LITHIC ANALYSIS AND THE INTERPRETATION OF TWO PREHISTORIC SITES FROM THE CANIAPISCAU REGION OF NOUVEAU QUEBEC

by

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ABSTRACT

This thesis is concerned with the explanation of the lithic tool production system that generated the collections found on two prehistoric sites from the Caniapiscau region of subarctic Quebec. Hypotheses concerning the potential structure of the lithic industry are derived from a consideration of possible constraints affecting the technology being studied. Test implications guide the selection of attributes used to describe the individual pieces of debitage. A multivariate statistical method, multiple correspondence analysis, is employed to suggest different debitage groups present in the collections. Additional information such as: the spatial distribution of different raw materials, an examination of the tool collections, and the conjoining of artifacts and sequentially removed flakes, is also included. Behavioral interpretations of the results provide the basis for a reevaluation of the original hypotheses and a description of lithic reduction processes. The methodology employed in this research has advantages over the a priori adoption of linear reduction models characterizing many recent debitage analyses.

RÉSUMÉ

Ce mémoire entreprend l'explication d'un système de production d'outils lithiques provenant des collections faites sur deux sites préhistoriques de la région de Caniapiscau dans le Québec subarctique. Des hypothèses concernant l'éventuelle structure d'une industrie lithique sont émises tout en considérant les contraintes possibles pouvant affecter la technologie à l'étude. Les hypothèses de travail ont guidé la sélection des attributs utilisés pour décrire les objets de débitage individuels. Une méthode de statistiques multivariées, dite analyse de correspondances multiples, a été employée pour suggérer différents groupes de débitage qui se présentent dans les collections. Des informations supplémentaires font aussi partie de cette étude: la distribution spatiale des différentes matières premières lithiques, l'examen des collections d'outils, et l'union des objets cassés et des éclats enlevés séquentiellement. À la lumière des résultats, une interprétation des comportements nous permet de reévaluer les premières hypothèses et de décrire les processus impliqués dans la réduction lithique. La méthodologie employée au cours de cette recherche possède des avantages sur l'adoption *a priori* de modèles de réduction linéaire qui caractérisent plusieurs analyses récentes sur le débitage lithique.

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CHAPTER 1

INTRODUCTION

> As much as I am intrigued by mastery of lithic technologies, as I enter more fully into the simulated life of the neo-aborigine, I realize how small a part of primitive living is shaping the projectile point. However, I believe, that those very cultural activities which constrain an individual's stone working time, affect in no small degree the decisions which are made while flaking tools into shape. . . . Only by understanding more fully the scope of the interaction of the relevant socio-cultural and natural environments can we come to grips with numerous decision-making processes, processes which were directly or indirectly impressed on the tool being flaked.
>
> (Callahan 1979:114-115)

The description and classification of lithic collections has always been an integral part of the practice of archaeology. However, recent advances in lithic studies - such as lithomechanical experimentation and functional analysis - combined with revised goals within the discipline of archaeology itself, have pointed out the inadequacies of many traditional methods of lithic analysis. In addition, archaeological research in regions previously unexplored, has in some cases produced collections which defy comprehension using traditional typological constructs. The result has been an increasing emphasis on understanding and explaining lithic technologies as dynamic systems. This is the approach followed in this study.

The aim of this thesis is the interpretation and reconstruction of the lithic tool production system which generated the assemblages found on two prehistoric Indian sites, GcEl-15 and GcEl-22B, in the central-interior of the Quebec-Labrador peninsula. The sites were discovered during an archaeological salvage program that studied contemporary, historic, and prehistoric Indian sites endangered by the James Bay hydroelectric development project. Prior to the summer of 1972, no systematic archaeological reconnaissance or excavation work had been conducted in the Quebec subarctic. Although ten years have since elapsed, the analysis and interpretation of recovered cultural materials remain in a nascent state. This situation is due in part to the nature of the contractual work which has been carried out. Budgetary and time constraints have dictated an emphasis on fieldwork rather than on analytical research; however, problems inherent in the data have also slowed down interpretive studies. For example, many of the data recovered from the prehistoric sites consist of lithic debitage - the by-product of stone tool manufacture and use. Few "diagnostic" tools have been found and modified flakes comprise by far the largest formal tool class. This fact, in addition to poor bone preservation, limited stratigraphy, small size of many sites, and mixed components, has greatly hindered the formulation of a cultural-historical framework for the region and has hampered analytical studies.

From this discussion, it is evident that archaeologists wishing to unravel the prehistory of the Quebec subarctic cannot rely on traditional methods of analysis involving comparative tool typologies, faunal analysis, or stratigraphy. New methods must be employed that are suited to the specific nature of these sites and which enable the extraction of a maximum of behavioral information from what is generally considered an extremely limited data base. Acknowledging this fact, a major part of the present study will consist of a technological analysis of debitage; supplemented by information obtained through an examination of complete and fragmentary tools. As Muto points out,

> The objective piece with its various flake scars is less than half of the diagnostic process. The thinning and shaping flakes, the platform preparation flakes, and what is described in the field as 'non-diagnostic debitage' are the important parts in reconstructing the manufacturing process.
>
> (1971a:8)

Additional insights will be gleaned from all available sources,(i.e., artifact conjoining, spatial and faunal analysis, and ethnographic analogy). The results of this process are used to evaluate a number of hypotheses proposed to explain prehistoric lithic technology on the two sites under study. A more general application of the findings is also considered.

The thesis is organized into five chapters. Chapter two presents an overview of archaeological research in the Caniapiscau region. Included is a discussion of the environmental context of the sites and a description of the assemblages. Chapter three outlines the theoretical framework which guided the study. It begins with a brief history of lithic research and evaluates the current use of structural reduction models in the interpretation of lithic collections. An alternate approach is proposed; which employs a model of possible constraints operative within the lithic tool production system. This explanatory construct guides the formation of working hypotheses concerning the structure of the industry. The methodology employed to analyze the data in light of these hypotheses is explained in Chapter four. Included is a discussion of attribute selection, measurement, and recording techniques. The results are presented in Chapter five. First the attribute frequencies for each site are tabulated and their significance discussed. Next, a statistical technique called "multiple correspondence analysis" is used to evaluate the interdependence of the attributes and to suggest flake groups which may have resulted from prehistoric production strategies. This is followed by an examination of the spatial distribution of raw materials on the sites; and finally, the remaining sources of information, such as analysis of the tool collection and faunal remains are considered. The validity of the hypotheses presented in Chapter three is then evaluated and serves as the basis for a reconstruction of lithic reduction strategies employed on the two sites. Finally, suggestions are made as to how this study can be used in the elaboration of subsequent research geared toward an understanding of the interactive, adaptive nature of prehistoric lithic technology within the Caniapiscau region.

CHAPTER 2

REGIONAL OVERVIEW AND SITE DESCRIPTIONS

Location and physiography

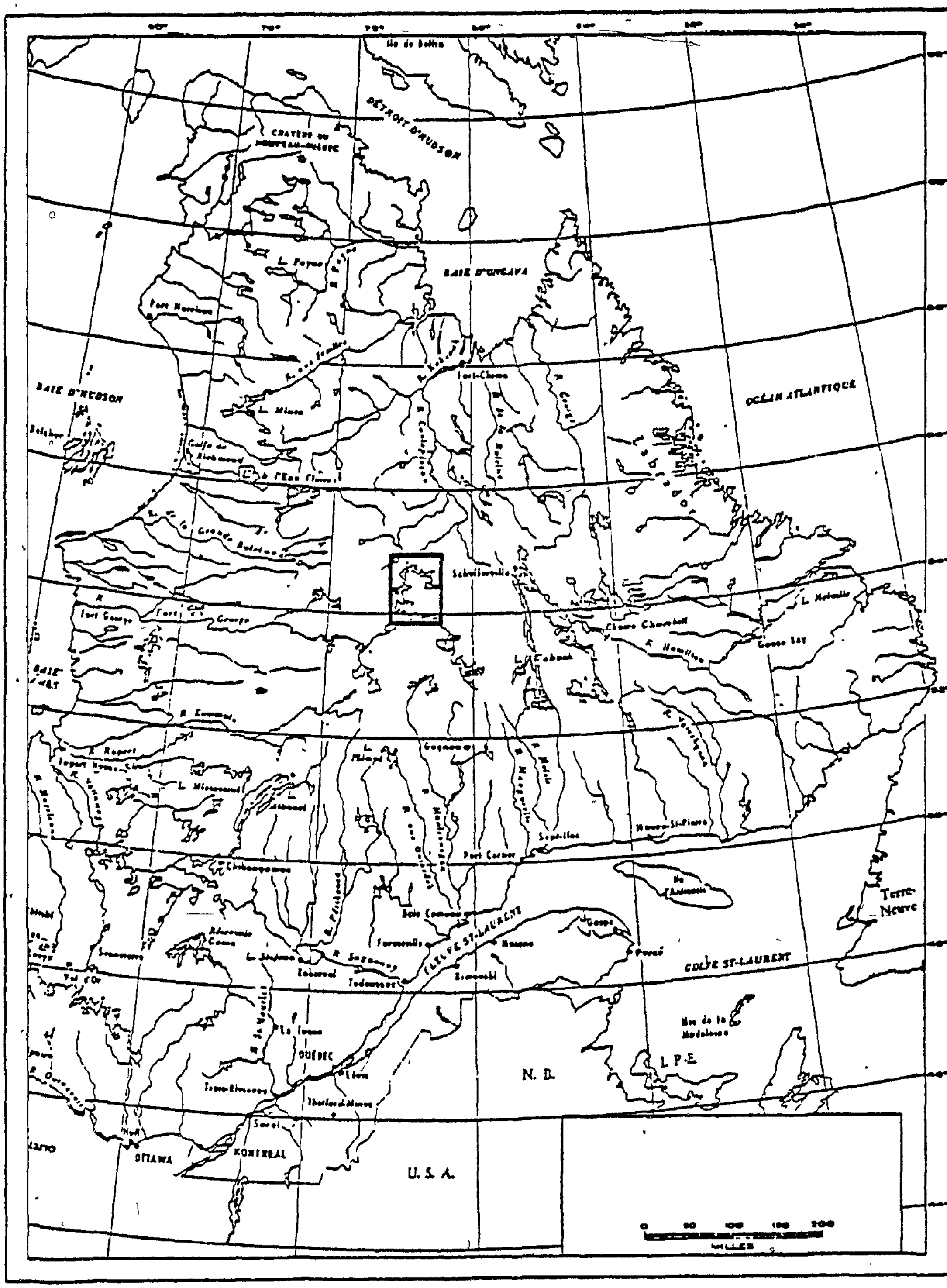
The Caniapiscau reservoir is located in the upper part of the Caniapiscau drainage basin and, when it has completely filled, will occupy approximately 4300 square kilometres (Figure 1).

> Prior to its diversion into the La Grande system, the Caniapiscau widened into a series of large inter-connected lakes (especially Lakes Caniapiscau and Delorme). Three main secondary drainages flow into the Caniapiscau from the southwest (Male Otter System), the west (Lakes Brisay and Marsilly), and east (Lakes Clairambault, D'Esperey, Vermeulle and Porée). (Denton n.d.:8)

Physiographically, the region is part of the "Lake Plateau unit" of the Canadian Shield and has been described as an undulating plain containing numerous lakes with occasional bedrock hills rising to an altitude of 500 feet above the surrounding landscape (Bostock 1970:16). It is situated in the northern part of the subarctic bioclimatical zone as defined by Rousseau (1962). The vegetation is characteristic of the northern part of the "open boreal woodland" forest classification (Hare 1950), and consists predominantly of black spruce and the lichen Cladonia. The northern part of the region, however, contains more open forest, with a higher

FIGURE 1

Location of the Caniapiscau reservoir region.



proportion of larch trees than is found in the south (Denton et al. 1981:5). The annual temperature average varies between -4 and -7° centigrade, with frost beginning in September and break-up occurring in early June.

Fauna

The number of mammal species found in the region varies between 20 and 35, depending on the vegetational sub-zones (Bider 1976, Legendre et al. 1978). The large mammals most important for aboriginal subsistence were the caribou and black bear, with caribou occupying the primary position. Initial inventories revealed a high concentration of caribou in the Caniapiscau region, as compared with other parts of the James Bay Territory (Audet 1979, Pichette and Beauchemin 1973). The importance of caribou in aboriginal economy is attested by historical records and oral traditions (Denton 1979). The moose appears to have made a relatively late entry into the Caniapiscau region and there is as yet no evidence to confirm the presence of this species during the prehistoric period.

Of the small mammals found in the area, those with the highest economic value to the current Cree inhabitants are the rodents: woodchuck, muskrat, and porcupine. Otter, martin, and mink, as well as fox, are trapped for their furs. Beaver are found in smaller numbers than in the more densely forested parts of the James Bay Territory situated to the west and the south (Traversy 1975). The relative rarity of this species in the Caniapiscau region is known since the 19th century (Denton 1979:108).

Sixteen fish species have been identified in the Caniapiscau river basin (Anon. 1978:235). Three of these, lake trout, northern pike, and whitefish are preferred by native fishermen.

Aquatic birds, which comprise many species of duck, loon, and goose, are found in relative abundance. Those whose nesting areas are located within the region, Canada goose for example, are very numerous during the summer months. Non-aquatic bird species include ptarmigan and spruce grouse.

Previous Research

Prior to the summer of 1976, the Caniapiscau region was archaeologically unexplored. The closest areas to have received archaeological investigation were Indian House Lake (Conrad 1972; Samson 1975, 1978a, 1978b, 1981), the Mistassini-Albanel region (Martijn and Rogers 1969), Hamilton Inlet on the Labrador coast (Fitzhugh 1972, 1975, 1976), the LG2 reservoir region in the lower portion of the La Grande river basin (Laliberté 1976), and the St. Lawrence North Shore (Chevrier 1975, 1977, 1978).

Research began during the summer of 1976, when a 5-person crew conducted a canoe reconnaissance within the future reservoir. The main objective of the project was to save the greatest possible amount of archaeological information concerning prehistoric and historic occupation of the area, before flooding began in 1981. Two long-term objectives were subsumed within the principal mandate: first, the elaboration of a preliminary cultural-historical framework for the region, and second, the description of specific settlement systems, resource utilization patterns, and demography for each of the periods identified (Denton et al. 1981:1).

The realization of these two objectives required a series of distinct operations:

> . ... (1) reconstruction of the palaeo-environment throughout the period of possible human occupation, (2) construction of a culture-historical framework for the prehistoric period, (3) to study, within a culture-ecological framework, the manner in which each identified cultural unit exploited available resources and organized itself on the landscape to do so (subsistence-settlement system), and (4) to identify the major changes in technology and in the subsistence-settlement system through time and analyse the natural and cultural factors responsible for these changes. (Denton n.d.:10)

With these objectives in mind, reconnaissance work continued in the summer of 1977. Excavations were initiated the following year. The last excavations prior to flooding took place during the summer of 1982.

At the completion of the 1982 field season, 315 sites had been recorded, of which 89 produced lithic material and are presumed to be prehistoric or protohistoric, with the remaining 226 sites being historic or contemporary in nature. Excavations or intensive testing have been conducted on 40 sites, of which 36 have prehistoric or protohistoric components (Denton n.d.:11).

Preliminary cultural-chronology

The analysis of data collected during field work in the Caniapiscau region is just beginning. Despite this fact, a very preliminary cultural-chronology - based on an examination of dated occupations, raw material distributions, tool typology, habitation structures, hearth forms, settlement patterns, and comparison with prehistoric sequences proposed by Samson (1978b) for the Indian House Lake material (located 175 km inland from the northern coast of Labrador), and Fitzhugh (1978a, 1978b) for occupations on the Labrador coast - has been proposed. A brief outline will be presented here, but readers are referred to the original reports for a more detailed discussion (Denton 1982, Denton et al. 1981: 290-305, Denton et al. 1982:102-111).

The prehistoric sequence is divided into three main periods: the Early Period, possibly dating from about 4000 BP to 3500 BP, the Intermediate period (3500-1500 BP), and the Late Period (1500 BP to the historic era).

Data supporting the Early Period are as yet minimal. However, late Maritime Archaic manifestations on the Labrador coast and the North Shore of the St. Lawrence suggest the potential for occupation of the central interior of the peninsula during this time period.

The Intermediate Period contains two main variants, both of which emphasize the use of local raw materials, contain relatively small amounts of Ramah quartzite and fine-grained cherts and are dated between 3500 and 2300 BP. Whether these two variants reflect cultural or technological differences, or are attributable to other factors, such as site seasonality or function, remains to be determined. Variant I includes an occupation unit which resembles, in predominant tool morphology and the abundant use of red ochre, certain aspects of the Brinex Complex defined by Fitzhugh (1972:114-115) for the Hamilton Inlet area and noted on the St. Lawrence North Shore by Martijn (1974). Variant II is characterized by a series of dated components containing large quantities of quartz, and having some typological affinities to Intermediate Period sites on the Labrador coast (Nagel 1978).

There are no dated components for the period from 2300 to 1500 BP. It is not known whether this absence reflects an actual change in the intensity of occupation of the region, or results from a bias in the sample of dated sites.

Late Period sites, which include the vast majority of dated components, are distinguishable from those of the Intermediate Period by a significant increase in the use of Ramah quartzite and fine-grained cherts, and by the appearance of new habitation forms with multiple hearths. Once again, two variants are apparent. The first is characterized by the use of Ramah quartzite and sometimes black quartzite, while collections of the second variant emphasize fine-grained cherts. In both cases, locally available quartz and quartzite are found in conjunction with these other materials. Denton originally hypothesized that these two variants were associated with the direction of inter-group contacts (east or west) and patterns of seasonal movement in the interior. However, he has recently stressed the tenuous nature of these suggestions as a result of small artifact samples and uncertainty regarding the source area(s) for the fine-grained cherts (n.d.:27 , 1983:per.comm.).

Assemblages of the first variant display affinities, both in typological comparisons and in the presence of Ramah quartzite, to the Point Revenge Complex (Fitzhugh 1972, 1978b), a late Indian occupation defined for the coast of Labrador and the North Shore of the St. Lawrence. A number of protohistoric assemblages found in the Caniapiscau area support the suggestion that the Point Revenge Complex is ancestral to the Algonkian groups (Montagnais/Naskapi) occupying the eastern part of the peninsula. Historic affiliations for the second variant are as yet undetermined.

The recent addition of a new series of C^{14} age determinations, along with a better understanding of raw material distinctions (i.e. Mistassini quartzite and slate are also present in the assemblages) resulting from an in-depth lithic analysis, are expected to supply new information which may alter some or much of the above outline.

The sites and assemblages

Two sites were chosen for the analysis. Both were located in the central part of the future Caniapiscau reservoir region, near a narrowing in the river called Lac Delorme (Figure 2). The selection of these sites was made on the basis of the availability of the collections, raw material similarity, physical proximity, and the representative nature of the lithic assemblages (i.e., few formal tools and large quantities of debitage).

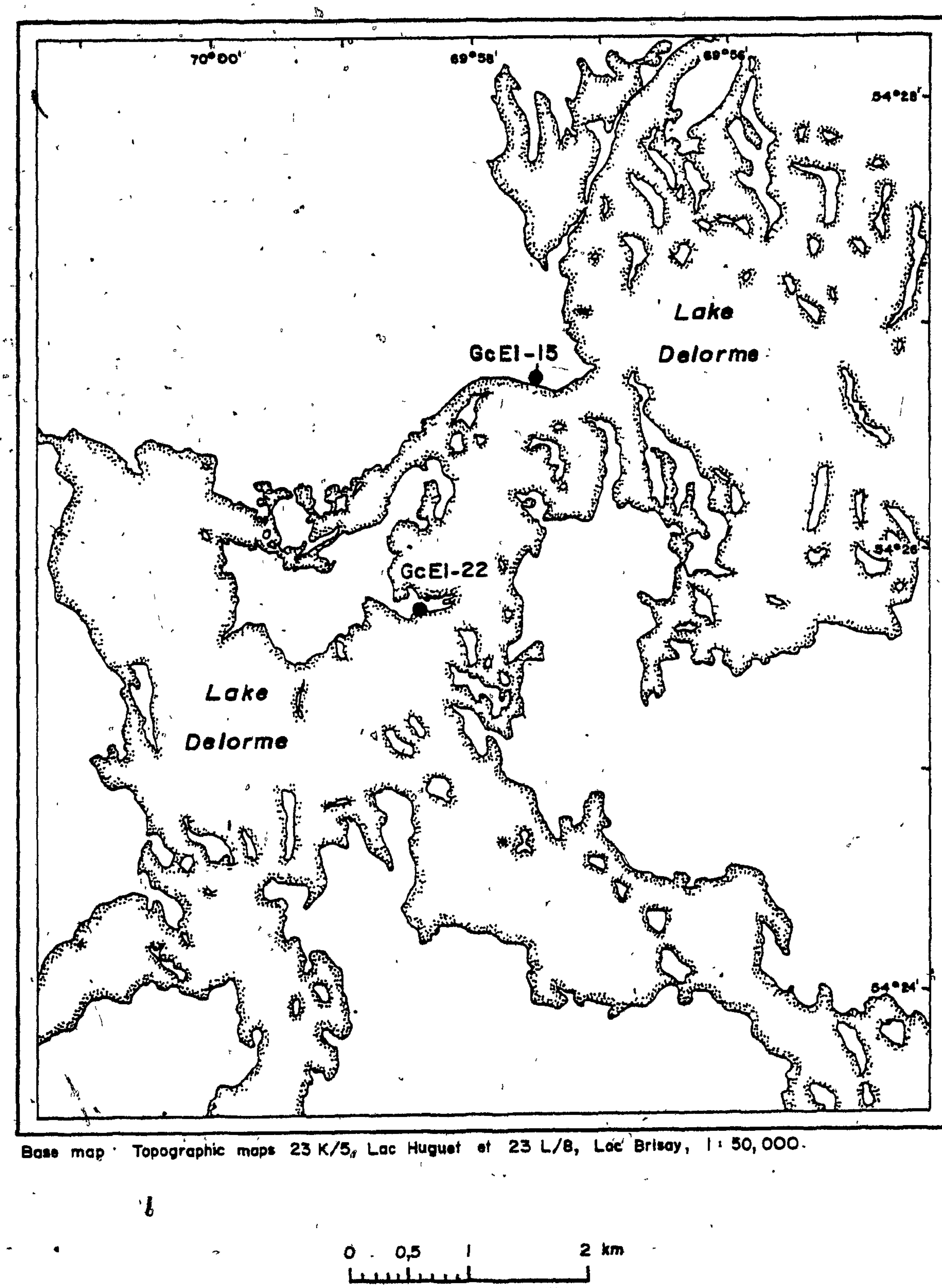
- GcEl-15

Site GcEl-15 is located on an eroding terrace overlooking the southern part of Lac Delorme. This locale appears to have been visited frequently during prehistoric times, as demonstrated by the presence of twenty prehistoric sites, along a 3.6 km stretch of the western shore of the lake. Denton (1978:1) has suggested that this concentration of sites was the result of a combination of factors: the importance of Lac Delorme as a travel route; the existence of propitious locales for camping; and the abundance of two important resources - fish and caribou.

Work was conducted on site GcEl-15 during the summer of 1978 by a crew of seven, of which I was a member. Forty square meters were excavated, using 50 centimetre quadrant subdivisions. The provenience of tools and tool fragments was recorded to the closest centimetre, both horizontally

FIGURE 2

Location of sites GcEl-15 and GcEl-22B.



and vertically. The other artifacts recovered, such as flakes and bone fragments, were located within quadrants and stratigraphic levels. All backdirt was put through $\frac{1}{4}$ inch screens and verified.

The excavation revealed a partially intact tent ring structure; and this factor, combined with stratigraphic evidence and artifact distributions, suggests a single occupation (Figure 3). The centrally located hearth contained a large amount of calcined bone, and charcoal which produced a date of 803±135 BP (GX-6712) or AD 1147±135, uncorrected (Denton 1978:17-33). Preliminary analysis of the faunal material revealed almost exclusively beaver bones, approximately five individuals being represented (Laroque n.d.). A resumé of the faunal identifications is presented in Table 1.

The lithic collection from GcEl-15 contains approximately 8735 specimens, of which 99% are unretouched flakes and flake fragments. Three raw material types predominate: an unidentified black quartzite (76.8% of the collection); quartz and quartzite of variable quality (14.3%); and Ramah quartzite (8.1%). The only complete "formal tool" found on the site is a small, laterally retouched linear flake. The two halves of a square-based biface or projectile point blank, apparently broken during manufacture, were also recovered. A preliminary examination of the lithics was conducted in the field. At that time, 18 tool fragments (i.e.,

FIGURE 3

Floor plan of the flake distribution on site GcEl-15.

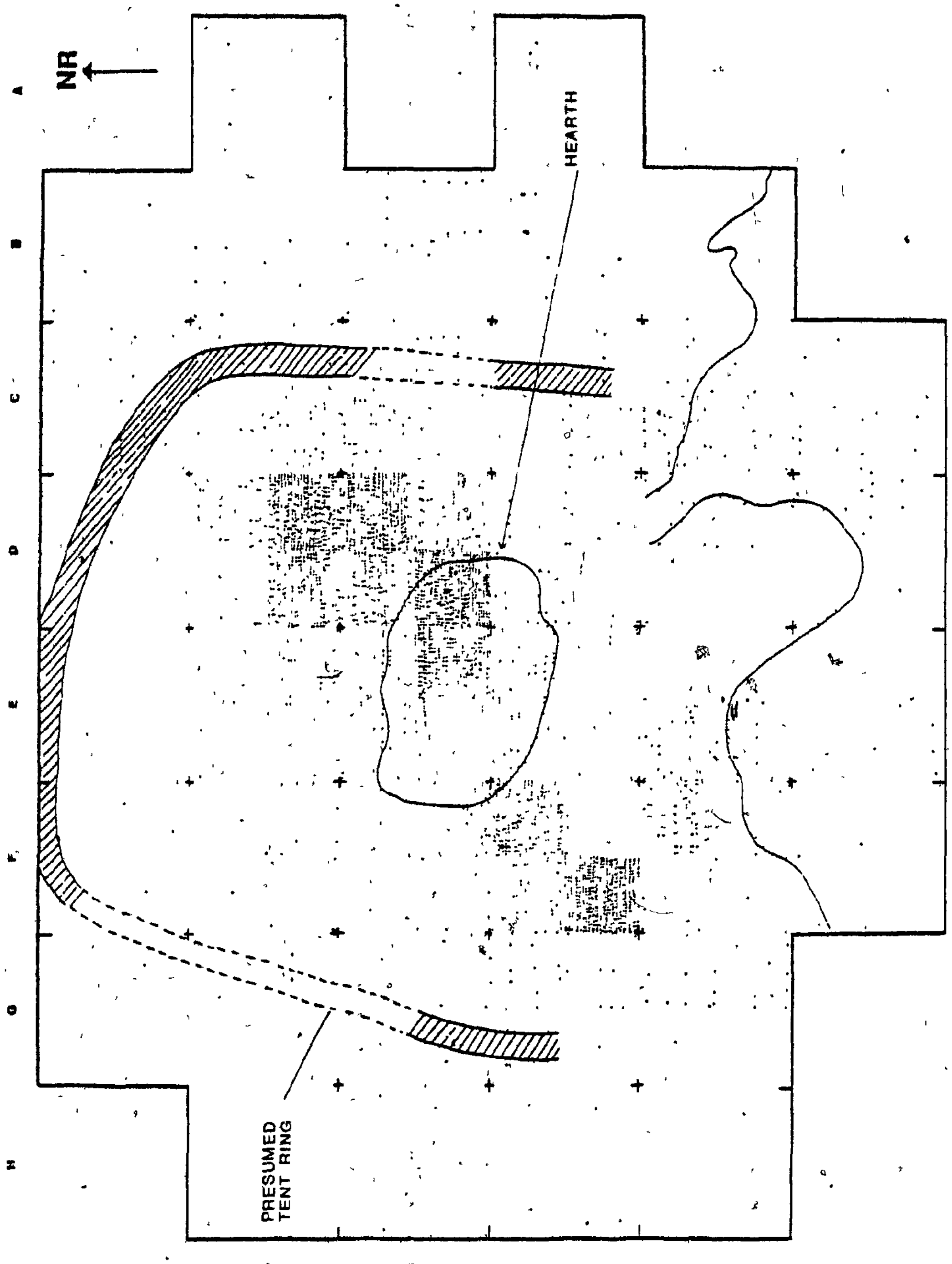


TABLE 1

Resumé of faunal identifications for site GcEl-15

Species	Anatomical Identification	N
Beaver (Castor canadensis)	radius	6
	ulna	13
	humerus	16
	tibia	5
	zygomatic arch	12
	mandible	6
	scapula	6
	patella	6
	clavicle	3
	sacrum	5
	fibula	1
	1st proximal phalange posterior	43
	1st proximal phalange anterior	8
	2nd medial phalange posterior	31
	2nd medial phalange anterior	16
	3rd distal phalange posterior	13
	3rd distal phalange anterior	10
	metatarsal I-V	25
	metacarpal	24
	1st cervicle vertebra	2
	2nd cervicle vertebra	6
	temporal	3
	premaxilla	1
	maxilla	1
Porcupine (Erethizon dorsatum)	mandible	2
	scapula	1
	1st proximal phalange	6
	2nd medial phalange posterior	10
	3rd distal phalange	4

pieces displaying obvious unifacial or bifacial retouch) and an additional 40 flakes with evidence of utilization were identified from among the black quartzite and Ramah quartzite pieces. A more thorough study of the collection, combined with many hours spent conjoining small fragments (reassembling stone elements struck from the same block, or fragments of the same artifact), has increased the total to 35 tool fragments and 70 utilized flakes (of which approximately one-half are complete). The collection also includes 10 resharpening flakes of black quartzite, 2 quartzite hammerstones, as well as 4 cores and 10 possible tools of quartz and quartzite. Forty-seven pieces of slate were found; these are described in the section dealing with raw material distributions. Readers will find a description of the tools and tool fragments from GcEl-15 in Appendix A.

A preliminary breakdown of the black quartzite and Ramah quartzite débitage into broad size categories revealed that the vast majority of the flakes, 78%, fall within the size range of 0-10 mm; while ~~another~~ 19% lie within the 11-20 mm range. The small size of the flakes along with the absence of cortical flakes and nuclei of black quartzite suggest that the initial stages of tool manufacture occurred elsewhere.

It is difficult to determine the seasonality of the site, although the stratigraphical evidence showing a tent ring structure points to an occupation during a time when the ground was not frozen (i.e., non-winter).

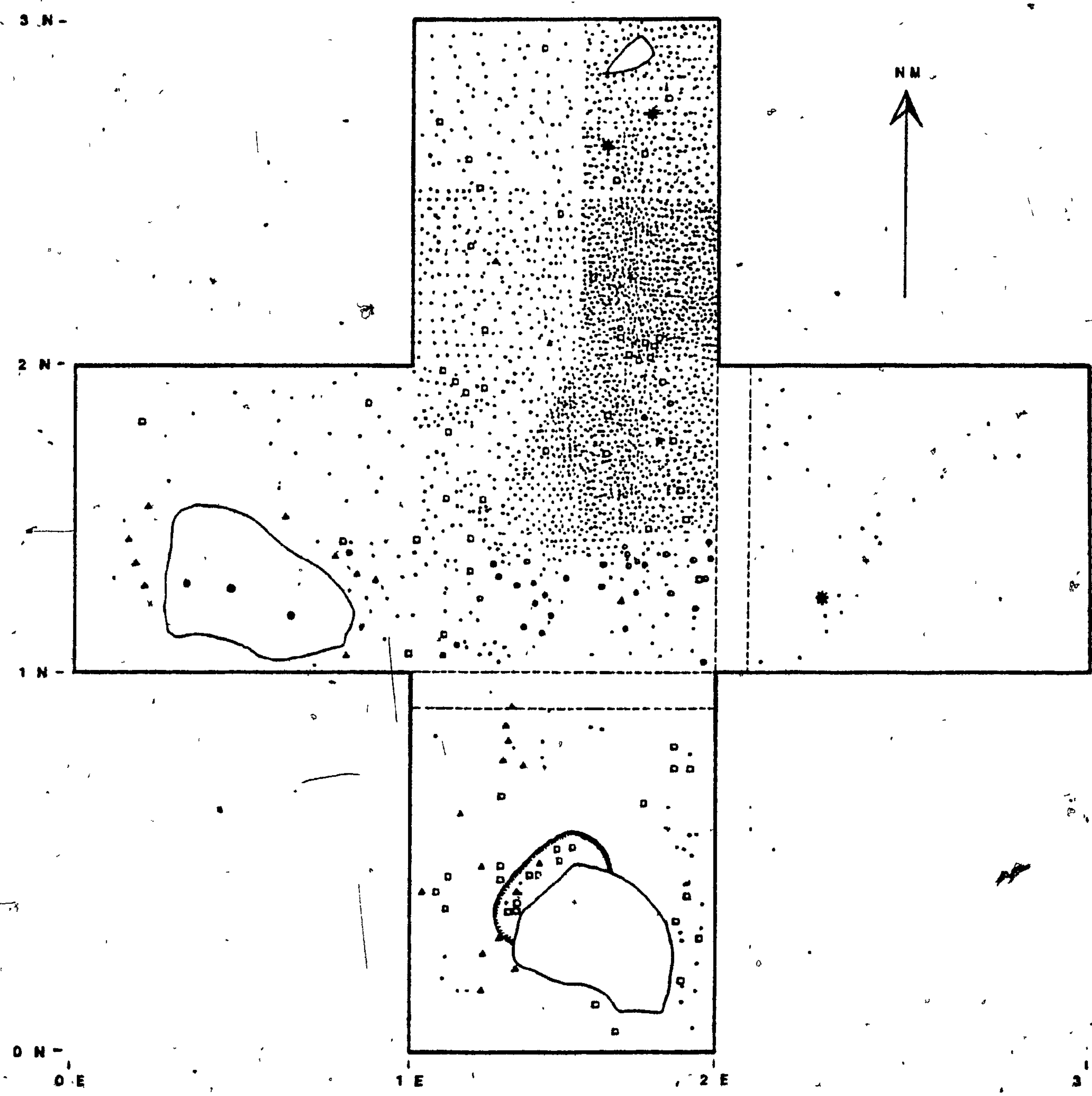
The problems associated with the elaboration of a cultural-chronology for the Caniapiscau region have already been discussed. Site GcE1-15 is a typical example of the difficulties archaeologists face when trying to incorporate such sites within a cultural framework. The lithic assemblage contains almost no formal tool types, and none of the tool fragments is particularly "diagnostic". However, the date of the site, along with the presence of Ramah quartzite and the general nature of the lithic collection, suggest the possibility of contacts (direct or indirect) with the coast of Labrador during the occupation of this region by people of the Point Revenge Complex. The development of this complex in the Hamilton Inlet region is documented by sites ranging in date from AD 1000 until AD 1650. They are described as follows:

> Notably absent are sites with large numbers of structures or evidence of intense occupation as is suggested by many Maritime Archaic sites. Most sites have thin cultural deposits, dispersed well beyond the confines of the dwellings; few tools; and clear patterns without disturbed or remodelled structures. . . . In addition to abundant Ramah chert, Point Revenge sites frequently contain high frequencies of biface thinning flakes and low tool to flake ratios. Some sites have large amounts of debitage but contain few diagnostic tools and appear to be preform or manufacturing stations. Combined, raw material, flaking technology, and elevations provide some justification for identifying Point Revenge sites even in the absence of diagnostic tools or structures. (Fitzhugh 1978b:165-168)

Sites with possible affiliations to the Point Revenge Complex have also been found by Samson, near Indian House Lake, to

FIGURE 4

Floor plan of the flake distribution on site GcEl-22B.



the northeast of the Caniapiscau region (Samson 1978a:196). Fitzhugh (1978b:172) has suggested that basic similarities in the Point Revenge complex and the Montagnais-Naskapi culture indicate a close relationship, or possibly direct ancestral links, between the two.

- GcE1-22B

Site GcE1-22B is situated on the summit of a 10 metre high moraine, near a constriction in the southern part of Lac Delorme (Figure 2). This factor, as well as the site's exposed location and proximity to a series of rapids, suggests an excellent fishing locale (Denton 1980:183-4).

Discovered during reconnaissance work in the summer of 1979, GcE1-22B was selected for excavation because of its location as discussed above and because of the raw material recovered in testing, which appeared to be identical to the black quartzite found on GcE1-15 the previous summer. Five square metres, encompassing a large flake concentration, were excavated (Figure 4). Stratigraphic evidence suggests a single occupation; but no habitation structure, hearth, or datable organic remains were found.

The lithic material that was recovered consists of 2824 flakes, of which 95.5% are of black quartzite. Ramah quartzite and brown chert comprise the remaining raw material types. Although approximately 134 additional quartz and quartzite fragments were also recovered, their placement within the cultural context is suspect, since scatterings of fragmented quartz and quartzite appear to be a common natural occurrence in the vicinity of the site (Denton 1980:186-187). As a result, I chose to omit these materials from the analysis. As with GcEl-15, the vast majority of flakes in the collection are small (99.5% measuring less than 20 mm) and thin in cross-section. Denton (1980:187) conjectured that the site was an "ad hoc" chipping station for final stages of tool manufacture or maintenance. Tools recovered consist of three fragments of retouched and/or utilized flakes of black quartzite; one of which is bifacially retouched.

Little can be said of site GcEl-22B in terms of its place within the cultural-historical framework of the region. The site, however, is of particular interest because of its potential for technological comparison with GcEl-15. It is also of interest because this type of site, unlike habitation sites, is rarely located or subjected to in-depth analysis.

CHAPTER 3

THEORETICAL ORIENTATION

> The annual output of archaeological data and the advent of techniques with novel and fundamental incisive powers make it quite apparent that archaeological interpretation is entering new, exciting, and difficult dimensions. It is equally apparent that the use of these new techniques demands a more coherent and rigorous framework of general conceptual scaffolding than that which the archaeologist has hitherto bothered to erect.
>
> (Clarke 1978:149)

Development of a Technological Approach

Traditionally, in American archaeology the analysis of lithic artifacts was closely tied to the elaboration of cultural chronologies. Emphasis was generally placed on the morphological comparison of tool types; individual tools being treated as static objects to be described and compared. For the most part, tool types were equated with cultural units, first through guide fossil types and later by the statistical manipulation of tool assemblages (Hassan 1976:39):

> There was little appreciation of the existence of the enormous variability characteristic of the archaeological record, and still less understanding of how it might be monitored or controlled.
>
> (Clark 1982:227)

Debitage, broken tools, or tools which differed from the classic or normative types established for a region were virtually ignored. However, in the early 60's this situation began to change.

> The self-imposed constraints that had reduced archaeology to a sterile kind of time-space systematics were lifted by Binford's contention that the entire cultural system was preserved (at least in theory) in the archaeological record. It followed from this that any limitations to an understanding of the past were not inherent in the nature of the archaeological data (as had often been claimed), but were instead to be attributed to flawed research designs and methodological naiveté.
>
> (Clark 1982:228 quoting Binford 1968:23)

One consequence of this revised outlook was the development of explicitly technological analyses, wherein the products (both tools and wastage) of an industry are examined to see how materials were processed (Sheets 1975:370).

The next section examines the fundamental assumptions on which the technological approach is based. This is followed by a review of recent research which has influenced the theoretical orientation and methods adopted in this study.

<u>Fundamental Assumptions</u>

A number of fundamental assumptions make up the conceptual scheme that underlies most current technological approaches. The first of these is that material culture is a product of behavior and that lithic artifacts, and the behaviors responsible for their production, reflect the ideas or mental concepts shared by the group of people who made them. This general scheme for the relation between artifacts and cultural ideas has been expressed in various forms by Rouse (1939, 1960), Kreiger (1944), Chang (1967), and Deetz (1965, 1967, 1968).

Deetz states that:

> The idea of the proper form of an object exists in the mind of the maker, and when this idea is expressed in tangible form in raw material, an artifact results. The idea is the mental template from which the craftsman makes the object. The form of an artifact is a close approximation of this template, and variation in a group of similar objects reflects variation in the ideas which produce them. (1967:45-46)

It is assumed that a group of people who participated in the same ongoing cultural experience would share common "mental templates" of tools frequently manufactured and would transmit knowledge of the manufacturing procedures necessary to produce these forms.

The second assumption is that these manufacturing procedures (or behaviors) were recorded on implements and their by-product, debitage, in the form of various morphological attributes. Finally, it is assumed that archaeologists can successfully train themselves to read and interpret this record. The archaeologist must have:

> . . . a working knowledge of the physical limitations placed on artifact form by properties inherent in the raw material and by the fracture mechanism associated with a given flintworking technique.
> (Faulkner 1972:2)

Phagan (1973:2) has pointed out that the basis of a technological analysis is the establishment of a theoretical framework or system within which various traits of flakes of implements can be seen to have technological significance. Though still in a nascent state, a theoretical framework to guide the analytical transition from artifacts to behavior to inferred cultural concepts, has been proposed in the form of a technological reduction model. I will now discuss this approach and its influence on my analysis.

Reduction Model Concept

The manufacture of chipped stone tools is based on a subtractive technology dependent upon the property of conchoidal fracture that characterizes many microcrystalline and cryptocrystalline masses. The technology is bounded by stringent limitations imposed by the behavior of conchoidal fracture, the availability of raw material possessing suitable properties, and the flintknapper's ability to control and exert the forces necessary to shape the rock into desired forms. Within these bounds, a certain basic and unavoidable reductive process centered on producing objects of a desired form has to occur (Collins 1975:16). The changing objectives and techniques involved in the continuous reduction of a parent core into a finished tool are thought to result in "stages" (Stahle and Dunn 1982:84). The decisions made by the flintknapper as he progresses from one stage to the next, are called the reduction strategy.

> A reduction strategy is viewed here as a sequence of behavioral units, each one determined by the preceeding unit. The links between them are decisions made by the flintworker based on predicted outcome of a certain action or set of actions. A particular reduction strategy constitutes an individual flintworker's conception of a manufacturing process, which in turn is part of a lithic industry. (Gummerman 1976:10)

In contrast to what generally occurs in an additive technology such as pottery-making, errors produced in a subtractive industry are preserved archaeologically and can provide the analyst with potential insights into the stone tool-making process (Deetz 1967:48). However, they also add an additional source of variation that can make formal classification difficult.

Holmes (1890) was one of the earliest to describe lithic implements in terms of their changing form through the manufacturing process. Although his descriptions reflect a certain naiveté, he recognized that intent is of great importance in the definition and recognition of implements (Muto 1971a:23). More recently, Sharrock (1966) dealt extensively with the manufacturing process of chipped stone implements from sites in south western Wyoming. He proposed five stages of quarry and workshop blanks and suggested that chipping debris be classified using a threefold division into primary, secondary, and tertiary flakes, with division criteria based on cortex cover, length, width, overall size, and striking platform size (Sharrock 1966:43).

Muto (1971a, 1971b), whose Masters thesis deals with biface manufacture, made extensive use of the early technological studies of Holmes and Sharrock and supplemented this with replication experiments and studies of lithomechanics. He postulated a "Blank-Preform-Product" continuum, and proposed that certain flake characteristics - bulbs, platforms, dorsal and ventral surfaces, and edge morphology - are indicative of various stages in the manufacture of lithic implements (Muto 1971b:5). Of particular interest is his contention that:

> Many lithic specimens which have been assigned to type categories and elevated to the status of finished implements, are no more than early stages in the manufacturing process of other 'typed' implements. (1971b:1)

Newcomer documented the results of experimental hand-axe manufacture and concluded that "we may be able to define stages in the manufacture of these tools by studying the morphology and weight of flakes from reconstructed nodules" (1971:93).

The first explicit model of lithic reduction was developed by Collins (1975) and has served as a starting point for most of the recent research into lithic manufacturing processes. Collins states that the process of reduction is a linear, continuous one, but contends that certain stages are distinct enough in terms of their procedures and output to merit separation. He lists five such stages: acquisition of raw material, core preparation and initial reduction, optional primary trimming, optional secondary trimming and shaping, and optional maintenance/modification. A pre-historic group sharing a common technology would be expected to reduce raw material into tools, using only a limited number of learned techniques and problem-solving options. As the raw material passes through each successive stage outlined in the model, choices on the part of the flintknapper, combined with limitations imposed by the stone itself, result in a "product group" comprised of waste by-products and objects destined for further reduction or use. Collins proposes that,

> If isolated, product groups can be described in terms of their technological attributes and inferences can be drawn concerning the specific activities by which the particular manufacturing step was accomplished. The waste, or debitage, is particularly amenable to this technological analysis (1975:17).

The analytical framework provided by this five-stage model is very useful, but contains a major drawback. Collins does not (and cannot) provide substantive criteria for the identification of debitage indicative of reduction stages (Ludowicz 1980:2). Consequently, a great deal of ongoing lithic research is geared toward closing the gap between the theoretical constructs of the model and its practical application. In the next few pages I will outline some of these papers and examine the only two studies from northern Quebec which focus on debitage analysis.

A Review of Recent Research

A number of authors have concentrated on the recognition and reconstruction of techniques involved in the manufacture of stone tools and the resultant debitage. This entails attempting to distinguish flakes produced by different impactors (i.e., hard and soft hammer); by various decisions on the part of the flintknapper (i.e., holding position, angle of impact, force of the blow); and by maintenance and modification procedures, such as resharpening. The narrower objectives of these studies vary. Most emphasize identification of attributes indicative of manufacture and classification of flakes according to the procedures employed in their production (Ellis 1979b,n.d.a., Fish 1979, 1976, Henry 1976, Lavine-Lishka 1976, Mallouf n.d., Pitts 1978, Stothert 1974). Geier (1973) examines morphological variability and develops a typology of debitage based on groups of flakes thought to result either from specific manufacturing techniques or intent on the part of the flintknapper to create flakes of specific shapes.

A group of studies deals directly with the attribution of debitage to specific stages in a reduction sequence. Jamieson (1975), in an analysis of surface-collected flakes, identifies manufacturing procedures and conjoins elements to determine the sequence of flake removal. Both Shafer (1973) and Patterson (1977) employ the linear reduction model proposed by Collins to describe and interpret, both structurally and functionally, the lithic technology found on two Archaic sites. They discuss the possibility that certain reduction strategies may be employed only in the manufacture of specific projectile point types. A holistic approach, incorporating environmental, spatial, and socio-cultural relationships, is endorsed.

The work of Magne and Pokotylo is of particular interest, because of its experimental nature. Magne's (1980) paper focuses on the procedures and results of a set of experiments in bifacial stone tool manufacture. The major goal was to determine if lithic reduction stages can be inferred from a minimal set of formal debitage attributes. A subsidiary goal of the experiments was the development of a debitage classification reflecting reduction stages and allowing rapid, consistent analysis of large collections. Five continuous and three ordinal variables were recorded on debitage; then several multivariate statistical techniques were used to search for recognizable patterns of sequential variability in the debitage. He concluded that:

> . . . for the basaltic groups of rocks, a minimal set of four variables can account for the greater proportion of debitage variability, can be used to predict stages of biface manufacture with approximately 70% to 90% accuracy, and can be reduced to a single variable (weight) that enables interpretations entirely consistent with much more complex and time-consuming analysis.
> (Magne 1980:5)

Magne and Pokotylo's 1981 paper carries on this research and employs hierarchical clustering, metric multidimensional scaling, and multiple discriminant analysis to reduce the number of variables needed to sort experimentally produced debitage into "product groups". The result is a six-part debitage classification based on four variables. The results of Magne and Pokotylo's work are referred to extensively in the next chapter.

Most recently, Stahle and Dunn (1982) presented the results of a replication experiment designed to test the hypothesis that the size range of waste flakes from biface manufacture (as determined by length and width measurements) decreases from initial to final reduction stages and may be used to distinguish stages of biface manufacture present in prehistoric debitage samples.

Finally, a number of researchers have examined intersite distributions of debitage reduction groups (Brose 1978, Burton 1980, Ludowicz 1980, Pokotylo 1978 and 1980, Sheets 1975). Most of the studies employ a functional model based on Binford and Binford's discussion of base-camps (maintenance activities) versus work camps (extractive activities) (1966: 291). Lithic debitage is correlated to specific stages in a reduction sequence, then this information is used to identify inter-site technological variability. The spatial distribution of this variability and its interrelationships with subsistence-settlement patterns are explored.

Technological Analysis of Lithic Material from Northern Quebec

Two analyses of lithic material from regions bordering Caniapiscau have been undertaken. Each of these studies is examined to determine the validity of the method employed and the relevance of the results.

Marcel Laliberté has analyzed lithic collections from sites in the eastern LG-2 reservoir region (1981a, 1981b, 1982a) and is currently completing a similar analysis of assemblages from Washadimi, located at the confluence of the La Grande and Griault rivers. In both cases, the same methodology, based on Collins' five stage reduction model, was employed. Laliberté sorted the debitage using pre-determined criteria to distinguish the different stages. General flake dimension and platform characteristics were deemed most valuable in this regard. Each platform-remnant bearing (PRB) flake was also described by an extensive attribute list. Compilations of attribute frequencies were then used to describe variability within flake groups from each of the stages. These results, along with information on varieties of raw material and tool types, provided the basis for intra- and inter-site comparisons of chronology, technology, function, and spatial organization.

Laliberté's work is notable in that it represents the first attempt, by an archaeologist working in Northern Quebec, to extract a wide range of cultural information from assemblages composed predominantly of debitage and amorphous tool forms. Yet, some of the procedures used in the study illustrate problems which arise when a theoretical model such as that of Collins is applied to data without the elaboration of an adequate conceptual framework. Laliberté's results are dependent, for the most part, on the analyst's ability to recognize intuitively a flake's place in a hypothesized sequence of reduction. In addition, he does not appear to deal with the possibility that the debitage may result from a combination of different stone-working techniques. Consequently, the equivocal nature of statistical extrapolations based on the five resultant classes of flakes must be considered. Statistical manipulations of the data are dependent on the accuracy of the original sorting. Conclusions drawn from these frequencies are true only insofar as individual specimens were correctly assigned to flake groups; and the data cannot be compared with those of other researchers who did not use identical groups to sort their flake collections. Finally, his disregard of crucial considerations, such as raw material type, when examining variability within the classes, greatly weakens the results.

Jean-Luc Pilon's thesis (1980) involved the analysis of debitage from two habitation structures on a Maritime Archaic Tradition site at Indian House Lake. Pilon states clearly that the analysis is not concerned with relationships between patterns of stone flake morphologies and patterns of behavior. Rather, his goal is the elucidation of three specific problems: similarity in the cultural affinity of the collections from the two structures; their contemporaneity; and strategies of differential raw material utilization. He employs 19 quantitative and qualitative variables to describe the flakes under study. Different raw materials on the site are treated separately. A comparison of frequency distributions resulting from the attribute analysis is used to support his hypothesis that the two structures were occupied by people of the same cultural group, who employed a specific strategy of raw material usage while at the site. Pilon includes palynologic and stratigraphic evidence to enhance his interpretation and stresses the importance of in-depth small site analyses in a region where a cultural-chronological understanding of sites is highly tenuous at best, and absent in the majority of cases.

Pilon's approach is seen as having distinct advantages in that the discussion of reduction strategies stems from an examination of the results of attribute analyses. In addition, these results are available in the report for consultation and comparison. The only drawback of the report is his presentation of the quantitative attribute frequencies only in the format used for normal distributions (i.e., minimum, maximum, mean). As the results presented in Chapter five of this thesis confirm, these frequencies present skewed distributions and are best represented by visual methods (i.e., histograms or bar graphs).

Research Design

My examination of current trends in the study of lithic technology and an evaluation of two analyses of collections from northern Quebec, provided an opportunity to question the applicability of certain concepts, such as linear reduction models, to the lithic collections from Caniapiscau. I concluded that when dealing with assemblages from an area not well understood archaeologically, adherence to an "a priori" reduction model, with insufficient consideration of the factors which interact differentially to structure lithic exploitation patterns within a region, can hinder rather than enhance the interpretation of sites. In the next few pages I will discuss this premise in more detail and propose a different conceptual framework based on a "constraint" model (Sheets 1975). This model then guides the formulation of working hypotheses concerning such aspects of lithic exploitation as: raw material preferences, procurement, reduction strategies, utilization, and disposal.

- Critique of the reduction model concept

Structural reduction models appear to hold great potential for facilitating the comprehension and classification of both debitage and tools. Yet, my examination of the current research just described suggests that reduction models work best in regions where at least one of the following preconditions is met:

1. The prehistoric groups under study had access to more than adequate amounts of good quality raw material.
2. A high degree of standardization in tool morphology is apparent.
3. Biface reduction, or some other specialized industry such as blade or microblade production, was the primary stoneworking technique used on the sites.

Even when these preconditions occur, a fundamental problem still exists concerning the body of theory which has directed investigations into lithic manufacturing procedures, resulting in the formulation of reduction models. In this regard, Bonnichsen and Young (n.d.) have discussed the normative versus the cognitive approach to interpreting archaeological data, or what Wallace (1961:27) called the "replication of uniformity" concept versus the "organization of diversity" approach. The former view defines culture as learned, shared behavior, transmitted from one generation to the next. The latter emphasizes a description of culture in terms of what is possible within its repertoire - "the range of non-idiosyncratic goals, plans of action, techniques and rules found within the group" (Young 1976:22).

Structural reduction models are based on a normative view of culture and stress that individuals in a group share "mental templates" of artifacts. However, current research related to cognitive theory demonstrates the need for revision in our concept of "mental templates" and "normative behavior". For example, Hardin's (1977, 1979) studies of modern pottery making in Pueblos suggest that mental templates are not verbalized or pictorialized, but consist of conceptual procedures that flow from unconscious motor and visual habits. Similarly, current work by flintknappers points to a more realistic representation of the lithic reduction process as a sequential arrangement of different "production units" (Bonnichsen 1983: per.comm., Bonnichsen and Young n.d.). These production units consist of specific maneuvers or gestures designed to effect particular alterations on the raw material, such as strengthening an edge, thinning a section, re-aligning a platform, creating a notch, removing a ridge, etc. . . . A number of different production units might be employed to create the desired end product; some might occur solely during the manufacture of specific tool forms; and their order of occurrence might be variable.

Other examples can be found in ethnographic evidence which suggest that certain native peoples regard the individual edge of a tool as the element of paramount importance rather than overall tool morphology (Gould et al. 1971:149; White and Thomas 1972:278). Also, what constitutes a finished object may vary depending on cultural or functional criteria differing from those of the archaeologist. Finally, the possibility that particular stoneworking traditions have been inaccurately replicated, in either a theoretical or practical sense, must be considered (Stahle and Dunn 1982:94).

This discussion shows that current methodology is based on presumptions concerning the ideational order (patterns in the minds of people), rather than on investigations of it, and considerations of possible different cognitive orders (Kleindienst 1975:383). Bonnichsen and Young (n.d.) claim that archaeologists can eventually reconstruct past cognitive frameworks and should be conducting research with this goal in the forefront. In constrast to this, I agree with Binford when he states that assemblage patterning observed in the archaeological record derives from organized behavior.

> Cognition is . . . a dynamic system whose form is partially dependent upon the behavioral or interactive context of discrimination . . . archaeological remains refer directly to the organization of behavior itself, and not to the cognitive conventions in terms of which behavior may be expressed or anticipated. (1976:33 and 36)

Nevertheless, I have tried to show that investigations of cognitive theory can provide fertile ground for the development of hypotheses concerning the technological behavior patterns we are trying to understand.

Therefore, although reduction models may prove useful as heuristic devices for classifying collections, they do not address questions of human adaptation as evidenced in lithic tool production systems (Ellis n.d.b.:12). Rather they exemplify,

> . . . a series of conventions for translating observations into interpretations, rather than attempting to investigate the processes responsible for the observed relationships. (Binford 1976:36)

It is clear then that in order to explore the dynamics of technological systems, we must develop models of a different order. Consequently, I have chosen an approach based on a behavioral model of "constraints" or potential variables affecting the structure of the lithic manufacturing industry under consideration. As derived from Sheets, the objective of this method is to,

> . . . assess the constraints producing the patterned behavior recorded in the artifacts, and explain these constraints in terms of their own dynamics and such factors as the utilized environment, and societal contacts, demography, subsistence strategies, socio-political organization, and change in all these. Finally, systemic interrelationships among the variables at different levels of abstraction must be explored. (1975:371)

The following analysis differs from that of Sheets, however, in that he began with a descriptive reduction model of a Mayan lithic industry, then assessed the constraints which produced the patterned behavior recorded on the artifacts. I propose to make initial hypotheses about the structural characteristics of the industry, based on my knowledge of what constraints should be relevant, and then test these hypotheses against the data. Binford has advocated a similar approach as a result of his ethnoarchaeological work among the Nunamiut Eskimo.

> Before one can make meaningful statements as to the significance of patterns of observed variability in the archaeological record, he must consider the causal determinants of the patterning. . . . Investigation of the organizational properties of systems and their processual consequences, archaeologically is the first step toward an accurate attribution of meaning to observed patterning. This must be accomplished through the trial specification and testing of law-like proposition[s] (1976:36).

An attribute analysis will be used to identify the specific behaviors (and any patterning in these) which are a result of the operation of certain constraints. Finally, the original constraint model is reassessed and the reduction strategies thought to be represented in the debitage and tools from the two sites are described.

The term "model" is conventionally employed in a number of different ways. I use it in the sense of "a simplified structuring of reality which presents supposedly significant features or relationships in a generalized form" (Haggett and Chorley 1967:22). It should be noted that:

> The system is studied with a certain purpose in mind; everything that does not affect this purpose is eliminated. The various features of the system need to be known as aspects of one identical whole; therefore their unity is exaggerated. (Haggett and Chorley quoting Apostel 1961:15-16)

A somewhat altered version of Sheets' original model is presented in Figure 5. Six potential areas of constraint are identified. The archaeologists' ability to determine these constraints and their outcome in terms of the lithic tool production system under study, depends on the ease with which the different areas of constraint can be conceptualized. This will be explained in more detail in the following pages.

In the next few paragraphs I will briefly describe each area of constraint and deduce expected archaeological consequences in terms of the organization of the lithic technology employed on sites GcEl-15 and GcEl-22B.

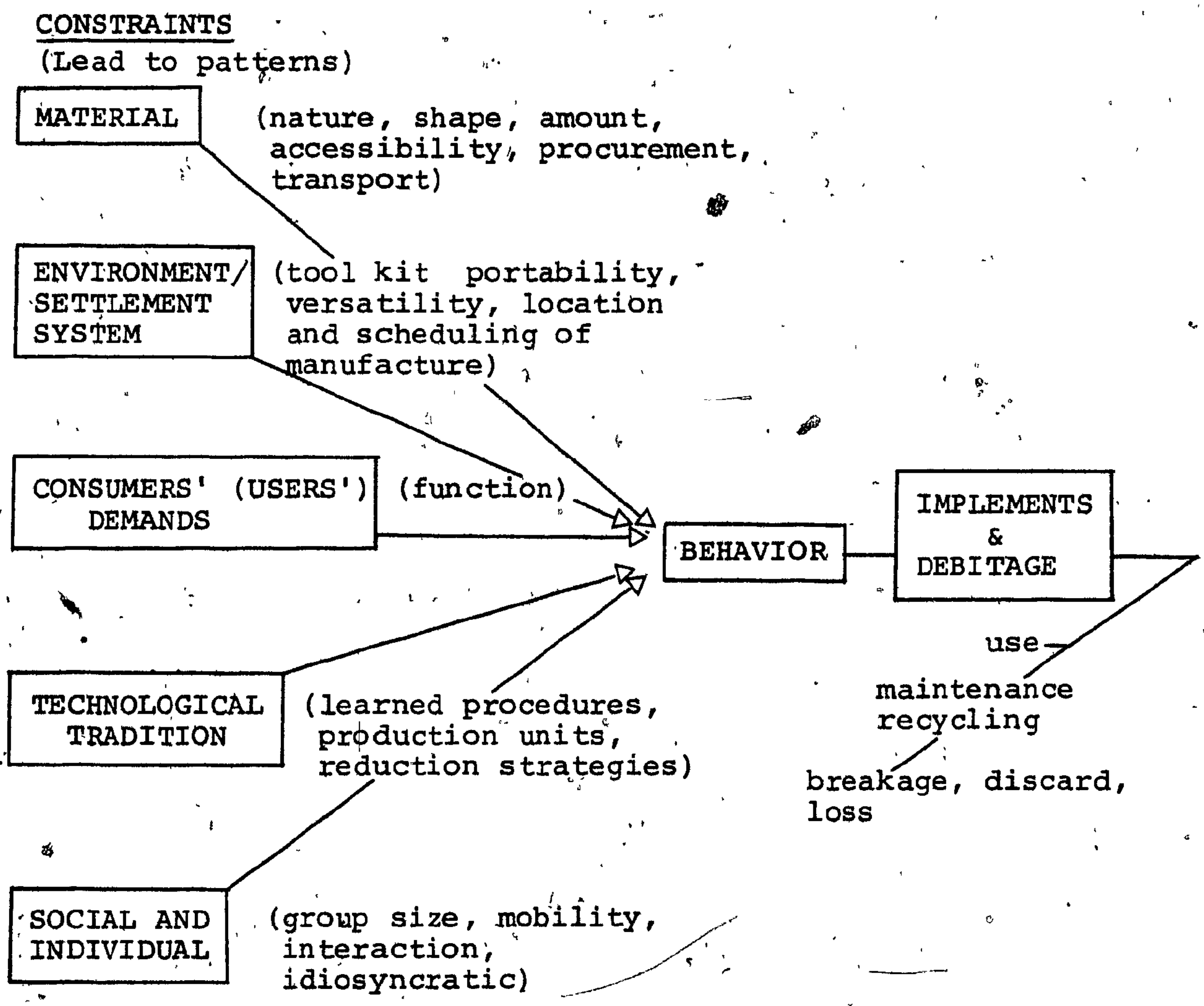
Material constraints

Material constraints refer to factors such as the fracture properties of raw materials used, their source location, quantity, procurement, and transport. Most of central Quebec-Labrador is Precambrian Shield which is devoid of lithic

FIGURE 5

Potential variables affecting the structure of a lithic manufacturing industry

(after Sheets 1975:371).



materials of particular use to man (Fitzhugh 1972:38). This probably explains the high quantity of exotic or non-local raw materials - such as chert, and Ramah and Mistassini quartzite - occurring on sites in the Caniapiscau region. The only lithic material that appears to be ubiquitous is quartz and quartzite of variable quality. The implications of this are as follows:

1. Certain raw materials, such as quartz and quartzite, were readily available in the region, but may have been of restricted utility due to knapping limitations imposed by their fracture properties.
2. Suitable quality stone had to be obtained through: trips made directly to the sources, trips made to neighboring regions where material could be scavenged from deserted sites (Gramley 1982:per.comm.), and/or some form of exchange or trade network.
3. This material would have to be obtained in or worked into a transportable form.
4. Planning and scheduling were required to ensure that adequate amounts of quality raw material would be available for both immediate and anticipated tasks.

Environmental/Settlement System Constraints

Many archaeologists involved in lithic analysis continue to take a "static, classificatory approach to environmental variables, regarding the biophysical landscape as a spatial and temporal backdrop" (Butzer 1980:417). This outlook is especially detrimental to a study of prehistoric lithic technology within the Quebec subarctic; an environment which places particularly harsh constraints on its inhabitants.

The interior subarctic region is composed of three major phytogeographic zones - the boreal forest, forest-tundra, and tundra. The boreal forest is characterized by limited production of primary plant material, resulting in short food chains and few food alternatives. Small mammal populations are subject to periodic fluctuations and the major food sources for human beings are dispersed or occur in small groups, such as Woodland caribou (Fitzhugh 1972: 168). In the tundra zone, food sources tend to be specialized (i.e., Barren Ground caribou) and subject to harsh environmental limiting conditions, such as forest fires and the winter icing of ranges. With few food alternatives available, the result may have been recurrent cycles of over-population and exhaustion of food supply (Fitzhugh 1972:168).

The Caniapiscau region is situated in a boreal-tundra environment between the two zones just described.

> C'est une région où le caribou, le poisson et le lagopède sont les ressources alimentaires les plus importantes; au plan de la grosseur des troupeaux et des habitudes migratrices, le caribou de la partie septentrionale de la région étudiée s'apparente de près aux caractéristiques du troupeau de la toundra, tandis que le caribou de la partie meridionale est plus facilement associable au 'caribou des bois'. (Denton 1979:114)

A program of pollen analysis conducted in the area indicates that no major changes in the vegetation cover have occurred during the last 4000 years (Richard et al. 1982).

Although prehistoric adaptive strategies are not well understood for the Caniapiscau region, Denton (n.d.:36) has offered two hypotheses based on ethnographical, biological, and archaeological evidence. The first proposes an intensive exploitation of caribou in the region north of the study area, with seasonal dispersion to exploit resources in more southerly areas like Caniapiscau. The alternate view is of prehistoric groups in Caniapiscau forming fairly stable (at least in winter) small hunting groups, and exploiting a wide range of resources, rather than just caribou. In this instance the seasonal movements of groups would be affected more by local than by regional differences in resource availability and, as a result, the Caniapiscau region could have been occupied as much in one season as in another. In both these strategies, coastal resources may have played an important role.

The question of how adaptive relationships such as those just described are reflected in lithic assemblages is a difficult one. Wright (1972:80) contends that the arduous nature of subarctic adaptation resulted in "cultural homogeneity over enormous tracts of country", as typified by what he terms the "Shield Archaic" technology. However, as Bonnichsen and Young have pointed out,

> . . . we might expect that unique cultural groups living in an ecological area might very well use superficially similar kinds of implements [anaolgous artifacts] in adapting to comparable environmental circumstances. (1980:11)

The fact that human populations are capable of formulating a variety of solutions to very similar environmental, technological, and social problems must also be considered . With these factors in mind, an attempt was made to suggest ways in which the lithic technology found on sites in Caniapiscau might reflect environmental constraints.

Survival in the subarctic was contingent on planning and scheduling of resources. A seasonal cycle, which exploited a variety of foodstuffs, would have been necessary. The unstable nature of subarctic ecological structures meant that overdependance on a particular resource, such as caribou, could have devastating effects (Fitzhugh 1972:168). In an environment where little could be counted on, prehistoric groups would have had to develop a variety of different food procurement strategies designed to increase their chances of survival in the event of resource fluctuation. This situation should be reflected in lithic technology in a number of ways:

1. Certain times of the year (presumably non-winter) would have been more propitious for the acquisition of raw material and perhaps also for the manufacture of certain tools. These activities would have constituted an

important element in a seasonal round; and consequently the nature of lithic assemblages might vary seasonally.

2. Portability of tool kits would have been an important consideration, as groups were highly mobile.
3. The quantity of occupation debris (i.e., tools, debitage, faunal remains) found on sites might be strongly affected by factors other than length of occupation (i.e., considerations with regard to conserving raw material, contingency planning, or the use of expedient as opposed to curated tools (Binford 1976).
4. Finally, tool kits would have to have been versatile. Raw material constraints and economic necessity would have demanded an inherently flexible, and if necessary, innovative technology; one in which different raw materials, including bone, might have been used interchangeably and one in which the same tool might have to fulfill various functional requirements.

Technological Tradition Constraints

The terms lithic technology and technological tradition are most commonly used in a restricted sense: to describe the knowledge and techniques, required for the production of stone tools, that are carried in the minds of all or some members of a prehistoric community (Geier 1973:2). In contrast to this normative view, the present study employs the term technology in its broadest sense:

> . . . as representing not only the tools and facilities with which a group exploits the resources of the environment, but also culturally defined 'scientific knowledge' and exploitative techniques. . . all developed within the context of the group's perception of its environment.
> (Denton n.d.:13)

Technological tradition is also used in a broader way; suggesting that what is transmitted is not necessarily a detailed, culturally determined guide for the production of specific tool forms (mental templates), but rather an understanding of the properties of different raw materials, of the functional requirements of tool kits (factors such as tool size, durability, edge angles) as related to anticipated activities, and of a variety of alternative production strategies or "back-up systems". The technological tradition would simultaneously establish the parameters within which experimentation could take place.

Two ways in which these considerations might be reflected in the lithic collections under study are suggested below:

1. The production of standardized tool forms would not have been an important part of the technology.
2. The necessity for alternate strategies of tool production meant that assemblage composition, even within the bounds of the same technological tradition, would be variable and possibly creative in its response to different situations.

Functional Constraints

The functional demands placed on the lithic technology represent the next set of constraints to be considered. Tools are produced in order to carry out either immediate or anticipated tasks; or to serve in the manufacture of other tools (i.e., of wood or bone). The nature of these tools would be influenced by culturally defined perceptions of what raw materials, and tool morphologies (including edge angle and type of retouch) are suitable for carrying out particular tasks. These decisions would in turn be tied to the raw material, environmental, and technological constraints already described. As a consequence of this:

1. Requirements that assemblages be versatile probably resulted in a system whereby many alternatives, rather than rigid functional types, predominated. Therefore, raw materials may have been reduced in such a manner as to allow numerous options as to their ultimate (utilized) form.
2. Ethnohistorical research suggests that bone and wood tools probably constituted an important part of the assemblages. Therefore, certain stone tools found on sites may have been produced specifically for use in manufacturing bone and wood implements.

Social and Individual Constraints

Finally, and most difficult to assess, are social and individual constraints. I am referring specifically to social organizational factors and also idiosyncratic behavior; both of which must have influenced the lithic production system, thereby introducing variation or "noise" not easily accounted for into the analysis. Stated another way, social organizational factors, such as group size, interaction, and mobility patterns, may have influenced the selection of particular problem-solving responses, in cases where several equally viable alternatives were available. Similarly, idiosyncratic behavior could be expected to introduce variability; particularly in a subarctic context, where it seems likely that all individuals (men and women) would have developed at least a rudimentary ability to manufacture the tools necessary for survival. The limited data base for the Caniapiscau region, precludes a more detailed investigation of social and individual parameters.

Hypotheses

The foregoing model was used to guide the formulation of a series of hypotheses concerning the structure of the lithic production system on sites GcEI-15 and 22B.

1. Exotic raw materials (Ramah quartzite, black quartzite, chert) will show evidence of intensive use, suggesting that they were a precious commodity and were exploited to a maximum.

Evidence will take the form of:

- reworking, resharpening, and maintaining tools
- curation (as demonstrated by the lack of fresh formal tools)
- small tool size
- flake utilization
- recycling through breaking up bifaces and large flakes (Crabtree 1973)
- reduction strategies designed to maximize a lithic resource

2. Local raw materials will show a more expedient technology and less conservation of the resource.

   Evidence will take the form of:

   - large amounts and size of debitage
   - low degree of platform preparation (some of this may be attributed to the fracture properties of the material)

3. Specific raw materials were preferred for the production of certain tool types.
4. Exotic raw material was transported to the sites as preforms or bifaces. Callahan (1979:40) has pointed out the advantages of reducing materials past what he calls the "crucial point" in fabrication, (i.e., major knapping errors tend no longer to occur and any flaws in the raw material have been detected) before transportation. Also, these bifaces could function as tools until designated for further reduction.

Evidence will take the form of:

- large amounts of bifacial reduction flakes
- small flake size
- high degree of platform preparation
- use-wear on dorsal ridges of flakes resulting from bag transport or utilization of the "parent" biface
- paucity of cores, cortical flakes, and chunks.

5. The expedient tool kit (tools made, used, and disposed of coincidentally) will reflect the fact that an important part of the technological system was the incorporation of anticipated functional demands into reduction strategies. (This refers only to exotic raw materials.)

   Evidence will take the form of a subjective evaluation of the amount of preparation that went into producing the expedient tools, as demonstrated by flake and striking platform morphologies.

6. Data from the two sites (the C^{14} date, hearth, spatial distribution of debris, and choice of raw materials) suggest a common technological origin (perhaps affiliated with that of the Point Revenge Complex).

   Evidence will take the form of:

   - similar patterning or continuity in reduction strategies and manufacturing practices, as demonstrated by a comparison of attribute frequencies from the two debitage collections
   - a comparison of the spatial distribution of flaking debris

7. A number of different reduction strategies occurred within the lithic production system used by the occupants of the two sites.
   - a multivariate statistical analysis of the recorded attributes will be used to suggest groups of flakes which may have resulted from different reduction procedures.

The next chapter will describe the methodology employed in the debitage analysis. It will focus on the significance of the attributes selected with regard to validating or refuting the aforementioned hypotheses.

CHAPTER 4

METHODOLOGY

Debitage Sorting

The initial strategy of the analysis was to divide each debitage collection into a number of basic artifact categories, each of which would receive individual analytical treatment. This process provided an opportunity to familiarize myself with the material and to segregate any overlooked tool fragments, modified and/or utilized flakes, resharpening flakes, and anomalies. Fragments resembling sections of tools or that were just "interesting" were given temporary catalogue numbers and laid out on a table. A moderate degree of success was realized in conjoining these pieces and the tool fragments, as will be shown in the next chapter. The collections were then divided by raw material type. Frequencies of different raw materials on each site are presented in Table 2. The shale is in a highly fragmentary state and showed no evidence of polish. A cursory examination of the quartz/quartzite specimens revealed a high degree of variation in some morphological attributes (due to the fracture properties of the material) but consistency in platform characteristics (they were always unaltered or crushed).

TABLE 2

RAW MATERIAL FREQUENCIES

Site GcEl-15

	N	%	% (only black and Ramah quartzite)
black quartzite	6490	76.8	91.4
Ramah quartzite	687	8.1	9.6
chert	1	.01	
quartz and quartzite	1208	14.3	
other	61	.7	
Total	8447	100	100

Site GcEl-22B

	N	%
black quartzite	2754	95.5
Ramah quartzite	74	2.6
chert	56	1.9
Total	2884	100

As a result of these considerations, neither the shale nor the quartz and quartzite was subjected to in-depth analysis. Their distributions on the sites, however, are discussed in the next chapter. Therefore, until otherwise indicated, the rest of this discussion will concern only debitage of Ramah and black quartzite.

For each provenience unit, the debitage was sorted into platform-remnant bearing flakes (PRBs - complete and incomplete) and fragments (flake and block shatter).

The flake fragments were next counted and weighed collectively by provenience unit. This was done to provide an estimate of the amount of mass reduced on the site. No further analysis was conducted on these fragments.

Each PRB was labelled with a sub-catalogue number and weighed individually. Table 3 presents the frequencies in each flake class and the size of the sample selected for detailed attribute analysis. The large number of flakes and the length of time required to analyze individual specimens necessitated sampling to reduce the collections to a manageable size. For the eight excavation units on GcE1-15 (C4, D4, D5, E4, E5, F2, F3, F4) and the two excavation units on GcE1-22B (2N1E, 3N1E) with the highest flake frequencies, a 50% random sample was taken from among the complete PRBs. For the other excavation units, all PRBs (complete and incomplete) were included in the analysis.

TABLE 3

Debitage frequencies by flake class

Nature of the Specimen	GcEl-15		GcEl-22B	
	N	%	N	%
PRB (complete)	1884	26.2	436	15.1
PRB (incomplete)	1591	22.2	815	28.2
fragments	3703	51.6	1634	56.6
	7178	100	2885	100

	GcEl-15	GcEl-22B
Sample size for Attribute Analysis (complete and incomplete PRBs)	1578	223

Attribute Analysis

> If the analyst carefully selects the characteristics to be examined and understands the derivations or implications of each characteristic, the analysis can result in a study that examines inferences and hypotheses on cultural behavior patterns—a realm as yet little explored. That is, output from one level or type of study can act as input for another level of study. In this manner, a dynamic explanatory system is built rather than a static one where description is an end in itself. (Lavine-Lischka 1976:13)

The significance and selection of attributes is a problem of crucial importance and one that has received a great amount of attention from archaeologists. Despite this fact, there is still controversy about types of attributes (i.e., morphological, technological, stylistic), their recognition, and interdependance. For example, although it is generally acknowledged that the geometry of the lithic mass undergoing reduction, and the force and angle of the blow delivered by the knapper have a consequent effect on the morphology and nature of the flake detached, knowledge of the "relevant attributes" of force and materials and the relationships among these attributes are still only partially understood (Gummerman 1976). I point this out to demonstrate why a large number of attributes, covering a wide range of characteristics, were selected for this study.

The definitions of variable and attribute used here are derived from Clarke (1978:496,489). A variable is "any quantity or value which varies, or a quantity which may take any one of a specified set of values". An artifact attribute is defined as "a logically irreducible character of two or more states, acting as an independant variable within a specific artifact system." I agree with Speth when he states that:

> The choice of the most relevant attributes cannot be based on arbitrary or traditional criteria. There will be no universal set of attributes which can be applied meaningfully to all problems. (Speth 1974:5)

Therefore it is the duty of the analyst first to develop a clear understanding of the kind of variability that will be appropriate to her specific problem. Once this has been determined, those attributes should be selected which permit quantification of this variability in the most effective and least redundant manner (Speth 1974:5).

I have already outlined a number of hypotheses devised to explain variability among the flakes in the collections, and have attempted to correlate certain technological flake variables with the acceptance or rejection of these hypotheses. The following factors also influenced my selection of variables. First, a consideration of the nature of chipped stone implement manufacture. As previously mentioned, it has been well documented that the geometry of the mass to be flaked and the preparation of the area of intended force application have a major effect on the type of flake removed. In order to understand how these factors may be elucidated through flake variables, I consulted both studies in the mechanics of conchoidal fracture (Faulkner 1972, Speth 1972, 1974) and commentaries on modern flintknappers' replicative experiments (Bonnichsen

1977, Callahan 1979, Magne 1980).

Second, I examined reports of recent debitage analyses in order to evaluate the attributes used by other researchers (Burton 1980, Geier 1973, Laliberté 1981a, 1981b, Magne 1980, Magne and Pokotylo 1981, Pilon 1980, Pokotylo 1978).

Third, the descriptive capabilities of certain variables were considered. For example, variables of shape and size, though not always directly reflecting manufacturing techniques, allow for comparisons of morphological similarity.

Fourth, some personal experience in flintknapping along with the initial examination of the material under study assisted in the process of attribute selection.

Last, and most important, I took account of those attributes thought to result directly from "aspects of the artifact production strategy in which the craftsman had many options open to him" (Bonnichsen & Young n.d.:11). For example, constraints of raw material availability and quality meant that in the Caniapiscau region prehistoric flintknappers were quite restricted with regards to the range of decisions made when selecting and shaping raw materials. However, two areas in which the Caniapiscau flintworker could exercise a variety of decisions were in platform size, shape, and preparation and in the relationship of the striking platform to dorsal surface scar configuration. Therefore, variables reflecting these factors were emphasized. The result of this exercise was the list of 19 variables illustrated in Figure 6. The variables

FIGURE 6

Lithic coding form.

Coder ____________________ Date ____________________

Site no. [2]
1 GCEL—15
2 GCEL—22 B

Cat. no. [3 4 5 6]

Sub. cat. no. [7 8 9]

Square no. [10 11]
1
2

Quadrant [12]
1 NW
2 NE
3 SW
4 SE

Level [13 14]
1
2

Feature [15]
1 HEARTH
2
3

Nature of specimen [16 17]
1 complete flakes
2 fwsp
3 utilized flakes (comp)
4 utilized flakes (frags)
5 retouched flakes (frags)
6 biface reduction flakes
7 unifacial tool frags
8 bifacial tool frags
9 scraper frags
10 unidentified tool frags
11 resharpening flakes

Raw material [18 19]
1 BLACK QUARTZITE
2 RAMAH DARK GREY BANDED
3 RAMAH TRANSLUCENT WHITE
4 RAMAH ORANGE TINGE
5 GREY MAT BIFACE FRAGS
6 GREY BLACK COARSE
7 CHERT
8 QUARTZ / QZITE
9 OTHER

Length [21 22 23 24]

Width [25 26 27 28]

Flake shape [29]
1 PARALLEL
2 PARALLEL CONVEX
3 EXPANDING
4 CONTRACTING
5 CONVEX
6 IRREGULAR
7 DISPLACED
8 round

Flake curvature [30]
1 STRAIGHT
2 CURVED
3 VERY CURVED
4 dorsal curved

Distal termination [31]
1 feathered
2 hinged
3 snapped or broken
4 feathered/ hinged
5 feathered / chipped

Bulb of percussion [32]
1 FLAT
2 PRONOUNCED
3 VERY PROM

Length of str. plat. [33 34 35 36]

Width of str. plat. [37 38 39 40]

Lipping [41 42]
1 present
2 absent

Shape of str. plat. [43 44]
1 punctiform
2 linear
3 triangular
4 triangular — convex
5 bi—convex
6 concave — convex
7 convex — concave
8 plano — convex
9 convex — plane
10 chapeau de gendarme
11 winglike
12 double

Modification of str. plat. surface [45]
1 smooth
2 facetted
3 abraded
4 dihedral (crested)
5 facetted — abraded
6 not observable
7 rough / stepfractured

Dorsal edge modif. of str. plat. [47]
1 UNALTERED
2 TRIMMED
3 STEPPED
4 ABRADED
5 ABRADED TRIMMED
6 ABRADED STEPPED
7 not observable

Dorsal flake scar pats. [48]
1 uniform
2 longitudinally fac
3 marginally fac
4 irregularly fac

Polish on dorsal ridge/s [49]
1 present
2 absent

Flake angle [50 51 52] **Thickness** [53 54 55] **Weight** [56 57 58 59 60] are organized on a coding form to facilitate computerization of the data. What follows is a brief discussion of the significance and measurement of the variables used in this analysis.

Raw Material

The first process to receive attention in any reduction strategy is the selection of the raw material. As Stothert (1974:53) has pointed out, the molecular quality of the material will affect the kinds of platform and core surface preparation required. The experienced knapper will be familiar with the variation among materials and will know what adjustments in production behavior are necessary to compensate for the variation.

The raw material types recognized in this analysis are:
1. Black quartzite:[1] This material, which comprises the majority of the collections from both sites, is of an unknown origin. It appears to have very similar fracture properties to Ramah, but it has a finer grain and lacks the "sugary" luster characteristic of the latter material. Fitzhugh has described a black chert which may form part of the Ramah series:

> Ramah chert occasionally grades into a cryptocrystalline black rock which appears identical to black chert, though when associated with the Ramah chert bed it usually has a vitreous luster which the black chert often lacks. (1972:39)

---

[1]Quebec archaeologists refer to Ramah as a quartzite. I have followed this convention for the Ramah and the black raw material; however, outside of Quebec both would probably be identified as "cherts".

Gramley (1982:per.comm.) suggested that the black quartzite could originate in the wide variety of outcrops found along the Labrador coast near Saglek Bay. A petrographic analysis soon to be undertaken is expected to clarify the origin of the black quartzite, as well as its relationship to other cryptocrystalline rocks.

2. <u>Ramah Quartzite</u>: This is a fine-grained, gray to black, often banded, translucent quartzite whose only presently known sources are along the northern Labrador coast (Gramley 1978:38). The Ramah found on the two sites is predominantly translucent with grey banding. The far-ranging distribution of Ramah in the Northeast attests to its desirability, both in terms of flaking and aesthetic quality.

3. <u>Quartz and quartzite</u>: Quartz is a hard white or semi-translucent stone with pronounced internal planes of cleavage. Quartzite refers to a variable category of white to grey stones with noticeably fine, granular texture and few, if any, internal planes of cleavage (Gould 1978:82). Cobbles or blocks of both these materials can be found in glacial deposits throughout the Caniapiscau region.

4. <u>Chert</u>: The chert found on site GcEl-22B has a light brown colour and is fine-grained and vitreous in nature. Site GcEl-15 contains one piece of dark grey chert, with a mat surface. Chert sources are known to be present in a number of geological formations east of James Bay although the exact location of outcrops has not yet been determined.

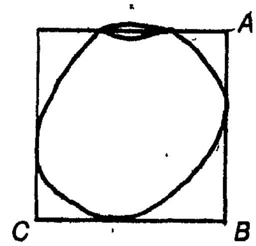
FLAKE MORPHOLOGY

Flake length

This is a measure of the longest dimension of a flake. The long axis of the striking platform is used for orientation along one axis of millimeter graph paper and a flake edge is used on the other. (A-B)

Flake width

This is a measure of the widest separation of flake edges, using the same method of flake orientation described above. (B-C)



A number of different methods have been used, in the past, to record flake length and width. This method was chosen because it requires a minimum of subjectivity (aligning the long axis of the striking platform) and is very rapid.

Both flake length and width are thought to be dependent on the amount and positioning of the force used to effect the flake removal (Phagan 1976:18, Pokotylo 1978:181). In addition, the progression of a specific reduction strategy should be reflected in part by a gradual decrease in flake dimensions.

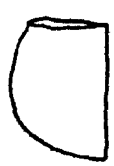
These measurements were taken only on complete flakes and flakes whose fractured edges did not alter maximum length and width.

Flake shape: The shape which a flake takes on being struck depends on a variety of factors, of which core morphology (i.e., guiding ridges or lack thereof) and angle and amount of force are most important. Geier (1973:33) suggests that prehistoric knappers had to be able to produce flakes with specific morphological characteristics in order to ensure the success of the artifact.

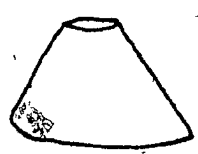
The following descriptive categories of flake shape were used to determine whether patterning could be observed in the collections.

1. Parallel

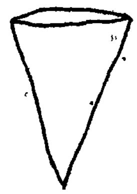
2. Parallel-convex



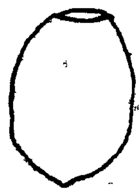
3. Expanding



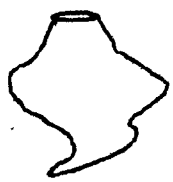
4. Contracting



5. Convex



6. Irregular



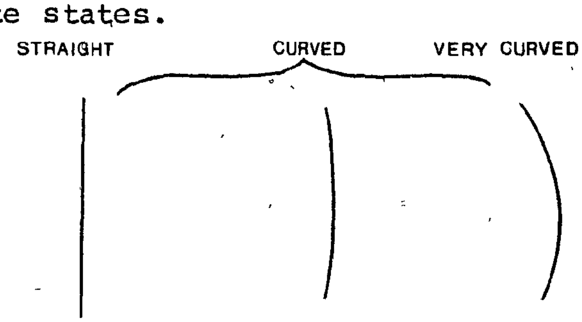
7. Displaced

8. Round

9. Indeterminate (used for incomplete PRBs whose shape could not be discerned.)

Flake curvature: The first three attribute states of this variable record "the curvature of the ventral flake surface longitudinal profile measured along the bulbar axis" (Pokotylo 1978:185-186). The fourth attribute state records a class of flakes with ventral surfaces that are straight longitudinally but convex laterally. (The proposed significance of these flakes will be discussed in the next chapter.)

Crabtree (1972a:12) suggests that this variable depends on the inertia of the core - large masses of stone will remain inert because of their size and weight - and on the manner of the blow - arc-like blows cause curved flakes, while straight line blows produce straighter flakes. Ellis (1979a:4) proposes that, in biface manufacture, flake curvature is a product of the skimming nature of the flake removals, such that they approximate the lenticular cross section of a biface. In an attempt to reduce the subjective nature of this measurement, templates were used to distinguish between the first three attribute states.



Distal end termination: Bonnichsen (1977:132) states that the main determinant of flake termination is the velocity of the fracture front removing the flake. Feather terminations, which exhibit a sharp, thin flake margin at the distal end of the flake, are the most desirable type since they represent well-controlled force application. Hinge terminations are manufacturing errors resulting from insufficient force of removal. Step terminations can be a result of manufacture; however, in this analysis it was impossible to distinguish these from fractures which occurred post-depositionally, therefore they were grouped together in attribute state 3. (See also Crabtree 1972:190).

1. Feathered
2. Hinged
3. Stepped or broken
4. Feathered/hinged
5. Feathered/chipped

Bulb of Percussion: The two most common factors mentioned as explanations for differing bulbs of percussion are the nature of the percussor and the amount of force applied. For example, Muto (1971a:115-116) states that a salient bulb is most commonly the product of a hard hammer while a diffuse bulb is characteristic of soft hammer; while Crabtree (1972:6-7) observes that saliency of the bulb reflects the amount of force applied in flake detachment. Subjective evaluations of three attribute states were used.

1. Flat

2. Visible

3. Pronounced

Flake thickness: The thickest point on the flake (including the bulb) was measured in millimeters with callipers. It has been suggested that flake thickness reflects the location and direction of the applied force which detached the flake (Pokotylo 1978:182, Faulkner 1972:110-115).

Weight:

Weight is interpreted to be representative of overall flake dimensions - the relative mass of the flake - and was measured to the nearest milligram (0.001). Given a constant size or mass of raw material, one would generally expect flake weight to decrease through the reduction sequence. (Pokotylo 1978:181, Ludowicz 1980:6)

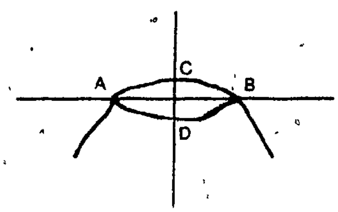
STRIKING PLATFORM CHARACTERISTICS

Striking Platform Length:

This is the distance in millimeters between the two points (A-B) where the striking platform surface intersects the margins of the flake (Pokotylo 1978:181). When applied to biface reduction flakes, low platform length values are interpreted as representing more careful attention to platform preparation, which would be critical in the final steps of manufacture.

Striking Platform Width:

This is the maximal dorsal to ventral surface distance in millimeters, perpendicular to the axis of the striking platform length (C-D) (Pokotylo 1978:181). Platform width should decrease in later reduction steps. The minimization of this distance is critical in bifacial flaking, where the objective is to thin the implement section while removing as little as possible from the margins (Muto 1971a:63-73). Wilmsen (1970) noted that platform thickness is apparently a strong determinant of specimen thickness and width, and, to a lesser extent, of specimen length. Both length and width measurements were taken using a loupe gradiated in millimeters.



Lipping:

This attribute is observed as an overhang on the ventral flake surface immediately adjacent to the striking platform. A certain amount of controversy exists concerning the significance of this attribute (Crabtree 1972:74, Muto 1971a: 114-115, Bonnichsen 1977:165); however, there does seem to be general consensus that lipping on flakes occurs during bifacial thinning and finishing steps. For this reason, presence or absence of lipping was recorded.

Shape of the Striking Platform:

To a certain extent, the shape of the striking platform will reflect the configuration of ridges on the core surface and the flintknappers' choice of where blows are aimed (i.e., at natural ridges, between two ridges, etc. . . .). Processes involved in preparing ridges, moving them or straightening them may also, in part, be determined by an examination of the shape of the striking platform (Stothert 1974:54-55).

1. Punctiform: platform shape is roughly circular and extends less than 1 mm in any direction.

2. Linear: surface area of the platform extends toward the lateral edges of the flake; the width of the platform is minimal.

3. Triangular: dorsal edge peaked, ventral edge straight.

4. Triangular Convex: dorsal edge peaked, ventral edge convex.

5. Biconvex: dorsal and ventral edges symmetrically convex.

6. Concave-convex: dorsal edge concave, ventral edge convex.

7. Convex-concave: dorsal edge convex, ventral edge concave.

8. Plano-convex: dorsal edge plano, ventral edge convex.

9. Convex-plano: dorsal edge convex, ventral edge plano

10. "Chapeau de gendarme": results from striking one flake directly behind another.

11. Winglike: dorsal edge peaks rapidly then curves downward, ventral edge convex.

12. Double: two adjacent platforms are visible (one of these is probably unintentional and resulted from the size or position of the impactor).

Modification of the Striking Platform Surface:

This variable measures the treatment of the platform with respect to flake removals. The treatment may be intentional in order to facilitate the application of the detachment force, or it may have resulted from previous flake removals and edge preparation. One would expect more platform preparation to be evident in advanced stages of artifact manufacture that require specific flake removal patterns to achieve the desired end product (Pokotylo 1978:190-191).

1. Smooth: a single facet striking platform; smooth and unmodified. This characteristic can occur when the platform area from which the flake is detached is unaltered or covered by a large flake scar.

2. Faceted: the platform surface exhibits small flake scar ridges extending across the width of the platform resulting from intentional or previous flake removals.

3. Abraded: the platform surface is entirely rounded, showing evidence of intentional grinding or abrading.

4. Dihedral (Crested): the platform surface is formed by two facets. This may indicate an intentional process by which the striking surface of the flake is moved in line with its face. (Muto 1971a:67)

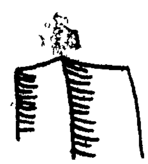
5. Faceted-Abraded: the platform surface is rounded but still shows evidence of previous faceting.

6. Scalar: the platform surface is covered with step-fractures and shows some evidence of crushing. These characteristics may result from the application of excessive force to the platform.

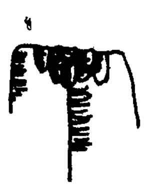
Modification of the Dorsal Edge of the Striking Platform:

This measures efforts to change the dorsal flaking angle through alterations on the dorsal surface immediately beneath the striking platform. Such action serves to strengthen and position the platform surface, thereby avoiding platform collapse due to overhangs and similar kinds of ineffective flaking (Pokotylo 1978:191-192; see also Crabtree 1972:15 and Muto 1971a). Unfortunately, it is often impossible to distinguish when this variable occurs intentionally from when it results from the impact of the percussor (except in the case of abrasion). This factor must be kept in mind when evaluating the results.

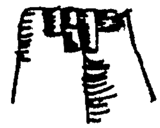
1. Unaltered: flake scar ridges of previously removed flakes intersect the dorsal edge of the striking platform.



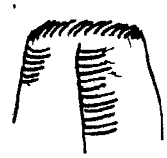
2. Trimmed: flake scar ridges from earlier flaking are removed where they intersect the striking platform.



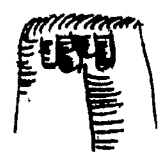
3. Stepped: the edge looks "battered", and is covered with small step-fractured removals.



4. Abraded: the edge shows evidence of grinding against a hard surface. Abrasion is thought to strengthen the platform by removing thin and weak parts and creating macroscopic surface flaws which facilitate the initiation of fracture (Sheets 1973).



5. Abraded-Trimmed: a combination of 2 and 4.



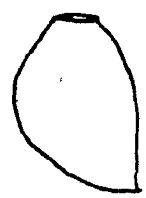
6. Abraded-Stepped: a combination of 3 and 4.

7. Not observable.

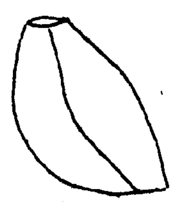
Dorsal Surface Flake Scar Patterning:

The pattern of dorsal flake removal affects the character of the flake and can offer processual insight with regard to the direction of previous removals and the utilization of specific strategies of reduction. Four general attribute states were recorded (Pilon 1980:53).

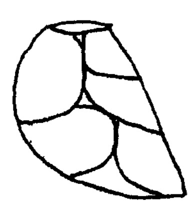
1. Uniform: the dorsal surface presents a single scar. (No cortical flakes were observed in the collection.)



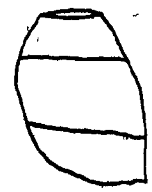
2. Longitudinally faceted: flake scars have orientations or directions parallel to the longitudinal axis of the flake.



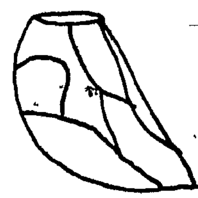
3. Marginally faceted: flake scars merge towards the longitudinal axis or a central point on the flake;



or flake scars have orientations or directions perpendicular to the flake's axis of detachment.



4. Irregularly faceted: no overall pattern to flake scars.



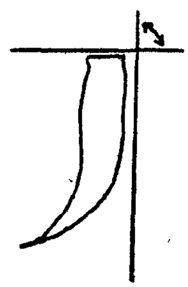
Polish on Dorsal Surface Ridge/s:

Presence of this variable indicates that dulling or scarring has occurred along ridges on the flake's dorsal surface. This can result from exposure to natural elements. It can also occur through abrasion if lithic pieces are carried together in a skin bag, or as a result of utilization.

1. present
2. absent

Dorsal Flaking Angle:

The angle between the plane of the striking platform width and the average dorsal surface was measured in 10 degree intervals, using a template. Wilmsen (1970) has stated that specimen thickness and high dorsal flaking angles are correlated, and that a decision to produce thin or thick flakes could be implemented in part by controlling the striking direction and the point of striking force application. In the case of bifacial reduction, the cross-sectional thickness of the biface gradually decreases. Consequently, dorsal flaking angles will become more acute as the reduction process advances. This variable was recorded only for those flakes on which it could be measured with a reasonable degree of accuracy.



Recording Procedures

Three people recorded the flake attributes and informal blind tests were conducted frequently in an attempt to ensure standardization. When this process was completed, the information was computerized and attribute frequencies were tabulated for each site and also for each excavation unit within the two sites. These results were analyzed by using a multiple correspondence analysis. The results of the analysis and interpretations drawn from them are presented in the next chapter.

CHAPTER 5

THE LITHIC ANALYSIS

In the two previous chapters, I described my areas of analytical concern and suggested certain flake attributes that should be observed in order to measure variability in stone tool production and use on the two sites under study. This chapter presents the technological analysis of debitage and an examination of the tool collections. The results will be dealt with in four separate sections: attribute frequencies, statistical analysis, distributions of raw materials, and description and spatial distribution of tools and conjoined artifacts. Finally, the original hypotheses are reexamined, followed by suggestions for future applications of this methodology.

I. Attribute Frequencies

Attribute frequencies were compiled separately for the sites and then compared. This was done not only to study inter-assemblage variability, but also in the hope that the debitage would provide some insight into the quantitative patterning of technological attributes and their significance as measures of variation in reduction strategies.

The attribute frequencies for both sites are presented in Appendix B under three headings: flake morphology, striking platform characteristics, and dorsal surface morphology. Data pertaining to the quantitative variables are presented using histograms based on twenty-five classes of equal length, arbitrarily chosen. Means, standard deviations, and coefficient of variance percentages (standard deviation divided by the mean) were also calculated. Although stratigraphic levels were recorded in the analysis, no distinctions were made when compiling the frequencies, since both site GcEl-15 and GcEl-22B appear to be single occupations. The sites will be referred to as "15" and "22B" for the rest of this presentation.

- Flake Morphology

Flakes on both sites are exceedingly small, as demonstrated by the histograms illustrating flake length, width, and thickness. Yet, site 15 contains a slight proportion of flakes that are larger and thicker than those in the sample from site 22B, while 22B has a higher proportion of flakes in the smallest size categories. As would be expected, this trend is borne out in a comparison of flake weights. On site 15, 68.5% of flakes weigh less than .12 grams, while on 22B 78.9% of flakes are in this category; whereas approximately 3% of flakes on 15 weigh over 1 gram as compared with only 1% on 22B.

The shape of flakes on the two sites is very similar. This is perhaps partly a reflection of the limited number of forms which any flake can assume. The highest percentages of flake shapes on both sites are expanding (27.6% and 24.8% respectively) followed by displaced, convex, and irregular. Site 22B has a higher proportion of displaced flakes than site 15, while the opposite is the case for contracting shapes.

Approximately 45% of flakes on the two sites are straight while another 30 to 35% are curved. A higher percentage of flakes on site 15 are very curved (8.1% to 3.7%) while site 22B has a slightly higher percentage of dorsally curved flakes (7.8% to 5.3%).

A comparison of the results concerning bulb of percussion show that approximately 60% of all flakes have flat or non-apparent bulbs. The frequencies for the other two attribute states vary somewhat, with site 15 containing a higher percentage of slight bulbs while site 22B has a higher frequency of pronounced ones. Unfortunately the subjective method of recording this variable precludes assigning much importance to these small variations.

Distal terminations are primarily feathered or feathered/chipped. A low percentage of hinge-fractured flakes is found on each site (3.6% and 4.1%).

- Striking Platform Characteristics

There is once again remarkable similarity in this set of attribute frequencies for the two sites. Striking platform lengths extend over a larger size range than widths, with the highest frequencies between 1.0 mm and 5.0 mm for both sites. Site 22B contains a higher proportion of flakes with striking platform widths of less than .8 mm (62.2% compared to 51.6% for site 15).

The percentage of flakes with lips is high and almost identical for the two sites (site 15, 37.9% and site 22B, 35.3%). If this is a reliable indicator of bifacial reduction, more than one-third of the flakes in each collection resulted from this process.

Striking platform shapes tend to be equally divided among triangular-convex, bi-convex, concave-convex, and plano-convex, with these four forms accounting for 75% of all flakes in the sample. A smaller sub-group of winglike and linear striking platform shapes also exists.

Striking platform surface modification is predominantly smooth or faceted (site 15, 34.2% and 32.3% and site 22B, 23.4% and 29.8%). The figures for faceted platforms correspond well with those for lipping, and would seem to point to a distinction between bifacial reduction flakes with faceted, lipped platforms and other types of flakes with smooth or unaltered, unlipped platforms. Site 22B has a higher percentage of platforms with rough/step fractured (scalar) surfaces (19.7% to 9.0%). This represents one of the only divergences in attribute frequencies for the two sites, and perhaps suggests the use of a different impactor or greater force to remove some of the flakes found on 22B.

An examination of dorsal edge modification of striking platforms once again demonstrates inter-site similarity, and a distinction between flakes with unaltered platforms and those with traits characteristic of bifacial reduction. Site 15 contains 36.6% unaltered platforms and 23.8% trimmed. These same attribute states are found on 34.4% and 18.3% of flakes from site 22B. Dorsal edges with step-fractures are slightly higher on 22B and probably correspond to the higher percentage of scalar platform surfaces. Frequencies for flakes showing abrasion are virtually identical for the two sites (16.1%).

- Dorsal Surface Morphology

Approximately 50% of flakes in both collections have longitudinally oriented flake scars with another 16 to 20% showing irregular faceting. The low percentage having marginal flake scars is to be expected since flintknappers commonly aim their blows directly behing the scars and ridges formed by previous flake removals. The relatively high frequency of flakes with uniform surfaces (17.3% and 23.9%) is probably a reflection of the small size of the flakes and their position within the reduction process (i.e., towards the completion of artifacts). This would explain the higher proportion of uniform dorsal surfaces on site 22B since the site also contains a correspondingly higher percentage of very small flakes than does site 15.

On both sites approximately 5% of the flake sample shows polish on one or more dorsal flake ridge.

The distribution of dorsal flaking angle measurements indicates that the vast majority of flakes in the sample have angles of less than 90°. Site 22B contains a slightly higher proportion of flakes with very acute angles (30.1% measure between 36° and 52° compared to 25% on site 15). Yet, only 2.6% of flake angles on site 22B were over 90°, while site 15 contains a corresponding proportion of 5.2%.

Discussion

Inspection of the individual attribute frequencies and their inter-site comparison reveals two main tendencies. The first concerns the nature of the stoneworking which occurred on the sites. It would appear that both biface reduction and core or preform reduction were taking place. The size of the flakes, combined with the range of different striking platform shapes, the amount of abrasion found on striking platform dorsal edges, and the acute flaking angles, suggests that a good deal of preparation went into removing the flakes. This, in turn, points to the crucial last steps of production, when even slight errors can destroy the artifact. Site 15, and site 22B to a more limited extent, also contain larger flakes, flakes with large platforms, and flakes with unaltered striking platforms, all of which would indicate that some core or preform reduction was occurring.

The second tendency is the striking similarity of attribute frequencies in the two collections. It is possible that the dominant raw material, black quartzite, assumes a limited range of morphological characteristics when fractured. The potential for variation, as demonstrated in the different attribute frequencies, however, appears to support the contention that similarity results from use at both sites of the same technology, incorporating comparable reduction strategies and objectives.

Although the attribute frequencies themselves suggest some interpretations for the debitage collections, their potential for the extraction of behavioral information is quite limited. Without an understanding of which attributes covary, and which account for the most observed variation and have the least redundancy, the analysis must remain at a descriptive level. In an attempt to overcome this problem, and to try to identify groups of flakes indicative of production units and reduction strategies, a multiple correspondence analysis was employed.

II. Statistical Analysis

Multiple correspondence analysis (MCA) is a multivariate statistical technique that was developed in France in the late 1960's (Benzécri 1973). The references consulted for the present study were Bensimon (1979), David and Dagbert (1975), Fenelon (1981), Landry (1975), and Teil (1975). The method is a variant of principal components factor analysis and has as its objectives to reveal the existence of correlations between measurable variables; to identify, if they exist, certain sub-groups which are representative of the entire population under study; and to characterize these sub-groups by one or many measurable variables (Landry 1975). In contrast to principal components analysis which employs quantitative data only, MCA can deal with both quantitative and qualitative variables.

Clark (1982) distinguishes between two kinds of data analysis, confirmatory (with an emphasis on hypothesis testing) and exploratory (which emphasizes the use of systematic pattern-search techniques to suggest relationships among suites of variables). Exploratory data analysis

> . . . employs visual methods and (visually represented) non-parametric measures of central tendency and dispersion. The techniques advocated are relatively simple and straightforward, and thus less likely to be abused than more complex procedures. Moreover, they can be used with qualitative (nominal, ordinal) as well as metric (interval, ratio) data. (Clark 1982:250)

The MCA method is an "exploratory" technique in that no a priori distributional hypothesis is assumed. The results or hypotheses are derived directly from the data sets evaluated (consequently, to test for significance would be meaningless). The MCA method seems to have been little used in archaeology; nevertheless, since the completion of my analysis, a paper suggesting the potential of correspondence analysis (which treats only quantitative data) and illustrating some applications to archaeological material has appeared in print (Bølviken et al., 1982).

The mathematical basis of the MCA method is explained in detail in the references cited above. For the purposes of this presentation, a basic overview of the technique should suffice. The general idea is to locate the plane (or view-point) which best depicts the distribution of points representing plots of the varying attribute states recorded for each sample. The outcome is a graphic representation of the attributes in a two-dimensional subspace. The coordinate axes in the reduced data space represent the factors which account for the most variation and "which may express archaeological effects that were hidden in the unordered raw data" (Bolriken, et al., 1982:43). If there is residual variation, a second or third factor will be extracted and plotted separately. Then, by examining the location of the attributes with respect to the coordinate axes and the origin (the point where the two axes intersect), conclusions can be drawn regarding which attribute(s) comprise the factors and which co-vary, are atypical or rarely co-occur. Interpretation of the graphic display requires frequent reference to a contingency table of absolute and relative frequencies of attribute combinations, produced by the program (Tableau de Burt). The user is entirely responsible for assessing the results and attributing archaeological meaning (if warranted) to them.

Procedure

The original sample of 1578 flakes from site GcEl-15 was reduced to the 1198 complete PRBs. Since the program requires that the data sets submitted be complete, specimens with missing measurements were excluded. For the same reason, the variable "flaking angle" was not considered. The data from site 22B was not included in the statistical analysis, due to the small sample size (223) and the similarity of attribute frequencies for the two sites.

The unit of measurement employed in the study of the data set must have the same meaning throughout the matrix. Therefore, the quantitative data were characterized using a logical code, i.e., the range of each variable was divided into ten classes, and values (or measurements) were considered as being present or absent in each class. Because the quantitative data were non-normally distributed, they were reexpressed in log equivalents to facilitate the selection of relative distances between values and the division into classes. The actual range in measurements represented by these classes and an explanation of the code used for the qualitative variables are presented in Figure 7, in the order in which they appear in the analysis.

Results

The program first produces two symmetrical matrices consisting of the absolute and relative frequency of combinations of attributes encountered in the sample (Tableau de Burt). The program then extracts the 6 most important factors, and the percentage of variation accounted for by each. This information is reproduced in Table 4.

FIGURE 7

ATTRIBUTE IDENTIFICATION CODE

ATTRIBUTE	CODE	DESCRIPTION
Flake length	1FL	under 3.8 millimeters
	2FL	3.9 - 4.9
	3FL	5.0 - 5.9
	4FL	6.0 - 6.8
	5FL	6.9 - 7.9
	6FL	8.0 - 9.1
	7FL	9.2 - 10.6
	8FL	10.7 - 12.7
	9FL	12.8 - 15.9
	10FL	16 and above
Flake width	1FW	under 4.3 millimeters
	2FW	4.3 - 5.2
	3FW	5.3 - 6.1
	4FW	6.2 - 7.0
	5FW	7.1 - 7.9
	6FW	8.0 - 9.1
	7FW	9.2 - 10.4
	8FW	10.5 - 12.2
	9FW	12.3 - 15.1
	10FW	15.2 and above
Flake shape	1FS	parallel
	2FS	parallel-convex
	3FS	expanding
	4FS	contracting
	5FS	convex
	6FS	irregular
	7FS	displaced
	8FS	round
Flake curvature	1FC	straight
	2FC	curved
	3FC	very curved
	4FC	dorsal curved
Distal termination	1DT	feathered
	2DT	hinged
	3DT	snapped or broken
	4DT	feathered/hinged
	5DT	feathered/chipped

FIGURE 7 (continued)

ATTRIBUTE	CODE	DESCRIPTION
Bulb of percussion	1BP	flat
	2BP	visible
	3BP	pronounced
Platform length	1PL	under 1.80 millimeters
	2PL	1.80 - 2.23
	3PL	2.24 - 2.63
	4PL	2.64 - 3.04
	5PL	3.05 - 3.49
	6PL	3.50 - 3.99
	7PL	4.00 - 4.49
	8PL	4.50 - 5.39
	9PL	5.40 - 6.79
	10PL	6.80 and above
Platform width	1PW	under 0.38 millimeters
	2PW	0.38 - 0.49
	3PW	0.50 - 0.60
	4PW	0.61 - 0.71
	5PW	0.72 - 0.80
	6PW	0.81 - 0.99
	7PW	1.00 - 1.17
	8PW	1.18 - 1.43
	9PW	1.44 - 1.89
	10PW	1.90 and above
Lipping	1LP	present
	2LP	absent
Striking platform shape	1SP	punctiform
	2SP	linear
	3SP	triangular
	4SP	triangular-convex
	5SP	bi-convex
	6SP	concave-convex
	7SP	convex-concave
	8SP	plano-convex
	9SP	convex-plano
	10SP	chapeau de gendarme
	11SP	winglike
	12SP	double

FIGURE 7 (continued)

ATTRIBUTE	CODE	DESCRIPTION
Striking platform surface modification	1MP	smooth
	2MP	faceted
	3MP	abraded
	4MP	dihedral (crested)
	5MP	faceted-abraded
	6MP	not observable
	7MP	rough/stepfractured
Striking platform dorsal edge modification	1DM	unaltered
	2DM	trimmed
	3DM	stepped
	4DM	abraded
	5DM	abraded/trimmed
	6DM	abraded/stepped
	7DM	not observable
Dorsal flake scar patterns	1DP	uniform
	2DP	longitudinal
	3DP	marginal
	4DP	irregular
Polish on dorsal ridge(s)	1PD	present
	2PD	absent
Flake thickness	1FT	under 0.66 millimeters
	2FT	0.66 - 0.79
	3FT	0.80 - 0.93
	4FT	0.94 - 1.17
	5FT	1.18 - 1.19
	6FT	1.20 - 1.36
	7FT	1.37 - 1.56
	8FT	1.57 - 1.79
	9FT	1.80 - 2.19
	10FT	2.20 and above
Weight	1WE	under 0.015 grams
	2WE	0.015 - 0.023
	3WE	0.024 - 0.033
	4WE	0.034 - 0.046
	5WE	0.047 - 0.061
	6WE	0.062 - 0.083
	7WE	0.084 - 0.111
	8WE	0.112 - 0.149
	9WE	0.150 - 0.259
	10WE	0.260 and above

TABLE 4

Factor	Percentage	Cumulative Percentage
1	4.90	4.90
2	3.03	7.93
3	2.27	10.20
4	2.08	12.28
5	1.83	14.11
6	1.78	15.90

These figures seem quite low; however, this is to be expected in an analysis using such a high number (105) of possible attribute states. In effect, the attributes comprising the first factor account for 5 times as much variation as do the others; therefore, these low percentages should not be treated in an overly pessimistic manner.

Table 5 outlines the absolute contributions of the different variables to the first six factors. An examination of this table shows that the first two factors consist primarily of variables describing flake mass or size. The third factor is accounted for by variables of flake size combined with striking platform surface and dorsal edge modification. The fourth consists of weight, flake width, platform shape, platform length, flake curvature, flake length, and platform width. This could be summarized as a factor of overall flake morphology. Striking platform shape dominates the fifth factor, and weight the sixth.

TABLE 5

ABSOLUTE CONTRIBUTIONS OF VARIABLES TO FACTORS

VARIABLES	FACTORS 1	2	3	4	5	6
Flake length	14.3	15.3	14.4	8.4	4.8	13.7
Flake width	15.8	17.9	12.2	11.8	7.1	14.6
Flake shape	1.4	0.4	1.7	3.6	5.3	3.4
Flake curvature	0.3	1.5	2.2	9.4	5.6	2.7
Distal termination	0.7	0.1	1.4	1.7	2.7	3.4
Bulb of percussion	1.4	0.6	1.6	4.2	8.0	1.4
Striking platform length	10.4	7.4	5.7	10.8	5.8	2.7
Striking platform width	10.7	9.5	5.6	8.2	7.3	1.9
Lipping	0.8	0.7	4.0	0.8	0.0	0.0
Striking platform shape	2.3	3.1	5.4	11.4	19.8	8.9
Striking platform surface modification	4.0	1.4	9.3	2.8	9.1	4.2
Striking platform dorsal edge modification	3.1	0.6	10.0	4.2	6.5	6.8
Dorsal flake scar patterns	1.0	1.1	2.6	5.1	10.3	4.7
Polish on dorsal ridge(s)	0.7	0.6	0.2	0.0	0.3	0.3
Flake thickness	15.1	16.1	4.8	5.3	5.0	8.6
Weight	18.0	23.9	18.9	12.8	2.1	22.6

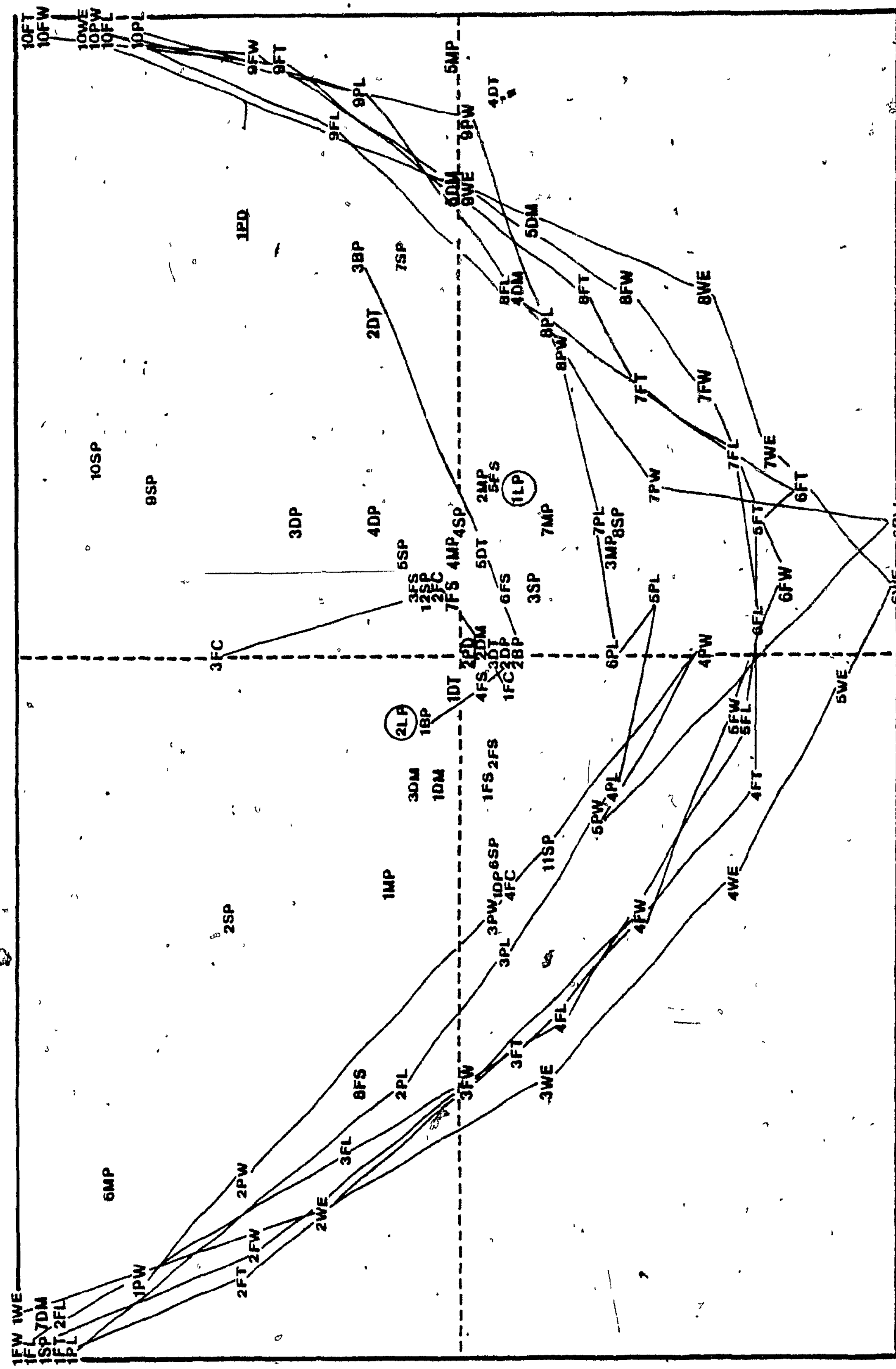
=100%

The program also produces graphic representations of these results. Figures 8 and 9 illustrate the plots of factor 1 versus factor 2 and factor 3 versus factor 4. The different classes of individual quantitative variables have been joined with lines to illustrate the progression in measurements. Other variables are identified by their codes (as explained in Figure 6) and symbols added to highlight their locations.

The most striking feature of the first plot (factor 1 versus 2) is the concave curve in the plane defined by the two axes. All of the variables describing flake size (weight, flake length, flake width, flake thickness) follow the same trajectory and in effect repeat the same information. Knowledge of flake weight alone should suffice for analysis; the other size estimates provide no new information. This lends support to Pokotylo's findings (1978). Platform length and width, to a certain degree, also follow this path. Yet, on occasion they can be independent of flake size (i.e., a certain proportion of small flakes have large platforms and <u>vice versa</u>). The horizontal axis distinguishes the smallest flakes from the largest, with the majority of samples found towards the center of the graph. The only variable that fluctuates independently of the size factor is flake curvature. In other words, flakes can be straight, curved, or very curved, regardless of size. Flat and slight bulbs of percussion are also somewhat independent, although pronounced bulbs are definitely associated with large flake size.

FIGURE 8

Plot of factor 1 versus factor 2



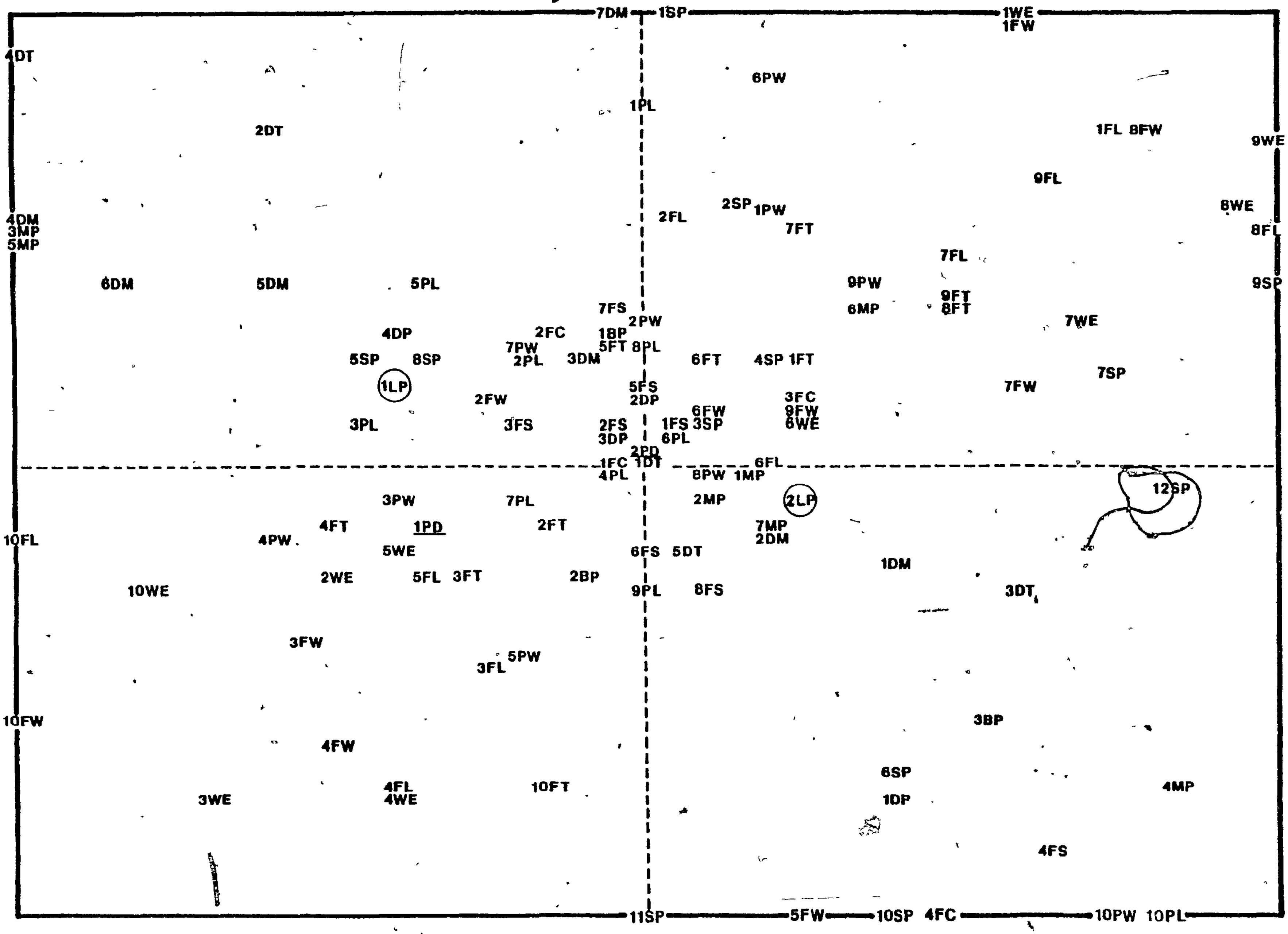


FIGURE 9

Plot of factor 3 versus factor 4

Those attributes, which cluster around the center of the graph, characterize the majority of the flakes (i.e., feathered distal termination, no polish on dorsal ridges, longitudinally faceted dorsal flake scar patterns). The qualitative variables located towards the center, top of the graph tend to be found on either small or large flakes. For example, linear platform shapes occur mainly in the three lightest (1WE, 2WE, 3WE) and the two heaviest (9WE, 10WE) weight categories. Very curved flakes and flakes with marginally faceted and irregular dorsal flake scar patterns are found primarily in weight categories 2, 9, and 10. Both convex-plano and "chapeau de gendarme" platform shapes also occur with the lighest and the heaviest shapes, but, because so few of them were found, this observation will not be given much consideration. In general, the closer an attribute lies to the curve produced by the size variables and the farther it is from the center, the more it tends to be found in conjunction with the specific size category nearest its position.

The plot in Figure 9 (factor 3 versus factor 4) is a different view of this same distribution of points. In this case, flakes are contrasted on the basis of their platform characteristics and sizes. For example, the attributes at the top and bottom of the graph relate to the smallest sizes of flakes; those towards the extreme left and right correspond to the large flakes. Attributes clustering towards the center characterize the majority of the flakes.

By examining these two plots, it is possible: first, to identify characteristics that occur in all size ranges (for the most part this information duplicates the results of the compilation of attribute frequencies in the previous section); second, to trace flake size from large to small and determine whether specific attributes covary with certain sizes; and third, to observe whether different groups of flakes sharing similar characteristics occur within a single size category, or span a number of general size categories.

As explained earlier, the plots are two-dimensional representations of a distribution which in reality has 105 dimensions (105 attribute states). Therefore, the location of an attribute is only a projection, and as a result, all observations must be verified by consulting tables which list relative and absolute frequencies of attribute combinations. Table 6 reproduces and explains a small section of the table of relative combinations. This should assist readers in following the discussion.

Beginning with the largest flake size categories, a number of features are apparent. On the one hand, a group flakes exist that have faceted-abraded platforms and abraded, abraded-trimmed, or abraded-stepped, dorsal edge modification. Platform shapes are primarily bi-convex and plano-convex. When lipping, polish on dorsal ridges, and hinge fractures

TABLE 6

Excerpt from the table of relative frequencies of attribute combinations.

means: 65.2% of flakes in the first flake length category are in the first weight category.

		1WC	2WE	3WE	4WE	5WE	6WE	7WE	8WE	9WE	0WE
1FL	1	652.	174.	87.	0.	87.	0.	0.	0.	0.	0.
2FL	1	465.	414.	71.	40.	10.	0.	0.	0.	0.	0.
3FL	1	194.	400.	212.	112.	47.	18.	12.	6.	0.	0.
4FL	1	48.	254.	349.	151.	71.	79.	40.	0.	8.	0.
5FL	1	15.	96.	147.	228.	250.	140.	59.	22.	29.	15.
6FL	1	0.	34.	68.	153.	186.	198.	141.	136.	79.	6.
7FL	1	10.	29.	19.	29.	78.	233.	214.	194.	146.	49.
8FL	1	0.	0.	9.	9.	28.	112.	121.	187.	374.	159.
9FL	1	0.	0.	0.	0.	0.	17.	59.	85.	432.	407.
0FL	1	0.	0.	7.	0.	0.	0.	7.	14.	86.	885.
1FW	1	684.	241.	51.	0.	13.	0.	0.	0.	13.	0.
2FW	1	267.	450.	183.	75.	8.	8.	8.	0.	0.	0.
3FW	1	82.	367.	278.	108.	108.	25.	25.	6.	0.	0.
4FW	1	20.	201.	228.	255.	174.	87.	13.	13.	7.	0.
5FW	1	0.	38.	154.	308.	192.	154.	38.	77.	38.	0.
6FW	1	0.	26.	84.	126.	179.	263.	132.	89.	84.	16.
7FW	1	0.	0.	10.	71.	71.	212.	192.	182.	192.	71.
8FW	1	7.	0.	0.	7.	41.	75.	192.	178.	370.	130.
9FW	1	0.	0.	0.	0.	0.	9.	26.	120.	325.	521.
0FW	1	0.	0.	0.	0.	9.	0.	0.	0.	61.	930.
1FS	1	93.	196.	144.	103.	103.	62.	72.	31.	113.	82.
2FS	1	130.	117.	130.	117.	65.	91.	52.	91.	52.	156.
3FS	1	82.	132.	90.	76.	79.	65.	65.	82.	135.	194.
4FS	1	118.	153.	74.	129.	94.	94.	118.	71.	59.	71.
5FS	1	41.	106.	94.	59.	76.	94.	65.	82.	159.	224.
6FS	1	64.	106.	99.	99.	99.	106.	57.	85.	99.	184.
7FS	1	79.	141.	84.	79.	73.	136.	84.	31.	110.	183.
8FS	1	171.	232.	183.	98.	73.	49.	49.	37.	85.	24.
1FC	1	89.	132.	113.	85.	102.	81.	78.	66.	108.	146.
2FC	1	89.	122.	89.	89.	64.	100.	68.	71.	112.	195.
3FC	1	79.	211.	79.	79.	53.	53.	44.	53.	167.	184.
4FC	1	55.	192.	178.	96.	96.	110.	55.	68.	96.	55.
1DT	1	97.	150.	114.	94.	80.	81.	73.	63.	109.	144.
2DT	1	20.	39.	39.	59.	118.	98.	39.	59.	176.	353.
3DT	1	50.	250.	50.	150.	0.	100.	100.	100.	50.	150.
4DT	1	0.	0.	0.	71.	143.	143.	71.	71.	71.	429.
5DT	1	81.	119.	90.	57.	86.	110.	57.	81.	133.	186.
1BP	1	113.	145.	112.	98.	75.	80.	66.	64.	109.	139.
2BP	1	54.	164.	115.	74.	103.	105.	69.	62.	100.	154.
3BP	1	44.	44.	36.	66.	58.	73.	88.	95.	182.	314.
1PL	1	311.	274.	189.	85.	47.	47.	19.	0.	28.	0.
2PL	1	212.	227.	159.	129.	68.	53.	61.	30.	38.	23.
3PL	1	137.	218.	185.	81.	105.	56.	56.	48.	81.	32.
4PL	1	65.	167.	136.	97.	97.	143.	52.	45.	117.	78.
5PL	1	81.	177.	48.	65.	97.	129.	65.	129.	81.	129.
6PL	1	57.	148.	57.	123.	74.	107.	74.	90.	148.	123.
7PL	1	28.	93.	102.	120.	102.	93.	83.	83.	83.	213.
8PL	1	0.	77.	71.	54.	95.	101.	83.	77.	185.	256.
9PL	1	0.	26.	60.	60.	60.	86.	95.	95.	147.	371.
0PL	1	0.	0.	0.	47.	66.	57.	104.	104.	198.	425.

TABLE 6 continued

		1WE	2WE	3WE	4WE	5WE	6WE	7WE	8WE	9WE	0WE
1PW	1	300.	233.	133.	117.	42.	42.	17.	25.	58.	33.
2PW	1	258.	280.	108.	118.	54.	65.	32.	22.	32.	32.
3PW	1	106.	234.	157.	81.	77.	72.	94.	43.	51.	85.
4PW	1	26.	167.	103.	154.	77.	179.	51.	64.	51.	128.
5PW	1	99.	169.	183.	70.	141.	113.	42.	14.	85.	85.
6PW	1	0.	59.	0.	118.	176.	59.	235.	235.	118.	0.
7PW	1	27.	88.	102.	111.	102.	115.	66.	66.	168.	155.
8PW	1	8.	91.	91.	50.	91.	124.	58.	83.	182.	223.
9PW	1	14.	0.	48.	29.	77.	87.	115.	144.	192.	298.
0PW	1	8.	8.	15.	53.	68.	30.	83.	113.	173.	451.
1LP	1	55.	127.	93.	89.	91.	91.	66.	76.	110.	203.
2LP	1	106.	148.	112.	86.	76.	86.	72.	61.	117.	138.
1SP	1	83.	292.	250.	83.	125.	42.	42.	0.	83.	0.
2SP	1	171.	195.	110.	73.	49.	37.	49.	37.	122.	159.
3SP	1	49.	146.	98.	73.	122.	49.	122.	122.	73.	146.
4SP	1	77.	97.	93.	77.	101.	69.	56.	89.	153.	190.
5SP	1	70.	157.	115.	66.	59.	80.	63.	45.	115.	230.
6SP	1	136.	158.	98.	114.	76.	103.	103.	71.	60.	82.
7SP	1	125.	0.	0.	0.	0.	250.	125.	125.	250.	125.
8SP	1	47.	116.	70.	107.	107.	116.	70.	93.	116.	158.
9SP	1	250.	0.	0.	0.	0.	125.	0.	0.	375.	250.
0SP	1	118.	118.	59.	0.	59.	176.	59.	0.	118.	294.
@SP	1	68.	162.	216.	135.	68.	108.	54.	41.	68.	81.
#SP	1	100.	100.	0.	100.	100.	100.	100.	0.	300.	100.
1MP	1	129.	210.	120.	90.	72.	79.	66.	70.	75.	88.
2MP	1	71.	102.	97.	81.	81.	92.	66.	71.	137.	201.
3MP	1	34.	126.	103.	115.	126.	80.	69.	34.	172.	138.
4MP	1	105.	105.	105.	105.	53.	105.	79.	26.	184.	132.
5MP	1	0.	53.	53.	26.	105.	105.	79.	105.	66.	408.
6MP	1	240.	290.	163.	120.	0.	80.	0.	0.	80.	120.
7MP	1	28.	65.	93.	102.	102.	93.	102.	65.	157.	194.
1DM	1	128.	176.	104.	85.	77.	99.	56.	54.	114.	108.
2DM	1	74.	128.	117.	124.	57.	78.	64.	82.	128.	149.
3DM	1	82.	182.	112.	71.	100.	88.	76.	59.	88.	141.
4DM	1	11.	56.	102.	45.	107.	79.	102.	73.	113.	311.
5DM	1	19.	38.	38.	96.	115.	58.	115.	115.	115.	280.
6DM	1	0.	38.	38.	115.	115.	77.	38.	77.	192.	308.
7DM	1	375.	250.	250.	0.	0.	125.	0.	0.	0.	0.
1DP	1	129.	189.	161.	111.	83.	92.	78.	37.	74.	46.
2DP	1	91.	124.	104.	94.	96.	92.	71.	68.	122.	139.
3DP	1	51.	136.	93.	68.	34.	76.	42.	110.	110.	280.
4DP	1	54.	136.	62.	58.	70.	78.	70.	70.	132.	268.
1PD	1	15.	104.	60.	60.	45.	90.	60.	45.	134.	388.
2PD	1	90.	141.	107.	88.	84.	88.	70.	68.	113.	150.
1FT	1	478.	278.	157.	43.	35.	9.	0.	0.	0.	0.
2FT	1	238.	425.	213.	88.	13.	25.	0.	0.	0.	0.
3FT	1	121.	329.	179.	135.	97.	72.	39.	19.	10.	0.
4FT	1	22.	103.	195.	211.	146.	114.	76.	59.	49.	27.
5FT	1	0.	74.	132.	74.	118.	250.	147.	15.	147.	44.
6FT	1	0.	28.	85.	99.	141.	225.	127.	155.	56.	85.
7FT	1	0.	47.	19.	38.	142.	170.	85.	132.	208.	160.
8FT	1	0.	0.	0.	40.	90.	100.	190.	170.	200.	210.
9FT	1	0.	0.	0.	29.	22.	36.	58.	102.	350.	401.
0FT	1	0.	16.	0.	8.	8.	0.	47.	62.	171.	690.
1WE	1	86.	0.	0.	0.	0.	0.	0.	0.	0.	0.
2WE	1	0.	137.	0.	0.	0.	0.	0.	0.	0.	0.
3WE	1	0.	0.	104.	0.	0.	0.	0.	0.	0.	0.
4WE	1	0.	0.	0.	87.	0.	0.	0.	0.	0.	0.
5WE	1	0.	0.	0.	0.	82.	0.	0.	0.	0.	0.
6WE	1	0.	0.	0.	0.	0.	88.	0.	0.	0.	0.
7WE	1	0.	0.	0.	0.	0.	0.	69.	0.	0.	0.
8WE	1	0.	0.	0.	0.	0.	0.	0.	67.	0.	0.
9WE	1	0.	0.	0.	0.	0.	0.	0.	0.	114.	0.
0WE	1	0.	0.	0.	0.	0.	0.	0.	0.	0.	164.

occur in this size category, they will be found in this group of flakes. A second group of large-sized flakes is characterized primarily by smooth, faceted, or stepfractured platform surfaces and trimmed or unaltered dorsal edge modification. Convex-plano, convex-concave, triangular-convex, and triangular platform shapes predominate. Lipping and pronounced bulbs of percussion are rare. Finally, the flakes which were identified as having step-fractured in manufacture tend to be found within this group. Very curved flakes, and expanding, irregular, and displaced flake shapes occur in both groups, but in greater frequency than they do among smaller-sized flakes. Irregular dorsal flake scar patterns are found more often in the first group of large flakes, but both marginal and irregular flake scar patterns are more frequent on large flakes than on small ones.

The flake size categories spanning weights 8 to 5 do not show many particular features. In other words, they are characterized by the predominant attributes and, with one exception, specific clusterings are not discernable. The exception consists of flakes with faceted-abraded platform surfaces, and dorsal edge modification that is abraded, abraded-trimmed, and abraded-stepped.

The flakes under weight category 5 reveal a number of clusterings. One subgroup has winglike and concave-convex platform shapes, uniform surfaces, and dorsal curvature. These flakes might be interpretated as resulting from the formation of notches on tools. Another subgroup of flakes ranging in size from weights 5 to 2 have completely abraded platform surfaces combined with abraded dorsal modification.

At weight 2, a different clustering of attributes occurs. This group of flakes is very curved, has expanding shapes, smooth platform surfaces, stepped dorsal edge modification, marginal and irregular flake scar patterns, and some polish on dorsal ridges. All of these characteristics, combined with small size, suggest scraper (or possibly other tool form) resharpening flakes.

Two other groups of flakes are contrasted within the three smallest size categories. The first consists of flakes with round shapes but no other distinctive characteristics, while the second group has punctiform platforms and either parallel, expanding, or displaced flake shapes.

Discussion

I would contend that the groups of flakes just described represent different production or maintenance units, that were combined in one sequence (or differing sequences) or interspersed within the same sequence of reduction. The description followed a progression from largest to smallest flakes that, to a degree, probably mirrors the actual reduction process which occurred. Yet certain of these units could have occurred at any point in manufacture, with the exception of the very early steps involving decortification and roughing-out. As for the groups of flakes themselves, their meaning may be inferred by reference to known techniques and processes of manufacture. For example, both biface and core or preform reduction appear to have taken place on the site. As biface reduction progressed, stronger abrasion was applied to platforms and the resulting flake shapes became more regular. The core reduction flakes show that less attention was paid to altering platform morphology, and more force or perhaps a different percussor was employed. Basically, these two trends in reduction continue through the sequence.

The sub-groups of smaller flakes are more difficult to interpret. A hypothesis suggesting that the flakes with dorsal curvature result from the production of notches on tools has already been proposed. It should be noted that there are at least two notched artifact fragments in the tool collection. The flakes with punctiform platforms may result from pressure flaking, though delicate soft hammer percussion could have produced the same effect and seems more in keeping with the nature of retouch scars observable on some of the tool fragments. Two of the bifacially worked fragments show distinctly round retouch flake removals and this could account for one other subgroup. Finally, retouch and resharpening flakes from scrapers and/or other unifacial tool forms would comprise another subgroup.

It should again be stressed that exploratory data analyses like the MCA method produce results which <u>suggest</u>

rather than confirm hypotheses. Yet, I think that in a situation such as this, where virtually nothing was known of the lithic technology used on the site (or in the area) and the collection appeared as a deceptively homogeneous mass of flakes attributable only to "the last stages of reduction", the advantages of using this method should be obvious.

III. Spatial Distributions of Raw Materials

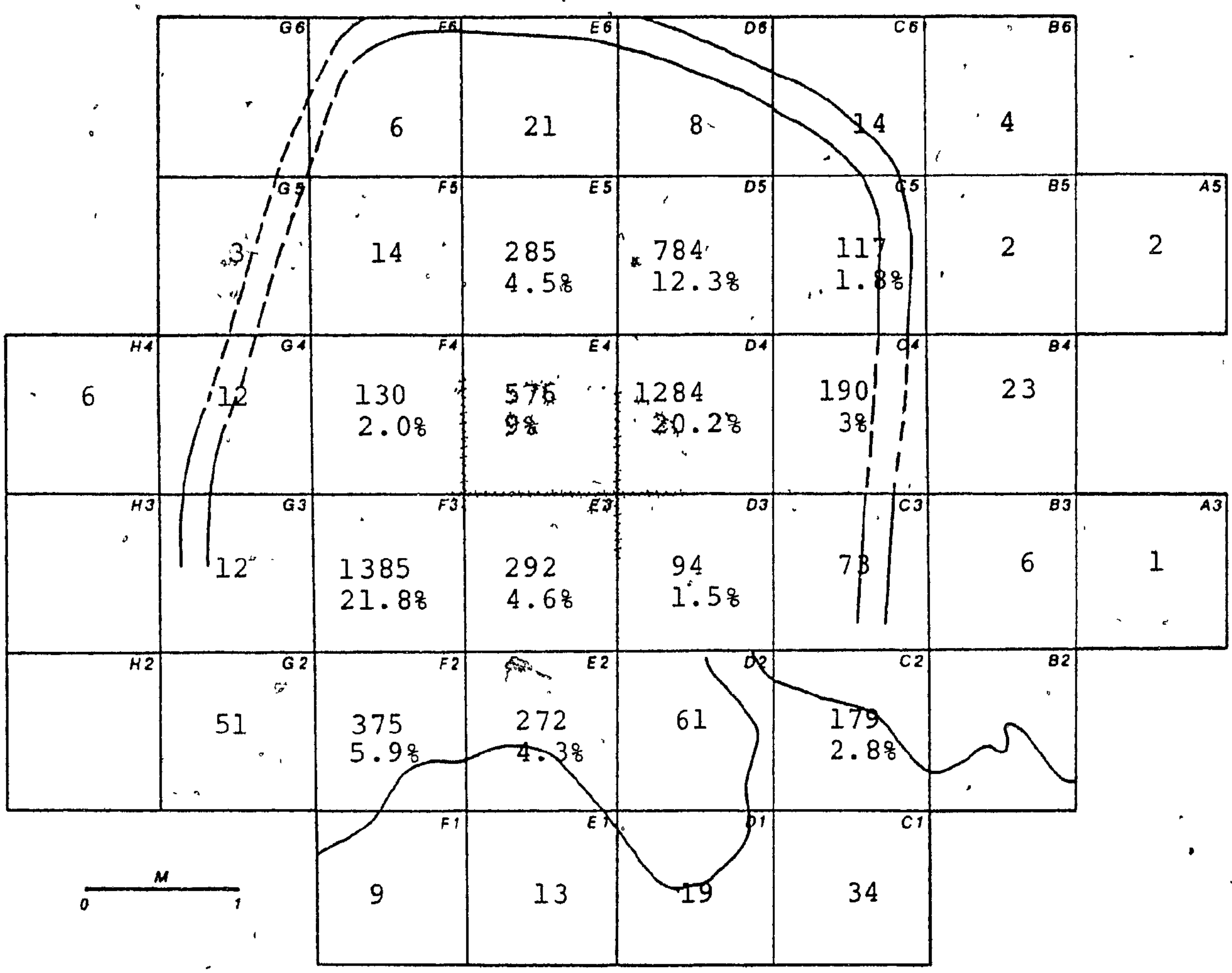
The following section will examine the spatial distribution of the different raw materials comprising the entire debitage collections from both sites. Particular attention will be paid to an investigation of the size and shape of individual "flake scatter- patterns" (Newcomer and Sieveking 1980). The two sites will be examined in turn and most of the information will be presented using visual means. This will be followed by a brief discussion.

- Site GcEl-15:

The predominant raw material, black quartzite, is concentrated in two locations on either side of the hearth. Figure 10 presents the frequencies and corresponding percentages of black quartzite flakes found in each excavation unit. The two concentrations are similar in both size and shape, and their positioning compared with stratigraphic evidence suggests

FIGURE 10

Distribution of black quartzite on site GcEl-15.



N=6357 (tool fragments not included)

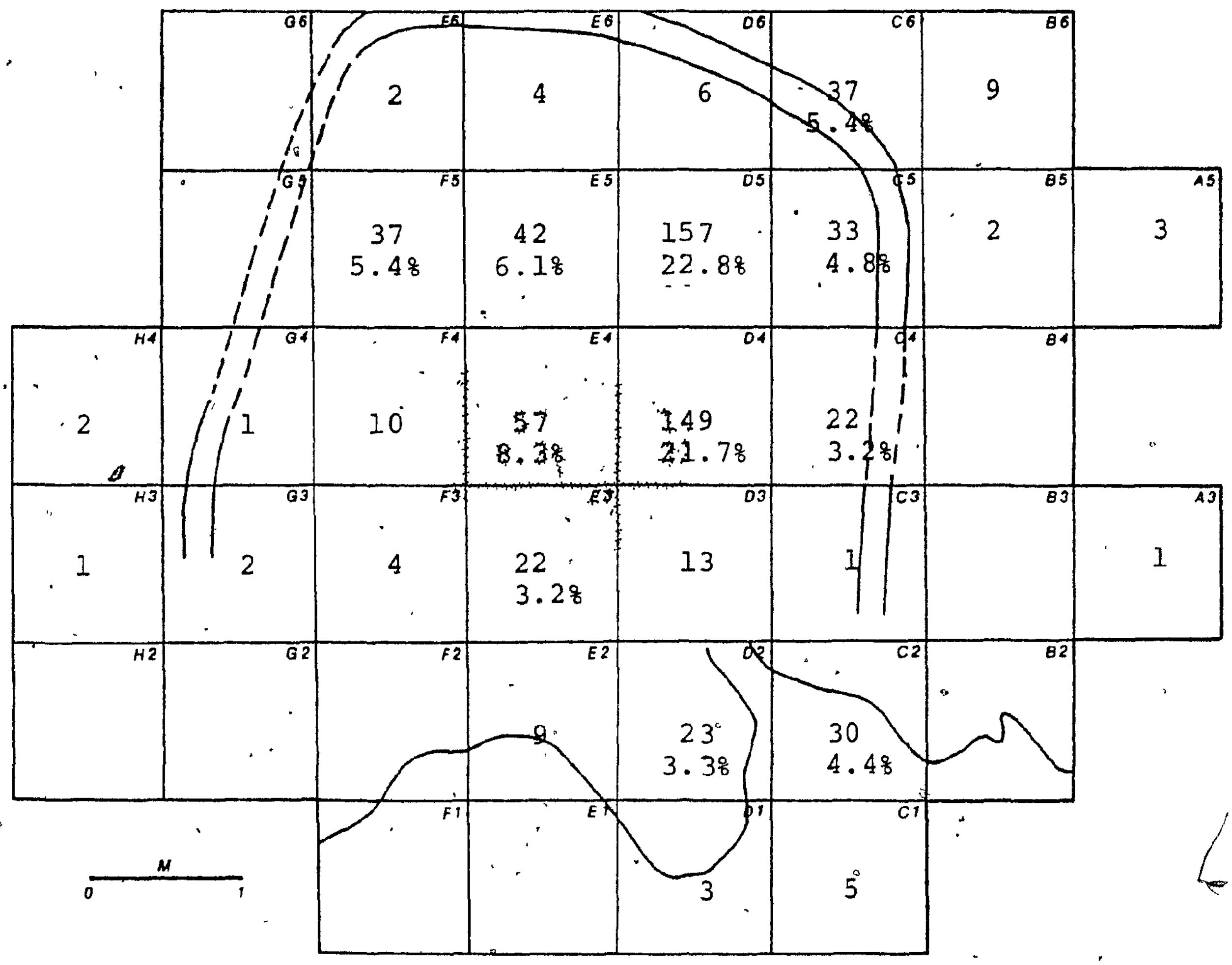
that the entrance to the habitation structure was located in either the northwest or the southeast corner (the latter would face the river and correspond well with the position of entrances in historic and contemporary Indian structures). A small sub-concentration of black quartzite flakes occurs in excavation unit C2, though its significance is not understood.

Figure 11 illustrates the location of Ramah quartzite flakes. The center of the concentration lies in units D4 and D5, but small amounts of the material are widely dispersed on the site. The Ramah was apparently being worked in the same locale (by the same flintknapper?) as one of the black quartzite concentrations. It is interesting to note that the quantity of flakes drops off in approximately the same direction and at the same rate as that of the black quartzite.

The quartz and quartzite distribution is displayed in Figure 12. Aside from a small concentration in excavation unit C2, the distribution of this material does not correlate with those of either the Ramah or black quartzite. The principal concentration of quartz and quartzite lies almost directly on (or in) the hearth zone (excavation unit E4). One possible explanation for this situation can be found in a comment made by an elderly Cree woman. In the context of an ethnohistorical project, she mentioned a technique for starting fires that consisted of striking quartz blocks together to create sparks (Denton 1983:per.comm.). Another alternative, and one that

FIGURE 11

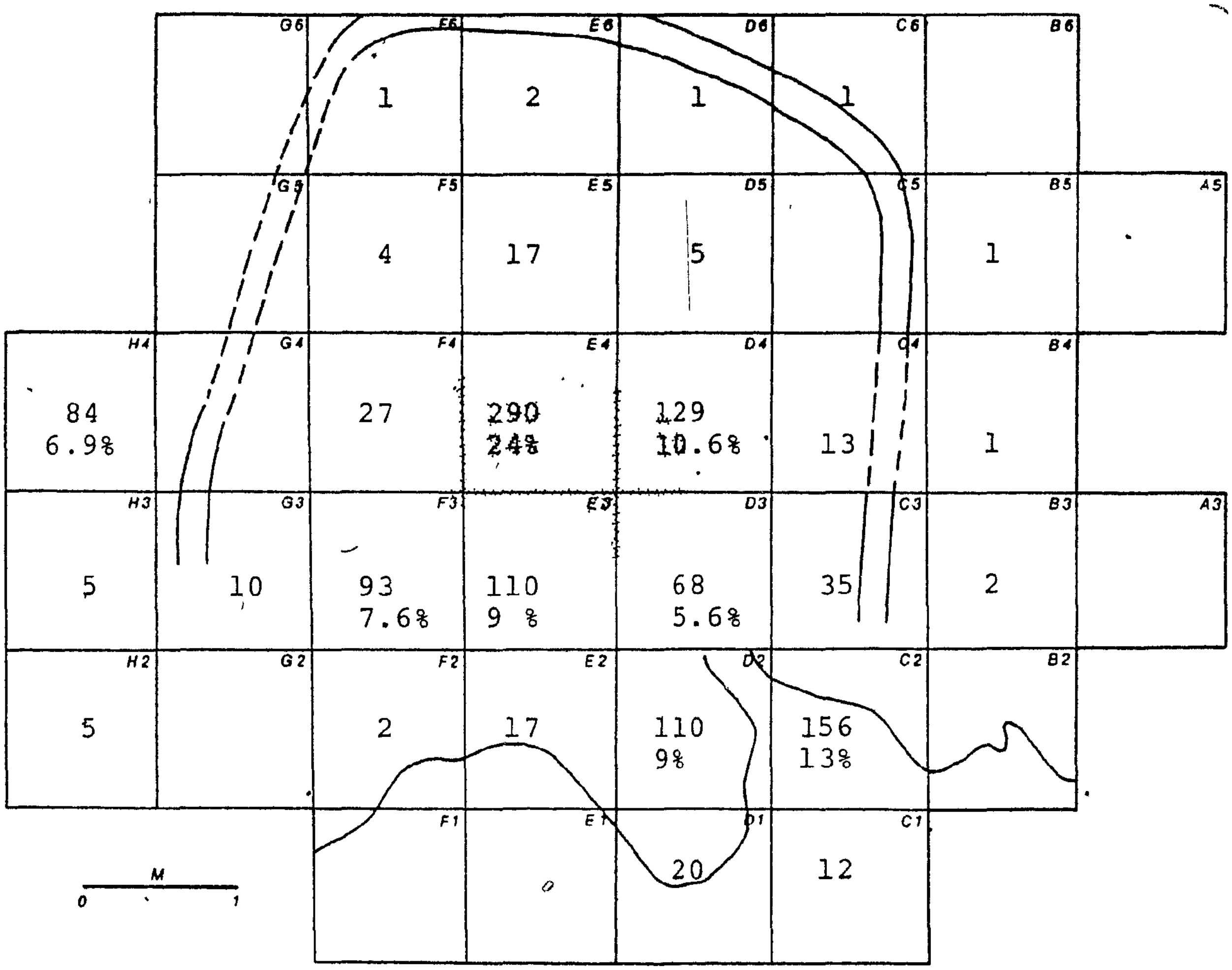
Distribution of Ramah quartzite on site GcEl-15.



N=687

FIGURE 12

Distribution of quartz and quartzite on site GcE1-15.



N=1208

is perhaps mildly supported by the occurrence of a quartz and quartzite concentration outside the supposed limits of the habitation structure, is that this material was used in the construction of the habitation and to perform domestic tasks relating to wood and bone work.

The slate pieces, which are highly fragmentary and show no evidence of polish, are contained within excavation unit G3. This locale does not correspond with any of the other raw material distribution zones.

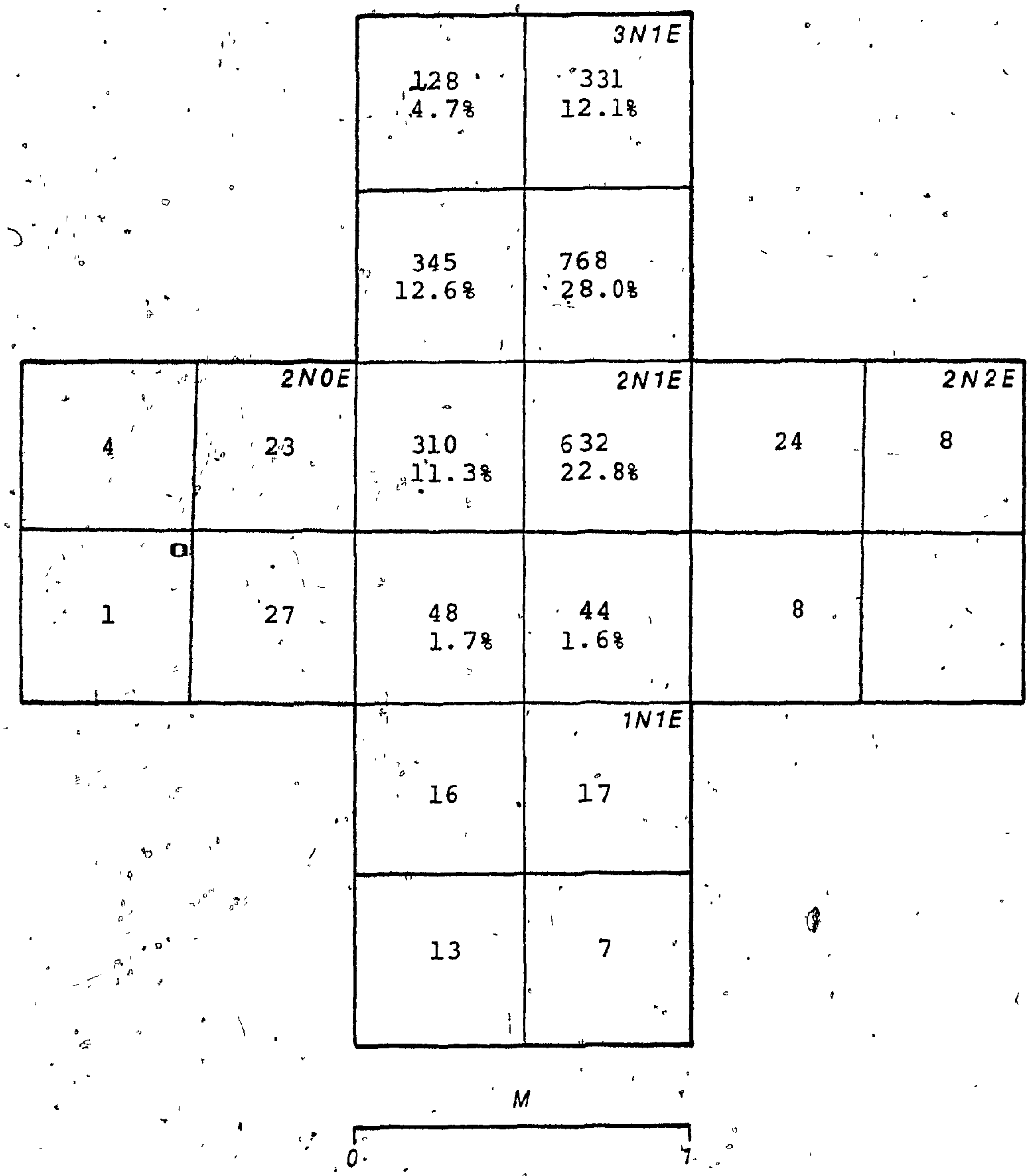
- Site GcEl-22B

The small size of the excavation conducted on site GcEl-22B limits its potential for examining and comparing flake scatter-patterns. Some observations, however, can be made.

The distribution of black quartzite illustrated in Figure 13, resembles, both in absolute and relative density, the two concentrations of the same material found on site GcEl-15. In addition, the quantity of flakes falls off in approximately the same manner and at the same distance from the center of the concentration. This fact, combined with the similarity observed in the attribute frequencies for the two sites, suggests that the knapping which took place in both places was of a corresponding character and intensity. Situations such as these could be studied in more detail and the results used to identify characteristics of single or multiple flaking episodes. In turn, this information could assist in

FIGURE 13

Distribution of black quartzite on GcEl-22B.



N=2754

the task of distinguishing separate components on multi-component sites.

Both the Ramah (Figure 14) and the chert (Figure 15) distributions are light in intensity and dispersed. This may reflect the manner in which the material was knapped (i.e., flintknapper's position and technique) or it may just be a result of restricted intensity (i.e., had more of this material been worked, a pattern similar to that found for the black quartzite might have been produced).

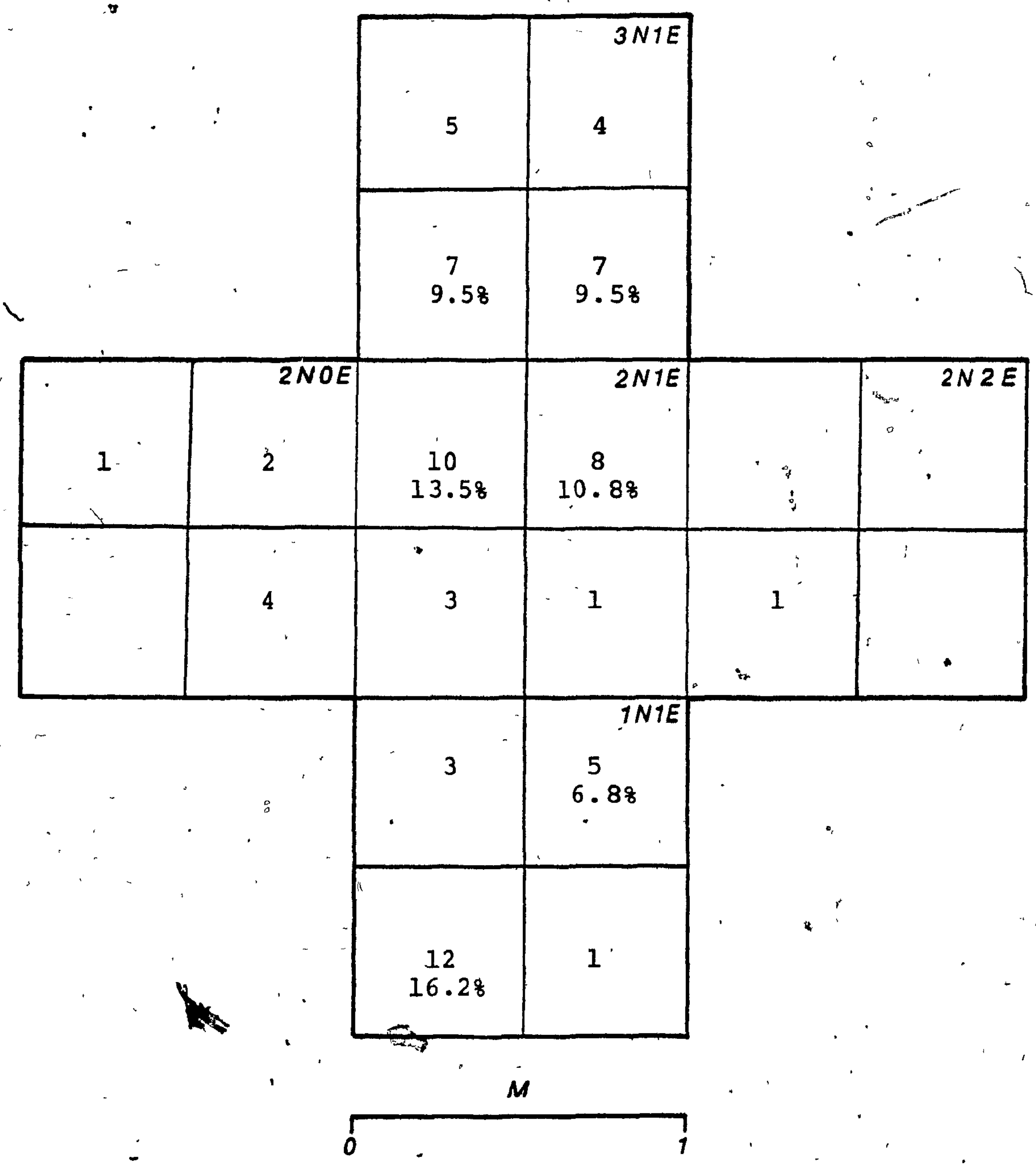
IV. Spatial Distribution of Tools and Conjoined Artifacts

The spatial distribution of the different classes of black quartzite and Ramah quartzite tools, described in Appendix A, is illustrated in Figure 16. A number of observations can be made. Virtually all of the tools are contained within the habitation structure. A clustering occurs in excavation unit F3, and corresponds to one of the black quartzite debitage concentrations. It is interesting to note that the locale of the second black quartzite debitage concentration is virtually devoid of tool fragments; however, the two halves of the biface projectile point preform were located nearby. The northwest corner of the structure is clear of lithic debris. This fact supports the suggestion that the entranceway was located in this region.

Two separate groups of sequentially removed flakes were also recovered. The first three overlapping flakes

FIGURE 14

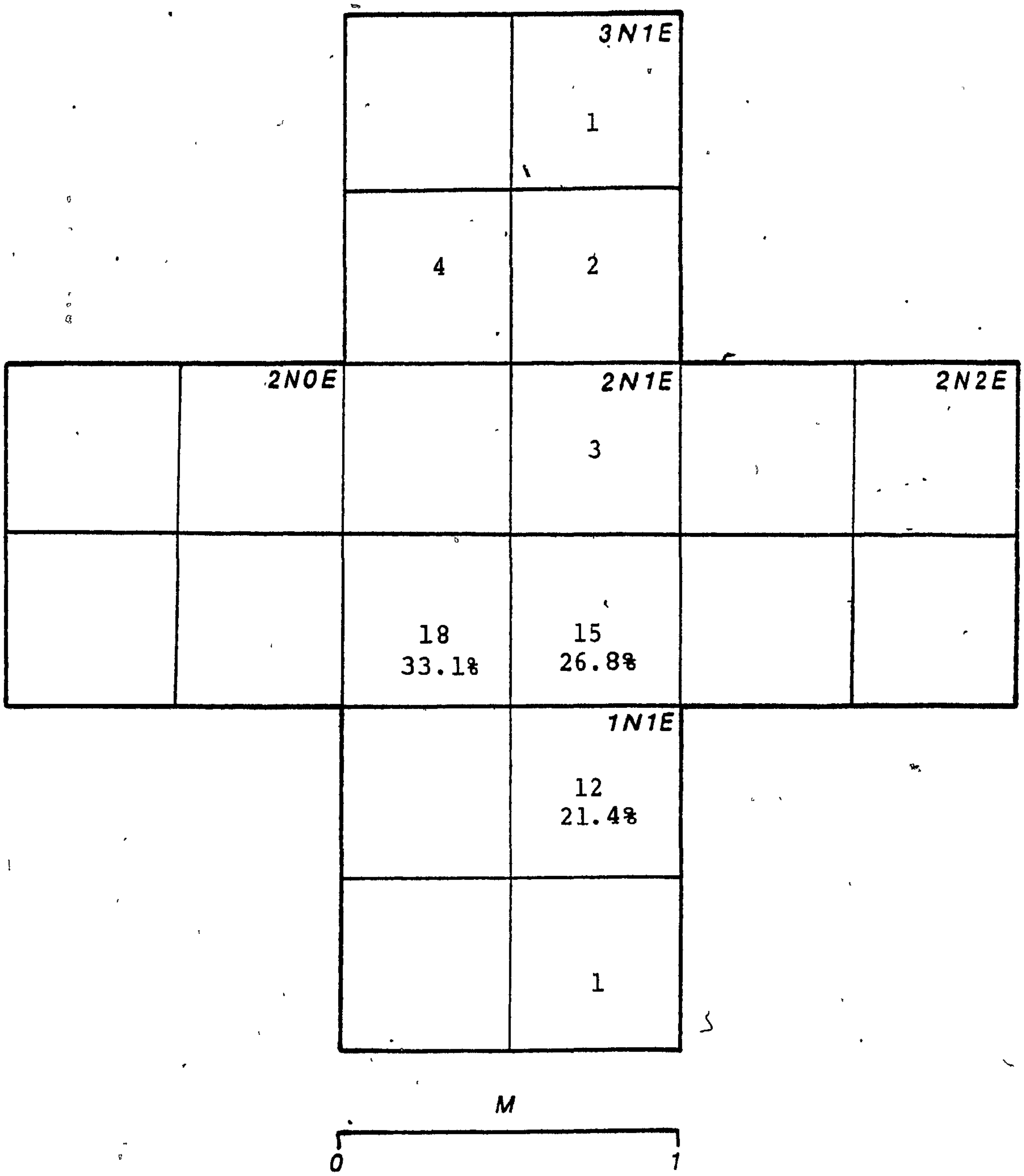
Distribution of Ramah quartzite on site GcEl-22B



N=74

FIGURE 15

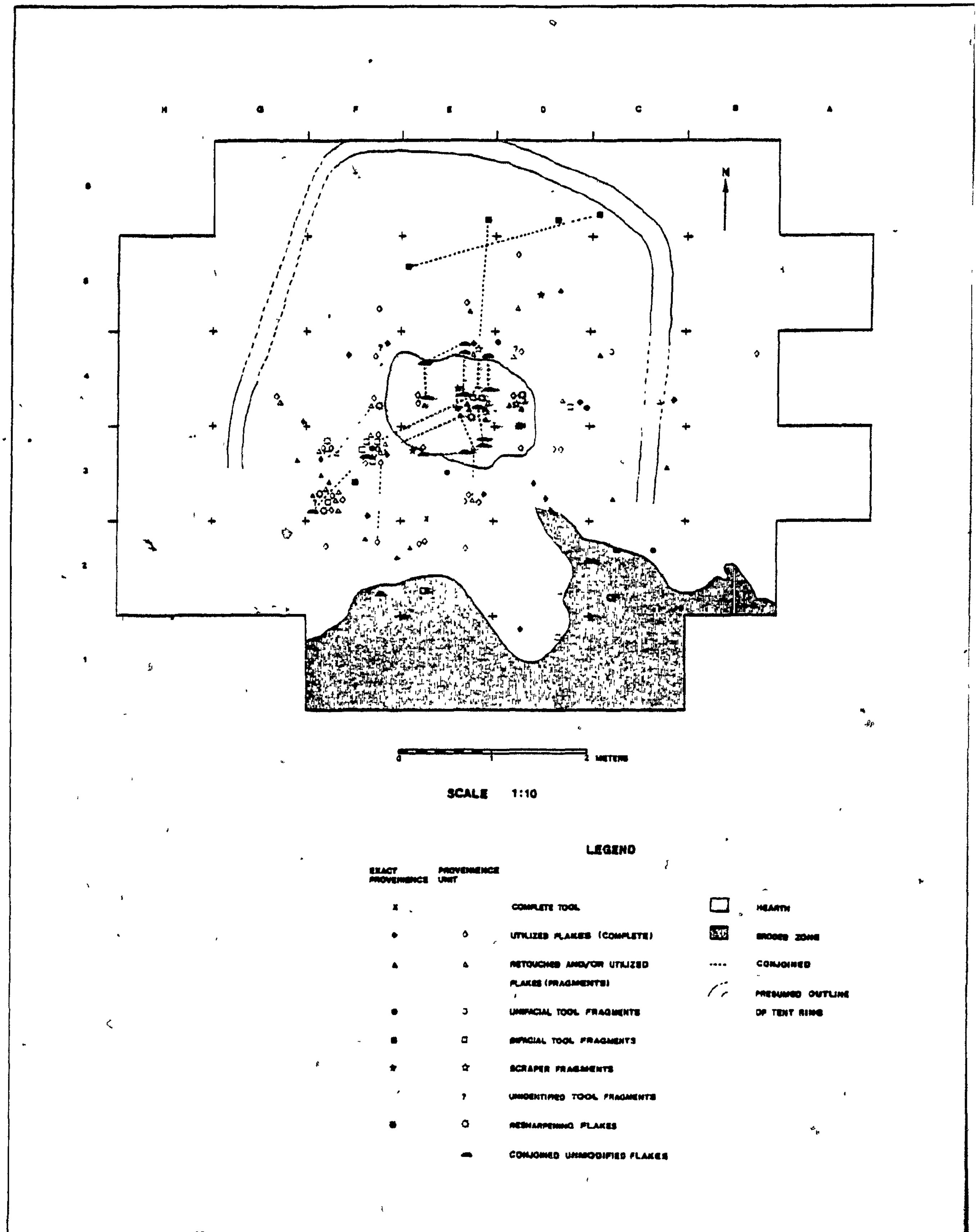
Distribution of chert on site GcEl-22B.



N=56

FIGURE 16

Distribution of tools and conjoined artifacts



were located in excavation units G2 and F3. The second set (consisting of two flakes) is from excavation units F2 and F3. In both cases, the flakes are quite thick and appear to have been struck from bifacial blanks.

CHAPTER 6

CONCLUSIONS AND SUMMARY

The foregoing sections serve as a basis for a reconsideration of the original hypotheses (p.51) and an evaluation of their validity:

1. Exotic raw materials show evidence of intensive use. Most significant in this respect is the small size of the tool fragments (suggesting reworking of the larger broken sections), and the intensive utilization of all large flakes and of fractured tool edges. The lack of fresh formal tools or unused large flakes suggests both curation and attention to conserving raw material resources. No evidence that bifaces had been broken up and reused was found. Some of the largest flakes, however, show fractures which suggest that they were recycled in this manner.
2. Local raw materials, the quartz and quartzite, show a more expedient technology, as demonstrated by a lack of platform preparation; however, much of this is probably attributable to the nature of the material itself (large amounts have to be broken before functional pieces of a suitable size can be obtained).
3. The quartz/quartzite and exotic raw materials appear to have played a complementary role on sites such as GcEl-15.

The examination of the tool collection suggests that the readily accessible materials, such as quartz and quartzite, may have been used primarily in domestic activities centering on wood and bone working, where durable rather than sharp edges are desirable. The high quality materials were conserved for cutting tasks and the production of a range of hunting and processing tools. These observations will remain speculative, however, until a use-wear analysis is undertaken.

4. Both the black quartzite (presumed to be exotic) and the Ramah quartzite were being transported to the sites as bifaces or biface preforms. This is supported by the bifacial reduction characteristics observable both in the debitage and on the majority of utilized flakes. Supporting evidence comes from the virtual absence of cortical flakes, chunks, and cores of these materials.

5. The expedient tool kit, as represented by the utilized flakes in the collection, demonstrates that planning and anticipated task situations played an important role in shaping the lithic technology. The concept of "expediency" tends to imply that the tools were rapidly manufactured, with little or no preparation of the raw material. In contrast to this, the expedient tools on site GcEl-15 appear to be the result of a reduction strategy based on planning and foresight, with regard both to functional requirements and to constraints of raw material availability.

6. The results of the attribute and spatial analyses strongly suggest a common technological (and possibly cultural) origin for the two sites. Until more lithic analyses of this kind are undertaken, claims for affiliation with the Point Revenge Complex remain tenuous at best.
7. The different flake groups suggested by the multiple correspondence analysis and observations derived from spatial distributions and tool morphologies support the contention that a number of different reduction strategies occurred on the two sites. Figures 17 and 18 present the hypothesized reduction models for the different raw materials on sites GcEl-15 and GcEl-22B. I employ Muto's (1971a:109) definition of blank,

> . . . a roughly shaped stone artifact, still in the process of manufacture, which has been blocked out to the approximate shape and thickness desired for a completed tool or a usable piece of lithic material of adequate size and form for making a lithic artifact - such as an unmodified flake of a size larger than the proposed artifact, . . .

and preform

> . . . a more finished blank - where the intent of the manufacturer can be established.

Summary

> In lithic analysis, as in other areas, there has been a tendency to remain on the level of artifact description, categorization, and comparison without attempting to broach more profound anthropological questions that involve the behavior of the people who made and used the artifacts. . . . It is encouraging that archaeological theory and technique have entered a stage that permit the study and resolution of questions that pertain to prehistoric behavior. The development of lithic analysis has been particularly rapid, broadening in scope to include technological and functional aspects that appeared remote only a few years ago. (Odell 1980:427)

FIGURE 17

Reduction models for site GcE1-15

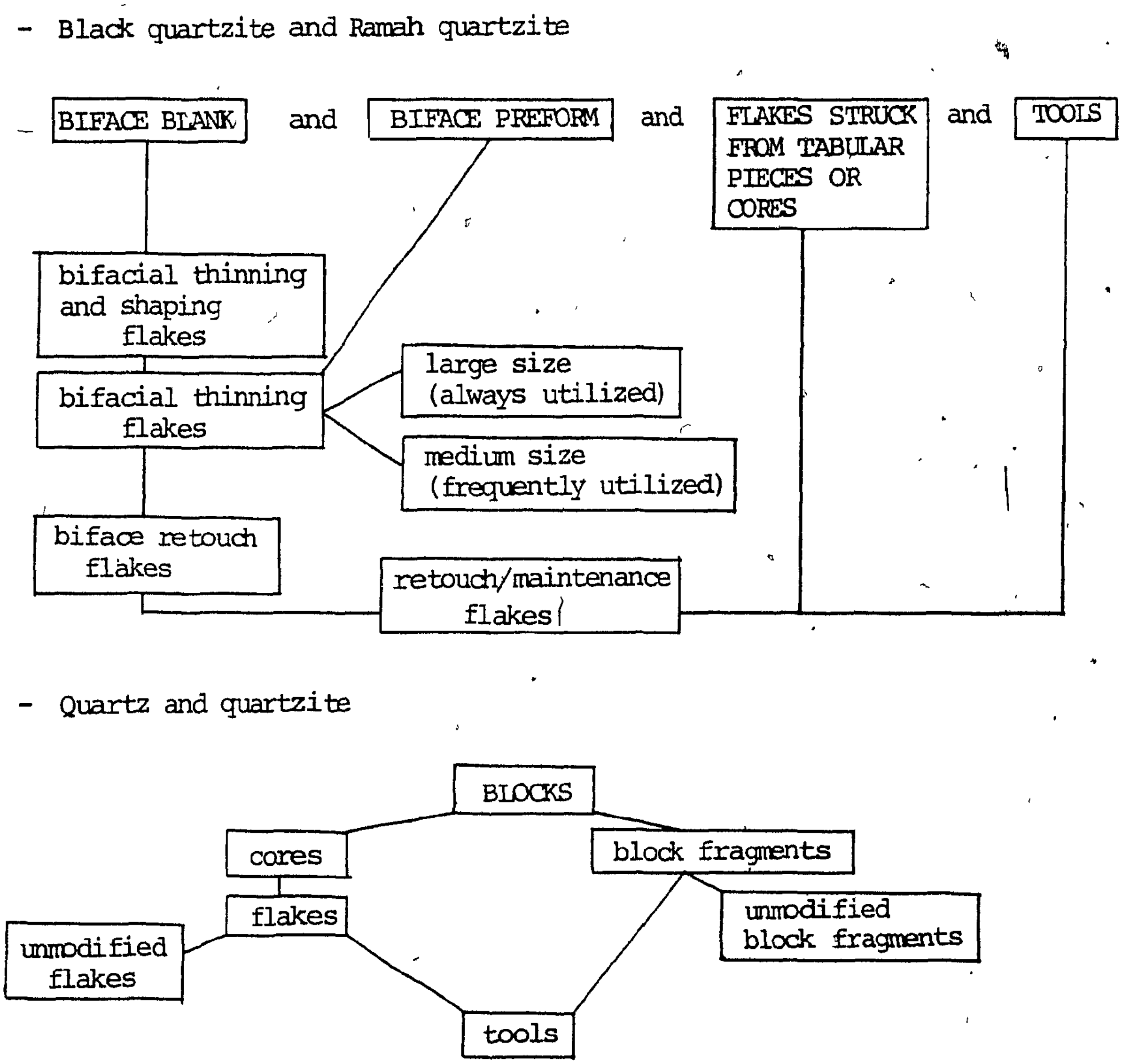
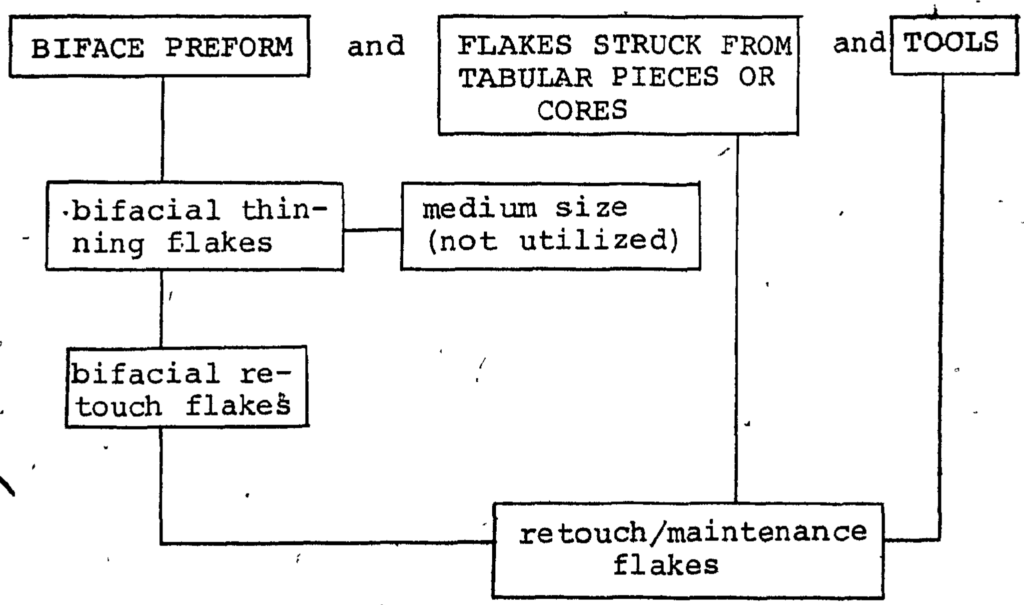


FIGURE 18

Reduction models for site GcEl-22B

- Black quartzite, Ramah quartzite, chert



The main goal of this research was the explanation of the lithic tool production system that generated two collections from prehistoric sites located in the subarctic region of Quebec. Both sites contained large quantities of debitage and a small number of tools showing high morphological variability. Assemblages of this nature are fairly common for sites in subarctic Quebec and diminish the utility of many traditional approaches to lithic analysis.

Although recent studies of debitage, such as those employing structural reduction models, have suggested new methods for the analysis and interpretation of these collections, I have tried to show that the a priori adoption of reduction models can limit, rather than expand, our capacity to understand human behavior - particularly in view of their implicit foundation in normative theory. A more useful conceptual framework was proposed in the form of a constraint model. Hypotheses were formulated as a result of the exploration of the possible constraints that could have affected the structure of the lithic technology being studied. A consideration of the implications of these hypotheses guided the selection of attributes used to describe the individual flakes in the sample.

An exploratory data analysis approach was followed. The process of analysis was an iterative one, whereby increasing structure was extracted from the data by: first, an examination of attribute frequency tabulations; second, a multiple correspondence analysis employing visual methods and non-parametric measures of central tendency and dispersion; and finally, recourse to all remaining sources of information, such as the tool collections, conjoined elements, and spatial distributions. Interpretations drawn from the results of these precedures were used to reexamine the original hypotheses and to structure a description of the lithic reduction process which occurred on the two sites.

I think that the advantages of this methodology and the primary contributions of my research are as follows: (1) the method employed makes the vital connection between a seemingly unpatterned mass of artifacts and a patterned and describable set of human behaviors; and (2) the analysis provides readily accessible behavioral data that can be studied by other researchers. Finally, I would contend that the theoretical and methodological foundations for more comprehensive analysis of lithic collections from the Caniapiscau area lie in the study of small, single-component sites such as GcEl-15 and GcEl-22B.

APPENDIX A

Description of the tool collections

This appendix contains a brief description of the tool collections from both sites and some preliminary observations on breakage patterns and use-wear.

- Site GcEl-15

Only two potentially "diagnostic" tools were recovered. Both are made of black quartzite. The first is a complete, linear flake (40 cm long, 10 cm wide, 1.668 grams) with small, regular retouch on the ventral surface of one lateral edge. The second consists of the two halves of a bifacially-worked, square-based projectile point preform, broken in manufacture (60 cm long, 21.7 wide, 9.610 grams).

The remaining tools are grouped into a number of different classes. Unless otherwise indicated, the pieces described are of black quartzite.

Scraper fragments

Four conjoining fragments form part of a flake scraper, with alternate retouch, and heavy wear along the ventral surface adjacent to the area where retouching is on the dorsal surface. The tool may have broken during resharpening however the fractures suggest that the piece was struck in the center. Subsequent to breaking, the largest fragment was used along the fractured edge. Another small scraper fragment may be part of this same tool. Two other segments of scrapers were recovered: one has an abrupt edge angle and a high degree of rounding and polish along the edge; the other may be an overstruck resharpening flake.

Bifacial tool fragments

Four pieces conjoined to form a fragment of a large, thick flake (17.165 grams), bifacially worked along one edge. The fragments were found in different parts of the site, and the largest has use-wear (polish and rounding) along the fractured edge. The other bifacial fragments are broken (projectile) point tips, with highly variable morphologies. The largest has a rounded tip and irregular bifacial retouch. The others appear to have been made on thick flakes. Retouching varies from very delicate to deep and irregular.

Unifacial tool fragments

Two of the unifacial tool fragments have large notches on them. The first is a thick fragment consisting of a stem with a notch on one side. The dorsal surface edge below the notch is steeply retouched and half of the dorsal surface is cortex-covered. The other small fragment is a notch on a tabular flake. The proximal section of a thick, wide flake, with a battered and rounded striking platform, was recovered. It terminates in a hinge fracture however, the retouch down one margin suggests that the fracture occurred subsequent to modification. Another unifacial fragment has deep, widely spaced retouch along the dorsal surface edge. This edge is also heavily worn and polished. A thin distal flake fragment has slight, irregular retouch alternating on both margins. The three other unifacial fragments are too small to merit description. One Ramah quartzite flake fragment has abrupt, continuous retouch along some of a lateral margin and slight retouch along the ventral surface of the remaining edge. The type and manner of retouch shows a strong resemblance to that of the black quartzite scraper (4 conjoined fragments) previously described.

Retouched flake fragments

The proximal section of a large cortical flake was recovered. One lateral margin is steeply retouched down the ventral surface until the retouch abruptly changes to the dorsal surface. Seven small fragments of a biface reduction flake conjoin and show delicate, regular retouch along both lateral margins. Six other retouched flake fragments are too small to merit description. One dorsally retouched fragment of Ramah quartzite was also recovered.

Utilized and/or retouched flakes (complete)

Twenty-eight unbroken utilized flakes were identified, though, in many cases, the modification may have resulted from retouch or utilization, or both. I subjectively divided them into four groups to facilitate description. The first group consists of 8 large flakes of which one is of Ramah quartzite. They are all bifacial reduction flakes and show distinctive use-wear patterns in that corners or projections, rather than margins, were utilized. A group of ten biface reduction flakes, of which three are of Ramah quartzite, are smaller in size and have continuous microscarring along lateral or distal edges. One other thick Ramah quartzite flake has similar retouch along one edge; however flake removals visible on the opposite margin suggest that it originally was a unifacial resharpening flake. Three other bifacial reduction flakes show heavy scarring and polish along all margins. Six thick flakes with large, unaltered platforms comprise the final group. Two of these (one of which is partially cortical) are linear in shape and show slight, regular microscarring at the distal tip. Another flake is heavily worn along the distal edge while the fourth has alternating utilization consisting of step-fractured removals. Finally, two flakes which appear to have been struck from the corners of tabular blocks, were utilized along the distal margins.

Utilized and/or retouched flakes (incomplete)

Approximately 45 fragments with traces of use-wear were identified. For the most part, their small size precludes description. Exceptions are 3 large Ramah quartzite flake fragments, with faint microscarring along at least one lateral margin.

Miscellaneous tool fragments

One bifacially worked projectile point tang (and a possible second) and a black quartzite chunk, heavily worn along a fractured edge, were also recovered.

Resharpening flakes

Ten variably shaped resharpening flakes were identified. They are all quite large and some may be "errors" in that they would have removed a sizable portion of the tool's working edge.

Tools made from quartz and quartzite

Tools of quartz and quartzite are often difficult to identify because of the fracture patterns of the material and its resistance to use-wear alteration. Nevertheless, a number of artifacts from site GcEl-15 do appear to show intentional modification. Two hammerstones, of differing sizes (41.0 and 140.98 grams) were recovered. Five chunks (including two that weigh 130.35 and 292.5 grams respectively) have battered, or step-fractured edges. The 12 remaining specimens are difficult to interpret; however, they do appear to have been intentionally flaked. One possible core was also identified.

- Site GcEl-22B

Four tool fragments were recovered. The largest is a broken, unifacially retouched flake with an unaltered platform and cortical dorsal surface. Abrupt, dorsal surface retouch goes down one margin while the other margin has slight, regular retouch on the ventral surface. The three other tool fragments, one of which is made of Ramah quartzite, are too small to identify; however, one may be a projectile point tang.

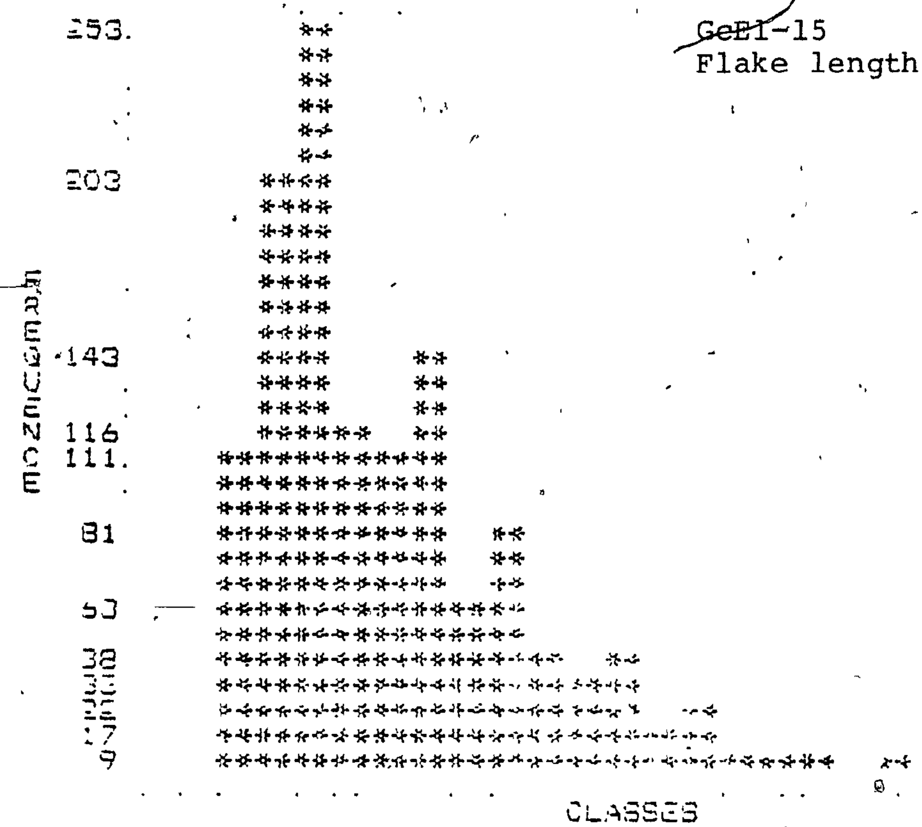
APPENDIX B

Comparison of attribute frequencies for sites GcEl-5 and GcEl-22B.

- flake morphology
- striking platform characteristics
- dorsal surface morphology

FLAKE MORPHOLOGY

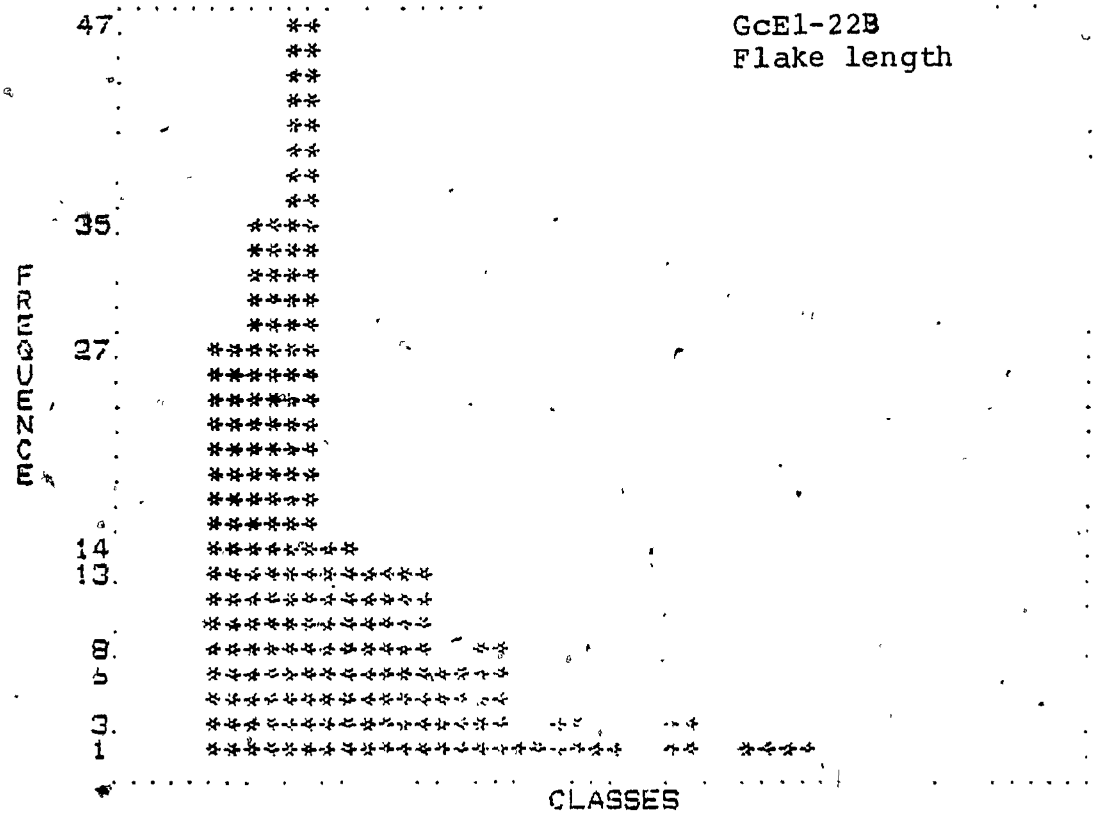
GeE1-15
Flake length



CLASSE	BORNE INF	BORNE SUP	EFFECTIF	%
1	0 000	1 400	2	.2
2	1. 400	2 800	0	0 0
3	2. 800	4 200	111	8 7
4	4. 200	5 600	203	15 9
5	5 600	7 000	253	19 8
6	7 000	8 400	116	9 1
7	8 400	9 800	111	8 7
8	9 800	11 200	143	11 2
9	11. 200	12 600	63	4 9
10	12. 600	14 000	81	6. 3
11	14 000	15 400	43	3 4
12	15 400	16. 800	33	2. 6
13	16. 800	18 200	38	3 0
14	18. 200	19 600	17	1 3
15	19. 600	21 000	22	1 7
16	21. 000	22. 400	6	5
17	22 400	23 800	10	8
18	23 800	25 200	10	8
19	25. 200	26 600	1	1
20	26 600	28 000	9	7
21	28 000	29 400	1	1
22	29 400	30 800	0	0 0
23	30 800	32 200	3	2
24	32 200	33 600	0	0 0
25	33 600	35 000	2	2
			1279	100

mean 9.42
std.dev. 5.082
c.v.pct. 54.0

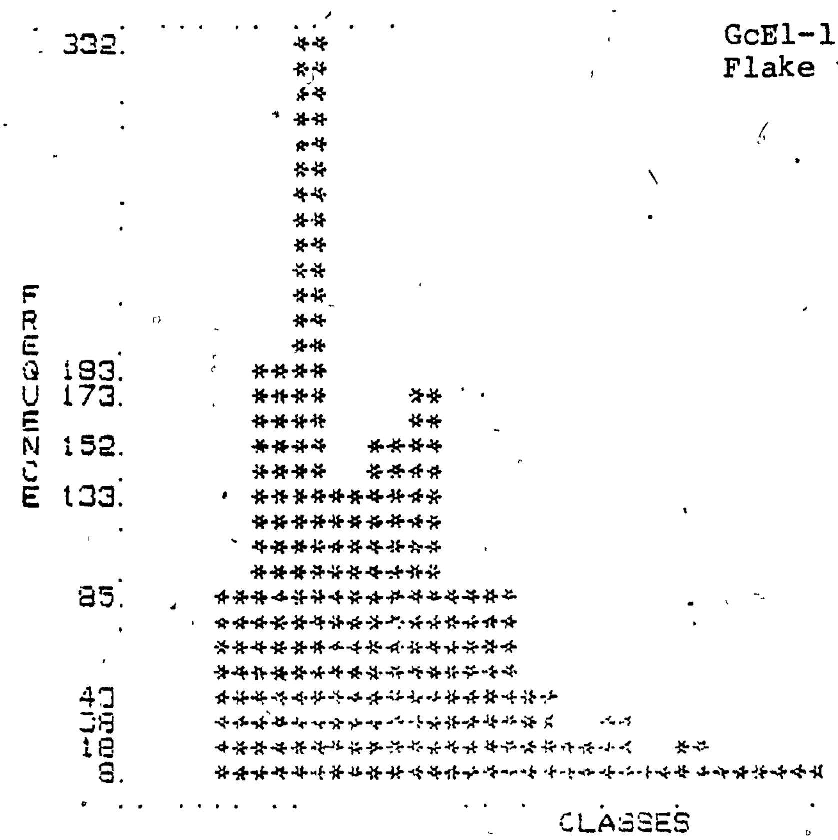
GcE1-22B
Flake length



CLASSE	BORNE INF	BORNE SUP	EFFECTIF	%
1	0.000	1.400	0	0.0
2	1.400	2.800	0	0.0
3	2.800	4.200	27	15.5
4	4.200	5.600	35	20.1
5	5.600	7.000	47	27.0
6	7.000	8.400	14	8.0
7	8.400	9.800	12	6.9
8	9.800	11.200	13	7.5
9	11.200	12.600	6	3.4
10	12.600	14.000	8	4.6
11	14.000	15.400	2	1.1
12	15.400	16.800	3	1.7
13	16.800	18.200	2	1.1
14	18.200	19.600	0	0.0
15	19.600	21.000	3	1.7
16	21.000	22.400	0	0.0
17	22.400	23.800	1	.6
18	23.800	25.200	1	.6
19	25.200	26.600	0	0.0
20	26.600	28.000	0	0.0
21	28.000	29.400	0	0.0
22	29.400	30.800	0	0.0
23	30.800	32.200	0	0.0
24	32.200	33.600	0	0.0
25	33.600	35.000	0	0.0
			174	100

mean	7.67
std.dev.	3.977
c.v.pct.	51.9

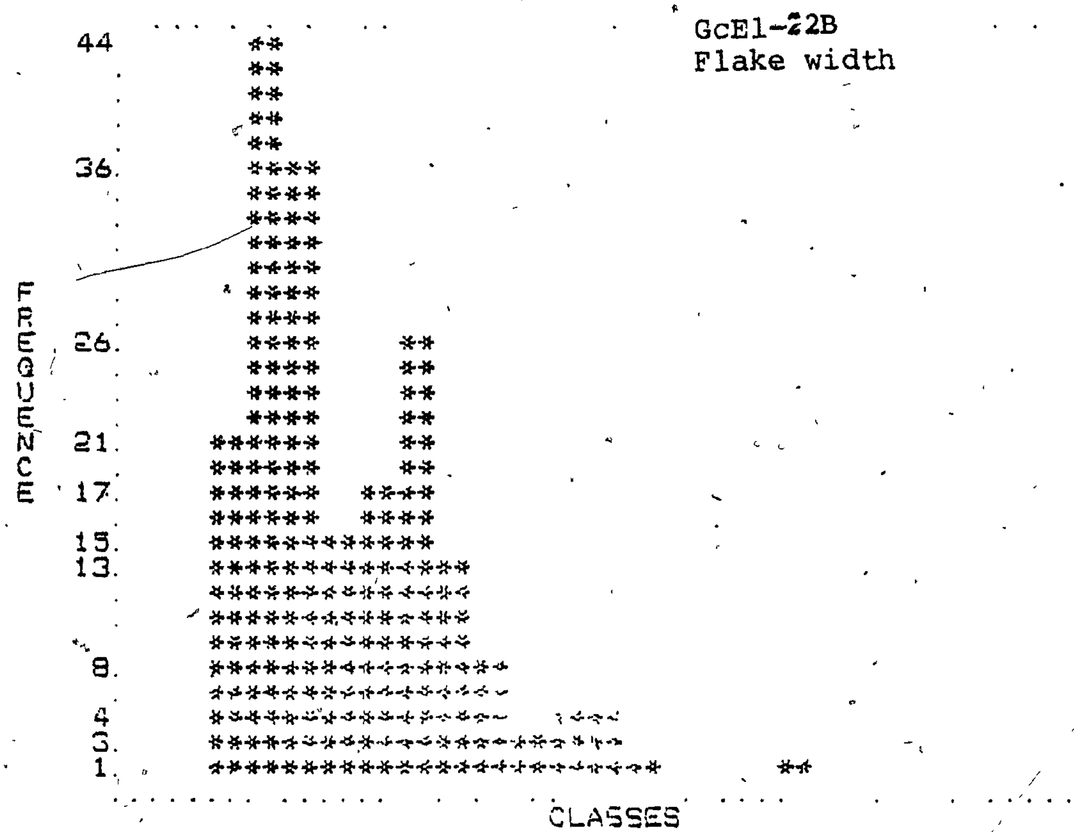
GcEl-15
Flake width



CLASSE	BORNE INF	BORNE SUP	EFFECTIF	%
1	0. 000	1 400	2	1
2	1 400	2. 800	0	0 0
3	2 800	4 200	91	6 4
4	4 200	5 600	183	13. 0
5	5 600	7 000	332	23 5
6	7 000	8 400	133	9 4
7	8. 400	9 800	152	10 8
8	9 800	11 200	173	12 3
9	11. 200	12. 600	88	6. 2
10	12 600	14 000	85	6 0
11	14 000	15. 400	43	3 0
12	15. 400	16 800	25	1 8
13	16 800	18. 200	38	2 7
14	18 200	19 600	15	1 1
15	19 600	21 000	18	1 3
16	21 000	22 400	9	6
17	22. 400	23 800	8	6
18	23. 800	25 200	8	6
19	25 200	26 600	3	2
20	26 600	28 000	2	1
21	28 000	29 400	0	0
22	29 400	30 800	3	2
23	30 800	32. 200	0	0 0
24	32 200	33 600	0	0. 0
25	33. 600	35 000	1	1
			1412	100

mean 9.2
std.dev. 4.5
c.v.pct. 48.6

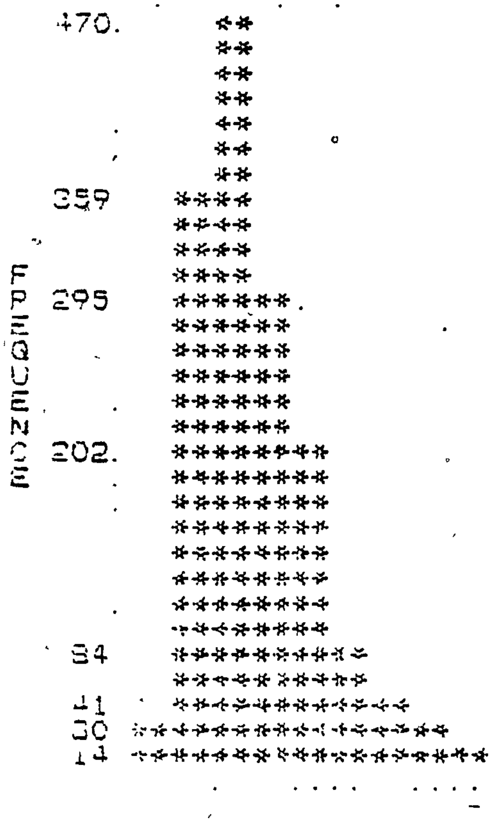
GcE1-22B
Flake width



CLASSE	BORNE INF.	BORNE SUP	EFFECTIF	%
1	0.000	1.400	0	0.0
2	1.400	2.800	0	0.0
3	2.800	4.200	21	10.9
4	4.200	5.600	44	22.8
5	5.600	7.000	36	18.7
6	7.000	8.400	15	7.8
7	8.400	9.800	17	8.8
8	9.800	11.200	25	13.5
9	11.200	12.600	13	6.7
10	12.600	14.000	8	4.1
11	14.000	15.400	3	1.6
12	15.400	16.800	4	2.1
13	16.800	18.200	4	2.1
14	18.200	19.600	1	.5
15	19.600	21.000	0	0.0
16	21.000	22.400	0	0.0
17	22.400	23.800	0	0.0
18	23.800	25.200	1	.5
19	25.200	26.600	0	0.0
20	26.600	28.000	0	0.0
21	28.000	29.400	0	0.0
22	29.400	30.800	0	0.0
23	30.800	32.200	0	0.0
24	32.200	33.600	0	0.0
25	33.600	35.000	0	0.0
			193	100

mean 8.1
std.dev. 3.65
c.v.pct. 45.1

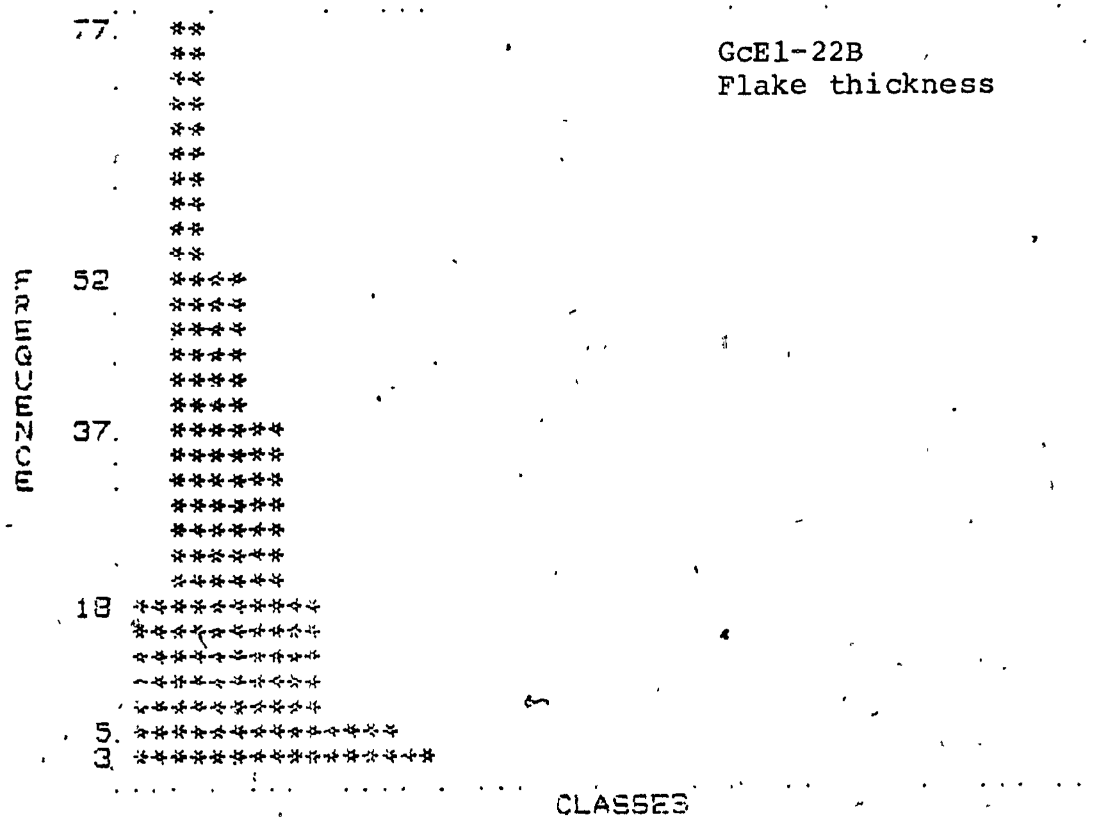
GcEl-15.
Flake thickness



CLASSE	BORNE INF	BORNE SUP	EFFECTIF	%
1	0.000	400	27	1 8
2	400	800	359	23 3
3	800	1 200	470	30 5
4	1 200	1.600	295	19 2
5	1.600	2 000	202	13 1
6	2.000	2.400	84	5 5
7	2.400	2 800	41	2.7
8	2 800	3 200	30	1 9
9	3 200	3 600	14	.9
10	3.600	4 000	7	.5
11	4 000	4 400	2	.1
12	4.400	4 800	4	.3
13	4 800	5 200	2	1
14	5.200	5.600	0	0.0
15	5.600	6 000	0	0 0
16	6 000	6 400	0	0 0
17	6 400	6.800	0	0 0
18	6.800	7 200	0	0 0
19	7 200	7 600	0	0 0
20	7 600	8 000	0	0 0
21	8 000	8 400	0	0 0
22	8 400	8 800	0	0 0
23	8.800	9 200	2	1
24	9 200	9 600	0	0 0
25	9 600	10 000	1	1
			1540	100

mean 1.3
std.dev. .8
c.v.pct. 56.7

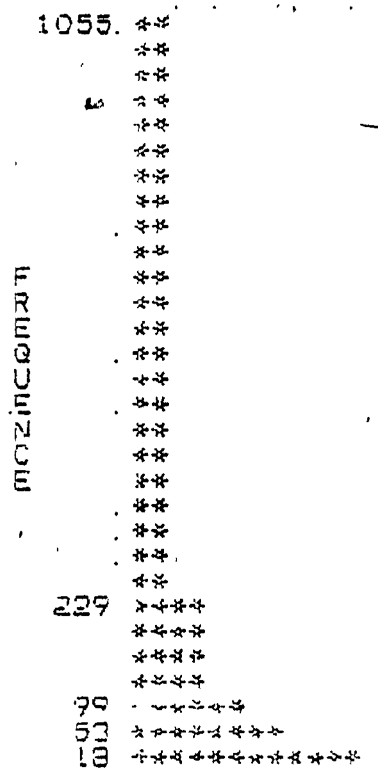
GcE1-22B
Flake thickness



CLASSE	BORNE INF.	BORNE SUP	EFFECTIF	%
1	0.000	.400	19	8.7
2	.400	.800	77	35.3
3	.800	1.200	52	23.9
4	1.200	1.600	37	17.0
5	1.600	2.000	18	8.3
6	2.000	2.400	6	2.8
7	2.400	2.800	5	2.3
8	2.800	3.200	3	1.4
9	3.200	3.600	0	0.0
10	3.600	4.000	0	0.0
11	4.000	4.400	1	.5
12	4.400	4.800	0	0.0
13	4.800	5.200	0	0.0
14	5.200	5.600	0	0.0
15	5.600	6.000	0	0.0
16	6.000	6.400	0	0.0
17	6.400	6.800	0	0.0
18	6.800	7.200	0	0.0
19	7.200	7.600	0	0.0
20	7.600	8.000	0	0.0
21	8.000	8.400	0	0.0
22	8.400	8.800	0	0.0
23	8.800	9.200	0	0.0
24	9.200	9.600	0	0.0
25	9.600	10.000	0	0.0
			218	100

mean	1.1
std.dev.	.3
c.v.pct.	55.8

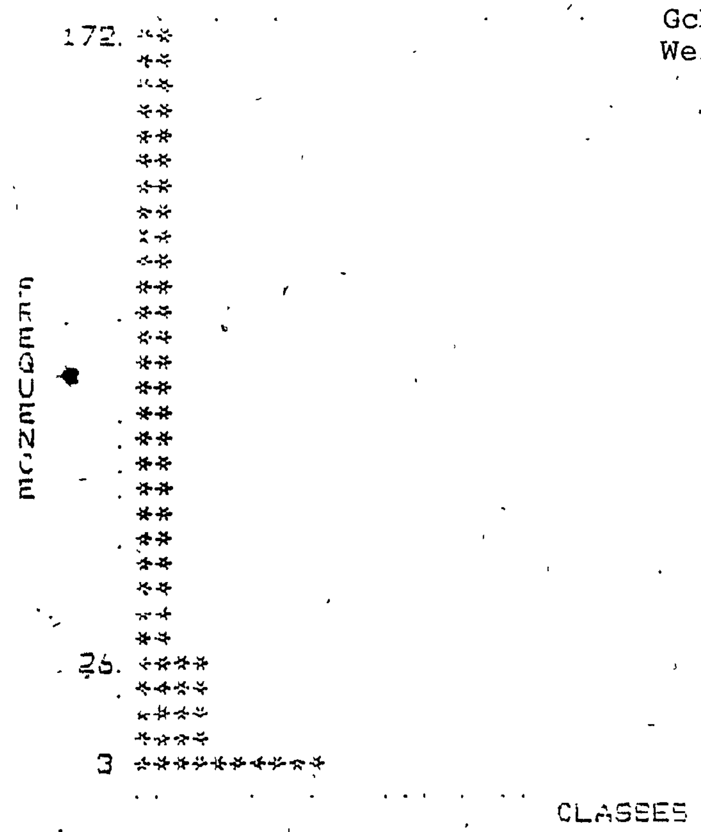
GcE1-15
Weight



CLASSE	BORNE INF	BORNE SUP.	EFFECTIF	%
1	0.000	120	1055	68.5
2	120	240	229	14 9
3	240	360	99	6. 4
4	360	480	53	3 4
5	480	600	24	1. 6
6	600	720	18	1 2
7	720	840	15	1. 0
8	840	.960	8	5
9	.960	1.080	9	6
10	1.080	1 200	7	5
11	1.200	1 320	7	5
12	1.320	1 440	1	.1
13	1 440	1 560	4	.3
14	1 560	1 680	3	.2
15	1.680	1.800	1	.1
16	1.800	1 920	2	1
17	1.920	2 040	2	1
18	2 040	2 160	1	1
19	2.160	2 280	0	0 0
20	2 280	2 400	0	0 0
21	2.400	2 520	0	0 0
22	2.520	2 640	1	1
23	2 640	2.760	1	1
24	2.760	2 880	0	0 0
25	2.880	3 000	0	0 0
			1540	

mean .153
std.dev. .263
c.v.pct. 171.8

GcEl-22B
Weight



CLASSE	BORNE INF	BORNE SUP	EFFECTIF	%
1	0 000	.120	172	78.9
2	.120	.240	26	11 9
3	.240	.360	6	2 8
4	.360	.480	8	3 7
5	.480	.600	3	1 4
6	.600	.720	1	5
7	.720	.840	0	0 0
8	.840	.960	1	5
9	.960	1 080	0	0 0
10	1 080	1 200	0	0. 0
11	1 200	1 320	0	0 0
12	1. 320	1 440	0	0 0
13	1. 440	1 560	0	0 0
14	1 560	1 680	0	0 0
15	1 680	1 800	1	5
16	1. 800	1 920	0	0 0
17	1 920	2 040	0	0 0
18	2. 040	2 160	0	0 0
19	2 160	2 280	0	0 0
20	2 280	2 400	0	0 0
21	2. 400	2 520	0	0 0
22	2 520	2 640	0	0 0
23	2. 640	2 760	0	0 0
24	2. 760	2 880	0	0 0
25	2 880	3 000	0	0 0
			218	100

mean .095
std.dev. .170
c.v.pct. 179.1

FLAKE SHAPE		GcEl-15 FREQUENCY	%	GcEl-22B FREQUENCY	%
1	PARALLEL	10	4.6	119	7.7
2	PARALELL CONVEX	8	3.7	88	5.7
3	EXPANDING	54	24.8	425	27.6
4	CONTRACTING	5	2.3	91	5.9
5	CONVEX	23	10.6	190	12.3
6	IRREGULAR	26	11.9	158	10.3
7	DISPLACED	40	18.3	210	13.6
8	ROUND	19	8.7	92	6.0
9	----	0	0.0	0	0.0
10	----	0	0.0	0	0.0
11	----	0	0.0	0	0.0
12	----	0	0.0	0	0.0
9	NOT RECORDED	33	15.1	167	10.8
			100.0		100.0

****

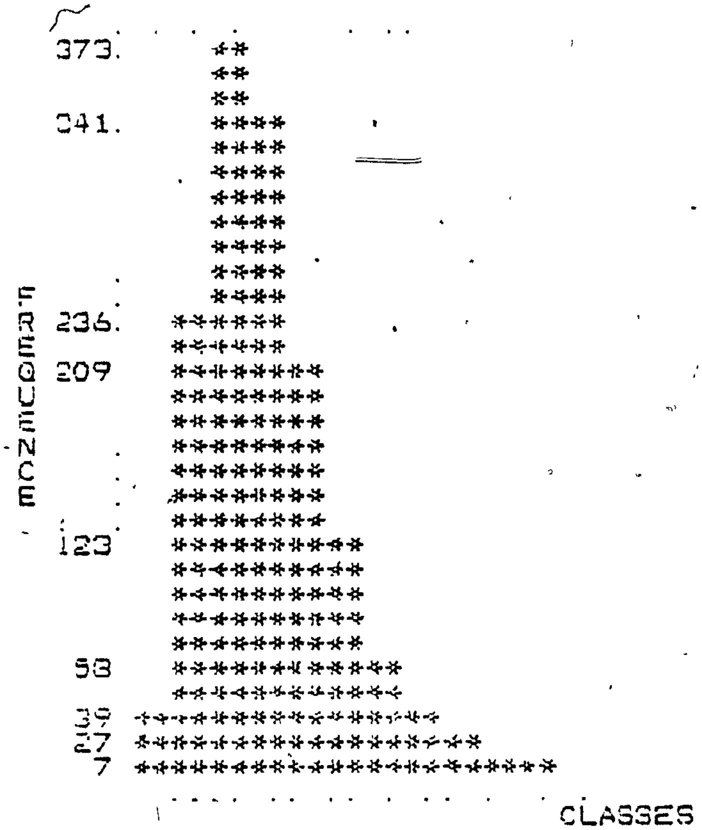
FLAKE CURVATURE		FREQUENCY	%	FREQUENCY	%
1	STRAIGHT	680	44.2	101	46.3
2	CURVED	547	35.5	68	31.2
3	VERY CURVED	125	8.1	8	3.7
4	DORSAL CURVED	82	5.3	17	7.8
5	----	0	0.0	0	0.0
6	----	0	0.0	0	0.0
7	----	0	0.0	0	0.0
8	----	0	0.0	0	0.0
9	----	0	0.0	0	0.0
10	----	0	0.0	0	0.0
11	----	0	0.0	0	0.0
12	----	0	0.0	0	0.0
9	NOT RECORDED	106	6.9	24	11.0
			100.0		100.0

****

BULB OF PERCUSSION		FREQUENCY	%	FREQUENCY	%
1	FLAT	884	57.4	136	62.4
2	PRONOUNCED	492	31.9	45	20.6
3	VERY PRONOUNCED	161	10.5	37	17.0
4	----	1	.1	0	0.0
5	----	0	0.0	0	0.0
6	----	0	0.0	0	0.0
7	----	0	0.0	0	0.0
8	----	0	0.0	0	0.0
9	----	0	0.0	0	0.0
10	----	0	0.0	0	0.0
11	----	0	0.0	0	0.0
12	----	0	0.0	0	0.0
9	NOT RECORDED	2	.1	0	0.0
			100.0		100.0

****

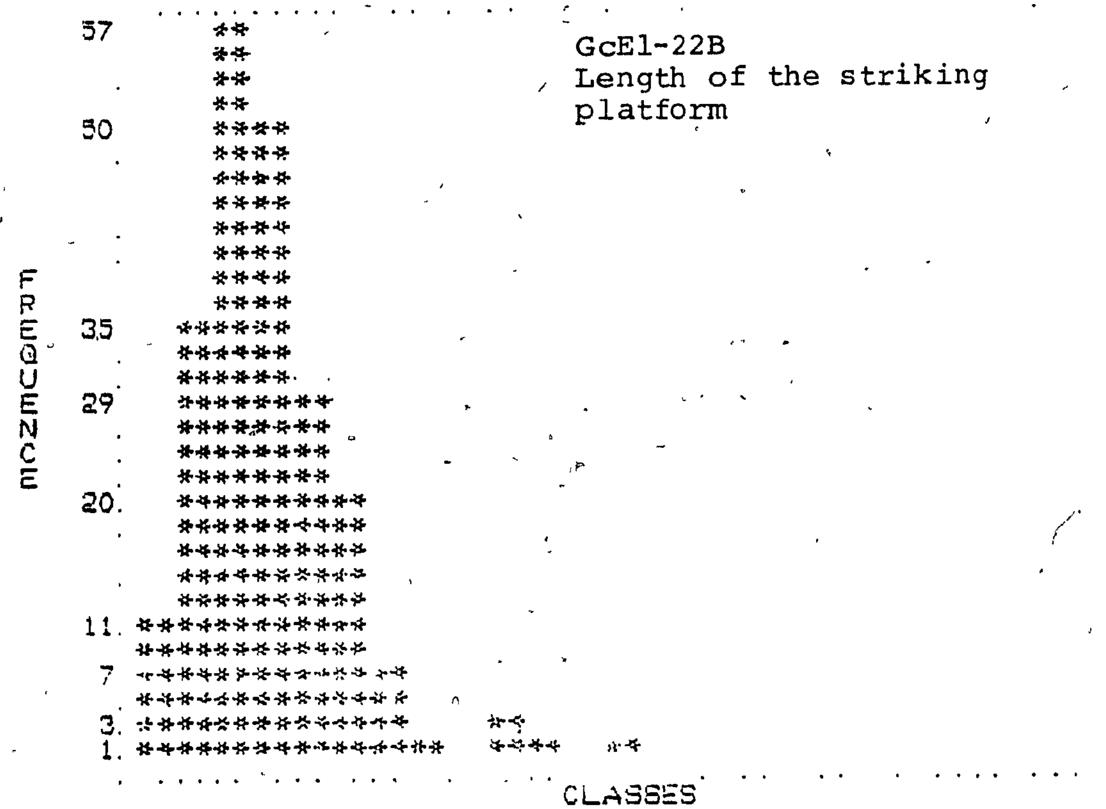
DISTAL TERMINATION		GcEl-15 FREQUENCY	GcEl-15 %	GçEl-22B FREQUENCY	GçEl-22B %
1	FEATHERED	942	61.2	147	67.4
2	HINGED	56	3.6	9	4.1
3	SNAPPED OR BROKEN	259	16.8	45	20.6
4	FEATHERED/HINGED	17	1.1	1	.5
5	FEATHERED/CHIPPED	264	17.1	15	6.9
6	-----	0	0.0	0	0.0
7	-----	0	0.0	0	0.0
8	-----	0	0.0	0	0.0
9	-----	0	0.0	0	0.0
10	-----	0	0.0	0	0.0
11	-----	0	0.0	0	0.0
12	-----	0	0.0	0	0.0
9	NOT RECORDED	2	.1	1	.5
			100.0		100.0



GcEl-15
Length of the striking platform

CLASSE	BORNE INF	BORNE SUP.	EFFECTIF	%
1	0.000	1.000	41	2.8
2	1.000	2.000	236	15.9
3	2.000	3.000	373	25.1
4	3.000	4.000	341	22.9
5	4.000	5.000	209	14.1
6	5.000	6.000	123	8.3
7	6.000	7.000	58	3.9
8	7.000	8.000	39	2.6
9	8.000	9.000	27	1.8
10	9.000	10.000	16	1.1
11	10.000	11.000	7	5
12	11.000	12.000	2	.1
13	12.000	13.000	4	3
14	13.000	14.000	4	3
15	14.000	15.000	3	2
16	15.000	16.000	0	0 0
17	16.000	17.000	1	1
18	17.000	18.000	1	1
19	18.000	19.000	0	0 0
20	19.000	20.000	0	0 0
21	20.000	21.000	1	1
22	21.000	22.000	0	0 0
23	22.000	23.000	0	0 0
24	23.000	24.000	0	0 0
25	24.000	25.000	0	0.0
			1487	100

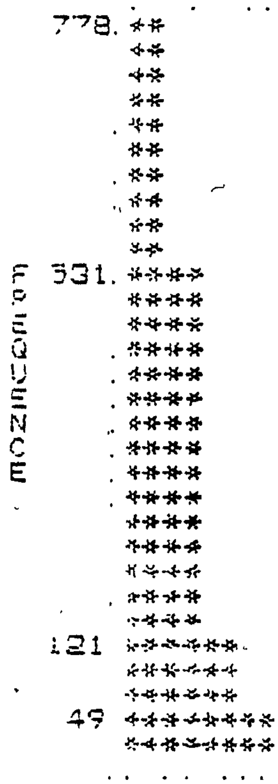
mean	3.9
std.dev.	2.2
c.v.pct.	56.7



CLASSE	BORNE INF.	BORNE SUP	EFFECTIF	%
1	0.000	1.000	11	5.1
2	1.000	2.000	35	16.2
3	2.000	3.000	57	26.4
4	3.000	4.000	50	23.1
5	4.000	5.000	29	13.4
6	5.000	6.000	20	9.3
7	6.000	7.000	7	3.2
8	7.000	8.000	2	0.9
9	8.000	9.000	0	0.0
10	9.000	10.000	3	1.4
11	10.000	11.000	1	0.5
12	11.000	12.000	0	0.0
13	12.000	13.000	1	0.5
14	13.000	14.000	0	0.0
15	14.000	15.000	0	0.0
16	15.000	16.000	0	0.0
17	16.000	17.000	0	0.0
18	17.000	18.000	0	0.0
19	18.000	19.000	0	0.0
20	19.000	20.000	0	0.0
21	20.000	21.000	0	0.0
22	21.000	22.000	0	0.0
23	22.000	23.000	0	0.0
24	23.000	24.000	0	0.0
25	24.000	25.000	0	0.0
			216	100

mean	3.5
std.dev.	1.84
c.v.pct.	52.0

GcE1-15
Width of the striking platform

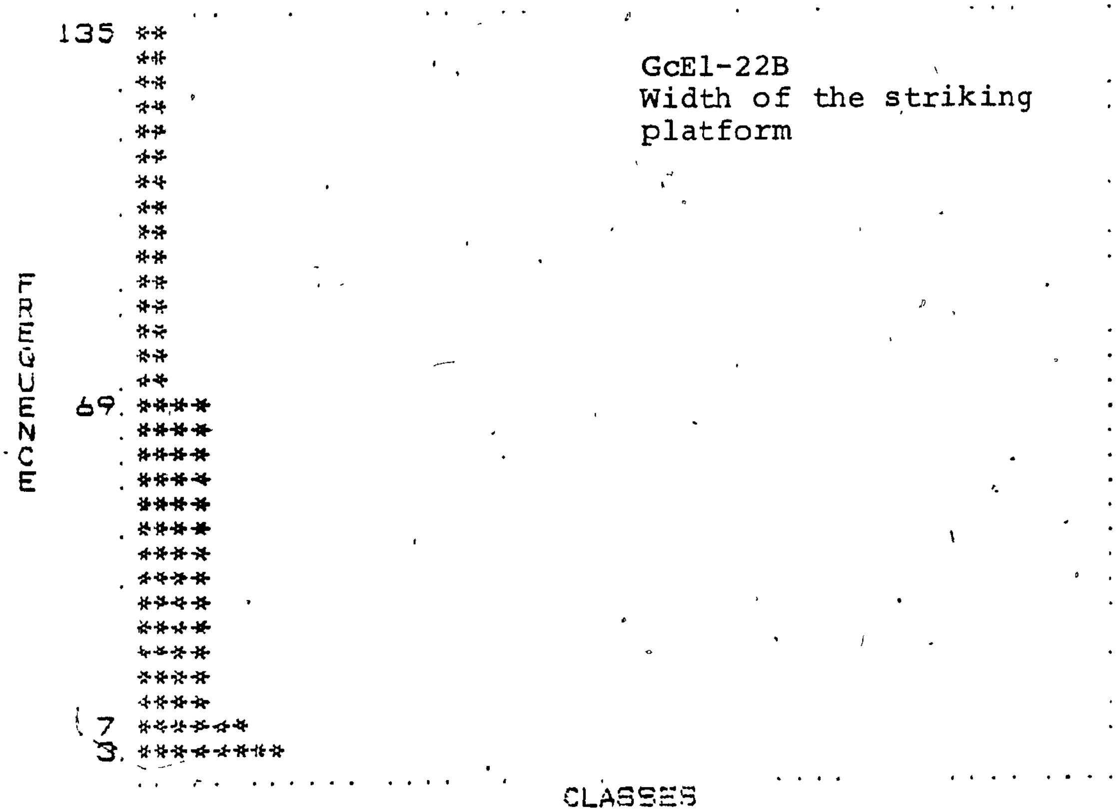


CLASSES

CLASSE	BORNE INF	BORNE SUP.	EFFECTIF	%
1	0 000	800	778	51.6
2	800	1 600	531	35.2
3	1 600	2 400	121	8.0
4	2. 400	3 200	49	3.2
5	3 200	4 000	12	3
6	4 000	4 800	2	1
7	4 800	5 600	6	4
8	5. 600	6 400	3	2
9	6. 400	7 200	2	1
10	7. 200	8 000	3	2
11	8. 000	8 800	0	.0 0
12	8 800	9 600	0	0.0
13	9 600	10 400	0	0 0
14	10 400	11 200	0	0 0
15	11. 200	12. 000	1	1
16	12. 000	12 800	0	0.0
17	12. 800	13. 600	0	0 0
18	13. 600	14 400	0	0 0
19	14. 400	15 200	0	0 0
20	15 200	16 000	0	0 0
21	16. 000	16 800	0	0 0
22	16. 800	17 600	0	0 0
23	17. 600	18 400	1	1
24	18. 400	19 200	0	0 0
25	19. 200	20 000	0	0 0
			1509	100

mean	1.0
std.dev.	1.0
c.v.pct.	93.7

GcEl-22B
Width of the striking platform



CLASSE	BORNE INF	BORNE SUP	EFFECTIF	%
1	0. 000	800	135	62. 2
2	800	1 600	69	31 8
3	1 600	2. 400	7	3. 2
4	2. 400	3 200	3	1 4
5	3. 200	4 000	2	. 9
6	4. 000	4 800	0	0. 0
7	4 800	5 600	0	0. 0
8	5 600	6 400	0	0. 0
9	6. 400	7 200	0	0 0
10	7 200	8 000	1	5
11	8. 000	8 800	0	0. 0
12	8 800	9. 600	0	0 0
13	9 600	10 400	0	0 0
14	10 400	11 200	0	0 0
15	11 200	12. 000	0	0 0
16	12. 000	12 800	0	0. 0
17	12. 800	13 600	0	0. 0
18	13 600	14 400	0	0 0
19	14 400	15 200	0	0 0
20	15 200	16 000	0	0 0
21	16 000	16 800	0	0 0
22	16 800	17 600	0	0 0
23	17 600	18 400	0	0 0
24	18. 400	19 200	0	0. 0
25	19 200	20 000	0	0 0
			217	100

mean	.85
std.dev.	.75
c.v.pct.	87.6

LIPPING		GcEl-15 FREQUENCY	%	GcEl-22B FREQUENCY	%
1	PRESENT	583	37.9	77	35.3
2	ABSENT	954	62.0	140	64.2
3	----	0	0.0	1	.5
4	----	0	0.0	0	0.0
5	----	0	0.0	0	0.0
6	----	0	0.0	0	0.0
7	----	0	0.0	0	0.0
8	----	0	0.0	0	0.0
9	----	0	0.0	0	0.0
10	----	0	0.0	0	0.0
11	----	0	0.0	0	0.0
12	----	0	0.0	0	0.0
9	NOT RECORDED	2	.1	0	0.0
			100.0		100.0

****

SHAPE OF STRIKING PLATFORM		FREQUENCY	%	FREQUENCY	%
1	PUNCTIFORM	32	2.1	9	4.1
2	LINEAR	98	6.4	25	11.5
3	TRIANGULAR	52	3.4	7	3.2
4	TRIANGULAR-CONVEX	297	19.3	36	16.5
5	BI-CONVEX	349	22.7	44	20.2
6	CONCAVE-CONVEX	231	15.0	42	19.3
7	CONVEX-CONCAVE	8	.6	1	.5
8	PLANO-CONVEX	277	18.0	32	14.7
9	CONVEX-PLANO	0	0.0	0	0.0
10	CHAPEAU DE GENDARME	23	1.5	0	0.0
11	WINGLIKE	88	5.7	19	8.7
12	DOUBLE	15	1.0	2	.9
99	NOT RECORDED	69	4.5	1	.5
			100.0		100.0

MODIFICATION OF STR PLAT SURFACE		FREQUENCY	%	FREQUENCY	%
1	SMOOTH	527	34.2	51	23.4
2	FACETTED	498	32.3	65	29.8
3	ABRADED	145	9.4	19	8.7
4	DIHEDRAL (CRESTED)	54	3.5	15	6.9
5	FACETTED-ABRADED	99	6.4	18	8.3
6	NOT OBSERVABLE	54	3.5	6	2.8
7	ROUGH/STEPFRACTURED	139	9.0	43	19.7
8	----	1	.1	0	0.0
9	----	0	0.0	0	0.0
10	----	0	0.0	0	0.0
11	----	0	0.0	0	0.0
12	----	0	0.0	0	0.0
9	NOT RECORDED	23	1.5	1	.5
			100.0		100.0

****

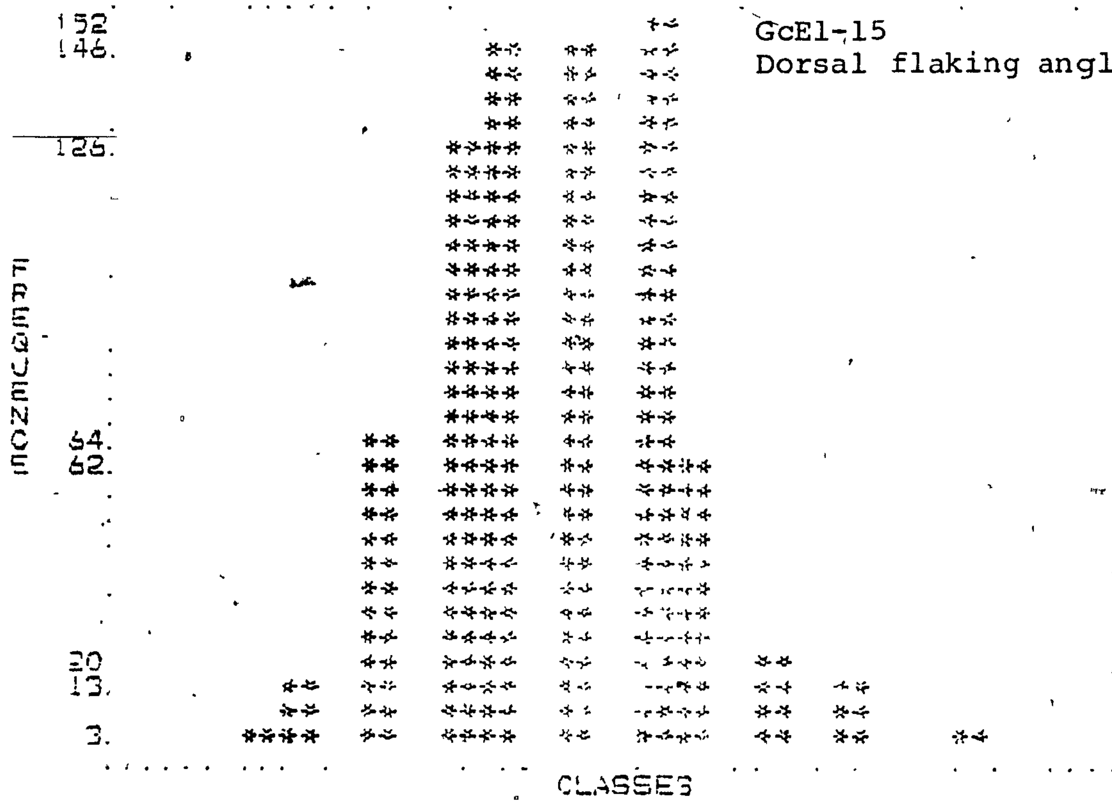
DORSAL EDGE MODIF. OF STR PLAT		GcE1-15 FREQUENCY	%	GcE1.22B FREQUENCY	%
1	UNALTERED	564	36.6	75	34.4
2	TRIMMED	366	23.8	40	18.3
3	STEPPED	233	15.1	42	19.3
4	ABRADED	248	16.1	35	16.1
5	ABRADED TRIMMED	69	4.5	11	5.0
6	ABRADED STEPPED	36	2.3	11	5.0
7	NOT OBSERVABLE	13	.8	2	.9
8	----	0	0.0	0	0.0
9	----	0	0.0	0	0.0
10	----	0	0.0	0	0.0
11	----	0	0.0	0	0.0
12	----	0	0.0	0	0.0
9	NOT RECORDED	10	.6	2	.9
			100.0		100.0

DORSAL SURFACE MORPHOLOGY

DORSAL FLAKE SCAR PATTERNS		GcEl-15 FREQUENCY	GcEl-15 %	GcEl-22B FREQUENCY	GcEl-22B %
1	UNIFORM	266	17.3	52	23.9
2	LONGITUDINALLY FAC	770	50.0	106	48.6
3	MARGINALLY FAC	159	10.3	14	6.4
4	IRREGULARLY FAC	328	21.3	35	16.1
5	----	6	.4	0	0.0
6	----	0	0.0	0	0.0
7	----	0	0.0	1	.5
8	----	0	0.0	0	0.0
9	----	0	0.0	0	0.0
10	----	0	0.0	0	0.0
11	----	0	0.0	0	0.0
12	----	0	0.0	0	0.0
9	NOT RECORDED	11	.7	10	4.6
			100.0		100.0

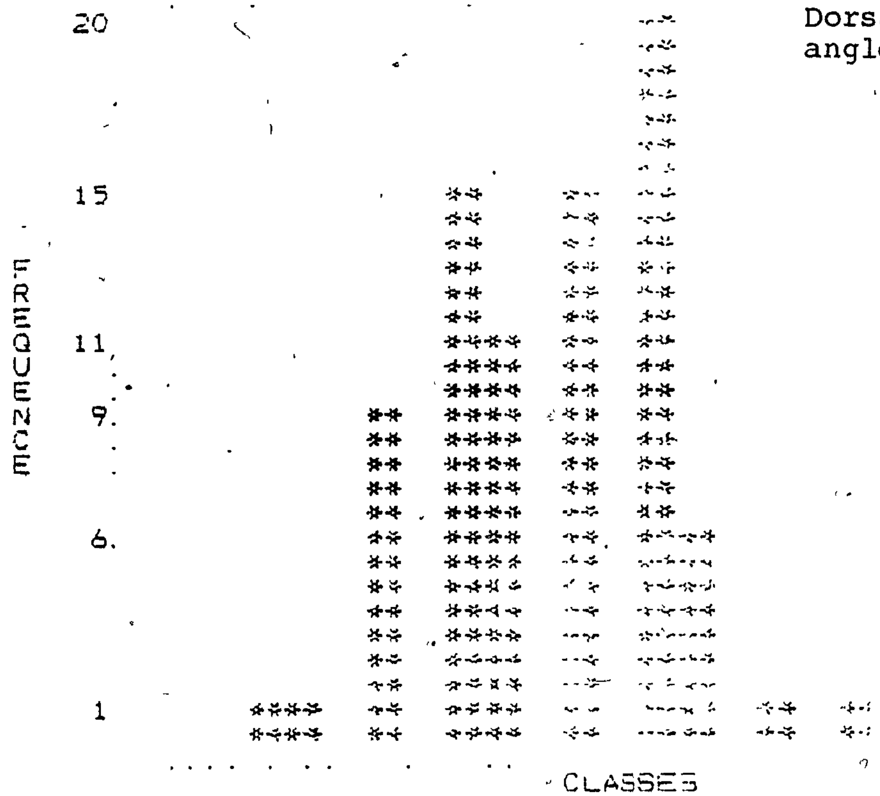
POLISH ON DORSAL RIDGE/S		GcEl-15 FREQUENCY	GcEl-15 %	GcEl-22B FREQUENCY	GcEl-22B %
1	PRESENT	74	4.8	11	5.0
2	ABSENT	1462	94.9	206	94.5
3	----	0	0.0	0	0.0
4	----	0	0.0	0	0.0
5	----	0	0.0	0	0.0
6	----	0	0.0	0	0.0
7	----	0	0.0	0	0.0
8	----	0	0.0	0	0.0
9	----	0	0.0	0	0.0
10	----	0	0.0	0	0.0
11	----	0	0.0	0	0.0
12	----	0	0.0	0	0.0
9	NOT RECORDED	4	.3	1	.5
			100.0		100.0

GcEl-15
Dorsal flaking angle



CLASSE	BORNE INF.	BORNE SUP	EFFECTIF	%
1	0 000	6 000	0	0 0
2	6. 000	12 000	2	3
3	12. 000	18 000	0	0. 0
4	18. 000	24 000	5	7
5	24 000	30 000	17	2 2
6	30. 000	36 000	0	0 0
7	36 000	42 000	64	8 4
8	42. 000	48 000	0	0 0
9	48 000	54. 000	126	16 6
10	54 000	60 000	147	19 3
11	60 000	66 000	0	0 0
12	66. 000	72 000	146	19 2
13	72. 000	78 000	0	0 0
14	78 000	84 000	152	20 0
15	84 000	90 000	62	8 1
16	90. 000	96 000	0	0 0
17	96 000	102 000	20	2 6
18	102 000	108 000	0	0 0
19	108 000	114 000	13	1 7
20	114 000	120 000	1	1
21	120 000	126 000	0	0 0
22	126 000	132 000	3	4
23	132 000	138 000	0	0. 0
24	138 000	144 000	2	3
25	144 000	150 000	1	1
			761	100

GcE1-22B
Dorsal flaking
angle



CLASSE	BORNE INF.	BORNE SUP	EFFECTIF	%
1	0.000	6.000	0	0 0
2	6.000	12.000	0	0.0
3	12 000	18 000	0	0 0
4	18.000	24.000	1	1 3
5	24.000	30 000	1	1 3
6	30 000	36 000	0	0 0
7	36 000	42 000	9	11 3
8	42 000	48 000	0	0 0
9	48 000	54 000	15	15 8
10	54.000	60 000	11	13 8
11	60.000	66 000	0	0 0
12	66.000	72 000	15	18 8
13	72 000	78 000	0	0 0
14	78 000	84 000	20	25 0
15	84.000	90 000	6	7 5
16	90.000	96 000	0	0 0
17	96.000	102 000	1	1.3
18	102.000	108.000	0	0 0
19	108 000	114 000	1	1 3
20	114 000	120 000	0	0 0
21	120.000	126 000	0	0 0
22	126 000	132 000	0	0 0
23	132 000	138.000	0	0 0
24	138 000	144.000	0	0 0
25	144.000	150 000	0	0 0
			761	100

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