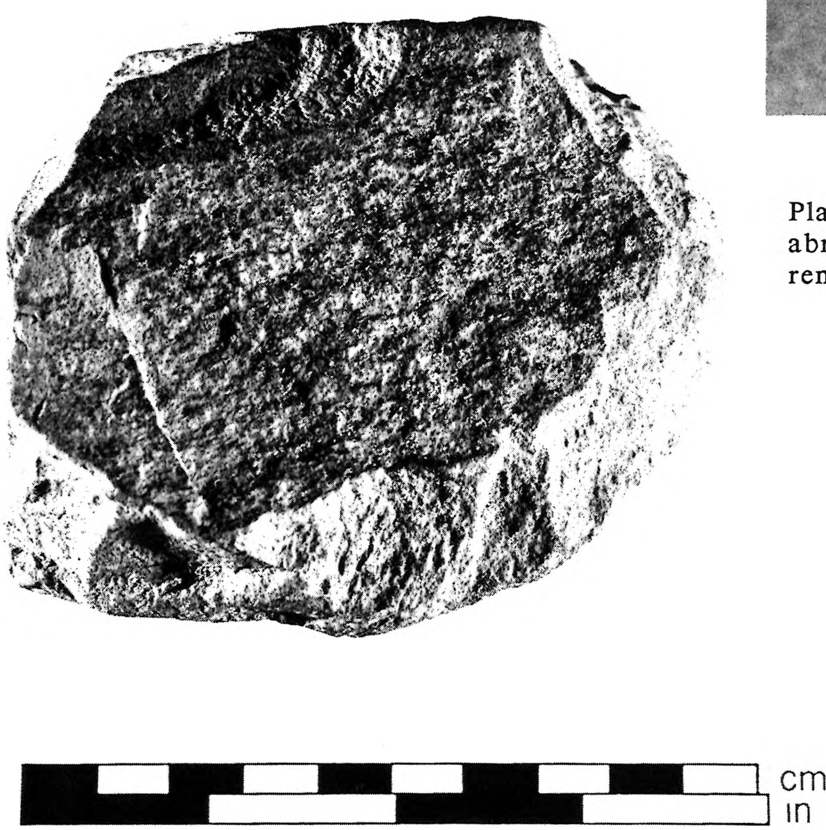


Plate 3-18. Christian Hill diabase "core" tool with blunt, sinuous edge.

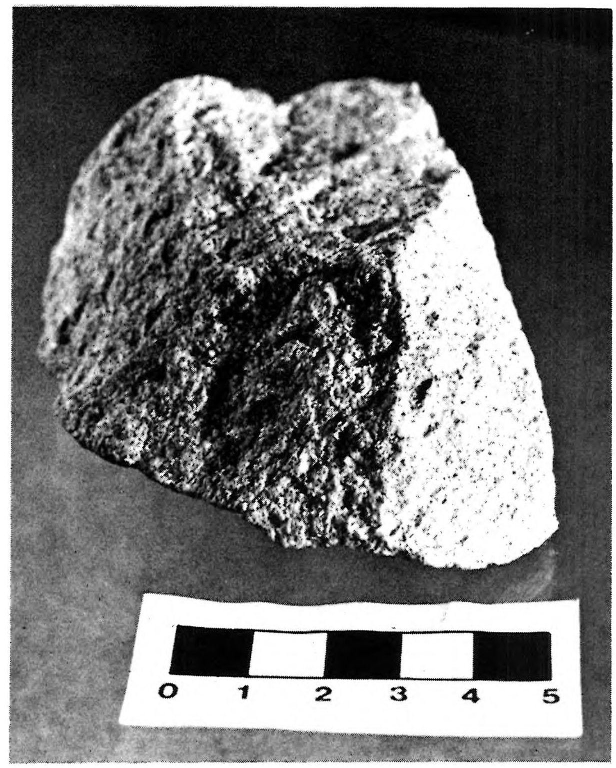


Plate 3-21. Medium-coarse grit probable abrading stone, with evidence of flake removal.

Plate 3-19. Christian Hill diabase "core" tool.

Plate 3-20. Green felsite "core" tool. Abrasion marks are visible along lower right hand edge of cobble cortex at intersection with flaked surface.

CHAPTER FOUR

FEATURES, CHARCOAL, RADIOCARBON DATES, BONE AND THE BOG CORE

This chapter is designed to present data on non-lithic material recovered from the Michaud site. It includes the only "architectural" information from the site: descriptions of three features that are likely to be Paleoindian in age.

PALEOINDIAN FEATURES

We had recorded forty soil discoloration features before realizing that those associated with bright soil colors were relatively recent in date, being associated with burned or rotten tree roots (see Chapter 1). Thereafter, thirty-seven such features were excluded from further consideration since they were no longer considered to be of human origin, which left three (Features 7, 8 and 21) as possible Paleoindian features (Figure 4-1). Two, Features 8 and 21, fell inside the largest flake and artifact concentration at the Michaud site. Feature 7, the best preserved candidate for a Paleoindian hearth, lay between two flake/artifact concentrations, but was closely adjacent to one of these two concentrations.

Feature 7 was recognized early in the excavation as a dark charcoal-flecked stain in the B2 soil horizon along the border between two squares, N22E48 and N24E48. Subdivision designations were assigned to each part of the bilobate stain (Figure 4-2). Feature 7a was originally noticed in the NW 1/4 of the NE quadrant of N22E48 at about 9 cm below the soil surface, which was a B1 soil. Feature 7b was recognized in the SE quarter of the SE quadrant of N24E48. At a depth of 9 cm, each feature subdivision was recognizable as a dark--stained (grey) core surrounded by a "halo" of lighter grey soil. The "halos" of both the 7a and 7b darker cores joined at the 9 cm level.

Excavation proceeded in vertical and horizontal section, under the expectation that two possible forms of disturbance, soil movement and contamination by later charcoal through soil turbation, would decrease with greater depth. The darker feature centers were excavated first, and all the dark grey (10YR 5/3) soil was retained for future laboratory processing (approximately 20 quarts). Charcoal lumps and flecks were noted in the sand, the largest being 1 x 1 x 3 mm. Average size was about 1 mm^3. At depths of 14-18 cm, a few larger (4 mm length) lumps were encountered. No calcined bone or lithic material was recovered from the feature fill. In fact, the closest concentration of cultural debris, mostly uniface resharpening flakes of Cegl and Cr1, small fragments of diabase, and approximately 27 small fragments of red ocher, was located 1-2 meters northwest of Feature 7 (see Figure 6-1). The charcoal was a mixture of wood charcoal and a frothy, or resinous, charred material.

The margins of the dark grey stain were marked by earthworm holes: visible mottling of the 10YR 5/4 and surrounding "yellow" B2 or C soil horizons as the earthworms had moved soil particles horizontally. This bioturbation had created a boundary zone several centimeters thick rather than a sharply defined pit edge. The pit base was encountered approximately 27 cm below the soil surface datum (18 cm below the elevation at which the feature had been recognized). It is very important to note that there was no charcoal present in the surrounding B2 and C soil horizons outside the light grey (10YR5/4) halo. Thus, the charcoal was in excellent association with the pit-shaped feature.

The pit turned out to be roughly bi-lobate

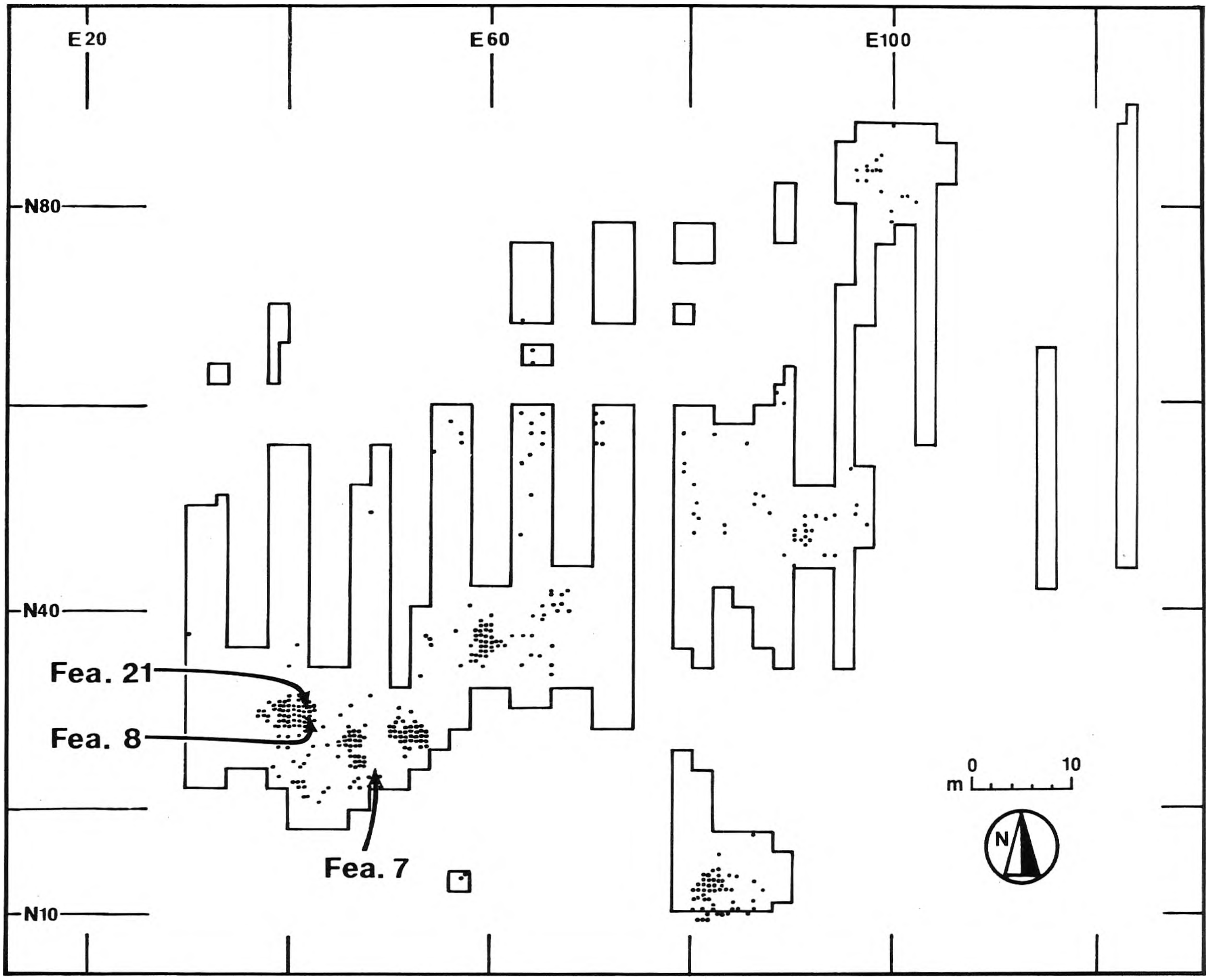


Figure 4-1. Locations of probable Paleoindian hearth features relative to artifact and flake concentraions. Each dot represents an excavation unit (quadrangle) with one or more tools or flakes.

in plan view, with a long axis running NE-SW. We excavated a profile NW-SE across the center of Feature 7b (Figure 4-3), which revealed that the pit had a very steep, almost undercut eastern wall. Feature 7 was a steep-sided, elliptical basin. The depths of feature 7a exhibited two deep conical pit bases connected by a more shallow shelf. We interpret Feature 7a and 7b as a pit hearth, dug in the sand by hand or with a small scoop-like tool, probably from the western side, creating a steep southeastern wall and a shallower western wall.

Feature 8 was located in the NW 1/4 of the NE quad and the NE 1/4 of the NW quad of N28E40. It appeared as a grayish tinge in the B2 and C soil horizon sand, and was associated with a visibly increased charcoal incidence compared with the surrounding sand. It was an elongated (possibly bilobate) ellipse, very similar in shape to Feature 7a and 7b. Unfortunately, the margins were not as clearly defined.

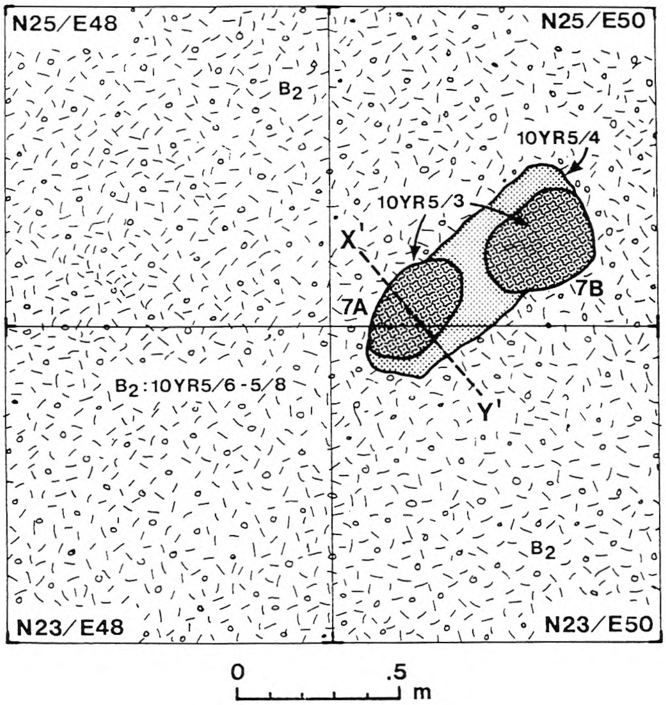


Figure 4-2. Plan view of Feature 7 at top of B_2 horizon sands.

Feature 21 occurred on the square margin in the eastern halves of N28E40 and N30E40. It appeared as a darker charcoal--containing stain in the B2 horizon soils. The feature was about 70 cm maximum diameter NE to SW, with maximum width 30-40 cm. The north end of the feature had been cut by a definite rodent burrow (of approximate chipmunk diameter).

The contents of Features 8 and 21 comprised numerous lithic waste flakes of the cherts dominant in the rest of Concentration I. No heat-related characteristics, such as pot-lidding or fracturing, were evident to separate these flakes from the rest of the Concentration I assemblage. Although several "coarse" rocks displaying reddened surfaces characteristic of heating were found within Features 8 and 21, other coarse rocks were recovered outside of the feature margins, suggesting that these rocks were probably not structural components of the features.

These three features were clearly similar in dimension and in construction, all being elliptical or bilobate shallow basins. Where orientation and margins were most certain, a NE to SW long axis of each feature was recorded. The oblong shape of the pits was consistent, but whether that shape represents an accommodation to the size of the fuel supply, or an attempt to control draft (perpendicular or parallel with prevailing wind?), or some other factor, is unknown.

It is notable that there were no features similar to these three elsewhere on the site. With the exception of a few disturbed areas, such features would have been detected if they were present. Especially so, since Feature 7a-b was recorded early in the excavation and we subsequently watched for such features. It may also be significant that the three features were discovered at the western margin of the site where certain kinds of raw material are dominant in the activity areas near the hearths. Other materials are dominant in activity areas elsewhere on the site. We will explore this topic further in

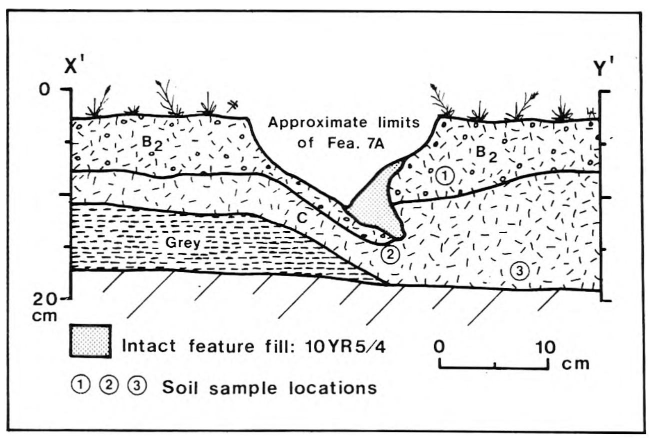


Figure 4-3. Cross section of Feature 7A (x-y on Figure 4-2) taken after partial excavation of the fill of Feature 7A. Note the steep eastern pit margin and the sloping western margin.

TABLE 4-1. Attributes of various features from the Michaud site.

FEATURE/ PROVINCE	SOIL SAMPLE NUMBER	CHARCOAL SAMPLE NUMBER	TOTAL SOIL VOLUME	CHARCOAL VOLUME	RADIOCARBON DATE	OTHER
7a lighter grey	90281	---	2,200 ml	11 ml	----	charred pitch and wood charcoal
7a center of feature	90258	80045(coarse) 80046(fine)	800 ml	4 ml	Beta-15,660 10,200+-200	all wood charcoal
7b center of feature	90280	80047(coarse) 80048(fine)	1,750 ml	10 ml(3.2 gr) 2 ml(0.8 gr)		wood charcoal, charred pitch, or fat
7a lighter grey margin	-----	23.12 Fea 7(1)	2,000 ml	? (3.0 gr)	Beta-13,833 9010+-210	wood charcoal and burned pitch
8	90278		3,000 ml(')	90 ml	----	See Table 5-2
7a light or grey	90282	----	3,500 ml	12 ml		
7a + b (between)	90283	----	2,300	5 m.		

the horizontal patterning section (Chapter 5).

CHARCOAL

Bulk feature fill samples were processed in the laboratory for charred plant material by placing the feature fill on a window screen (1 mm mesh) and washing gently with running water. By far the vast majority of the sample bulk was silty fine sand. Also passing through the mesh was a very small volume of powdered charcoal, and some fine particles of charred plant material. All the material passing through the screen was collected in a small childrens' plastic swimming pool (3 foot diameter), and rescreened several times to recover charcoal bits with maximum dimension greater than 1 mm. One attempt was made to float a sample in super-saturated salt brine. More charcoal was recovered than during the first washing of soil through the window screen, but recovery in the brine was not sufficiently improved over the multiple washings through window screen to indicate its further use.

Subsequently, charcoal samples were examined under a dissecting microscope (to 20x magnification), and remaining pieces of mineral (sand or mica) and any uncharred plant matter were removed by hand. Sample volumes and weights for extracted charcoal from several feature fill samples are presented in Table 4-1.

The charcoal content of Feature 7 (Table 4-1) was approximately 5% by volume, but there is evidence from the radiocarbon dates that not all of that volume dates to the Paleoindian period.

TABLE 4-2. Feature 8 Contents, Soil Sample 90278.

Volume	
40%	Charred pitch (?) frothy.
20%	unoxidized plant root and root bark.
20%	Charred wood charcoal.
True	Wood charred with partially oxidized patches - rotten lighter brown color.
True	Small round fungal fruiting bodies or seed, some partially charred.
5%	Chert microflakes, Cr1 and Ceg1
True	Partially charred seed (? coniferous nut)
10%	Remaining mineral

Feature 8 (Table 4-2) yielded a much higher percentage of charcoal volume to soil volume, but its contents do not all date to the Paleoindian occupation. About 40% of the Feature 8 fill that remained on the window screen was a charred frothy substance interpreted as burned conifer pitch. One-fifth of the residue was unoxidized plant root fragments. A few percent of the wood charcoal pieces in the sample exhibited patches of light brown, softer material that appeared to be incompletely oxidized (and rotting) wood, apparently the remains of a burned tree stump of recent date.

Mrs. Dosia Laeyendecker, Department of Anthropology, Smithsonian Institution, kindly consented to examine the small pieces of charcoal which were recovered from the feature fill. Although specific identifications were impossible on the small charcoal chunks in these samples, the contents of several of the features produced some interesting specimens. Charcoal sample 23.12.80045, from Feature 7a, contained pieces identifiable as a coniferous species and pieces identifiable as a hardwood species. Sample 23.12.80047 yielded charcoal fragments of a charred berry, as well as charred frothy non-charcoal material. The high proportion of the same frothy material in the Feature 8 fill, which is clearly contaminated by modern (partially oxidized) wood, tends to support the hypothesis that this material is a more recent charred vegetable matter, such as pine pitch.

The berry fragment cannot be identified further. We suggest that, even if it dates to the Paleoindian use of Feature 7, it need not indicate fall seasonal use of ripe berry resources for food. Berry fragments can overwinter when covered with snow in a low, thick vegetation mat. Such berries are even desirable to eat as they begin to ferment in the early summer (based upon personal observation in Labrador).

In sum, the Feature 7 charcoal preserves evidence of a wooded and brushy environment on or near the site during Paleoindian occupation, including both hardwood and softwood species.

RADIOCARBON DATES

Charcoal sample number 23.12 Fea7 (1) consisted of 3.0 grams of wood charcoal and some burned, frothy material described by Spiess as pitch on the radiocarbon submission form. The sample came from the lighter grey margin around Feature 7a, and, recovered early in the site excavation, was submitted expeditiously to Beta Analytic. Pretreatment consisted of hand removal of uncharred grass rootlets, then sequential boiling in acid-alkali-acid solutions. The synthesis and radiocarbon counting that followed went normally (Murray Tamers personal communication 9/18/85). The radiocarbon date was reported as 9010 +-210 B.P. (Beta-13,833).

After the field season, charcoal sample 23.12.80046 was submitted, which consisted of 0.8 grams of wood charcoal with minor rootlet penetration by modern grass. This

sample came from soil excavated from the very darkest, central portion of Feature 7a at a depth of 14 to 18 cm below the surface. Microscopic examination of the sample prior to submission ensured that it was clean of any of the frothy, burned material (pitch?) that was suspected of causing contamination of the first radiocarbon sample. This sample was pretreated by the laboratory in the same way as the previous sample, with manual rootlet removal and standard acid-alkali-acid boiling. Extended counting time was purchased to reduce the standard error, because the sample was small for a standard radiocarbon date (only 0.4 gr charcoal surviving pretreatment). The sample yielded 0.1 gr carbon, an absolute minimum for a standard radiocarbon date, and produced a date of 10,200 +- 620 B.P. (Beta-15,660).

CALCINED BONE

The Michaud site excavation yielded 26 fragments of calcined bone weighing a total of 1.5 grams (Table 4-3). All pieces are more heavily eroded and fragmented, and therefore less likely to be identifiable, than the calcined bone from the Bull Brook and Whipple Paleoindian sites that has been identified (Spiess, Curran and Grimes 1985). Some of the factors controlling calcined bone identification are discussed in that reference. Essentially, calcination occurs in the heat of a wood fire in temperatures above 600 degrees centigrade, and results in bone shrinkage and fracture as it turns white. Calcined bone is much less resistant to stress fracture than is fresh bone, so that it breaks into small pieces with human passage or soil movement, among other variables. It is, however, more resistant to acid groundwater and bacterial action than is fresh bone, and tends to survive when fresh bone does not (Knight 1985).

The Michaud site calcined bone comes from only two areas of the site. Twenty--two pieces were found in the vicinity of N10E80 (Concentration VII-see Figure 6-2), all lying on the deflated ground surface with a large number of flakes, microflakes and a few artifacts. The spatial co--occurrence of this bone concentration and the flaked stone concentration supports the hypothesis that the bone is of Paleoindian age. The second group of calcined bones came from an area about 40 meters north of the first group (Concentration VI). One piece was found in-situ in B2 horizon soils in N46E90. Three more pieces were found in bulldozed soils pushed in to fill a drainage ditch that appeared in N58E64. This fill may have originated in the N50E90 area, or further west around N50E70. The distribution of the calcined bone in the second area is again congruent with a light scatter of flaked stone material, including flakes and artifacts pushed into the drainage ditch fill.

No calcined bone was recovered from the densest areas of lithic discard on the southwestern half of the site, and no calcined bone was recovered from any of the three probable Paleoindian hearths (Features 7, 8 and 21). We suspect that this absence of bone in the most concentrated lithic discard areas may be due to some factor of preservation, since the calcined bone that was recovered on the site was rare, highly fragmented, and extremely heavily eroded.

The calcined bone can only be positively identified as mammal bone, based on the structure of the bone cortex and the trabeculae occasionally preserved on its interior surface. Two pieces are definitely from large or medium-sized mammals (beaver, wolf, or larger) based on bone cortical thickness alone. Four of the pieces exhibit a fine-grained, parallel trabecular structure that Spiess has come to associate with cervid antler. Since there may be other possibilities for such structure in small or medium-sized mammals, however, the identification as cervid antler on these very small fragments cannot be conclusive.

The impression, however, is of a calcined bone assemblage similar to that from the Bull Brook and Whipple sites (Spiess, Grimes and Curran 1985), which were dominated by large mammal bone, some of which has been identified as caribou (*Rangifer tarandus*). It is possible that the Michaud collection of calcined bone can be accounted for by this single

TABLE 4-3. Calcined Bone from the Michaud Site

Sample	Provenience	Weight	Number	Identification
70052	N10E80 SEq,Surface	0.2 gr.	6	Mammal bone cortex, one may be an antler fragment based on be structure: small, parallel trabeculae.
70052	N10E80 over bank edge	0.4 gr.	2	Mammal bone cortex, one may be antler based on bone structure.
70048	N10E80 NEq, Surface	0.1 gr.	3	Mammal bone cortex.
70046	N10-12E82-84, Surface	0.1 gr.	7	Mammal bone cortex, two may be antler fragments based on trabecular structure.
70049	N10E80 NEq, Surface	0.2 gr.	4	Mammal bone cortex.
70053	N58E64 SEq, Disturbed Soil	0.3 gr.	2	Mammal bone cortex, one is a large or medium-sized mammal with minimum bone cortex thickness about 1 cm.
70051	N58E64 SWq, Disturbed	0.1 gr.	1	Large or medium mammal bone cortex fragment, 0.4 cm. thick in its highly eroded state.
70045	N46E90 NEq, B2 Soil	0.1 gr.	1	Mammal bone cortex fragment.

species, although taphonomic factors and butchery pattern differences between animals of different body size may skew the faunal sample away from other species that were also hunted.

BEAVER BOG CORE

On February 14, 1986, we obtained a series of core samples to a depth of nearly 7 m under the frozen beaver bog in Moose Brook south of the Michaud site, using a 1" diameter piston core head attached to a series of steel rod sections. The sediments under the frozen surface of the beaver bog were water-logged, rock free, and either sandy or silty in general particle size.

Two different bore holes were used, 15 cm apart. From the first we obtained core sample 1 at 2.30 meters below surface, and core sample 2 at 3.44 meters below surface. From the second we obtained core sample 3 at 1.59 meters below surface, core sample 4 at 6.30 meters and core sample 5 at 6.76 meters. Thus, we obtained 5 bulk samples, each covering a vertical depth of 15 to 20 cm. Each core only represents 3% of the total 7 meter depth of sediment that post-dates the Presumpscot Transgression clay.

Visual descriptions of the samples when wet are presented in Table 4- 4. It should be noted that charcoal and plant macrofossils were present in all samples. Sample 5, the deepest, is clearly Presumpscot Formation clay. Forty centimeters above it (Sample 4) there is a high proportion of organic matter and a few shell fragments as might be expected on the surface of a marine, inshore clay. Granulometry data (Table 4-5) demonstrate that the silt and clay-sized particles are by far

Table 4.4. Beaver bog core sample contents.

Sample 1. Medium-dark grey, silty, fine sand with abundant wood fragments, and fragments of partially oxidized or oxidized plant parts, plus plant rootlets. Abundant mica flecks.

Sample 2. Dark grey, silty fine sand with high content of small mica flecks. Organic content lower than Sample 3. Apparently dark charcoal-like color caused in part by many fine flecks of black mica.

Sample 3. A dark charcoal grey, clayey, silty, very fine sand with high content of small mica flecks. Oxidized organic flecks (plant parts?) present. Possibly some are unoxidized macrofossils.

Sample 4. When wet, a dark grayish green, silty, clayey, very fine sand with a high proportion of particulate organic matter, including wood fragments, and a few pieces of what look like shell fragments.

Sample 5. Greenish-blue, very fine sandy, silty clay, with very fine mica flecks and occasional organic debris, including some unoxidized or poorly oxidized wood.

most common (85% by weight) in Sample 5 at 6.75 meters, the Presumpscot clay, and that they are less frequent (56%) in Sample 4. The upper three samples are dominated by sand.

Charcoal derived from Sample 4 (6.30 m depth) returned a date of 9630+- 140 B.P. (Beta-16122). This date indicates that the sediment approximately 1/2 meter above the terminal Pleistocene clay was collecting wood charcoal during the Pleistocene--Holocene interface, or during the first few centuries of the Holocene. Precise contemporaneity of Sample 4 with the Paleoindian occupation is unlikely, although the uncertainties of radiocarbon dating leave it a remote possibility. Because sample 4 documents a level with a clay and sand content intermediate between the samples above and below, and because of the lack of resolution of change over time imposed by the small bulk core samples, the exact depositional nature of Sample 4 sediments is unknown.

Our initial interpretation is that the valley filled rapidly with sand derived from adjoining valley slopes beginning at some point following the retreat of the marine transgression. It may be that Sample 4 represents a portion of the first depositional events in the sequence.

The charcoal and plant macrofossils were sent to Dosia Laeyendecker at the Smithsonian Institution for identification. All of the pieces were too small for specific identification, although all five samples contained wood from one or more coniferous species not further identifiable. Samples 3 (3.44 m.) and 4 (6.30 m.) contained wood that might be from a hardwood species as well.

Irene Good Beckwith, Dept. of Archaeology at Boston University, provided preliminary pollen identifications for samples 1 (2.30 m), 3(1.59 m) and 4 (6.30 m) (Table 4-6). Sample 2 yielded an insufficient pollen sample. It also exhibits the highest proportion of very fine sand of any of the sediment samples, possibly indicative of a more rapid sedimentation rate than earlier and later samples, and a low pollen content per volume.

All three samples are characterized by a high count of *Lycopodium* spores, and birch and Haploxlon pine (white pine) pollen. Differences among the three

Table 4-5. 23.12/13 Soil Core, February 14, 1986, soil granulometry and organic content for each size fraction.

SCREEN SIZE AND CONTENTS
% OF INORGANIC

SAMPLE#/DEPTH	#18/1,000U.	#60/250 U. FINE SAND	#140/105 U. VERY FINE SAND	#270/53 U. SILT	LESS THAN 53 U. CLAY
1. 2.30 meters	0.2 gr. organics	0.2 gr. organics			
(63.1 gr. mineral)	0%	28.2 gr. 44.7%	27.8 gr. 44.1%	5.5 gr. 8.7%	1.6 gr. 2.5%
2. 3.44 meters	0.1 gr. organics	<0.1 gr. organics			
(46.7 gr. mineral)	0%	6.5 gr. 13.9%	34.8 gr. 74.5%	4.6 gr. 9.9%	0.8 gr. 1.7%
3. 1.59 meters	0.1 gr. organics	<0.1 gr. organics			
(32.7 gr. mineral)	0%	9.2 gr. 28.1%	18.6 gr. 56.9%	4.0 gr. 12.2%	0.9 gr. 2.8%
4. 6.30 meters	0.1 gr. organics	0.2 gr. organics			
(18.5 gr. mineral)	0%	1.7 gr. 9.2%	6.4 gr. 34.6%	7.4 gr. 40%	3.0 gr. 16.2%
5. 6.75 meters	<0.1 gr. organics	0.1 gr. mica			
(35.8 gr. mineral)	0%	0%	5.2 gr. 14.5%	21.8 gr. 60.9%	8.8 gr. 24.6%

Table 4-6. Pollen identifications for three soil samples from the Bog Core, provided by Irene Good Beckwith. Number of pollen grains.

	Sample 3 1.59 m	Sample 1 2.30 m	Sample 4 6.30 m
Betula	50	36	42
Pinus (Haploxlon)	47	74	59
Picea	35	33	10
High Spine Compositae	1	6	14
Abies balsaminea	4	2	0
Graminae	6	4	5
Populus	10	3	2
Quercus	5	6	4
Castanea	2	1	0
Alnus	7	6	31
Salix	1	1	3
Corylus	8	15	1
Chenopodeaceae	0	6	3
Myrica	0	2	4
Acer	1	0	3
Fagus	0	0	4
Sphagnum	0	0	1
Ulmus	0	0	1
Celtis	0	0	2
Lycopodium	401	161	177

CHAPTER FIVE

SPATIAL DISTRIBUTIONS

The Michaud Site is a presumed single component site in which minimal vertical sorting occurred through frost action, tree throws, animal burrowing, and bioturbation. Horizontal disturbance is limited, with small portions of the site displaced by bulldozing and deflated by blow-out of the devegetated sandy surface. Since a small number of tools and flakes were recovered, with a large percentage in-situ, we had an opportunity to assess the spatial dimensions of a Paleoindian site to a much finer degree of resolution than is usually reported.

Nine identifiable material culture concentrations are visible in the distribution of all tools, flakes and microflakes from the site. The artifacts include specimens of chert and Neponset rhyolite plus coarse diabase tools, flakes and shatter (Figure 5-1). Artifacts recovered in-situ (Figure 5-2) and those from disturbed contexts or surface collection (Figure 5-3) group well within the concentrations defined in Figure 5-1. Examination of the distribution data presented below shows that there is significant variability among the concentrations in terms of raw material utilization, flake to microflake ratio within some materials, and functional types of stone tools represented (Tables 5-1 through 5-5). We here present a description of each concentration, followed by a discussion of the probable relationships between concentrations.

CONCENTRATION I

Concentration I was located between E36-E44 and N20-N32 (Figure 5-4), and covered an area approximately 8 m x 12 m. The northern portion of this area was characterized by a very high concentration of tools, flakes, and microflakes and a number of pieces of coarse stone. The southern section of Concentration I contained a light scattering of material blown out, or otherwise displaced from the northern area. Features 8 and 21, oblong, bilobate gray-brown lenses containing much charcoal, were located at about the center of the northern portion of the concentration (in squares N28E40 and N30E40).

Artifacts recovered from this concentration include four fluted points and fragments and four fluted point preform fragments (see Tables 5-1 and 5- 2). Interestingly, all of the fluted points were made from red Munsungun chert, while the broken preforms were all made from grey-green patinated chert like that found at the Bull Brook site. The four fluted points were all broken: one was whole except for a missing tip; one was reconstructed from distal and proximal portions which had been transversely snapped, but again the tip was missing; one was a distal half with the tip missing; and one was simply a basal ear which did not match any of the other points. All of the specimens had been resharpened to some degree, and were probably being replaced at the end of their use-life. A total of 10 channel flakes were recovered in Concentration I, nine of which were not modified or utilized and one of which had a graver spur worked on a lateral corner of a medial break. All three limaces present at the site were located in this concentration, along with two end-scrapers, one concave scraper, and a number of retouched and utilized flakes.

Several significant observations resulted from visual inspection of the artifacts as they were laid out in correct provenience on a large scale plan. It was apparent that Concentration I was an area where tool replacement had been carried

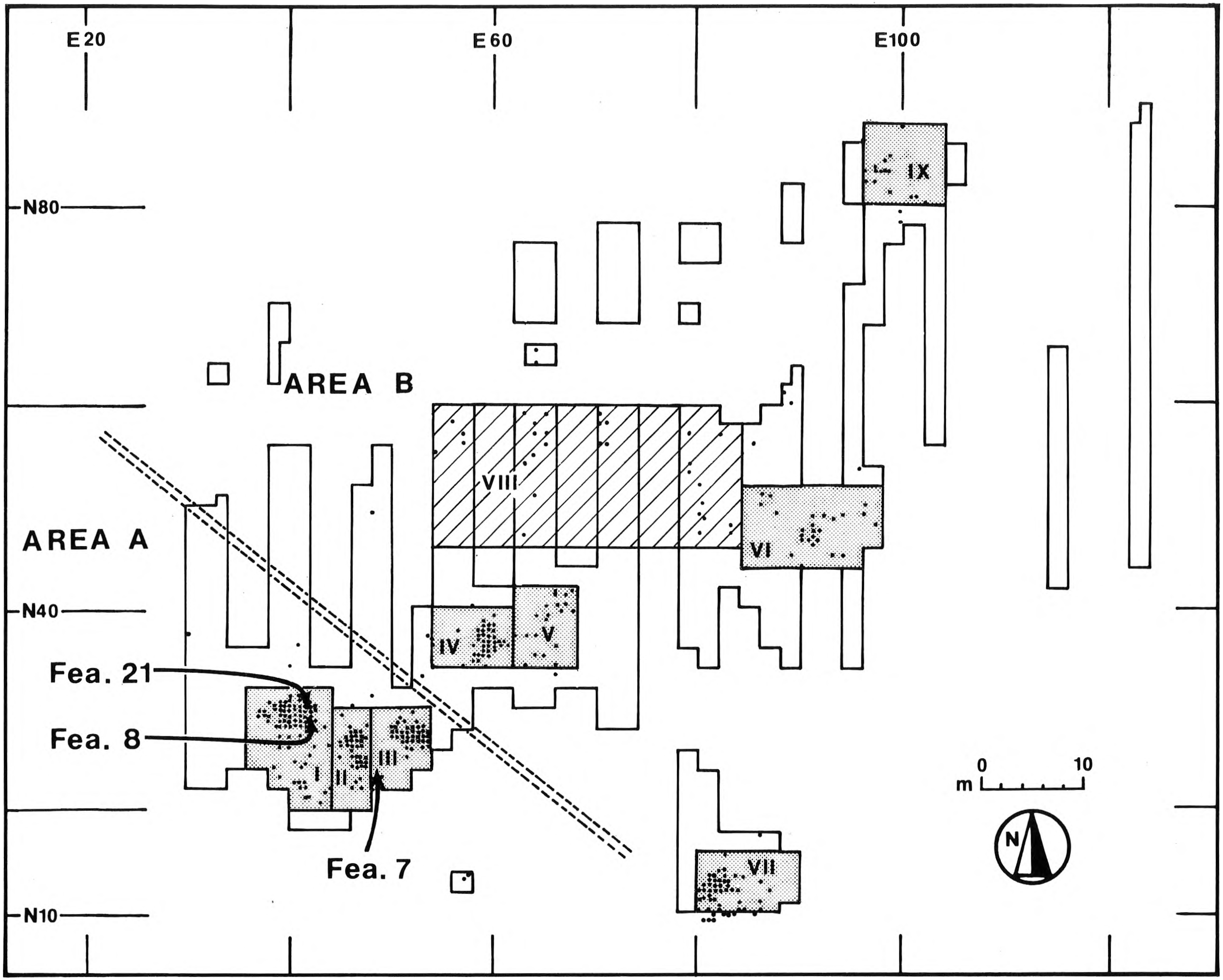


Figure 5-1. Dots locate all quadrangles with (a) flakes(s), microflake(s), or artifact(s). The limits of concentrations I - IX are shown. Concentration VIII, shown crosshatched, represents ex-situ material derived from concentrations IV, V, VI, and/or a totally obliterated concentration.

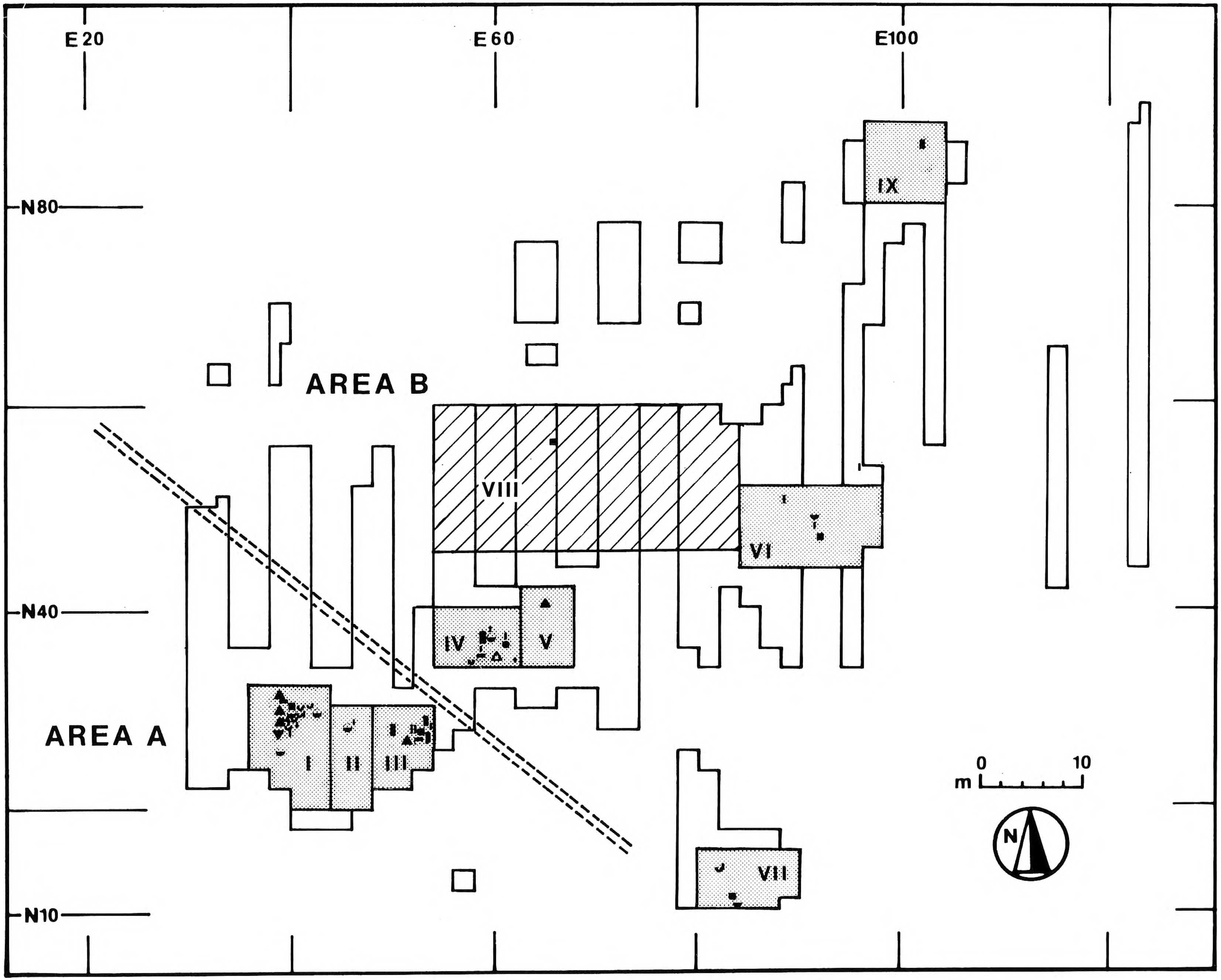


Figure 5-2. In-situ artifacts shown relative to the 9 concentrations. Symbols are similar to those used in Figures 5-4 through 5-7.

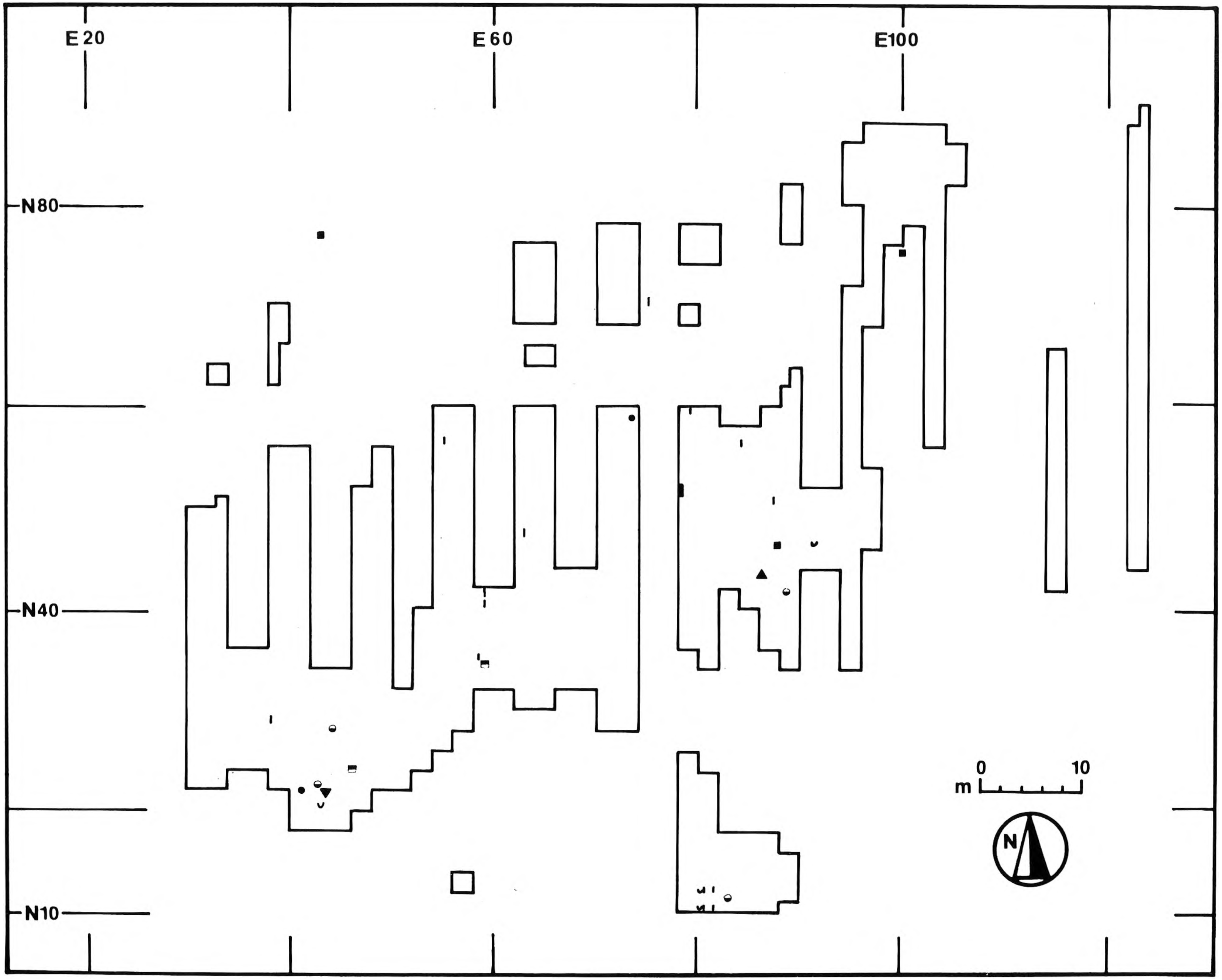


Figure 5-3. Ex-situ tool distributions.

Table 5-1. Counts of artifact types for each Concentration.

CONCENTRATION	I	II	III	IV	V	VI	VII	VIII	IX
Artifact Type									
Fluted point, # fragment	4	0	1	1	1	1	0	1	0
Biface preform	4	1	0	0	0	0	0	0	0
Channel flakes (number utilized)	10 (1)	0	0	4 (3)	1	3	4	0 (2)	0
Sidescraper	0	1	5	1	1	0	1	2	0
Endscraper	2	0	2	0	0	2	1	1	0
Concave Scraper	1	0	0	1	0	0	0	0	1
Scraper or uniface fragment	1	1	3	2	0	1	0	1	0
Limace	3	0	0	0	0	0	0	0	0
Retouched flake	3	0	1	4	0	1	1	0	0
Utilized flake	6	0	2	1	0	4	4	6	0
Tip (perforator or graver)	1	0	0	1	0	1	1	0	0
Combination perforator graver	0	0	0	2	0	0	0	0	0
Rough stone core, cobble tool	4	3	6	0	1	0	0	0	0
Rough stone, large flakes	9	4	1	7	2	0	0	4	0
Rough stone, shatter	109	108	13	118	3	11	0	16	0
Pigment, # pieces	0	0	48	0	0	0	3	0	0

Table 5-2. Artifacts listed by concentration.

Catalogue Number	Description	Material	Weight (grams)	Inferred Use on Soft, Medium or Hard Material
	TOOLS OF CONCENTRATION I			
00321	fluted point	Cr05	7.8	?undergoing resharpening
00377	fluted point tip	Cr05	3.1	projectile
00433	fluted point tip frag.	Cr05	2.0	joins .00321
00451	fluted point ear	Cr1	0.6	projectile
00643	fluted point	Cr1	7.3	projectile
01127	channel flake base	Ceg1	0.4	not utilized
01137	channel flake	Cr1	0.8	joins .00895
00597	channel flake	Cr05	0.4	not utilized
00610	channel flake	Ceg1	1.9	not utilized
00817	channel flake	Ceg1	1.0	not utilized
00895	channel flake	Ceg1	1.2	not utilized, joins .01137
00932	channel flake	Ceg1	1.1	not utilized
01076	channel flake	Ceg1	2.5	not utilized
01387	channel flake frag.	Cr05	1.5	not utilized
00330	biface preform	Ceg1	48.1	not utilized
00660	biface preform	Ceg1	13.7	not utilized
00661	biface preform	Ceg1	13.0	not utilized
01355	biface preform frag.	Ceg1	2.8	not utilized
00215	channel flake/graver	Ceg1	2.4	grave med. or soft material
00634	limace	Cb01	1.4	socket production?
01342	limace	Cr05	3.8	socket production?
None	limace	Ceg1	?.?	socket production
00586	endscraper	Ct01	3.8	scraping medium
00151	endscraper	Cr05	8.9	scraping medium
00335	concave scraper	Cr05	7.2	scraping medium
00814	retouched flake	Rfnp	0.4	cutting soft
00896	retouched flake frag.	Ceg1	0.4	scraping medium
00150	retouched flake	Cr05	8.9	scraping medium
01121	utilized flake	Ceg1	0.8	unknown
01158	utilized flake	Cr1	0.7	scraping ?
00209	utilized flake	Cr1	0.2	joins .00462
00462	utilized flake	Cr1	1.8	unknown
00471	utilized flake	Cr1	0.1	unknown
	TOOLS OF CONCENTRATION II			
01167	uniface frag.	Cr1	0.5	unknown
00488	sidescraper	Cr05	3.9	scraping ?soft
00152	biface preform frag	Cb01	3.6	
00153	utilized flake	Cb01	2.7	scraping medium
02798	biface preform frag	Cb01	4.3	
	TOOLS OF CONCENTRATION III			
02052	sidescraper	Ceg1	42.2	scraping, cutting soft
02193	endscraper	Cr05	3.6	scraping medium and ?hard
02209	sidescraper	Cr1	5.4	joins .02293, scraping soft

Table 5-2 con't

02214	endscraper	Cr05	2.8	unknown
02215	retouched flake	Cr1	0.9	unknown
02216	scraper fragment	Cr05	0.5	scraping soft, joins .02218, .02282
02218	sidescraper frag.	Cr05	2.1	joins .02216, .02282
02264	utilized flake frag.	Cr05	0.1	?joins .02322
02282	scraper frag.	Cr05	1.9	joins .02216,.02218
02293	sidescraper	Cr1	52.7	scraping soft, joins .02209
02302	utilized flake	Cr02	0.4	?cutting soft
02322	utilized flake	Cr05	4.3	scraping soft or medium
02159	fluted point ear	Rfnp	0.2	projectile, broken
	TOOLS OF CONCENTRATION IV			
01568	fluted point frag.	Sslt	1.5	projectile, broken
01590	retouched flake	Rfnp	13.1	scraping medium
01591	concave scraper	Rfnp	4.6	scraping medium or soft
01592	perforator	Rfnp	13.8	perforating
01700	sidescraper	Cr05	12.0	scraping soft
01801	retouched flake	Cr1	1.0	unknown
01803	channel flake	Cr1	1.3	not utilized?
01804	perforator on channel fl	Cbst	1.7	perforating, and scraping medium
01809	uniface frag.	Cr1	0.2	unknown
01814	retouched flake	Cr1	0.3	scraping medium
01816	channel flake frag.	Cr1	0.7	scraping and cutting medium
01820	utilized flake	Rfnp	0.9	?cutting soft
01828	retouched flake	Rfnp	2.7	scraping medium
01843	perforator, scraper	Rfnp	14.5	perforating, scraping medium
02314	channel flake	Cr05	0.6	scraping and cutting ?medium
02319	scraper frag.	Cr05	1.7	unknown
	TOOLS OF CONCENTRATION V			
00333	scraper frag.	Rfnp	3.4	scraping ?soft
00336	scraper frag.	Rfnp	0.9	used on medium material
00112	fluted point tip	Cb01	3.7	broken point, retouched
00130	utilized flake	Cr05	3.2	cutting soft
	TOOLS OF CONCENTRATION VI			
01748	utilized flake	Cb01	1.4	unknown
01749	utilized flake	Cr1	6.8	edge 1: cutting soft
				edge 2: cutting medium
02109	endscraper	Rfnp	3.4	edge 1: scraping medium
				edge 2: cutting or sawing medium
02329	retouched flake	Rfnp	2.0	scraping hard
02350	utilized flake	Rfnp	4.7	no use wear visible
02396	endscraper	Rfnp	10.8	cutting soft
02401	scraper frag.	Rfnp	0.8	scraping hard and medium
01974	fluted point tip	Rfnp	2.6	broken point
01818	graver/perforator	Cb01	2.4	perforating?, not utilized?
02367	channel flake	Rfnp	0.3	not utilized?
	TOOLS OF CONCENTRATION VII			
01396	utilized flake	Cr1	0.2	unknown
01397	utilized flake	Cr05	2.2	scraping or cutting medium
01398	channel flake frag.	Cr1	1.5	joins .01399,.01401
01399	channel flake frag.	Cr1	0.7	scraping medium
01401	channel flake frag.	Cr1	0.5	joins .01398, .01399

Table 5-2 con't

00006	utilized flake	Rfnp	1.7	scraping medium
02439	channel flake	Rfnp	0.6	unutilized?
02454	channel flake	Rfnp	0.3	joins .02439, .02498
02498	channel falke	Rfnp	0.3	joins .02439, .02454
02657	retouched flake	Rfnp	0.6	unutilized?
00087	channel flake	Cr1	3.1	scraping medium, cutting medium
01534	perforator/scraper	Cr1	7.7	perforating
01528	endscraper	Ct01	11.6	scraping medium, poss. hard also
01477	sidescraper	Ct01	7.2	scraping medium
01392	utilized flake frag.	Rfnp	1.7	scraping medium
01393	utilized flake frag.	Rfnp	0.5	joins .01392, .01394
01394	utilized flake frag.	Rfnp	0.3	joins .01392, .01393
02448	channel flake frag.	Rfnp	0.7	unknown
01580	utilized flake	Rfnp	5.6	scraping medium
		TOOLS OF CONCENTRATION VIII		
00308	sidescraper	Rfnp	8.4	heavily patinated
00632	utilized flake	Rfnp	11.7	scraping unknown
01447	utilized flake	Rfnp	3.4	scraping unknown
00126	uniface frag.	Rfnp	1.9	unknown
02325	utilzied flake	Rfnp	2.8	unknown
00289	sidescraper	Cr1	42.1	scraping soft, light use
00088	fluted point base	Cb01	7.1	broken projectile
01319	concave scraper	Cr05	10.8	scraping medium
00089	utilized flake	Cb01	4.5	cutting soft or medium
02204	utilzied flake	Ct01	5.3	cutting ?soft
00110	endscraper	Rfnp	3.8	scraping medium
00070	utilized flake	Rfnp	5.0	unknown
		TOOLS OF CONCENTRATION IX		
00086	concave scraper	Cr1	9.4	scraping medium
01582	sidescraper	Cr1	20.6	scraping soft
00090	endscraper	Cr1	4.6	scraping hard

out, as evidenced by the discarded broken fluted points and broken biface preforms, and that much of this activity had centered around a hearth (Feature 8/21). Several of the apparently spent artifacts (fluted points 23.12.321/.433, 23.12.377 and endscraper 23.12.151), all made from Munsungun chert, displayed linear fractures, often filled with a black, oxidized mineral, surface discoloration, and pot-lid fractures, indicating that these artifacts had been subjected to uncontrolled, intense heat. The endscraper was long, narrow, and exhibits bilateral notching, probably indicative of hafting (see Chapter Three discussion of endscraper hafting). We hypothesize that these artifacts were removed from their hafts near the fire of feature 8/21, and that possibly heat from the fire was utilized to help soften or remove some sort of mastic that had held them in their hafts (cf. Gould 1971).

Flakes and cores of coarse stone were recovered in abundance from Concentration I (Table 5-3). As previously mentioned, it is unclear to what use most of these specimens had been put at the Michaud Site since they lack "readable" edges and surfaces. We suggest that some of these specimens were used for an abrading function, including grinding biface edges for platform preparation. This usage is suggested by the green felsitic core recovered just south of Concentration II,

Table 5-3. Coarse rock (mostly diabase) distribution by size within concentrations. Number of specimens.

	Small (<25 gr)	Medium (25-300 gr)	Large (> 300 gr)
Concentration I	102	9	4
Concentration II	108	4	3
Concentration III	13	3	6
Concentration IV	118	7	0
Concentration V	3	2	1
Concentration VI	11	0	0
Concentration VII	0	0	0
Concentration VIII	16	4	0
Concentration IX	0	0	0
TOTALS	371	29	14

which showed abrasion striations and several highly polished surfaces. These tools may also have been used for grinding and polishing bone implements, as well as for chopping and/or splitting bone.

Our use-wear studies support the suggestion that many of the tools recovered from Concentration I may have been used in the replacement of armament. The limaces, for example, show wear at the tip and on the dorsal flake ridges, possibly indicating their use in a confined space such as a socket. The concave scraper and flake utilized on a concavity exhibit curvatures of 3 to 5 cm diameter, indicating that portions of the object being scraped had a diameter less than 3 to 5 cm. We surmise that a wooden spear shaft would fit these dimensions. Further, both endscrapers from Concentration I show wear patterns suggesting use on a medium hard substance, with edge damage correlating well with the experimental tool edges which had been used on wood. Making or modifying a haft for any stone tool may have been carried out with these scrapers, or they may have been simply removed from their hafts in an area where tool replacement was being carried out.

The debitage from Concentration I adds additional insight into the activities occurring in the vicinity of that concentration. Flakes and microflakes were sorted by material type. The microflakes, being of extremely small size (less than 7 mm in length), were not examined in detail. The flakes, however, were analyzed for type (uniface or biface), general size (see Table 5-5), and any other distinguishing characteristics.

Debitage from the heavily patinated chert (Cegl) like that used at the Bull Brook site dominated Concentration I. Of the 227 flakes recovered, only two were identified as uniface sharpening flakes. The rest were identified as biface thinning flakes, as evidenced by their ground, low angle (35-50 degree) striking platforms. Cegl flakes were of moderate size, about 16 x 10.5 x 1.6 mm average, although they ranged in size from tiny microflakes to a moderately large specimen (28.8 x 19.2 x 2.8 mm). Most flakes had fairly well-developed bulbs of percussion, indicating that they were probably struck by soft-hammer percussion. Because no primary debitage such as quarry fragments, angular pieces, or chunky pieces were recovered, it is suggested that this material was brought to the Michaud site as large flakes of appropriate size and shape to be napped into a fluted point with very little waste. A flake origin of these preforms is also suggested by the form of the early stage specimen from this concen-

Table 5-4. Numbers and weights (in grams) of various raw materials recovered in each concentration, divided into tools, flakes, and microflakes. The data are reported as follows: number/weight.

Concentration		Other	Ceg1	Cb01	Cr1	Cr02	Cr03	Cr04	Cr05	Ct01	Rfnp
I	tools	2/0.2	11/88.2	1/1.4	3/10.3				10/70.4	1/3.8	1/0.4
	flakes		250/43.1	33/7.5	173/26.7	7/2.4	43/35.3	8/2.0	58/8.9	14/1.2	
	microflakes		1167/30.4	143/3.8	979/31.9		1/0.1	3/0.6	203/6.7	54/1.4	
II	tools		31/10.5	1/0.5				1/3.9			
	flakes		86/15.2	26/6.1	34/4.4		2/0.2	3/1.0		2/1.1	
	microflakes		203/6.1	30/0.6	187/3.4				25/0.5	2/0.6	
III	tools		2/65.8		4/81.3	1/0.4		7/15.2		1/0.2	
	flakes		94/27.7	4/0.5	12/2.1		4/0.4			3/0.7	
	microflakes		273/4.6	11/0.6	130/2.3				27/0.5	20/0.5	
IV	tools	2/3.2			5/3.8			1/1.7	2/12.6		6/49.6
	flakes			1/0.1	5/3.6		1/0.3		5/2.1		205/108.0
	microflakes			7/0.3	20/0.4					1/0.5	433/19.7
V	tools			1/3.7					1/3.2		3/4.0
	flakes			1/0.1	9/10.5		1/1.5	1/0.6	10/4.0		3/1.5
	microflakes				2/0.1						
VI	tools			2/3.8	1/6.8						7/24.7
	flakes				2/1.4				1/0.3	1/0.3	72/75.8
	microflakes				3/0.1					2/0.1	54/0.8
VII	tools				5/21.9				1/2.2	2/18.8	5/5.5
	flakes				2/2.4						368/115.2
	microflakes			3/0.1	3/0.1					7/0.2	181/3.5
VIII	tools			2/11.6	1/42.1				1/10.8	1/5.3	7/79.1
	flakes			1/0.3	4/2.9				1/0.3	1/0.2	32/46.9
	microflakes	not fine screened									
IX	tools	1/2.1			3/34.6						2/0.2
	flakes				6/0.4						24/2.5
	microflakes			8/0.2							24/2.5
Not in defined concentration		1/2.1	1/2.9	3/9.9	1/2.4					1/2.5	2/17.8
Total tools		4/3.5	13/154.0	12/40.9	24/203.7	1/0.4		1/1.7	24/120.8	5/30.4	32/181.3
Total flakes			430/86.0	66/14.6	247/54/4	7/2.4	51/37.7	12/3.6	75/21.0	21/3.5	704/347.6
Total Microflakes			1643/41.1	202/5.6	1321/38.4		1/0.1	3/0.6	255/7.6	86/2.8	692/17.6
Total weight for each material		3.5	273.6	61.1	296.4	2.8	37.8	6.5	149.4	36.7	546.5

Table 5-5. Average weight (in grams) of chert and Neponset rhyolite flakes by concentration. Asterisk indicates small sample size (n<4).

Concentration	Ceg1	Cb01	Cr1	Cr02	Cr03	Cr04	Cr05	Ct01	Rfnp
I	0.17	0.23	0.16	0.34	0.82	0.25	0.25	0.10	
II	0.18	0.23	0.10		0.10*	0.33		0.60	
III	0.30	0.13	0.18		0.10			0.20*	
IV	0.10*	0.10	0.72		0.30*				0.53
V	0.10*	0.10*	1.50		1.50*	0.60*	0.42		0.50*
VI	0.25		0.70				0.30*	0.30*	1.10
VII									0.31
VIII	0.10*	0.30	0.9*				0.30*		1.46
IX									0.10

tration (23.12.330), although, since the striking platform is absent on all specimens, the core type is indeterminable. Since ten channel flakes were recovered from this concentration, and two channel flake fragments belong to a single broken fluted preform, it is likely that at least one and probably several finished fluted point(s) of Bull Brook-like chert was (were) carried off the site.

Approximately eight of the Cegl biface thinning flakes displayed heavily ground dorsal surfaces, with striations occurring on several. Significantly, several of these specimens were also recovered from Concentration III. Because several of the specimens from Concentration I refit to each other, it was apparent that this use-wear occurred prior to the flaking episode, suggesting that the preform had been utilized before the final flaking episode. The apparent grinding use of this surface is unusual, and may parallel the use of some of the coarse diabase.

Only a small number (33) of black chert (Cb01) flakes were recovered in Concentration I. They do not display a well-developed bulb of percussion, but rather appear to be the result of early stage reduction from a large biface core. Extreme arris polish was noted on all old flake surfaces, suggesting that the "core" may have been carried for some distance in a pouch of some sort, perhaps being reduced in stages as time allowed.

A moderate number (43) of biface thinning flakes of brown chert (Cr03) were recovered from both sides and the middle of the feature in Concentration I. All are large and extremely thin, displaying ground striking platforms and small bulbs of percussion indicating soft-hammer removal. As no microflakes or channel flakes were recovered, it seems likely that here again we have an instance of a stage of reduction that did not lead to an end product on-site. Two of these flakes were utilized, but so many were unutilized that it seems unlikely that the purpose of the removals was to produce usable flakes. This chert has been identified in thin section as a variety of Munsungun chert (Pollock personal communication 1987).

"Classic" red and red and green Munsungun chert debitage also supports the hypothesis that fluted point manufacture may have been a several step process. Two red and green Munsungun chert (Cr05) channel flakes were recovered from Concentration I, accompanied by only a small amount of debitage, with a numerically large proportion of this represented by microflakes from final finishing or resharpening. The general size of the red

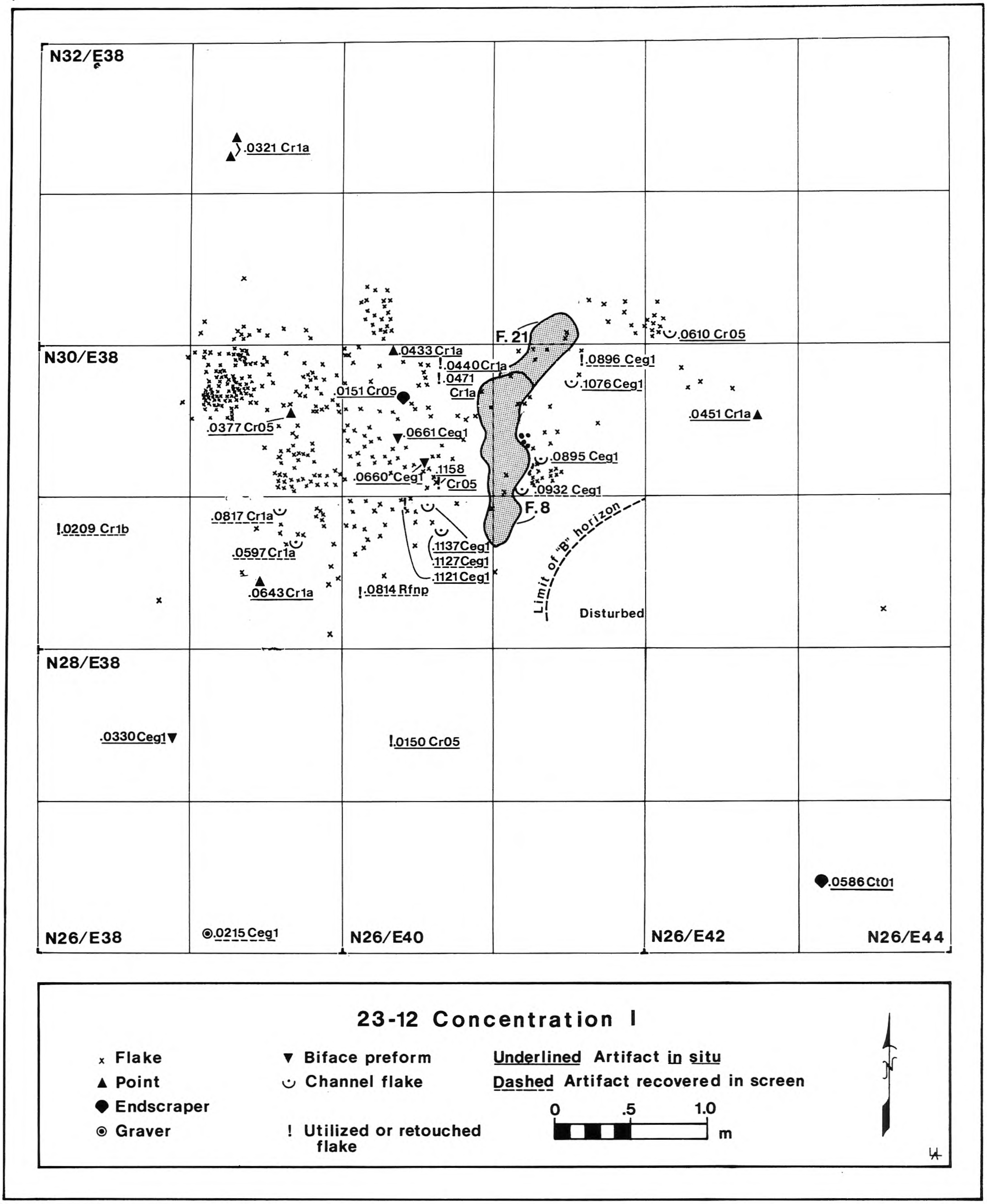


Figure 5-4. Tools and flakes with point provenience in Concentration I. All tools are shown on Figures 5-4 through 5-7 whether recovered in-situ or on the screen. Those recovered on the screen are located in their approximate provenance as the quarter quadrangle was being excavated. Only those flakes recovered in-situ and mapped in exact provenience are noted on these maps. The in-situ flakes represent a random sample of all flakes recovered from the concentration.

chert (Cr1) flakes was small, and only a single red chert channel flake was recovered. Fine details on the chert (including an occasional mottle, stripe, mineral pit, texture or luster variation) suggest that some of these flakes are resharpening flakes from fluted points or preforms which were being utilized before final finishing as fluted points, because the details of the debitage match variations in discarded tools present in Concentration I. Some flakes, on the other hand, appear to be the result of fluted point finishing.

Several possible patterns emerge from these data, any or all of which may be correct: 1) It may not have been standard procedure to create a fluted point from early stage biface preform to finished specimen in one sitting. Instead, it may have been general practice to work on the piece at any convenient time. Preforms in various stages of manufacture may have been carried in a tool replacement kit. 2) Fluted point resharpening episodes left small amounts of debitage of small size. 3) Fluted points and/or preforms were utilized for tasks requiring a bifacial edge, and were resharpened and reshaped as necessary, leaving small amounts of debitage. Debitage clusters by material type, although overlapping in the areas of densest discard, suggest single episodes of reduction and resharpening. In fact, several such discard patterns indicate that a tool maker sat in one spot while flaking stone, and the resultant debitage was scattered around a central "seat".

The tools from Concentration I consistently display characteristics which suggest that they were created by a single maker. Both of the nearly complete fluted points (23.12.321/.433, 23.12.643) are remarkably similar in total form (see Chapter 3). The biface preforms from the same concentration are extremely well formed even in the early stages of reduction, and attained a shape early in the sequence suggestive of the forms of the finished fluted points from the same concentration. Both extant limaces from this concentration are extremely long and thin, and though apparently functionally the same as limaces recovered from other Northeastern Paleoindian sites (e.g., exhibiting the same tip wear), they appear to be a distinctive stylistic form. The possibility exists, of course, that these tools were created for a special function, and may represent the modification of a standard tool form. That this exact form remains unique in known Northeastern Paleoindian assemblages suggests that it is the product of an individual toolmaker. One endscraper from this concentration, two from Concentration III, and one with only general site provenience, also appear to have been created by this toolmaker. These tools, unlike others in the collection, are particularly small and either have medial thinning flakes removed from the dorsal surface or were created on flakes whose original shape had a dorsal surface centered between flake ridges, possibly suggesting use with a particular haft type (see Chapter 3). Symmetrical shape, fine, regular flaking, replicated forms within a tool type, similarity in form from preform to fluted points in the biface category, and provenience data support the suggestion of a single toolmaker having created at least the formal tools in Concentration I. In fact, only one specimen from Concentration I, endscraper 23.12.0586, does not appear to be a tool manufactured by this maker.

In sum, Concentration I provides an interesting association of tools with the one activity that we can clearly define: the production of a few (3-6?) fluted points and the replacement of several others, for which we found the discards. Associated are a variety of tools for scraping a medium hardness substance (such as wood), including "spokeshaves" and limaces, which we propose were used in the production of hafts. Associated with these activities is a rough stone industry, most likely for abrading tasks in this concentration.

CONCENTRATION II

Concentration II covered an area from E44-E48 and N20-N30, just east of and adjacent to Concentration I. Features 7a and 7b, together forming an elliptical hearth similar in form to Features 8/21 in

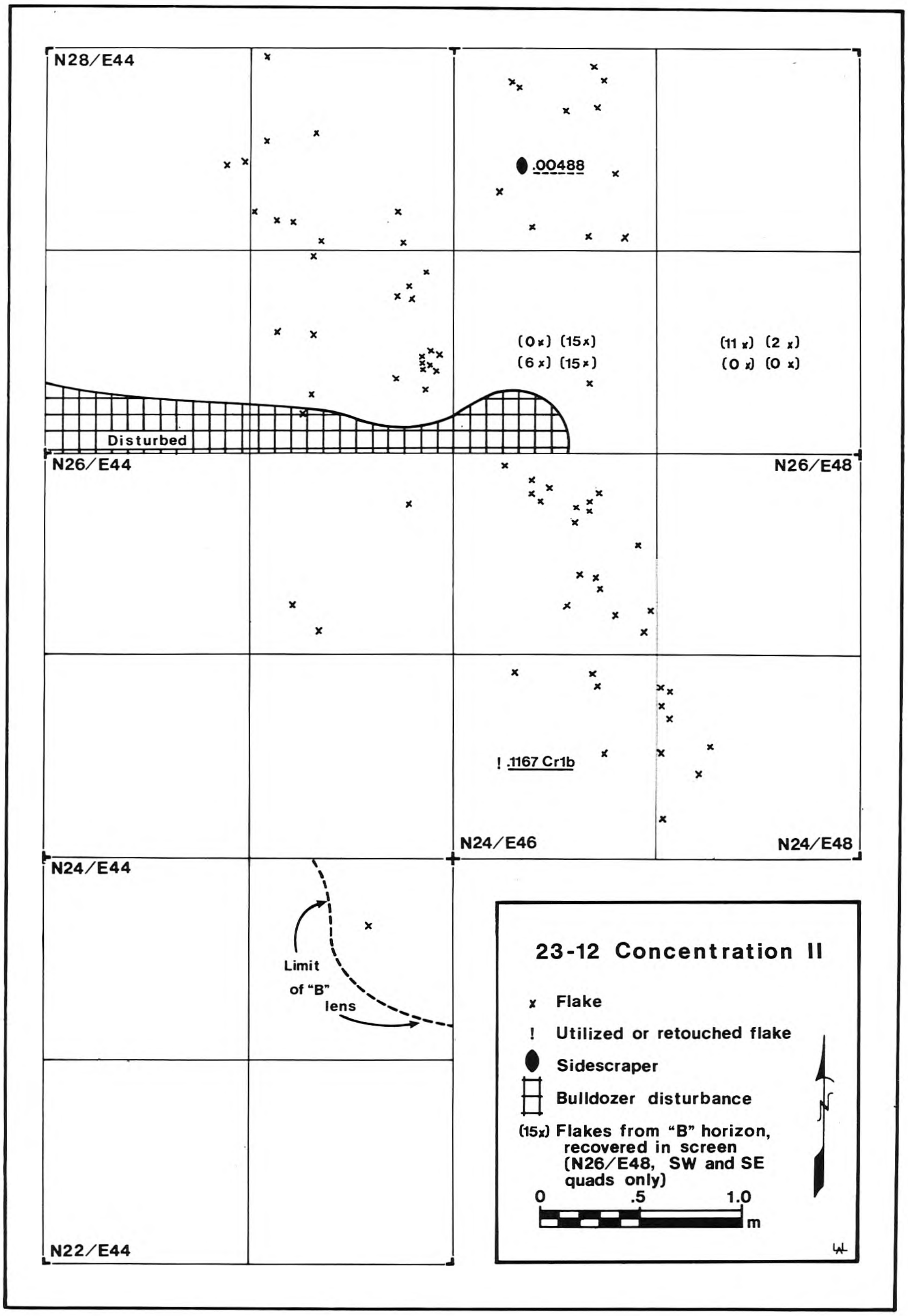


Figure 5-5. Tools and flakes with point provenience in Concentration II.

Concentration I, were found in the southeast corner of this concentration, actually on the border between Concentrations II and III. Although charcoal dated to 10,200 BP was removed from this feature, no cultural debris was immediately associated. In fact, the few artifacts and the majority of the debitage recovered from Concentration II (Figure 5-5) were centered on an area several meters north of the hearth, but several meters south of the dense cultural debris in Concentration I.

Two chunky fragments of an early biface preform of black chert (Cb01) with well worn flake arrisses were recovered from Concentration II, along with several flakes of large size and several of small size of the same material. The on-site reduction of this preform must have been limited to the removal of only a few flakes and fragments. Perhaps work on this particular preform was presenting difficulties and further reduction was postponed until a later time. On the other hand, this preform may have been a practice piece for a child or a chunk whose use was limited to extracting sharp-edged flakes. The crude form of the chunky flakes suggests that the "core" did not belong to the toolmaker in Concentration I. One large, utilized flake of this material was found in Concentration II, while several others were recovered during the MDOT survey and have only general site provenience. One small sidescraper (23.12.488), which appeared to have been used to scrape soft material, and a very small uniface fragment were the only other tools recovered from this concentration.

The flakes from Concentration II were few in number and were mostly uniface sharpening flakes or flakes of unknown type. Very few (5-7) biface thinning flakes were recovered. The largest group of flakes included 17 specimens of a deeply olive green patinated piece of Bull Brook--like chert. All of these were uniface sharpening flakes and appeared to have been removed from the same sidescraper. Several have been refitted to show the heavily used sidescraper edge, although the tool from which the flakes were removed must have been carried off the site.

The coarse stone industry dominated the overall inventory from Concentration II (Table 5-6). A large number of small flakes (<25 gm) as well as several medium sized flakes and three large cores were recovered. The green felsite cobble, which shows polish and striations as described in Chapter 3, was retrieved from a sandy blow-out to the south of this concentration, but much of the debitage which refits the cobble comes from Concentration II.

Interestingly, the majority of Cegl flakes and microflakes found discarded in Concentration II were recovered a meter or two further east than the scatter of coarse diabase (Rc01) and coarse green felsite shatter. The black chert flakes and biface preform fragments were found just to the north of both the Cegl flakes and the rough stone shatter, again suggesting a slight separation of activities involving these materials.

Thirty-six small nodules of red ocher were found in the middle of Concentration II, mostly in square N24E46. Also recovered in this square were a small number of red chert flakes and a small red chert uniface fragment, the uniface resharpening flakes of Cegl, and some bits of diabase shatter. The majority of the coarse stone flakes and shatter, however, were recovered from the northern portion of Concentration II, rather than the area around the red ocher. If there is an association between rough stone for grinding and pigment, there is no obvious, substantiable connection within Concentration II.

In sum, the light scatter of artifacts and flakes in Concentration II displayed none of the specialized activity focus suggested for the debris from Concentration I. The dominant form of debitage was coarse stone shatter, much of which had been removed from the green felsite core found ex-situ to the south of this concentration. An area in the middle of the concentration contained a number of fragments of red ocher; no clear association with either components of the rough stone industry, or with any other tools was observed.

CONCENTRATION III

Concentration III (Figure 5-6) covered an area from E48-E54 and N24-N30. It was distinguished by the high incidence of sidescrapers and the lack of biface or fluted point fragments. Although it was located adjacent to Concentration II, several meters of sterile, undisturbed soil separated the two. In fact, Concentrations I, II, and III form a line along an east-west axis, although the area of densest discard in Concentration I was located just to the north of this axis. Feature 7a/b was located near the southwest corner of Concentration III.

The Concentration III assemblage was dominated by sidescrapers (N = 5), complimented by a small number of endscrapers (N = 2), scraper fragments (N = 3), and retouched and utilized flakes (N = 3). The use-wear patterns on the sidescrapers all suggested butchering activities or scraping of a soft substance, presumably hide. The utilized flakes included one specimen used to cut a soft material, one used to scrape a soft to medium hard substance, and one of unknown function. In all, the artifacts from this concentration represent a very different functional suite of tools than those present in Concentration I. We hypothesize that this area was one in which butchering game and processing of hides took place.

The debitage from Concentration III confuses the hypothesis that this area was primarily a butchering and hide processing station. We expected to find little debitage associated since tool replacement was not the primary focus, and when present, expected to find uniface resharpening flakes. This hypothesis held for the majority of raw material types, but many biface thinning flakes and microflakes of Cegl were recovered in this concentration. A glance at the intra-concentration lithic distributions (Figure 5-6) reveals several discrete clusters, and this pattern leads us to two possible explanations.

The sidescrapers, endscrapers, and utilized flakes from Concentration III were discarded in the eastern portion of the concentration, with the exception of one sidescraper which was recovered on the west side. The biface flaking episode which produced a number of Cegl flakes and microflakes occurred south and slightly west of the tool cluster. In fact, there were no flakes in the area of densest tool discard. Coarse stone was distributed in a seemingly random fashion throughout the concentration; no bias in distribution towards either the area of biface thinning flakes or sidescraper discard was noted.

It was suggested in the discussion of Concentration I that fluted points may have been manufactured in a number of stages, and not necessarily completed from early preform to finished point in one sitting. Evidence in that concentration led us to infer that complete production did occur there, but that only particular stages in the manufacturing sequence were represented for some raw materials. The presence of the biface thinning flakes in Concentration III reinforces our idea that fluted point manufacture did not involve rigid behavioral patterning. That is, the presence of an area seemingly devoted entirely to tool manufacture, and particularly biface reduction, did not preclude similar biface production in Concentration III, where butchering and hide preparation appear to be the dominant activities. Alternatively, the biface thinning flakes may represent biface resharpening flakes which were removed to reshape the edge of a preform which was being used as a butchery tool. Although the striking platforms were ground, this practice may extend to the removal of flakes from any bifacial edge, making functional recognition difficult. The presence of several bifacial thinning flakes displaying polished, striated dorsal surfaces, similar and perhaps belonging with specimens with like wear patterns from Concentration I, suggests that biface preforms may indeed have been utilized before being shaped into projectile points. The association of six large cobble/core fragments of rough stone with this concentration, and the near absence of rough stone shatter are also of particular note. Either the cobble/core objects were flaked at this location and the debris was cleaned up and

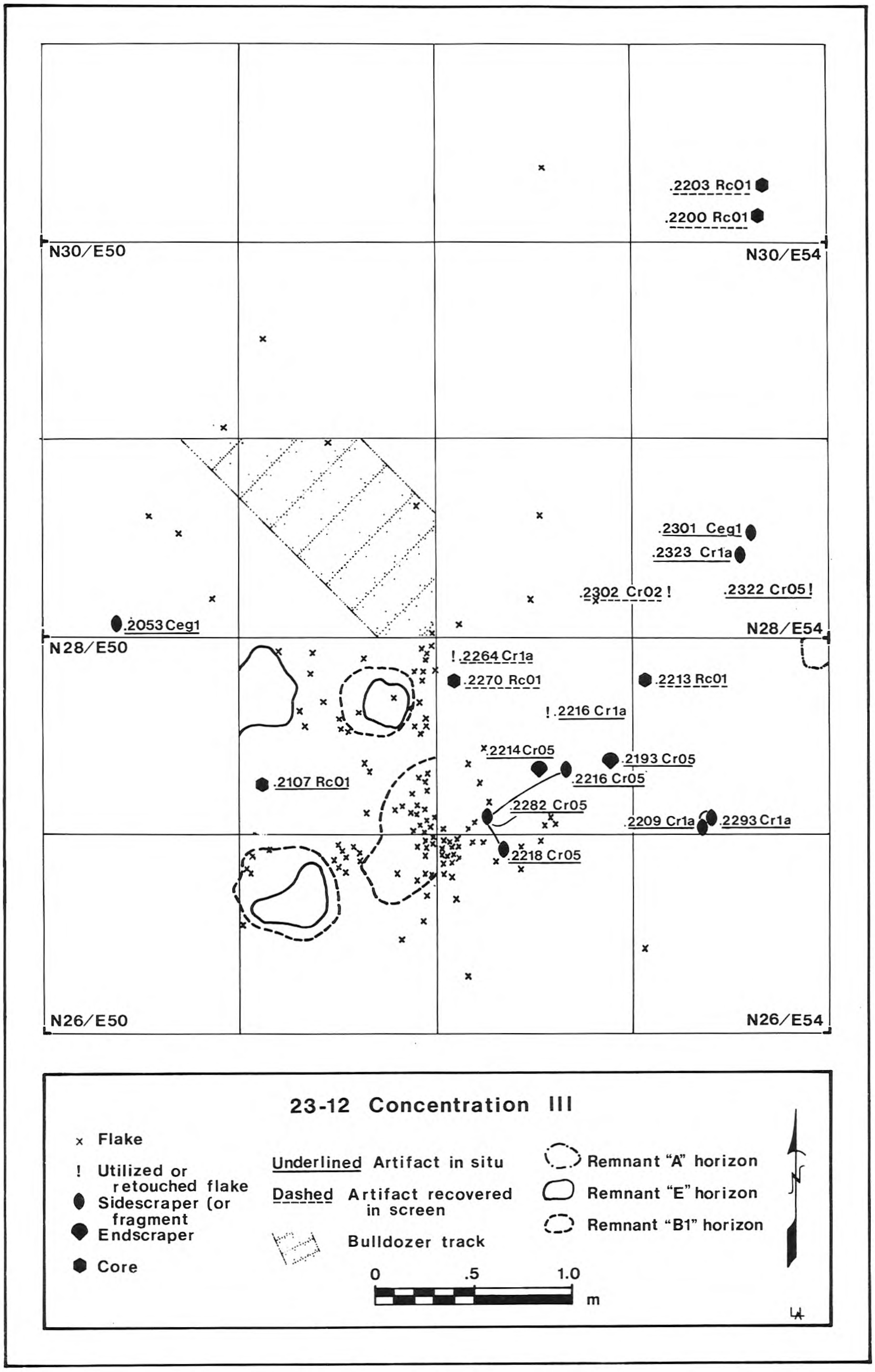


Figure 5-6. Tools and flakes with point provenience in Concentration III.

moved elsewhere, or the cobble/core objects were flaked elsewhere and moved into Concentration III. Much of this material was recovered from both Concentrations I and II as shatter and so, the latter interpretation seems more likely. If this inference is correct, then the cobble/core objects themselves were the desired products, at least in Concentration III. These specimens may be functionally similar to the cobble choppers which were recognized at the Debert site (MacDonald 1985), a function logically associable with butchery activities. In sum, we suggest that Concentration III represents a specialized activity area, involving the cutting and scraping of soft materials. Although the dominant and probably most time consuming activity in this area may have been butchering and hide-working, there was a modest scattering of biface thinning flakes in the western portion of the concentration that represent the partial reduction of a biface of the same lithic material that was being used in Concentration I. We propose that biface reduction may not have been a rigid practice limited to certain work space and production constraints; rather, it may have been expedient to remove mastic and haft lashing in a fire, and to have gathered together the necessary materials for the refurbishment of a tool kit all in one place. However, once the production process was initiated, it was possible that biface manufacture would be undertaken in several different areas. We recognize, alternatively, that biface preforms may have been utilized before the final reduction to fluted point form, and that resharpening at the site of use would produce biface thinning flakes identical in appearance to those created during reduction of a biface to form a fluted point.

CONCENTRATION IV

Concentration IV (Figure 5-7) covered an area from E54-E62 and from N34-N40, all of which was in-situ. Concentration IV was characterized by the densest grouping of Neponset rhyolite flakes and microflakes on the whole site, a moderate concentration of coarse rock (mostly diabase) flakes and shatter, and the near absence of chert debitage. The small collection of artifacts from Concentration IV was diverse in terms of raw material and functional types represented.

Concentration IV can be divided on the basis of horizontal clustering into three sub-groups of tools, with a number of other tools scattered outside of the clustered tools. One cluster of nine tool fragments, centered on N34.5 E58.5, was found in the southwest corner of the concentration. Interestingly, all of the tools and tool fragments in this cluster were made from chert, which was the minority material in the rest of the concentration. A single graver was made on a channel flake of a unique chert (Cbst) which is not represented in any form elsewhere on the site. Several of the other tools in this cluster are channel flakes whose edges have been utilized. No debitage was associated with this cluster of tools, and only minor amounts of chert debitage were present elsewhere in this concentration. Therefore, it seems likely that these channel flakes were "curated" tools, specifically retained for their fine cutting edge. They may have been included as part of a larger tool kit. In fact, this cluster of tools, aside from the tools just discussed, is made up of small scraper fragments and small utilized flakes. The entire group may be the pieces lost from a functionally specific tool kit-perhaps a child's kit or a woman's sewing kit made up of tool fragments scavenged from manufacturing debris. The graver shows wear patterns which suggest that the tip had been used and resharpened. It is a unique cluster on the Michaud Site.

The other two clusters of tools in Concentration IV were centered on N35.5 E59.5 and N35.5 E60.5. Both clusters were dominated by Neponset rhyolite artifacts, with localized concentrations of rhyolite debitage. Each of these two sub-groups included one Neponset rhyolite graver/perforator, which, in each case, had a thicker, more expanding tip than the chert graver on a channel flake just discussed. It seems likely that on this basis there was a functional difference between the strongly-

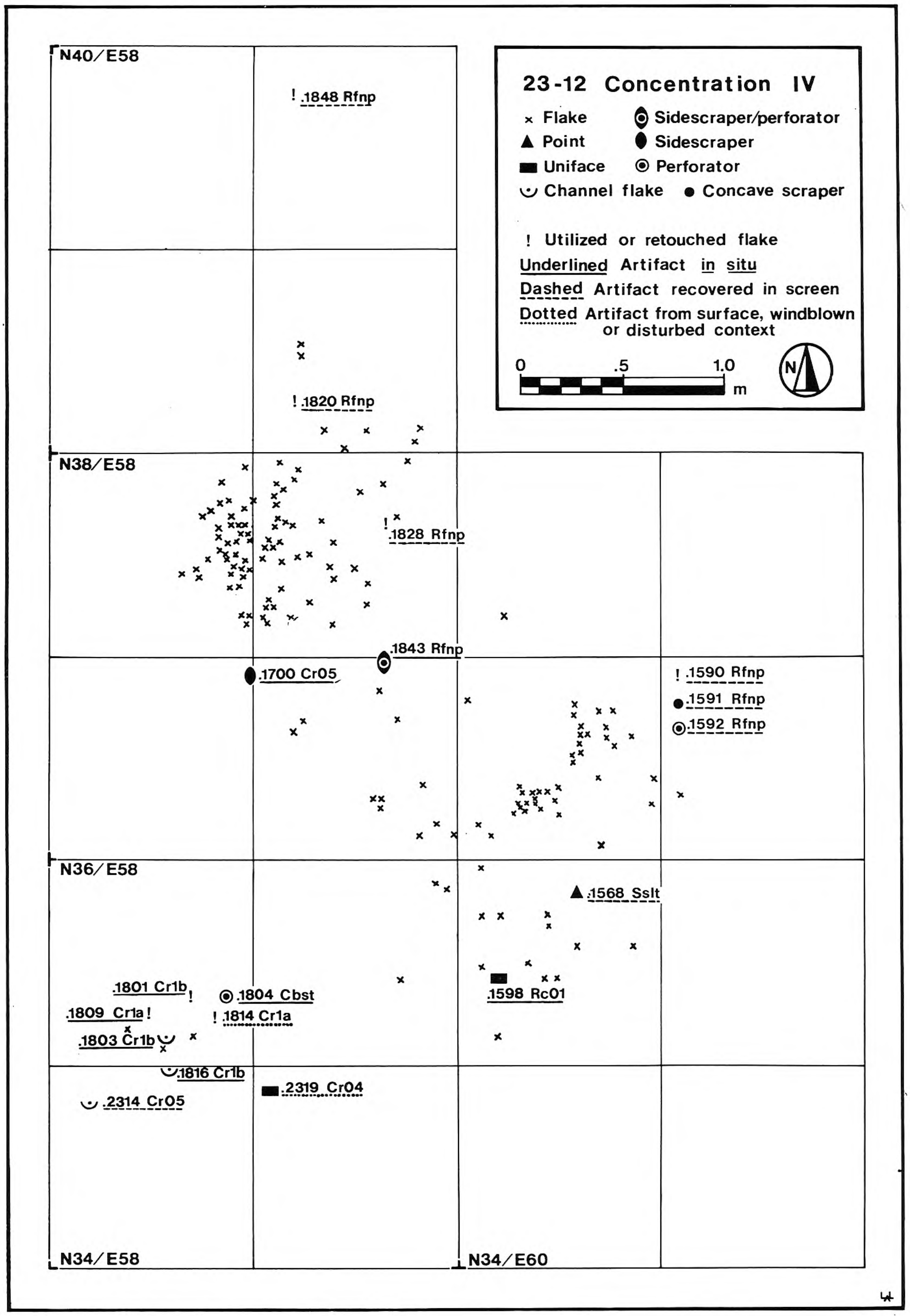


Figure 5-7. Tools and flakes with point provenience in Concentration IV.

tipped rhyolite specimens and that made from chert. Each of these clusters also included a utilized flake and a scraper, one a concave scraper and the other a sidescraper.

Debitage occurred in two main clusters in Concentration IV, the densest of which was located in the northwest corner of the concentration in association with one of the tool clusters. Large amounts of Neponset rhyolite were found in this area as well as large amounts of diabase and other coarse rock shatter. The Neponset rhyolite debris includes both large (over 5 grams) fragments, suggesting early phases of reduction, and well-developed biface thinning flakes. The larger fragments, displaying bedding plane surfaces and few previous flake removals, are distinctive in relation to the chert debitage of Concentrations I, II, and III. That is, the latter concentrations produced chert flakes which are of generally small size and display ground striking platforms with low angles, suggesting that those preforms came onto the site in an already shaped and reduced state. In contrast, the toolmaker(s) in Concentration IV began the reduction process with preforms which apparently had not been significantly shaped prior to arrival at the Michaud site. This difference may indicate that the preforms of Neponset rhyolite originated from a different type of core than did those of the Bull Brook-like chert (blocky core versus biface core?).

The second concentration of debitage was located in the middle of the Concentration IV, just west of the second rhyolite tool cluster and south of the debitage and tool cluster just described. Again, the debitage includes both Neponset rhyolite and coarse stone shatter. A very small fluted point mid-section of a heavily patinated silicified siltstone (?) was found in this debitage cluster, perhaps representing a point which was being replaced with a Neponset rhyolite point.

Our use-wear studies of the discarded tools in all three of these sub-groups indicate that a primary activity in Concentration IV was scraping a medium hard substance, but there is also substantial evidence of cutting material of medium hardness and scraping soft substances. The combination of a graver/perforator in each cluster, plus tools showing wear from cutting and scraping of medium-hard substances, suggests the manufacture of wooden objects, perhaps in conjunction with working softer materials such as skins. The horizontal distribution suggests that this suite of activities was performed two or three different times, or in two or three different locations. The total lack of chert in two of the clusters, and the lack of Neponset rhyolite in the third, plus the physical spacing about one-two meters apart, seems strong evidence that three individuals were involved or that the incidents resulting in the lithic debris occurred on several different occasions.

In sum, Concentration IV contained three clusters of tools and two areas of intense flaking debris. Neponset rhyolite was the primary discarded cryptocrystalline material, dominating two of the tool clusters and all of the debitage in this concentration. Coarse rock shatter of various grades was found in association with the rhyolite debitage. Biface reduction is suggested by the presence of many biface thinning flakes, but large, angular fragments of Neponset rhyolite suggest that the inhabitants of Concentration IV had either just come from the rhyolite quarry and/or they did not carry well-reduced preforms as did the occupants of Concentrations I, II, and III. The activities undertaken in Concentration IV probably included cutting and scraping hide and wood, and perforating holes in one or both substances. With the discard of a broken fluted point fragment in Concentration IV, we can state that the range of activities performed there approaches the range of activities performed at Concentrations I, II, and III together, but the spatial organization of those activities is radically different. Moreover, while one individual in Concentration IV apparently had access to a chert tool kit, the rest produced theirs from Neponset rhyolite. This situation contrasts with the presence of only two artifacts of Neponset rhyolite in Concentra-

tions I, II, and III, both possibly highly curated before discard: the ear of a fluted point and the proximal end of blade-like flake notched on two sides for suspension on a thread or cord.

CONCENTRATION V

Concentration V covered an area from N34-N42 and E62-E68, all of which was in-situ except for the northeast corner, which was a blow-out, and the northern margin, which was bulldozed. Several tools were recovered from this concentration, including a fluted point tip, several scraper fragments and a utilized flake. The fluted point tip had been retouched along the break for reasons which are unclear. The utilized flake and scraper fragment appear to have been used to scrape a soft material. A dispersed scatter of flakes of a variety of cherts and Neponset rhyolite was present in Concentration V. These flakes represent the resharpening or retouch of only a few tools; no single episode of manufacture using a large piece of chert was indicated. Interpretation of Concentration V is hampered by the disturbance that may have truncated its northern margins and contributed to the dispersed tool scatter in Concentration VIII.

CONCENTRATION VI

Concentration VI extended from E86-E98 and N44-N52; about half of the area was in-situ, while the other half had been "blown out". A central portion was defined by a light concentration of flakes and one artifact in-situ, which was surrounded by a dispersed "halo" of chert and Neponset rhyolite flakes and artifacts. A broken fluted point tip made from Neponset rhyolite, either poorly manufactured or poorly resharpened, coupled with a channel flake of Neponset rhyolite and plenty (91 grams) of Neponset rhyolite flakes, indicated fluted point replacement in this concentration. Two Neponset rhyolite endscrapers were present, which our use-wear studies suggest were used to scrape hard substances. A graver/perforator of black chert was also included in the inventory. There were also three utilized flakes which were used for a variety of activities, including cutting soft, scraping medium, and cutting or sawing materials of medium hardness.

Like Concentration IV, the Concentration VI assemblage is dominated by materials attributable to the production of perhaps one Neponset rhyolite tool, while the chert debitage present is concentrated enough to indicate local retouch of chert tools that had been imported to the activity area from elsewhere. Fluted point replacement may have been limited to the final thinning of a preform and fluting, like several specimens in Concentration I. Although the uniface tool kit is small, the range of activities suggested by the use-wear studies is large. In fact, there are enough general similarities between Concentrations IV and VI to postulate a functional parallel between these two: Neponset rhyolite dominated flaking, with imported chert artifacts, one fluted point fragment, presence of graving/perforating tools, and a variety of other cutting and scraping functions represented by the other tools. The major difference between these two concentrations is the lack of a rough stone component in Concentration VI, and its high incidence in the form of shatter and flakes in Concentration IV.

CONCENTRATION VII

Concentration VII extended from N10-N16 and E80-E88. The southern boundary and the southwestern corner of this concentration were disturbed by drainage ditch construction and a blow-out. The Concentration VII tool assemblage again represents a range of activities similar to those observed in Concentrations IV and VI. Specimens recovered from concentration VII include utilized flakes (N=5) and channel flakes (N=6), of which two were definitely utilized. Also present were one retouched flake, one perforator made on a broken scraper, one endscraper, and one sidescraper. Our use-wear studies indicate that most of the utilized flakes and the utilized channel flakes were used to scrape or cut materials of medium hardness. Although no wear patterns were observed

on the retouched flake, both the sidescraper and endscraper exhibit wear patterns suggesting the scraping of a substance of medium hardness, possibly wood.

As in Concentrations IV, V, and VI, the discarded tools made on chert appear to be at the end of their use-life, while Neponset rhyolite appears to be the dominant manufacturing material. Both channel flakes of red chert are long, parallel sided, and heavily utilized. The debitage of red chert is of such insignificant proportion (2 flakes and 3 microflakes) that it is unlikely that even final fluting and finish retouch on bifaces were accomplished using this material. As previously discussed, channel flakes of the proportions represented by these specimens would make ideal cutting or scraping tools, in the same manner as microblades, and their curation as tools thus seems logical. There is insufficient debitage from any of the other cherts represented as discarded tools to indicate manufacture from these materials. The inference that Neponset rhyolite was the incoming raw material is supported by the fact that only utilized flakes, presumably not curated tools, and un-utilized channel flakes of this material are present in Concentration VII. The debitage further supports this hypothesis. The majority of the debitage is Neponset rhyolite, including both biface thinning flakes and larger, more irregular flakes suggesting reduction from angular, blocky cores. Although there are no fragments of fluted points in Concentration VII, the evidence of fluted point manufacture is inescapable: (1) about 120 grams of Neponset rhyolite flakes and microflakes are present, many of them biface thinning flakes, indicating substantial reduction of Neponset rhyolite preforms or bifaces; and (2) the presence of Neponset rhyolite channel flakes, including a basal portion with a characteristic nipple remnant for striking the flute. There is no rough stone associated with Concentration VII.

Thus, Concentration VII exhibits several parallels with other concentrations. Like Concentrations IV and VI, the dominant material used for tool manufacture was Neponset rhyolite. Again, like Concentrations IV and VI, chert tools must have been imported to the area much as they were found because there is little evidence of their retouch and no evidence for manufacture from any of the cherts. The principal function of the stone tools in Concentration VII appears to have been working wood. Like Concentrations IV and VI, a single graver/perforator is present, on a possible "one per tool kit" basis, but the range of activities (cutting and scraping soft and medium hard materials) is not present in Concentration VII. Like the other areas, however, there is local evidence of fluted point production and/or replacement.

CONCENTRATION VIII

Concentration VIII is a label applied to a diffuse, disturbed area affected by the bulldozing of soil to fill the east-west drainage trench that stretched along the northern margin of the site. It covered an extensive area from N46-N70 and E54-E84. The few flakes and artifacts pushed into the ditch fill probably originated in Concentration VIII. All artifacts from the area were derived from surface or disturbed contexts, except for one Neponset rhyolite endscraper (23.12.00110). The artifact assemblage includes the black chert fluted point base that conjoins with the tip portion recovered from Concentration V, two sidescrapers, an endscraper, and five utilized flakes. Seven of the twelve artifacts were made from Neponset rhyolite, while the rest were made from a variety of cherts. Though few flakes were recovered from this area, the dominant raw material for flaking was Neponset rhyolite. We suggest, based on the observed direction of several bulldozer tread impressions, that Concentration VIII represents redeposited soil containing tools mostly derived from the periphery of Concentrations V and VI. Cutting soft substances and scraping medium substances are indicated by the use-wear on utilized flakes, and by the endscraper from Concentration VIII. If some or all of these tools originated in Concentration V, the addition of these forms would augment the somewhat limited

range of activities indicated for the in-situ collection from that concentration.

CONCENTRATION IX

Concentration IX covered the area from N80-N88 and E96-E104. Little can be said about the assemblage from this area: three red chert artifacts were assigned to the concentration, only one of which was recovered in-situ. The other two were attributed to the area by the MDOT personnel who initially surface collected the site. Very little debitage from this concentration was collected during excavation, but there was enough to indicate that some sort of ephemeral activity area had once been present in this general area.

DISCUSSION

The perceived spatial distribution of the material remains from the Michaud site allows suggestion of at least eight and perhaps nine non-overlapping areas that were utilized by the Paleoindian inhabitants. Much of the site was in-situ when we began excavation, although disturbance by light bulldozing and sand blow out was present to some extent in nearly all of the concentrations. The southern portion of Concentrations I, II, and III showed slight disturbance, as did the northwest corner of Concentration V. Concentration IV was entirely in-situ, but up to one half of Concentrations VI and VII was disturbed. Most of Concentrations VIII and IX were disturbed, by bulldozing in the former and blow-out in the latter. As a result, the following discussion is limited to the spatial distributions found in Concentrations I-VII. Because of the paucity of tools recovered from Concentrations V-IX, and because of their functional overlap with those recovered from Concentration IV, we present detailed artifact plans for Concentrations I-IV only (Figures 5-4 through 5-7).

Upon examination of the distribution patterns, both with regard to the intra-site distribution of raw materials (Figures 5-8 through 5-14) and to spatial/functional patterning (Figure 5-15), it was immediately obvious that there were two clusters of concentrations. Concentrations I, II, and III, henceforth collectively called Area A, in many ways form a cohesive unit, as do Concentrations IV-VII, which are henceforth designated Area B. While Concentrations VIII and IX appear to belong with the latter group, we will not include them in this discussion due to their disturbed condition. Because refits of broken artifacts between concentrations may indicate relatedness (Gramly 1984), we shall next examine the results of our conjoining efforts.

REFITS

Attempts to conjoin broken flakes and artifacts resulted in 28 successful refits. In most instances, refits were between two fragments of one flake or tool, but nine cases resulted in the refitting of three or more pieces. One chunk of diabase was refitted from eight flakes of shatter. Twelve of the cases were refits of broken flakes, while the rest involved utilized flakes and formal artifacts (Table 5-6). Three of the refits occurred between pieces with only general site provenience, thereby contributing no information on internal site structure. Several other small, refitted flake fragments were recovered from windblown sand, again adding little information about internal site structure. Of the remaining 22 cases, 14 involved refits between pieces displaced horizontally by less than a meter, suggesting that the items fell where they broke. Six other cases were pairs involving pieces refit within a concentration, but which were displaced more than one meter. Of particular interest, two channel flake fragments from the center of Concentration I were refitted with the basal portion of a fluted point preform from the southern limit of the concentration. These pieces show clearly the configuration of the basal nipple created for the removal of the channel flake. However, the distribution of these pieces within the concentration does not suggest any definitive behavioral pattern. None of the other intra-concentration refits were distributed in such a way as to suggest that their movement was function--

Table 5-6. Listing of refits of material found in situ, where pieces were further apart than one meter.

Item	Material	Catalogue Numbers and Proveniences
Fluted point and channel flakes	Ceg1	.00082, N22 E40 vicinity; .01076 N29.73 E41.49; .00932 N28 E40 NEq SWq
Fluted point	Cr1	.00321 N31.34 E39.30 .00433 N29.99 E40.38
Fluted point base, tip	Cb01	.00088 N70 E70 vicinity (surface) .00112 N40.40 E62.16
Utilized flake	Cr1	.00440 N28 E40 NWq NE 1/4 .00462 N29.63 E42.75
Flake	Rfnp	.01567 N34 E66 SWq .02108 N37.10 E53.65
Flake	Rfnp	.02328 N48 E92 Nwq .02354 N46 E90 NWq NW 1/4

ally intended.

Items 23.12.02108 and 23.12.01567 are broken pieces of a substantial Neponset rhyolite flake (weights 5.7 grams and 12.1 grams, respectively). Neither shows detectable evidence of use or retouch; likewise, neither falls within the boundaries of a defined concentration. One was recovered from just west of Concentration IV, while the other was found to the southeast of the same concentration. These flakes are large enough to have been utilized, and we suspect that their breakage occurred within the Neponset rhyolite work area of Concentration IV, but we cannot present a plausible reason why they were ejected from the concentration.

The final refit case involves the broken tip of a black chert fluted point retouched for use as a scraper (in-situ, 23.12.00112), and the base of the fluted point. The tip was recovered from the northeastern margin of Concentration IV, while the point was surface collected by George Eaton from the margin of a sand blow-out near N70E70. Eaton was definite in his attribution of the point to that area (plus or minus 5 meters). The point base, then, may be associated with the diffuse scatter of material from Concentration VIII, which was in part disturbed by bull dozing, thus providing no basis for a possible original provenience for this item.

In sum, none of the refits definitively linked the different concentrations. For various reasons (time constraints, patination), we did not attempt extensive refitting of flakes to artifacts: refitting attempts were principally confined to broken items. Nonetheless, these data confirm that there was not a great deal of movement of broken pieces between concentrations after breakage occurred. The lack of refit items contrasts sharply with the Vail site, where artifacts were matched over several hundred meters (Gramly 1984), and suggests not only that non-overlapping activity areas existed at the Michaud site, but may also point to

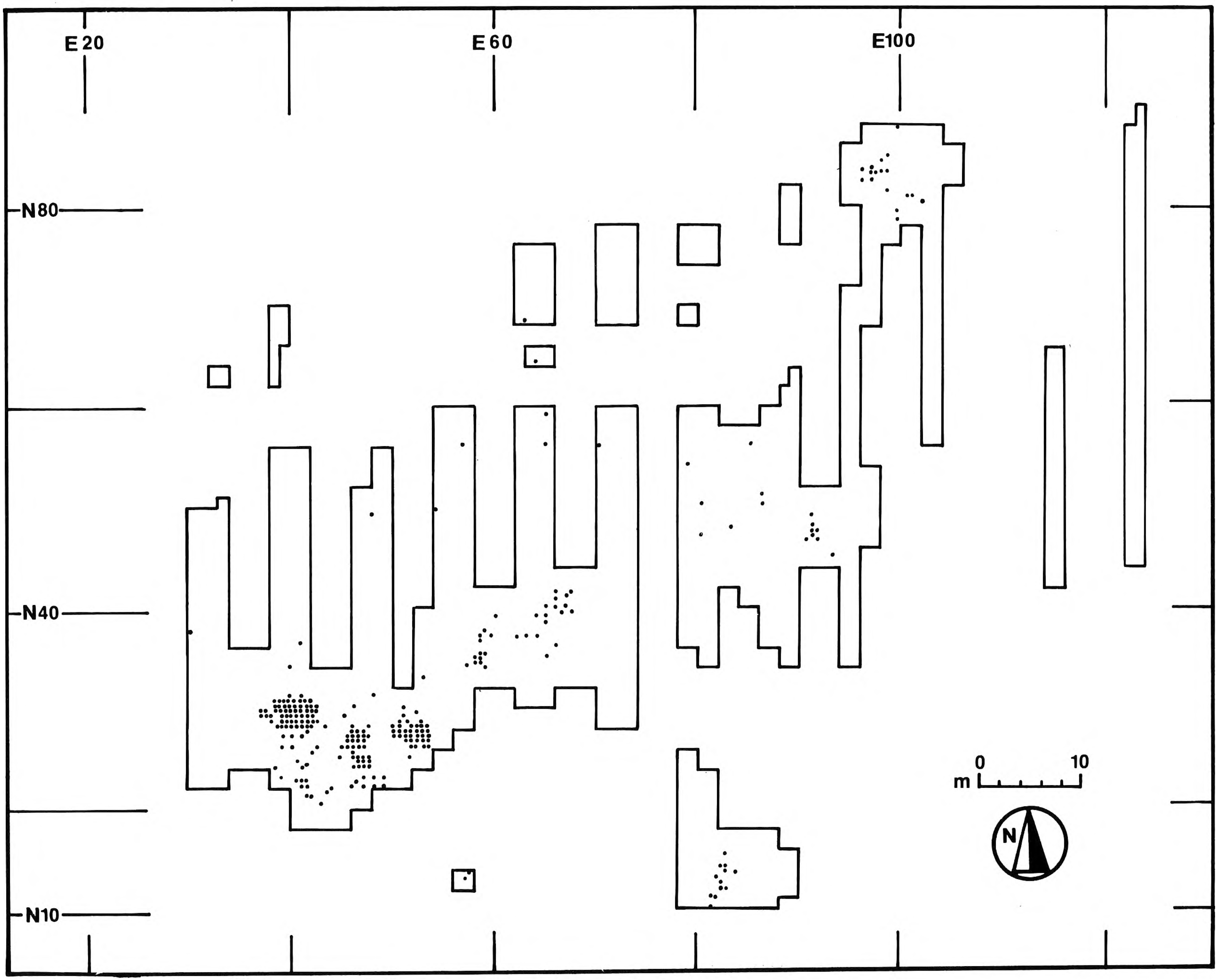


Figure 5-8. Quadrangles with chert flake(s) or artifacts are noted with a dot on this plan.

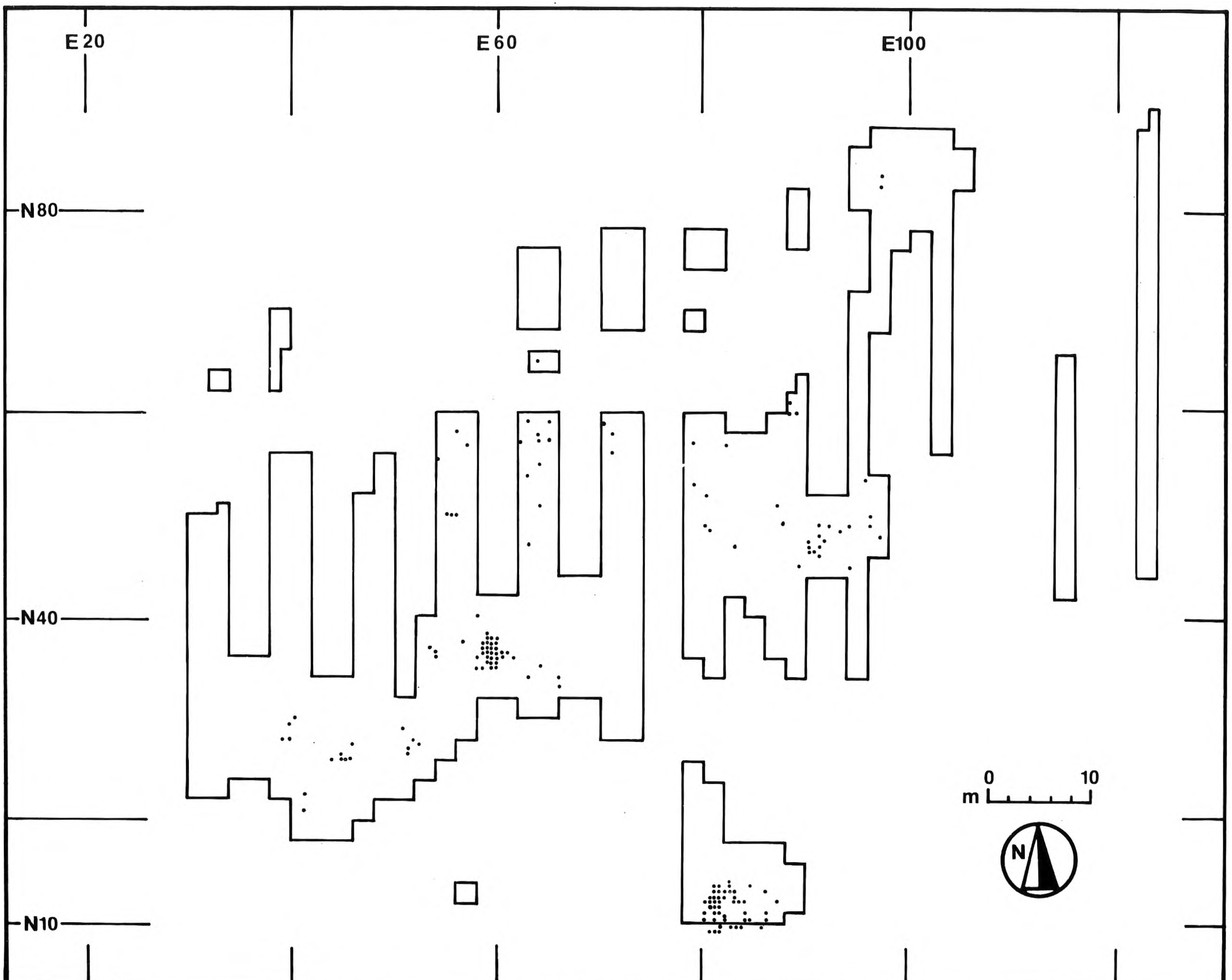


Figure 5-9. Quadrangles with Neponset rhyolite flakes or artifacts.

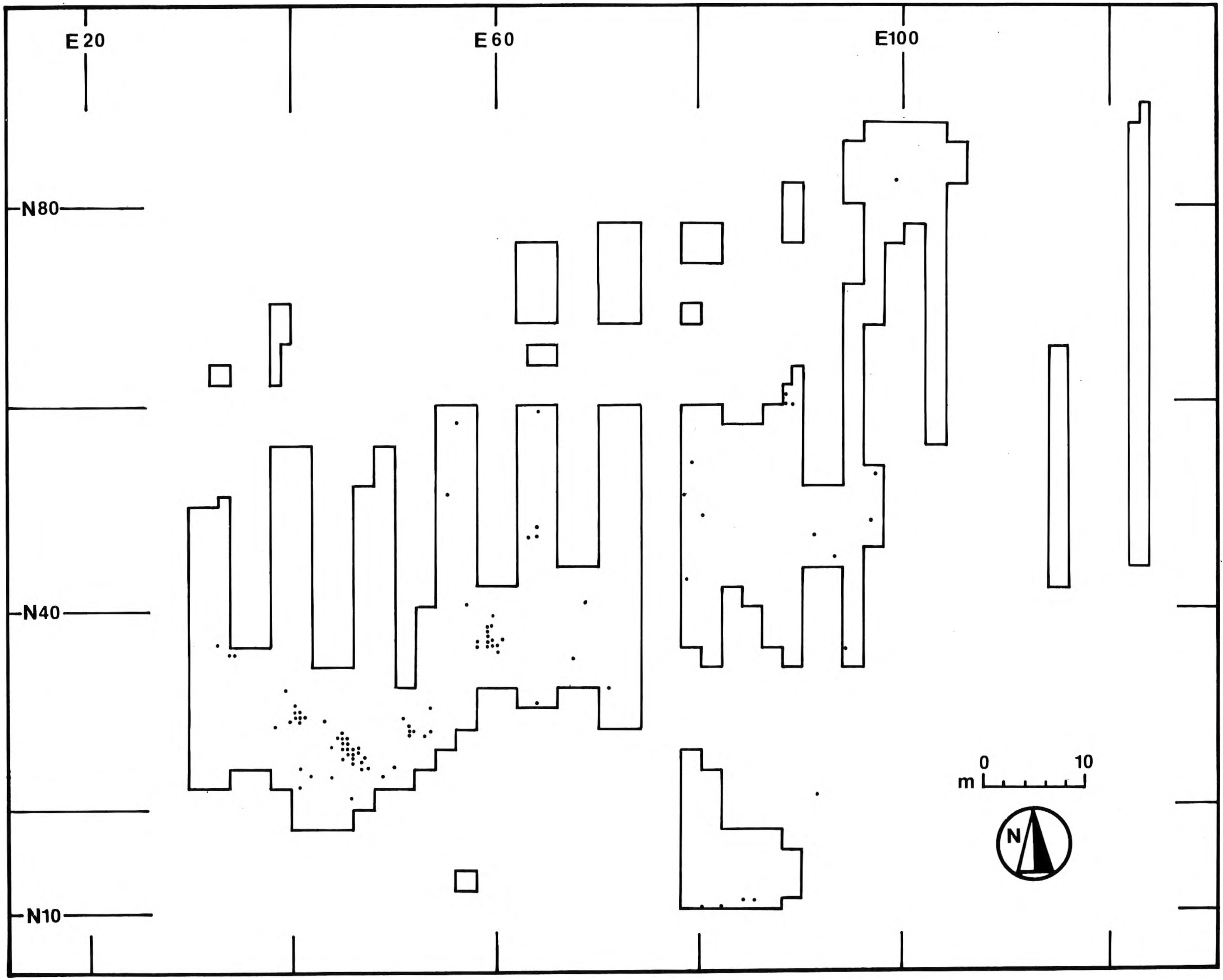


Figure 5-10. Quadrangles with Christian Hill diabase shatter, flakes, or modified pieces (cores or tools).

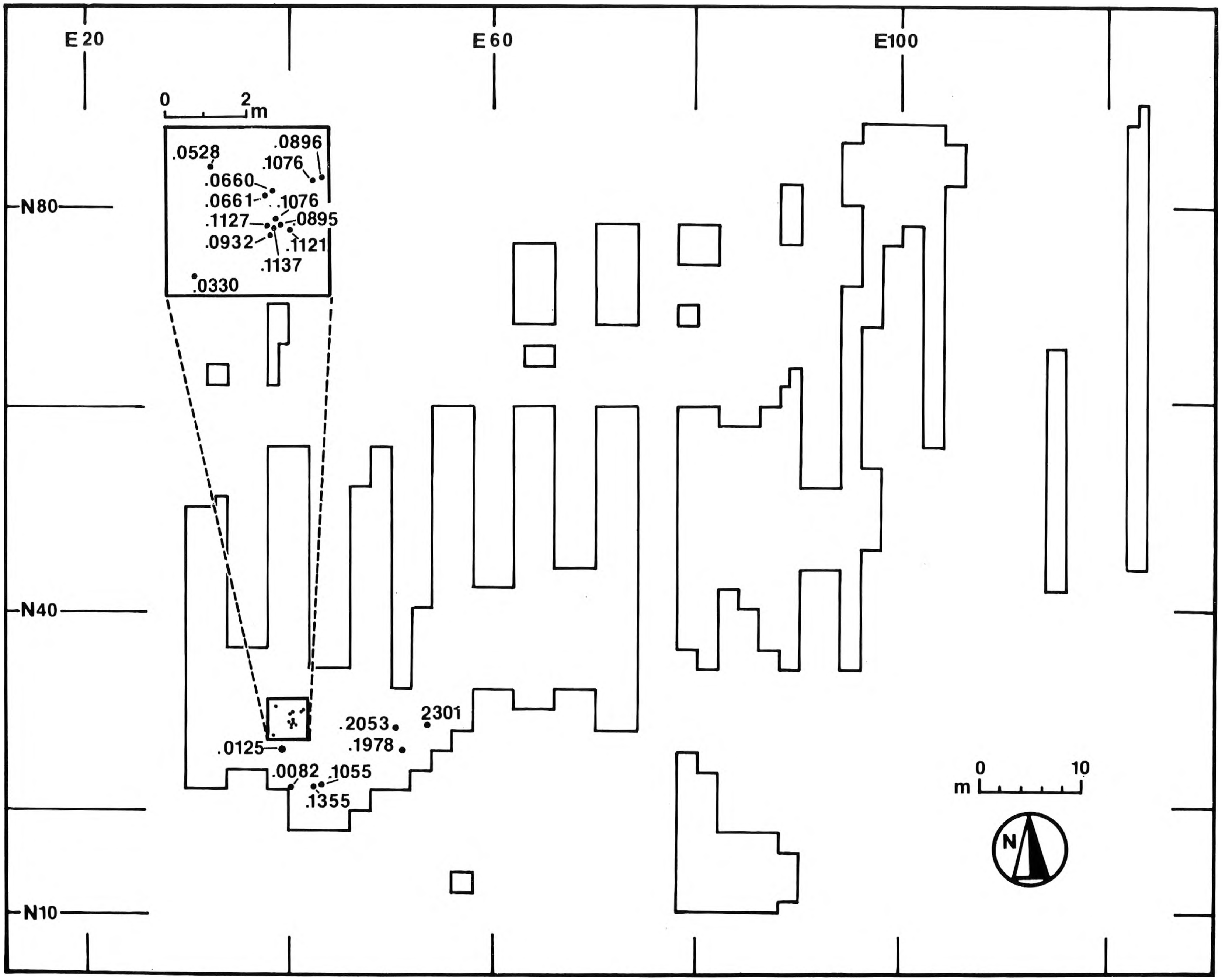


Figure 5-11. Location of Bull Brook chert (Ceg1) tools, with artifacts numbers.

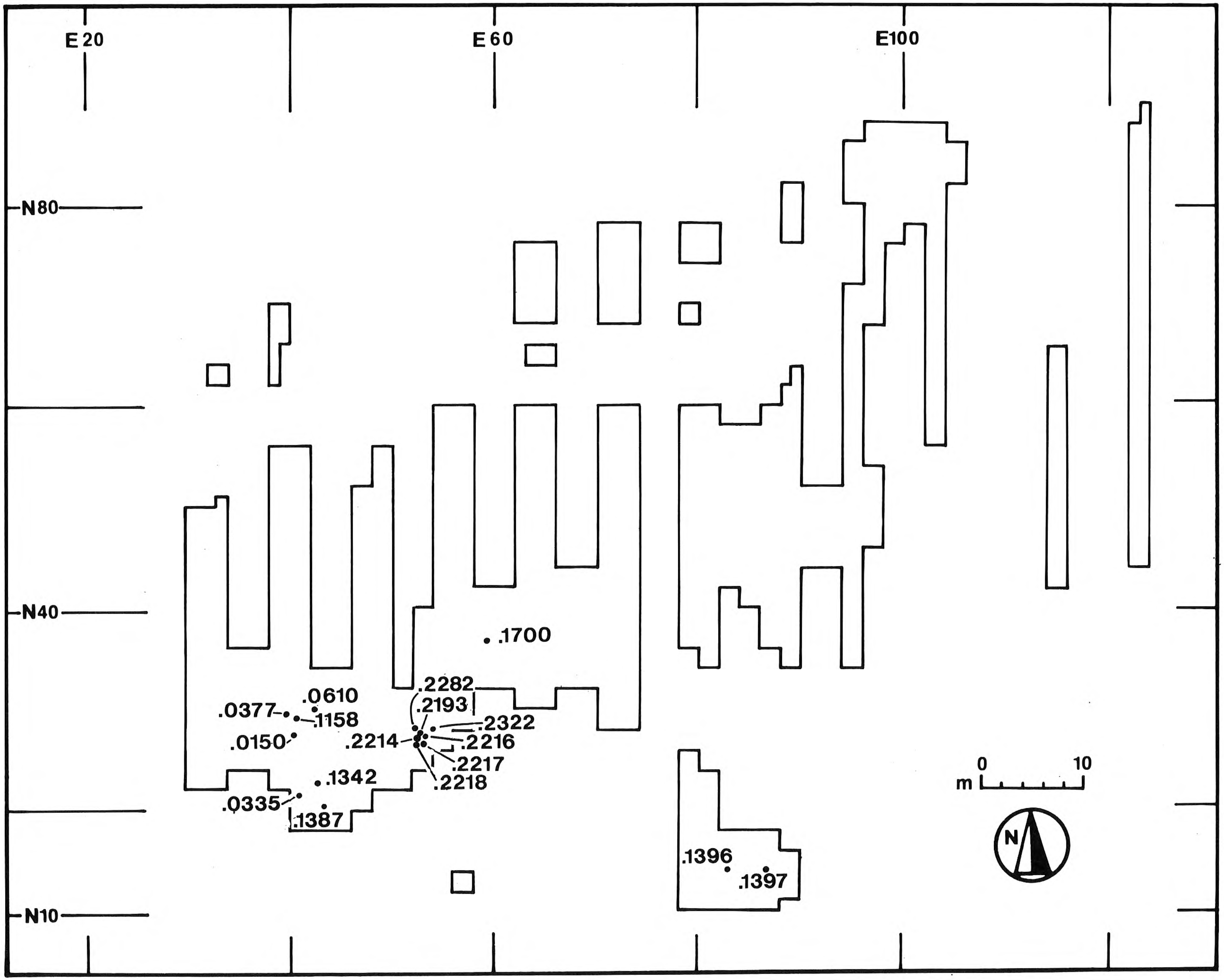


Figure 5-12. Location of red and green Munsungun chert (Cr05) tools, with artifact numbers.

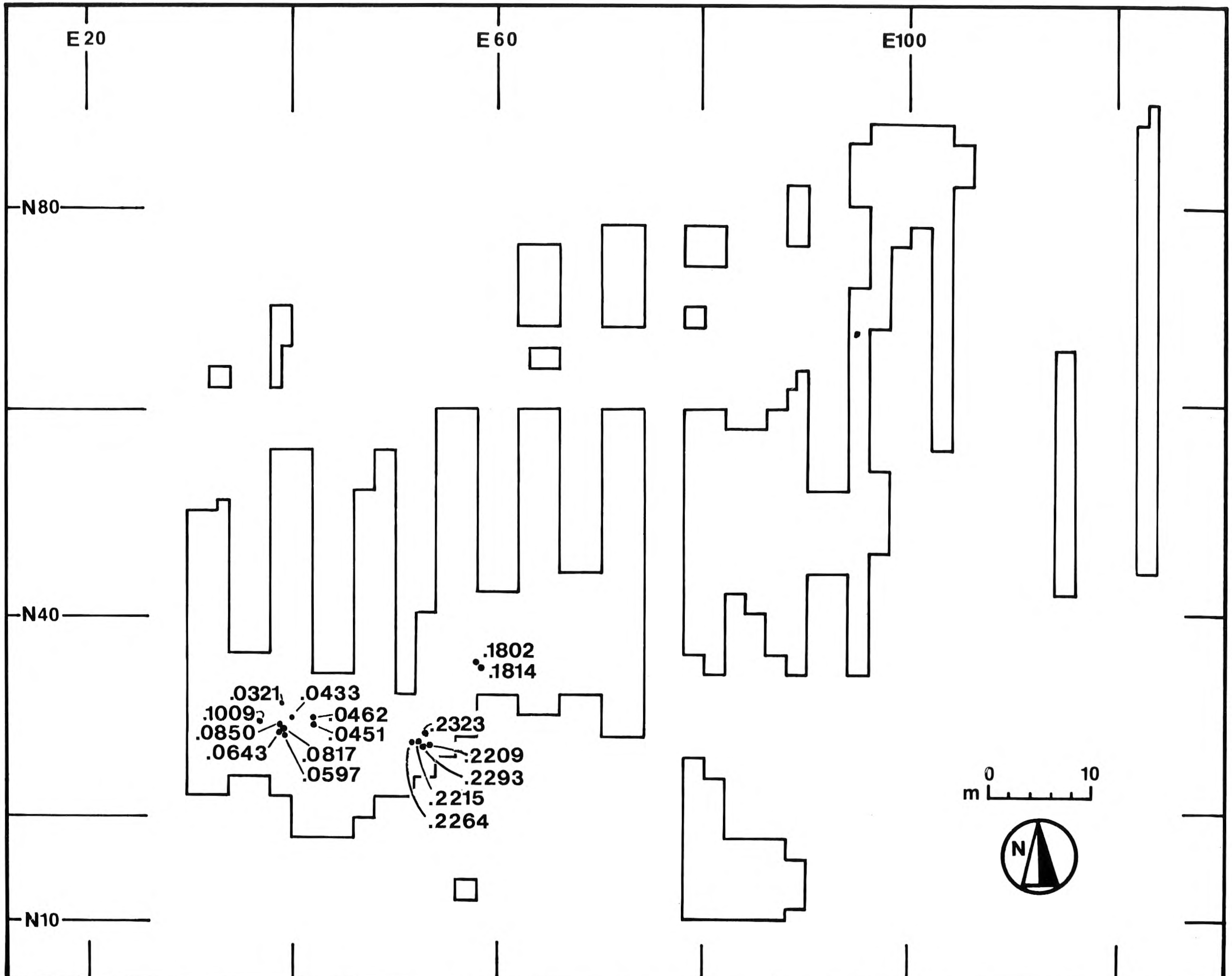


Figure 5-13. Location of red chert (Cr1) tools, with artifact numbers.

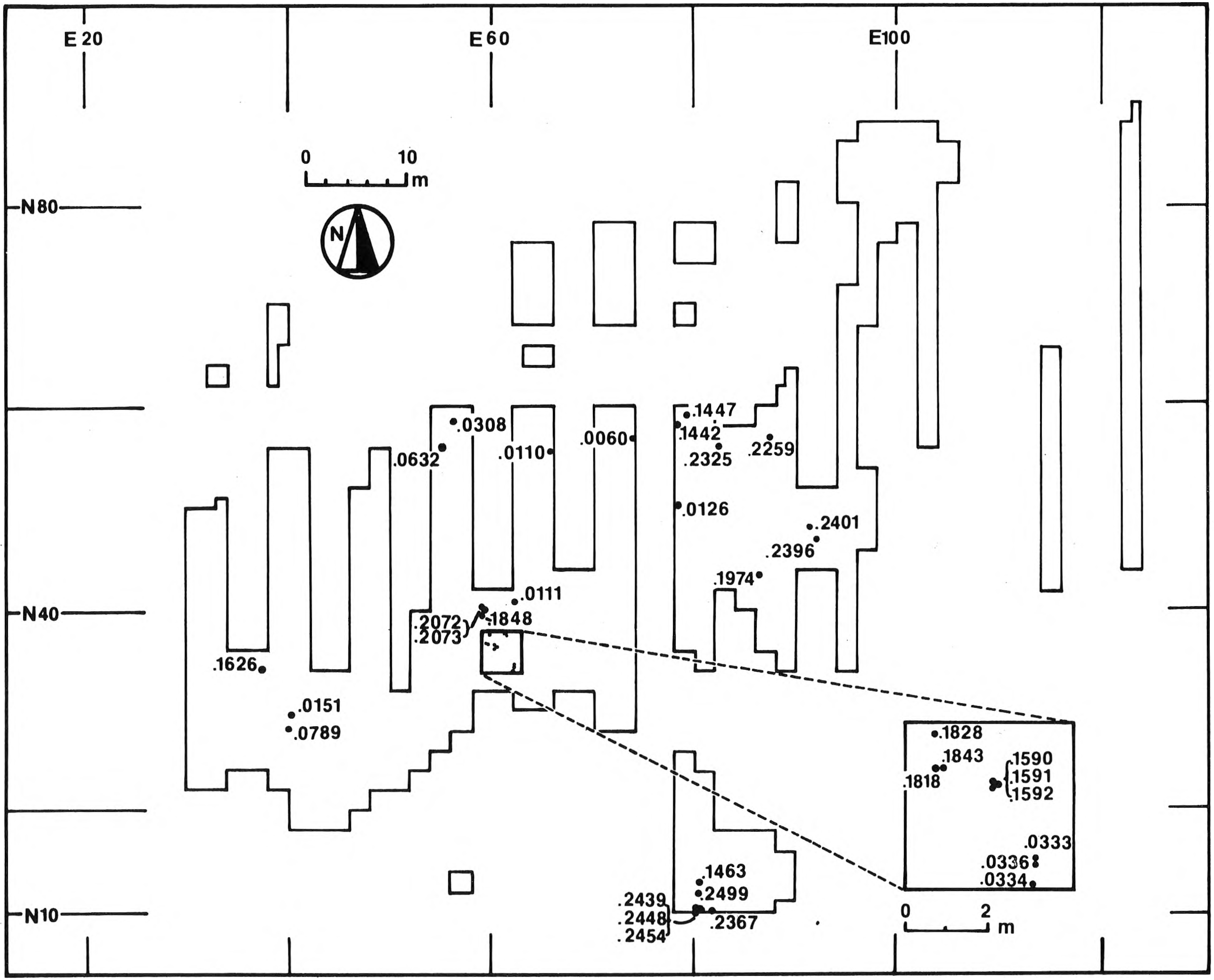


Figure 5-14. Location of Neponset rhyolite (Rfnp) tools, with artifact numbers.

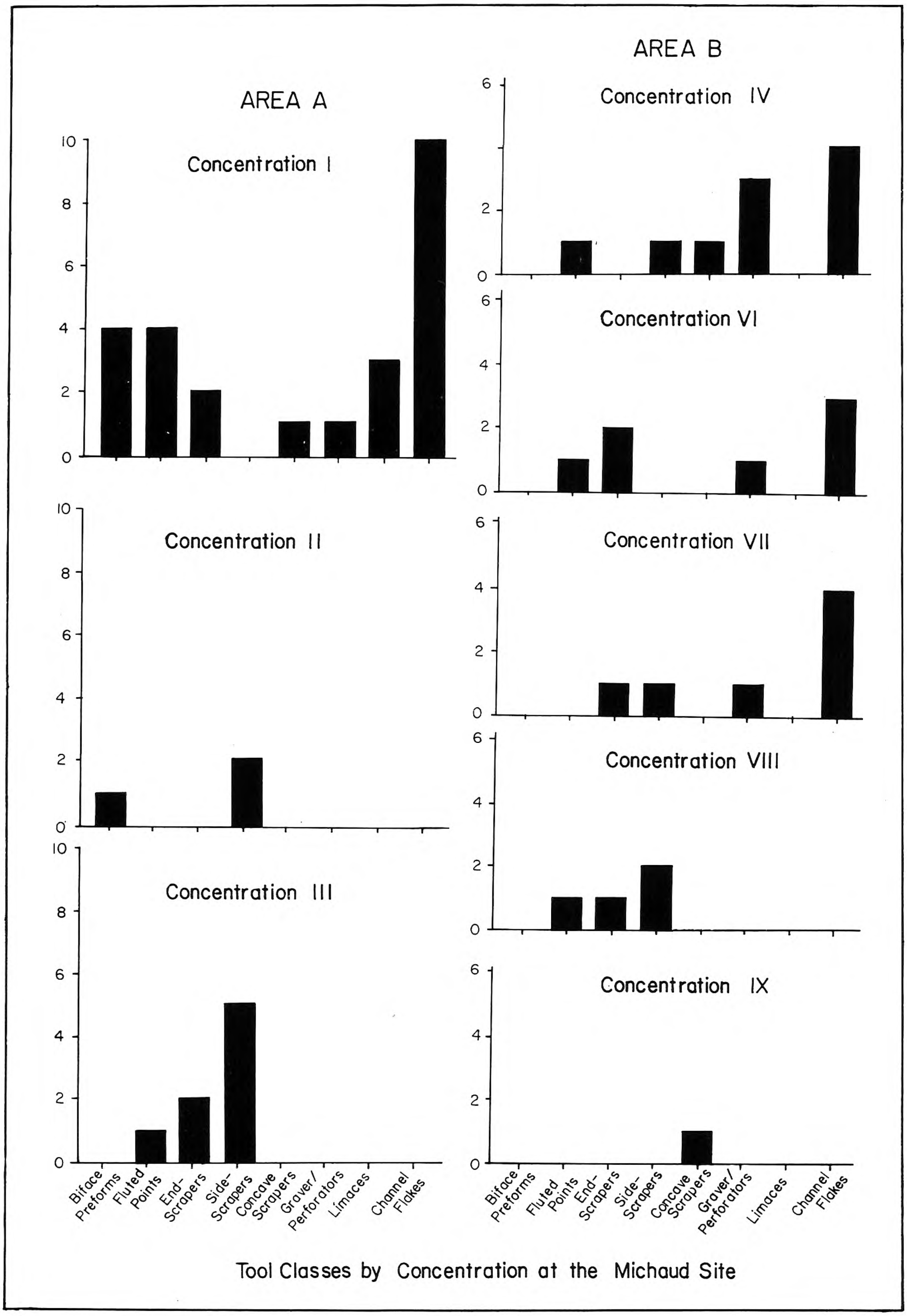


Figure 5-15. Frequency of different tool classes in different concentrations at the Michaud site.

the short duration of site occupation. In fact, the refit pieces present a strong case for the integrity of the concentrations and for the relatively limited nature of post-depositional disturbance to the site.

RAW MATERIALS DISTRIBUTIONS

Aside from minority components of a number of raw materials without associated provenance data, three major cryptocrystalline lithic materials were utilized at the Michaud site (see Chapter 3). The red and red and green varieties of Munsungun chert are represented throughout the site. Although artifacts of this material are present in all concentrations, sufficient debitage to suggest that tool manufacture was undertaken with this material only occurred in Concentrations I, II, and III. In all other concentrations, the scarcity of red chert flakes suggests that only minor resharpening of existing red chert tools took place at the Michaud site.

We have suggested that the heavily patinated olive green chert (Bull Brook chert) and the black chert (Cb01) may be examples of Champlain Lowlands cherts from western Vermont. This material dominates the manufacturing debris in Area A. Of particular importance, there are no tools either of the black or patinated-green variety in these concentrations which exhibit morphological features suggestive of long use-life, even though the source for this chert may lie 350 km to the west of the site. Rather, all of the material in this category appears to be freshly flaked. But if the tools all appear to have been manufactured on the site, the flake scars on some of these pieces display extreme arris polish, suggesting that they had been carried for some distance in preform or core form. Only two heavily used fluted points and minimal amounts of debitage of the black variety of this chert were recovered from Area B, and no specimens of the patinated-grey-green variety.

Neponset rhyolite, on the other hand, was the only manufacturing material present in Area B. We interpret the extreme minority presence of chert debitage as the by-product of minimal resharpening episodes. Although no Neponset rhyolite debitage was recovered from Area A, one fluted point ear fragment was recovered from Concentration III, while a side-notched blade-like utilized flake fragment was recovered from Concentration I.

Based on the foregoing discussion, we suggest that we have two different occupations or two different social groups at the Michaud Site, one responsible for Area A and the other for Area B. The presence of the same raw materials in both areas suggests that, even if Areas A and B were not occupied contemporaneously, the groups were most likely related.

SPATIAL-FUNCTIONAL PATTERNING

Areas A and B display a marked contrast in the functional use of space (Figure 5-15). Area A is composed of three discrete, non-overlapping tool concentrations, each of which appears to be functionally different; together they span a linear distance of 16-18 meters. We suggest that the activities represented in the three concentrations together include many of the activities necessary for short term (days to weeks) maintenance of a small group of Paleoindians. Concentration I, as previously mentioned, appears to have been a center of tool manufacture, particularly fluted point replacement. Concentration III is dominated by sidescrapers, which our use-wear studies suggest were used to cut and scrape soft materials such as flesh and hide. Concentration II lacks discarded tools and debitage suggestive of a single, focussed activity pattern as shown by Concentrations I and III. However, the large amount of coarse stone shatter and the presence of pigment fragments are of particular interest in Concentration II. It is possible that the pigment fragments were associated more with domestic activity than with tool manufacture or butchering. If there was a structure associated with Concentrations I, II, and III, it is unlikely to have been inclusive of all three. It is equally unlikely that Concentrations I and III were covered with "separate but equal" structures for such disparate activities. Thus, it is most likely that, if there were a

single structure, it was focused on Concentration II. Following this reasoning, it is logical that Concentrations I and III were open-air activity area satellites to Concentration II. Therefore, one hypothesis to explain the seemingly restricted activities in Concentration II is that it represents "interior", perhaps domestic, space. This reconstruction places Feature 7 within or near the boundary of a hypothetical structure, and Feature 8/21 in the open air.

Area B, in sharp contrast to Area A, is organized into at least four non-overlapping tool concentrations that are more-or-less functionally repetitious. Significantly, none of these were associated with hearths that were large enough or deep enough to have survived post-depositional disturbance, no matter how minor these disturbances may have been. Activities suggested by the use-wear patterns on the discarded tools from this area include both cutting and scraping functions on substances of soft and medium hardness, probably including but not limited to work on wood and hide. Broken fluted point fragments were recovered from four of the tool concentrations in Area B, while bifacial thinning flakes of Neponset rhyolite occurred in all Area B concentrations to one degree or another. Channel flake fragments of Neponset rhyolite were also recovered from most of the Area B assemblages, notably excluding Concentration IV. Thus, in Area B fluted points of a variety of materials, including black chert and silicified siltstone, were being replaced by weaponry of Neponset rhyolite. Coarse stone tools, cores, and shatter are absent from Area B except for the high incidence of coarse stone shatter in Concentration IV.

We speculate that the seemingly repetitious activity patterns of Area B represent assemblages discarded or dropped by small groups of hunters, or by a number of small family groups over a short span of time. Their non-overlapping placement in seemingly random fashion over a large area argues for contemporaneous use, or for sequential use where the evidence of previous settlement was obvious and positive efforts at avoidance were made for some unknown reason.

SUMMARY

We have defined two areas of tool concentrations which display significant differences in incoming/outgoing lithic raw materials. The mode of transporting the raw material also appears to have been different. Bifacial preforms and large, shaped flakes appear to be the form used for transport into Area A. The presence of some angular, unformed fragments of Neponset rhyolite displaying bedding plane surfaces from Area B suggests that the inhabitants of Area B carried in raw material in a less reduced state.

Although the same tools forms are represented in Area A and Area B, with the exception of the limaces found only in Area A, stylistic differences, particularly between fluted points, suggest that we are not looking at the artifacts of a single toolmaker with an associated group of people occupying the Michaud Site during opposing phases of a seasonal round. Further, the highly patterned spatial division in Area A contrasts sharply with the non-patterned, activity inclusive assemblages from Area B. It is possible that two groups of different social composition, possibly a family group in Area A and a small, specialized hunting party in Area B, were responsible for the different forms of assemblage as seen between these two areas. With respect to the latter, the concept of exploitation camp (Cox 1972), or "location" (Binford 1978, 1980), may be applicable. If a major encampment existed at some reasonable distance from the Michaud Site, it is possible that hunting parties left for days at a time, making camp and repairing and/or replacing equipment as necessary. Small camp sites, including limited tool types as seen in Area B, would be the expected result of such short term forays. On the other hand, a campsite such as is seen in Area A may represent the occupational debris of a family group, with task specific division of labor.

The distribution patterns at the Michaud Site, then, have important implications for Paleoindian settlement patterns as

a whole. The Michaud Site appears to include the remains of two distinct groups, who either occupied the site contemporaneously, or who were groups of different social composition and task orientation occupying the site at different times. Since Paleoindian sites of much greater size and tool density occur (Vail, Debert, Bull Brook) in the Northeast, we suggest that large groups came together periodically, possibly to cooperate in the seasonal procurement of large-bodied or group-migratory game species. However, the population must have also divided into smaller segments, such as family or small task groups, to exploit seasonally diverse resources, or possibly to procure quantities of fine quality lithic material.

Tables 5-3 and 5-4 present the flake data for the Michaud site. Microflakes were not included in the average flake weights in Table 5-4, since they have not been consistently recovered at Paleoindian sites and their usage here might make our figures difficult to use for comparative purposes. The total mass of all the cherts and glassy rhyolite discarded and lost on the Michaud Site is quite small. There were only 274 grams of Cegl, 237 grams of Cr1, 146 grams of Cr05, and 610 grams of Neponset rhyolite, plus much smaller amounts of other cherts. The total amount of these "non-local" rocks lost, flaked, or discarded on the site falls just short of 1.5 kilograms. Whatever the length of stay at the site, and we assume that it was fairly short in both areas based on the non--overlapping, confined tool concentrations with limited lithic debris, the stone tool kits were only 1.5 kilograms lighter when the inhabitants left than when they arrived.

CHAPTER SIX

THE LAMOREAU SITE

The Lamoreau site (Maine archaeological survey number 23.13) is a fluted point Paleoindian site discovered during the Michaud site excavation. It is located near the Michaud site, and has yielded through surface collection a small assemblage that clearly relates the two sites. We present what is known about the Lamoreau site, and the relationship between the Lamoreau and Michaud sites at the time of preparation of this report (summer, 1986).

LAMOREAU SITE DESCRIPTION

The Lamoreau site is located less than one kilometer from the Michaud site. In a forest parkland or unforested environment, it would have been possible to see directly from one site to the other. On a calm day it is possible to signal from one site to the other with a loud shout. Both sites are located on the outer margin of the Moose Brook Valley, on a sandy substrate that was apparently reworked by eolian action during the terminal Pleistocene and stabilized by vegetation before Paleoindian occupation. In a treeless or parkland environment both sites together or sequentially would enable visual surveillance of a substantial portion of the Moose Brook Valley. Perhaps preferential use of one site or the other depended on prevailing wind direction, or other factors directly related to season, weather and geography. Site proximity, similar choice of site location attributes (i.e. location on sandy substrate, proximity to Moose Brook) plus a similar suite of lithic raw materials and artifact styles on both sites, indicates a close relationship between the Michaud and Lamoreau sites.

To date, the Lamoreau site is known only from surface collection. It was unknown prior to its discovery by Henry Lamoreau, and so we suspect that it will likely yield a complete assemblage to future work.

The site occupies at least 63 m along the crest of a fossil dune feature along the margin of the Moose Brook valley. The soils have been minimally disturbed there, in some ways less disturbed than portions of the Michaud site. The soil appears to be an intact, well developed podzol similar to the original soil on the Michaud site. One margin of the Lamoreau site is partially bounded by a parabolic dune with its concavity pointing southeasterly. The age of the parabolic dune is unknown, but the podzol on it is well developed. Thus, it is older than the last few hundred years.

The preliminary indications from surface collection are that at least three concentrations of cultural remains exist at the site. These were emplaced along 63 m of dune top, with a maximum dimension perpendicular to the long axis of the site of 10 to 15 m.

THE ARTIFACT ASSEMBLAGE AND RAW MATERIALS

Three tools were recovered during surface collections of the Lamoreau site (Plates 6-1 and 6-2). One is a miniature fluted point similar to those described from 6LF21 (Moeller 1980) in Connecticut and Debert (MacDonald 1985: Plate V: i and g) in Nova Scotia. It is made on a flake of red and green Munsungun chert, whose proximal end has become the tip or distal end of the point. Ventral flake surface ripple marks indicate that it may have been made on a channel flake. Retouch is present along both lateral margins on the dorsal side, and along the right lateral margin and the distal half of the left lateral margin on the ventral side. Also, a slight concavity has been partially worked

into the base by retouch along the ventral side of the base. No attempts at fluting are seen, and the ventral flake surface is unmarred save for retouch on the outer margins. Two moderate sized flake scars intrude on the interior dorsal face, though they appear to have been removed prior to the shaping of the lateral sides. The point measures 32.7 x 16.5 x 3.2 mm. It exhibits a transverse break which occurred one quarter of the distance from the base toward the distal end. Both pieces were found at the same location, and it is unclear whether it is an ancient or new break.

A second specimen is a red and green Munsungun chert biface preform fragment, which broke with an outre passe fracture during the removal of the second channel flake. It measures 48.5 mm in length. (The reader is referred to Chapter 3 for a more detailed description, with the biface preforms from the Michaud site.)

The final artifact to report from the Lamoreau site is a red chert endscraper, which measures 28.5 x 22.2 x 7.7 mm. The striking platform is intact on the proximal end, and both lateral sides are retouched, the right more steeply than the left side. The distal end is angled rather than arcuate in outline, and steeply retouched. Rounding and polish is quite noticeable on the distal and lateral edges, and it extends up to 4.5 mm onto the retouched surface on the dorsal side along the distal and left lateral margins.

Fourteen flakes were also surface collected. Six of these are Neponset rhyolite (Rfnp), three are of patinated blackish-green (Bull Brook) chert, and two are red Munsungun chert. Two flakes are of a white patinated light brown chert which was not present at the Michaud site; likewise not present at the Michaud site is a single flake of a multi-colored red and blue chert. Additionally, three small chunks of Christian Hill diabase, ranging in weight from 17.7 g to 63.2 g were collected.

Plate 6-1. Artifacts from the Lamoreau site. Miniature point at left, endscraper in middle, broken fluted preform at right.

Plate 6-2. Reverse side of points shown in Plate 6-1.

CHAPTER SEVEN
SYNTHESIS AND DISCUSSION

NEW ENGLAND-MARITIMES PALEOINDIAN REGION

In this section we turn our attention from patterning on the intra-site scale to patterning on the regional geographic scale. We propose a New England-Maritimes region for the Paleoindian period, within which fluted point Paleoindian sites share similarities in site location attributes, site size relationships and/or content attributes, and whose inhabitants shared access to a limited number of preferred lithic sources (Table 7-1). We are not suggesting that a single population or populations (with time-transgressive change in specific tool attributes) continuously occupied this region during the entire fluted-point Paleoindian time period, nor are we rejecting this hypothesis. Rather we are suggesting a loosely-defined region which provided the necessary economic base to support one or quite possibly more populations at any time during the Paleoindian period. Just as we recognize a defined region, however, so also do we recognize the permeability of its boundaries. Regionally exotic lithics are present in small quantity in a number of the assemblages from New England-Maritimes Paleoindian sites, suggesting possible remnants from immigration, or contact on an inter-regional level.

The concept of Paleoindian use of specific geographic regions is not new. Gramly (1986) has proposed that present day New York state may be part of three geographic regions utilized by different groups of Paleoindians. The westernmost, characterized by lithic assemblages dominated by Flint Ridge and other central Ohio cherts, he suggests extended from central Ohio up the Allegheny River watershed to westernmost New York southwest of Lake Erie. The central region, with lithic assemblages composed primarily of Onondaga cherts, extended from central New York south to the Shoop site in central Pennsylvania (c.f. Lantz 1984). The eastern region occupied the eastern third of New York, along the west bank of the Hudson and its tributaries. Site assemblages in this latter region are dominated by Normanskill and other Hudson Valley cherts.

Other possible Paleoindian regions in the east seem to have internally consistent settlement patterns. Sites located in the eastern Great Lakes region are found on strandlines of glacial lakes which may or may not have been occupied subsequent to the presence of the lakes (Deller and Ellis 1984, 1986a, 1986b; James Payne, personal communication; Storck 1982, 1983). Lantz (1984) proposes a coherent settlement pattern for western Pennsylvania, with observed occupational differences between glaciated and unglaciated terrain. Settlement in the Mid-Atlantic states seems focussed on river floodplains and swampy areas, as at the Thunderbird site (Custer 1986:53).

On the basis of the criteria stated at the beginning of this section, we define the New England-Maritimes Paleoindian region with a western boundary along what was then the eastern shore of the Champlain Sea (Davis and Jacobson 1984: 20) and its southern tributary valley as far south as 43° 30' north. South of 43° north, the boundary appears to have been the western margin of the Connecticut River valley drainage basin. (The western boundary between 43° and 43° 30' north is archaeological terra incognita.) The northern boundary of this region is the border between Quebec and Maine, New Hampshire, Vermont or New Brunswick.

This political boundary conveniently follows, for the most part, the height of land between the St. Lawrence watershed and more rugged terrain to the south. No provenienced fluted points have been found northward of this boundary. Indeed, the only recorded specimens (Levesque 1962) come from collections which include exotic pieces (Chapdelaine 1985), suggesting that Quebec may not have been inhabited until after fluted points had become obsolete. To the east, the New England-Maritimes Paleoindian region extends across the St. John River valley, on the basis of isolated point finds. Eastern New Brunswick, Nova Scotia including the Debert site, and perhaps Prince Edward Island, are provisionally included in the region based on similarities in tool form between major sites, principally the Vail and Debert sites. We have not personally examined the lithics utilized at the Debert site. Although most appear to be indigenous materials, the lack of description for minority lithics does not preclude the inclusion of more westerly lithics which dominate the assemblages in the rest of the New England-Maritimes Paleoindian region. The southern regional limits extend across Massachusetts to include the Bull Brook, DEDIC, Hanneman, Neponset and Wapanucket sites within the region. The eastern regional margins include the now submerged coastal plain.

In concurrence with Bonnichsen *et al.* (1985: 155), we suggest that access into this region would have been limited to penetration from the south along the coastal lowlands and/or from the west along the Champlain Sea. Access from the north would have been precluded by the presence of the Champlain Sea and inhibited by the Boundary Mountains. Since the dominant recognizable "exotic" lithic raw material in New England-Maritimes Paleoindian assemblages appears to be "Pennsylvania Jasper", we suggest that the most frequent direction of immigration and probably inter-regional contact was from the southwest.

SITE LOCATION ATTRIBUTES

Many sites within the New England--New Brunswick Paleoindian region share a similar set of site location attributes. With only one exception known currently, regional fluted-point sites (ignoring isolated fluted point findspots) are located on sandy soils. Near the coast, these sands generally derive from proglacial runoff deltas built into waters of the marine transgression that inundated coastal margins of northern New England ca. 13,000 B.P. As the transgression ebbed, deltas were built at lower and lower elevations. Further away from the coast the deltas were built into proglacial or meltwater lakes (e.g., Curran and Dincauze 1977). Often, these sandy deposits were blown into dune forms and stabilized by vegetation before Paleoindian occupation. The only known Paleoindian sites in the New England-Maritimes region that are exceptions are the quarry-related sites located on the Munsungun-Chase Lake Thoroughfare. These sites occupy a landform interpreted as a kame terrace (Bonnichsen *et al.* 1982).

Approximately 5% or less of the land surface of the state of Maine is composed of sandy soils. The rest are till or clay-derived soils, Holocene alluvium or bedrock (visual inspection, Maine Geological Survey surficial map). A similar percentage of sandy soils is expected in the rest of the New England-Maritimes region. The location of more than 90% of the regional Paleoindian sites on a sandy substrate is, therefore, significantly non-random. These sandy soils are extremely well drained, which must have had an effect on their vegetation cover ca. 10,500 B.P. In terms of their attractiveness to Paleoindians, we suggest several hypotheses: (1) The sandy areas maintained more open vegetation associations as the rest of the Northeast was slowly overgrown with brush and forest cover; (2) the sandy areas attracted pioneer or soil specific plant species not available elsewhere; or, (3) sandy soils were simply well-drained, making them more attractive camping locations than elsewhere. At present, the pollen and plant macrofossil data are not sufficient to further refine these hypotheses. Sites on this type of terrain include the Michaud and Lamoreau

Table 7-1. Lithic raw materials distribution in New England-Maritimes Paleoindian Region sites. (Percentages noted where possible, plus sign indicates presence).

	Munsungun cherts	Bull Brook chert	Neponset rhyolite	Cheshire quartzite	crystal quartz	Pennsylvania jasper
Bull Brook I	+	85%	+			+
Bull Brook II		86.4%				1.4%
DEDIC		82%	14%			
Hanneman						>70%
Neponset	1%	+	95%			+
Wapanucket		95%				+
Whipple		90%		9%		+
Atkins	+	40%			20%	
Dam	+	+		+	+	+
Lamoreau	+	+	+			
Michaud	30%	30%	40%			
Morss	95%					
Vail	+	40%				+

sites as well as the Dam, Bull Brook I and II, Wapanucket, DEDIC (Ullrick 1978), Whipple, Neponset, Hanneman and Debert sites. The Vail site and several nearby smaller sites are located on valley side, lacustrine sandy soils.

It is seemingly significant that most of the sites, with the possible exceptions of the Vail and Debert sites, are located on sandy soils *adjacent* to a wet or boggy landform. It is not at present possible to reconstruct the condition of any of these wet places at the time of Paleoindian occupation. Similar associations have been noted for several other places where Paleoindian settlement patterns have been examined (e.g., Deller 1976, 1979; Lantz 1984; Judge and Dawson 1972; Storck 1982, 1984). We currently feel that some plant or animal resource associated with these wetlands made it very desirable to camp nearby when a sandy campsite could be located. Such possible wetland-associated resources could be as mundane as cat-tail reeds (Gramly 1986), or as dramatic as mammoth and mastodon (Fisher 1984a,1984b).

Judge and Dawson (1972) published the first systematic Paleoindian site location attribute study, using data from the Southwest. All the Paleoindian sites in Judge's study area combine the attributes of an overview, a hunting area, and water source. Moreover, Judge detected subtle changes in settlement pattern between Folsom and later Paleoindian time periods. "The distinctiveness of the Folsom pattern, however, lies in the close proximity (vertically and horizontally) of the sites to water and in the key role of the playas as sources of water." This association of camping locality with special attributes (elevation) in conjunction with a water source attractive to game might be expected in the dry Southwest.

However, Lantz (1984:210-211) reports similar attributes in a portion of his western Pennsylvanian study area. On the glaciated plateau section of western Pennsylvania, Paleoindian sites and find-spots both are closely tied horizontally and vertically to lakes, marshes and abandoned river channels. Lantz suggests (1984: 216 with references) that this settlement pattern was influenced by usage of the swampy lowlands by mammoth and mas-

todon. In the unglaciated southern portion of Lantz's study area, there is less of a concentration of sites on elevations near water, suggesting to Lantz use of a more diverse fauna. Lantz also recognized a strong association between Paleoindian findspots and sites and low-order (small, upland) streams, with proportionately less use of the major river valleys.

Sites in the New England-Maritimes region exhibit similarities among themselves in site location attributes. The Bull Brook and Bull Brook II sites occupy a sandy high spit, probably a delta remnant. Low ground around the site, which is currently being encroached by the Muddy Run and Egypt River, was probably the location of extensive wetlands during Paleoindian occupation of the sites. The Neponset site occupies a sandy soil area, probably a delta remnant. It is situated at the base of a hill, adjacent to a huge area of wetlands. The Wapanucket site occupies a sandy dune adjacent to a low area, which is now filled with water raised by a dam in a former lake basin. The DEDIC site lies on the foreset beds of a sandy delta built into glacial Lake Hitchcock, on sands blown into a dune form before Paleoindian occupation. Its association with lower, wetter ground is unclear on the USGS map of the area because of development. The Whipple site occupies a valley side sandy delta surface near a bog (formerly a pond, Curran personal communication 1987) and low-lying marsh.

The newly discovered Dam site (Wayne, west of Augusta, Maine) is located on the sandy surface of a small lobe of a terminal Pleistocene delta, probably reworked by eolian action into dunes before the Paleoindian occupation. Immediately adjacent to the east and south is a small stream and large bog. The Michaud and Lamoreau sites are on valley side sand dunes, originally formed by eolian reworking of a sandy upper facies of the Presumpscot Formation. Adjacent to these sites is a deep valley currently occupied by a beaver bog resting on top of 7 meters of saturated stratified fine sand and silty fine sand.

The Vail site is located on sandy, lacustrine soils which have been reworked to some degree by manmade Lake Aziscohos. In front of the Vail site lies the flat--bottomed Magalloway River valley (at low lake level). The habitation site, and killing ground #1 (Gramly 1984) may be associated with a fossil river channel, or a stream channel connecting a kettle hole to the main channel.

The Debert site is located on a sandy outwash delta high above the existing Minas Basin. There does not appear to be any bog, pond, river or other freshwater source naturally occurring immediately adjacent to the main portion of the site on the basis of a personal visit to the site in 1975. Section One, however, does have a possible bog association: "The area of the artifact concentration occurred on a low sand ridge higher in elevation by some six feet than the southern sections. Toward the southwest of Section One, this elevation falls off at a rate of six feet per hundred feet and enters a swampy area of willows and alders" (MacDonald 1985: 50). Although the spruce growth now obscures one's line of sight, the site's inhabitants might have had an excellent view southward and westward for many miles given conditions that were less tree-covered.

In sum, extant Paleoindian sites in the New England-Maritimes region, with the exception of several quarry-related sites, are all located on sandy deposits of marine deltaic or lacustrine origin which had generally been reworked into dune formations prior to vegetative cover and prior to Paleoindian occupation. The Vail site remains the only exception for phenomenon of bog and wetland association with these sand--based sites. Its location in a steep-walled river valley may indicate, per Gramly's interpretation, that this was a strategic area from which to intercept a species such as caribou during their spring or fall migration. It is possible, then, that sites located on a sandy surface adjacent to a bog were desirable locations for exploiting non-migratory game or migratory game in a sedentary portion of their annual cycle.

SITE SIZE AND CONTENT ATTRIBUTES

However measured, the Bull Brook site is the largest Paleoindian site in the New England-Maritimes region. The Bull Brook site is composed of approximately 42 loci or "hotspots", which yielded roughly 8000 flaked stone tools. The 42 loci are arrayed in a rough semicircle of large diameter.

The Vail site was dug and analyzed as 8 loci (Gramly 1982; various), although the artifact plots of Locus E suggest the presence of two nearly equal-sized elliptical concentrations of tools. Moreover, Locus E contains nearly twice the number of tools as the next-largest locus. Thus, Locus E might be considered as two adjacent loci (or tool concentrations). The total tool count for the Vail site is very near 4000 (3935 as last published).

The Debert site contained 11 loci, with eight in a closely spaced array. Two Debert loci (D and E) were located 200 to 400 feet westward of the main array, and Locus One was located 800 feet north-eastward. Like Locus E at Vail, Mac-Donald's plots of artifact locations for Locus F seem to show a northern and southern tool concentration, so the main section of the Debert site may include 9 loci. The total tool count at Debert is roughly 4000 artifacts.

Bull Brook II contained 6 loci and 487 tools; Grimes *et al.* state that the 6 loci were more closely spaced (less sterile space between) than the 42 loci at Bull Brook. The Whipple site had 3 loci and 136 tools; the Michaud site had 8 loci (Concentration VIII being considered disturbed soil from Concentrations V and VI) with approximately 130 tools; the Neponset site had at least 3 loci and 200 tools. The Wapanucket 8 site provided incomplete data due to limited excavation and prior disturbance. The DEDIC site was only partially surveyed (Ullrich 1978), but yielded evidence of 6 loci. A testpitting program recovered only a very small number of artifacts from the site.

There is a range of nearly 2 1/2 orders of magnitude (50-8000) in number of stone tools, but only 1 1/2 orders of magnitude (1- 40) in number of loci among these sites. Thus, the range in number of tools per locus varies by a factor of ten, yet even the largest sites maintain discrete spatial patterning with tools deposited in bounded concentrations. We feel that internal site patterning such as exhibited by the non-overlapping concentrations of loci at Bull Brook, Vail and Debert could not be accounted for by 10 to 20 repetitive occupations of the "size" of the Bull Brook II site, or even more of smaller site size (cf. Spiess 1984). A much more random distribution pattern should have resulted from many repeated small occupations as domestic structures were rebuilt, added or moved. Even the largest sites must have been occupied once, or a very few times. Thus, there must have been some social or economic (food or non-food) factor causing either scheduled or random large population gatherings (e.g., 40+ loci at Bull Brook) and/or longer residence within one pattern of campsites and activity areas (8-12 loci at Vail and Debert).

In terms of intensity of occupation, and considering that Locus F at Debert and Locus E at Vail actually consist of two tool concentrations, the number of tools per intact concentration ranges from roughly 100 to 648 at Debert, roughly 60 to 230 at Vail, and roughly 70 to 270 in a sample of loci at Bull Brook (Grimes *et al.* 1984). Bull Brook II yielded 50 to 120 tools per locus, and therefore was roughly similar in intensity to the Neponset and Whipple sites. The Michaud site yielded between 1 and 20 tools per locus.

To date, there does not appear to be a regular pattern of site size or intensity of use correlating with geographic location. The largest sites (Vail, Bull Brook, Debert) are widely separated (Figure 7-1). We also note that there is *not* a continuum of site size: there are approximately 8000 tools at Bull Brook (I) and 4000 tools each at Debert and Vail. The next largest site, Bull Brook II, contains about 500 tools, a drop in total occupation (as measured in tools finding their way into archaeological context) of an order of magnitude.

Another geographic pattern emerges from a close examination of site location

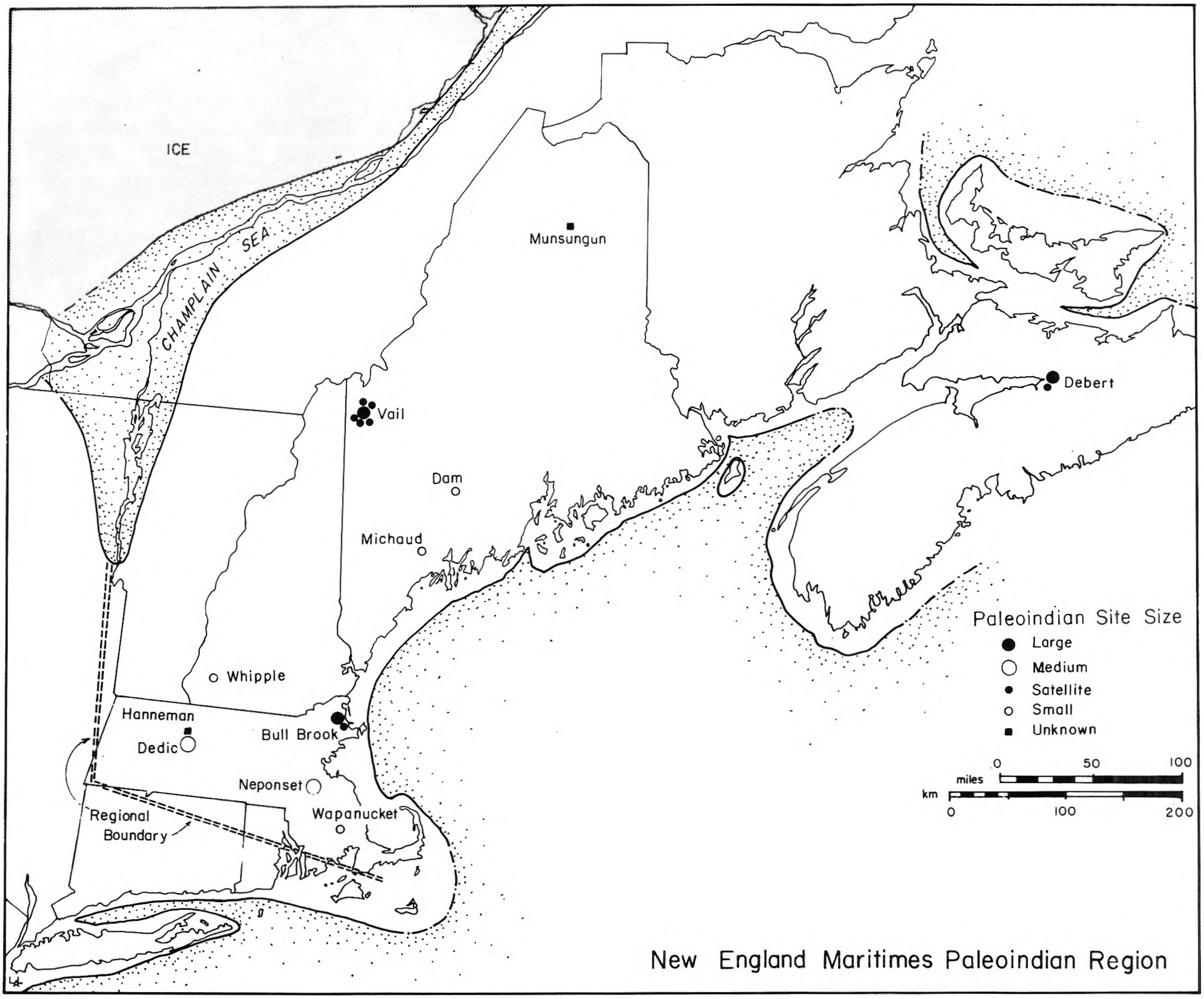


Figure 7-1. The New England-Maritimes Paleoindian Region.

data. Many of the sites in the New England-Maritimes region occur as site clusters or site pairs. The Michaud and Lamoreau sites are an example which share a common suite of lithics. Another association includes the Bull Brook I and Bull Brook II sites, which also share a common suite of lithics. The Vail site has at least 5, possibly more, smaller Paleo-indian sites in geographic proximity. We argue that Section One at Debert, separated as it is from the other loci by 800 feet and with a significantly different suite of lithics, represents an analogous associated but geographically and probably temporally distinct site. The presence of the mineral pigment pyrolusite in Section One and in none of the other sections, the presence of a different suite of lithic raw materials than in the other loci at Debert, and the slightly different topographic location tend to support this suggestion. In many of these cases there appears to be a small--site: larger-site association which may represent a smaller occupation followed (shortly, perhaps seasonally or within a few years) by a larger occupation in the same vicinity, or vice versa. We call this concept the "satellite site" phenomenon. A major gathering may have resulted from the transmission of information concerning a successful kill by an initial settlement, or about the availability of game locally. An alternative to this economic hypothesis is that the larger gatherings were planned primarily for social reasons, without economic constraint.

The Michaud and Lamoreau sites apparently prove that not all multiple reuses of a small geographic area resulted in, or followed, a major gathering. Perhaps the Michaud and Lamoreau occupations reflect (seasonally?) different short term occupations. We suggest that the inhabitants were either (1) a family(s) or small group(s) who were moving during a time of the year when the population segmented for the acquisition of widely dispersed resources; or (2) task groups sent out from a major encampment for the purpose of observing or procuring game, obtaining lithics or some other resource which need not involve the participation of the entire population. We have above suggested that the location of the Michaud and Lamoreau sites directly above the headwaters of the Royal River may be indicative of the area's position on a travel corridor from the coastal plain into the interior. Small groups may have met at the Michaud and Lamoreau sites on this known route, or may have occupied the site at different times because the physical characteristics (sandy soil and associated bog) were desired locational attributes.

STONE TOOL KITS

In this section we consider some of the processes responsible for the appearance of stone tools in archaeological context, with the intent of examining the variability in stone tool assemblage content between loci within each regional Paleoindian site and between sites. We suggest that there are three main processes by which material in these assemblages was deposited. First, material may have been discarded during the manufacture or resharpening of stone tools, resulting in the production of flakes, microflakes, preforms broken during manufacture, and the discard of spent tools whose replacement was imminent. For example, broken or heavily resharpened fluted points could have been discarded from a haft as a replacement for them was made. Secondly, tools for which a duplicate or a replacement already existed may have been discarded in a work area as their size was reduced below the threshold of usefulness and/or their working edge became dulled and steepened beyond the point where resharpening could reinstate a useful edge. Some of the endscrapers with advanced step-flaking may fall into this category. Thirdly, there is simple loss (misplacement, with unsuccessful attempt to recover) or abandonment (including caching with intent to retrieve later) of tools that had not been broken and had much use left in their existing edges, or much potential for resharpening or reworking into other tools. Seemingly, many of the large

sidescrapers fall into this last category, as they would certainly at least represent a reservoir of raw material that could have been used if the need were there.

The use of a stone tool, its breakage, end of useful life, discard or simple laying aside, may or may not occur congruently with the manufacture of a replacement piece (see discussion of Gramly 1980, below). To some degree, however, the coincidence of such activities within each locus at a Paleoindian site should be testable. The killing ground at the Vail site (Gramly 1984), for instance, reveals the use of fluted points at one locality, the curation of broken hafted proximal ends, and their return to a second locality for replacement.

We do not assume that there was a one-to-one correspondence between use of a single stone tool and a single task. For example, production of a set of snowshoes (if present in the technological repertoire) must have required the use of at least 3 or 4 stone tools or tool edges: one for splitting wood, one for whittling (scraping), one for making holes and one for cutting rawhide line. Thus, there was often a suite of tools habitually used for a task.

Based on Osgood's (1940) ethnohistoric data, it can be demonstrated that different types of tools have different lifetimes of usefulness. Some simply wear out more quickly and must be replaced more often. All other things being equal, we would expect to find tools with short use lives more often in archaeological context than we would tools with longer useful lifetimes. Thus, the tools recovered by the archaeologist will reflect not only the frequency of particular tools in the original kit and their frequency of use, but their shorter or longer use life as well. A given task repeated many times over with associated tool maintenance and replacement will yield an average signature of tool proportions diagnostic of that task. The statistics of sampling, however, will create some variability in the tool assemblage deposited into archaeological context, especially among short-term deposits originating from the same activity. (Additional sampling problems occur during archaeological recovery, of course.) Thus, while we cannot consistently expect a characteristic signature from any given task performed during a short-term occupation, we may recover an assemblage that is interpretable. We believe that the "toolkit" from Concentration I at the Michaud site is, for example, a signature for fluted point replacement and some sort of associated activity (possibly hafting, making foreshafts or shafts).

Consideration must also be given to the *context* of discard as well as to the *content* of discard. Keeley (1982: 800) suggests that hand-held tools are most often discarded at the location of their use and are generally not curated. Hafted tools, because dislodging the stone implement from the haft may require some special effort and more time, are often found discarded in a location other than where the tool was last used. Interestingly, Keeley states (1982: 800) that "because the handle or shaft is usually more 'expensive' than the tool that arms it, it follows that the former would be regarded as especially valuable, and therefore highly-curated and carefully conserved, while the hafted tool would be replaced several times during the use-life of the haft." Thus, careful examination of the tool associations within a site locus should yield information on the context of discard or loss.

Following the logic presented above, we may be able to decipher some of the tasks performed in activity areas at any one site. Those tasks, of course, would have varied from site to site for a variety of reasons. We suggest that variability in the performance of tasks within a Paleoindian region over a short time resulted from: (1) seasonally variant activities; (2) geographically variant activities; (3) scheduling of activities relative to lithic supply replacement; (4) seasonally and geographically random activity, associated with "windfall" resource procurement for example; and/or (5) duration of occupation. Seasonally focussed activity in arctic culture includes the production of winter clothing in fall, production of transporta-

tion equipment (kayak, sled, toboggan, snowshoe) at appropriate season, repair of skin tents with the approach of summer or winter (with appropriate cover), and manufacture of many items seasonally when some raw material (root, wood, bark, bone) is available or "best" in quality, and/or when certain working conditions (use of small outdoor fires for charring wood, for example) are available (e.g., Osgood 1940). There is no certainty that Paleoindians in the New England-Maritimes region were operating on a seasonal schedule, but it seems probable, as all known ethnographic arctic, subarctic, or north temperate hunter-gatherers seem to have done so to a greater or lesser degree.

Geographically focussed activity may have included the preparation of boats when near large bodies of water, or the harvesting of plant resources (wood, bark, roots for lashing, reeds for weaving, or food resources) when near or in certain "patch types" in the environment, wherever located. It is probable that the harvesting of certain faunal resources was also geographically focussed. An example is the postulated focus on boggy or marshy localities in a portion of our study region, possibly for trapping and killing proboscidians or other fauna.

It is only when geographic variability and seasonal variability co-vary in parallel over spans of time longer than a few years that a true "seasonal round" can be established. At present there is little or no evidence (discussion below) that we can detect such a construct during the classic fluted point Paleoindian period in our study area. Perhaps the decoupling of geographic and seasonal variability is an apt characterization of the "free wandering" mode of life postulated for Paleoindian so long ago (Beardsley *et al.* 1956).

Gramly (1980) proposes an effect which may be a further source of variability in the stone tool record, based on a concept of scheduled or periodic (Gramly 1980:828) returns to lithic quarries. He hypothesizes that formal tools are curated (sensu Binford 1976), pushed to their limits of resharpening and usefulness, then replaced at periodic visits to chert (or other cryptocrystalline lithic) quarries. There the archaeologist finds these discarded, heavily worn tools, often of imported lithic materials, where they were replaced by newly made objects. Based on evidence from West Athens Hill (Gramly 1980:829), he postulates either frequent Paleoindian visits to quarry sources, or that "journeys to other provinces and lithic sources may have lasted a shorter time than it took for the complete tool kit to become worn and in need of replacement." The Vail site is situated less than thirty miles from a chert source. Our re-examination of the Vail collection, however, has produced several lines of evidence that lead us to question the hypothesis of annual visits to a chert source. Contrary to Gramly's interpretation that the vast majority of the Vail site lithics are from the Ledge Ridge chert quarry, we suspect that (at a conservative estimate) over two-thirds of the Vail site lithics come from distant sources. Also, there are a number of very large tools in the collection, contrary to Gramly's hypothesis that nearly all lithic reserves had been exhausted. In any case, nearness to a quarry source, or a sudden infusion of new raw material into the "economy", could have caused extensive tool replacement activities which would influence the Paleoindian archaeological record.

Our model of New England-Maritimes Paleoindian transhumance, developed more fully below, tends to support Gramly's (1980) hypothesis of several to multiple Paleoindian visits to chert sources every year.

Only roughly 2 kg of cryptocrystalline rock was "used up" by the occupants at the Michaud site. Assuming that the occupations lasted a few weeks by several families, and assuming that the Michaud site is "average" for lithic loss rates, then total annual use of cryptocrystalline rock per family may have been on the order of magnitude of 10 kg. Obtained several times a year, and carried as biface blanks or large quarry flakes, this rate of expenditure of cryptocrystalline rock would not have been a tremendous burden to maintain.

Luedtke (1979) estimates that 50 kg per year per family of flakeable stone was used by late Woodland inhabitants of the Upper Great Lakes. This figure compares with 20-40 kg chipped stone per year per family for Australia and New Guinea, estimates she derives from the literature. Luedtke states that chert was widely available in surface gravel and stream deposits in her study area, and that late Woodland inhabitants could have satisfied their stone requirements during the course of other activities. For the Paleoindian populations in the New England-Maritimes region, our lower estimate of chert use per year seems reasonable in view of the cultural requirement that chert come from bedrock outcrop, and in view of the possible long-distance transport involved.

Another source of variability in the archaeological record may involve the duration of site occupancy, a function perhaps linked to season of occupancy or site location. The production of items not frequently manufactured, but required for winter subsistence, for instance, or items which required materials, perhaps a special type of wood, available only in certain areas, may have been carried out at campsites which were occupied for longer duration. The presence of drills at the larger regional sites such as Bull Brook, Vail, and Debert, and their absence at many of the smaller sites, may be an indication of their use in "long term" tasks. Their absence or limited presence in smaller sites may also indicate that they were a minority tool which did not as often find its way into the archaeological record. However, they are present in less than expected frequency, or are absent altogether, at sites other than the largest ones. Certain tasks, such as fluted point replacement, appear to have been frequent activities which were not related to length of occupation.

Finally, tool kit content and use might have changed slowly over time, as tool forms were modified or new ones invented. Such change could have been a gradual response to environmental change, in the sense that some activities were no longer as frequent and new ones were invented. Thus, chronological change may be a source of variation in the record as well.

As an effort at intersite comparison, in an attempt to "crack" the Paleoindian adaptation pattern puzzle in the study area using lithic analysis, we examined any available data on stone tool type counts and frequencies, and tool status (fragmentation, etc.). Where possible, data were collected for each locus on a site, because of the recognized inter-locus variability in each site. It became immediately apparent that a comprehensive, detailed description of each stone tool assemblage, including raw material, fragmentation, heat induced pot-lid fracture, and use-wear has not been published for any of the larger assemblages available for comparison. There is a general lack of other information such as: which portion of a fluted point was present when counted as a fluted point; whether it had been broken during manufacture or during usage, or simply mislaid; to what use retouched flakes had been put; whether or not channel flakes were utilized, and so forth. Even more limiting, we found a non-congruence in classification of stone tools into named tool types. Gramly's "cutter" category, for example, contains objects designated in other reports as endscrapers with spurs, gravers, and (his new identification) snapped pieces. Often channel flakes were not counted and limaces were not consistently reported. We are limited by these factors to comparing data on fluted points (undifferentiated), endscrapers, sidescrapers, drills, pieces esquillees, and occasionally, flake:tool ratios.

Even with these severe limitations, some interesting patterns emerge. Table 7-2 presents locus-by-locus tabulations for the Michaud, Bull Brook I and II, Debert, Whipple and Vail site assemblages. Table 7-3 presents range (among loci) and mean frequency data for solely these five tool types. The small samples from Michaud (Table 7-2) make standard errors on the proportions large (not calculated). However, the contrast between Concentration I, interpreted as biface manufacturing, and Concentration III, dominated by sidescrapers, is apparent. The homogeneity apparent in Concentrations IV through IX is

Table 7-2. Frequency and percentages of different tool classes within concentrations at the site.

Site and Concentration	Fluted points	Endscrapers	Sidescrapers	Drills	P.Esquillees	Total	Tool:Flake ratio
MICHAUD							
I	4 (66.6%)	2 (33.3%)				6	
II			1			1	
III	1 (12.5%)	2 (25%)	5 (62.5%)			8	
IV	1 (50%)		1 (50%)			2	
V	2 (40%)		3 (60%)			5	
VI	1 (33%)	2 (67%)				3	
VII		1 (50%)	1 (50%)				
(VIII added to V)							
Sum of IV-VIII	4 (33%)	3 (25%)	5 (42%)			12	
BULL BROOK I							
Locus 6		14 (40%)	20 (57%)		1 (3%)	35	
Locus 10		33 (53%)	25 (40%)	1 (2%)	3 (5%)	62	
Locus 36	1 (4%)	10 (36%)	11 (39%)		6 (21%)	28	
Locus 18	2 (2%)	50 (60%)	24 (30%)		7 (9%)	83	
Locus 2	2 (9%)	5 (23%)	12 (55%)	1 (5%)	2 (9%)	22	
Locus 32	3 (5%)	38 (58%)	23 (35%)		2 (3Z%)	66	
Locus 27	5 (4%)	55 (47%)	37 (32%)	2 (2%)	18 (15%)	117	
Locus 11	5 (9%)	29 (55%)	16 (30%)		3 (6%)	53	
Locus 9	6 (6%)	42 (43%)	40 (41%)		10 (10%)	98	
Locus 41	5 (7%)	26 (36%)	33 (45%)		9 (12%)	73	
Locus 19	7 (5%)	59 (46%)	50 (39%)	1 (1%)	11 (9%)	128	
Locus 15	12 (11%)	46 (42%)	39 (35%)	4 (4%)	9 (8%)	110	
Site total: 8000 tools.							
BULL BROOK II							
Locus A	3 (11%)	15 (56%)	6 (22%)		3 (11%)	27	5.5:1
Locus B	2 (5%)	37 (90%)	1 (2%)		1 (2%)	41	3:1
Locus C		19 (86%)	1 (5%)		2 (9%)	22	10:1
Locus E		25 (93%)	1 (4%)		1 (4%)	27	1:1
Locus F		24 (75%)	2 (6%)		6 (19%)	32	
Locus G	1 (2%)	43 (77%)	4 (7%)		8 (14%)	56	

Note: These figures are based on the sample size figures used by Grimes (1984: 174) to compare tool frequencies between the Bull Brook and Bull Brook II assemblages. Some discrepancy has been encountered between total tool counts (Grimes 1984: 164-165) and those extrapolated from the data presented in the comparative table mentioned above.

Table 7-2 cont.

DEBERT

Locus A	3 (2%)	121 (68%)	11 (6%)	1 (0.5%)	41 (23%)	177	6:1
Locus B	2 (2%)	62 (60%)	5 (5%)		34 (33%)	103	4:1
Locus C	17 (5%)	224 (66%)	22 (6%)		77 (23%)	340	5:1
Locus D	19 (28%)	28 (41%)	6 (9%)	2 (3%)	13 (19%)	69	35:1
Locus E	2 (40%)	3 (60%)				5	22:1
Locus F	25 (5%)	363 (67%)	47 (9%)	9 (2%)	95 (18%)	539	5:1
Locus G	11 (3%)	216 (52%)	43 (11%)		144 (35%)	414	4:1
Locus H		40 (62%)	2 (3%)		22 (35%)	64	6:1
Locus I	5 (6%)	44 (64%)	1 (1%)		19 (28%)	69	7:1
Locus J	27(6%)	233 (55%)	61 (14%)	2 (0.5%)	103 (24%)	426	4:1
Locus One		31 (44%)	3 (4%)		37 (52%)	71	1.2:1

Site total: 3935 tools, 23,636 flakes
These data have been extrapolated from Table 3 of the Debert site report. Percentages of tool types were given by locus, with a total number of specimens listed below tool percentages. The number of specimens in the selected tool classes were obtained by multiplying the percent given by the total number of artifacts for the given locus.

WHIPPLE

Locus A	12 (55%)	4 (18%)	5 (23%)	1 (5%)		22	545:1
Locus B	3(14%)	17 (81%)	1 (4%)			21	65:1
LOcus C	3 (3%)	19 (63%)	6 (20%)		2 (7%)	30	120:1

The figures used in the Whipple site table were derived from the test describing the Whipple site in locus by locus discussions (Curran 1984: 10-12).

VAIL

Locus A	8 (8%)	49 (51%)	8 (8%)	1 (1%)	30 (31%)	96
Locus B	8 (11%)	42 (57%)	9 (12%)		15 (21%)	74
Locus C	8 (9%)	40 (43%)	8 (9%)	20 (21%)	17 918%)	93
Locus D	9 (7%)	43 (36%)	7 (6%)	3 (3%)	59 (49%)	121
Locus E	19 (6%)	109 (36%)	23 (8%)	8 (3%)	143 (47%)	302
Locus F	3 (14%)	17 (77%)			2 (9%)	22
Locus G	1 (3%)	6 (16%)	6 (16%)		22 (59%)	37
Locus H	4 (9%)	13 (30%)	3 (7%)	1 (2%)	23 (52%)	44

The tool frequencies per locus cited above have been taken from the updated version of the Vail report (Gramly 1985: 66, 93).

Table 7-3. Range of percentages and mean percentage of different tool classes among the loci at various northeastern Paleoindian sites.

	Range	Mean	N (total for tool type)
ENDSCRAPERS			
Bull Brook	22-60%	45%	407
Debert	40-68%	55%	1365
Vail	16-77%	43%	319
Whipple	18-81%	54%	40
Bull Brook II	55-92%	79%	163
Michaud	25-66%	43%	7
SIDESCRAPERS			
Bull Brook	30-57%	40%	
Debert	1-14%	7%	
Vail	6-16%	8%	
Whipple	5-23%	16%	
Bull Brook II	2-22%	8%	
Michaud	5-62%	25%	
DRILLS			
Bull Brook	0-5%	1%	9
Debert	0-3%	1/2%	14
Vail	0-21%	4%	33
Whipple	0-5%	1 1/2%	1
Bull Brook II			0
Michaud			0
PIECES ESQUILLEES			
Bull Brook	3-21%	9	81
Debert	18-52%	26%	585
Vail	9-59%	37%	311
Whipple	0-7%	2%	2
Bull Brook II	Inaccurate figures		
Michaud			0
FLUTED POINTS			
Bull Brook	0-11%	5%	48
Debert	0-28%	5%	111
Vail	3-14%	8%	60
Whipple	3-54%	24%	18
Bull Brook II	0-11%	3%	6
Michaud	0-67%	29%	9

masked by missing tool types and small numbers, but it is apparent in comparing the summation with individual loci.

We have previously discussed the variation evident in site size in the New England-Maritimes Paleoindian region. Here we will examine assemblage variability in relation to site size, first among sites of roughly similar proportions and then between sites dissimilar in size.

Bull Brook remains the largest Paleoindian site in the region. However, since the Vail and Debert sites are an order of magnitude larger than any other regional Paleoindian site, we will compare these three as one group of "large" sites. Among the tool classes chosen for comparison, both endscraper and fluted point percentages are roughly equivalent in each of these sites. Endscraper proportions range from 43-55% and fluted point densities (unknown stages) average from 5-8% of the comparable assemblages.

Drills are present at all three of these sites in low frequency. (Stylistic variability in drill bit form has already been discussed in Chapter 3). Locus C at the Vail site displays an uncharacteristically high proportion of drills, several of which were found in proximity to fluted points, biface thinning flakes, an endscraper, cutter, and in one instance, a limace. It would be hard to draw any conclusions about the associated tool types without a much greater familiarity with the entire assemblage. The high proportion of drills in a single locus does, however, suggest focussed activity. The explanation may be as simple as a particularly proficient drillmaker who periodically replaced the drills of a number of inhabitants or, on the other hand, may involve the production of specialized gear which required the use of many drilled holes.

Examination of the proportions of pieces esquillees and sidescrapers reveals major differences between sites. The mean frequency of pieces esquillees per locus at Bull Brook is 9.2%, with the largest value being 21.4%. At Vail and Debert, mean incidence is 36.8% and 26.2%, respectively, while the greatest proportion of this tool in a single locus is well over 50% in both cases. Sidescrapers likewise show significant variation in frequency between Bull Brook and Vail and Debert. Bull Brook shows an average incidence of 40% at the sample loci, while the averages for Debert and Vail are between 7% and 8%. We concur with Lothrop and Gramly (1982) and MacDonald (1985) that pieces esquillees were used as tools, and do not represent discarded cores (contra Goodyear 1982). Thus, the unusually high frequencies of pieces esquillees at the Vail and Debert sites may, in fact, indicate a temporally or socially significant elaboration of activities which occur in lesser frequency at many other Paleoindian sites in New England--Maritimes region. Likewise, the large numbers of sidescrapers recovered at Bull Brook and their low incidence at the Debert and Vail sites probably indicate functional differences between major activities carried out at these sites.

In sum, while some tool types are present in approximately the same frequencies among the largest Paleoindian sites in the New England-Maritimes region, the incidence of both pieces esquillees and sidescrapers are disproportionate between Vail and Debert (as a pair) and Bull Brook.

We will next consider sites in the medium size range together with satellite sites of the larger sites. (In most cases these satellite sites are either an order of magnitude smaller than their larger relatives in terms of the number of loci present, or in the density of artifacts per concentration.) We include herein Bull Brook II, Locus One at Debert, and the Vail related sites (Gramly personal communication) in the Magalloway Valley. Sites located in close proximity to the Vail site include the Adkins site, Morss site, Wight site, Site A, and Site B; all are composed of one locus each, with a tool density per site of several tools to approximately one hundred tools (Gramly, personal communication, 1986). Relatively high percentages of both endscrapers and pieces esquillees are found in all of these sites, parallel to the Vail site. Drills are absent from all of these sites, however. Fluted points are

present in various but always relatively low proportion. Although the average depth of the basal concavity on projectile points varies somewhat between sites, it generally attains a depth similar to the mean for Vail points. Coupled with a definite similarity in other fluted point attributes, it can be reasonably stated that all of these sites are "related". Of particular interest is a stone-lined cache pit recorded and recovered from the Adkins Site. It suggests that the inhabitants left the area with the intent to return, and that they left during a season when they expected stored meat to remain edible.

Bull Brook II represents an assemblage dominated by endscapers, with a mean per locus presence of 79%. A small number of sidescrapers were recovered from each locus, as were a small number of pieces esquillees. A total of six fluted points were recovered from three of the six loci. Seventeen biface preforms and fragments, as well as a substantial number of biface thinning flakes, attest to the significance of fluted point manufacture at the site (Grimes *et al.* 1984: 163-165). Drills are completely absent from the site assemblage. Interestingly, only a single hammerstone completes the rough stone component at Bull Brook II, providing a possible example of the exclusion of activity related to abrading and/or chopping functions.

Locus One at the Debert site is rather small in comparison to the Bull Brook II site, but is actually roughly proportionate in the total number of tools recovered in comparison to the number of tools recovered from the main site (136 in Section One, 4,000 total at the main Debert Site; 335 at Bull Brook II, 8,000 at Bull Brook). "In the artifact assemblage (for Section One) pieces esquillees hit their peak at over 27%, while bifacial artifacts including points was a low 1.5%. In general, it can be said that tool manufacture and maintenance was almost negligible on this floor (MacDonald 1985: 52)." Endscrapers are also present in considerable proportion, although certainly not in the dramatically high percentages present at Bull Brook II.

In sum, a potential correlation exists between the satellite site phenomena at the Debert Site (Section One) and at the Vail site (Adkins Site, etc.). Dramatic similarities in tool attributes and proportions of specific tool types at the main sites, coupled with the similar number of loci in each site (nine each, assuming that Sections D and E at Debert are tool manufacturing areas), suggest that the groups who occupied the Debert and Vail sites may either have been related or were actually the same group geographically and temporally displaced. Bull Brook II seems to represent the same phenomenon of being a satellite site, but rather in relation to Bull Brook.

The Upper and Lower Wheeler Dam sites reported by Gramly (personal communication, 1986) are located in a river valley north of Lake Aziscohos where Vail and its related satellite sites are located. Although these sites have been only tested and not thoroughly excavated, a pattern of site use similar to that at the Vail site may be emerging. The Lower Wheeler Dam site (Gramly, personal communication, 1986) has yielded to date an assemblage from multiple loci which includes over 600 pieces. The Upper Wheeler Dam Site, on the other hand, appears to be smaller, possibly a satellite of the Lower Wheeler Dam Site. Anticipated analysis of the existing collections by Gramly should prove most interesting as the information generated is compared with other regional sites.

Other sites of apparently "medium" size, but without known satellite sites, include the Neponset Site just west of Boston, the DEDIC site in Deerfield, Massachusetts and possibly the Hanneman site in western Massachusetts. Unfortunately, thorough analyses of these sites are not available.

Sites of small magnitude which are apparently unrelated to larger sites have now been noted for a number of locations in the New England-Maritimes Paleoindian region. Included under this heading are the Michaud and Lamoreau sites, the Dam site, and the Whipple site. As mentioned in Chapter 6, the Michaud site contained two

distinct areas, probably representing two separate occupations.

The Lamoreau Site remains unexcavated, although testing done in the fall of 1986 suggests that the site is of approximately the same magnitude as the Michaud Site, i.e. very small with several dense concentrations of tools and debitage separated by sterile soil. An insufficient number of tools have thus far been recovered to reveal significant tool percentage relationships.

The Dam Site was thoroughly excavated by a crew under Spiess's direction in the spring of 1986 and 1987. Although distributional data are not exact due to deflation of the sandy soil and because of soil displacement by sheet runoff movement through portions of the blown-out sandy area, an interesting, small assemblage was recovered. A complete analysis has not yet been undertaken (preliminary analysis has been accomplished by Brush), but subjectively determined tool proportions are presented here. One complete fluted point, which had been broken at mid-section, and a fluted point base complete the biface inventory. No preforms and very few biface thinning flakes were recovered, suggesting that fluted point replacement was not a primary occupation at the Dam Site. Endscrapers and sidescrapers were present in low and nearly equal proportions. Several gravers and "snapped pieces" were present in the assemblage, while drills and pieces esquillees were absent. The raw materials from the site are diverse, and are from seemingly such widely separated localities as eastern New York State, the Champlain Lowlands, central Vermont, Pennsylvania, Nova Scotia and northern Maine.

The Whipple Site produced approximately 136 tools in three loci. Interestingly, considerable amounts of debitage were recovered, suggesting large scale reduction of lithics which apparently came from western Vermont. The formal tool inventory includes most of the known northeastern regional Paleoindian tool forms. Particularly notable in this small collection are a single fluted drill and several pieces esquillees, which are usually absent in sites of comparable size. Distribution of tool forms among loci is uneven, as are the percentages of raw material types. These internal inconsistencies have led the analyst (Curran 1984: 14-15) to speculate on functional and perhaps temporal differences between loci.

Two Paleoindian sites which have not as yet been fully reported do not fit neatly into the pattern of site sizes suggested above. These are the Windy City and Fluted Point sites currently being analyzed by Payne and Bonnichsen (Bonnichsen *et al.* 1982). The sites are located on a kame terrace which was deposited along the bedrock-controlled margin of the Chase--Munsungun Lake Thoroughfare in northern Maine. Their location in close proximity to the Munsungun chert outcrops, and the large amounts of lithic reduction debris present at both sites, attest to the quarry-related function of both of these sites. Total site size has not been determined for either site. These sites should eventually provide information on Paleoindian lithic procurement strategies in the New England-Maritimes region.

INTRA-REGIONAL LITHIC DISTRIBUTIONS

We have suggested that a limited number of high quality lithic materials, whose sources appear to be distributed throughout the New England-Maritimes region, occur in variable combinations and proportions in site assemblages within the region (see Table 7-1 and Appendix 3). This pattern of lithic distribution indicates a high degree of mobility of some sort within the region. For many lithic materials, there appears to be no "cost" for travel in terms of decrease in proportion of stone with distance from source until an abrupt frequency fall-off is reached near the borders of the region. The mobility that created this pattern need not have been mobility of large population segments, nor need it have been tied to a seasonal cycle of subsistence activities (see discussion below). We suggest that the movement of lithic material *within* a Paleoindian "region" was different in kind than the less

than the less frequent movement of raw materials from far away into a particular region. Lantz (1984:213) uses the term "migration" to characterize Paleoindian behavior that transported lithic material from great distances. He states that Paleoindian knowledge of high quality lithic materials "seems more likely due to personal encounters with various deposits, rather than a trade system being established at such an early date." We suggest that movement of lithics within a region was a result not only of the high mobility of at least a portion of the population, but also resulted from "trade" or "exchange", perhaps very informally, between people who interacted frequently. Movement of pieces inter-regionally over longer distances might have been a less frequent, although not unique, event rather than a reciprocal trade connection.

We have noted subtle variations in the pattern of lithic use in the New England-Maritimes region. Several materials, including Munsungun chert and eastern Champlain shore cherts from Vermont, have a wide distribution in regional Paleoindian sites, indeed, support the concept of no "cost" for travel in terms of frequency fall-off with distance from source. On the other hand, several materials appear to polarize by either geographical location and/or use in sites displaying the Vail/Debert type fluted points or the Bull Brook-like fluted points. For example, the distinctive Nova Scotia chalcedonies dominant at the Debert site have not been noted at more westerly Paleoindian sites, although an isolated fluted point of this material was recovered at Prince Edward Island. On the other hand, several materials, including Neponset rhyolite and Saugus rhyolite, appear to be limited to a more southerly regional distribution and have not been recovered in a Vail/Debert type assemblage. "Pennsylvania Jasper" has been identified as a minority component in assemblages displaying either point type, and apparently dominates the Hanneman site assemblage.

DISCUSSION

We propose that the Paleoindian period in the New England-Maritimes region may involve several distinct phases, or that more than one population inhabited the area, either concurrently or within several hundred years of one other. We cluster the Vail and Debert sites as one group, including the satellites of the Vail site from the Magalloway Valley area, based not only upon consistent congruence of fluted point form and similarity of other tool forms, but also on the basis of major site-satellite site size relationships and possibly patterns of lithic procurement. The main sites at Vail and Debert (excluding Section One at Debert and considering it as a separate occupation, and considering Sections D and E as tool replacement areas rather than habitation loci) are quite similar both in the number of loci occupied and in the number of tools discarded overall. The consistent relationship of a single locus satellite a number of times in the Vail site locality and seemingly once at Debert provides another interesting analogy. Lithic use patterns also provide a key difference: Vail/Debert assemblages do not appear to include lithic materials from Massachusetts. The absence of sites displaying the distinctively deep-based fluted points in the New England-Maritimes Paleoindian region south of the Magalloway Valley, and their occurrence to the northeast at the head of the Bay of Fundy, may in time provide some temporal-economic clues to be used in conjunction with more detailed micro--environmental data in reconstructing the particular adaptive pattern of these people in the regional Paleoindian picture.

In the same way that the former sites appear to cluster, so also do Bull Brook, Bull Brook II, and probably Whipple, DEDIC, the Hanneman site and possibly a number of others. The fluted points from these sites fall within a range of attributes distinctly different from the range of attributes displayed by the Vail-Debert group. A proportionately higher incidence of side-scraper use by the Bull Brook group, coupled with the proportionately lower

frequency of pieces esquillees further segregates the two groups.

Site locational attributes also display some subtle differences: all of the sites of the Bull Brook group are located on duned sandy deposits associated with wetlands of varying magnitude. Section One at Debert shows this association, but the main site, although located on duned sand, is not significantly juxtaposed with a bog or other wetland. The Magalloway Valley sites are located adjacent to the early Holocene course of the Magalloway River which Gramly (1982) has postulated to have aided early hunters in directing game movements. The Magalloway River and associated valley, however, might not have supported the same faunal and floral communities as would a bog or wetland.

Site size associations provide another possible pattern relevant to this discussion. Bull Brook II is comprised of six loci. While other sites postulated to belong to the Bull Brook group are apparently not this large, none are limited to a single locus. As Bull Brook represents the largest Paleoindian site in the New England-Maritimes Paleoindian region, so also do its apparently related sites contain multiple rather than single loci.

Assemblages of the Bull Brook group are comprised of a variety of lithic materials, often including Neponset rhyolite, occasionally Saugus rhyolite, as well as Munsungun chert, eastern Champlain shore cherts from Vermont, and Cheshire quartzite. A broad regional lithic procurement pattern of some sort is indicated by the apparent high frequency of lithics from distant sources at many of the Bull Brook group sites.

It is difficult to postulate seasonal or otherwise repetitive patterns of movement for the Debert-Vail group. However, the Bull Brook group appears to have utilized a corridor west from the Massachusetts coast, up the Connecticut River Valley and into the Champlain Lowlands of western Vermont. It is possible that this was an ephemeral part of a "seasonal round" based on a relatively short period of resource stability. Alternatively, the sites distributed to the west and north of the Bull Brook site may represent parts of a much more complex pattern of land use, group mobility and social segmenting, as well as resource procurement.

The Michaud Site does not belong with the Vail-Debert group, nor does it fit comfortably into the northwest-southeast "seasonal round" model presented above for the Bull Brook group. Fluted point style and composition of the tool kit, however, suggests that the Michaud Site is more closely related to some phase of the regional occupancy by the Bull Brook group. An alternate or expanded north-south route utilizing the coastal plain may also have been a part of the patterns of movement of at least portions of this band (Curran and Grimes, personal communication). As we shall now suggest, Paleoindian regional movements may have been highly influenced by rapidly changing late Pleistocene environmental conditions.

Paleoindian culture, defined by the use of fluted points, is characterized by the use of finely made implements manufactured from high quality cryptocrystalline lithics, an apparently highly mobile population, and an predilection for hunting big game including many now extinct species of megafauna. Regionalization and limited time-transgressive change in lithic assemblage and subsistence base have now been recognized within what is considered the "classic" fluted point time period. The demise of fluted-point Paleoindian culture, or rather that point in time when fluted points no longer maintained recognizable continent-wide similarity as such, coincides with the beginning of the Holocene epoch.

Whether Paleoindian culture connotes the rapid spread of a highly successful technology to an indigenous population, or human expansion through unpopulated landscapes, the fact remains that Paleoindian culture had originated in a period of great environmental reorganization. It had terminated by about 10,000 B.P., as local environments became less complex, less diverse, and more stable. In fact, it is the coincidence of rapid environmental change, faunal extinction and range changes, and the visible presence of man which mark the late Pleistocene as a fascinating subject of

study for many disciples. It is, of course, not chance that these three factors co-exist in dynamic relationship. In terms of geological time, the changes were so rapid as to appear synchronous, and the current data available to interpret those changes are so incomplete and unrefined to offer few definitive answers to questions about the interrelationship of these factors. It is becoming increasingly clear that a number of answers and an understanding of Paleoindians are bound to the geographic distribution and microchronology of the events of the late Pleistocene. Climatic changes induced major vegetational reorganization, changes which were not great shifts in major vegetational zones but rather reorganization on a species by species basis (M.B. Davis 1983:166-181; Colinveaux 1987:1-7). Late Pleistocene faunal and floral communities were characterized by the coexistence of species that are allopatric and presumably ecologically incompatible today (Graham and Lundelius 1984:224). Both the speed and direction of response to terminal Pleistocene changes must be considered on a species by species basis.

It is not simple to track faunal response to changing climatic and vegetational patterns. Many studies exist, however, which demonstrate that species which had co-existed within open, multiniche late Pleistocene vegetational communities readjusted their ranges, on an individual basis, to best accommodate their ecological requirements (Guilday 1982,1984; Graham and Lundelius 1984). Some species flourished in the newly created, simpler vegetational communities, some species drastically changed in geographic distribution, and others found themselves in ever-narrowing hospitable refuges. Some became extinct.

Colinveaux (1987:6) gives an example of late Pleistocene vegetational change (simplification) and faunal response for the Great Plains: the land spreading from the Appalachians westward far into the Great Plains held communities strongly influenced by spruce trees from the 34th parallel to the edge of the narrow tundra strip fronting on the Laurentide ice sheet itself. The heartland of late glacial America was not prairie, but spruce forest [woodland]. At the end of the Pleistocene, a relatively homogenous prairie replaced the spruce woodland. Of the formerly diverse spectrum of large fauna which had co-existed in an open spruce forest (including mammoth, camel, horse and other species of megafauna) many became extinct or apparently relocated. Bison, previously present in only moderate abundance, proliferated.

North American glaciated regions were colonized by both plants and animals soon after the ice had retreated. These regions appear to have been particularly heterogeneously receptive to colonizing plant species. The tundra vegetational suite of deglaciated regions in eastern North America has no analogue in the array of tundra present in the modern arctic, nor was it a cognate of the tundra present along the margins of the ice edge on unglaciated terrain (M.B. Davis 1983). Trees invaded the tundra as climatic conditions ameliorated (Colinveaux 1987:6), on a species by species basis, and not as communities of species. This invasion created open, coniferous woodlands. But the distribution of raw, glacially emplaced soils, local topography, and drainage must have guided the invader's in their distribution on the landscape.

Fauna quickly followed vegetation onto deglaciated terrain. The species present, however, must have been limited to those which were pre-adapted to the edibles offered on this rapidly changing land, and, unless migratory, to the severe winter conditions of the north.

The preceding statements have implications for Paleoindian adaptations in the New England-Maritimes region. A detailed examination of the vegetational reorganization of the late Pleistocene, coupled with the probable changing distribution patterns of specific faunal species, allow us to reconstruct in general the range of possible game which Paleoindian hunters had to exploit in the New England Maritimes region. This statement is not to evade the obvious: that Paleoindian culture was adaptable to diverse geographical locations

and presumably to a diverse subsistence base. Yet to suggest, as does McNett (1985: 322), that "Paleoindians were not primarily hunters but rather foragers, following a seasonal round of food procurement", is misleading. One need only refer to numerous references from Midwestern and Western North America, where conditions are conducive to faunal preservation, to determine that Paleoindian technology was sufficient and the inclination strong to hunt megafauna. Radiocarbon dates on extinct fauna, never in enough quantity or with sufficient resolution and geographic coverage, nonetheless indicate that Paleoindians and extinct fauna co-existed in most parts of North America for at least some portion of the Paleoindian period (Mead and Meltzer 1984).

The New England-Maritimes region vegetational and climatic paleoenvironment has received several extensive reviews (e.g., Curran 1987; Davis and Jacobson 1985; Curran and Dincauze 1977; Parent et al. 1985; Jacobson and Grimm 1986; Gaudreau 1986; Webb 1986). We present a summary of climatic information below, followed by a review of the vegetational record.

Regional climate is controlled by insolation and cloud cover, albedo, airmass circulation and movement patterns, and localized modifying conditions such as bodies of water or ice. The conditions for Northeastern North America and the North Atlantic are fairly well understood for the height of the last glacial, circa 18,000 B.P. (CLIMAP Project Members 1976, Gates 1976). Although there are minor arguments about the extent of glaciation (Vilks and Mudie 1978), the New England-Maritimes region was covered with ice. The land surface immediately south of the region then is modeled to have had an 11°C cooler than present July surface temperature (Gates 1976). High pressure systems are modeled over the continental ice cap of northwestern Canada and over the mid-Atlantic east of New York. Average low pressure is modeled between the mid-Atlantic high and Iceland, and inshore just southeast of Boston. these authors and others (Ruddiman and McIntyre 1981, Ruddiman 1977) place the track of the Gulf Stream much further south than today, moving east from North Carolina to Spain.

The low pressure located off Boston must have produced, on average during summer, cool wet easterly winds from the north Atlantic for the New England-Maritimes region (under ice). In winter, a northern flow of cold dry air from the ice cap may have dominated the region.

The detailed orbital mechanics that change insolation patterns and trigger or modify ice ages are also well known (Imbrie and Imbrie 1980). Insolation at 45° North Latitude at roughly 11,000 B.P. was 30 calories/cm^2-day greater than 1950 A.D. values during the summer, and the same amount less during winter (Ruddiman and McIntyre 1981). Kutzback (1981,1983) gives the figure as roughly 8% greater sum and 8% lesser winter insolation. these insolation extremes set off a series of changes in atmospheric pressure cells (highs and lows), resultant wind and current patterns that cut off the energy and water supply feeding the eastern arctic ice mass.

Dangaard's oxygen-18 isotope work with the Camp Century Core (Dansgaard et al. 1969) demonstrates that roughly 2/3 of the decrease in worldwide ice volume in continental glaciers occurred in less than 1000 years, between 11,000 and 10,000 B.P.

The oceanic and atmospheric circulation dynamics responsible for ice-sheet growth, and the ice-sheet decay just described, have been modeled in detail (Johnson and McClure 1976). Models of high and low pressure center locations for ice sheet growth (ibid:338) include factors of a warm West Greenland current pumping heat into the high arctic (causing moisture evaporation and snowfall on eastern arctic ice cap centers). Eventually, the Laurentide ice cap expanded far enough to push the Gulf Stream due east by moving the margin of the ice-cap centered high pressure cell southward, strengthening westerly airflow and southwestward coastal currents along the Nova Scotian ice front (ibid: 341). This pattern established a large subpolar mid-Atlantic low pressure (gyre) south of Iceland, with net westerly and

northwesterly airflow over the New England-Maritimes region. This pastern tends to be a stable condition, one that would have just predated (circa 18,000 to 15,000 B.P.) the Paleoindian period in question.

A combination of extreme advance of the Laurentide ice sheet, coupled with high insolation in summer, is needed to push the Gulf Stream far enough south to starve the large sub-polar mid-Atlantic low pressure cell of energy, cutting off snowfall in the eastern arctic while at the same time causing rapid ice melt of the continental glacier. This condition must have existed sometime around 14,000-11,000 B.P.. the end result (ibid: 343-344) is reestablishment of a smaller low pressure center over Iceland and return of the Gulf Stream to the arctic east of Greenland (hitting Scandinavia), similar to the present day pattern (ibid:333), causing further wasting of the ice mass.

We know from the ice-volume data that most of this change occurred very rapidly between 11,000 and 10,000 B.P. The period 11,000 to 10,000 was the period of the younger Dryas in Europe, caused by an sea-ice advance in the northeast Atlantic as meltwater lowered salinity on the northeast Atlantic surface and allowed surface refreezing (ibid: 346). One major source for this meltwater was a change of meltwater drainage from the Mississippi to the St. Lawrence as ice retreated past the Great Lakes (ibid), a catastrophic environmental change indicated by Gulf of Mexico oxygen 18 isotope data.

Stable regional circulation patterns have been postulated just before the change (circa 14,000 to 11,000 B.P.) and for the postglacial (after 10,000 B.P.). During the period of massive change, the ice-sheet wasted rapidly, the Gulf Stream shifted northward, and the drainage of the Great Lakes basin shifted to the St. Lawrence. Dominant seasonal wind directions, cloud cover and precipitation patterns, and therefore effective insolation and surface temperature all probably changed very rapidly, although in a generally warming sequence.

This warming is suggested in the vegetational data: "An increased rate of progression (of flora into the New England region) from 11,000 to 10,000 B.P. suggests a more rapid warming than in the prior 2,000-3,000 years (Davis and Jacobson 1985:1)".

Recently deglaciated landscape was left open to vegetative colonization; however, edaphic (soil) conditions, surface water distribution, elevation, and the differential rate of colonization by specific plant species would all have influenced the appearance of the first vegetated landscapes in the New England-Maritimes region.

Surface water distribution following glacial retreat was in a state of dynamic change for at least several thousand years, in response to isostatic movement, eustatic sea-level changes, isolated wasting ice chunks, draining of ice and debris blocked lakes and ponds, and changes in seasonal output of rivers and streams. Glacial lakes persisted in some areas until as late as 11,000 B.P. (Davis and Jacobson 1985: 14). In areas where glacial lakes drained and ice-blocked or drift dams gave way, the land occupied by these bodies of water remained wet for some time, probably as huge tracts of marsh and wetlands.

Following deglaciation, soils at higher elevations would have been poor and sparse or non-existent due to glacial scouring and hydraulic action. In contrast, soils along the coastal plain seem to have been conducive to early, rapid vegetative colonization. "Apart from the possibility of a relatively mild, maritime climate, soil conditions (based partly on glacio-marine silt-clays) would have been better [along the coast] than in the uplands and mountains to the west and north. The delay in the establishment of tree populations on the thin, coarse upland soils where the climate may have been colder is exemplified by sites in the White Mountains, N.H., by Berry and North Ponds in western Massachusetts, and by Moulton Pond, Maine (Davis and Jacobson 1985:17)." Under possibly analogous post-glacial conditions in Britain, Pennington (reviewed in Colinvaux 1987:7) postulates a soil maturation effect

to explain the "migration lag" of certain species into areas where data indicate amenable climatic conditions. Most interesting for the New England-Maritimes region, where 90% of the known Paleoindian sites are located on sandy surfaces, is Pennington's correlation between vegetation and soil. "She recognizes two soil parent materials by the importance of the pollen taxa *Artemesia* or *Rumex*. The *Artemesia* sites should be the driest, and they, in fact, correlate with regions of sandy soil. These are also the sites with the longest lags [in colonization]. *Rumex* (dock) sites are on places with clay-rich soils that should have developed moisture-holding powers more rapidly, and these are the sites with the shortest lags (Colinvaux 1987:7)." The tundra vegetation which colonized the Northeast following deglaciation has no modern analogue (Davis 1983). Of particular interest here, it contained a high percentage of *Artemesia* (10%, Webb 1987:180), a plant adapted to dry soils. Using the isopoll technique to plot contours of equal pollen percentages at chosen intervals, "Webb's *Artemesia* map for 500 years ago shows 10% *Artemesia* only in the western Great Plains, the land we now think of as a sagebrush prairie or steppe.... 10% *Artemesia* pollen in arctic Alaska...is a perplexing property of the herb tundra of the old Bering land bridge-....(Colinvaux 1987:5)." M.B. Davis (1983:167) suggests that both soils and climate had determining effects on the high percentage of *Artemesia* in the tundra of the deglaciated Northeast. Interestingly, pollen assemblages from southern New England contain less *Artemesia* but more willow than do the corresponding spectra from New Hampshire and Maine (M.B. Davis 1983:167-168). Davis speculates that this relationship may indicate heavier snowfall in the southern portions of the region and a drier, more continental climate where *Artemesia* percentages were higher. Certainly, available moisture was less in northern New England, whether due to precipitation differences or to moisture-holding properties of some poorly developed soils.

Although the tundra in the New England-Maritimes region changed in distribution in the millennia following deglaciation, it did not change significantly in major plant taxa composition (Davis and Jacobson 1985:12). Thus, we can present a profile of other distinguishing characteristics of the post-glacial tundra of the Northeast, and expect it to be valid for 11,000 B.P.: 1) It was less scrubby than modern tundra, with lower abundances of dwarf birch, alder, and heaths (Davis and Jacobson 1985:12). In contrast, the earlier (circa 14,000 B.P.) tundra of the mid-Atlantic region appears to have been more scrubby, with more inclusions of jack pine and dwarf birch (Sirkin 1977:212). 2) It contained an abundance of both fern and moss. 3) It may have contained a higher ratio of sedges to grasses than the late glacial tundra south of the glaciated area. This effect has been demonstrated in pollen assemblages recorded from glaciated and unglaciated terrain on sites several kilometers distance from each other in Longswamp, Pennsylvania (Watts 1979).

Some plants of this ancient tundra required wet conditions (mosses and ferns), while others, particularly *Artemesia*, were adapted to dry, well, drained soils. Thus, this early tundra was not homogeneous, suggesting that a diversity of ecozones, defined by drainage patterns, vegetation, elevation, and exposure, were present in early post-glacial New England. The woodland of New England circa 11,000 was composed of such a tundra base with patchy tree distribution added.

Paleoindians could have inhabited the New England-Maritimes region within a short time following deglaciation. Radiocarbon dates from regional Paleoindian sites, however, bracket probable occupation between 11,200 and 10,200 B.P. Because environmental change was rapid during this period, we will summarize the paleoecological data available for the beginning and the end of this period, in order to better assess possible resource changes through time.

By 11,000 B.P., nearly all of the ice was gone from the study area, except for

small, isolated patches in the lowlands of northernmost Maine (Davis and Jacobson 1985:19). The ice sheet persisted, however, just to the north of the Champlain Sea. The Champlain Sea remained an extensive, marine body of water bounding the study area to the north and west. Along the coast, isostatic rebound exceeded rising eustatic sea level, exposing land surfaces seaward of the present coast (Davis and Jacobson 1985:19). Glacial lake remnants dotted the landscape, leaving more wide-spread wetlands than are present on the landscape today.

Woodland covered a large part of the central portion of the New England-Maritimes region at 11,000 B.P., including most of Vermont, New Hampshire, central and southwestern Maine, and possibly southern New Brunswick (Davis and Jacobson 1985). "Woodland is largely tundra, with trees scattered sparsely or in small groups across the landscape (Bonnichsen et al. 1985:153)." Spruce was a dominant component of this early woodland. It also included poplar and jack/red pine, birch locally, and possibly ash, elm and ironwood (Davis and Jacobson 1985:15-16). The inclusion of ironwood is notable, for its is an understory shrub or small tree indicative of a drier climate or soil conditions (M.B. Davis 1983: 177).

Southwesternmost Maine, coastal New Hampshire, and Massachusetts clearly maintained a denser tree cover than the sparse northern New England woodland at 11,000 B.P. Davis and Jacobson (1985) characterize this tree cover as "forest", dominated by spruce, balsam fir, birch and poplar, with some jack/red pine, ash and larch. Several other authors characterize the environment as more open. Webb (1987: 182) states that closed forest existed for the first time at 10,000 B.P. "because the distributions of Picea pollen and herb pollen cease to overlap." This effect is confined to the areas of highest spruce pollen percentage, in New Hampshire and Massachusetts and across the Great Lakes. M. B. Davis (1983:172) dates the inception of closed forest clearly after 10,000 B.P. these slightly differing interpretations were based upon different methods of interpreting pollen data. Davis and Jacobson use critical percentages to determine species arrival, M. B. Davis plots time of first major increase of pollen percentage for arrival of species, and Webb uses pollen isopolls. (For a comparative discussion, see Colinvaux 1987). We conclude that the conservative approach of M. B. Davis is more likely to detect the first major presence of a tree species. Thus, the 11,000 B.P. environment was unlikely to have been closed forest anywhere in New England.

The broad vegetation reconstructions just presented do not consider local conditions. It is apparent that much of the study area was somewhat "open" at 11,000 B.P. What faunal species would have been supported in this environment? Guilday (1982) notes that at least 75 species of mammals were present during the late Pleistocene in mid-Appalachia, in contrast to 51 species present during the Holocene (Guilday 1982:23). He suggests that during the late Pleistocene, Appalachia displayed a much greater degree of ecological diversity, therefore supporting more diversified faunal populations, particularly megafauna. "This varied megafauna suggests a mosaic of ecological opportunities such as mixed forests and grasslands, allowing a greater variety of housekeeping possibilities to coexist. It would include prairie, with its open-grazing possibilities, as well as forest edge, rich in understory vegetation, and woodlands, with their largely arboreal, seasonal fruitings. All of these, when combined into a landscape of open forest with trees thinly dispersed, or in copses, with a ground cover of grasses, seasonal herbs and shrubs would provide the maximum in ecotypes and support the greatest number of vertebrate species, large and small, per area unit (Guilday 1982:23)." As pine and then largely deciduous closed canopy forest gradually covered the area, many species became extinct or moved from the area. In mid-Appalachia, "at about 12,000 years ago, this rich and varied late Pleistocene fauna crashed in numbers, most of the megafauna

became extinct, and many other vertebrates adjusted their ranges, either becoming of relic status or leaving the area completely, some to the north, some to the west, as the regional environment changed rapidly and the deciduous forests closed in to present, by at least 9,000 years ago, an essentially modern aspect (Guilday 1982:25)." In some ways conditions in the Northeast at 11,000 B.P. were similar to those in mid-Appalachia before 12,000 B.P., with some important exceptions. Plants adapted to dry conditions grew on some localized well-drained, poorly developed glacial soils; at the same time the abundance of water on the landscape from recent hydrologic events and the distribution of fine particle, moisture-retentive soils seems to have encouraged other species. Thus, an open, diverse landscape, was present. However, major stretches of grasslands were probably not present in the same configuration as in mid-Appalachia several millennia earlier, nor were winter conditions as amenable.

In view of possible environmental limitations and with due regard to readjustments of individual faunal species to vegetational reorganization to the south and west, we suggest that the New England-Maritimes region at 11,000 B.P supported some, but not all, of the species which were present south of the ice sheet several millennia earlier. It is beyond the scope of this section to review all of the fauna potentially available for human consumption at 11,000 B.P. in the New England-Maritimes region. Certainly ptarmigan, spruce grouse, and many migratory members of the duck and goose families were present, as well as several species of fish. Together, fish and waterfowl rarely are found in enough abundance and properly seasonally distributed to provide the focus of a subarctic hunting-gathering existence. (The Cree around James Bay are a notable exception.) Thus we must consider subarctic Pleistocene mammals found either as large single specimens or small family groups (the behavioral configuration for mammoth and mastodon), or to herd mammals (such as caribou and possibly horse and muskoxen). An adaptation based upon hunting such large mammals, supplemented by smaller mammals such as beaver, would have provided enough geographic and seasonal flexibility to maintain a mobile Paleoindian population.

Our premise is that the potential resource base changed through time, as megafauna diminished in the study area and as caribou perhaps increased in herd size and distribution in response to changing environmental conditions.

The fossil record for New England is poor in comparison to that for the greater Northeast, although dated specimens do exist. Moeller (1984:1) recovered a partial mastodon skeleton including ivory, teeth, and bone fragments which returned a date of 11,440±655 on bone collagen. Associated white spruce cones were dated at 11,630± 470 B.P. Both a mammoth and a mastodon tooth were recovered from the continental shelf off Massachusetts which returned accelerator dates of 10,930±315 B.P and 11,070±130, respectively (Oldale, Whitmore, and Grimes n.d.). Although as yet undated, a partial skeleton of a mastodon was recovered from a farm pond several miles from the Bull Brook site some decades ago (John Grimes, personal communication). Other undated megafauna specimens from New England include a tooth of an extinct species of horse, and the astragalus of a muskox. Both were recovered from Pleistocene gravel deposits in the Penobscot River valley, Maine, circa 1980 and were briefly in the possession of Bonnichsen, who showed them to Spiess.

Caribou bones were recovered at both the Bull Brook and Whipple sites, and beaver bone was identified in the Bull Brook collection as well (Spiess, Curran and Grimes 1985). Although the Bull Brook site is not well dated by radiocarbon assay, the average date from Whipple is 10,680±400B.P. Thus, if we accept the radiocarbon average, caribou were being exploited, at least in the southern portion of the study area, sometime after 11,000 B.P.

In summary, the tundra, spruce woodland, open forest ecozones present in the New England-Maritimes region circa 11,000 B.P. would have supported a diverse faunal

assemblage, although one probably less diverse than that present in mid-Appalachia several millennia earlier. Paleoindians entering the region at this time would have had ample choice to exploit culturally chosen faunal resources.

By 10,000 B.P., the landscape in the New England-Maritimes region had changed considerably. Glacial ice had retreated from even the northern portions of the study area. "Marine conditions in the Champlain Sea came to an end shortly after 10,200 B.P., as rebound decanted the Champlain Sea [Cronin 1977; F.J.E. Wagner 1970] (Curran 1987)." Along the coast, the effects of isostatic rebound were noticeable in the transgressing shoreline, which was still located well offshore, however (Davis and Jacobson 1985: 20). The large tracts of wetlands created by drained glacial lakes, isolated melting ice blocks, and immature drainage patterns must have begun shrinking, although they were perhaps still extensive.

Importantly, much of New England by 10,000 B.P. was covered by a closed-canopy forest of variable composition (Davis and Jacobson 1985:21; Webb 1986:182). Tundra was, however, still present in Canada to the north of northernmost Maine, while "woodlands were present in northern Maine and adjacent Canada to the east and west, and data from several sites indicate that it persisted in certain uplands farther south (Davis and Jacobson 1985:20)."

Davis and Jacobson suggest (1985) that the transition from woodland to forest was gradual, but that the pace accelerated between 11,000 B.P. and 10,000 B.P., a phenomenon which they attribute to more amenable climatic conditions. Soil maturation processes may also have been a factor. M.B. Davis (1983:169) has noted that some of the early vegetation on deglaciated terrain was capable of fixing nitrogen and therefore, may have been well-adapted to the nitrogen-poor, sterile soils left by the melting ice sheet. As these soils matured with the addition of rotting plant material, they could support more species of vegetation.

The south to north progression of a closed-canopy forest from 11,000 to 10,000 B.P. suggests that the fauna which had, within the past several millennia, become established in the open, diversified environment of the post-glacial New England-Maritimes region must have continued to adapt by either changing range or habits, or face extinction. Large mammals potentially affected by the closure of the forest include grazing and specialized browsing herbivores, such as mammoth and mastodon, caribou, and muskoxen. Indeed, several researchers (Meltzer and Mead 1985:147; Kurten and Anderson 1980) suggest that the extinction process was not synchronous across either time or space, but was regionally heterogeneous. Mammals which did not become extinct, but which must of necessity have changed their range gradually over time include the caribou and muskoxen.

Basing our reconstruction on some general principles of caribou biology, and analogues with other forest-woodland-tundra transition areas (Spiess 1979), we can reconstruct how at least the caribou reacted to these changes. Environments of open woodland and tundra are inhabited today by caribou either on a seasonal-movement basis between these ecotypes, or as resident herds. (Herd refers to the breeding population of caribou. Caribou normally are encountered as smaller or larger bands, with a few to many bands comprising a herd. It is the encounter with caribou bands or various sizes in various frequencies that makes a caribou-hunting adaptation more or less successful.) Caribou herds tend to increase in size, synchroneity of band seasonal movement, length of migration, and maximal seasonal concentration with increased homogeneity (decreased patchiness) of the forest and tundra biomes. Seasonal long-distance migration for the vast majority of a region's caribou becomes obligatory in such circumstances.

In the heterogenous, generally open environment of 11,000 B.P. New England, caribou would have tended toward wide dispersal in small herds (10^2 to 10^3 individuals) with limited seasonal migrations. (Note that some caribou do remain year-

round on tundra given appropriate snow conditions.)

By 10,000 B.P. the more sharply defined forest-woodland-tundra south-to-north transition across New England and the Maritimes provinces must have supported a situation similar to that in Labrador today: large herds (10^4 to 10^5 individuals) with moderate or long-distance migratory movements (100 to 600 km.), surrounded by smaller, locally-migratory herds (10^2 to 10^3 individuals) as satellites to the south, or in montaine basins or other situations not accessible by the main herd(s). The rapidity of environmental change, however, must have made establishment of repetitive seasonal migration routes lasting for more than a few decades very difficult.

Thus, it is probable that caribou could have become an economic focus for some Paleoindian groups in northern New England or the Maritimes Provinces for some centuries during the 11,000 to 10,000 B.P. transition. For a relatively short time, the caribou herds presented enough concentrated biomass to replace an earlier hunting pattern dependent on more diversified megafauna.

CONCLUSION

The period between 11,000 and 10,000 B.P. in the New England-Maritimes region appears to be one of accelerated environmental change in comparison to the rate of change in the preceding millennia subsequent to deglaciation (Davis and Jacobson 1985). Again, the individualistic nature of response by both vegetation and fauna, as well as the interdependence (cf. Graham and Lundelius 1984) one upon the other, must be stressed. This period, or just before, is also the period of time of human arrival in the New England-Maritimes region. No matter what the situation south of the limit of glaciation in regard to pre-fluted point cultures, the fluted point Paleoindians were pioneers in the New England-Maritimes region. They arrived coincidentally with or following the immigration of suitable game. Because phytogeographic distributions were changing so rapidly, we conclude that large mammals could not establish migratory patterns that would remain constant for more than several decades. Consequently, human subsistence and settlement was extremely fluid on the same time scale. The rapidity of environmental change must have inhibited formation of a repetitive seasonal-geographic cycle, or seasonal round. Certainly few Paleoindian sites in the New England-Maritimes Region show evidence of many reoccupations.

Whatever the range of seasonal activities, the Paleoindian economy was capable of supporting a range of residential group sizes. Thus, Paleoindians had the ability to harvest protein and calories in large quantity. Large mammal hunting must have played a part in the ability to aggregate. We hypothesize that hunting proboscidians was a major part of this adaptation prior to their extinction, with caribou perhaps playing an ever increasing economic role.

The resulting archaeological record ranges from small sites with a few tools to sites with thousands of tools in up to 45 residential or activity foci. The Michaud site is one of the smaller sites. It preserves evidence of occupation by two differently organized groups. Fluted point and other stone tool styles indicate that probably two tool makers were involved. The site demonstrates that not only is there diversity in Paleoindian social organization from large to small site, but small groups could also exhibit diversity.

The two groups that used the Michaud site were more closely related to each other than they are to some of the other Paleoindian sites in the New England-Maritimes Region. This conclusion is based upon the fact that they reutilized the same small camping area and had access to a similar suite of major lithic materials.

When the stone tool style and raw material distributions of all New England-Maritime Paleoindian sites are considered, sites cluster into two groups. One group exhibits affinity with the Bull Brook I and II sites. These sites are distributed throughout most of the region, except its northeasternmost portions. The Michaud

site is related to this group of sites. The other group comprises sites related to the Vail and Debert sites. This latter group utilized the northern and western portions of the New England-Maritimes region.

We believe that the Vail-Debert group follows the Bull Brook group in time. It is unclear whether or not there is an ancestral-descendent relationship between the people involved. The general northward shift in range evident between these groups is paralleled by a northward shift in general phytogeographic zones. The fact that both groups have very large sites associated may indicate that optimal aspects of the habitat favorable to Paleoindian economy were also shifting distribution northward. We suspect that the presence of particular species of large fauna, or migratory patterns of large fauna, shifted northward.

Perhaps other fluted point Paleoindian groups formed in the territory behind this moving front of optimal Paleoindian habitat, or perhaps there were vast stretches of unutilized territory in the northeast at any given time. In any case, the northward movement washed up on the shores of the St. Lawrence, and the production of classic fluted points ceased in the Northeast shortly thereafter.

APPENDIX ONE

SOIL CLASSIFICATION, GENESIS AND MORPHOLOGY

by James Balogh and Geoffrey Gordon

This chapter contains the detailed soils information prepared for the site by Spectrum Research Inc., Duluth, Minnesota (formerly Resource Assessment Service, Orono, Maine), acting under contract to the Maine Historic Preservation Commission (Balogh and Gordon 1986). It has been edited to insure format and site location consistency with the rest of the monograph. All the substantive contributions of this chapter were generated by Balogh and Gordon.

INTRODUCTION

Deposition of glacial outwash sand and eolian movement of these outwash deposits have created common geomorphic features in southern Maine (Bloom 1960; Borns and Hagar 1965; McKeon 1972; Soil Conservation Service 1970). Wind action under cold or periglacial conditions is responsible for late-Quaternary and post-glacial eolian depositional activity (Embleton and King 1968). McKeon (1972) provides an excellent review of research on eolian deposits associated with outwash sands in southern Maine. An overview of late-Quaternary events and glacial retreat in southern Maine and New England has been presented by Borns et al. (1981).

Formation of both longitudinal and transverse dunes in outwash sand deposits has been observed in the vicinity of both the Androscoggin and Kennebec River valleys. The post-glacial sand dunes in this region were formed primarily by prevailing west-northwest winds, approximately 12,900 to 12,200 BP while outwash was actively accumulating. The Embden and Presumpscot formations are the sources for the sand dunes and outwash deltas (Bloom 1960; 1963; Borns and Hagar 1965; McKeon 1972). The outwash and eolian deposits were stabilized with rapid vegetation of the exposed surfaces (Bloom 1960; McKeon 1972).

If soil horizons develop in the surface outwash sand or other glacial deposits, subsequent eolian deposition will cover these horizons (Grigal et al. 1976; Macoun 1968; Ruhe 1986, 1969). The buried soil horizons, or paleosols, will retain in part the genetic characteristics developed during their residence as surface soils (Crawford et al. 1983; Muhs 1985; Ruhe 1969; Simonson 1941; Soil Survey Staff 1975). A series of soils buried by a succession of periglacial dune formation events in an outwash plain has been observed in northern Minnesota (Grigal et al. 1976). These buried soils have the spodic characteristics developed during their genesis in a forested environment. The pattern of development for paleosols is analogous to genesis of current surface soils (Ruhe 1969). Buried soil horizons are easily identified in outwash and eolian dune sand by the occurrence of discontinuities, changes in color, texture, chemical, and bedding characteristics (Grigal et al. 1976; Muhs 1985). The extensive buried soil horizons have not been reported in outwash sands and eolian deposits of southwestern Maine (Epstein et al. 1962; McKeon 1972; Rourke and Beek 1968; Soil Conservation Service 1970, 1974).

Bloom (1960) speculated that the majority of the coastal eolian sand movement occurred in the 18th century with agricultural settlement of Maine rather than as a result of periglacial wind conditions. Pollen profiles indicate that emerging marine sand was covered by forest vegetation as fast as the uplifted surfaces were

exposed. However, most other investigations have attributed post-glacial movement of outwash sands to periglacial wind action (Borns and Hagar 1965; McKeon 1972; Borns et al. 1981).

Recent reworking of outwash and dune sand has occurred in Maine as a result of agricultural activity, construction, and overgrazing with subsequent loss of stabilizing surface vegetation (McKeon 1972). Dune "blow-outs" are bowl shaped surface deflations produced by wind excavation of previously stabilized sand surfaces (Schwab et al. 1981). Shifting sand from the dune blow-out is deposited downwind in dune form. Current soil horizons buried by over 30 cm of eolian overburden would be classified as buried soils (Soil Survey Staff 1975).

THE MICHAUD SITE

The study site is located on sand dune features at the headwaters of the Royal River. The dunes located on a marine outwash delta have experienced recent wind erosion with surficial de-stabilization and de-vegetation.

The objectives of this cooperative research project were 1) to evaluate the site landform; 2) to describe the morphology of soil profiles on the archaeological site; 3) to determine selected physicochemical characteristics of sampled soil horizons; and 4) to briefly evaluate the genesis of the soil sequence on the Michaud site. During initial site reconnaissance a potentially buried soil horizon, a subsurface fine sand 'gray' horizon, was identified in the stratigraphy of the sandy parent material. Other surface features noted during site reconnaissance in blow-out areas of the archaeological site were exposed concentrated tongues of podzolization penetrating the subsurface sand. The origin of these two soil features will also be briefly discussed in this report.

METHODS

Site Reconnaissance and Site Location

Initial field reconnaissance of the Michaud archaeological site was conducted on June 18, 1985. A brief evaluation of the soil on the research site was developed on an exposed section of a drainage ditch. A sequence of soil horizons was observed to have field characteristics similar to typical sandy Haplorthods. A mottled gray subsurface horizon was observed at a depth of approximately 90 to 150 cm. Surface wind eroded features were identified as recent dune blow-outs.

Overstory vegetation on the site had been harvested in the late 1960's and early 1970's. Approximately 20-25% of the area was disturbed by mechanical grading and drainage ditch filling. The area is now partially vegetated by remnant forest forbes and field herbs. Following loss of overstory cover and mechanical surface disturbance, unvegetated surface sand of the site has been subjected to wind erosion, and dune deflation. Drifted sand was observed to cover 20% of the study site in the form of overburden on older dune and inter--dune surfaces. The overburden has formed new, unstable dune surfaces.

During initial field reconnaissance of the Michaud site, the general locations for soil pit excavations were identified. Two soil pits were to be located off the actual area of archaeological activity: one profile to be located in an area of undisturbed forest vegetation, and another profile to be described in a representative dune blow-out. Within the archaeological site six profiles were located for description of both undisturbed and wind eroded profiles. Soil pits were located on September 6, 1985, the first day of intensive field investigation.

Soil Profile Morphology and Soil Samples

Soil pits were excavated and soil profiles were described on September 7-8, 1985. Exact locations of the six on-site soil profiles were identified using the grid system developed by the Maine Historic Preservation Commission. Description of soil profiles on the Michaud site followed standard methods and terminology (Soil Survey Staff 1951; Soil Survey Staff 1981). Soil taxa were identified using current USDA Soil Conservation Service taxonomic criteria (Soil Survey Staff 1975; USDA Soil Management Support Services 1985). Soil

was sampled from each profile horizon at the Michaud site. All soil samples were labeled to identify site location, sampling date, site profile code, depth, and horizon designation.

Laboratory Analyses

Soil samples were air-dried and sieved to pass a 2 mm sieve. Particle size distribution was determined by a hydrometer method (Day 1965) as modified by Grigal (1973). Particle size distribution of the sand fraction was determined by dry sieving (Day 1965) after wet sieving the sand fraction. Organic carbon was analyzed by dry combustion (Allison 1965; Nelson and Sommers 1982). Iron (Fe) and Aluminum (Al) were extracted from soil samples using both a dithionite-citrate extract (Olson and Ellis 1982) and a pyrophosphate extract (Bascomb 1968). Pyrophosphate extraction is associated with amorphous Al and Fe associated with organic translocation and illuviation (Mokma 1983). Free oxides of Fe and Al are associated with the dithionite-citrate extraction (Olson and Ellis 1982; Soil Survey Staff 1975). All physical and chemical variables are reported on an oven-dried basis.

Morphological/chemical criteria and rationale for verification of spodic horizons has been presented and reviewed by the Soil Survey Staff (1975), Mokma (1983), and Holmgren and Yeck (1984). These criteria were applied to field identified spodic B horizons to differentiate spodic Bs horizons from cambic Bw horizons. These criteria are based on color, observed morphology in the field, and a combination of clay, organic carbon, and extractable Fe and Al. The relationship of organic carbon, Fe, and Al content in the sequence of horizons was used to identify 1) spodic horizons, 2) cambic horizons with spodic characteristics, and 3) potentially buried sequences of horizons. Reddish-brown spodic horizons and cambic horizons subject to podzolization (translocation of amorphous carbon, Al, and Fe) will have combined elevated levels of carbon, Al, and Fe relative to the surface horizons. Elevated levels of carbon and Al in subsurface B horizons in relation to E or Ap horizons (eluviated horizons) is critical for diagnosis of soil development under moist climatic conditions with forest vegetation (Buol et al. 1973), Mokma 1983, Soil Survey Staff 1975).

Statistical Analyses

Differences among physicochemical characteristics of soil horizons sampled at the Michaud archaeological site were tested using one-way analysis of variance (ANOVA) (Snedecor and Chochran 1967; SAS 1982). Separation of mean values of soil horizons was tested by Bayes least significant difference (BLSD) at the 0.05 level, when the ANOVA demonstrated significant differences at the 0.05 level (Smith 1978; Waller and Kemp 1975). Simultaneous comparison of differences between physicochemical properties were tested using one-way multiple analysis of variance (MANOVA) using the 0.05 level of significance from the Wilks' criterion and Hotelling T-squared at the 0.05 level, when the MANOVA demonstrated significant differences at the 0.05 level (Dixon 1983; Morrison 1976). To facilitate the statistical comparison of soil properties, soil horizons were grouped for mean comparison based on aggregation of E horizons, spodic B horizons, non-spodic B horizons (Bw, Bh, Bm), oxidized C horizons above the gray C horizon, the gray colored C horizons, and oxidized sandy C horizons observed beneath the gray C layer.

Multivariate analysis of variance and Hotelling T-square statistics are multivariate generalizations of univariate analysis of variance and mean separation techniques. MANOVA allows simultaneous comparison of p variables in p-dimensional space. MANOVA is analogous to a discriminant classification and provides a test statistic. The MANOVA test statistic is based on a linear combination of the p-variates to evaluate p-dimensional differences among classified groups (soil horizons) based on all selected variables. Multiple analysis of variance was used primarily to elucidate multidimensional differences of chemical characteristics between horizons. Multivariate comparison was directed to elucidate

similarities or differences between the surface soil and potentially buried subsurface horizons.

RESULTS

Dune Field Landforms

The surficial features and stratigraphy of the parent material observed at the Michaud archaeological site are characteristic of sand dunes formed by eolian movement of glacial outwash sands (Embleton and King 1968; Smith 1968; McKeon 1972). The original outwash sand was deposited over fine textured marine sediments. The marine sediments were observed at the base of the drainage ditch exposure (at N0 E72) and at the base of the undisturbed soil profile (West Offsite)-(Table A1-6). Stratigraphic characteristics related to depositional processes of the sandy parent material were observed during soil profile description. Horizontal bedding of the parent material was observed at a depth ranging from 28 to 94 cm. Horizontal bedding within the parent material stratum of the soil profiles (C horizons) provides evidence that the sandy parent material was deposited as glacial outwash over the marine sediments. Cross-bedding within the dune remnants was not observed and has been lost with freeze/thaw pedoturbation of the shallow dune matrix.

With recent loss of vegetative cover and surface disturbance, these dunes are being subjected to wind erosion and deflation. Formation of the bowl shaped dune blow-outs is common on the site (Schwab et al. 1981). An undisturbed dune was observed at a location nearer Moose Brook, on a line southeast from the Michaud site.

Within many of the dune blow-outs, remnant soil horizons have been exposed. These remnant features are described in detail at several site locations (North Offsite, N78 W10, N30 E38). These remnant horizons are more resistant to wind erosion than the surrounding soil matrix, and these features have high concentrations of carbon, iron and aluminum bound in place by the amorphous organic-sesquioxide complex. These features are also cemented in part with nodules of particles cemented with iron and organic matter (orstein). Soil genesis of these features will be discussed in Soil Classification and Genesis, below.

Soil Morphology at the Michaud Site

Soils observed on the Michaud research site all have similar morphology, horizon development, and physicochemical properties (Tables A1-1, 2, and 3). The observed profiles are similar to descriptions of other sand texture soils in this section of Maine (Epstein et al. 1962; Rourke and Beek 1968; Soil Conservation Service 1970, 1974). Soil morphology of the soils observed at the Michaud site is characteristic of soils developed under humid climatic conditions with coniferous overstory vegetation (Buol et al. 1973; Pritchett 1979; Soil Survey Staff 1975).

The soil horizons and parent materials at the Michaud site have formed in glacial outwash sands. These outwash sands range in texture from sand to loamy sand (Table A2-1 and A2-2). Some of the surface horizons have finer texture, sandy loam, which may have derived in part from low flow periods or by post-glacial/Holocene incorporation of eolian dust. The outwash sediments were deposited on silt loam marine sediments, the Presumpscot formation. The marine sediments have been characterized by Bloom (1963) and Goldthwaite (1951).

The West Offsite soil profile is the site control profile having no recent disturbance or loss of vegetation. Soil profiles described at N0 E72 (drainage ditch exposure), N36 E66, and N34 E62 are intact profiles covered with sandy overburden from recent dune blow-outs. Soil profiles described at N78 W10, North Offsite, and N18 E68 are the morphology of remnant soil horizons within dune blow-outs. The morphology of N30 E38 provides a detailed description of a concentrated tongue of podzolized horizon within the archaeological site.

The surface layers of the soils on the Michaud site are sandy dark brown A and bleached E horizons. Both the A and E horizons are eluviated horizons, although

the A layer retains a higher percentage of organic matter giving it a darker color than the highly weathered albic E horizons (Table A1-3). Surface A horizons are very thin ranging in depth from 3 to 5 cm. The albic horizons (E) are also relatively thin ranging in depth from 1.5 to 7 cm.

All the observed profiles at the Michaud site have horizons with morphological (color, depth, organic coatings) and chemical (Tables A1-1 and A1-3) characteristics demonstrating spodic development. The illuviated near-spodic Bh and Bm and spodic Bs horizons occur in sequence beneath the eluviated surface A and E horizons. Soil profiles observed at N36 E66 and N18 E68 within the archaeological excavation area did not have B horizons meeting the defined chemical characteristics for spodic designation under taxonomic criteria (Soil Survey Staff 1975; USDA Soil Management Support Services 1985). Although the cambic Bw horizons in these profiles do not meet the arbitrary limits for spodic classification, the color and elevated carbon content of the Bw1 horizon in both sites indicates active spodic formation (podzolization) has occurred. Bh horizons indicate illuvial accumulations of organic matter and the Bm horizon is a horizon indurated with illuviated iron (Soil Survey Staff 1981). The spodic horizons have a range of texture from sand to loamy sand and vary in depth from 5 to 14 cm.

The central concept of spodic horizon development includes the subsurface illuviation (accumulation) of organic carbon and Al, with or without Fe. The dominant characteristic of Bs horizons is the reddish brown color imparted by illuvial organic carbon and to some extent by iron oxide. Sandy soils, with relatively low surface areas for absorption, show much stronger color for a given level of accumulation than finer textured soils (Holmgran and Yeck 1984). Therefore, even the cambic horizons in profiles N36 E66 and N18 E68 have colors characteristic of spodic development. The accumulated amorphous materials are translocated (eluviated) from the surface A and/or E horizons. The Al and Fe are transported as organic complexes and the spodic horizons are the zone of organic Al and Fe precipitation (Holmgren and Holzhey 1984; Mokma 1983; Soil Survey Staff 1975). Spodic horizons should have greater cumulative accumulations of organic carbon and associated (pyrophosphate extracted) Fe and Al (Table A2-3) (Mokma 1983). Genesis of spodic (Bs) and near-spodic (Bh and reddish Bw) horizons is associated with acidic leaching conditions under humid coniferous and deciduous forest vegetation in Northeastern United States (McFee and Stone 1965; Soil Survey Staff 1975).

In profiles N0 E72, West Offsite, North Offsite and N30 E38, one or two cambic (Bw) horizons occur. The first cambic horizon (Bw1) intergrades into the spodic horizon. The second cambic horizon (Bw2) or single Bw horizon are horizons with limited color development and organic carbon accumulation. The lower cambic horizons have limited accumulation of translocated organic amorphous materials and intergrade into the unweathered parent material or C horizons. The cambic horizons range in texture from sand to loamy sand. However, the particle distribution (texture) is closer to the unweathered C1 layers than the horizons associated with surface activity (Table A1-2).

The C horizons observed in all soil profiles are the unweathered parent material derived from glacial outwash sands. Except for the gray colored C2 horizon in profiles N0E72, West Offsite (C horizon), N34 E62, and N18 E68, all the C horizons have well oxidized colors and very low accumulations of organic complexes. The C horizons have a wide range of depths and have a predominantly sandy texture. The texture and color of the C horizons reflect the original properties of the relatively unweathered original parent material.

It is unlikely that the gray C horizon is a gleyed layer, as this horizon is bounded by well oxidized horizons. A gleyed subsurface horizon requires chemical (Fe) reducing conditions associated with chronic waterlogging and lack of oxygen (Buol et al. 1973; Bohn et al. 1979). The predominantly oxidized matrix of sandy

Table A1-1. Summary of morphological properties of soil profiles at the Michaud site.

Profile	Horizon	Depth (cm)	Color	Texture	Mottles
N0 E72	A	0-3.5	10YR3/3	sand	
	Bs1	3.5-13	7.5YR4/4	sand	
	Bs2	13-24	5YR4/6	sand	
	Bw	24-30	7.5YR5/6	sand	
	C1	30-98	10YR5/6	sand	
	C2	98-128	2.5Y5/1	sand	common,medium,prominent,7.5YR5/4
	C3	128-162	10YR6/4	sand	few,fine,distinct, 7.5YR5/6
	C4	162+	10YR6/4	sand	few,fine,distinct, 7.5YR3/4
N78 W10	E1	0-3	10YR6/2	sand	
	E2	3-6	10YR5/2	sand	few,fine,distinct, 7.5YR4/6
	Bh	6-13	5YR3/2	sand	
	Bm	13-15	5YR4/4	sand	
	Bs1	15-22	7.5YR4/4	sand	
	Bs2	22-28	7.5YR4/4	sand	few,fine,faint, linear, 7.5YR4/6
	C1	28-33	10YR4/6	sand	
	C2	33-70	10YR5/6	sand	few,fine,distinct, 5YR4/6
	C3	70-140+	10YR6/3	sand	few,fine,distinct, 7.5YR4/6 few,coarse,prominent, 5YR4/6
West Offsite	E1	0-3	10YR4/2	sand	
	E2	3-10	10YR5/2	fine sand	
	E/B	10-16	10YR5/2 5YR4/6	loamy sand	
	Bs	16-19	5YR4/6	loamy sand	
	Bw1	19-29	7.5YR4/6	loamy sand	
	Bw2	29-53	10YR4/6	loamy sand	
	C	53-114	2.5Y6/2	fine sand	few,fine,prominent 10YR4/6
	C2	114+	10YR5/3	silt loam	few,fine,prominent 7.5YR4/6
North Offsite	A	0-3	7.5YR3/3	sand	
	Bs1	3-13	5YR4/4	sand	
	Bs2	13-27	7.5YR4/6	sand	
	Bw	27-47	10YR4/4	sand	
	C1	47-109	10YR6/6	sand	few,fine,faint 10YR4/4
	C2	109-135	10YR5/4	sand	few,fine,distinct 7.5YR5/6
	C3	135-153	10YR5/4	sand	
	C4	153-233+	10YR4/6	sand	few,fine,distinct 10YR5/6

Table A1-1 continued.

N36 E66	A	0-3	7.5YR4/4	fine sand	few,fine,faint 7.5YR4/6
	Bw1	3-13	7.5YR5/6	sand	
	Bw2	13-54	10YR5/4	sand	few,fine,prominent 5YR4/6
	C2	63-94	10YR5/3	sand	few,fine,distinct 5YR5/3
	C3	94-148+	10YR5/4	sand	few,medium,distinct 7.5YR5/6
N34 E62	A	0-3	10YR3/2	loamy sand	
	E	3-4.5	10Yr6/2	sand	
	Bs1	3-8	5YR4/4	loamy sand	few,fine,faint 7.5YR4/6
	Bs2	8-21	7.5YR5/6	sand	few,fine,faint 7.5YR5/6
	C1	21-68	10YR5/6	loamy sand	few,fine,faint 7.5YR5/6
	C2	68-84	2.5Y5/2	sand	few,fine,prominent 5YR3/6
	C3	84-128	10YR6/4	sand	few,coarse,prominent 5YR4/6
	C4	128-150+	10YR6/4	sand	
N18 E68	A	0-5	7.5YR3/2	sandy loam	
	Bw1	5-7	7.5YR4/4	sand	
	Bw2	7-19	7.5YR5/6	sand	few,fine,faint 7.5YR4/6
	C1	19-56	10YR5/6	sand	few,fine,faint 7/5YR5/6
	C2	56-77	10YR5/2	loamy fine sand	
	C3	77-100+	10YR5/6	sand	few,fine,distinct 5YR4/6
N30 E38	A	0-3	7.5YR3/2	fine sand	
	E	3-8	7.5YR5/2	fine sand	
	Bh	8-13	7.5Yr3/4	loamy fine sand	
	Bhs	13-17	5YR3/6	loamy fine sand	
	Bs	17-22	7.5YRd4/6	loamy fine sand	
	Bw	22-32	7.5YR5/6	fine sand	
	C1	32-74	10YR5/4	fine sand	few,fine,faint 7.5YR4/4
	C2	74-101	10YR5/3	sand	common,medium, distinct 5YR4/6
	C3	101-121+	10YR4/3	sand	common,medium, distinct 5YR4/6

outwash beneath the gray C horizon eliminates this horizon as a gleyed layer. The potential of this horizon as a buried albic (E) horizon will be discussed in the analysis of horizon chemical and physical properties. It should be noted that horizontal bedding was observed in all the gray C horizons. This indicates that the gray C horizon is part of the original matrix of outwash sand. In profile N0 E72 bedding of the oxidized C1 horizon was observed above the gray C2 layer. In the C3 horizon directly beneath the gray C2 layer in profile N0 E72 and N18 E68 bands of the C2 matrix were embedded in the otherwise well oxidized matrix. This morphology suggests the possibility of the gray C2 horizon resulting from deposition of sand with a light gray color in relation to other sand deposits. Analysis of texture in the next section will

Table A1-2. Particle size distribution (mm) of soil horizons at the Michaud Figures in percentage of all particles and percentage of sand sizes.

		TOTAL			SAND PARTICLE DISTRIBUTION					
size (mm)		Sand (2-0.05)	Silt (0.05-0.002)	Clay (<0.002)	Very Coar. (2-1)	Coar. (1-0.5)	Med. (0.5-0.25)	Fine (0.25-0.18)	V. Fine (0.18-0.15)	V. Fine (0.15-0.05)
N0 E72	A	88.76	8.32	2.92	0.02	0.48	12.16	20.30	21.19	34.03
	Bs1	87.43	8.85	3.72	0.00	0.53	11.38	21.11	20.98	32.88
	Bs2	88.29	9.06	2.65	0.02	0.58	11.67	21.17	20.99	33.72
	Bw	90.19	6.96	2.15	0.02	0.51	11.77	21.21	23.16	33.85
	C1	97.60	1.77	0.63	0.02	0.80	13.20	21.32	24.38	37.49
	C2	88.70	10.18	1.12	0.00	0.08	3.30	5.58	6.43	73.04
	C3	98.05	1.23	0.72	0.04	0.88	16.73	25.90	23.74	29.96
	C4	97.90	1.93	0.17	0.02	1.35	17.61	23.47	23.89	31.56
N78 W10	E1	91.24	7.94	0.82	0.12	1.11	10.64	14.06	17.02	47.78
	E2	88.57	7.89	3.54	0.10	1.23	12.02	16.56	18.53	40.17
	Bh	89.32	7.53	3.15	0.13	2.08	16.47	18.08	17.45	34.68
	Bm	91.61	6.09	2.30	0.31	1.83	15.50	18.38	18.36	36.56
	Bs1	88.52	8.47	3.01	0.17	1.52	15.56	17.27	17.00	36.55
	Bs2	96.63	1.69	1.98	0.01	0.81	13.06	19.67	22.96	39.52
	C1	97.41	1.98	0.61	0.01	1.22	12.00	15.87	17.49	50.52
	C2	97.78	1.71	0.51	0.02	1.22	15.36	22.72	23.45	35.27
	C3	98.16	1.14	0.70	0.01	0.45	10.40	18.21	31.37	37.28
West Offsite	E1	82.20	13.25	4.55	0.08	0,29	2.20	4.19	10.40	64.98
	E2	85.45	11.04	3.51	0.06	0.22	1.44	4.03	9.97	68.94
	E/B	81.55	13.24	5.21	0.13	0.37	2.16	5.53	12.11	60.41
	Bs	81.90	12.71	5.39	0.14	0.30	1.89	5.31	12.66	61.01
	Bw1	89.95	12.71	5.39	0.14	0.30	1.89	5.31	12.66	61.01
	Bw2	81.86	15.82	2.32	0.13	0.34	3.07	5.78	11.35	60.89
	C	97.23	1.97	0.80	0.01	0.08	1.94	9.64	26.87	58.23
	2C	18.05	69.81	12.14	0.00	0.02	0.25	1.09	2.83	13.64
North Offsite	A	86.64	10.32	3.04	0.04	0.39	11.57	21.71	21.75	30.64
	Bs1	88.77	7.80	3.43	0.03	0.34	12.50	23.36	23.86	28.37
	Bs2	93.54	4.81	1.64	0.02	0.43	13.31	24.37	24.99	28.99
	Bw	97.09	1.96	0.95	0.13	0.67	18.78	27.31	25.06	24.69
	C1	98.84	0.28	0.88	0.02	0.18	16.38	32.69	28.14	21.19
	C2	95.97	3.03	0.99	0.41	1.04	11.28	17.37	21.72	44.04
	C3	97.21	1.80	0.99	0.03	0.92	12.31	19.31	22.93	42.00
	C4	97.54	1.16	1,30	0.06	2.17	18.51	22.71	20.99	32.44

Table A1-2 cont.

N36 E66	A	87.78	8.30	3.92	0.07	0.51	6.11	11.17	15.02	54.48
	Bw1	87.43	10.08	2.49	0.05	0.31	4.22	8.33	10.90	63.30
	Bw2	86.03	13.10	0.87	0.02	0.16	3.57	6.65	7.63	67.99
	C1	92.66	6.59	0.75	0.02	0.60	10.67	15.24	20.57	45.15
	C2	98.10	1.72	0.18	0.10	1.30	13.95	20,36	21.99	40.09
	C3	98.34	1.48	1.18	0.01	0.62	12.83	21.20	24.23	39.23
N34 E62	A	82.32	13.50	4.18	0.07	0.44	4.80	9.28	12.55	55.99
	E	-----	-----	----	----	----	-----	-----	-----	-----
	Bs1	83.10	13.32	3.58	0.04	0.32	4.80	9.00	11.70	57.11
	Bs2	88.54	9.34	2.12	0.05	0.37	5.77	10.03	13.34	58.87
	C1	84.40	14.34	1.26	0.01	0.23	5.85	9.10	9.45	59.27
	C2	98.39	0.92	0.69	0.03	1.06	14.50	20.78	23.79	37.76
	C3	98.26	1.57	0.17	0.03	1.28	19.77	25.11	23.80	28.07
	C4	98.79	1.04	0.17	0.02	0.78	13.65	22.56	24.38	37.14
N18 E68	A	74.13	19.25	6.62	0.11	0.80	7.27	11.01	12.51	42.14
	Bw1	89.35	5.31	5.34	0.04	0.46	8.69	17.09	18.23	44.07
	Bw2	88.40	9.45	2.15	0.01	0.36	8.21	13.85	18.94	46.61
	C1	87.03	10.94	2.02	0.06	0.30	6.01	11.22	15.15	55.03
	C2	76.15	21.84	2.01	0.01	0.07	1.81	3.61	4.65	66.01
	C3	97.30	1.75	0.95	0.12	1.79	18.59	21.35	21.43	33.51
N30 E38	A	81.13	15.45	3.42	0.05	0.26	5.02	10.67	14.73	49.87
	E	83.70	14.16	2.14	0.09	0.23	4.21	8.82	11.61	58.00
	Bh	76.68	15.71	7.61	0.01	0.17	3.33	7.38	11.57	54.06
	Bhs	84.26	12.89	2.85	0.02	0.25	4.64	9.13	12.48	57.30
	Bs	84.59	12.41	3.00	0.01	0.25	4.34	8.55	11.84	59.00
	Bw	86.16	12.00	1.84	0.02	0.25	3.66	7.45	9.87	64.26
	C1	82.34	16.58	1.08	0.02	0.19	4.89	7.95	7.73	61.05
	C2	97.60	2.04	0.36	0.03	0.78	14.16	21.27	22.83	38.11
	C3	98.22	1.59	0.19	0.02	1.08	13.40	17.06	21.92	44.81

further illuminate this possibility.

Many of the subsurface horizons exhibit mottling varying in intensity from weak to prominent with progression in horizon depth. Mottles and iron banding are indications of periodic soil wetness associated with localized changes in soil redox potential (Buol et al. 1973; Soil Survey Staff 1981). Mottles in the observed profiles may reflect current soil moisture regimes associated with periodically poor drainage conditions. The fine sand of the gray C2 horizon and the silty marine deposits beneath the outwash sand will periodically inhibit drainage as a result of textural discontinuity (Hillel 1971). The faintly developed mottles generally observed in the surface horizons and a few of the B horizons may be relic features associated with older moisture regimes. As the headwaters of the Royal River (Moose Brook) were downcutting through the freshly exposed outwash, the local water table would have been accordingly close

Table A1-3. Selected chemical properties of soil horizons at the Michaud site.

Soil Profile and Horizon		% Organic Carbon	Pyrophosphate Extractable (ppm)		Dithionite Extractable (ppm)	
			Fe	Al	Fe	Al
N0 E72	A	2.17	456	1130	837	380
	Bs1	1.72	761	1902	1041	688
	Bs2	2.64	292	1183	1985	893
	Bw	1.53	24	403	1174	345
	C1	0.40	0	135	363	1
	C2	0.41	8	185	548	63
	C3	0.19	3	110	297	<1
	C4	0.19	0	50	151	1
N78 W10	E1	0.30	84	116	244	29
	E2	1.29	1848	1762	309	691
	Bh	2.82	1672	2182	1943	1464
	Bm	2.19	1400	2073	2630	1356
	Bs1	4.21	1287	4441	3378	1547
	Bs2	0.97	494	2052	2088	293
	C1	0.42	26	204	381	80
	C2	0.22	22	195	244	20
	C3	0.16	4	79	356	<1
West	E1	2.45	851	990	1337	628
Offsite	E2	0.84	377	508	603	238
	E/B	2.35	1012	1824	2560	1268
	Bs	2.88	908	2632	2445	1254
	Bw1	1.47	79	492	1016	287
	Bw2	0.58	7	170	628	91
	C	0.22	0	45	192	1
	2C	1.32	1662	2321	2741	272
North	A	2.99	2516	3851	2713	1124
Offsite	Bs1	3.38	869	2888	1915	1516
	Bs2	1.97	163	928	935	468
	Bw	0.86	44	372	610	157
	C1	0.20	12	117	372	33
	C2	0.40	29	136	363	24
	C3	0.26	11	116	206	<1
	C4	0.25	20	97	231	<1
N36 E66	A	2.72	704	1740	1609	782
	Bw1	1.30	75	587	1811	333
	Bw2	0.73	50	352	1137	172
	C1	0.34	15	135	892	25
	C2	0.22	0	57	488	1
	C3	0.19	0	55	263	<1

N34 E62	A	2.38	3363	3713	481	665
	E	----	----	----	----	----
	Bs1	3.80	340	689	1933	1001
	Bs2	1.50	63	563	900	371
	C1	0.66	42	296	904	279
	C2	0.18	7	127	395	16
	C3	0.16	3	55	495	23
	C4	0.17	0	38	406	<1
N18 E68	A	5.37	1452	1763	2583	1347
	Bw1	1.33	161	593	921	245
	Bw2	0.99	12	286	817	165
	C1	0.65	17	210	914	143
	C2	0.67	36	250	707	143
	C3	0.28	14	85	516	<1
N30E38	A	3.60	988	966	284	587
	E	0.86	712	549	1244	234
	Bh	2.98	3224	4623	997	964
	Bhs	4.57	1696	3871	1957	1761
	Bs	2.61	397	1947	2703	758
	Bw	1.84	109	786	1527	462
	C1	0.77	11	226	1174	149
	C2	0.21	0	114	622	17
	C3	0.21	0	55	315	18

to the surface. Under these conditions of fluctuating redox potential, mottles in the surface horizons will develop (Buol et al. 1973). Mottles are accumulations of iron oxide or centers of iron oxide deposition on ped and grain surfaces. Formation of orstein or iron concretions, observed in several Bs horizons, may have been initiated as mottles during previous moisture regimes. Mottles and iron concretions are very stable and will remain as relic features in the soil for considerable periods after the original conditions have changed (Buol et al. 1973; Kubiena 1970; Soil Survey Staff 1975).

Silt loam marine sediments beneath the outwash sand were observed in the bottom of the site drainage ditch and at the base of the West Offsite profile. The marine sediment is a lithologic discontinuity and designated as a 2C horizon. These marine sediments were deposited during the post-glacial marine submergence of the Maine coast between 13,000 BP and 12,000 B.P. (Stuvier and Borns 1975). These sediments have been designated as the Presumpscot Formation. The Michaud site is within the limits for deposition of this formation (Bloom 1963; Goldthwaite 1949; Stuiver and Borns 1975). Most likely the outwash sands sediments were deposited over the marine silty sediments as a marine delta.

Comparison of Soil Physical and Chemical Properties

The particle size distribution and selected chemical characteristics of the

soils sampled at the Michaud archaeological site have a range of values similar to other soils developed in outwash sands in southwestern Maine (Epstein et al. 1962; Rourke and Beek 1969; Soil Conservation Service 1968, 1970). The particle size distribution or texture of all horizons is dominated by sand, especially in the fine-very fine sand fraction. Significant differences in particle size distributions were observed for the aggregated horizons (Table A1-4). There is a trend of an increasing coarse fraction (sand) and decreasing fine fraction (silt/clay) with depth. The surface horizons are exposed to the forces of physical and chemical weathering as well as incorporation of atmospheric dust. These factors are associated with formation and accumulation of fine particles. The gray C horizons also have a significantly higher fraction of fine-very fine sand and silt as compared to the deeper oxidized C horizons. The gray C layer has a particle size distribution similar to the transformed and weathered surface horizons. The range in total depth of the eluviated surface horizons (A and E) varies from 1.5 to 10 cm, whereas the gray C horizon varies in depth from 16 to 39 cm. Considerable weathering and translocation of chemical constituents would be required to create eluviated horizons with depths of 16 to 39 cm.

The distribution of organic carbon, Al, and Fe in the soil horizons is characteristic of soils developed in acidic leaching environments with forest vegetation (Pritchett 1979; Soil Survey Staff 1975). The surface A horizons, where they exist, have high concentrations of organic carbon associated with litter decomposition (Table A1-3). The precipitation of organic Al and Fe complexes are observed in both the Bs and non-spodic horizons with elevated levels of carbon, Al, and Fe. The spodic horizons have significantly higher levels of organic carbon and aluminum as compared to both the E and non-spodic horizons. This condition is critical for identification of a spodic horizon (Mokma 1983). All the surface horizons, E, Bs, and non-spodic B, have significantly greater accumulations of organic matter and Al as compared to all the sand subsurface C horizons. The Fe distribution follows a similar pattern, but does not exhibit as clear a statistical differentiation (Table A1-4). Accumulation of organic carbon and Al content are the critical factors in identification of Bs and spodic-like Bw horizons. The oxidized C horizons are not statistically nor numerically different from the gray C horizon in their content of organic carbon, Al, and Fe. The oxidized C horizons beneath the gray C horizon exhibit no chemical evidence of illuviation of organic amorphous materials. This suggests that the development of a sequence of a buried E horizon over even a remnant B horizon has not occurred on this site. Buried soil horizons should retain in part the genetic characteristics developed during their residence as surface soils (Crawford et al. 1983; Muhs 1985; Ruyhe 1969; Simonson 1941; Soil Survey Staff 1975).

The simultaneous and multidimensional comparison of chemical characteristics of the surface and subsurface horizons confirms the univariate analyses of the genetic relationships of the soil horizons (Table A1-5). There is an overall difference among the chemical variables used to identify spodic development. Comparison of multidimensional group means confirms the conclusions that 1) the illuviated B horizons differ significantly from all the sandy C horizons; 2) the oxidized C layers are not significantly different from the gray C layer; 3) the horizons beneath the gray C horizon (originally hypothesized as buried E horizons) do not demonstrate a simultaneous accumulation of organic carbon, Al, and Fe; 4) the oxidized C horizons beneath the gray C layers are not similar to the Bs horizons nor the non--spodic B horizons; 5) the highly leached E horizons have lost significant amounts of amorphous material to the Bs and non--spodic B horizons; 6) with translocation of amorphous material out the E horizon, the E horizons have a multidimensional composition of organic carbon, Fe, and Al similar to the unweathered C horizons.

Table A1-4. Univariate analysis of variance of physical and chemical characteristics by soil horizons and group separation of horizon means.

Means with the same letter in one row do not differ significantly at the 0.05 level by Bayes L.S.D.

Soil Variable	E (n=6)	Spodic B (n=11)	Non-Spodic Bh, Bm, Bw (n=12)	Non-gray C above (n=16)	Gray C (n=4)	Non-gray C below (n=5)	ANOVA F-probability (df among,within)
Sand %	85.45a	87.78a	87.90a	94.95bc	90.12ab	98.06bc	<0.001 (5, 48)
Silt %	11.25a	9.21ab	9.31ab	4.26bc	8.72ab	1.51c	0.002 (5, 48)
Clay %	3.3a	3.01a	2.79a	0.79b	1.15b	0.44b	<0.001 (5, 48)
Sand %							
Mesh 18	0.10	0.05	0.08	0.05	0.01	0.05	0.519 (5, 48)
Mesh 40	0.58	0.52	0.61	0.82	0.32	1.22	0.091 (5, 48)
Mesh 60	5.45a	8.99a	8.24ab	11.95b	5.39a	17.27c	<0.001 (5, 48)
Mesh 80	8.87a	15.36ab	13.10ab	18.35bc	9.90a	23.68c	0.002 (5, 48)
Mesh 100	13.21a	17.53abc	15.47ab	20.90bc	15.43ab	23.45c	0.017 (5,48)
Mesh 300	56.71ab	44.85bc	50.00ab	42.68ab	58.76a	32.05c	0.008 (5. 48)
Organic Carbon %	1.34b	2.75a	1.55b	0.35c	0.37c	0.20c	<0.001 (5, 48)
Pyrophosphate Extractable:							
Fe (ppm)	814a	661ab	571abc	13bc	13bc	4bc	0.008 (5, 48)
Al (ppm)	958bc	2100a	1077b	139c	152c	67c	<0.001 (5, 48)
Dithionite Extractable:							
Fe (ppm)	1050bc	1935a	1268b	506cd	460d	373d	<0.001 (5, 48)
Al (ppm)	515b	959a	503b	49c	56c	5c	<0.001 (5, 48)

DISCUSSION

Soil Classification

The soil profiles observed at the Michaud archaeological site have been identified as Typic Haplorthods and Typic Dystrochrepts (Soil Survey Staff 1975; USDA Soil Management Support Series 1985). These two soil taxa are differentiated primarily on the basis of the presence of the diagnostic spodic horizon. Haplorthods are more or less freely drained Spodosols that have accumulations of organic carbon and aluminum with or without iron in a subsurface spodic horizon. Spodosols are usually found in coarse, acidic, Pleistocene or Holocene deposits under forest vegetation (Soil Survey Staff 1975). In the Northeastern United States, conifer forests are usually associated with spodosol development.

The typic subgroup taxa of Haplorthods is the modal designation or central

Table A1-5. Multivariate analysis of variance (MANOVA) and multivariate mean separation (Hotelling mean separation) for soil horizons presented as F-probabilities (overall MANOVA) and T-square probabilities. The multivariate combination of variables is for organic carbon, pyrophosphate extractable Al, and pyrophosphate extractable Fe.

Matrix of probabilities > T-square

Horizon	Spodic B	Non-spodic Bh, Bm, Bw	Non-gray C above	Gray C	Non-gray C below
E	0.002	0.047	<0.001	NS	NS
Spodic B	-----	0.001	<0.001	0.013	0.002
Non-spodic Bh,Bm,Bw	-----	-----	<0.001	0.014	0.001
Non-gray C above	-----	-----	------	NS	NS
Gray C	-----	-----	------	-----	NS

concept of the great group classification. Mottles do occur in several spodic horizons, however these faint mottles do not have the intensity required for an aquic designation. The Haplorthods are an intergrade between the aquic and typic subgroup designation. The mottles are associated with periodic moisture saturation, iron reducing conditions, and subsequent segregation of precipitated iron oxides (Buol et al. 1973). The textural discontinuity of the C2 layer and the lithologic discontinuity at the contact with the silt loam marine sediments is responsible for the subsurface mottling. Previous moisture regimes during downcutting of the Royal River headwaters through the newly exposed outwash delta may be responsible for the faint relic mottles in the spodic (Bs) and cambic (Bw) horizons.

Dystrochrepts are relatively undeveloped brownish colored Inceptisols, more or less freely drained. Dystrocrepts form on acidic Pleistocene or Holocene deposits. Vegetation is usually deciduous forests with genetic processes of eluviation-/illuviation occurring with less intensity than under coniferous vegetation. Dystrochrepts are associated with spodosols as local variations in the intensity of podzolization (Soil Survey Staff 1975). Development of cambic (Bw) subsurface horizons and the observed distribution of organic carbon are diagnostic features of dystrochrepts (Soil Survey Staff 1975). At the Michaud site the cambic horizons lack sufficient deposition of illuvial amorphous materials to be designated as a spodic horizon. However, color, morphology, and soil chemistry do indicate podzolization is currently operating in these soils. High variability in the magnitude of soil genetic processes will account for localized variation in soil classification in a single site. Considering both the spodosols and inceptisols on the Michaud site, podzolization has been the dominant soil genesis process.

Selected Profile Morphological Features

Throughout the Michaud archaeological site, intense tongues of podzolization were

Table A1-6. Soil Profile Description, N30 E38. This description is included as an example of soil descriptions prepared for each soil test area.

Date: September 8, 1985 Name: Balogh and Kosian
Location County: Androscoggin Site Name: Michaud
Landform Type: Sand dune field, dune blowout
Slope: 0-10%
Shape: convex, dune crest
Aspect: 2 degrees
Parent material: sand dunes from marine outwash delta sands, deposited over fine marine sediments
Vegetation: abandoned field, bare surface, weeds and grasses, mixed hardwoods with pine present on the field edge
Soil water status at time of description: moist
Drainage: well drained
Depth to water table: greater than 3 meters
Depth to mottles: 32 cm
Effective rooting depth: 74 cm
Comments: Horizontal bedding of sand becomes evident at 74 cm. This profile was described within the archaeological site and the morphological description is focused on an example of a deep podzolized tongue, as seen throughout the dune field and the archaeological site. A thin (<1 cm) band of Bs2 was observed between the broken A and E horizon. This morphological feature may be remnant overburden from a past tree throw event or an indication of the beginning of bisequel development in the soil profile.

Classification: sand, mixed, frigid, typic haplorthod

A - 0 to 3 cm, bark brown (7.5YR 3/2) fine sand; weak, medium platy structure; very friable; common, fine roots; abrupt, irregular boundary.

E - 3 to 8 cm, dark brown (7.5YR 5/2) fine sand; weak, fine subangular blocky structure; very friable; few, fine organic coatings on ped surfaces; few, fine roots; clear, broken boundary.

Bh - 8 to 13 cm, dark brown (7.5YR 3/4) loamy fine sand; weak , fine angular blocky structure; very friable; common, fine organic coatings (7.5YR 3/3) on ped and grain surfaces; few, fine iron coatings (5YR 3/4) on ped surfaces; few, fine roots; clear, broken boundary.

Bhs - 13 to 17 cm, dark reddish brown (5YR 3/6) loamy fine sand; strong, fine subangular blocky structure; friable; few, coarse iron coatings (5YR 4/3) on ped surfaces; common, fine, rounded iron concretions (orstein); few, fine roots; abrupt, irregular boundary.

Bs - 17 to 22 cm, dark brown (7.5YR 4/6) loamy fine sand; moderate, medium subangular blocky structure; friable; few, fine organic coatings on grains of root channels; few, fine iron coatings (5YR 3/4) on ped surfaces; few, fine roots; clear, wavy boundary.

Bw - 22 to 32 cm, strong brown (7.5YR 5/6) fine sand; weak, medium angular blocky structure parting to weak, fine angular blocky structure; friable; few fine iron coatings (5YR 3/4) on surface of root channels; very few, fine charcoals; few, fine roots and few, medium roots; diffuse, wavy boundary.

C1 - 32 to 74 cm, yellowish brown (19YR 5/4) fine sand; weak, coarse angular blocky structure; friable; few, fine, faint (7.5YR 4/4) mottles; few, fine faint (7.5YR 4/6) mottles; <1% small platy coarse fragments; few, fine roots; very few, medium roots; gradual, wavy boundary.

C2 - 74 to 101 cm, brown (10YR 5/3) sand; weak, coarse angular blocky structure; friable; common, medium, vertical/linear distinct (5YR 4/6) mottles; few, fine, faint bands of iron coatings on grain surfaces; <1% small platy coarse fragments (mica); horizontal bedding present throughout horizon; clear, smooth boundary.

C3 - 101 to 121+ cm, brown (10YR 4/3) sand; weak, coarse angular blocky structure parting to weak,medium angular blocky structure; friable; common, medium, vertical/linear distinct (5YR 4/6) mottles; many,fine, distinct bands of iron coatings on grain surfaces; <1% small platy coarse fragments (mica); horizontal bedding present throughout horizon.

observed by the principal investigator. Profile N30 E38 provides an example of this relic feature in a dune blow-out. At the time of site reconnaissance and soil profile location, there was a question whether these particular features were of natural or of anthropogenic origin. In the control soil profile, West Offsite, located in an undisturbed area of the outwash deposit with overstory cover, several intense podzolized tongues were observed. Tonguing of the albic/spodic horizon sequence into the parent material of a soil has been associated with local intensification of the spodic development (podzolization). This phenomenon has been attributed to increased leaching with water concentration from stemflow (Buol et al. 1973; Pritchett 1979). (Stemflow is the water that runs down tree trunks during rainfall events.) Stemflow funnels a portion of the precipitation intercepted by the forest canopy into the soil at the base of individual trees. This often results in higher levels of soil moisture and leaching environment directly beneath the tree. This may result in increased podzolization and formation of albic/spodic tongues. These tongues with deep spodic development were observed on the Michaud site and should be attributed to natural soil genetic processes.

During initial site reconnaissance on June 18, 1985, the gray C horizon was observed in profile N0 E72. It was hypothesized that this horizon could be a buried E horizon. The color, morphology, and strong mottling suggested during the initial observation that this horizon was the E layer of a buried Aquod or Aquept. Subsequent analysis of 1) bedding morphology, 2) color characteristics relative to the other oxidized horizons, and particularly, 3) the distribution of organic carbon, Al, and Fe, demonstrates that this horizon is not a buried albic horizon nor a gleyed horizon. The color of this fine sand textured horizon reflects the originally deposited outwash sand. Layers of light gray to olive brown sand have been frequently observed in soil profiles developed in glacial outwash sand throughout southwestern Maine (Epstein et al. 1962; Rourke and Beek 1968; Soil Conservation Service 1968, 1970).

Sequence of Glacial Outwash Deposition and Dune Formation

The stratigraphy of soil and geologic parent material on the Michaud site provides evidence of deposition of glacial outwash sands over marine silt sediments. Marine sediments are part of the Presumpscot Formation deposited during the post-glacial marine invasion of the Maine coast. The glacial outwash snads were deposited over the marine sediments. The finer textured layers of sand may have been deposited during low flow events. The outwash sands were exposed to wind erosion and dune formation after isostatic rebound of the Maine coastal area (ca. 12,200 BP). Development of forest vegetation in a cool,

Table A1-7. Soil profile description, West Offsite. This description is included as an example of a natural soil profile, away from the archaeological site.

Date: September 7, 1985. Name: Balogh and Kosian
Location: Androscoggin County.
Landform Type: sand dune field, undisturbed marine outwash sands
Slope: 0-5%
Shape: level
Aspect: 334 degrees
Parent material: sand dunes from marine outwash delta sands deposited over fine marine sediments
Vegetation: cut-over hardwoods (esp. Populus tremuloides) with pine and fir present.
Water status
Soil water status at time of description: moist
Drainage: well drained
Depth to water table: below 3 meters
Depth to mottles: 53 cm
Depth to restricting layer: 114 cm
Effective rooting depth: 120 cm
Comments: Horizontal to slightly sloping bedding of sand becomes evident at 53 cm. A vertical column of 2C material has been pulled up into the C horizon by an old tree throw. Irregular tonguing of E-Bs1-Bs2 horizons into B3 and C horizons is evidence of localized concentrations of podzolization possibly associated with stemflow from previous forest vegetation. 2C horizon is marine sediment deposited as the Presumpscot Formation.
Classification: sand, mixed, frigid Typic Haplorthod

Oi - 3 to 0 cm, hardwood leaves and twigs.

E1 - 0 to 3 cm, dark grayish brown (19YR 4/2) loamy sand; weak, fine granular structure; friable; common, tonguing of organic matter coatings (10YR 3/2) on grain surfaces form surface; <1% very fine, platy coarse fragments (mica); many fine roots, common medium roots, few coarse roots; clear, wavy boundary.

E2 - 3 to 10 cm, grayish brown (10YR 5/2) fine sand; weak, fine subangular blocky structure; friable; <1% very fine, platy coarse fragments (mica); few, fine roots and few, medium roots; clear, irregular boundary (tonguing of E horizons into B horizons with tongue widths ranging from 1 to 17 cm).

E/B - 10 to 16 cm, grayish brown (10YR 5/2) and yellowish red (5Yr 4/6) loamy sand; weak, medium granular structure; friable; few, fine (5YR 4/4) iron coatings on ped surfaces in B portion of horizon; very few, fine rounded, iron concretions (orstein) in B portion of horizon; <1% very fine, platy coarse fragments (mica); few, fine roots and common, medium roots; clear, broken boundary.
Bs - 16 to 19 cm, yellowish red (5YR 4/6) loamy sand; strong, medium subangular blocky structure parting to weak, fine subangular blocky structure; firm; few, fine (5YR 4/6) iron coatings on ped and grain surfaces; many, fine, weakly cemented iron concretions; common, fine roots an common, medium roots; clear, wavy boundary (few tongues into lower horizons).

Bw1 - 19 to 29 cm, dark brown (7.5YR 4/6) loamy sand; weak, fine subangular blocky

structure; very friable; few, fine (5YR 4/6) iron coatings on root channels; few, fine iron concretions (orstein); common, fine roots; gradual, wavy boundary.

Bw2 - 29 to 53 cm, dark yellowish brown (10YR 4/6) loamy sand; weak, medium subangular blocky structure; very friable; few, fine (7.5YR 4/6) iron coatings in root channels; few, coarse (5YR 3/6) iron concretions (orstein) concentrated directly beneath tonguing from E-Bs horizons; few, fine roots; clear, wavy boundary.

C - 53 to 114 cm, light brownish gray (2.5Y 6/2) fine sand; weak, medium angular blocky structure; friable; few, fine, prominent (10YR 4/6) mottles; few, fine (7.5YR 5/6) bands of iron coatings on grain surfaces; 20 percent of C horizon has a vertical inclusion: fine sandy loam, brown (10YR 5/3); moderate, medium angular blocky structure grading to moderate, fine angular blocky structure; friable; few, fine prominent (10YR 5/8) mottles, very few, medium lens of 2C material distributed evenly throughout inclusion; <2% fine, platy coarse fragments (mica); very few, fine roots; strong horizontal to slightly downward sloping bedding present throughout horizon; abrupt, wavy boundary.

2C - 114+ cm, brown (10YR 5/3) silt loam; strong, coarse subangular blocky structure parting to strong, medium subangular blocky structure; firm; common, medium prominent (7.5YR 4/6) mottles; few, fine iron coatings in root channels and on ped surfaces; few, fine roots and very few, medium

humid climate created the acidic leaching conditions necessary for genesis of the spodosols observed on the Michaud site.

Some investigators have suggested that coastal dune formation is related to agricultural activity in the 18th century (Bloom 1960). Considering the well developed spodic horizons, horizons with orstein (mineral particles cemented with iron), and proximity to verified post-glacial dune fields in the Androscoggin and Kennebec River valleys (Borns and Hagar 1965; McKeon 1972), the shallow dunes on this archaeological site were most likely formed and rapidly stabilized immediately after isostatic emergence. The lack of well defined buried horizons with evidence of surficial organic accumulation (formation of A horizons) indicates that there has been limited eolian activity on this site between the original dune stabilization and the current localized dune deflation due to deforestation within the last decade.

CONCLUSIONS

Glacial outwash sand was deposited over marine sediments at the Michaud archaeological site. Concurrent with post-glacial rebound of southwestern Maine, eolian movement of the emerging sand plain resulted in dune formation. Rapid vegetation of the site is associated with development of soils with spodic horizons. Soils formed in the sandy parent material are Haplorthods and Dystrochrepts. Natural tonguing of intense and at times weakly cemented spodic horizons was observed throughout the disturbed and undisturbed portions of the Michaud site. The gray subsurface C horizon reflects its original color and physical characteristics. The gray C horizon is not a gleyed horizon nor a buried albic horizon.

APPENDIX TWO

ARTIFACT USE-WEAR STUDIES AND FUNCTIONAL ANALYSIS

A limited use-wear study was conducted to provide a frame of reference for correlating use-wear patterns observed on Michaud site materials and use-wear analyses from the literature. The results recorded here are suggestive and are not intended as definitive. The limited experiments reported herein were performed because of a paucity of comprehensive use-wear studies involving artifacts with retouched edges. We found that use of retouched edges produces wear that is not interpretable with the same criteria as that on unretouched (flake) edges. These experiments were intended to provide an interpretive link between the horizontal patterning evident at the Michaud site and a reconstruction of the human activities involved.

USE-WEAR STUDY METHODS

A visual record of the most significant specimens was produced by placing them on a photocopy machine, covered with a white cloth background. Subsequently, the collection was examined at 10-40x magnification under a binocular dissecting microscope for such signs of use-wear as are visible on cherts and glassy rhyolites at that magnification, and notations were made on the photocopy record.

Our initial assumption was that the cherts which comprise the majority of the assemblage would show use-wear patterns similar to the flint artifacts analyzed by Tringham et al. (1974). Notations were made describing the micro-flaking and/or rounding and polish seen on our materials that followed the use-wear attributes described in that study. Principally, these attributes include the form (scalar or step) of flake removals, their shape and size, their distribution (along the edge, and bifacial or unifacial), and the presence, intensity and distribution of any polish, gloss, abrasion or scratching. We also attempted to record information relevant to Ahler's (1979) use-wear attributes. Interpretation of the results of the use-wear study proceeded with cognizance of relevant recent work (Brink 1978; Odell 1980, 1985, 1986; Rule and Evans 1985).

Initially we discovered that the Michaud bifaces exhibited varying amounts and intensity of edge abrasion, interpretable as grinding, depending on whether they were unfinished preforms or finished fluted points. This "wear" has been interpreted by many investigators as either platform preparation in Paleoindian biface preforms, or dulling of basal and proximal lateral edges for hafting of fluted points. We will not discuss this apparently well understood phenomena further.

It was rare to find a wear pattern on an unretouched flake edge. Such use was confined mostly to the sharp edges of channel flakes and the few "utilized" flakes. More commonly, what appeared to be a step-microflaking wear pattern occurred along the edges of pieces that had been retouched unifacially. This "use-wear" appeared to be superimposed over the pre-existing retouched edge, and it came in two basic forms: arris polish or lustre (rare) and step-flaking of varying intensity.

Sidescrapers often exhibited a retouched edge with subsequent crushing or step-flaking. Moreover, both limace fragments had been laterally retouched to a steep angle and subsequently the edges had been heavily step-flaked, invasively undercutting the edge.

Tringham et al. (1974) discuss use--wear on retouched edges briefly and inconclusively. We were facing a major

variable not considered by Tringham et al. since we were mostly dealing with retouched edges, not fresh edges. We conceived and executed a few experiments to test the null hypothesis that the use-wear patterns visible on our *retouched* tool edges were produced by actions on materials similar to those reported in the experiments by Tringham et al..

The experimentation began after Charles D. Cox, one of our crewmembers who had recently completed a summer flint-napping fieldschool, used Munsungun cherts to produce a limace, a sidescraper, a retouched flake, and a graver/perforator. These tools were examined visually, macroscopically and microscopically, and photographed. Molds of the working edges were then produced using Dow-Corning L-RTV casting rubber, and epoxy casts made. Subsequently, these tools were utilized for a number of tasks, beginning with ones thought to produce relatively little edge wear. The mode of action and number of strokes were recorded, and each tool was re-examined and rephotographed to provide a permanent, sequential record. The form of the used retouched edges were checked against the epoxy casts.

USE-WEAR EXPERIMENTS

When absolutely fresh and unutilized, both the limace and the sidescraper exhibited a very thin band of step-flaking confined to the edge of the dorsal (retouched) surface. The steeper retouched angle on the lateral sides of the limace were accompanied by lightly invasive or undercutting step-flaking. In both cases perhaps 80% of the retouched edge exhibited this step-flaking. Charles D.Cox indicated that this step-flaking is often a normal result of the practice of "evening up" a retouched edge to remove the very small projections caused by the intersection of the flake arrisses with the edge. This result was accomplished by rubbing the retouched edge lightly from the ventral side with a hammerstone or an abrading stone. We suggest that step flaking along a retouched edge of an archaeological specimen may be the result either of a specific use action or may be a product of tool manufacture.

Tringham et al. (1974: 180) report that the micromorphology (flaking, polish, etc.) or scarring of an utilized, unretouched flint edge is task specific, but that the degree of edge damage produced by a specific action correlates inversely with edge angle. Moreover, use-wear patterns vary in part with the hardness of the worked material (Tringham et al. 1974: 183), with antler and bone being hardest, woods of various densities intermediate, and skin and flesh softest. We recognize that Paleoindians probably used a much wider range of raw materials, but that materials of analogous hardness might produce similar wear patterns.

Whether the worked material was hard or soft, initial use of unretouched flake edges produced wear comprised of scalar--shaped scars. The harder the material, the more rapidly the flakes detached, and the larger and deeper were the scars thus produced (Tringham et al. 1974: 188-191). However, scalar scars were always smaller, and easily differentiable from, scars produced by deliberate retouch. When "hard" materials were worked, early, rapid removal of scalar flakes weakened the flake edge such that flakes terminating in hinge fractures (step flakes) were subsequently removed. Work on soft materials (skin and flesh) produced only small, scalar shaped scars. Effects of abrasion (polish, etc.) from soft materials were hardly visible below 100x magnification, if then. No matter what species of tree, use on wood produced scalar scars "including semi--circular and triangular scars, but also including trapezoidal scars not observed on working any other materials" (Tringham et al. 1974: 188-191). Wood-working scars consistently presented a "fuzzy" appearance due to abrasion and fine polish of the scar edge and interscar arrisses subsequent to scar formation. Work on "hard" materials, such as bone and antler, produced step--scarring that obliterated any scalar flaking.

A distinction has been made (Tringham

et al. 1974: 188-89) between longitudinal action of the flake (cutting and sawing) and transverse action (scraping and shaving). In the former, use-wear scars occur on both surfaces of an edge (bifacially), while they occur unifacially when produced through transverse action.

Thus, on a gross morphological level one can distinguish between use on soft material (edge "nibbling"), use on medium materials (common scalar flaking with arris polish and obscured flake scar edges) and hard materials (step-flaking). Further, differentiation can be made between a scraping (transverse) action and cutting (longitudinal) action.

Our experiments consisted of producing artifacts with retouched edges and using those edges in actions and on materials similar to those reported by Tringham et al. "Exp-1" was a grey Munsungun chert limace, which was flaked to conform to the "normative" shape reported by Grimes and Grimes (1985). In its unused state this piece exhibited retouched edge angles of 60 to 69 degrees along the lateral sides, and scalar retouch of 3.75 to 5.0 mm wide (perpendicular to the edge). The lateral margins, however, were characterized by step-flaking (or crushing with hinge terminations) that were 0.5 to 1.5 mm wide. In this instance, the scarring had been created simply by grinding the hammerstone along the edge to "even" it up. Use-wear experiments with this tool consisted solely of pushing it along a piece of deer antler cortex (in the push-plane manner suggested by Grimes and Grimes 1985), several hundred times. The tool efficiently scraped away a narrow patch of antler, but exhibited no evident wear. Had we used the tool on soft material (skin or hide), we suspect that no wear would have been evident. Use on wood may have produced polish on the high points and inter-flake arrisses along the edge.

Most of the use-wear experimentation was done with "Exp-2" and "Exp-3". "Exp-2" was a large, thick flake of red Munsungun chert retouched to a steep edge angle (between 60 and 78 degrees) on the edge that we utilized. The retouch was mostly scalar, up to 6.4 to 8.0 mm wide (perpendicular to the edge), and step-flake terminations were few and widely spaced. "Exp-3" was a thinner, lighter, grey Munsungun chert flake retouched to a 45-47 degree edge angle in the region that we utilized. The deliberate retouch was mostly scalar, 2.6 mm (average) wide perpendicular to the edge. Step-flake terminations were rare and intermittent, averaging 0.5 to 0.2 mm wide.

The first experiment with "Exp-2" and "Exp-3" (Plates A2-1 and A2-2) involved scraping 500 strokes on dry deer hide with each experimental tool, attempting to keep all force on the same portion of the retouched edge. The ventral side of each retouched flake was held away from the experimenter, and the action was to push away. We anticipated that dry hide would produce the most wear, if any, of any possible "soft" substance. The only visible wear (up to 40x magnification) thus produced, however, was very slight rounding or dulling of the arris ridges near the edge.

Subsequently, we did 500 strokes scraping dry hardwood with "Exp-2" (same action as above). Afterwards, the edge itself no longer appeared fresh: it showed definite, light rounding, and noticeable gloss. Arrisses and slight projections, especially, showed noticeable rounding and gloss. No new step-flakes or scalar flakes had been removed from the edge. Thus, for "Exp-2", with its steeply retouched edge, use-wear produced by skin scraping and wood scaring differs markedly in degree, but not in kind. No new flakes were removed from the edge.

Five hundred strokes scraping hardwood with "Exp-3" (thin flake, lower retouched edge angle) proceeded with the same motion as reported above. We then compared the edge microscopically with the epoxy cast made of the fresh edge. The utilized portion of the edge had been worn into a shallow concavity by the repeated removal of very shallow step-flakes of 0.5 to 0.8 mm width perpendicular to the edge. (Compare step-flake widths with the 2.0 to 3.0 mm widths for the retouch flake scars.)

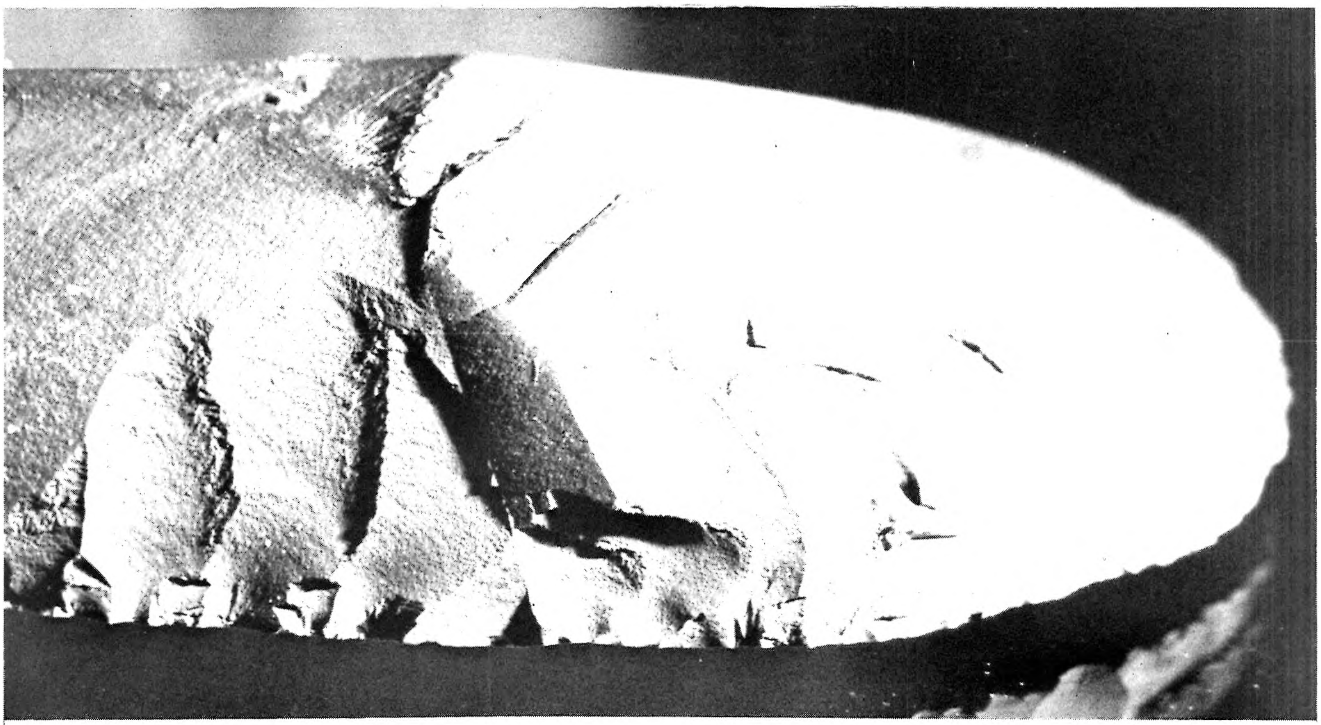


Plate A2-1. Fresh, unused, steeply retouched edge of Exp-2, an experimentally used red Munsungun chert side scraper. This photograph, coupled with an epoxy cast of the unused edge, were used for comparative purposes during use wear experiments.

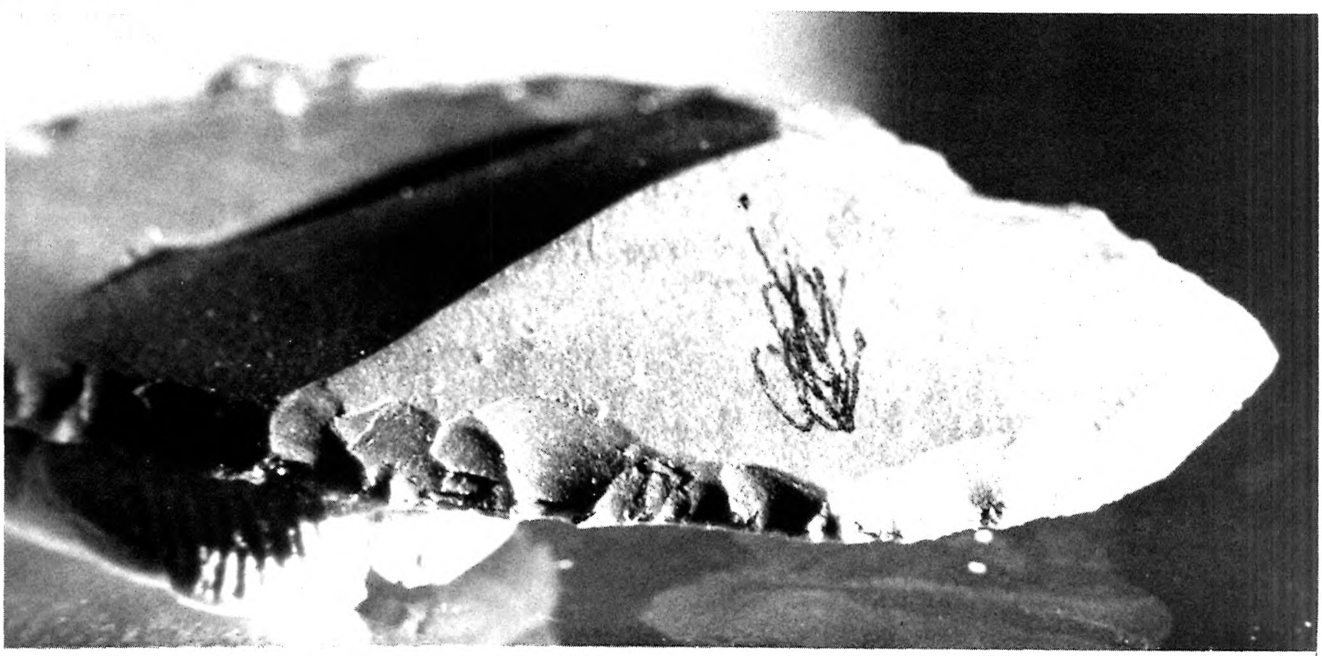


Plate A2-2. Fresh, unused, low-angle retouched edge of Exp-3, an experimentally used grey Munsungun chert retouched flake.

The edge of the flake itself was not polished and rounded, but appeared fresh; as the step-flakes came off, any polish was removed from the ventral flake surface. Thus, the resistance of a retouched edge to step-flaking is determined in part by its edge angle. Edges with low retouched edge angles will exhibit step-flaking on wood, while steeply retouched edges will exhibit arris and flake margin polish.

We then did 500 strokes scraping dry antler with "Exp-2". There was a visible effect: small undercutting step-flakes of less than 0.5 mm width perpendicular to the edge were common along the utilized portion of the edge. However, the wood--scraping polish from the previous experiment was still present on arrisses and projections not removed by step-flaking.

One hundred strokes scraping dry antler with "Exp-3" destroyed the edge. A deep concavity was worked in the side of the flake, and the retouched edge was nearly obliterated by step-flaking.

In sum, it appears that use of a retouched edge on soft materials may leave a little polish, or perhaps no trace of wear at all. Use on medium or hard materials will produce step-flakes at some threshold value determined by edge angle. If the material being worked is of medium hardness, it will either cause polish or step-flaking depending on the retouched edge angle of the tool. No scalar flakes are produced, in contrast to use-wear of unretouched flake edges on medium-hard materials. Hard materials appear to produce step-flaking no matter what, but the intensity of step-flaking varies with edge angle. Step flaking produced by use-wear can usually be differentiated from intentional retouch, even intentional retouch terminating in step hinges. Use wear step flaking is generally less wide, perpendicular to the edge, than intentionally produced step flaking. However, even intensive use-wear on hard substances may be "lost" in the heavy, narrow step-flaking retouch such as appears on the limace ("Exp-1") when its retouched edge is abraded deliberately by a stone in the hand of the maker. The evidence produced by these few experiments contrasts strongly with interpretations of use-wear patterns on Paleoindian archaeological specimens being made by some researchers (e.g., Davis et al. 1985).

One variable that we have not investigated is the effect of heat treatment on the production of use-wear on chert tools. One of the effects of heat treatment on some cherts is an increased lustre on facets flaked after the heat treatment (Rich and Chappell 1983). Since much of the chert in the Michaud assemblage exhibits a fairly high lustre, we suggest, without any current evidence, that some of the pieces may have been heat treated. Olansson (1983) has demonstrated that heat treatment, among other things, decreases the tensile strength of flint. While this conveys an advantage when manufacturing implements, it also increases the rate at which edges wear, because microflaking initiates at lower forces.

We think that heat treating would tend to lower the force threshold at which step-flaking occurs on a retouched edge of a given angle. Logically it would tend to increase the edge angle at which step flaking occurs for a given force used on a given material. The magnitude of these effects, however, remains uninvestigated on the cherts used by the Michaud site inhabitants. If anything, heat treating would tend to reduce the amount of wood polish accumulating on a retouched edge, producing step-fracturing instead. Thus, a heat treated, retouched edge without polish and without step flaking is even more likely to have been used lightly on soft materials.

RESULTS OF EXAMINATION OF MICHAUD COLLECTION

Channel Flakes

Sixteen channel flakes and flake fragments were examined for use wear, which was found on six, along the lateral edges. A similar pattern of channel flake edge use was noted by Judge (1973) and Ellis (personal communication). These pieces are mostly *not* retouched, and are characterized by a low edge angle. Use

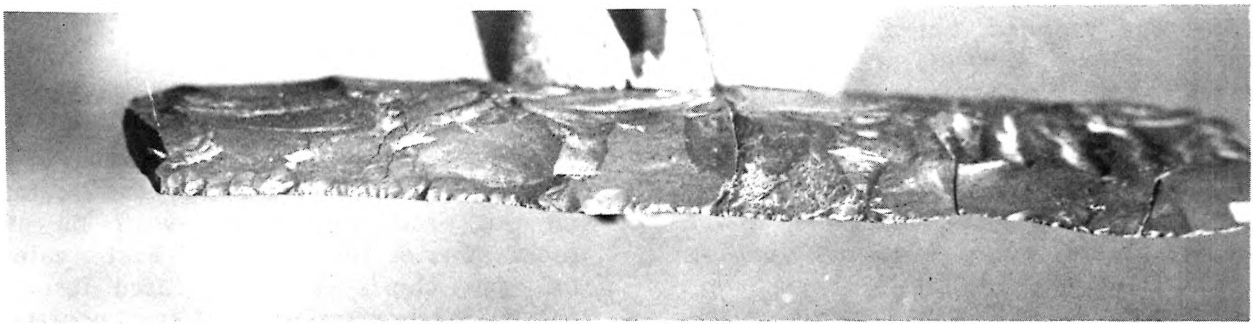


Plate A2-3. Channel flakes (23.12.01398, .01399 and .01401) exhibiting use wear along unretouched edge. Use wear consists of extensive scalar flaking coupled with polish or arrises and promontories along the edge.

Table A2-1: Channel Flakes, artifact number(s) and use wear notes.

0087. Medium hard material scraping or whittling with light cutting/sawing. N10E80

1398, 99, 1401. Medium hard material scraping or whittling with light cutting-/sawing. N14E82

1816. One edge retouched. Both scraping/whittling. N35E58

1803. Medium hard material, scraping?? N35E58

1387. Cutting medium hard material. N20E42

2314. Cutting medium hard material. Scraping and light whittling or sawing.

wear on all six was similar (Plate A2-3, Table A2-1). It can be characterized by the extensive presence along the lateral edges of small scalar flakes (< 0.1 mm width), plus noticeable polish on the flake edge itself, heavy polish on chert promontories, and polished or obscured flake margins. The wear is essentially unifacial, with the number of flake scars on one face being at least an order of magnitude less than on the opposite face. Opposite edges of the channel flake may or may not have been used on opposite faces, i.e., most of the flake scars may be ventral on one edge and dorsal on the other. Only one of the twelve edges on these six channel flakes has been retouched (low angle), and it too exhibits edge and promontory polish. Step flakes along all edges are small and very rare, but present.

We interpret these objects to be curated, light-duty unidirectional cutting or whittling implements. Most or all of the action was transverse, producing unifacial wear. Sawing motion wear was present but minimal. There is no consistent pattern in whether the ventral or dorsal flake side was "up" relative to the object being worked. The extent of polish and presence of occasional step-flakes indicates that the hardest material on which these objects were consistently used was of "medium" hardness, probably a wood. We hypothesize, then, that these objects were used for whittling or light scraping of wood, or light cutting of bark.

Utilized Flakes

All flakes with retouch on less than 50% of their edges, or showing signs of wear without retouch, were classified as "utilized and/or retouched flakes". For the purposes of use wear analysis this category was further subdivided into "utilized flakes",

those flakes showing utilization on a fresh flake edge, and "retouched flakes", those flakes displaying use signs, if any, on the retouched edge.

Results of the "utilized flake" wear examination are presented in Table A2-2. The vast majority of chert utilized flakes exhibit wear in two patterns. The most common pattern is intense unifacial scalar microflaking with arris polish and obscured flake margins. We interpret this wear pattern to indicate scraping a medium hard material, possibly wood. The intensity of these indications varies, either reflecting the intensity of use of the flake, or the nature of the medium-hard material (wood, bark, roots, etc.). The second, less common pattern, includes bifacial edge nibbling and scattered microflake removal. This pattern is interpreted as cutting of soft material, possibly either flesh or hide. The intensity of edge polish and scalar microflakes associated with this pattern varies. Probably a variety of activities are involved: some, such as butchery of meat, may involve encounters with harder materials (bone, cartilage), producing more or less polish or flaking. Use wear on the Neponset rhyolite specimens was less easily discerned due to heavy patination on some pieces. However, when the use wear was unequivocally visible, it fell into the above two categories. Thus, casually used flakes, or those selected for use without retouch, were utilized for two types of activities: scraping medium hard materials (possibly wood) and cutting soft materials (possibly meat or hide).

Retouched Flakes

For retouched flakes and all subsequent retouched tool classes, interpretation of edge wear must take into account the retouched edge angle. The steeper the angle (near or exceeding 60°) the harder the substance needed to produce extensive step-flaking. Of five retouched chert flakes, use-wear indications are clear on four, of which one exhibits use wear interpreted as scraping on a hard substance, while three suggest scraping on a medium hard substance (wood?). Four Neponset rhyolite retouched flakes exhibit use wear interpreted as scraping on a medium (or soft in one case) substance. Indications of extensive step-flaking, as seen below in the Neponset rhyolite endscrapers, was absent. In general, apparently retouched chert and Neponset rhyolite flakes were casually made for light scraping of medium hard substances.

Endscrapers

The endscraper sample (Table A2-4) also shows a range of scraping use wear. Scraping on medium-hard substances was a common function, but there is more evidence of scraping hard substances. There are seven chert endscrapers and three of Neponset rhyolite. The three Neponset rhyolite endscrapers and the largest of the chert endscrapers (.01528) account for the four highest edge angles in the series (57° to 68°). Three of these four exhibit step-flaking sufficient to indicate dominant use on hard substances (Plate A2-4), whether or not there was use on

Plate A2-4. Use wear on distal end of endscraper (23.12.01528), showing invasive step-flaking, plus obscuration of flake margins, polish on projections, and slight rounding of the working edge itself.

Table A2-2: Utilized Flakes

Black Chert

0089. Very low edge angles, lateral edges. Edge nibbling with occasional scalar microflakes, both dorsal and ventral. Cutting soft or medium material - probably soft.

0091. Edge nibbling and minor scalar microflaking, random and bifacial. Little edge rounding of arrises or flake scars. Bifacial cutting soft or medium, probably soft material.

0153. Utilized edge is covered with scalar microflakes and a few step flakes, small. Unifacial wear. Edge of flake and arrises are heavily obscured and polished. Scraping medium material.

1748. Edge (1): Edge nibbling and a few scalar microflakes, bifacial, polish minimal. Cutting soft. Edge (2): Edge covered with scalar microflakes, no step-flakes. Edge of flake scars and arrises obscured/polished. Unifacial - scraping medium material.

Red Cherts, various.

1397. Large biface thinning flake with ground striking platform. This is a "snapped cutter" by Gramly definition.
(1) "cutter" edge - 3 sharp points showing extensive polish on tips. Edge connecting these sharp peaks (90° sides) exhibit edge nibbling - very small scalar microflakes about 0.05 mm width. Used for graving or cutting a medium hard material.
(2) 2cm long edge covered with scalar microflaking and a few step flakes. Flake scar edges and arrises obscured by polish. Unifacial scraping medium material.
(3) Heavy step-flaking. Deliberately blunted.

1158. (1)Edge nibbling, bifacial, well spaced scalar microflakes. Arris and flake edge polish minimal. Cutting soft or medium material, probably soft.
(2) Unifacial extensive scalar microflaking, a few step-flakes. Arrises and flake margins obscured by polish and wear. Scraping medium material.

2322. All edges exhibit unifacial, extensive small scalar microflakes with rare step-flakes. Flake margins and arrises exhibit light polish and some obscuration. Scraping soft or medium, likely medium material.

1749. (1) Unifacial extensive coverage by small microflakes, arrises and flake margins obscured, rare small step-flakes. Scraping medium material.
(2) Bifacial edge nibbling and some microflaking. Arrises and flake margins exhibit some polish. Probably cutting or sawing medium hard material.

0092. Unifacial scalar microflaking covering the edge.

0093. Occasional step- flaking. Flake edges and arrises lightly 0123. obscured by polish. Light scraping of medium hard substance, or possibly scraping soft substance.

1801. Broken flake. Very short segment with bifacial scalar microflakes. Not enough present to be diagnostic.

Tan Chert

2204. Mostly unifacial edge nibbling and small scalar flakes, but one segment with curvature at base of utilized flake edge has scalar flakes on ventral side. A few larger scalar flakes. Probably cutting soft material.

Neponset Rhyolite

0029. (unpatinated) Unifacial scalar microflaking with edge obscuration and

polish on projections and arrises. Light scraping of medium hard substance.

1590. Unifacial scalar microflaking with flake edges obscured

1392. Unifacial scalar microflakes with arris polish and flake edge obscuration. Scraping medium material.

2350. Patinated. Wear appears to be bifacial edge nibbling and occasional scalar microflaking. Cutting soft (?) material.

0033. Bifacial edge nibbling and widely spaced scalar microflaking. Cutting soft material.

0006. Unifacial scalar microflaking along the inside of a concavity, flake edges obscured. Scraping medium hard material.

1820. Possibly very light edge nibbling and polish on flake high points near edge. Possible, but not conclusive, evidence for cutting soft material.

1447. Heavily patinated. Unifacial, scattered rather large scalar microflakes present. No possibility of use assignation.

0814. Flake edge exhibits bifacial edge nibbling and slight polish. Probably cutting soft material. Note: proximal end of this flake/blade has been retouched with bilateral side-notches, possibly for suspension on a thong.

Plate A2-5. Distal end of endscraper (23.12.00151) showing multiple step flakes with heavy polish and obscured flake margins.

medium substances as well. Artifact number .00110, a Neponset rhyolite endscraper with edge angle 60°, displays such light use wear that it must have been predominantly used on medium hard substances, or resharpened shortly before discard.

Of the six chert endscrapers, with edge angles of 54° to 41°, four show evidence of dominant use scraping medium hard substances (Plate A2-5). Use wear on one (.02214) is so extreme that it must have been nearly useless and demanded replacement or reshaping. The other two endscrapers in this low-edge angle category exhibit one case of dominant use on a hard substance and one equivocal case of use on perhaps both medium and hard substances. None of these tools were used exclusively for scraping soft substances, which we interpret as leaving little or no wear on retouched edges. The universal accumulation of wear from harder substances suggests that they were especially designed for such work.

In general, more polish accumulates on the scrapers of lower edge angle, supporting the hypothesis that they tended to be used more on medium hard than on hard substances. The high edge angle (>55°) pieces tended to be used more on hard substances. However, the data indicate that this is a general tendency to differential task use, and not an exclusive behavioral practice.

Sidescrapers

Wear patterns on the sidescrapers seem to be consistent (Table A2-6). The carefully retouched edge (or one of the two if two) has been carefully retouched, exhibits light unifacial polish on chert arrisses and projections, and in some cases exhibits enough polish to obscure the retouch flake scars (Plate A2-6). On several specimens this wear is barely noticeable. No step-flakes or scalar flakes such as might be produced by scraping medium or hard substances are evident. We hypothesize that these edges were all used

Table A2-3. Retouched Flakes, artifact numbers and use-wear notes.

Cherts

0150. Edge angle 55°. Retouch width 2 mm. Intensive step-flaking 1 mm wide and less. No evidence of arris polish or projection polish. Scraping hard substance.

2215. Edge angle 50°. Retouch width 1.5 mm. Step-flaking .05 mm wide, plus arris and projection polish. Scraping medium substance.

1121. A small fragment of a retouched flake with retouched edge 1.1 cm long. Recovered portion has been bifacially retouched by pressure flaking to an edge angle of 40°. Use wear on the piece, if any, is arris polish only. (This curious little piece is not a fragment of a biface point or preform.)

0896. Edge angle 45°. Retouch width 3 mm. This is a small fragment of a larger piece, only 1 cm of retouched edge is preserved. Use wear along the flake edge. Scraping medium hard material.

Neponset Rhyolite

0070. Edge angle, both edges 55°. Retouch width 2 mm. Use wear: occasional step-flakes. Probably scraping medium hard material.

1848. Edge angle 31°. Retouch width 2 mm. Use wear: a few wide (up to 1 mm) step-flakes. Probably scraping medium hard material.

1828. Edge angle 45°. Retouch width 2 mm. Use wear: a few step flakes about 0.5 mm wide. Probably scraping medium had material.

0333. Edge angle 30°.

Retouch 4 mm wide. Use wear: Possible 0334. edge nibbling. Probable use, scraping soft material or 0336. light scraping of medium material.

2329. Edge angle 50°. Retouch width 2 mm. Only about 1 cm of retouched edge preserved on this fragment. No use-wear indications seen.

2474. Edge angle 60°. Retouched width 2.5 mm. No use wear seen 2553. except for polish on a short graver-like spur at one end. Possibly a graver or cutting tool.

2657. Retouched edge angle 60° approximately. Small fragment, no use wear seen.

to scrape soft materials, possibly skins. This hypothesis is reinforced by the impression that extra care was taken to retouch the edge to be utilized into an even edge with no sharp projections. The side opposite the most heavily utilized edge has either been retouched and utilized little if at all, or has been "backed" or dulled with a combination of casual retouch and edge nibbling, plus abrasion or grinding of a thicker edge similar to that seen in platform preparation on biface preforms.

Perforators and Gravers

Two Neponset rhyolite flakes have naturally occurring tips of triangular cross-section on one corner that look as if they could withstand considerable force (.01592; .01843). Both tips seem to have been rotated inside a hole in a medium or hard substance, because scalar microflaking wear extends approximately 1/2 cm from the tip along the flake ridges (Plate A2-7). On one piece the microflaking appears to indicate dominant counter- clockwise rotation. The other piece seems to indicate equal wear on both sides of the tip arrisses (Table A2-5).

Two chert perforator/gravers show light use wear in the form of minute, uncommon scalar flaking, polish and edge abrasion (Plate A2-8). Apparently they were not used on a hard substance, but whether their use was confined to medium

Table A2-4. Endscrapers, artifact numbers and use wear notes.

Chert

0151. Distal edge angle 45°. There is a small "graver spur" on the right-hand margin of the distal edge, which has been broken and heavily polished. Use wear on the main portion of the distal scraping edge consists of multiple small step-flakes of 1 mm or less width. Their margins have been heavily polished and obscured. The last use of this edge was for scraping a medium hard substance (wood?). Both lateral margins have been heavily ground, producing abrasion and extensive heavy step- flaking. The grinding is interrupted by retouched side notches.

0214. Distal edge angle 52°. Intensive step-flaking along the edge, with very heavy abrasion of flake margins. The distal edge itself is heavily rounded by abrasion. Very heavy use scraping a medium hard substance. The lateral margins have been heavily ground.

0090. Distal edge angle 49°. Extreme step-flaking to a maximum width of 2 mm. Flake scar edges and projections only lightly polished or obscured. Probably scraping a hard substance, or mostly scraping hard substances.

2193. Distal edge angle 54°. Distal edge wear is heavy step-flaking, to a width of 4 mm. Light to medium polish on arrises and projections. Largest step-flake margins not obscured or polished. Probably scraping both medium and hard substances although exact sequence and proportion of use equivocal. Lateral edges heavily abraded, purposefully ground.

0022. Distal edge angle 41°. Moderate width step-flaking, up to 1| mm with heavy polish of arrises and projections, and some obscuring of flake margins. Working edge itself shows beginnings of rounding due to abrasion. Used to scrape medium hard substance.

1528. Distal edge angle 67°. Extreme invasive and undercutting step-flaking with heavy polish on chert projections and obscuration of flake margins. Working edge itself has been rounded slightly by abrasion. Heavy use scraping medium--hard substances at least, possibly hard substances as well. This edge has been "used up", in need of resharpening before re-use.

0586. Edge angle 47°. Light step-flaking with arris polish and flake scar obscuration. Scraping medium hard substances.

Neponset Rhyolite

2396. Edge angle 68°. Invasive, undercutting step-flaking up to 2 mm wide on left half of working edge. Amount of polish difficult to judge because of patination, but appears to be moderate. Scraped hard substances and possible medium substances. Lateral edge intentionally dulled, producing large step-flakes indicating no use polish.

0110. Distal edge angle 60°. Light step-flaking <1 mm wide with noticeable rounding of edge. Probably scraping medium substance.

2109. Edge angle 57°. Undercutting step-flaking up to 2 mm wide. Light or no polish or abrasion of flake scars in place. Edge used most often or most recently, mostly or exclusively to scrape hard substances.

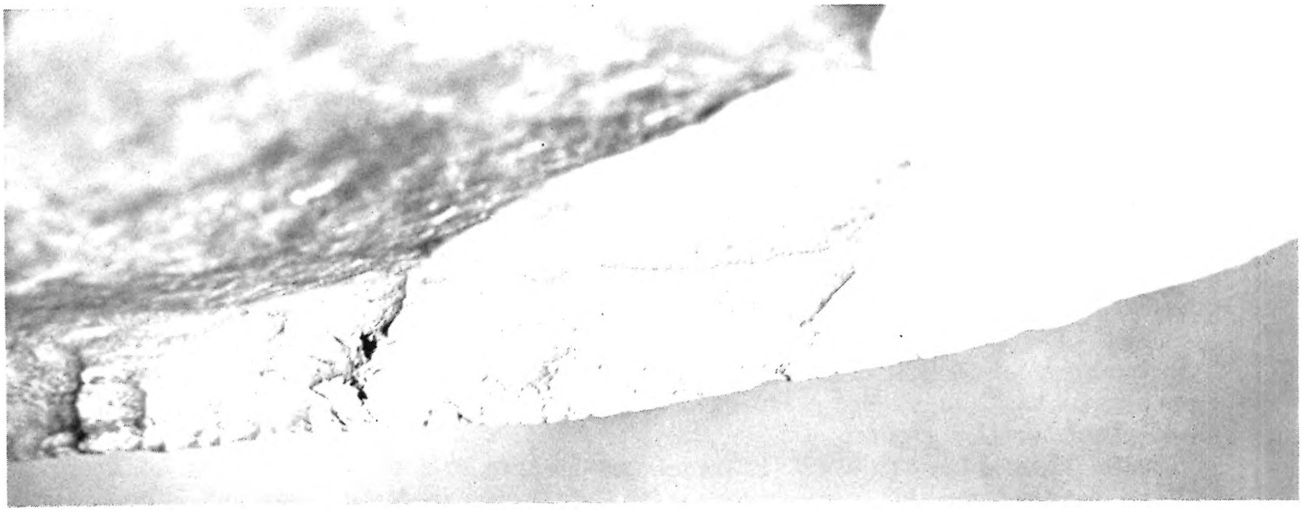
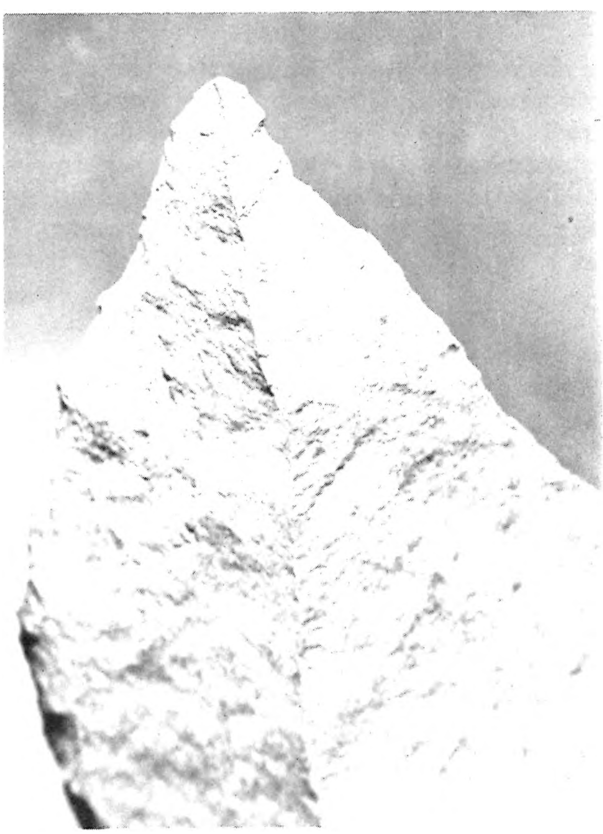
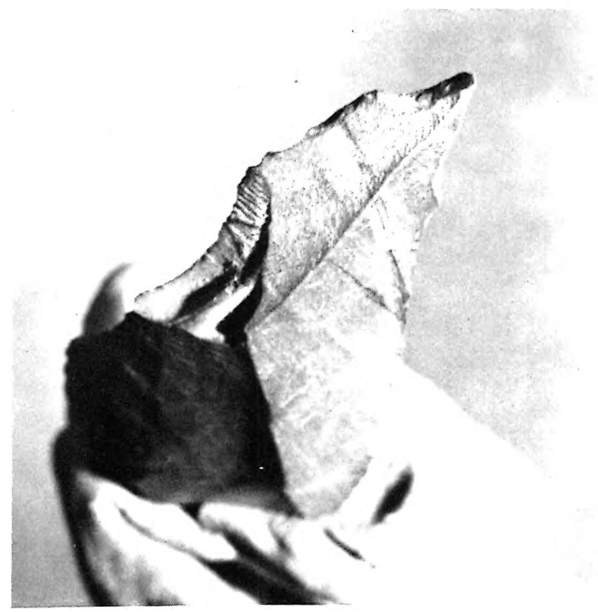


Plate A2-6. Sidescraper (23.12.02051/.02053) working edge showing light polish on retouch flake scars and arrises.

Plate A2-7. Perforator/graver tip (.01843) exhibiting scalar microflaking extending approximately 1/2 cm. from the tip.

Plate A2-8. Perforator/graver (23.12.01818), close-up of tip and distal edges.





or soft substances is difficult to determine. The one formally flaked perforator in the collection has been too heavly "sand--blasted" to detect all but the grossest use wear, which is seemingly absent.

Table A2-5. Perforators and Gravers, artifact numbers and use wear notes.

Neponset Rhyolite

1592. Distinct scalar flake removals from flake edges within 1/2 cm of tip indicated predominant but not exclusive counter-clockwise action. Tip definitely worn, evidenced by scalar flaking on all sides. One of flake edges appears to have microflaking wear extending 2| cm proximal to the tip.

1843. One margin exhibits convex retouched edge along 4 cm, with noticeable polish and arris wear on the 1 mm closest to the edge. This edge has been used to scrape a medium hard material. Opposite flake edge, concave, exhibits the same type of wear. The tip exhibits more intensive scalar flaking along flake margin within 1 cm of the perforator point. The point seems to have been rotated in both a clockwise and counter-clockwise direction.

Chert

1818. Flake edges show edge nibbling that produced occasional scalar flakes bifacially, plus abrasion. Tip formed by retouch. Tip itself exhibits abrasion and polish and minute step-flaking along retouched edge within 3 mm of tip. Flake edges used to cut a soft or medium substance. A possible interpretation is that the tip was used to pierce and the flake edges were used to cut away from the puncture.

1534. Two flake margins retouched proximally. One exhibiting light arris polish similar to the sidescraper use pattern which apparently antedates the snap used for one side of the perforator point. Point itself shows minute flake removals on the very tip.

0215. Tip damaged by minute flake removals and polished.

1804. This piece appears to have been abraded or "sandblasted" after discard, making it impossible to specify whether or not abrasion was caused by use wear. Tip appears to have lost several flakes ventrally to force applied during piercing or graving, or through intentional removal to sharpen the tip. Lateral margins of the tip do *not* exhibit microflaking that would be indicative of rotary or boring motion in a medium or hard substance. Proximally, two separate segments of the edge of this channel flake have been retouched to a low edge angle. One segment exhibits little wear beyond very small scalar flakes. The second retouched segment exhibits step-flaking from scraping a hard or medium substance. This is a "multi-purpose" tool.

Concave Scrapers

The use wear indications along all retouched edges on the concave scrapers indicated dominant or exclusive use on a medium hard substance, possibly wood (Table A2-7). There is heavy step microflaking along some edges, but it is accompanied by use polish (Plate A2-9). None of the edges exhibit the fresh, unpolished extreme step microflaking which we associate with scraping on a hard substance.

Bifaces and Fluted Points

There is no evidence of use of any of the bifaces or fluted points for any function other than as piercing implements. All edge "wear" indications (where present) are consistent with edge grinding as platform preparation during bifacial flaking (Plates A2-10,11, Table A2-8), or basal edge grinding. The flakes removed from the broken edge of .00112 appear to be indications of an attempt to remove the chert "lip" overhang from the break.

Table A2-6. Sidescrapers, artifact numbers and use wear descriptions.

2301. *Edge preparation* accounts for most of the visual relief along the edge of this tool, including scalar and step-flake removals up to 10 mm wide, followed by light pressure retouch to produce a straight retouched edge. Scalar or step-flakes produced by use wear are *absent* from both the dorsal and ventral surfaces. Along some portions of the edge, the angle is low enough (40‘) to show step--fläking if it had been used on medium hard materials. The only indication of wear is a light polish on projections and flakes scar edges on the right-hand side of the tool, and a medium such polish and edge rounding on the left-hand edge. Definitely used exclusively for scraping soft substances (skin?).

2051. Same as .2301: light polish and flake scar obscuration on both .2051 edges, but more prominent on left (larger, convex) tool edge. No definite scalar or step flakes postdating the initial stages of edge retouch. Scraping soft, or no use at all.

2323. Left edge is retouched. Right edge has been dulled by slight retouch, grinding, and edge crushing similar to biface preform edge preparation. Only sign of use wear is light polish on chert projections along the left (retouched) edge. The amount of polish is only one, two, or three times the amount we produced with 500 strokes scraping dry deer hide on Exp-2. Conclusion: light use scraping soft material.

2293. A backed edge opposite a retouched convex edge. Very 2209. light polish on projections along retouched edge furthest away from striking platform. Scraping soft material.

0289. One side definitely "dulled" on purpose: bifacially flaked segment of edge has grinding on high points identical to biface preforms. Other edge a definite uniface with carefully prepared straight edge. Almost no polish on arrises on projections visible at all: used less than or equal to our 500 stroke experiment scraping soft material.

1700. A backed (lightly retouched and ground) edge opposite the carefully retouched working edge. Light but definite polish on chert projections along immediate working edge. Scraping soft material, with light use.

0488. Both edges of this piece are retouched. The broadly retouched (4-5 mm) edge exhibits little or no wear, while the narrowed retouched edge (2-3 mm) exhibits moderate polish on chert projections and flake arrises. Light use scraping soft material.

0308. Edge wear includes some abrasion and no scalar or step-flakes on this Neponset rhyolite piece. Patination is too advanced for definitive statements.

2216. Low angle retouched edges, with heavy arris and projection 2218. polish and flake scar obscuration. Scraping soft material.

Limaces

The lateral edges of our two specimens exhibit regular retouch, upon which has been superimposed invasive step-flaking along the junction between the retouched edge and the ventral surface. We interpret this step flaking as a deliberate attempt to "even up" and strengthen the edge by the napper because: (1) the step-flaking is nearly uniform in intensity along the whole of the extant lateral margins, and (2) identical "wear" was produced on the experimental limace made for us simply by running the hammerstone lightly along the

Plate A2-9.Use wear in the concavity of concave scraper (23.12.00086), including step flaking and use polish on arris margins.

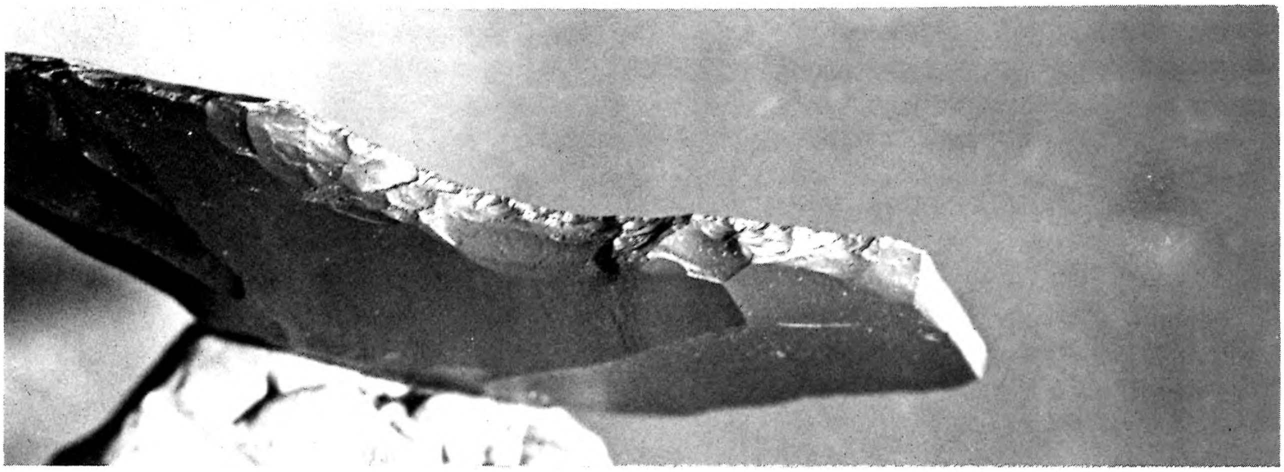


Plate A2-10. Oblique view of margin of biface preform (23.12.00660/.00661) showing edge dulling as platform preparation.

Plate A2-11.Edge on view of biface shown in Plate 4-10. Grinding along sinuous edge visible.

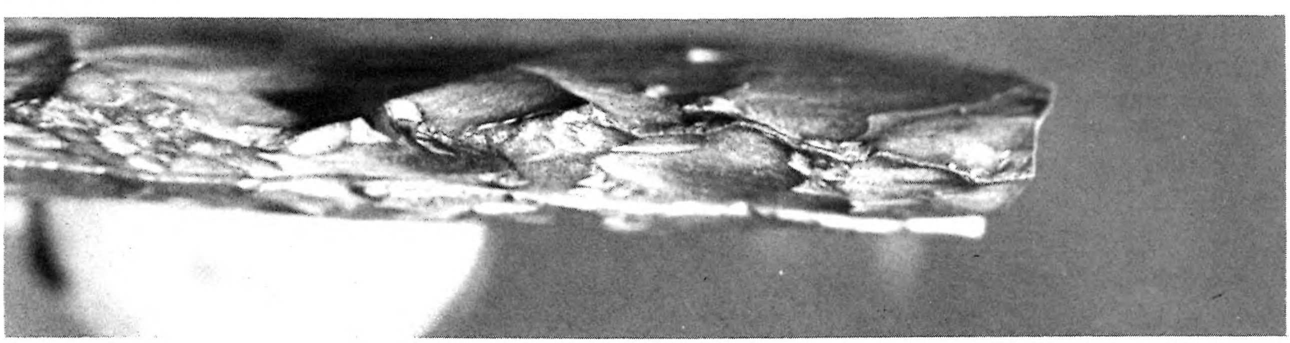


Table A2-7. Concave Scrapers (Retouched Edges)

Neponset Rhyolite

1591. No step-flaking visible along retouched edge. Nature of the material precludes discerning arris wear or polish. Used on medium or soft hard materials.

Quartzite

0032. Very minor step-flaking. Heavy edge polish and rounding. No experimental evidence for this material, but if it acts like chert, then use wear indicates scraping medium hard material.

Chert

0335. Invasive and undercutting multiple step-flaking, on a low angle retouched edge. Heavy flake margin polish and rounding. Scraping medium hard substance, fairly intensively.

1319. Unifacial scalar and uncommon step-flaking, accompanied with heavy edge rounding, arris polish and flake margin obscuration. Scraping medium hard material.

0086. Both the convex and concave edges on this piece exhibit the same signs of use wear: intense multiple step-flaking up to 1 mm wide, accompanied by heavy polish and wear on arrises and projections and obscuration of flake scars. The polish on these edges indicates use on medium hard materials. The intensity of the step-flaking indicates heavy use. Note that the convex edge has been retouched on alternate sides of the flake for each approximately half the length of the side of the flake, making this piece a very versatile scraping tool.

edge. On both specimens the major evidence of use, therefore, consists of scalar flakes removed from the ends on the ventral face (Plate A2-12).

The dorsal surface on the complete specimen (Table A2-9) exhibits small scalar flakes removed at random from the distal half of one of the dorsal blade arrisses, yet the edges show no evidence of twisting or rotating wear. We suggest that these tools were used to shave out or whittle inside a long concavity, such as the scraping of the sides of a deep, narrow socket. The dorsal arris acquired its use marks while rubbing in and out on the edge of the concavity.

The mode of use of the flake-shavers proposed by Grimes and Grimes seems consistent with this wear pattern, although the fact that the complete specimen from the Michaud site exhibits use wear on both ends (albeit one end much more intensely) might mean that not all limaces were hafted in the manner proposed by Grimes and Grimes.

Additional use wear experiments would have to be undertaken to decide which range of hardness of raw materials would produce the use wear scalar flakes seen on these specimens; we suspect that at least a medium or a hard substance would be involved.

Table A2-8: Bifaces and Fluted Points

0330: Biface preform. Some of bifacially flaked edge had been lightly ground as platform preparation, producing localized, bifacial step-flaking alternating with intense abrasion and dulling of some edges. No other signs of use wear present.

0660: Biface preform. Edge grinding for platform preparation 0661 visible around whole bifacially flaked edge; e.g., breakage of artifact occurred after platform preparation but before extensive flaking of the prepared edge. Possible use wear confined to a 1 cm long stretch of one edge of the freshly broken surface, where there are a series of small scalar microflakes. Fresh edge may have been "tried" as a scraping edge on some object but not utilized further.

0082: Fluted point preform, broken on first flute attempt. Traces of bifacial edge preparation (grinding) visible between flake scar (e.g., grinding predates the existing regular flaking, and the fluting attempt). Use wear absent on distal edge (the flute carry-over fracture), which contrasts sharply with a similar specimen from 23.13 which was heavily utilized along the freshly broken edge.

0037: Biface tip, red chert. Edges have been ground in preparation for bifacial resharpening, which never took place. No other signs of use wear.

0451: Fluted point ear, red chert. Bifacially flaked edge has been heavily ground.

1355: Biface preform tip. Biface edge had been heavily ground as platform preparation, then subsequently flaked.

1974: Biface tip, Neponset rhyolite. No use wear indications.

0109: Fluted point, black chert. Base heavily ground. A few traces of bifacial edge platform preparation antedating last resharpening incident visible on distal portion. No other use wear indications.

0643: Red chert, fluted point, tip missing. Same comments as 0109.

0321: Fluted point, broken tip refitted. May have been 0433 undergoing resharpening when break occurred because both of the lateral edges distally show unifacial removal of large flakes that postdate the edge grinding platform preparation. No other indications of use wear, except grinding of the proximal portion of the point.

0088: Black chert fluted point. Tip broken, tip utilized. No use wear visible on fluted point edges, which are clean and sharp except for remnants of platform preparation antedating last resharpening plus basal grinding. The broken edge of the tip is another matter. A serious attempt was made to remove the "overhang" of chert on the break by retouch, a procedure which ended in failure as the edge crushed after a few scalar flake removals. There is no evidence of use of this edge subsequent to the flaking attempt.

Table A2-9. Limaces, use wear descriptions.

0634: All flake arrises and projections on whole object have been lightly "sandblasted", probably by the wind. Lateral, retouched edges are marked by intrusive, invasive multiple step flakes removals up to 1 mm wide. We believe that this step-flaking represents intentional edge "evening"; it is nearly universal along one edge but only occurs on projection portions of the edge on the other margin. Use wear indications are confined to two large scalar flake scars on the ventral surface originating from a lateral edge within 1/2 cm of the tip, and a series of several generations of scalar microflake removals from one side of the distal tip.

1342: Almost universal and uniform step-flaking of both lateral edges, again interpreted as intentional edge evening/grinding. Use wear indications are confined to scalar flake scars on the ventral surface which originate from, in the case of this complete object, both ends of the tool. Only one scar originated at the proximal (striking platform) end of the implement. Distal end has multiple generations of scalar scar removals.

Plate A2-12. Ventral view of end of limace (23.12.01342) with scalar flaking removals visible at tip.

APPENDIX THREE

A SURVEY OF ISOLATED FLUTED POINTS FROM MAINE AND ADJACENT AREAS

Here we review the record of isolated fluted points from our research area with respect to both raw materials and various morphological attributes. The purpose is to augment data obtained from habitation sites in an attempt to detect geographic patterning. All of the isolated Paleoindian finds mentioned in previous compilations for Maine (Brennan 1982:27-46; Ritchie 1980:5), with one exception, are discussed below. New information is added where available. The exception is a fluted point indicated on Ritchie's map by a dot in the Farmington--Wilton area, for which no known specimen exists. The discussion of isolated Maine point finds proceeds generally from those at the southern and western end of the state toward the northern and eastern end. At the end of the Appendix Three we discuss a few finds from New Hampshire, New Brunswick and Vermont.

ISOLATED FLUTED POINT FINDS FROM MAINE

Desert of Maine Point

The Desert of Maine point is mentioned in print by Howard Sargent (Brennan 1982:43). It was known to Douglas Jordan who provided a sketch in a personal communication to Bruce Bourque (October 22, 1974), and it has been studied recently by Spiess, courtesy of Sargent. This point is delicately made (Figure A3-1), with slightly concave sides flaring to distinct, moderately pointed ears. The basal concavity is approximately 3 mm deep; point length is 71 mm, width 19 mm, thickness 7 mm. The point exists in 3 pieces: a distal and medial piece have been refitted, while the medial piece may have a single point of contact with the basal piece. The dorsal fluting scar is 21 mm in length, ventral fluting scar 12 mm. The lateral retouch on this piece, and retouch scars producing the sharp tip, are identical in spacing, sequence and style to point 23.12.0088/0112 from the Michaud site. The raw material is an olive-green chert with vesicles similar to Bull Brook Chert. The point is from the "L. M. Crosbie" collection from the Desert of Maine, near Portland, currently a partially vegetated and partially reactivated sand dune system. Recent reports (H.Lamoreau) indicate that a habitation site may have been present but is now destroyed.

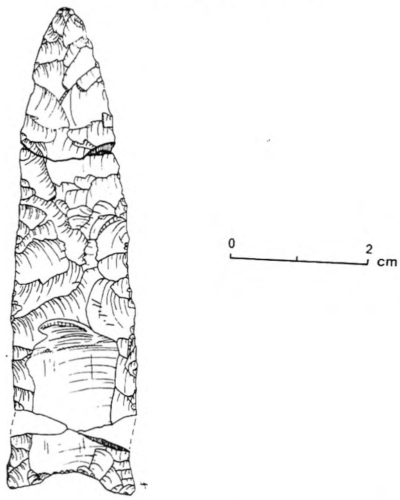
McAllister Point

In 1986 a new fluted point was reported to Bruce Bourque by M. B. McAllister of Lebanon, Maine (Bourque personal communication). The point, which was found underwater near the shore of Northeast Pond, consists of four-fifths of the total length of a fluted point with the tip and basal ears missing (Plate A3-1,2). Originally approximately 50 mm long, it is made of a light and medium grey mottled dull-lustre chert. The nearest analogue in terms of material is the Earle Flanders point (below). The most recent collections from the site include a quartz flake and small chert core fragment, so a habitation site of some size may be associated.

Clarke and Lake Site Point

The Clarke and Lake site (Baker 1985) is located on the Sasanoa River on Arrowsic Island, Georgetown. The principal component at the Clarke and Lake site is a mid-17th century European trading establishment with extensive structural features. The site has been partially excavated. During the course of the excavations, several score lithic and ceramic artifacts of prehistoric age were recovered from contexts indicating disturbance of a

Figure A3-1. Desert of Maine point. Redrawn after Jordan (personal communication to Bourque) and Spiess (personal observations on the specimen).



prehistoric site by the builders of the 17th century settlement. Thus, the prehistoric assemblage cannot be divided into components on any basis other than style. Except for the fluted point in question, the prehistoric assemblage from the site contains a series of points, endscrapers, ground/pecked stone and ceramics that document habitation at the site from Middle Archaic through late Ceramic (Woodland) periods.

The fluted point in the collection is slightly atypical (Plate A3-2). It is made on a black, phenocrystic felsite, and its tip has been broken. It is 37 mm long, 24 mm wide and 5.5 mm thick. The base is concave, and one side (only one) is clearly fluted (flute length 20 mm). The basal corners of this specimen exhibit pronounced ears. One can feel heavy grinding in the basal concavity, and on the sides as far as 18 mm along the lateral edges. Immediately distal to the termination of the grinding, the sides of the point converge sharply and asymmetrically, possibly indicative of heavy resharpening of the unhafted portion of the blade. The point tip has been broken away with some force, which produced two long flake scars ending in hinges. The hinges coincide with the distal limits of grinding, indicating that

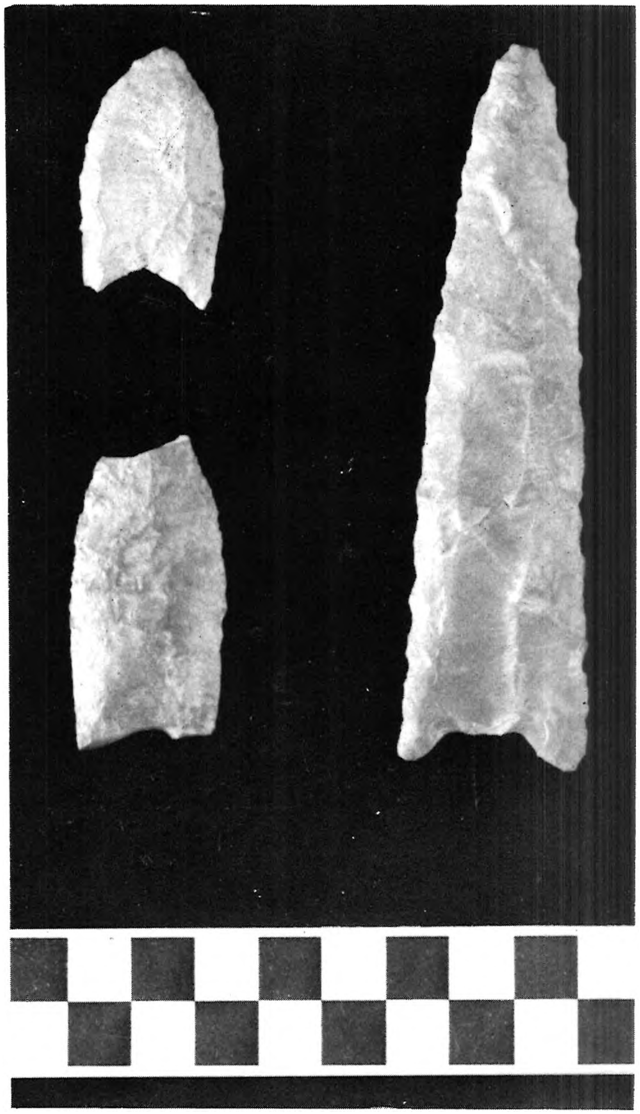


Plate A3-1. McAllister (lower left), Earle Flanders' (right) and Whitefield points (upper left), from the collection of the Maine State Museum. Scale in centimeters. Photograph courtesy of the Maine State Museum and Robert Lewis, used with permission.

impact fracture propagation may have been stopped by the lashing.

We attribute this point to the Paleoindian fluted-point tradition on the basis of a long flute on one face, coupled with a concave base and heavy grinding on the base and lateral margins. Heavy resharpening of fluted points distal to the termination of lateral grinding also seems

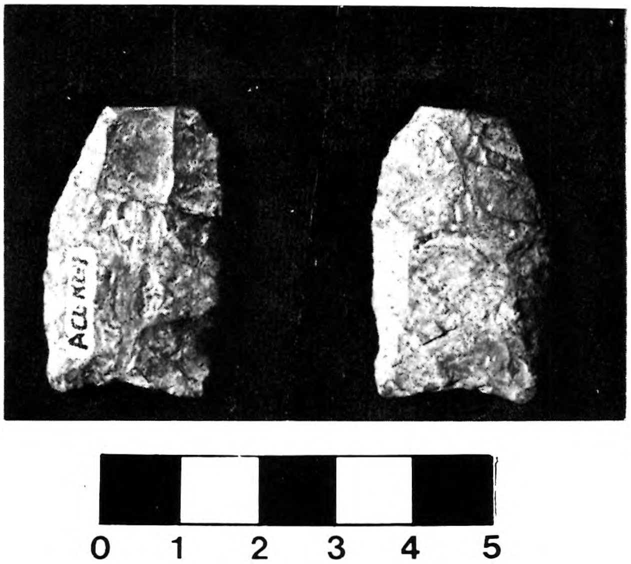


Plate A3-2. Dorsal and ventral views of the Clarke and Lake fluted point.

to be a common Paleoindian cultural trait.

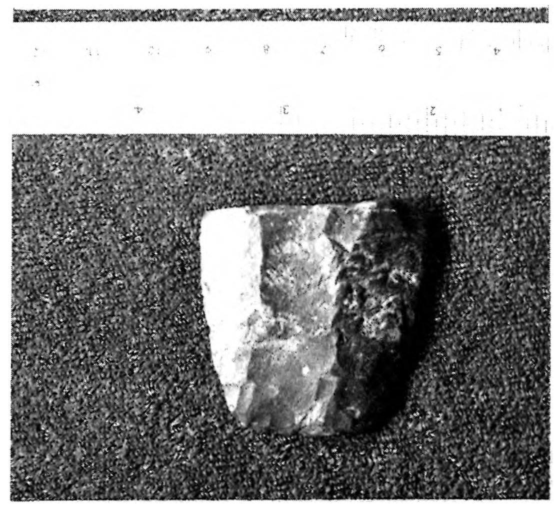
The point is atypical, however, with slight ears at its basal corners and unifacial fluting. Felsite is an uncommon raw material for Maine fluted points, but other examples exist.

Sagadahoc Island Fluted Preform

The Sagadahoc Island site (15.117) is located near the Clarke and Lake site in the lower Kennebec. It is currently under investigation by Robert Bradley and Emerson Baker, Maine Historic Preservation Commission. The circumstances of recovery of the aboriginal collection are similar to that at the Clarke and Lake site: a range of aboriginal occupation, including Middle Archaic, disturbed by 17th century Euro--American building.

The probable Paleoindian artifact is the base of a large, medially-thinned preform (Plate A3-3). There is a flute scar on both sides of this object. Subsequently the base has been retouched and lightly ground. The large size of this biface base, and lack of basal concavity, suggest that it may have been a preform awaiting further fluting and retouch. The material

Plate A3-3. The Sagadahoc Island medially thinned biface preform. Scale in centimeters and inches.



is a dark, grey quartzite(?) with slightly sugary texture.

Earle Flanders' Point

This point was donated to the Maine State Museum by Mr. Earle Flanders from the collection of a small museum in Monmouth, just west of Augusta. The point has an inexact provenience, from somewhere in the Monmouth area. A local collector mentioned to Spiess that he knew of a very old, large grey spearpoint collected from a hill overlooking Cochnewagon Lake in Monmouth, a possible provenience for this piece. This fluted point is very long (113.4 mm) with convergent straight sides and long fluting scars (59.1 and 50.5 mm)(Plate A3-1). The base is shallowly indented (5.0 mm). The point is made on dull-lustre chert that has patinated to a mottled light and medium grey. It may be related lithologically to Bull Brook chert.

Whitefield Point

In 1985 a short (41 mm), heavily resharpened fluted point was found in the yard of a house in Augusta. Bruce Bourque (personal communication) tested the yard extensively without finding further flakes or artifacts. According to the owner, the

yard had recently been covered with several loads of loam, which Bourque managed to trace to an origin in Whitefield, a community in hilly country east of Augusta. There the trail ends. This point has been so heavily resharpened (Plate A3-1) that the point edges approach the margins of the longest fluting scar in the manner of Folsom points (flute lengths 32 and 17.8 mm). It exhibits thin, pointed ears similar to the red chert fluted points from Concentration I at the Michaud site, and a moderately deep basal concavity (6.1 mm). The material is a grey-groundmass rhyolite visually similar to Neponset rhyolite (Spiess, Brush and Grimes personal observation).

Boothbay Point

The C. Haggett collection from the Boothbay region of the central Maine coast, examined for the MHPC by Anita Crotts (University of Maine, Orono) and Brush, contains a fluted point (Plate A3-4). Haggett had found the point on a tidal flat in front of a Late Archaic and Ceramic (Woodland) Period shell midden (site 16-37). This location may have been on a slope beside a small freshwater stream when relative sea level was much lower during the Paleoindian Period. The point is approximately 75 mm long, with nearly parallel sides, a moderately indented base, and a flute scar that extends nearly the whole length of one side. The point is made of red chert visually identical with the Cr1 chert from the Michaud site, that we attribute to bedrock sources near Munsungun Lake.

Rumford Center Point

Before 1980 the late Leo Bartlett of Rumford Point, on the upper Androscoggin River, discovered a fluted point in the garden behind his house (Gramly 1981). The findspot was on a remnant valleyside kame or river terrace near the mouth of a tributary valley, overlooking the Androscoggin Valley from a level significantly above the modern floodplain. Subsequent intensive investigation by the Maine State Museum of this seemingly ideal location for a habitation site failed to recover flakes

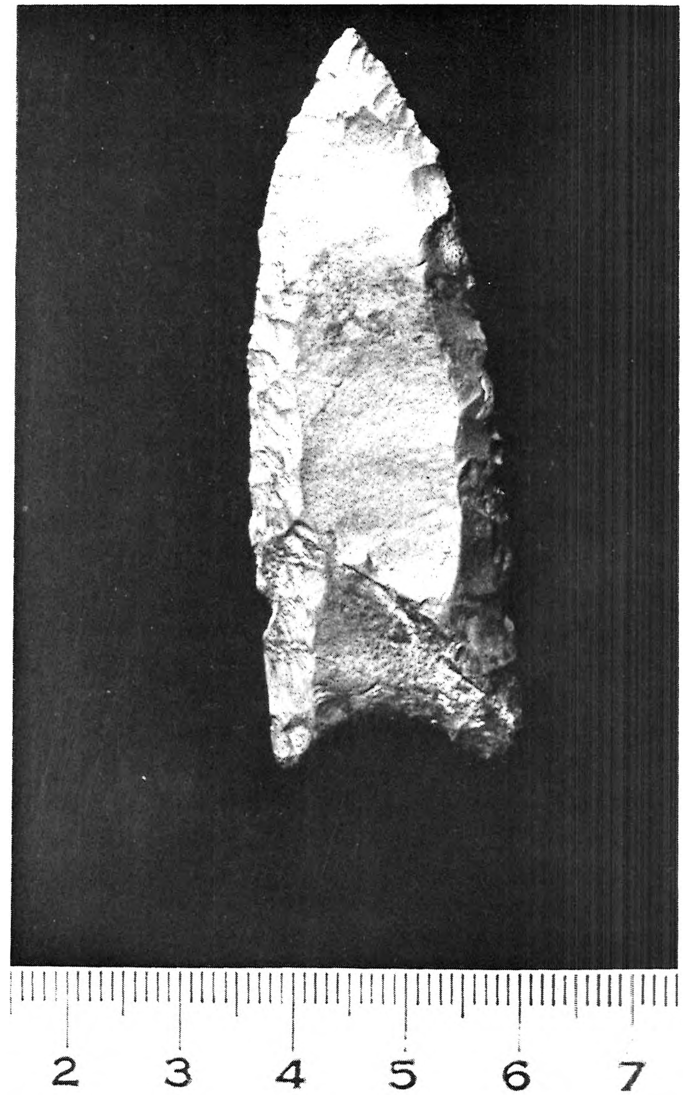


Plate A3-4. The Haggett point from Boothbay. Photo: Steven Bicknell, Dept. of Anthropology, University of Maine at Orono.

or other artifacts. The point (Plate A3-5) is complete, moderately long (81.5mm), with markedly convex sides, pointed ears on a base that does not fishtail, and displays a deeply indented basal concavity (9.8mm).The flute scars are short (34 and 24.8mm) in relation to point length. The point is made on a blotchy yellowish-brown dull-lustre chert with black swirls and rills. This chert is one of the variants of Bull Brook chert found in the Bull Brook collection (Grimes, Spiess and Brush, personal obs.).

Plate A3-5. Leo Bartlett's point from Rumford Point. Photo: R. Michael Gramly.

Mount Desert Island Point

Ritchie (1980:7) mentions a fluted point from Mount Desert Island without further details. Douglas Jordan (personal communication to Bruce Bourque 1974) refers to two fluted point specimens which were "reportedly surface finds" from Mount Desert Island. These points, from the R. S. Estee collection, were first reported by Fowler (1954). Both Bourque and Gramly are aware of these pieces and discount them as being neither from Maine originally, nor authentic (personal communication). We will not use these data in further analyses.

Graham Lake Point

A fluted point collected by Mickey Chandler from the shores of Graham Lake is currently in the Department of Anthropology, University of Maine, Orono collection (catalogue #74/158,15,056). The specimen (Figure A3-2) is the distal two-thirds of a thick, very large biface. It may be a biface preform having undergone the first of several stages of fluting and thinning. The material is a swirled, finely flow-banded red and purple rhyolite.

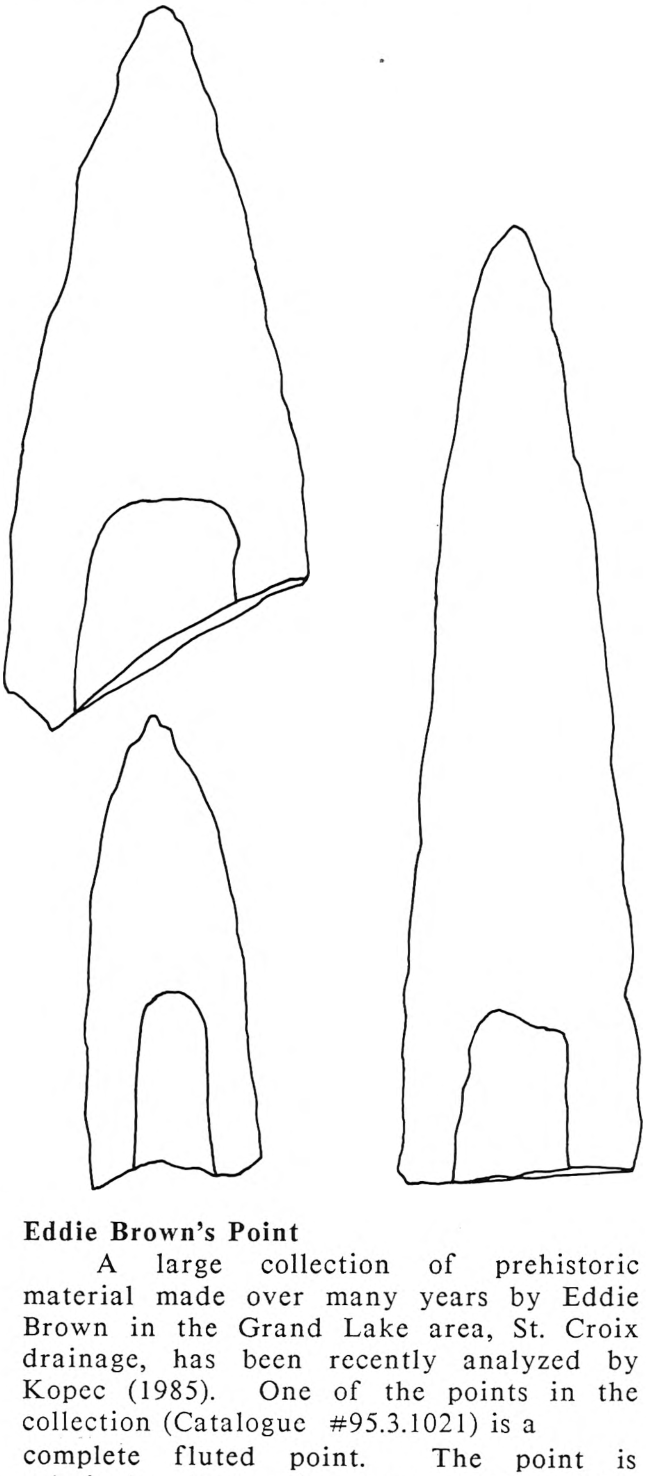
Second Graham Lake Point

According to Maine Archaeological Survey site form 58-21, a fluted point was found along the east shore of Graham Lake circa 1970. The spot was checked by Harold Borns Jr., Douglas Byers, and Robert G. MacKay, who considered that there was no site in association (ie. an isolated point find). Slides of this point, which is about 56 mm long, exist in the Dept. of Anthropology, University of Maine collection (70/001 to 70/004). The point is made of a red chert visually identical to the Cr1 series from the Michaud site, which we are attributing to a bedrock source origin near Munsungun Lake.

Layman Point

Eric Lahti (personal communication February 24, 1986) reports a fluted point (Plate A3-6) owned by J. Layman of South Solon. Mr. Layman is a Maine antique dealer who found the point in an attic box with other Maine prehistoric lithic material (non-Paleoindian). Unfortunately, there is no way to trace the provenance of this piece, beyond knowing that it certainly came from Maine and likely came from central Maine. The point is approximately 70 mm long, with a 4 mm basal indentation, and definite (asymmetric) ears providing a fishtailed appearance. The piece is made on a red and green chert visually identical to the Cr05 material from the Michaud site, of which one bedrock outcrop is the Willard Brook Quarry near Munsungun Lake. In form and flaking style it is hard to imagine a closer match to the large black point from the Michaud site.

Figure A3-2. Upper left: Graham Lake point outline. Lower left: Brassua Lake point outline. Right: Hall point from Lake Auburn, near Lewiston, outline.



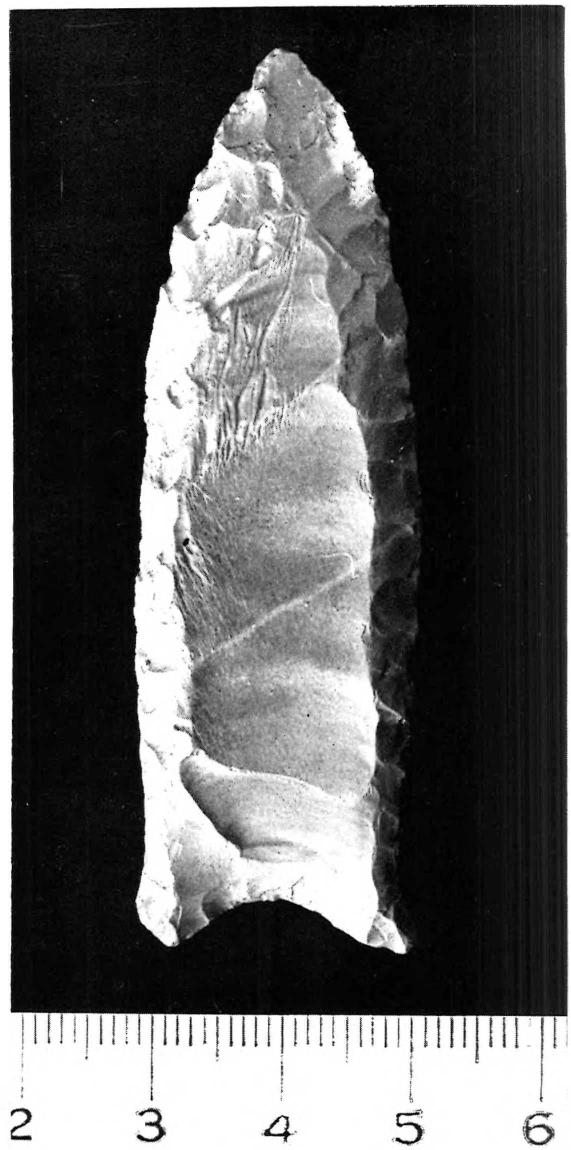


Plate A3-6. The Layman point, dorsal view. Photo courtesy of Eric Lahti, Maine Archaeological Society, and Steven Bicknell, University of Maine at Orono.

Eddie Brown's Point

A large collection of prehistoric material made over many years by Eddie Brown in the Grand Lake area, St. Croix drainage, has been recently analyzed by Kopec (1985). One of the points in the collection (Catalogue #95.3.1021) is a complete fluted point. The point is relatively short, with near parallel sides. One face exhibits a long fluting scar, the other a much shorter one. This point is made of a brecciated or variegated banded agate, with a deep pink ground mass and purple-grey and white bands. Beveling of the basal concavity is uncharacteristic of northeastern fluted points. Several professional archaeologists in Maine have

seen points of identical material which are known fakes. This raw material apparently outcrops in the American southwest. We will not use the data from this point in future analyses.

Flagstaff Point

The B. Clayton collection, made in the Flagstaff Lake area, includes a fluted point found below the high water level on this man-made lake. The point (Plate A3-7) is approximately 77 mm long, 27 mm wide at its widest, with a deeply indented (10 cm) basal concavity. The base is very reminiscent of Vail collection fluted points. Gramly (1985: 52) states that it is made of a "dark grey argillite, and was found in company with several flakes of the same material." It may be the same material as the Earle Flanders point and the McAllister point, based on the photograph and verbal descriptions, material we feel is most likely related to Bull Brook chert.

Plate A3-7. The Clayton point, Flagstaff Lake. Photo: R. Michael Gramly.

Brassua Lake Point

There is a short fluted point from the University of Maine (Orono) Department of Anthropology collection with a provenance of "somewhere around Brassua Lake". The point (Figure A3-2) has been marked with several catalogue numbers: "74/1", and "4815", and it may have come from the M. Chandler collection. This is a short point (approximately 50 mm) made on a fairly thick preform, displaying marked basal ears. It is fluted and ground for only approximately 25% of its short length. The point is made on white-patinated Kineo--Traveler porphyritic felsite, a material that outcrops at Mount Kineo and on ridges between Moosehead and Brassua Lakes. This material is also widely distributed southward as cobbles in glacial drift. Thus, this point was probably, but not certainly, locally manufactured and lost in the Moosehead-Brassua Lake basin.

Schoodic Lake Point

Jordan (personal communication to Bourque, October 2,1974) reports a "point about 3 inches long, both sides fluted, especially thick, of a dark yellow material, which came from Schoodic Lake. The specimen was in the hands of its finder, one Bernard Flynn of Dover-Foxcroft in 1954 when I recorded the data." Mr. Flynn returned to Danvers, Massachusetts, and his collection has been sold without possibility of recovery (Bourque personal communication). This yellow lithic material may be the mustard-colored chert found infrequently in the Vail and Dam site collections, and other New England collections (e.g., Bull Brook, Hanneman). If so, its bedrock source may be somewhere in the "Pennsylvania jasper" series from the Pennsylvania-Delaware border area. The point (Figure A3-3), as illustrated by a Jordan sketch, is another eared or "fish-tailed" specimen.

Hall Point

Milton Hall, father of Dr. Bradford Hall who is a faculty member and administrator at the University of Maine (Orono), found a large fluted point (Figure A3-2) in the vicinity of Lake Auburn near Lewiston, about the time of World War II. The existence of this point, and knowledge of potential chert outcrops, were principal factors in the development of Bonnichsen's Munsungun Lake project (Bonnichsen et al.

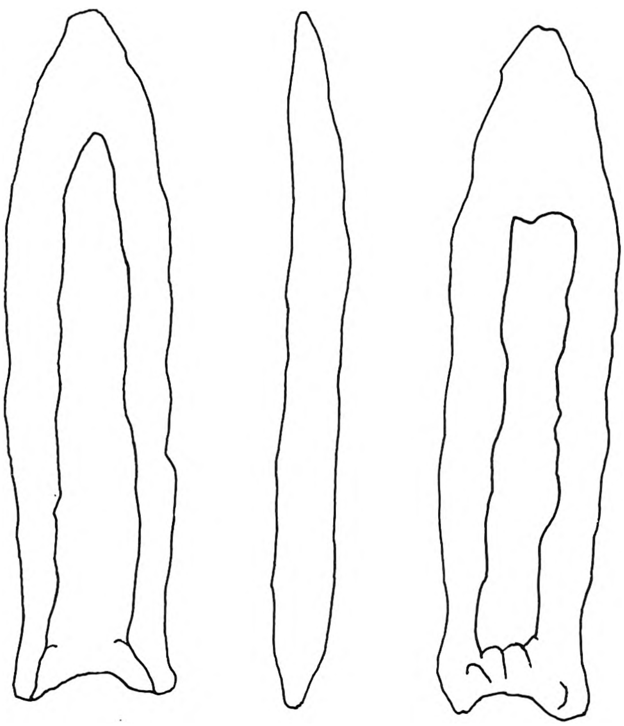


Figure A3-3.Outline drawing of the Schoodic Lake point, after Jordan (personal communication to Bourque).

1981, 1982). The point is exceedingly long, made on grey-black Munsungun chert. Its sides are nearly straight and converging, and the flute scar length is very short compared with the length of the point.

Moosehorn Artifacts

The Moosehorn site has been reported by Bonnichsen, Bourque and Young (1983). The circumstances of the discovery, and how it became known to Bourque, are presented therein (Bonnichsen, Bourque and Young 1983:37). We add our comments here. In the winter of 1980/81, Bourque was shown one (or more) black and white photograph(s) of the purported assemblage. Subsequent conversations with Earle Meyers (Spiess, field notes) indicated that the assemblage originally consisted of four whole fluted points, two broken proximal fluted points, two (side?)scrapers, a large bifacial knife made on a flake, one large flat flake, and a large biface with a broken tip. Thus, Meyer's recollection of the assemblage does not completely coincide with the photograph-based assemblage reconstructed by Bonnichsen and Bourque.

Bourque, Gramly and Spiess visited Meyers in 1981, who gave us vague directions to a hillside in the Moosehorn Wildlife Refuge where he understood the material might have been found. Meyers indicated that the collection was probably found on the ground surface or in sparse vegetation under the lip of a large boulder or at the entrance to a small cave. We made as thorough an inspection of the hillside as three energetic people could do in a day, indeed finding a group of house-sized boulders with many places underneath into which a person could crawl. No sign of disturbed soil or vegetation cover was found to confirm recovery of anything from the soil. On October 26, 1981, we returned to Mr. Meyers' residence and were met by his wife. Mr. Meyers was to return home from work shortly; his wife had no knowledge of the artifacts after which we inquired. Returning later, we were informed by Mr. Meyers that his wife had cleaned out the basement and taken a cigar box with two whole points and all the other pieces to the Machias Dump about two weeks previously. Thus, the Moosehorn specimens, except for two donated by Meyers to the State Museum, are currently lost. The lack of correspondence between Mr. Meyers' recollection of the collection (broken point bases) and the photograph, plus the inability to confirm who found them and where they were found, is puzzling.

Most importantly, the material from which the two extant points are made is unique in the New England-Maritimes region in our experience. Not even a flake of this material is found in the Bull Brook, Vail, Michaud, or Dam site assemblages, nor does it match any other fluted points so far found in this area. This material has been described (Young and Bonnichsen 1985:113) as a silicified limestone containing crinoid stem fragments, a brachiopod shell fragment and other fossils.

Young and Bonnichsen (1985) produce an elegant description of the differences in final manufacturing steps between the two extant Moosehorn points, and two unquestionably genuine Clovis points from the Anzick site. Indeed, there are radical differences in technology, but we would caution against using the Moosehorn points for any far-reaching hypothesis (i.e., Young and Bonnichsen 1985:125) about Paleoindian origins or behavior.

Discussion

Isolated Maine fluted points are found in a wide variety of circumstances. They are certainly not confined to the sandy soils that characterize New England--Maritimes region Paleoindian habitation sites. Many of these points were found on landforms associated with an existing lake basin, but at an elevation above the pre-contact lake/river levels. The construction of dams and flooding of land during the 19th century is one factor responsible for revealing several of these points. However, at least two points come from river terrace features in the lower Kennebec River valley. These locations would have been on fresh water, several score miles upstream from estuarine water during the Paleoindian period. Thus, they are definitely "riverine" locations.

The isolated points from Maine are made both of lithics recognized from extant sources or Paleoindian sites, and a few lithics that are "unique". The majority of materials are probably Ordovician cherts from bedrock sources in northern Maine, New Hampshire, and Vermont. Only a couple can be said to be "likely" Munsungun-area lithics. The presence of Neponset rhyolite, and probable Pennsylvania jasper are noteworthy, as are points made of Maine felsite.

ISOLATED FLUTED POINTS FROM ADJACENT TERRITORY

Neville Site

The Neville site, Amoskeag Falls, Manchester, New Hampshire, has yielded the "tip of a fluted point made of jasper" from the interface between Stratum 1 and 2 (Dincauze 1976:118-119). The material of the fluted point is not further described. Dincauze also assigns four flake tools to the Neville Paleoindian component because they are distinctive in raw material and manufacturing technique from the Middle Archaic component. She hypothesizes that these pieces, plus several Early Archaic pieces, were picked up nearby as curios, and brought to the Neville site by the Middle Archaic inhabitants. The sand-dunes formed along the higher margins of the river valley are implied as the probable provenance of these materials.

Smyth Site

The Smyth site, twin to the Neville site, has yielded two fluted points (Winter 1975:6), one apparently complete and one a basal section. No Paleoindian "campsite," as distinguished by other tools, has been recognized on this location. A slide of one of these points (Victoria Kenyon personal communication) discloses a long point made of lustrous red chert, possibly another Munsungun chert piece.

Intervale

A fluted point from Intervale, New Hampshire, near North Conway in the upper Androscoggin river valley, is currently on display at the Smithsonian Institution. It is made of a red chert with streaks of a darker color, another possible Munsungun chert.

Ossippee and Sunapee Lakes

Spiess has examined a fluted point of red Saugus rhyolite from the outlet of Ossipee Lake, New Hampshire, through the courtesy of Howard Sargent. The same reddish-pink rhyolite occurs as a minority component in the Bull Brook collection and the Neponset collection. The Ossipee point exhibits slightly flaring ears, and is thick and heavily made (length 79 mm, width 28 mm, thickness 8.5 mm). The flutes, single on each face, are short (29 and 23 mm).

Howard Sargent (1982, personal communication 1986) has also reported two Paleoindian sites near Lake Sunapee. Both

sites have yielded uniface and biface fragments which are consistent with Paleoindian technology, but no diagnostic forms to date. A retouched flake from one site is made of Neponset rhyolite (Spiess personal observation).

Vermont

Loring (1980) illustrated several fluted points from Vermont. Spiess, Grimes and Brush examined two of these points (Loring 1980: Plate I) in the University of Vermont collections, courtesy of Peter Thomas. Both are broken, short points with substantially flaring basal ears. One specimen is identical in form, thickness, retouch style, and basal ear configuration to Michaud specimen 23.12.0643. Both Vermont points are made of a patinated, speckled rhyolite visually similar to Neponset rhyolite in the Neponset, Michaud, Bull Brook, and DEDIC site collections. Microscopic examination in reflected light strengthened the impression of similarity, but revealed more very small, dark mineral inclusions in the Vermont specimens than in the other Neponset rhyolite specimens. At present, it appears likely that the Vermont points are made of Neponset rhyolite, or a lithologically related material.

Other fluted points in Vermont are made of local material (Ordovician cherts, Cheshire quartzite) (Loring 1980), and reddish-brown or red cherts (Giovanna Peebles, personal communication concerning the Crandall collection).

Maritime Provinces

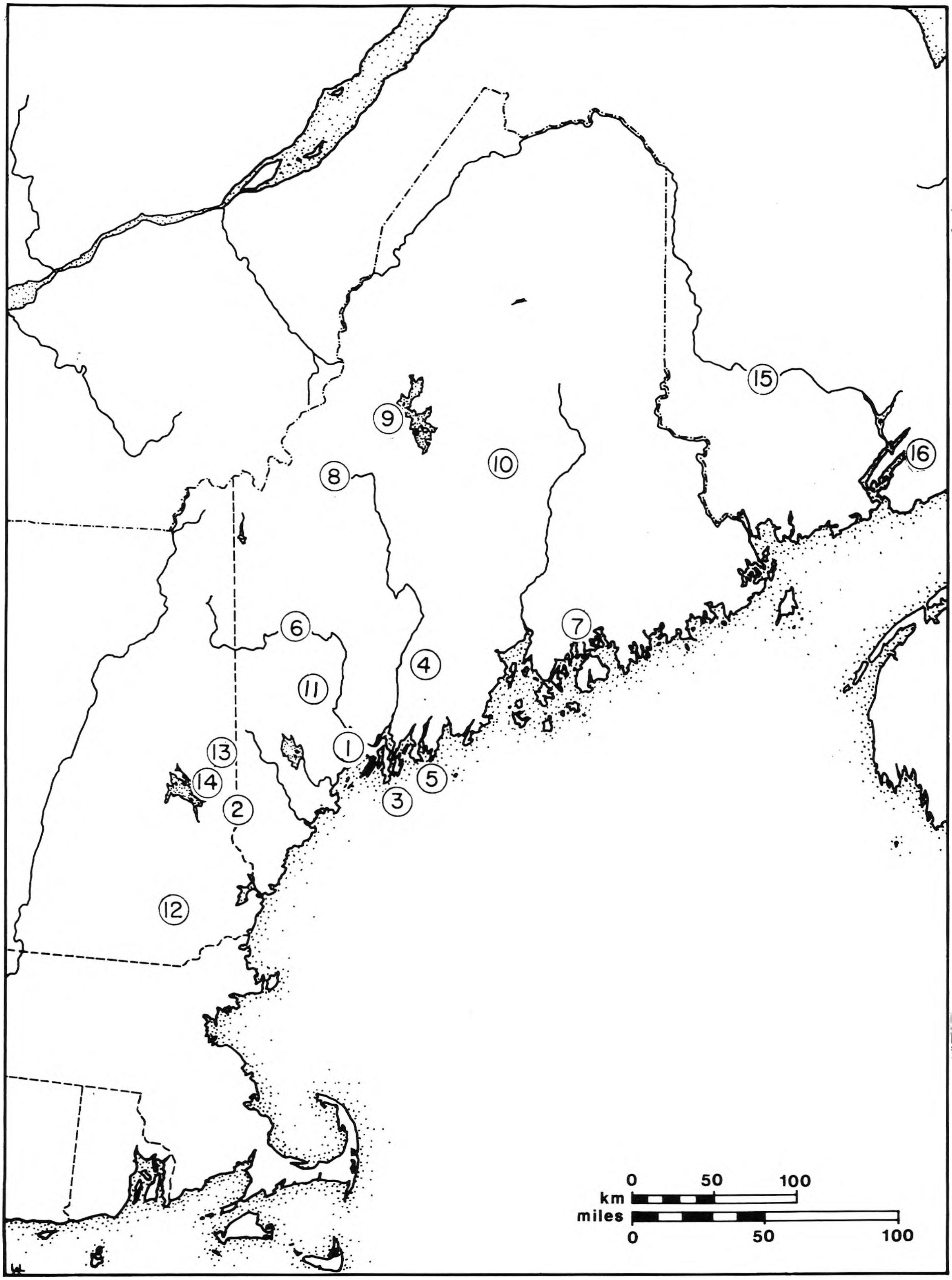
Fluted points from the Maritimes provinces have recently been reviewed by Keenlyside (1985:79-80). At present seven are known, outside the major Debert collection (Keenlyside personal communication to Spiess, April 1986). There is a point from Kingsclear, New Brunswick, well described by Turnbull (1974). It is 66 mm long, 25 mm wide, and 9 mm thick with a moderate basal concavity (4 mm). One side is multiply fluted, the other singly fluted. The basal ears are well defined by retouch along the base, but do not extend laterally (no fish-tail). The material (Keenlyside personal communication) is a red and blue-green chert similar to Munsungun chert (possibly our Cr05).

Opposite Page. Plate A3-4. Locations of isolated fluted points found in Maine and adjacent areas. 1) Desert of Maine point. 2) McAllister site. 3) Clarke and Lake and Sagadahoc Island points. 4) Whitefield point. 5) Boothbay point. 6)Rumford Center point. 7)Graham Lake points. 8) Flagstaff Lake point. 9) Brassua Lake point. 10) Schoodic Lake point. 11) Hall point. 12)Neville and Smyth site points. 13) Intervale point. 14) Ossipee Lake point. 15) Kingsclear point. 16) Quaco Head point.

There are two fluted points from Quaco Head, New Brunswick. One has a deeply indented base like the Debert or Vail points. The larger point is made on a dull brick red chert and the smaller point (50 to 60 mm length) is made of red and green Munsungun-like chert (Keenlyside personal communication), possibly our Cr05. There is a fluted point from North Tryon, Prince Edward Island, made on a translucent chalcedony, a material common at the Debert site.

A fluted point from Gaspereau River, Nova Scotia, is made of an unknown material (Keenlyside personal communication). This point is lanceolate in outline with slightly excurvate sides tapering toward the tip and slightly toward the base. Both faces are shortly fluted (maximum 23 mm), and the base is moderately concave. It is 8.2 mm long, 3.2 mm wide, and 0.9 mm thick.

The fluted point from the Hogan--Mullen site is lanceolate in outline, with nearly parallel sides, and an almost straight base (Turnbull and Allen 1978), 42 mm long, 20 mm wide and 6.9 mm thick. Fluted on one face only, it is made on "massive" white quartz, a locally available material. Turnbull and Allen (1978: 152) are uncertain whether the unifacial fluting of this point is due to the poor flaking qualities of the raw material.


15
16
9
10
8
7
6
4
11
1
13
14
5
3
2
12
0 50 100
km
miles
0 50 100

CONCLUSION

There is some evidence of geographic sorting in fluted point style attributes and raw material types within the New England--Maritimes Paleoindian region (see Figure A3-4 for most locations). The relatively well-defined Vail and Debert like points appear to be confined to the more northerly portion of the study area, while a heterogeneous group of fluted point types (see also Chapter 3) appear to be broadly distributed throughout the region. Both Munsungun chert and eastern Lake Champlain shore cherts are dominant lithics utilized throughout the region, with no apparent diminishment in frequency with distance from source, or any affinity with a certain point style. However, lithics from the southerly end of the study area, including Saugus rhyolite and Neponset rhyolite, are not seen on Vail and Debert-like points. The use of Nova Scotia chalcedonies on the other hand, appears to be limited to the local area (Nova Scotia and Prince Edward Island) and possibly to the Vail and Debert-like point style."Pennsylvania jasper" is a minority component in assemblages displaying both of these point styles.

Thus, isolated point finds support a possible geographic sorting of fluted point styles and raw materials usage. The distinctive Vail and Debert fluted points do not occur much to the south of northwestern Maine, and raw materials utilized at sites and findspots characterized by this point type do not include lithics from Massachusetts. Assemblages and isolated finds from the more heterogeneous group of fluted points, on the other hand, frequently contain Massachusetts lithics. Munsungun chert and materials from western Vermont were utilized extensively for fluted points of both of these types.

APPENDIX FOUR

COMPARATIVE THIN SECTION ANALYSIS OF ARTIFACTS FROM THE MICHAUD SITE

by Stephen G. Pollock

The first section of this Appendix presents the results of thin section analyses of chert-like materials from the Michaud site. The second section contains comparative material derived from thin section analyses of cherts from Vermont bedrock sources, Ledge Ridge in Maine, and flakes from the Vail site collection. All of the artifacts from the Michaud site that were sacrificed for thin section were debitage.

MICHAUD SITE ARTIFACTS

Volcanic (thin sections 001 through 005)

Rock type. These specimens are a felsic tuff. Additionally, these artifacts may be assigned an interpretive classification of coarsely aphanitic vitric tuff, perlitic tuff or globule ignimbrite. (All of these specimens were referred to as Rfnp, rhyolite fine Neponset, or Neponset rhyolite by Spiess and Brush.)

Handspecimens. Artifact #23.12.1445 (thin section 001). The flake was approximately 5 x 3 cm. The matrix of the flake was light olive gray (5Y 6/1). It weathered with a rusty stain. The groundmass appeared to consist of a mixture of quartz (grayish grains) and feldspar (grayish-white grains). The groundmass quartz ranges in size from 125 to 177 microns. The larger grains appeared as subrounded and anhedral. Groundmass feldspar appeared to be smaller than 0.5 mm. Within the groundmass were rounded anhedral grains which ranged in size from 250 to 750 microns. Concentration of these grains was approximately 15-20% by volume. These grains appeared to consist of grayish material interpreted to be quartz. Locally the grains appeared to be zoned with whitish centers. This material was interpreted to be feldspar.

Artifact #23.12.1609 (thin section 002). The flake was approximately 4 x 3 cm. The flake was a yellowish gray (5Y 7/2). The groundmass appeared to consists of quartz, which ranged in size from 88 to 125 microns, and feldspar which was less than 88 microns. Within the groundmass were rounded anhedral grains which were conspicuously zoned. The rims appeared to consist of quartz, while the interiors appeared to consist of feldspar. These grains were aligned as trains of single grains as well as consisting of coalescing trains 5 to 7 mm long. These grains did not appear to be flattened, or mechanically extended. Single grains ranged in size from 177 to 350 microns , while the coalesced grains ranged from 350 to 750 microns. These grains made up approximately 50% of the rock by volume.

Artifact #23.12.1406 (thin section 003). This flake was approximately 5 x 3 cm. Color of the groundmass of the fresh flake was yellowish gray (5Y 7/2). The groundmass consisted of an assemblage of quartz and feldspar. Groundmass quartz ranged in size from 88 to 125 microns. Groundmass feldspar was less than 62 microns. Rounded anhedral zoned grains made up approximately 25% of the rock. The rims of these grains were grayish, and were interpreted to be quartz. The cores were grayish white and were interpreted to be feldspar. These grains consisted of single grains ranging in size from 250 to 1000 microns. Additionally these grains coalesced to form trains to 5 mm in length.

Artifact #23.12.1726 (thin section 004).

This was a small whitish flake, 3.5 x 1.5 cm. This was a weathered flake that was textually and lithologically identical to 23.12.1406.

Artifact #23.12.1612 (thin section 005). This was a deeply weathered flake approximately 3 x 1.5 cm, texturally and lithologically similar to those described above. It differs from the previous flakes in that it was more deeply weathered, it exhibited a slightly larger groundmass grain size (to approximately 125 microns), and the rounded anhedral grains were pronouncedly less distinct than in the previously examined flakes.

Thin Sections. Thin sections 001 through 005 are identical in mineralogy and textural features. They are all characterized by microfelsitic to felsitic textures. That is to say, micron sized grains of quartz and feldspar occur as an aggregate of randomly interlocked grains as viewed under cross-polarized light. The average size of these grains is well below 0.1 mm. Small semi-opaque to opaque needle-like grains (microlites) are ubiquitous. Those which are semi-opaque appear to consist of chlorite. The opaque microlites are most probably iron-titanium oxides, such as ilmenite. Microlites have an average length of 0.05 mm, and an average width of 0.0025 mm. Visual estimates indicate that these comprise 25% to 30% of the rock. These microlites are aligned defining a weak to prominent fabric. Thin section 004 contains numerous irregularly shaped pyrite cubes.

The rounded anhedral grains observed in the hand specimens described above are rounded, circular to ovoid microfelsitic grains. These grains are not monomineralic microphenocrysts. The majority of grain boundaries are indistinct (Plate A4-1), and the grains grade texturally into the groundmass. However, locally, the grains exhibit moderately sharp edges. Locally, it is difficult to distinguish these grains from the groundmass. The majority of these grains are concentrically zoned. The zonation is produced by an alternation of nearly cryptocrystalline felsitic and microcrystalline felsitic textures. The cores of a few grains are relatively coarsely felsitic. These grains appear as either single grains, or as coalescing circular or elongate masses. When these grains coalesce, they define a fabric which parallels that defined by the microlites. Single grains range in diameter between .125mm and .250mm. Circular groups of these grains exhibit maximum diameters of 2.5mm. Elongated coalesced grains range from 3.5 to 7 mm in length.

Interpretation. These rocks are interpreted to have originally been a glassy volcanic rock. The rock may have originally been a vitric tuff, perlitic tuff or globule ignimbrite. These three rock types have grains of volcanic glass as a primary component. Fisher and Schimincke (1984) provide a discussion of vitric particles and pyrogenic clasts. Volcanic glass devitrifies with time. Silicic glasses may, upon devitrification, produce microfelsitic textures similar to those in the thin sections observed (cf.Williams et al 1982). Additionally, silicic glassy volcanic rocks may contain spherical or oval globules of glass. In perlitic tuffs, spherical or oval concentric fractures are superimposed on the welded glassy fabric. It is possible that the circular grains described above were initially glasses that devitrified to produce the aggregates of alternative cryptocrystalline and microcrystalline felsitic textures. Also, glassy spherulites with both radial and concentric textures are reasonably well documented features associated with glassy and devitrified tuffs. Alternatively, the circular grains may represent vesicles which were filled in after deposition of the tuff. Outlines of relict glass shards, typical of many vitric tuffs are not present in these thin sections (cf. Ross and Smith 1961). If the original grains of ash are of the finer size range, recognizable shard textures may not be present.

Possible Munsungun Lake Formation Artifacts(thin sections 006 to 009)

Rock type. Reddish chert, radiolarian bearing. (These artifacts were listed as Cr1, Cr04 and Cr05 by Spiess and Brush during the Michaud assemblage analysis.)

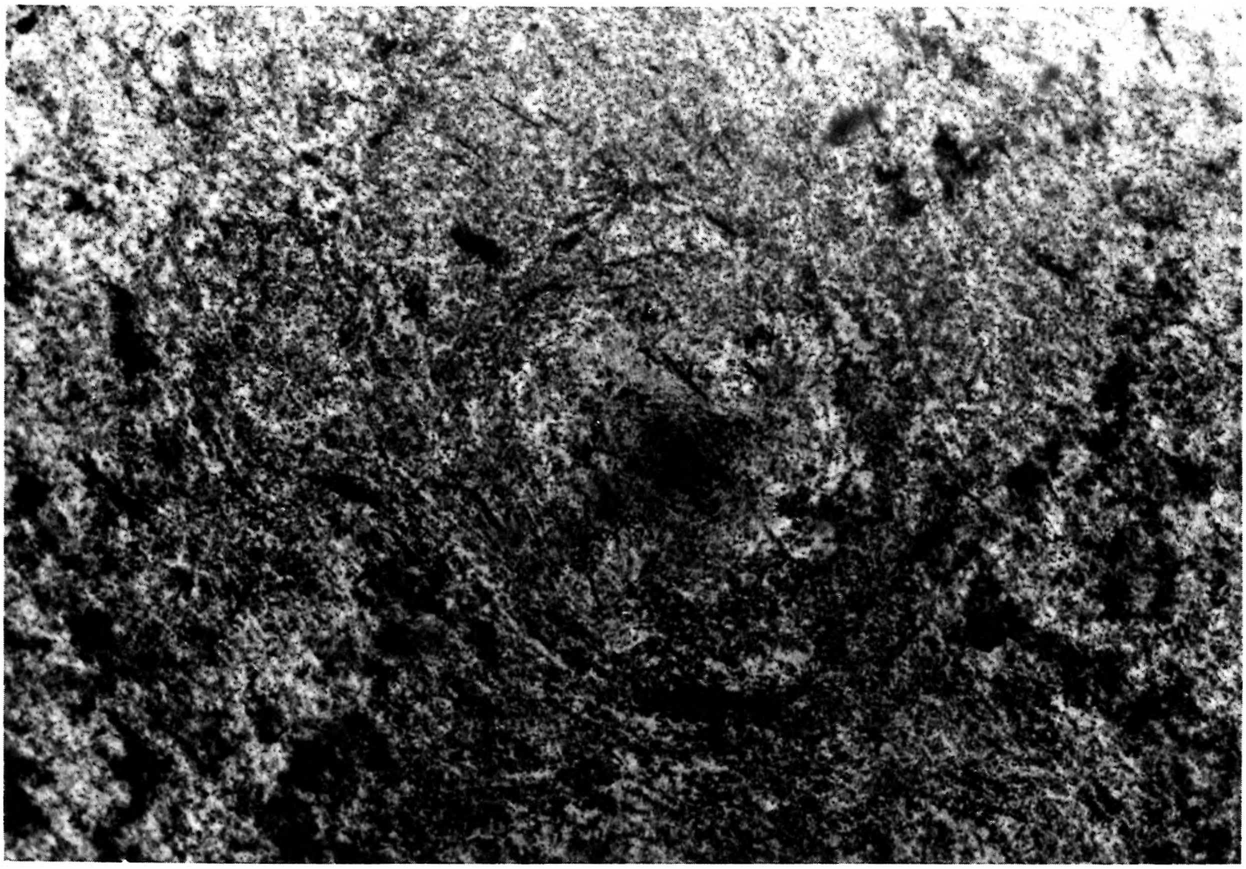


Plate A4-1. Photomicrograph of the felsic tuff. This photograph illustrates the nature of the rounded anhedral grains. Note the concentric structure. The microlites are seen as small black needles.

Handspecimens. Artifact #23.12.2185 (thin section 006). Artifact size approximately 2.5 x 2.6 cm. Color was grayish brown (5YR 3/2) to grayish red (5R 4/2). The specimen exhibits sedimentary laminations up to 0.8 cm thick. A pinstripe of clastic material was less than 0.25 mm thick. Radiolarians range in size from 177 to 250 microns. These appear as clear, uncompacted circles and spheres of quartz, comprising less than 15% of the chip. The groundmass is dense, fine grained, and nondescript.

Artifact #23.12.0630 (thin section 007). The artifact was approximately 4 x 2.5 cm. The color was grayish red (5R 4/2) to grayish brown (5YR 3/2). The specimen is non-laminated. Radiolarians are not observed in the chert. Color laminations, mottles and pinstripes are absent.

Artifacts #23.12.0395, 0735, 0832, and 0833 (thin section 008). These flakes were all approximately 1.0 x 1.5 cm. Colors were grayish red (5R 4/2). These were non-laminated, radiolarian bearing rocks. Radiolarians were circles or spheres less than 0.25 mm in diameter, and comprised less than 20% of the artifact volume.

Artifacts #23.12.0849, 0924, 0925, and 1013 (thin section 009). These were grayish red (5R 4/2) laminated or mottled radiolarian bearing chert. Radiolarians were less than 0.25 mm and comprised less than 20% of the rock.

Thin sections. These thin sections are grouped together because of color, mineral-

ogical, textural, and faunal similarities. These consist of a semi-opaque cryptocrystalline groundmass characterized by a close-packed distribution of cryptocrystalline hematite grains. Detrital silt grains comprise less than 5% of the thin sections. Chlorite platelets to approximately 0.05 mm comprise less than 3% of the groundmass. The groundmass of thin sections 006, 008, and 009 is characterized by color mottles or laminae (including pinstripe laminae) which are produced by differential concentrations of hematite. These three thin sections are characterized by variable concentrations of randomly distributed circles interpreted as radiolarians. These radiolarians appear as both adult and juvenile(?) forms. The adults range in diameter from 0.15 to 0.25 mm; the juveniles(?) are small circles which consistently range in diameter between 0.01 and 0.03 mm. The adults commonly exhibit spines or portions of spines. They have been recrystallized or replaced by radial length-fast chalcedony or blocky sub-equant microcrystalline quartz (Plate A4-2). Locally, these have been replaced and appear only as faint circles or "ghosts" within the groundmass. The smaller circles appear to consist of singe grains of quartz(?) or to have been replaced by multiple small grains of chlorite or epidote. Within these three thin sections (006, 008, 009) elongate needle-like grains are relatively common. These are interpreted as spines broken from the adult radiolarians, or as sponge spicules. Thin section 009 contains one length-fast chalcedony grain that appears to be the base of a tetraxon sponge spicule. Portions of thin section 009 appear to be biogenic cherts. This is to say fossil remains (adult and juvenile radiolarians and radiolarian spines or sponge spicules) comprise up to 75% of portions of the thin sections. Here, adult radiolarians account for approximately 20% of the rock. The juveniles(?), spines or spicules account for the remainder. Thin section 007 is devoid of radiolarians or other faunas. It is a texturally uniform thin section where the groundmass has less than 5% detrital silt grains.
Interpretation. These artifacts are interpreted to have originated from the Munsungun Lake Formation. This conclusion is based upon similarities between the artifacts and samples collected from outcrops of the Munsungun Lake Formation. The thin sections are very similar to, if not identical with, thin sections of reddish gray cherts which were obtained from known outcroppings (cf. Pollock 1987).

Siliceous Mudrock or Chert, Probably Not Munsungun Formation (thin sections 013 and 014)

Handspecimens. Artifact #23.12.0503: 1.8 x 1.3 cm, black (N1), thin, ubiquitous laminae. Artifact #23.12.1358: 1.7 x 1.2 cm, dark gray (N3), two laminae, 1 and 3 mm thick, indistinct radiolarians within the laminae. Artifact #23.12.1374: 1.8x1.2cm, black (N1), massive, no visible radiolarians or laminae. These three artifacts comprise thin section 013. Artifact #23.12.1097: 1.4 x 0.7 cm, grayish black (N2), laminated, no radiolarians. Artifact #23.12.1361: 1.8 x 0.7 cm, dark gray (N3), laminated, no radiolarians. Artifact #23.12.1376: 1.3 x 0.5 cm, no laminae, possible radiolarians. Artifact #23.12.1377: 0.9 x 0.8 cm, grayish black (N2), no laminae, no radiolarians. These latter four specimens comprise thin section 014. (All seven artifacts were originally catalogued as Cb01 by Spiess and Brush.)
Thin sections. Two thin sections (013 and 014) contain three and four flakes respectively. These artifacts are identical in texture, mineralogy and faunal content. These two thin sections are characterized by abundant chlorite grains. These grains exhibit circular or elliptical cross sections, averaging between 0.01 and 0.02 mm diameter. Maximum observed size was 0.03 x 0.07 mm. These chlorite grains make up between 50% and 75% of the rock by visual estimates. The laminae observed in the flakes are due to darker colorations as opposed to grain size or textural differences. The darker coloration is most probably due to carbonaceous material. Silt size detrital grains are variable between the flakes. In two of the flakes they may be present in amounts up to 15%. Small, clear

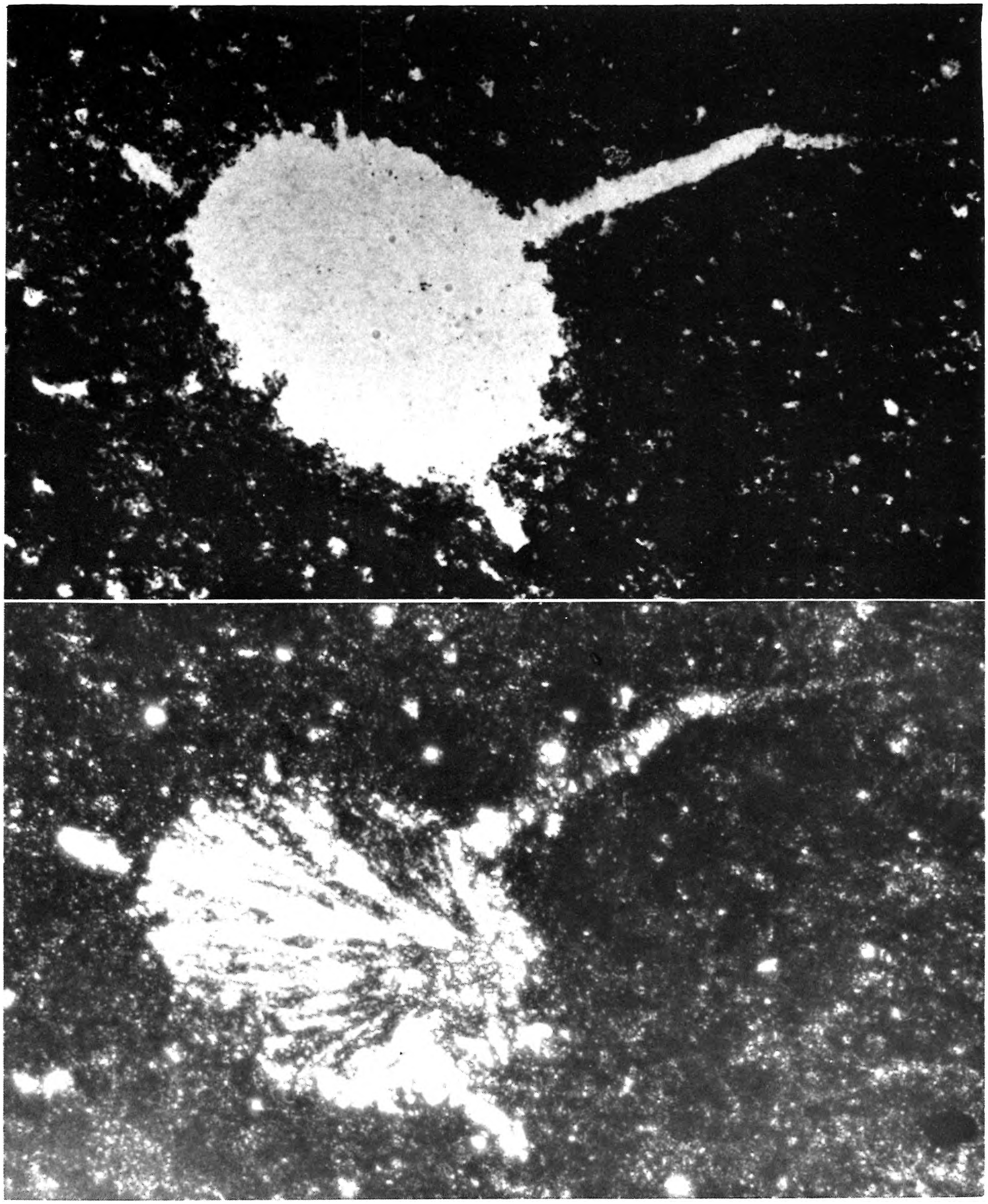


Plate A4-2. Photomicrograph of radiolarians. The upper photograph was taken using plane light, while the lower figure was taken with cross-polarized light. The streaked pattern in the radiolarian in the lower photograph is due to the fibrous nature of the chalcedony which infills the radiolarian test.

circular grains are locally present. These range between 0.02 and 0.03 mm in diameter. They exhibit sharp boundaries, and are composed of single clear grains of quartz or feldspar (albite?). These are not interpreted as fauna such as radiolarians. The preferred interpretation of these features is that they formed through the infilling of small pores, which were initially filled with a gas or fluid.

Radiolarians make up less than 10% of the volume of these flakes. These are flattened elliptical shapes which are filled with very fine (<<0.01 mm) microcrystalline blocky subequant quartz. Boundaries of the grains are not sharp. These boundaries are diffuse where the flattened radiolarian appears to be gradational into the groundmass. Sponge spicules or radiolarian spines are small rod-like grains which are composed of chlorite.

Interpretation. Chert would be an acceptable hand specimen classification of these artifacts. However, the abundance of relatively large chlorite grains suggests that the rock is not a chert in the true sense. The abundance of chlorite plus the identifiable feldspar (albite?) grains suggests clayey sediments and/or clay mineral precursors to this rock, opposed to a more siliceous precursor for true chert. The laminations and faunas indicate that this was a good sedimentary rock initially. The textures of this rock (ie. chlorite grains and compressed radiolarians) may have developed through regional or contact metamorphism, presumably low grade (greenschist facies) metamorphism.

Ferrugineous(?) Chert(thin sections 015 and 016)

Hand specimens. Artifact #23.12.0234: 1.8 x 1.9 cm, light olive gray (5Y 5/2) to yellowish gray (5Y 7/2). Light colored speckles less than 0.125 mm may be replaced radiolarians or microphenocrysts. No discernable laminae. Artifact #23.12.0435: 2.0 x 1.6 cm, color mottled, light olive gray (5Y 5/2) to dusky yellow (5Y 6/4). Same speckles as in .0234. Artifact #23.12.0620: 1.7 x 1.45 cm, grayish yellow (5Y 8.4), texturally uniform weathered fragment. No discernable mottles, faunas or sedimentary structures. These three specimens comprise thin section 015. Artifact #23.12.2118: 1.4 x 1.3 cm, light olive gray (5Y 5/2), weathering in color mottles of yellowish gray. Abundant yellow speckles less than 0.125 mm. Artifact #23.12.2224: 2.0 x 1.7 cm, light olive gray (5Y 5/2), some weathering. Abundant speckles, no mottles, structures or faunas. The latter two flakes comprise thin section 016. (These five flakes were classified as Cegl by Spiess and Brush.)

Thin sections. Two thin sections (015 and 016) each contain two flakes (one lost in section preparation). The chips are cryptocrystalline. There is no evidence of lamination or fauna. When viewed under cross polarized light, small grains of sericite (very fine-grained white mica) are visible. These grains range between 0.01 and 0.05 mm. Small aggregates of brownish isotropic needles 0.01 to 0.02 mm long comprise up to 15% of the rock by visual estimate. These needles range in color from dark brownish black to yellowish brown. Additionally, subcircular anhedral bits of this mineral are present, comprising 5% of the thin sections by visual estimate. These grains are probably limonite replacement of geothite (Plate A4-3). These are the grains which produce the speckles seen in thin section. Anhedral epidote grains are present in trace quantities.

Interpretation. These rocks are most probably ferrugineous cherts. The artifacts were deeply weathered, however, and exhibited no diagnostic features. The thin sections are relatively nondescript also, except for the limonite grains.

COMPARATIVE SPECIMENS, NOT FROM THE MICHAUD SITE

Black Chert from Vermont (thin sections 017, 018, 019, and 020).

Rock type. Chert. [These specimens were removed as flakes from artifacts, mostly biface preforms, of unknown site provenience from the Champlain lowlands south of

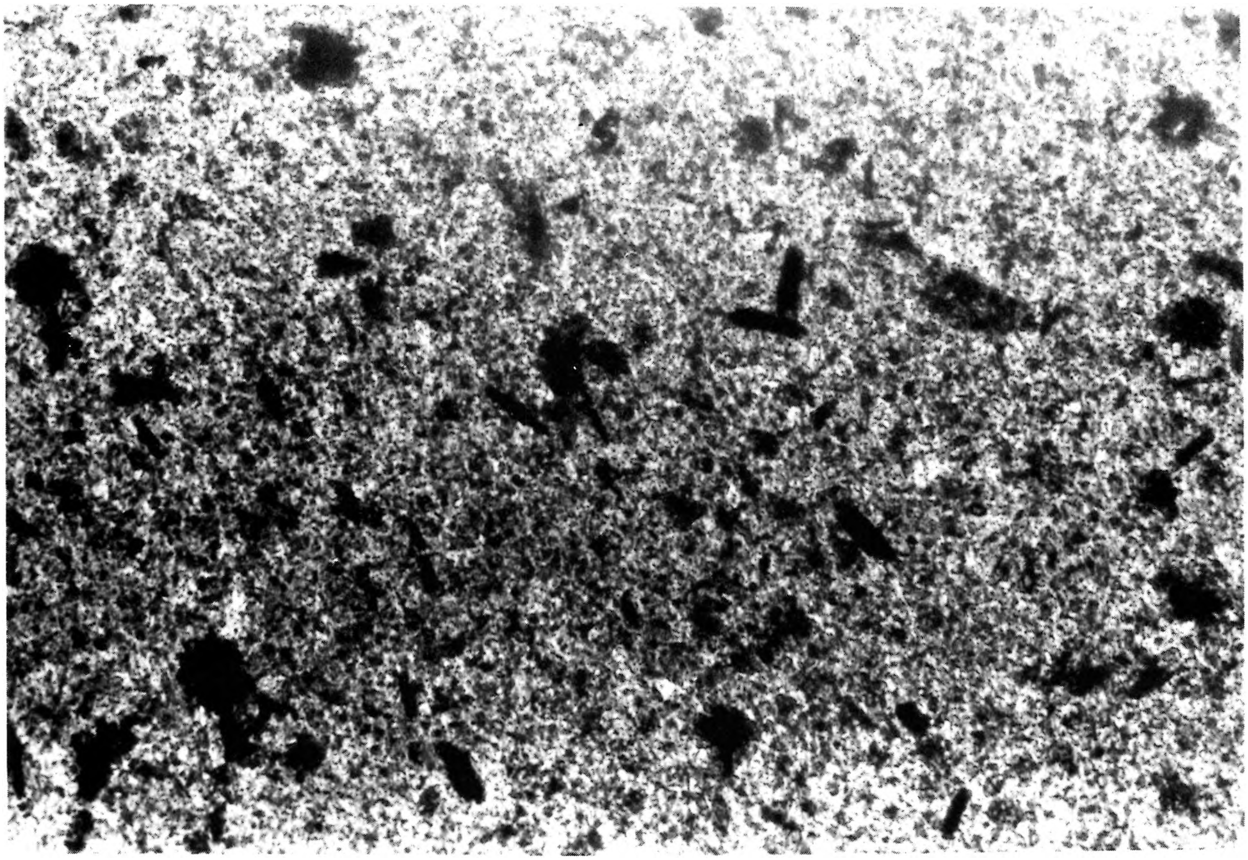


Plate A4-3. Photomicrograph illustrating the nature of the fine needles of geothite after hematite. Note the absence of radiolarians.

Burlington, Vermont. The specimens were selected for visual match in patination effects to Michaud artifacts designated Cb01 and Cegl, and to the dominant chert in the Bull Brook collection. These unprovenienced artifacts were donated to the Michaud project by Giovanna Peebles, Vermont SHPO archaeologist.]

Hand specimens. Black (N1) coarse grained, almost silty textures. Pinstripe laminae with very thin (< 0.1 mm) annealed fractures present. Fresh surfaces with small spherical to circular pits which appear to be filed with ocher colored (limonite?) material, in sizes up to 0.25 mm. Radiolarians appear to be reasonably abundant in a few of the flakes.

Thin sections. Four thin sections were prepared from flakes. Groundmass is predominately cryptocrystalline. Detrital silt comprises less than 5% of the rock. Euhedral rhombohedrons of calcite locally replace the groundmass. These range in size from 0.05 to 0.1 mm. Locally these are either partially or completely replaced by hematite or other iron oxide. Thin, quartz-filled fractures locally cross-cut the groundmass. These thin sections exhibit extensive burrow features, usually slightly darker in tone than the surrounding groundmass. Irregularly shaped areas of thin sections 019 and 020 contain abundant circular radiolarians, radiolarian spines and sponge spicules. These have been recrystallized or infilled with length-fast chalcedony and/or blocky subequant quartz.

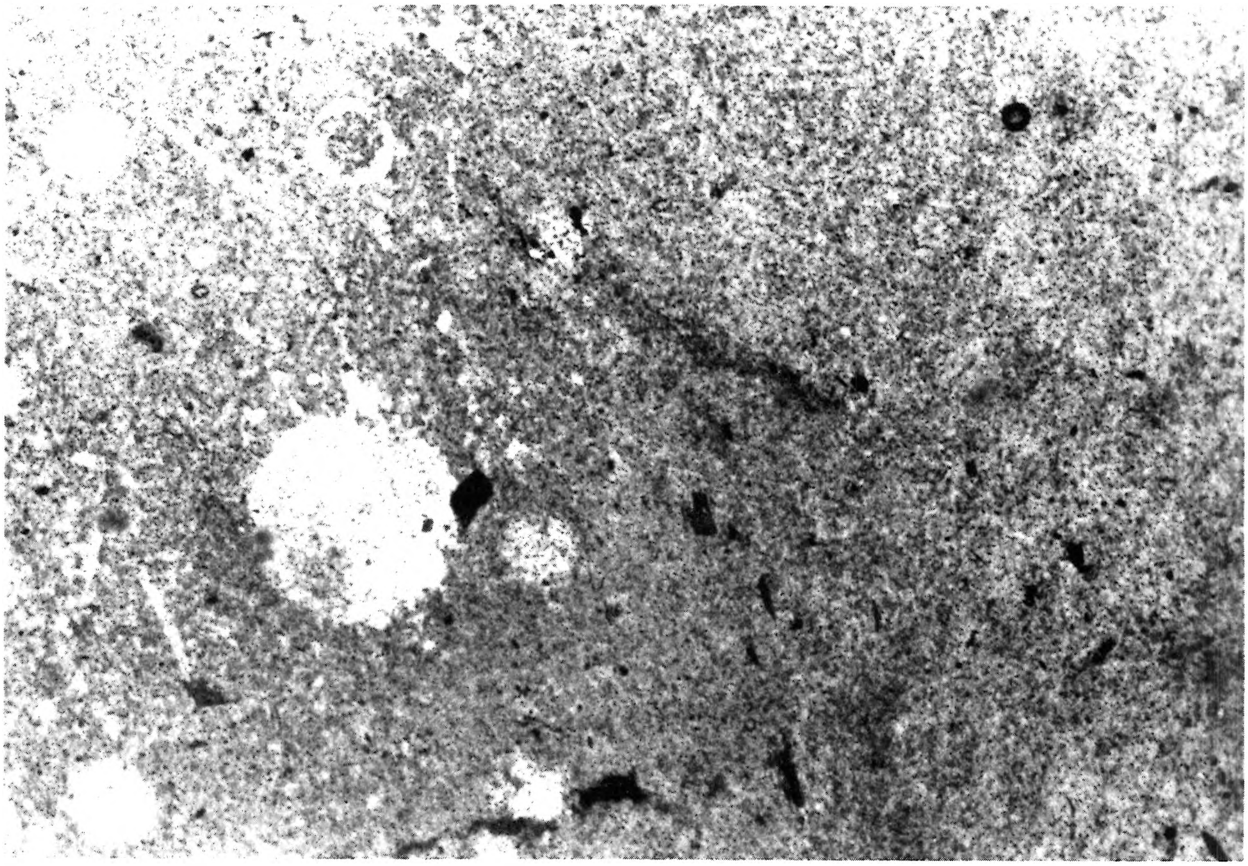


Plate A4-4. This photomicrograph illustrates the nature of the boundary between the biogenic radiolarian-bearing chert (on the left) and the burrowed portion in which radiolarians are not present (on the right). Note the coarser texture of the groundmass in the non-burrowed portion.

The groundmass of these areas is slightly coarser grained than those areas which exhibit abundant burrow structures.

Interpretation. These rocks are interpreted as biogenic cherts. The irregularly shaped zones which contain numerous to abundant radiolarians and sponge spicules (Plate A4-4) are interpreted to be areas which escaped ingestion by burrowing organisms. Digestion within the guts of invertebrates is interpreted to have obliterated much of the siliceous fauna. The presence of calcite grains (Plate A4-5) suggests that the original sediment was, in part, limy.

Hathaway Chert, St. Albans, Burlington, Vermont (thin section 024)

Rock type. Chert. [This specimen was obtained at the Hathaway chert bedrock outcrop in Burlington by Charles Paquin, who donated the specimen to the Michaud project.]

Hand specimen. The rock is a very fine grained mottled brownish black (Y 2/1) chert. The mottles are black (N2). Radiolarians comprise approximately 15% of the rock.

Thin section. This thin section resembles certain aspects of thin sections 017, 018, 019, and 020. The groundmass is microcrystalline to cryptocrystalline. Detrital silt comprises less than 5% of the rock. Radiolarians make up less than 15% of the thin section. Rhombohedral grains of calcite locally replace the groundmass, but comprise less than 5% of the rock. A major characteristic of the rock is the presence of burrow structures, which

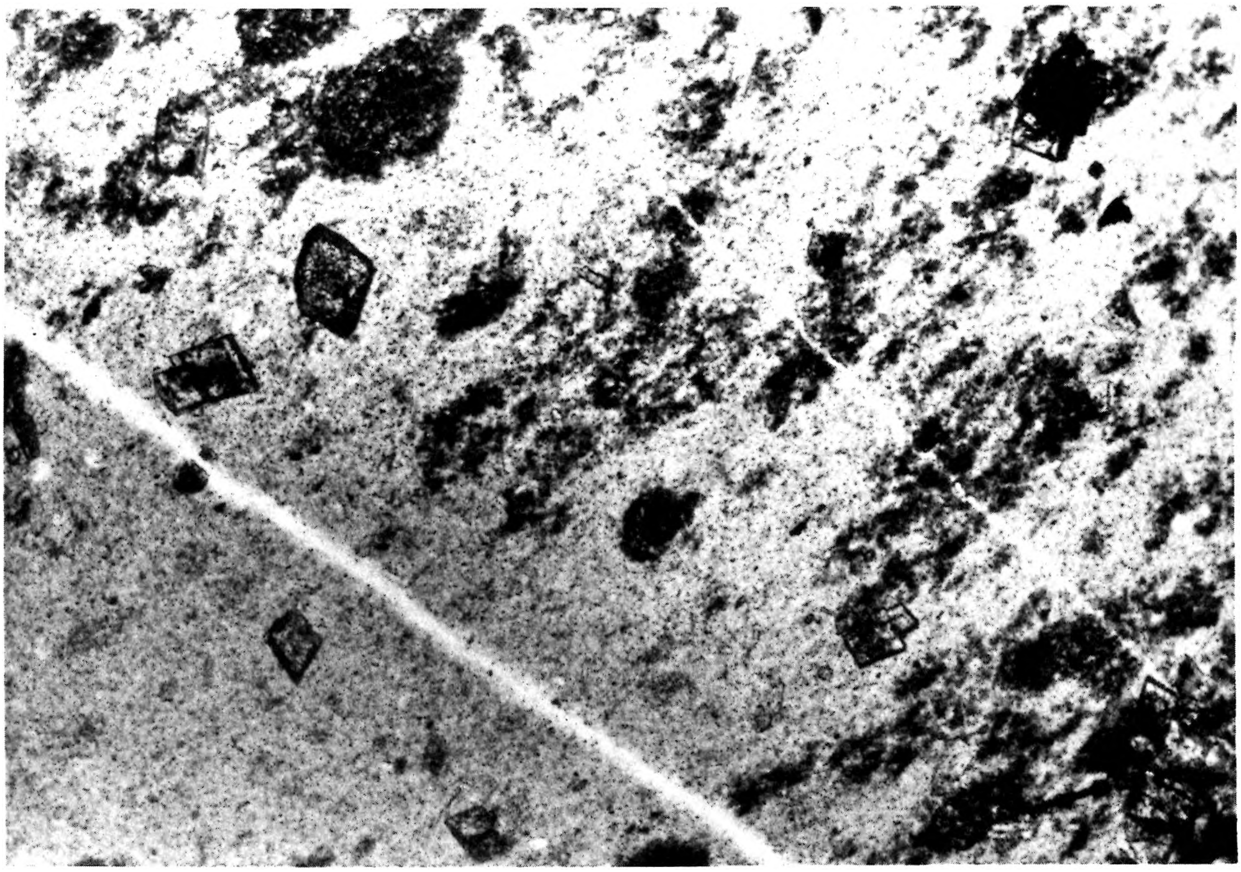


Plate A4-5. Photomicrograph illustrating the nature of the calcite rhombohedrons and burrow textures in the black cherts from Vermont.

account for the color mottles seen in the hand specimen. Fecal pellets are relatively common.

Ledge Ridge Material

Rock type. Metavolcanic(?) or hornfels(?). [These specimens were obtained at the Ledge Ridge quarry, Oxford County, Maine by Richard Michael Gramly, and donated by him to the Michaud project.]

Hand specimen. These were moderate olive brown (5Y 4/4) to light olive (10Y 5/4) in color. There were no color mottles or laminae. These were texturally uniform and structureless, except for small thin annealed fractures. Small inclusions to approximately 0.25 mm are locally present.

Thin sections. These specimens exhibit good microcrystalline granoblastic textures (Plate A4-6). Both thin sections consist of 50% to 60% fine-grained epidote, 40% to 35% quartz and feldspar and 10% to 5% pumpellyite. The epidote is present in small grains (to approximately 0.03 mm), as well as coarser single grains (to 0.1 mm)., and multiple grains within circular to irregularly shaped areas. These areas are up to 0.25 mm diameter. The fractures are filled with epidote. The pumpellyite is present as very small single needle-like grains and as bundles or sheaves of needle-like grains.

Interpretation. The mineralogy is suggestive that the rock is a mafic metavolcanic such as a metabasalt. Alternatively the original, or unmetamorphosed, rock may have been an iron-rich marl, where a marl is a calcareous mudstone. The rock exhibits a mineralogy which suggests that the rock was subjected to very-low-grade metamor-

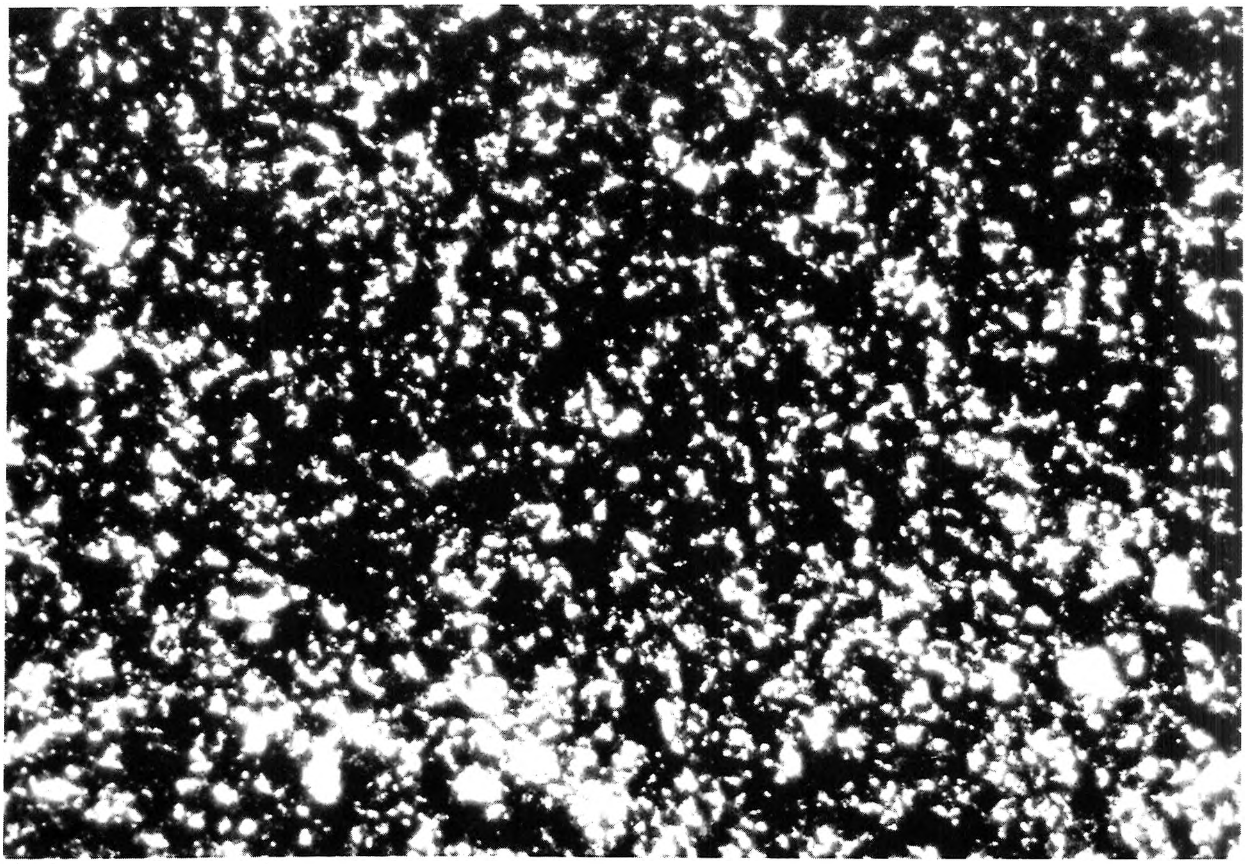


Plate A4-6. Nature of the groundmass of the metabasalt(?) of the Ledge Ridge material. The darker areas are composed of fine grained epidote, while the lighter areas are composed of plagioclase feldspar and quartz.

phism, specifically prehnite-pumpellyite facies.

Ledge Ridge Material(thin section 025)
Rock type. Chert. [This specimen was collected at the Ledge Ridge outcrop by Richard Michael Gramly and donated to the Michaud project by him.]
Hand specimen. Very dusky red (10R 2/2) to blackish red (5R 2/2) thinly laminated chert. Laminae average 0.5 cm and appear to be graded. The coarser portions of the laminae exhibit a slight greenish black coloration. Radiolarians or biogenic structures are not present.
Thin section. The thin section consists of distinctly laminated microcrystalline chert. The individual quartz grains in the groundmass exhibit blocky subequant shapes. Pinstripe laminae consist of concentrations of hematite and small pyrite cubes. These separate the graded laminae. The grading of laminae is due to grain size decrease. The coarser portions of these laminae consist of (apparently?) detrital silt combined with epidote (of metamorphic origin). The epidote is present as single well formed crystals and as small groupings of several crystals. The finer portions of the laminae consist of very fine grained subequant blocky quartz. Cryptocrystalline hematite is ubiquitous. Small microcrystalline cubes of pyrite(?) are common. Faunas or biogenic structures are not present.
Interpretation. This is a bedded chert. It has been subjected to metamorphism. The epidote is similar to that observed in the metavolcanic section. The metamorphism has obliterated any fauna that may have

been present in the original sediment.

Vail Site Flakes (thin section 023)
Rock type. Chert: biogenic. [These flakes were selected by Brush and Spiess from the Vail site collection housed in the Maine State Museum. Flakes were selected for visual similarity to Cegl and Cb01 from the Michaud site, and to Bull Brook chert. Permission to section the flakes was granted by Bruce Bourque, Archaeology Curator at the Museum.]
Hand specimens. Artifact numbers Vail 5633, 5721, 5776, 12347, and 12399. These are small flakes, 1 to 2 cm in length. Fresh surfaces are olive gray (5Y3/2) to brownish black (5Y 2/1). The artifacts weather to light olive gray (5Y 5/2). They are color mottled and laminated, and appear to contain variable quantities of radiolarians, ranging from 5% to 40% of the rock mass.
Thin section. The thin sections appear to illustrate two types of chert. These are differentiated by their differences in faunas. Three of the artifacts consist of approximately 60% to 80% needle-like grains. Two of the artifacts exhibit a cryptocrystalline groundmass with approximately 25% to 40% radiolarian faunas. The needle-like grains may be interpreted as sponge spicules or radiolarian spines. These are most probably sponge spicules, however. The spine-like grains are mostly single or monaxon grains. Biaxon and triaxon morphologies are observed. Maximum length of the monaxon grains is 0.125 mm. Small circular grains with diameters of approximately 0.125 mm are probably cross sections of spicules. The spicules have been replaced by both chlorite and hematite. The chlorite exhibits a very pale or light green color, while the hematite exhibits a pale to dark red color. It is not clear, with the available thin section, whether hematite replacement occurred during the weathering process, or whether hematite replacement occurred during an earlier episode of alteration (diagenesis or very-low-grade metamorphism).

REFERENCES

Ahler, Stanley

1979 Functional analysis of non-obsidian chipped stone artifacts: terms, variables and quantification. Pp. 301-328 in Brian Hayden (ed.), *Lithic Use Wear and Analysis.* Academic Press, New York.

Alexander, Herbert, Jr.

1963 The Levi site: a Paleo-Indian campsite in central Texas. *American Antiquity* 28: 390-528.

Allison, L. E.

1965 Organic Carbon. In C. A. Black (ed.). Methods of soil analysis, Part 2. *Agronomy* 9:1367-1378. Madison, Wisconsin.

Baker, Emerson W.

1986 *The Clarke and Lake Company: The Historical Archaeology of a Seventeenth Century Maine Settlement.* Occasional Publications in Maine Archaeology, Number Four. Maine Historic Preservation Commission, Augusta.

Balogh, James C. and Geoffrey Gordon

1986 Soil classification, genesis, and morphology at the Michaud Archaeological site. Report on file, Maine Historic Preservation Commission. Resource Assessment Service, Orono, Maine, RAS Report Number 85.0002.1.

Bascomb, C. L.

1968 Distribution of phyrophosphate extractable iron and organic carbon in soils of various groups. *Journal of Soil Science* 19:252-268.

Beardsley, R. K. et al.

1956 Functional and evolutionary implications of community patterning. In Seminars in Archaeology 1955, R. Wauchope ed. *Society for American Archaeology Memoir* 11.

Binford, Lewis R.

1976 Forty-seven trips. Pp. 299-351 in *Contributions to Anthropology: the Interior Peoples of Northern Alaska,* Edited by Edwin S. Hall, Jr. National Museum of Man, Mercury Series Paper 49, Archaeological Survey of Canada, Ottawa.

1978 *Nunamiut Ethnoarchaeology.* Academic Press, N.Y.

1982 The archaeology of place. *Journal of Anthropological Archaeology* 1:5-31.

Binford, Lewis R. and Sally R. Binford

1966 A preliminary analysis of functional variability, in the Mousterian of Levallois facies. *American Anthropologist* 68(2):238-295.

Bloom, A. L.

1960 Late Pleistocene changes of sea level in southwestern Maine. Maine Geological Survey, Augusta. 143 pp.

1963 Late Pleistocene fluctuations of sea level and postglacial crustal rebound in coastal Maine. *American Journal of Science* 61:862-879.

Bohn, H. L., B. L. McNeal, and G. A. O'Conner
1979 *Soil Chemistry.* John Wiley and Sons, New York.

Bonnichsen, Robson, Bruce J. Bourque, and David E. Young
1983 The Moosehorn fluted point discovery, northern Maine. *Archaeology of Eastern North America* 11:36-48.

Bonnichsen, Robson, George Jacobson Jr., Ronald Davis, and Harold Borns Jr.
1985 The environmental setting for human colonization of northern New England and adjacent Canada in Late Pleistocene time. *Geological Society of America Special Paper* 197:151-159.

Bonnichsen, Robson, E. Lahti, B. Lapper, R. Low, J. McMahon, and S. Oliver
1982 Archaeological research at the Thoroughfare. Pp. 27-50 in R. Bonnichsen, (ed.), *Archaeological research at Munsungun Lake: 1981 Preliminary Technical Report of Activities.* Quaternary Institute, Orono, Maine.

Borns, Harold W. Jr. and D. J. Hagar
1965 Late-glacial stratigraphy of a northern part of the Kennebec River valley, western Maine. *Geological Society of America Bulletin* 76:1233-1250.

Borns, Harold W. Jr, Pierce LaSalle, and Woodrow B. Thompson (eds.)
1985 Late Pleistocene History of Northeastern New England and Adjacent Quebec. *Geological Society of America Special Paper* 197. Boulder, Colorado.

Boul, S. W., F. D. Hole, and R. J. McCracken
1973 *Soil genesis and classification.* Iowa State University Press, Ames.

Bradley, Bruce A.
1982 Flaked stone technology and typology. Pp. 181-208 in George Frison and Dennis Stanford (eds.), *The Agate Basin Site,* Academic Press, New York.

Brennan, Louis
1982 A compilation of fluted points of Eastern North America by count and distribution: An AENA project. *Archaeology of Eastern North America* 10:27-46.

Brink, John W.
1978 *An Experimental Study of Microwear Formation on Endscrapers.* National Museum of Man, Mercury Series, Archaeological Survey of Canada Paper No. 83.

Byers,Douglas
1954 Bull Brook--A fluted point site in Ipswich, Massachusetts. *American Antiquity* 19:343-351.
1959 Radiocarbon dates for the Bull Brook site, Massachusetts. *American Antiquity* 24:427-429.
n.d. Eastern and western Paleoindian sites: a consideration of some differences. R. S. Peabody Foundation, unpublished manuscript.

Callahan, Errett
1979 The basics of biface knapping in the Eastern fluted point tradition: a manual for flintknappers and lithic analysts. *Archaeology of Eastern North America* 7:2. 180pp.

Carty, Frederick M.
1985 Archaeological notes on the Mattapan volcanics of the Norwood, Massachusetts quadrangle. Manuscript on file with the Maine Historic Preservation Commission.
1986 Neponset: Background and working notebook. Manuscript, maps, and photographs on file with the Maine Historic Preservation Commission, Augusta.

Chapdelaine, Claude
1985 Presentation sur les traces des premiers Quebecois. *Recherches Amerindiennes au Quebec* 15:1-2:3-6.

CLIMAP Project Members
1976 The surface of the ice-age earth. *Science* 191:1131-1144.

Colinvaux, Paul A.
1987 The changing forests: ephemeral communities, climate and refugia. *Quaterly Review of Archaeology* 8:1:1-7.

Cox, Steven L.
1972 A reanalysis of the Shoop site. Manuscript on file, Department of Anthroplogy, Smithsonian Institution. (Also, by same title: 1986, *Archaeology of Eastern North America* 14: 101-170.)
1977 Prehistoric Settlement and Culture Change at Okak, Labrador. Doctoral dissertation, Department of Anthropology, Harvard University.

Crawford, T. W., L D. Whittig, E. L. Begg, and G. L. Huntington
1983 Eolian influence on development and weathering of some soils of Reyes Peninsula, California. *Soil Science Society of America Journal* 47:1179-1185.

Cronin, Thomas M.
1977 Champlain sea foraminifera and ostracoda: a systematic and paleoecological synthesis. *Geographie Physique et Quaternaire* 31:107-122.

Crotts, Anita L.
1984 Pattern and variation in prehistoric lithic resource exploitation Passamaquoddy Bay, Charlotte County, New Brunswick. M.S. Thesis, University of Maine at Orono.
1985 An examination of amateur collections from the Boothbay Region, Lincoln County, Maine. Manuscript report to the Maine Historic Preservation Commission.

Curran, Mary Lou
1984 The Whipple site and Paleoindian tool assemblage variation: a comparison of intrasite structuring. *Archaeology of Eastern North America* 12:5-40.
1987 The spatial organization of Paleoindian populations in the late Pleistocene of the Northeast. Doctoral dissertation, Department of Anthropology, University of Massachusetts.

Curran, Mary Lou and Dena Dincauze
1977 Paleoindians and Paleo-lakes: new data from the Connecticut drainage. In Bert Salwen and S. Newman(eds.), *Amerinds and Their Paleoenvironment in Northeastern North America*, Annals of the New York Academy of Sciences 288: 333-348.

Custer, Jay F., John A. Cavallo, and R. Michael Stewart
1983 Lithic Procurement and Paleo-Indian settlement patterns on the Middle Atlantic coastal plain. *North American Archaeologist* 4:263-275.

Dansgaard, W., J. Johnsen, J. Mollar, and C. C. Langway,Jr.
1969 One thousand centuries of climatic record from camp century on the Greenland ice sheet. *Science* 166: 377-381.

Davis, Leslie B., Sally T. Greiser, and Nicholas Toth
1985 Use wear analysis of Paleoindian unifaces from the Indian Creek site. *Current Research in the Pleistocene* 2:45-46.

Davis, Margaret B.
1983 Holocene vegetational history of the Eastern United States. Pp. 166-181 in *Late Quaternary Environments of the United States, Vol. 2: The Holocene*, edited by H. E. Wright. University of Minnesota Press, Minneapolis.

Davis, Ronald and George L. Jacobson Jr.
1985 Late glacial and early Holocene landscapes in northern New England and adjacent areas of Canada. *Quaternary Research* 23.

Day, P. R.
1965 Particle fractionation and particle-size analysis. In C. A. Black(ed.), Methods of Soil Analysis, Part 1. *Agronomy* 9:545-567. Madison, Wisconsin.

Deller, Brian
1976 Paleo-Indian locations on late Pleistocene shorelines, Middlesex County, Ontario. *Ontario Archaeology* 26:3-19.
1979 Paleo-Indian reconnaissance in the counties of Lambton and Middlesex, Ontario. *Ontario Archaeology* 32:3-20.

Deller, Brian and Chris J. Ellis
1984 Crowfield: A preliminary report on a probable Paleo-Indian cremation in southwestern Ontario. *Archaeology of Eastern North America* 12:41-71.
1986a Thedford II: Investigations at a Paleo-Indian site in the Ausable River watershed of southwestern Ontario. Report on file, Ministry of Citizenship and Culture, Toronto.
1986b Early Paleo-Indian complexes in southwestern Ontario. Paper presented to the Smith Symposium, Buffalo Museum of Science, October 1986.

Dent, Richard J.
1985 Amerinds and the environment: myth, reality and the upper Delaware valley. Pp 123-164 in Charles W. McNett (ed.) *Shawnee-Minisink: A Stratified Paleoindian Archaic Site in the Upper Delaware Valley of Pennsylvania.* Academic Press, Orlando.

Dincauze, Dena
1976 *The Neville Site: 8000 Years at Amoskeag.* Peabody Museum Monographs 4. Cambridge, Massachusetts.

Dincauze, Dena and Mary Lou Curran
1983 Paleoindians as generalists: an ecological perpective. Paper presented to the 48th Annual Society of American Archaeology Meeting, Pittsburgh.

Dixon, W. J. (ed.)
1983 *BMDP Statistical Software*. University of California Press. 734pp.

Eisenberg, Leonard
1978 *Paleo-Indian Settlement Patterns in the Hudson and Delaware River Drainages.* Occasional Publications in Northeastern Anthropology 4.

Embleton, C, and C. A. M. King
1968 *Glacial and Periglacial Geomorphology*. St. Martin's Press, New York

Epstein, E., W. J. Grant, and J. S. Hardesty
1962 Soil moisture survey of some representative Maine soil types. USDA Agricultural Research Service and Soil Conservation Service. ARS 41-57. 57pp.

Fisher, Daniel C.
1984 Taphonomic analysis of late Pleistocene mastodon occurrences: evidence of butchery by North American Paleo-Indians. *Paleobiology* 10(3):338-357.

Fisher, Daniel C. and R. L. Koch
1983 Seasonal mortality of late Pleistocene mastodons: evidence for the impact of human hunting. *Geological Society of America Abstracts*, Program 15:573.

Fisher, R. U. and H. U. Schimincke
1984 *Pyroclastic Rocks*. Springer Verlag. 472pp.

Fitting, James E.
1965 A quantitative examination of Paleoindain projectile points in the Eastern United States. *Papers of the Michigan Academy of Sciences, Arts and Letters* 50:365-371.

Fitting, James E., Jerry DeVisscher, and Edward J. Wahla
1966 *The Paleo-Indian occupation of the Holcomb Beach.* Anthropological Papers, Musem of Anthropology, University of Michigan, 27.

Fitzhugh, William and Susan Kaplan
1985 *Inua: The Spirit World of the Southwest Alaskan Eskimo*. Smithsonian Institution Press.

Fowler, Don
1954 *Bulletin of the Massachusetts Archaeological Society* 16:1.

Frison, George and B. Bradley
1980 *Folsom Tools and Technology at the Hanson Site, Wyoming*. University of New Mexico Press, Albuquerque.

Frison, George and Dennis Stanford
1982 *The Agate Basin Site*. Academic Press, New York.

Funk, Robert E.
1976 The Paleo-Indian stages. Pp. 205-209, in *Recent Contributions to Hudson Valley Prehistory*. Number 22, New York State Museum and Science Service.

Gardner, William M. (ed.)
1974 The Flint Run Paleo-Indian complex: A preliminary report 1972-73 Seasons. Occasional Publication, Number 1, Archaeology Laboratory, The Catholic University of America.

Gardner, William M.
1983 Stop me if you've heard this one before: the Flint River Paleoindian complex revisited. *Archaeology of Eastern North America* 11:49-64.

Gardner, William M. and Robert A. Verry
1979 Typology and chronology of fluted points from the Flint Run area. *Pennsylvania Archaeologist* 49(1):13-46.

Gates, W. Lawrence
1976 Modeling the Ice-Age Climate. *Science* 191: 1138-1144.

Gaudreau, Denise
1986 Vegetational change in northeastern United States in the last 14,000 years: re-examination of plant population dynamics. Paper presented to the Smith Symposium, Buffalo Museum of Science, October, 1986.

Goldthwait, L. G.
1949 Clay survey--1949. *Report of State Geologist 1947-1948*. Maine Geological Survey, Augusta.

Goodyear, Albert C.
1982 Tool kit entropy and bipolar reduction: A study of interassemblage lithic variability among Paleo-Indian sites in the Northeastern United States. Unpublished manuscript, Institute of Archaeology and Anthroplogy, University of South Carolina.

Graham, Russel W., C. Vance Haynes, Donald Lee Johnson, and Marvin Kay
1981 Kimmswick: A Clovis-Mastodon association in eastern Missouri. *Science* 213:1115-1117.

Graham, Russel W. and Marvin Kay
1986 Taphonomic comparisons of cultural and non-cultural faunal deposits at the Kimmswick and Barnhart sites, Jefferson County, Missouri. Paper delivered to the Smith Symposium, Buffalo Museum of Science, October 1986.

Graham, Russel W. and Ernest Lundelius, Jr.
1984 Coevolutionary disequilibrium and Pleistocene extinctions. Pp. 223-249 in *Quaternary Extinctions: A Prehistoric Revolution*, edited by Paul S. Martin and Richard G. Klein. Univ. of Arizona Press, Tucson.

Gramly, Richard Michael
1979 A survey of Maine lithic sources. Manuscript report on file, Maine Historic Preservation Commission, Augusta.
1980 Raw material source areas and curated tool assemblages. *American Antiquity* 45:823-833.
1981 Report on archaeological survey in Western Maine. Manuscript report on file, Maine Historic Preservation Commission, Augusta.
1982 *The Vail Site*. Bulletin of the Buffalo Museum of Sciences 30, Buffalo, New York.

(Gramly, con't)
1984 Kill sites, killing ground, and fluted points at the Vail site. *Archaeology of Eastern North America* 12:101-121.
1985 Recherches archaeologiques au site paleoindian de Vail, dans le nord-ouest du Maine 1980-1983. *Recherches Amerindiennes au Quebec* 15:57-118.
1986 Paleoindian sites south of Lake Ontario, western and central New York State. Paper delivered to the Smith Symposium, Buffalo Museum of Science, October 1986.

Grigal, D.F.
1973 Note on the hydrometer method of particle-size analysis. *Minnesota Forestry Research Notes* 245: 4pp.

Grigal, D.F., R. C. Severson, and G. E. Goltz
1976 Evidence of eolian activity in north-central Minnesota 8000 to 5000 years ago. *Geological Society of America Bulletin* 87: 1251-1254.

Grimes, John R.
1979 A new look at Bull Brook. *Anthropology* 3(1-2):109-130, Stoney Brook, New York.

Grimes, John R. and Beth L. Grimes
1985 Flakeshavers: morphometric, functional and life cycle analyses of a Paleoindian unifacial tool class. *Archaeology of Eastern North America* 13:35-57.

Grimes, John R., W. Eldridge, B. G. Grimes, A. Vaccaro, F. Vaccaro, J. Vaccaro, N.Vaccaro, and A. Orsini
1984 Bull Brook II. *Archaeology of Eastern North America* 12: 159-183.

Gould, Richard A., Dorothy A. Koster, and Ann H. L. Sontz
1971 The lithic assemblage of the Western Desert Aborigines of Australia. *American Antiquity* 36:149-169.

Guilday, John E.
1982 Appalachia 11,000-12,000 years ago: A biological review. *Archaeology of Eastern North America* 10: 22-26.
1984 Pleistocene extinction and environmental change: case study of the Appalacians. Pp. 250-258 in *Quaternary Extinctions*, edited by Paul S. Martin and Richard G. Klein. Univ. of Arizona Press, Tucson.

Hasenstab, Robert
1987 Preliminary investigation at the Hanneman site: a Paleoindian component in the Connecticut River Valley. Paper delivered to the Northeast Anthropological Association meetings, Amherst, Massachusetts, March 21, 1987.

Haury, Emil
1953 Artifacts with mammoth remains, Naco, Arizona. *American Antiquity* 19:1-17.

Hawley, David
1967 Ordovician shales and submarine slide breccias of northern Champlain Valley in Vermont. *Bulletin of the Geological Society of America* 68:54-94.

Haynes, C. Vance, D. J. Donahue, A. J. T. Jull, and T. H. Zabel
1984 Application of accelerator dating to fluted point Paleoindian sites. *Archaeology of Eastern North America* 12:184-187.

Holmgren, G. G. S. and C. S. Holzhey
1984 A simple colorimetric measurement of humic acid in spodic horizons. *Soil Science Society of America Journal* 48:1374-1378.

Holmgren, G. G. S. and R. D. Yeck
1984 Field identification of spodic horizons with potassium hydroxide extractable aluminum and humic acid color. *Soil Science Society of America Journal* 48: 1370-1374.

Imbrie, John and John Z. Imbrie
1980 Modeling the climatic response to orbital variations. *Science* 207:943-953.

Irwin, Henry T. and H. Marie Wormington
1970 Paleo-Indian tool types in the Great Plains. *American Antiquity* 35:24-34.

Jacobson, George L., Jr and Eric C. Grimm
1986 Synchrony of rapid change in late-glacial vegetation south of the Laurentide Ice Sheet. Paper presented to the Smith Symposium, Buffalo Museum of Science, October 1986.

Johnson, R. G. and R. T. McClure
1976 A model for Northern Hemisphere continental ice sheet variation. *Quaternary Research*. 6: 325-353.

Jordan, Douglas F.
1960 The Bull Brook site in relation to "Fluted Point" manifestations in eastern North America. Doctoral Dissertation, Department of Anthropology, Harvard University.

Judge, W. James
1973 *Paleo-Indian Occupation of the Central Rio Grande Valley in New Mexico.* University of New Mexico Press.

Judge, W. James and Jerry Dawson
1972 Late Paleo-Indian settlement technology in New Mexico. *Science* 176: 1210-1216.

Keenlyside, David
1985 Late Paleo-Indian evidence from the southern Gulf of St. Lawrence. *Archaeology of Eastern North America* 13: 79-92.

Knight, Jay
1985 Differential Preservation of Calcined Bone at the Hirundo Site, Alton, Maine. Master of Science Dissertation, University of Maine, Orono.

Kopec, Diane
1985 The Eddie Brown collection from the West Grand Lake area, Maine. *The Maine Archaeological Society Bulletin* 25:2:3-37.

Koteff, Carol and Fred Pessl Jr.
1985 Till stratigraphy in New Hampshire: correlations with adjacent New England and Quebec. *Geological Society of America Special Paper* 197: 1-12.

Kurten, Bjorn and Elaine Anderson
1980 *Pleistocene Mammals of North America.* Columbia Univ. Press, New York.

Kubiena, W. L.
1970 *Micromorphological Features of Soil Geography.* Rutgers University Press, New Jersey.

Kutzbach, John E.
1981 Monsoon climate of the early Holocene: climatic experiment using the Earth's orbital parameters for 9000 years ago. *Science* 214:59-61.
1983 Modeling of Holocene climates. Pp. 271-277, in *The Holocene*, edited by H. E. Wright. University of Minnesota Press, Minneapolis.

Lantz, Stanley W.
1984 Distribution of Paleo-Indian projectile points and tools from western Pennsylvania: Implications for regional differences. *Archaeology of Eastern North America* 12:210-230.

Laub, Richard S.
1986 The Hiscock site: an unusually rich late Quaternary locality in western New York state. Paper presented to the Smith Symposium, Buffalo Museum of Science, October 1986.

Lavin, Lucianne and Donald Prothero
1981 Microscopic analysis of cherts within and adjacent to the Delaware River watershed. *Man in the Northeast* 21:3-17.

Lepper, Bradley T.
1984 Ohio fluted projectile points: a preliminary functional analysis, Part II. *Ohio Archaeologist* 43:4-12.

Levesque, Rene
1962 *Les Richesses Archaeologiques du Quebec.* La Societe d'Archaeologie de Sherbrooke.

Loring, Stephen
1980 Paleo-Indian hunters and the Champlain Sea: a presumed association. *Man in the Northeast* 19:15-42.

Lothrop, Jon and R. Michael Gramly
1982 Pieces esquillees from the Vail site. *Archaeology of Eastern North America* 10:1-21.

Luedtke, Barbara
1979 Quarrying and quantification: estimates of lithic material demand. *Mid-continental Journal of Archaeology* 4:255-267.

MacDonald, George F.
1966 The technology and settlment pattern of a Paleo-Indian site at Debert, Nova Scotia. *Quaternaria* 8:59-74.
1985 *Debert: A Paleoindian Site in Central Nova Scotia.* Second Edition. Persimmon Press, Buffalo, New York.

Macoun, J.
1968 The stratigraphy of eolian sediments and fossil soils in the Ostrava region and in the Odra part of the Moravian Gate. Pp. 309-311, in C. B. Shultz and J. C. Frye (eds.), *Loess and Related Eolian Deposits of the World.* University of Nebraska Press.

McAndrews, John H. and L. J. Jackson
1986 Age and environment of the Rostock mammoth and other postglacial elephants in southern Ontario. Paper presented at the Smith Symposium, Buffalo Museum of Science, October 24-25, 1986.

McCary, Ben C.
1975 The Williamson Paleo-Indian site, Dinwiddie Country, Virginia. *The Chesopiean* 13:3-4.

McFee, W. W. and E. L. Stone
1965 Quantity, distribution, and variability of organic matter and nutrients in a forest podzol in New York. *Soil Science of America Proceedings* 29:432-436.

McKeon, J. B.
1972 Late-glacial wind direction in west-central Maine. Master of Science Dissertation, University of Maine, Orono, Maine. 151 pp.

McNett, Charles W., Jr. (ed.)
1985 *Shawnee-Minisink: A Stratified Paleoindian-Archaic Site in the Upper Delaware Valley of Pennsylvania.* Academic Press, Orlando.

McNett, Charles W. Jr., Barbara MacMillan, and Sydne Marshall
1977 The Shawnee-Minisink site. In Bert Salwen and S. Newman (eds.), *Amerinds and Their Paleoenvironments in Northeastern North America.* New York Academy of Sciences 288: 282-296.

Mead, Jim I. and David J. Meltzer
1984 North American late Quaternary extinctions and the radiocarbon record. Pp. 440-450 in *Quaternary Extinctions*, edited by Paul S. Martin and Richard G. Klein. University of Arizona Press, Tucson.

Meltzer, David J.
1984 On stone procurement and settlement mobility in eastern fluted point groups. *North American Archaeologist* 6:1-24.

Moeller, Roger W.
1980 *6LF21: A Paleo-Indian Site in Western Connecticut.* American Indian Archaeological Institute, Occasional Paper Number 2.
1984 The Ivory Pond mastodon project. *North American Archaeologist* 5:1-12.

Morrison, D.F.
1976 *Multivariate Statistical Methods.* McGraw-Hill Book Co., New York.

Mokma, D. L.
1983 New chemical criteria for defining the spodic horizon. *Soil Science of America Journal* 47:972-976.

Movius, Hallam L., Nicholas David, Harvey Bricker, and R. Berle Clay
1968 *The Analysis of Certain Major Classes of Upper Paleolithic Tools.* American School of Prehistoric Research Bulletin 26. Peabody Museum, Harvard University.

Muhs, D.R.
1985 Age and paleoclimatic significance of Holocene sand dunes in northeastern Colorado. *Annals of the Association of American Geologists* 75:566-582.

Muller, Ernest H.
1977 Late glacial and early post-glacial environments in western New York. In B. Salwen and S. Newman (eds.), *Amerinds and their Paleoenvironments in Northeastern North* America. New York Academy of Sciences 288:223-233.

Nelson, D.W. and L.E. Sommers
1982 Total carbon, organic carbon, and organic matter. In A.L. Page (ed.), Methods of Soil Analysis, Part 2. *Agronomy* 9:539-579. American Society of Agronomists, Madison, Wisconsin.

Odell, George
1980 Toward a more behavioral approach to archaeological lithic concentrations. *American Antiquity* 45:404-431.
1985 Small sites archaeology and use-wear on surface collected artifacts. *Mid-Continental Journal of Archaeology* 10:21-48.
1986 Archaic lithic assemblages from the stratified Napoleon Hollow site in Illinois. *Wisconsin Archaeologist* 66:327-358.

Olansson, Deborah S.
1983 Experiments to investigate the effects of heat treatment on use wear on flint tools. *Proceedings of the Prehistoric Society* 49:1-13.

Oldale, Robert N.
1985 Rapid postglacial shoreline changes in the western Gulf of Maine and the Paleo-Indian environment. *American Antiquity* 50:145-150.

Oldale, Robert N., Frank Whetmore, and John R. Grimes
n.d. Elephant teeth from the western Gulf of Maine, Paleoindians, the Late Wisconsinan sea-level stand, and extinction. Draft manuscript.

Olson, R.V. and R. Ellis
1982 Iron. In A. L. Page (ed.), Methods of Soil Analysis, Part 2. *Agronomy* 9:539-579. American Society of Agronomists, Madison, Wisconsin.

Osgood, Cornelius
1940 *Ingalik Material Culture.* Yale University Publications in Anthropology 22. New Haven.

Parent, Michael, Jean-Marie Dubois, Pierre Bail, Armand Larocque, and Gerard Larocque.
1985 Paleogeographie du Quebec Meridional entre 12,500 et 8000 ans B.P. *Recherches Amerindienne au Quebec* 15:17-37.

Payne, James H.
1982 The western basin Paleo-Indian and Early Archaic sequence. Honor thesis, Bachelor of Arts, Department of Sociology, Anthropology and Social Work, University of Toledo. 73pp.

Petersen, James B. and Marjorie W. Power
1983 The Winooski site and the Middle Woodland Period in the Northeast. Report submitted to Interagency Archaeological Services under contract CX4000-2-0006.

Peck, Rodney (ed.)
1985 *The Williamson site.* Privately published, Harrisburg, North Carolina.

Pollock, Stephen G.
1982 Bedrock geology. Pp 5-11 in Robson Bonnichsen (ed.), Archaeological Research at Munsungun Lake: 1981 Preliminary technical report of Activities. Institute for Quaternary Studies, University of Maine, Orono.
1987 Chert formation in an Ordovician volcanic arc. *Journal of Sedimentary Petrology* 57:75-87.

Pritchett, W.L.
1979 *Properties and Management of Forest Soils.* John Wiley and Sons, New York.

Rich, John W. and Sylvia Chappell
1983 Thermal alteration of silica materials in technological and functional perspective. *Lithic Technology* 12:3:69-80.

Ritchie, William A.
1953 A probable Paleo-Indian site in Vermont. *American Antiquity* 18:249-258.
1980 *The Archaeology of New York State.* Harbor Hill Books, Harrison, New York. Revised Edition.

Roberts, Arthur
1985 Paleoindians on the North Shore of Lake Ontario. *Archaeology of Eastern North America* 12:248-265.

Roberts, H. H.
1935 A Folsom complex: preliminary report on investigations at the Lindenmeier Site in north Colorado. *Smithsonian Miscellaneous Collections* 94(4).

Roosa, William B.
1965 Some Great Lakes fluted point types. *Wisconsin Archaeologist* 11:3-4:89-101.
1977 Great Lakes Paleoindian: The Parkhill site. Pp. 249-253 in Bert Salwen and S. Newman (eds.), *Amerinds and Their Paleoenvironments in Northeastern North America*, Annals of the New York Academy of Sciences 288:349-354.

Ross C. S. and R. L. Smith
1961 Ash-flow tuffs: their origin, geologic relations and identification. *U.S. Geological Survey Professional Paper* 366. 81pp.

Rourke, R.V. and C. Beek
1968 Soil-water chemical and physical characteristics of eight soil series in Maine. *Maine Agricultural Experimental Station Technical Bulletin* 29.

Ruddiman, William and Andrew McIntyre
1981 Oceanic mechanisms for amplification of the 23,000 year ice-volume cycle. *Science* 212: 617-627.

Ruddiman, William F.
1977 North Atlantic ice rafting: a major change at 75,000 years before present. *Science* 196: 1208-1210.

Ruhe, R. V.
1968 Identificaiton of paleosols in loess deposits in the United States. Pp. 49-65 in E. B. Schultz and J. C. Frye (eds.). *Loess and Related Eolian Deposits of the World.* Proceedings VII Congress International Association Quaternary Research. University of Nebraska Press.
1969 *Quaternary Landscapes in Iowa.* Iowa University Press, Ames.

Rule, Pamela and June Evans
1985 The relationship of morphological variation to hafting techniques among Paleoindian endscrapers at the Shawnee-Minisink site. Pp. 211-220 in Charles W. McNett, Jr. (ed.), *Shawnee-Minisink: A Stratified Paleoindian-Archaic site in the Upper Delaware Valley of Pennsylvania.* Academic Press, Orlando.

SAS Institute, Inc.
1982 SAS User's Guide: Statistics. Cary, North Carolina. 584pp.

Sargent, Howard
1982 A new look at an old lake. *Monadnock Perspectives* 332-6. West Peterborough, New Hampshire.

Saunders, J. J.
1980 Model for Man-Mammoth relationships. *Canadian Journal of Anthropology* 1:1:87-98.

Schwab, G. O., R. K. Frevet, T.W. Edminster, and K.K. Barnes
1981 *Soil and Water Conservation Engineering.* John Wiley and Sons, New York.

Simons, Donald B., Michael J. Sholt, and Henry T. Wright
1984 The Gainey site: variability in a Great Lakes Paleo-Indian assemblage. *Archaeology of Eastern North America* 12:266-279.

Simonson, R.W.
1941 Studies of buried soils formed from till in Iowa. *Soil Science Society of America Proceedings* 6:373-381.

Sirkin, Les
1977 Late Pleistocene vegetation and environments in the Middle Atlantic Region. In Bert Salwen and S. Newman (eds.), *Amerinds and Their Paleoenvironments in Northeastern North America,* Annals of the New York Academy of Sciences 288:206-217.

Smith, C. W.

1978 Bayes least significant difference: a review and comparison. *Agronomy Journal* 70:123-127.

Smith, Geoffrey W.

1985 Chronology of late Wisconsinan deglaciation of coastal Maine. *Geological Society of America Special Paper* 197: 29-44.

Smith, H.T.U.

1968 Nebraska dunes compared with those of North Africa and other regions. Pp. 29-47 in C. B. Schultz and J. C. Frye (eds.) *Loess and Related Eolian Deposits of the World*. Proceedings VII Congress International Association Quaternary Research, University of Nebraska Press.

Snedecor, G. W. and W. G. Cochran

1967 *Statistical Methods*. The Iowa University Press, Ames.

Soil Conservation Service

1968 Soil Survey Laboratory Data and Descriptions for some Soil of New England States. *USDA Soil Survey Investigative Report* 20.

1970 Soil Survey: Androscoggin and Sagadahoc Counties, Maine. USDA Soil Conservation Service and Maine Agricultural Experimental Station.

1974 Soil Survey: Cumberland County, Maine. USDA Soil Conservation Service and Maine Agricultural Experimental Station.

Soil Survey Staff

1951 Soil Survey Manual. *USDA Handbook* 18.

1975 Soil Taxonomy: A basic system of soil classification and interpreting soil surveys. USDA Soil Conservation Service.

1981 Soil Survey manual: examination and description of soils in the field (Chapter 4). Issue 1. Directive 430-V-SSM, USDA Soil Conservation Service.

Spiess, Arthur

1979 *Reindeer and Caribou Hunters: An Archaeological Study*. Academic Press, New York.

1984 Arctic garbage and New England Paleoindians. *Archaeology of Eastern North America* 12:280-285.

Spiess, Arthur, Mary Lou Curran, and John R. Grimes

1985 Caribou (*Rangifer tarandus* L.) bones from New England Paleoindian sites. *North American Archaeologist* 6: 145-159.

Storck, Peter L.

1982 Paleo-Indian settlement patterns associated with the strandline of glacial Lake Algonquin in south central Ontario. *Candian Journal of Archaeology* 6:1-32.

1983 The Fisher site, fluting techniques, and early Paleo-Indian cultural relationships. *Archaeology of Eastern North America* 11:80-97.

Stuckenrath, Robert, Jr.

1966 The Debert archaeological project, Nova Scotia: Radiocarbon dating. *Quaternaria* 8:75-80.

Stuiver, Minze and Harold W. Borns, Jr.
1975 Late Quaternary marine invasion in Maine: its chronology and associated crustal movement. *Geological Society of America Bulletin* 86: 99-104.

Thomas, Peter, and Brian Robinson
n.d. Out of sight, out of mind: Evaluating the stratigraphy of shallow sites. Manuscript, Department of Anthropology, University of Vermont.

Tringham, Ruth, Glenn Cooper, George Odell, Barbara Voytek, and Anne Whitman
1974 Experimentation in the formation of edge damage: a new approach to lithic analysis. *Journal of Field Archaeology* 1: 171-196.

Turnbull, Christopher
1974 The second fluted point from New Brunswick. *Man in the Northeast* 7:109-110 and Plate IX.

Turnbull, Christopher and Patricia Allen
1978 More Paleo-Indian points from New Brunswick. *Man in the Northeast* 15/16:147-153.

USDA Soil Management Services
1985 Keys to soil taxonomy. *Technical Monograph* No. 6, Agronomy Dept., Cornell University, Ithaca, New York.

Ulrich, Thomas
1978 Preliminary report of a cultural resource survey of the Deerfield Industrial Park, Phase I/IIa. Manuscript report under contract 78A492. The Environmental Institute, University of Massachusetts, Amherst.

Vilks, Gustavs and Peta J. Mudie
1978 Deglaciation of the Labrador Shelf. *Science* 202:1181-1183.

Waller, R. A. and K. E. Kemp
1975 Computations of Baysian t-values for multiple comparisons. *Journal of Statistical Computational Simulation* 4:169-171.

Wagner, F. J. E.
1970 Faunas of the Champlain Sea. *Geological Survey of Canada Bulletin* 181:1-104.

Watts, W. A.
1979 Late Quaternary vegetation of central Appalachia and the New Jersey coastal plain. *Ecological Monographs* 49:427-469.

Webb, Thompson III
1986 The appearance and disappearance of major vegetational assemblages: long-term vegetational dynamics in Eastern North America. *Vegetatio* 57.

Williams, H., F. J. Turner, and C. M. Gilbert
1982 *Petrography: An Introduction to the Study of Rock in Thin Section.* Second Edition. W. H. Freeman and Co., San Francisco. 626pp.

Wilmsen, Edwin
1970 Paleoindian site utilization. Pp. 22-40 in Betty Meggars (ed.), *Anthropological Archaeology of the Americas*, Anthropological Society of Washington.

Wilmsen, Edwin and Frank H. H. Roberts, Jr.
1984 *Lindenmeier, 1934-1974 Concluding Report on Investigations*. Smithsonian Contributions to Anthropology 24.

Winter, Eugene
1975 The Smyth site of Amoskeag Falls: a preliminary report. *The New Hampshire Archaeologist* 18:5-8.

Witthoft, John
1952 A Paleo-Indian site in eastern Pennsylvania: an early hunting culture. *Proceedings of the American Philosophical Society* 96:464-495.

Young, David and Robson Bonnichsen
1985 Cognition, behavior and material culture. Chapter 4, pp. 91-131 in M. Plew, J. Wood and M. Pavesic (eds.), *Essays in Honor of Donald E. Crabtree*. University of New Mexico Press.

OTHER TITLES IN THE OCCASIONAL PUBLICATIONS IN MAINE ARCHAEOLOGY SERIES

OPMA 2. Christopher L. Borstel 1982 *Archaeological Investigations at the Young Site, Alton Maine*

OPMA 3. Arthur E. Spiess and Mark H. Kedden 1983 *Kidder Point and Sears Island in Prehistory*

OPMA 4. Emerson W. Baker 1985 *The Clarke and Lake Company: The Historical Archaeology of a Seventeenth Century Maine Settlement*

OPMA 5. Alaric Faulkner and Gretchen F. Faulkner. 1987 *The French at Pentagoet 1635-1674: An Archaeological Portrait of the Acadian Frontier*

OPMA publications are available from The Maine Archaeological Society, Inc., P.O. Box 982, Augusta, Maine, 04330.

Editorial Policy. Occasional Publications in Maine Archaeology accepts monograph length reports, or substantial sets of shorter essays with a topical focus, dealing with the archaeology of Maine and neighboring states or provinces. All submissions receive peer review by at least two archaeologists with expertise in the subject matter involved.