

LITHICS AND LIVELIHOOD:  
STONE TOOL TECHNOLOGIES OF CENTRAL AND SOUTHERN INTERIOR B.C.

by

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## ABSTRACT

This study is designed to investigate patterns of lithic technological variability in relation to settlement strategies that were employed by late prehistoric inhabitants of central and southern regions of interior British Columbia. The research contributes to current archaeological method through an experimental program of stone tool manufacture, and also to current understanding of Interior Plateau prehistory, through a multiregional analysis of technological variability.

The first stage of the study involves conducting a controlled experiment, to determine the degree to which lithic debitage can be used to predict stages of chipped stone tool manufacture, and to devise an efficient means of classifying debitage into general reduction stages. The experiment is unique in providing control over the precise sequential removal of flakes, and also in examining quantitative variability in debitage that have been produced as the by-products of the manufacture of several tools and cores. The result of the experimental program is the formulation of a debitage classification that classifies flakes into early, middle or late reduction stages, and also into bifacial and bipolar reduction types.

The archaeological analyses in the second major stage of the research use the debitage reduction stage classification and the occurrence of various lithic tools to examine the nature of interassemblage variability across the 38 sites from four regions of the Interior Plateau. A total of 14,541 flakes, 164 cores and 861 tools from the Eagle Lake, Mouth of the Chilcotin, Lillooet and Hat Creek regions are analyzed, using multivariate and bivariate quantitative methods. Three hypotheses relevant to lithic technology and hunter-

gatherer archaeology are evaluated in this stage of the study.

The analyses first employ the experimental debitage classification to obtain interpretable patterns of inter-assemblage similarities and differences. Multivariate analysis shows that several kinds of sites defined on the basis of features can be grouped by their predominance of early/core reduction, middle/wide ranging reduction, and late/maintenance reduction debitage.

The first formal hypothesis tested is that obsidian and chert raw materials should evidence patterns of conservation and economizing behavior by virtue of their geological scarcity in relation to vitreous basalt raw material. A series of chi-square tests demonstrates that debitage frequencies by reduction stage are proportionately equal for these three raw materials in all but the Mouth of the Chilcotin region. In all regions, except Lillooet where tool sample sizes are too small for reliable testing, tool sizes and scar counts show no significant difference attributable to raw materials. A slight trend is noted for chert tools to be larger and simpler than vitreous basalt or obsidian tools. A set of bivariate graphs demonstrates that while lithic raw materials may be reduced in highly similar manners, one raw material may have served to replace another.

The second hypothesis, that tool curation and maintenance strongly affects assemblage composition, is first tested by examining tool assemblage measures that have been suggested by recent lithic technological models. Assemblages are highly variable with respect to the numbers of tools left at sites in relation to the intensity of tool maintenance that occurred at sites.

The third hypothesis tested is that a set of site occupation purposes can be reliably predicted on the basis of debitage reduction stages and a functional tool classification. Using multiple discriminant analysis, house-pit sites are accurately predicted at an 80% rate, and lithic scatters without features are accurately predicted at a rate of 60%. Lithic scatters with housepits achieve 86% correct classification; lithic scatters with cache-pits are correctly classified at a rate of 75%; and lithic scatters with fire-cracked rock are accurately predicted 80% of the time. The results of this analysis are further strengthened by removing an ambiguous assemblage from consideration.

The most significant findings of the multiregional analyses are those of definite tool curation patterns as evidenced in the raw material analysis, and the occupation span inferences of the tool maintenance analysis. Overall, it has been demonstrated that an experimentally obtained stage classification of debitage enables the derivation of behavioral inferences that could not be currently obtained by other means. In its multiregional perspective, this study has shown that processes of lithic assemblage formation are largely independent of regional provenience and more dependent on settlement purpose. Overall, the greatest determinant of assemblage variability is inferred to be site occupation span.

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## CHAPTER 1

## INTRODUCTION

The purpose of this study is to discover how lithic technology varied within a wide range of settlement strategies that were employed by late prehistoric inhabitants of central and southern Interior British Columbia. To achieve this goal, the research proceeds in two major stages. The first step involves conducting an experimental program in chipped stone tool manufacture, to determine the degree to which tool manufacture stages can be inferred by analysis of the by-products of that process, and to devise a reliable, yet relatively simple means of classifying debitage into reduction stages. The second major aspect of this study involves the application of the experimental findings to archaeological collections from four regions of the Interior Plateau, to evaluate a set of general propositions concerning assemblage variability.

The major polemic that is advanced in the following pages is that the various uses of sites by hunters and gatherers, rather than the antiquity or ethnic affinity of sites are the most important determinants of lithic assemblage composition. The specific behavioral inferences that are derived for assemblages are based on both experimental and archaeological controls as well as analogs with recorded ethnographic patterns. This dissertation

has a strong empirical and methodological focus, and the inter-regional research is unique in investigating the extent to which prehistoric settlement behavior apparent in one region may be comparable to that exhibited in other nearby and distant regions.

The behavioral viewpoint discussed in Chapter 2, has been evolving in archaeological research for some two decades, but is only recently being applied in British Columbia, in studies that do more than allude to this important concept. Chapter 2 presents the critical origins of behavioral approaches to stone tools, and details the development of several approaches, as witnessed mainly in the continuing arguments of Lewis Binford.

The third chapter provides background discussions, focusing on the existing ethnographic and archaeological records of the Interior Plateau. The review of ethnographic knowledge serves to demonstrate that the early historic inhabitants of the Interior Plateau had an essentially common lifestyle, that was highly seasonal and very mobile. Here are discussed particular exceptions to the general pattern, that are in evidence with respect to the groups living within the four regions that are investigated. The chapter also briefly reviews ethnographic references to lithic technology. The development of prehistoric archaeological research in the central-southern Interior Plateau is discussed in terms of early historic observations and speculations, culture-history investigations, and settlement pattern studies. The latter are important in providing both the methodological and empirical bases

for the current study.

The experimental program in debitage analysis and classification is presented in Chapter 4. The task of rendering the description of chipped stone tool manufacturing stages into a quantitative method is discussed in terms of its origins and outstanding problems, and a solution to some of these problems is developed. The experiments are precedent-setting in their use of specific controls and in examining general reduction stages in the manufacture of a wide range of tools and cores, rather than single tool types.

In Chapter 5, I describe the archaeological data base of the research program. Each of the 38 sites under study is described. Summary quantitative data on the debitage and tool assemblages are provided, as are photographic illustrations of the tool and core assemblages.

Multiregional analyses of lithic assemblage variability are presented in Chapter 6, where three hypotheses of importance to model-building in hunter-gatherer archaeology are tested. The analyses disclose patterns of assemblage formation processes with respect to reduction stages, raw materials, tool curation, and settlement strategy factors. As a means of summarizing the results of the analyses, the sites are grouped in terms of inferred occupation spans, and kinds of cultural features present, and consistent and prevailing patterns of lithic assemblage formation are discussed.

The final chapter concludes the study by summarizing its major contributions to current archaeological method and to Interior Plateau archaeology. The overall success of the study is evaluated here, and areas of research in need of further consideration are identified.

## CHAPTER 2

## LITHIC TECHNOLOGY AND HUNTER-GATHERER MOBILITY

2.1. Introduction

The interpretation of lithic assemblage variability in prehistoric human locales is one of archaeology's leading problem areas. Until well into the 1960's, and still a valuable paradigm, the prevailing approach to stone tools was culture-historic, and was rarely based on quantified explanations of meaning in tool form. The major theoretical and methodological innovations that initiated behavioral approaches to lithic assemblages were provided by Binford and Binford (1966, 1969), and continue to be actively pursued by Lewis Binford, although he would probably not presently label his approach as behavioral (see Binford 1981b).

This study explicitly employs Binford's perspective and expectations, and the purpose of this chapter is to examine the development of behavioral analyses of lithic assemblages. Here are first discussed the beginnings of the shift in paradigms, that focused on the interpretation of stratigraphic differences in assemblages from the Mousterian of Europe. The Mousterian problem has been at the forefront of archaeological awareness, and a thorough discussion of its development provides a suitable analog of the changes in archaeological theory and method that have

been brought about by mainly Western archaeologists in the last 20 years. The discussion also reveals some valuable empirical information, and reinforces the large-scale perspective of this study.

To provide the major theoretical background to this study, I then review current developments in understanding the relationships between lithic technology and the mobility of hunters and gatherers. Again, Binford's contributions are extremely relevant, and are detailed enough to provide propositions that are examined in future chapters, as are certain generalizations provided by other researchers working along these lines.

## 2.2. The Mousterian Problem

The term Mousterian is used to describe artifact assemblages occurring during the time of the Eemian interglacial and early to middle Würm environmental episodes in Europe and Western Asia. It has also been applied to assemblages in China (Bordes 1969: 129 - 130). The Mousterian was first defined by de Mortillet (1869) at Dordogne shelter, as a means of distinguishing its flake tool industry from the earlier handaxe assemblages of the Acheulian. Francois Bordes, the researcher who was by far the most familiar with the Mousterian and all of its variants, maintained that the Mousterian is described technologically as an industry composed of flakes that may or may not have faceted striking platforms, with variable proportions of points, side-scrapers, denticulate tools,

bifaces, and burins (among other sub-types). In all, 63 tool types are used to describe Mousterian variability (Bordes 1972: 48).

There are four recognized major kinds of Mousterian assemblages, or facies, that are based on cumulative frequency graphs of the 63 tool types, when they are arranged in a specific order (Bordes 1972: 49 - 52; cf. Fish 1976).

1. The Mousterian of Acheulian Tradition (MAT) was thought by Bordes (1961) to be derived from the late Acheulian, and is divided into two subtypes, A and B. MAT subtype A contains relatively intermediate amounts of sidescrapers and denticulates (20 to 40 %), well-made cordiform and triangular handaxes (8 - 40%), and rare backed knives. MAT subtype B contains very low frequencies of sidescrapers, but large amounts of denticulates. Handaxes are rare. Occasionally, tool types more common in the Upper Paleolithic, such as burins and endscrapers, are present.

2. The Typical Mousterian is principally defined by the absence of tools such as handaxes, backed knives, and any tools with steep "Quina" retouch. Sidescrapers range from 20 - 65% of the total inventory of tools. While MAT subtypes A and B are thought to occur in the Wurm I and Wurm II/III respectively, no chronological position is assigned to Typical Mousterian. Furthermore, Bordes (1972) apparently placed any assemblage that cannot be assigned to the other Mousterian types, into the Typical Mousterian.

3. Denticulate Mousterian assemblages contain few sidescrapers and many denticulate tools. Notched and denticulated tools account together for some 80% of all tools.

4. In the Charente Department of France there occur tools of two kinds of Mousterian assemblages that together constitute the Charentian. Quina Mousterian is readily identified through the presence of sidescrapers with a high angle of retouch. Ferrassie Mousterian is different from Quina in that the Levallois technique of flake manufacture is much more predominant, and it also contains relatively few Quina scrapers. Both of these types have relatively few denticulates, handaxes, and Upper Paleolithic tool types.

It is generally accepted that these four kinds of facies represent a general level of technological and typological development amongst *H. sapiens neanderthalensis* populations, but it is also generally recognized that the spatial and temporal/stratigraphic occurrence of these kinds of assemblages is extremely complex. As attempts to explain variability in the Mousterian, three kinds of interpretations have been offered, and there is a great deal of debate among authors as to the significance of Mousterian variability.

The first kind of interpretation offered is the idea that each kind of Mousterian represents a separate but largely contemporaneous cultural tradition. Bordes (1961) also examined the possibility that each kind was an industrial facies adapted to a particular microenvironment, and he also considered that each type could represent seasonally different activities. He was able to reject both of these hypotheses. On the basis of microgeological

work at the important sites of Combe Grenal and Pech de l'Aze (Bordes 1972), he demonstrated that there was no correspondence between Mousterian type and indicated microenvironment. Also, some kinds of Mousterian are widely distributed throughout France and the Levant, leading one to doubt that the effects of a single environment type could account for assemblage type differences. To tackle the second hypothesis, Bordes with the assistance of Bouchud and Prat (cf. Bordes and Prat 1965) analysed faunal data which to them showed that some of the Mousterian occupations were year-round. While this seemed quite unusual for what is commonly thought of as a hunting and gathering adaptation, Bordes found his original hypothesis of tool types representing different ethnic groups most acceptable. However, Bouchud's faunal analysis of caribou has been strongly criticised by Binford (1973: 238 - 240) on the basis of certain assumptions made concerning tooth eruption stage, and it seems more probable that the Mousterian samples analysed all represent short-term occupations.

The second major interpretation of Mousterian variability is that each kind of Mousterian occurs in a discrete temporal span. This position has been mostly defended by Mellars (1965, 1970), who argues that there is little temporal overlap in the occurrence of Quina, Ferrassie, and Mousterian of Acheulian Tradition. This hypothesis is based on the analysis of 12 sites in southern France, which suggest that Quina evolved from Ferrassie, and that MAT occurs

after Quina. Doran and Hodson (1966) subscribe to essentially the same hypothesis. In their work, an early multivariate analysis of 16 sites from France, Monaco, Spain and Greece produced three clusters that seemed to broadly agree with Bordes' Mousterian facies. While Doran and Hodson's results can be dismissed as probably fortuitous due to poor sampling considerations, Mellars' research was much more carefully thought out and executed, but has major problems as well!

First of all, Mellars ignores the contemporaneity of the MAT and Charentian types at Combe Grenal and Pech de l'Aze (cf. Bordes 1972) during the early Wurm I period. Secondly, Laville (1973) has shown through sedimentological work on the early Wurm chronology at these sites and Caminade and Le Moustier that the three types of Mousterian did co-exist. He was also able to demonstrate that Quina can precede Ferrassie, and the MAT subtype B can precede Ferrassie and Quina (Laville 1973). In short, Laville's work seems to confirm Bordes' expectations of contemporaneity. There is still a major flaw in Mellars' argument, and that is that even if sequential assemblage types were demonstrable, what would that tell us about why this is so? Binford has stated the problem as follows:

Time and space are reference dimensions which we use for monitoring the operation of system dynamics. The demonstration of clustering along either of these dimensions only informs us that some systemic processes were at work. Such a demonstration does not inform us of the nature of these processes (Binford 1973: 247 - 248).

The third approach to assemblage variability in the Mousterian is known as the "functional argument" (Binford 1973, Mellars 1970). The origin of this argument is the now classic article by Binford and Binford (1966; see also Freeman 1966) briefly presented in Binford and Binford (1969). The Binfords' purpose was to show that the Mousterian assemblages' variability could be systematically partitioned according to the kinds of activities that had been undertaken at sites, with the kinds of activity being represented by varying proportions of tools in Bordes' type list. Thus, rather than assuming that the proportions of the 63 tool types varied with ethnic differentiation, chronological ordering, or strictly seasonal patterning, the Binfords assume that proportions of tools should vary according to discrete functions.

There are two other basic assumptions here. The first is that "function" is multivariate and systemic, or that there are multiple, linked "determinants of any given situation" (Binford and Binford 1966: 241). The second is "that variation in the structure and content of an archaeological assemblage is directly related to form, nature and spatial arrangement of human activities" (Ibid). The reasoning behind this argument has not been criticised except for the assumption that Bordes' tool typology expresses function, which is quite untested (Cowgill 1968).

In their analysis of Mousterian variability among one site from France (Houpeville) and two from the Near East (Jabrud and

Shubbabiq) the Binfords argued that differential proportional frequencies of tool types were the result of different tasks being carried out at sites. The essential distinction was between base camps, where maintenance tasks would be carried out, and work camps, where extractive tasks were undertaken. To demonstrate this, it was necessary for them to find functional units that could be used to compare site assemblages. This was accomplished through factor analyses of the data, to discover which tool types tended to covary; that is, tools used together would tend to be found together, and through factor analysis, the different tools used in any given task should constitute a distinct factor.

The principle upon which the Binfords' assumption was based was stated essentially in an early paper as follows:

The loss, breakage and abandonment of implements and facilities at different locations, where groups of variable structure performed different tasks, leaves a "fossil" record of the actual operation of an extinct society (Binford 1964: 425).

This principle has been strongly criticized by Schiffer (1976: 11), who makes explicit that there are cultural and natural transformation processes which may alter the spatial, quantitative, formal and relational characteristics of artifacts subsequent to their primary deposition. The Binfords made no attempt to study systematically the possible effects of n-transforms such as geo-

logical processes of erosion, nor such possible c-transforms as site re-occupation and tool re-use. Granted, these are difficult problems, but it is clear that assumptions about the homogeneity of these processes between sites of different kinds (i.e. sheltered and open) are unwarranted, even though Schiffer (1976: 57) seems to imply that using single occupation sites rather than divisions within stratigraphic layers as analytic units avoids most of such problems.

Thus, the Binford's exercise was primarily methodological in its contribution (which they readily admit; 1966: 289). It shows the kinds of explanations that could be offered about Mousterian variability given a processual perspective, but there is no claim to substantive or "factual" additions to our knowledge at the time. I mean that the tool types within the five factors isolated - 1. secondary tool manufacturing (non-lithic), 2. hunting and butchering, 3. food processing, 4. shredding and cutting, and 5. other killing and butchering - cannot be used as interpretive units in unrelated studies without computing an all new set of factor scores. The Binfords found a way to re-interpret Bordes' type list.

This essentially methodological aspect is witnessed by the fact that Freeman's (1966) factor analysis of Mousterian materials in Spain (see also Freeman 1978) failed to produce factor loadings on tool types similar to those in the Binfords' study. The scope of variability in the Spanish sites was interpreted to re-

sult from activities ranging from "scraping" to "cutting-chopping" (Freeman 1966: 235).

A very interesting situation is that in both sets of research, the isolated factors show broad similarities to Bordes' four Mousterian variants (cf. Freeman 1966: 234; Binford and Binford 1966: 259). However, this does not occur in all factors, and this confusion is reconciled by Freeman:

The two models (i.e. ethnic identity and functional specificity) are not alternative explanations of the same kinds of variation. Both may be equally correct in the most general sense, but their validity requires consideration of different aspects of the data (Freeman 1978: 58).

In a study aimed mainly at understanding the entire Paleolithic collection from Douara Cave in Syria (Hanihara and Akazawa 1979), Akazawa (1979) factor analyzed 71 Mousterian assemblages described with reference to Bordes' type list. These assemblages were from the Douara Cave, Yabrud Shelter 1, and included Combe-Grenal from France. The factor analysis produced five factors, and I think it worthwhile to extract some critical findings that are based on the plotting of factor scores:

Although the Upper French Acheulian shows concrete evidence of clustering, the other five types of assemblages classifiable as French Mousterian and Yabrudian show a wide range of distribution and overlapping. In particular, distribution of the Typical Mousterian assemblage is peculiar, characterized by overlapping with assemblages classified as another major group (Levantine). This suggests that these assemblage types have more complex features, and therefore cannot be explained simply on the basis of typological characteristics. (Akazawa 1979: 42, emphasis added).

Akazawa refrains from any functional interpretations, but adds that the groupings of assemblages are due mainly to their contained frequencies of sidescrapers, and Levallois and denticulate tools (Akazawa 1979: 42).

It seems clear in this discussion of factor analysis that the basic functional assumptions about the use of Bordes' type list are unwarranted, do not produce consistent results, and may in fact complement culture-historic interpretations.

The Binford's' logical argument that ethnic group identity cannot account for differential assemblage composition has been countered by Fish (1976: 19) who notes that the MAT is common in the Dordogne region, but practically non-existent in Charente. In this vein, however, there is the question of whether Bordes' classification is one that would have been recognized by the sites' inhabitants. In societies using stone tools today (granted, with much simpler lithic technologies),

there has been shown an appreciable difference between the producers' and the archaeologists' classifications (Gould 1972; White, Modjeska and Hipuya 1977).

Bordes' classification and general scheme have other faults. For example, the rigor of the method of assemblage type definition is weakened by the use at times of single tool types like denticulates while MAT is distinguished by several, and Typical is a sort of catch-all. Further, there is the problem of how to classify multiple tool types occurring on single artifacts. The method is not rigorous.

A recent article that is already a classic in method (Cahen, Keeley and Van Noten 1979: also Van Noten, Cahen and Keeley 1980) describes a site in which three Upper Paleolithic end-scraper types (eight actual tools) were fitted onto a single block and had all been used for hide-scraping (Cahen et al 1979: 666). This may indicate that Bordes' classification is far too finely split for functional interpretation, and this has serious implications for those who use the type list essentially unaltered for functional analyses (cf. Binford and Binford 1966: 244). One cannot deny the importance of Bordes' work - he formulated a complex, more or less objective typology that has permitted standardization and large-scale comparison and scholarly communication. His interpretations and theory however, are rather organic and undemonstrable. The ethnic hypothesis has not been completely refuted (although the temporal succession hypoth-

esis seems destroyed), since it still needs to be tested empirically with the use of ethnographic data, as indeed does the functional argument. This point is noted by Binford and Binford, who observe that "cultural borrowing" needs to be understood since it is impossible to imagine mobile cultures, depositing alternating assemblages, who never acknowledged their neighbours (1966: 240). Indeed, the Binfords apply the type list to assemblages from France and the Near East, which could be interpreted as a recognition of some degree of "borrowing" of basic traits. There is also good evidence that hunters and gatherers do maintain social identities with special membership requirements (Campbell 1968; Lee and DeVore 1976; Jorgensen 1980), and that actual ethnic differences can be demonstrated in chipped stone projectile points (Magne and Matson 1982; Greaves 1982), although there have been few attempts to resolve this issue with preservable material culture.

In an archaeological situation where the greater part of the information is obtained from stone tools, there has been an amazing lack of technological perspective for the Mousterian. If technology is defined as a mechanical means of articulating human populations adaptively to environments which necessitate movement between habitation and resource locations (Munday 1976: 113, cf. Binford 1962: 328), then it is apparent that the above studies have not dealt with technology. Apart from the common usage of the Levallois index (Bordes 1972), there has been minimal consideration of the manufacturing processes of stone tools, how

these might vary in space and time, and the conditions leading to such variability.

The utility of lithic debitage in behavioral reconstruction is now appreciated in archaeology (see Chapter 4), and debitage has been analysed in an Upper Paleolithic - Texas Archaic comparative study by Collins (1974, 1975). While Collins' work was undertaken within an explicit behavioral framework a la Schiffer (1972), Fish (1979) conducted a study of Mousterian debitage with the purpose of demonstrating "technological" regularities in Bordes' four Mousterian types. Fish's study, based on debitage and scrapers from four sites in France and the Near East, has serious methodological problems, such as the use of biased sampling techniques, small samples, very redundant measures, and no explicit statement about the significance of Levallois debitage (i.e. what does core preparation indicate?) in even a hypothetical manner.

On its positive side, Fish's study shows that debitage variability does not correspond well to typological Mousterian facies. Nevertheless, the removal of tools from sites is a factor not well controlled in traditional and behavioral studies. For example, at Pech de l'Aze Bed 4, 43% of the debitage analysed were flakes of bifacial retouch, yet only 5.8% of the tools were handaxes; and in Bed 28 at Combe-Grenal, no handaxes were found, yet 13.5% of the debitage were bifacial retouch flakes (Fish 1979: 133). Thus, we can see an advantage of debitage analysis; it is a way of reliably

demonstrating that the tools left at a site may not represent the full range of activities that were performed there.

As concerns the Levallois index, or the proportion of items in the assemblage exhibiting complex scar patterns other than deliberate retouch, I find this far too narrow a defining characteristic of "technological" differences between assemblages. Nevertheless, Fish (1979: 128 - 130) found an interesting correspondence between overall low Levallois occurrence at Combe-Grenal and Pech de l'Aze and the availability of predominantly small cobbles as the lithic resource for these locations. This seems to make a great deal of sense: the smaller the cobbles used for tool manufacture, the more conservative tool-making will result in complex "exhausted" debitage. Obviously this has implications for the use of standardized tool typologies. It can be expected that tools near locations where only small size raw materials are present, would be less "expedient" than those with larger cobbles available, but also that scarce lithic resource areas would tend to exhibit more tool curation, paradoxically resulting in small, highly complex retouched items.

For the Mousterian, an explicitly technological approach is that of Munday (1976). Working in the area of the Negev desert of Israel, Munday sought to explain the variable composition of open-air sites, rather than cave or shelter sites that are typical of Mousterian studies (but see Binford and Binford 1966: Houpeville). Jelinek (1976) notes that the "value of in situ deposits in open sites (with few exceptions)

is in the clear functional association of elements of single or traditionally linked occupations" (Jelinek 1976: 23; cf. Wobst 1979). Among 11 sites, Munday examined quantitative relationships among cores and debitage, and flint and water resources. Using multiple regression analysis, it was found that debitage size and core weight are highly related to six independent variables that essentially control the amount of work involved in moving raw materials between sites: raw material distance, slope of site to raw material, distance to water, slope to water, altitude to water and altitude to raw material. These factors accounted for 90% of the variability in debitage, and 80% of the variability in core weight (Munday 1976: 139).

In relation to Fish's (1979) findings regarding Levallois technique variability, Munday (1976: 139) found that at sites far from raw material "more intensive core preparation took place, as exhibited by the more complex qualitative technological variables (platform types, dorsal scar patterning and dorsal scar count) found with the resultant debitage" (1976: 139). This is explained with reference to the principle of least effort (Zipf 1949), or simply, it seems that assemblage composition is strongly affected by economizing behavior.

We thus see in the Mousterian example that archaeological method has developed to seeking ways of reconstructing behavioral situations that lead to inter-assemblage variations in lithic contents. The culture-historic and ethnic paradigms of archaeo-

logical remains are not completely refuted in the theoretical sense and are essential constructs in both the Old and New Worlds, even if only as convenient ways of describing large-scale evolutionary trends. The traditional paradigms are basically complementary to the behavioral viewpoints, but are also in need of methodological improvement.

### 2.3. Lithics, Logistics and Livelihood

#### 2.3.1. Introduction

In many respects the archaeological interests in stone tools as indicators of subsistence and social activities in the 1960's were unable to answer with much certainty the questions they posed. Much of Binford's writing through the 1970's was theoretical, and the advent of systems theory applications, as well as a generally greater philosophical awareness contributed a great deal to the quality of the questions being asked. Binford's continual re-evaluations of the state of archaeological conduct have recently been focused on precisely methodological problems and ways of "bridging" empirical facts with theoretical demands. This process he calls "middle-range theory building", and he considers it to represent a major shift in scientific archaeological terms of reference, models and paradigms (Binford 1972, 1977; Kuhn 1962).

Throughout the development of behavioral research with stone tools, there is an interesting interplay of inductive and deductive reasoning, that is; between questions they ask, in the extreme: What can this stone tool tell us about behavior, and; What are the implications of behavior for stone tools? However, I choose not to review separately here the philosophy of scientific reasoning and the many theoretical interfaces of analogy, experimentation and ethnoarchaeology. Recent comprehensive discussions by Charlton (1981) and Salmon (1982) reveal that the issues are complex and beyond the scope of this study.

### 2.3.2. Experimental lithic research

Replication and simulation experiments in stone tool manufacture generally seek to relate quantitative and qualitative variability in tools and manufacturing by-products (debitage) to processes of production, use and disposal. While the designs of such experiments, and the methods of analysis vary a great deal, most aim to increase the reliability of behavioral inferences that can be made on the basis of archaeological material patterning (see Tringham 1978; Charlton 1981: 146 - 147). Currently, behavioral insights provided by systematic stone tool replication (e.g. Muto 1971a; Crabtree 1972) are a significant part of many reconstructions or regional relationships between lithic technology and settlement patterns (e.g. Knudson

1973; Gardener 1976; Katz 1976; Phagan 1976; Chapman 1977; Pokotylo 1978a; Kimball 1980).

The general model of stone tool technology employed in this research was roughly developed by Holmes (1890) and has been refined by several researchers (Collins 1974, 1975; Bradley 1975; Gunn 1975; Sheets 1975; Katz 1976; Schiffer 1976; Pokotylo 1978). Flow charts are used to model the various steps involved in stone tool manufacture, use, modification and disposal, and are linear in nature because output products cannot resume a previous state. Perhaps the clearest and most useful such model is that proposed by Collins (1974, 1975), here summarized in Figure 1.

In Collins' (1975) model, the first step in making a stone tool is acquiring the raw material. As Binford (1979) has pointed out, this activity can be embedded in other subsistence tasks, or it can be a direct, special purpose task such as in visits to quarry locations. The next step in the model is to prepare cores and reduce them. Here, the cores themselves may be desired products, or flakes removed from them can be used as tools, or as blanks for further reduction. Following core or flake blank production, primary trimming may produce useful tools and/or preforms ("unfinished" tools). The next step is secondary trimming, to produce complex tools, hafting provisions, serrations, aesthetic flake scar patterns, and so on. Collins' model recognizes the use of tools as a distinct step in their modification, and following

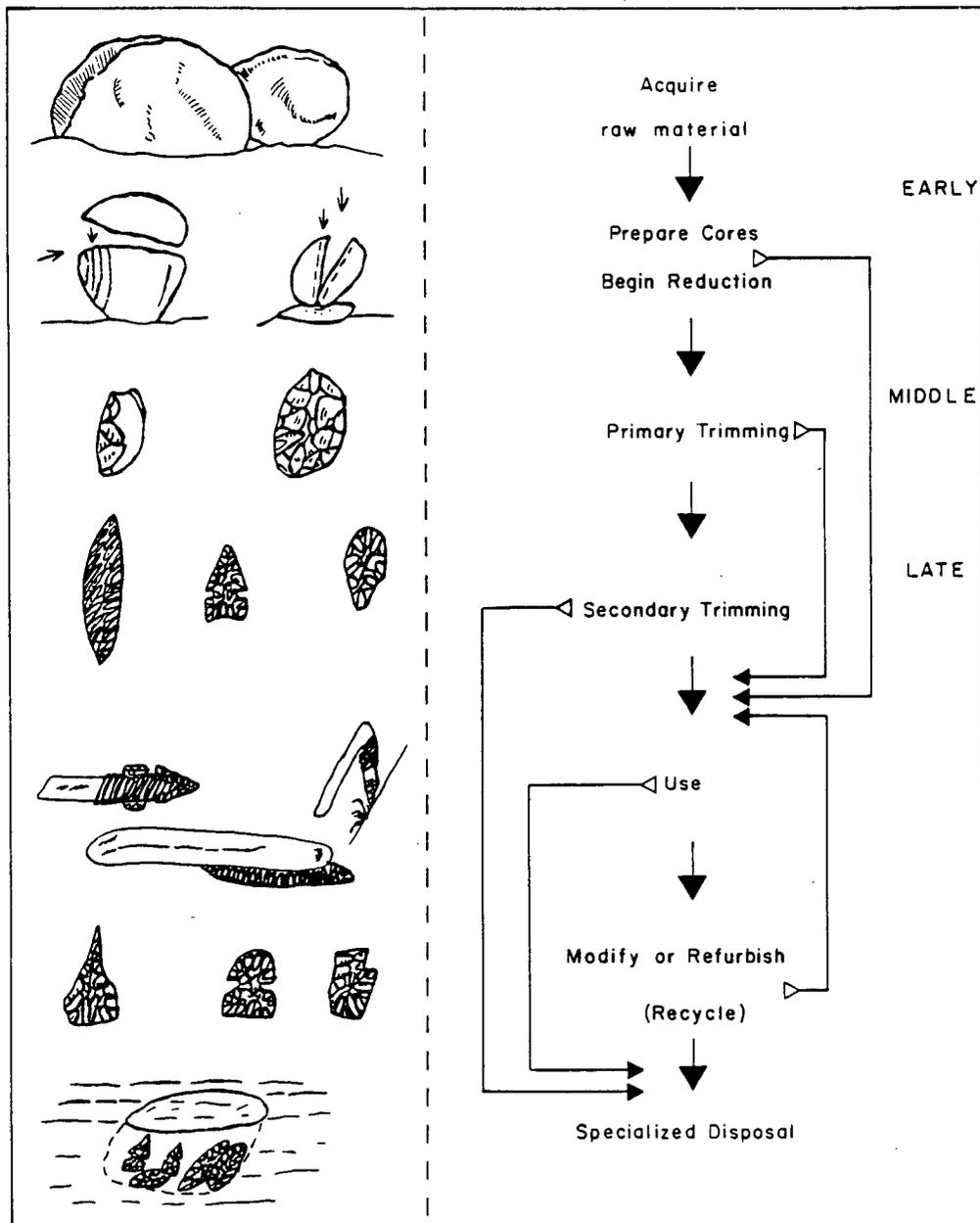


Figure 1. The general model of lithic reduction, maintenance and disposal. Revised after Collins (1975).

use, tools may be resharpened, or substantially refurbished. The final possible step in this model is specialized disposal of artifacts, in caches, as grave goods, and the like.

In general, a great deal of progress has been made in the last 20 years of a century of lithic experimentation (see Johnson 1978), but several problems persist in experimental stone tool studies:

1. There is a serious lack of adequate experimental controls (see Chandler and Ware 1976: 25; Dincauze 1978). Basically this problem stems from the history of viewing stone flaking, or flintknapping as an "art" rather than a scientific endeavor. Lithic use-wear analysts have clearly recognized the value of explicit experimental controls (e.g. Keeley 1980; Tringham et al 1974; Odell 1977), and only recently have lithic reduction experiments been conducted with firm controls (Speth 1972; Raab et al 1979; Burton 1980; Stähle and Dunn 1981).
2. Bifaces and projectile points are the usual subjects of investigations (e.g. Newcomer 1971; Callahan 1977; Flenniken 1978), and there is a lack of experimentation aimed at systematically understanding the manufacture of many other tool forms, or the full range of reduction processes. Again, this is related to the historical problem of dealing with items that are perhaps best suited to typological issues, yet even some of the better controlled experiments such as Stähle and Dunn (1981) propose to somehow characterize entire debitage assemblages only by dealing with biface production residues.

3. There is a strong tendency to use redundant analytic variables, especially size variables (e.g. Fish 1976, 1979, 1981), or morphological variables with little explicit analytic value (e.g. Patterson and Sollberger 1978; Burton 1980) to describe debitage variability. This problem is by no means limited to lithic analysis, since some archaeologists study as many variables as possible in the hope of deriving meaningful patterns, and often assign meaning to variables only after patterns have been detected. At the least, expectations of variable patterning should be proposed prior to completing a set of experiments.
4. Many experiments do not include statistical evaluations of research findings in their design, and interpretations are often subjective (e.g. Muto 1971a; Kobayashi 1975; Patterson and Sollberger 1976, 1978; Flenniken 1980). This is a serious problem but one that is being resolved as archaeologists gain greater familiarity with quantitative methods (e.g. Chandler and Ware 1976; Stafford and Stafford 1979; Stahle and Dunn 1981).
5. The field is very particularistic, and experimental results are usually applied to small-scale archaeological samples such as single sites, or are used with little other purpose than to demonstrate that certain techniques of tool manufacture were used in the past (e.g. Crabtree 1966, 1968; Callahan 1977; Flenniken 1978). This kind of particularism is necessary at a basic level, but the field has to generate higher levels of methodological and

theoretical awareness if it is ever to contribute to archaeology in a scientific manner.

Major contributions to lithic assemblage interpretations during the 1970's were made in the area of use-wear analysis, particularly the work of Keeley (1980), Odell (1977, 1980) and Tringham et al (1974), and as discussed above, the innovating work of Cahen et al (1979). The literature on use-wear is very extensive, fascinating, contentious and almost completely site-particular. For these reasons, and because this study is concerned with inter-assemblage lithic manufacturing particulars and patterns, the scope of use-wear research (see Hayden 1979) is beyond detailed elucidation here.

Lithic use-wear analysis contributes greatly to the kinds of models that archaeologists use, since theoretically, if we can observe specific tool functions then we should be able to measure time and energy expenditures and returns, and seek to model and understand the operations of populations in relation to stone tools. However, the field is not presently able to resolve such issues, due to difficulties in method, and interpretation of the empirical evidence. It is difficult to identify the type of material worked by stone tools, the motion involved, and less so, the general hardness of worked material and actual presence of wear. The experimental foundations of use-wear analysis are rapidly growing, and have always been scrupulously re-examined (e.g. Holly and Del Bene 1981; Keeley 1981). In intro-

ducing a volume on the then-current state of lithic analysis and prehistoric behavior, Davis noted that "while the major issues in the analysis of lithic assemblage variability are theoretical, the major difficulties are methodological" (Davis 1978: iii). It seems there are general schools of agreement about what we want to know, we just do not know how to gather the necessary information, nor how to interpret what we have.

### 2.3.3. Current models of lithic technology and settlement patterns

A community's settlement system can be defined as follows:

...a solution to the problem of locating sites so as to minimize the amount of energy that must be expended to procure necessary resources, be this by judicious choice of a single site, location of several sites at different times in different situations, development of storage and/or preservation techniques, or a combination strategy (Roper 1979: 16).

Hunter-gatherers are classified by Binford (1980) into two basic kinds of societies: foragers and collectors. Foragers procure resources on a day-to-day basis, do not practice extended food storage, and move residences often as local resources are depleted. Examples of foragers include the Kalahari Bushmen, (Lee and DeVore 1968, 1976; Yellen 1977), and the Australian Western Desert Aborigines (Gould 1969, 1980; Hayden 1976, 1977), at least those that remain and still engage in hunting and gathering as the

principle mainstay of their existence. Collectors maintain residences, yet move often for extended periods to procure individual or sets of resources, returning to the residences. Food storage practices are varied and common, and more seasonal extremes in subsistence activities are exhibited. For example, the Nunamiut Eskimo (Binford 1977, 1978a, 1978b), the Boreal Forest Cree (Bishop 1974, Leacock 1973, Rogers 1973) and most temperate hunters and gatherers, including the groups inhabiting the B.C. Interior Plateau, may be considered resource collectors.

Collectors employ at least five kinds of sites: 1. residential bases; 2. locations (of kills or gatherings); 3. field camps, for task groups; 4. stations, where information is gathered and scheduling decisions are made; and 5. caches (Binford 1980: 10). Binford does not discuss ritualistic sites such as petroglyphs or burials, although the nature and distribution of these is to a certain extent conditioned by mobility. Practically every kind of site can be re-occupied for another purpose, and this is a potential way to measure settlement mobility, since greater inter-assemblage variability can be expected, the greater the number of "generic functions" a site undergoes (Binford 1980: 12). Thus, the archaeological problem is to "develop a means of identifying generic types of functional differentiation when they are encountered in the archaeological record" (Binford 1979: 271).

The problem is to observe the outputs of human behavior in controlled conditions, where the systemic context is known.

Binford's method is ethnoarchaeology, the conduct of ethnographic research to solve archaeological, anthropological and even sociological issues (see Gould and Schiffer 1982; Gould 1978; Kramer 1979). Although Binford does not seem to recognize experimental archaeology as a means of approaching the same problems, there are several common theoretical grounds to ethnoarchaeology and experimental archaeology (Tringham 1978). Tringham views both as "experimental" research, but considers that "behavioral experimentation" is riskier, since variables are more difficult to control.

Armed with the experience gained in his intensive Nunamiut ethnoarchaeological research with faunal assemblages (Binford 1978a; 1981) and with the success of that research in providing empirical evidence of subsistence patterns operations, Binford has again focused on lithic assemblages (Binford 1979). The implications of the logistic and highly mobile Nunamiut settlement pattern for lithic technological inference are highly relevant to this and other explicitly technological studies of chipped stone, and are worth citing at length here.

In his reconstruction of how the Nunamuit used stone tools, Binford (1979) relies heavily on interviews with elders, and practically nil on observation, since the Nunamiut have long since abandoned stone tools, except for large hammers and anvils, bed warmers, and occasional instances of "survival gear". The

informants agreed that three basic kinds of gear are used, past or present. Personal gear and site furniture are anticipatory items, and situational gear is responsive in nature.

As far as lithics are concerned, the following are considered to have been personal gear: side-bladed tools to cut bone, cores used as sources of flakes for butchering or for manufacture into scrapers, axes, bows and arrows, stone points for bears (bone, antler or wood otherwise), pressure flaking tools with hafted scrapers on the end opposite the flaking end, and single flake knives.

Personal gear is curated, being recycled, reused, and maintained. It is always brought into the field in good condition, and Binford (1979: 263) deduces from this that personal gear should be largely discarded in residential camps, and not at the locus of use. It seems to me however, that some personal gear probably included items intended only for use at a distant locus, and that this material is meant to be left behind, and only if not used, would be returned to residential camp. Binford's expectation also does not include the breakage of personal gear beyond repair, or the disposal at least of fragments. Keeley (1982), for example, would maintain that the haft portion only of a complex item of personal gear would be returned to replace a stone piece.

Site furniture "belongs" to a site, and is available for use by any occupants (Binford 1978a: 339). Such items as large bone-cracking rocks, anvils, hearthstones, heavy marrow scrapers, and tent weights are common items of site furniture. These objects enter the archaeological record when a site falls into disservice, or as natural processes remove them from the active system. Site furniture, in Schiffer's (1972, 1976: 14) terms, is de facto refuse, usable gear that is abandoned.

Situational gear is task-specific. For example, Binford (1979: 266) relates an anecdote of two hunters, hunting caribou and needing knives to butcher the animals, but lacking a good steel knife. One of them found suitable rock, broke it, and they used the resulting flakes. No great deal of effort was expended, but it provided gear suitable for the task at hand. In certain situations, personal gear or gear that has been cached can be modified for the required purpose.

What of the interrelationships of these kinds of gear? Binford writes:

...we can expect assemblages which are "curated" in the broad sense to exhibit patterns of inter-assemblage variability depending upon the organization of the technology as seen in the proportion of situational to more curated types of gear (1979: 269).

The notion of proportional relationships is important, since sites can be re-occupied or abandoned independent of lithic

technology. The mere presence of any particular gear is insufficient evidence of the purpose of the occupation. The general archaeological goal then, is to reconstruct the archaeology of specific "places", by studying the inter-relationships of lithics, fauna, etc. and their spatial distribution (Binford 1982). Is Binford re-inventing settlement pattern archaeology (cf. Gummerman 1971; Euler and Gummerman 1978), by asking archaeologists to consider the inter-relationships of sites?

Binford offers several detailed, particular lithic technological expectations or "probable consequences" of various "systems conditions" of the Nunamiut settlement system:

1. Items of personal and household gear are apt to be both produced and maintained within residential sites, resulting in an association at such locations of debris from manufacture, repair, and final discard of worn-out items.
2. Items that have relatively long use lives are not likely to be "worn out" at special purpose locations, since pretrip gearing-up operations would result in the replacement of heavily worn items before leaving the residential location.
3. Manufacturing debris from lithic processing is apt to vary in content seasonally (representing different proportions of different sources), since there is likely to be seasonally variable exploitation of different geographical areas and lithic raw materials would generally be obtained within the context of normal subsistence procurement schedules. Given residential mobility, lithic source variability as indicated in primary debris should be correlated with the geographical position of the residential site.

4. Manufacturing debris occurring on special purpose sites which are intermediate between residential sites and procurement sites (such as hunting stands or camps) may well exhibit considerable lithic debris from work on partially finished or "staged" items. Flakes or (sic) bifacial retouch, core reduction, or the use of a "disproportionate " number of tools designed for the modification of other raw materials such as wood, antler, bone or fiber might well be anticipated. On such "intermediate" locations, work scheduling would generally be carried out in "dead time" on items introduced in anticipation of this activity (see Binford 1978a). This means that many "incomplete" items would be further modified on such locations, resulting in "disjunctive" debris to tool relationships.

5. The highest incidence of recycling and reuse of items of personal gear is most likely to occur in special purpose locations. This follows from the observation that personal gear is frequently "drafted" for use" as the source of material for situational gear.

6. High incidences of flakes from bifacial "cores" are apt to characterize special purpose sites. Such flakes can be expected to show relatively high use ratios, that is, the number evidencing use should be high.

7. We might expect a general inverse relationship between the proportions of reuse and recycling of personal gear and the abundance of situationally produced gear from immediately available raw materials (Binford 1979: 269 - 270).

These expectations are admittedly not exhaustive, and some are of vague utility. For example, it is no problem to recognize bifacial debris, but what exactly served as personal gear, site furniture or situational gear is not clear from Binford's arguments.

Ethnoarchaeological reasoning has also been used by Ebert (1979) to suggest that indices of tool sizes and complexity are better indicators of group mobility, tool curation behavior, and specific activities than traditional typological means of analysis. This research, conducted among the Botswana Bushmen, was aimed at providing some generalizations about stone tool use, discard, and loss by observing situations in which steel tools are employed today. The two major "bridging assumptions" between group mobility and lithic assemblages that Ebert addresses are:

1. Tools manufactured with the object of being carried out are expected to be smaller than tools intended to be used in one place.
2. Tools intended for multiple episodes of use are expected to be the result of greater input of energy during manufacture and maintenance than tools used once and then discarded (Ebert 1979: 68).

Thus, gear that is analogous to Binford's personal gear should be small and complex, while expedient tools and habitation site maintenance tools should be larger and simpler. Site furniture should also be relatively complex.

The practical ways to measure such differences are: for complexity, the frequencies of tools' flake scars produced during manufacture and maintenance, and for size, the product of length, width and thickness measures. It is suggested later in

this study that a more appropriate measure of a tool's size is its weight, and that scar counting requires rigid cut-offs in size and continuity. Like Binford's argument, Ebert's (1979) makes the point that it is overall assemblage variation that is important and that individual tool measures are secondary.

The predictions that Ebert makes about the relations between lithic assemblages and settlement mobility are less dependent on abstract constructions, and may be summarized as follows:

1. Assemblages with small tools exhibiting high manufacture/maintenance energy inputs are essentially composed of "curated, small, specific-use tools, possibly pieces of a mobile tool kit. Used in jobs or tasks in which a specific set of operations is carried out" (Ebert 1979: 68).
2. Large tools with complex reduction patterns are "specific use or specific job tools probably not transported as far as those [that are small and complex], but curated" (Ebert 1979: 69).
3. Small tools with low scar counts are "expedient, single-use, immediately discarded tools" (Ebert 1979: 69). Ebert suggests that small size here may indicate "raw material stress", but in such a case, complexity would be expected to result from extended maintenance. Thus, this expectation is ambiguous.

4. Ebert's final expectation is rather weak also, stating that large, simple tools "should be manufactured expediently, used only once, and not transported" (1979: 69); however, I think that multiple uses of large items seem likely, over extended periods of time.

The method requires each tool to be plotted, with respect to size and "energy" axes, observing the trends for each assemblage, particularly predominant extreme trends, and inferring the relative duration and intensity of the activities that produced them.

This seems straightforward enough, but a close look at Ebert's model reveals a serious flaw in his interpretations of two Botswana Middle Stone Age sites. In this case, the scales of examination of tool sizes are different by a factor of six (1979: 70). This error is illustrated in Figure 2. Ebert's scale of comparison for site KP47 encompasses that for site KP48. Thus, the interpretations that KP47 resulted from energy invested in mobile tools, and that KP48 indicates a minimum amount of energy invested in "medium-sized" and non-portable tools (Ebert 1979: 70), should be reversed. KP47 seems to be a longer term occupation, or re-occupation, kind of site, whereas KP48 is more restricted in variability, and probably in "function". Ebert's model-building is complementary to

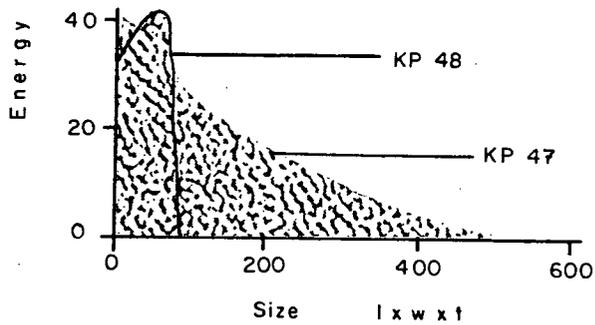
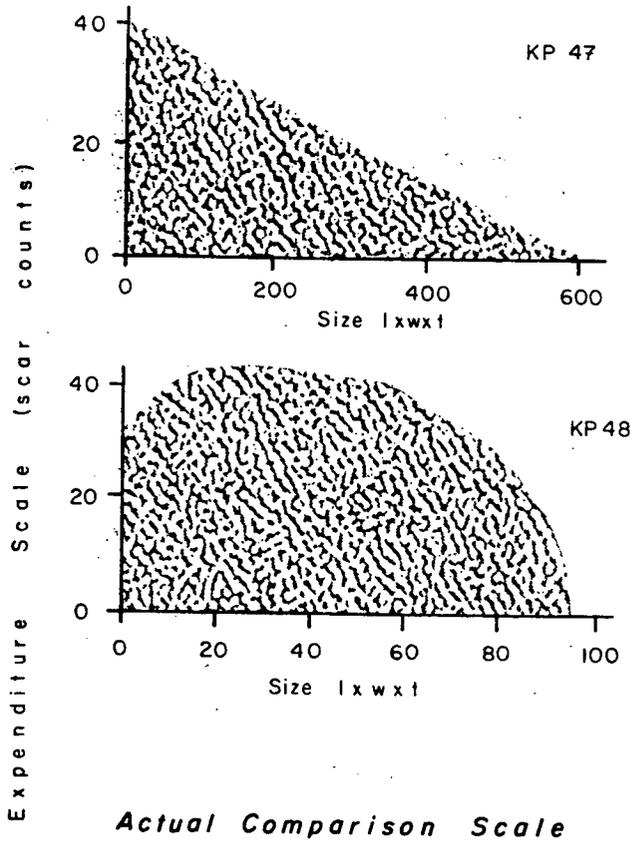
*Ebert's Graphs*

Figure 2. Comparison of Ebert's inferential point swarms with actual comparative scale.

Binford's, but with a method of "analytical convention", or "observational language" that enables us to differentiate one kind of gear from another, and thus add precision to our ability to differentiate sites one from another (Binford 1982). Ebert's "curve-fitting" approach is the basic method of Binford's (1978, 1981) faunal analysis techniques of reconstructing site purpose, and like them (see Gould 1979), has a few problems with confidence levels. However, approaches like Ebert's are necessary to provide lithic assemblages with a "generic" taxonomy comparable to identifying skeletal elements with bone fragments. These kinds of factors are examined later in this study, in Interior Plateau assemblages.

Collins (1975) has presented a model of lithic technology as a subsystem of cultural ecology that is remarkable in its generality and in its basis in behavioral archaeology. I have reviewed the model extensively elsewhere (Magne 1978; see also Pokotylo 1978), and discuss it further and attempt to operationalize it in Chapter 4. Thus the present review is brief.

Collins (1975: 16 - 19) argues that ongoing cultural systems using stone tools (the systemic context; Schiffer 1972, 1976) produce distinct product groups through five major lithic technological steps: 1. acquisition of the raw material; 2. core preparation and initial reduction; 3. optional primary trimming; 4. optional secondary trimming; 5. optional maintenance

and modification. Collins supports the model in a unique cross-cultural comparison: Archaic period materials from Arenosa Shelter in Texas, and Solutrean deposits at Laugerie Haute Ouest in France (Collins 1974). General patterns of reduction through time are traced at both sites, but difficulties are encountered in identifying any but the earliest and bifacial reduction strategies. Substantive findings include, that even in the Solutrean, known for its fine bifaces, less than 20% of the tool kits were produced by secondary trimming. Furthermore, the Arenosa Archaic assemblages average some 20% more secondary trimming debitage than Laugerie Haute Ouest (Collins 1974).

The value of lithic debitage in revealing basic stone tool manufacturing patterns is made explicit:

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 (Collins 1975: 17).

Without ethnographic analogy, the "specific activities" are purely lithic technological, and indeed such findings as that bifacial manufacture in the Archaic levels was far more efficient than in the Solutrean occupations (27 bifaces per 100 secondary stage flakes versus 2 per 100) and the observation

that Solutrean debitage is more variable than the Archaic material, are valuable. The further meaning of this pattern in terms of human evolution is not developed by Collins, but with a larger number of such analyses, is quite possible, given such discussions of Old and New World similarities in cultural evolution as that of Hayden (1981). The assemblages analysed by Collins seem to indicate that Solutrean groups were less logistically organized, and more residentially-based than Archaic groups, and more expedient and less curative with their gear. However, bifaces may have been more specialized, and more apt to removal from sites in the Solutrean, resulting in the small number of such items in comparison to late stage debitage.

Collins' application of his model was fraught with technical difficulties, particularly in data reduction, attribute selection and stage inferences. Successful refinement in method and outlook, but maintaining the behavioral approach and the general reduction model provided by Collins (1975), was achieved in Pokotylo's (1978) studies of the Upper Hat Creek Valley of British Columbia. Pokotylo's concern was with explaining the "dispersal or aggregation of lithic reduction steps at different site locations" (1978: 163) within the valley. Since this meant having in hand some means of measuring reduction steps, a sample of archaeological debitage (in contrast to experimental materials as in Collins 1974) was factor analysed to yield

a reduced number of variables likely to yield stage data. The tool data, as morphological types within raw material classes, were analysed separately to provide information on basic use-related patterns.

Overall, the Hat Creek data exhibit high variability. Five separate debitage site groupings exist, ranging from single event, situational kinds of assemblages, to quarry-like, to late-stage maintenance and occupation patterns (Pokotylo 1978). The tool data also revealed five patterns of deposition, and again these are highly variable. Several sites of the 42 are expedient, while many are abundant, high diversity assemblages, and microblade assemblages occur relatively frequently.

Pokotylo's (1978) "experimental" method of defining appropriate debitage attributes was similar to that of Katz (1976), who studied reduction stages of several Kansas City Hopewell assemblages. Both researchers solved the problem of providing behavioral analogs for chipped stone processes by interpretation of patterns within a small archaeological sample. This kind of method has the advantage of limiting extraneous, knapper-specific bias, but lacks generality to other assemblages. Thus, within each of Pokotylo's and Katz' final assemblage groupings, ambiguities occur (see Chapter 4) which are difficult to explain. Nevertheless these studies improved significantly on approaches of Fish (1976: 1981) and Collins (1974), which are typified by analysis of redundant variables.

The contribution of Pokotylo's research is that the operation of two major processes of assemblage formation has been demonstrated: deposition of manufacture debris, and post-use deposition of tools. It is apparent that these processes are partially independent, but when combined, yield patterns interpretable as "site utilization" (Pokotylo 1978: 321 - 322). The patterns are also far more useful than those obtained using either process by itself. The lithic sub-system as a whole is dependent on the settlement system, but the interpretations of site occupation purposes are not as "fine-grained" as precise identification of large mammal or floral resource acquisition, processing, storing, consuming and disposal would allow, since use-wear, faunal analysis and other non-lithic evidence are not part of the argument. However, in the "generic" sense (basecamp, staging camp, hunting/butchering, special purpose), Pokotylo's (1978) reconstruction of the Hat Creek settlement system was highly successful. The entire combination of technological detail, at a regional level, with an environmentally-stratified set of abundant lithic assemblages, with a fair degree of ethnographic analogy, is an archaeological precedent in Canada comparable to earlier systemic Great Basin studies (Matson 1971; Thomas 1973).

It is interesting to observe the similarity in structure of the research being undertaken by Collins, Pokotylo, Katz, Fish and the current study. All first make clear they are operating under

the assumptions and limitations of a general lithic reduction model, then propose means to measure the distribution of various "stages" or states of complexity. Finally, the analyses performed are multivariate and multidimensional, offering comparisons from the levels of inter-feature, intra-site, to intra-regional, and in this study, inter-regional.

Several researchers acknowledge that lithic technology, when appropriately described, not only offers clues as to the operation of the larger settlement system, but is also a resource procurement and processing sub-system that itself poses constraints on the larger system, and at its scale, is worthy of analysis as an economy (Singer and Ericson 1977; Goodyear 1979; Gardener 1976). The principal argument is that patterns of mobility can be tied to constant lithic sources that are geologically distinct, and that succeeding reduction stages should be highly determined by conservation and distance to sources.

Goodyear (1979) presents the general case for Paleo-Indian uses of various raw materials, where the situation was that lithic resources exhibited "some severe spatial incongruencies" with locations where the stone was actually used. Note the contrast between this and Binford's (1979) "embedded" argument for the Nunamiut, in that the Paleo-Indian acquisition of stone is a special purpose task. Yet Goodyear's perspective is similar to Binford's in also being interested in the organization of curated or "carrying" technologies. Furthermore, Binford (1979), Goodyear (1979),

and Pokotylo (1978) and others see the need to model lithic technology as a flexible, situationally responsive means of solving other resource-related problems, yet as made clear by Collins (1975), the operation of the technology is in many ways independent of the subsistence and/or settlement model under investigation.

An important substantive implication of Goodyear's considerations is that on a continental scale, Paleo-Indians exhibit ranges (i.e. diameters) of mobility of 100 to 200 miles (160 to 320 km), and that during the following Archaic periods, raw material use becomes increasingly local, indicating decreased mobility (Goodyear 1979: 9 - 10).

Goodyear uses his arguments to propose the hypothesis that:

Among mobile hunter-gatherers, the use of cryptocrystalline raw materials is a strategy for creating portable and flexible technologies to offset geographic incongruencies between resources and consumers (Goodyear 1979: 12).

This kind of "economic" model is explicit in Gardener's work on the Flint Run Complex (Gardener 1976) as well as in the research of Kimball (1980), Raab, Cande and Stahle (1979), Chapman (1977), and Singer and Ericson (1977), who investigate changes in patterns of reduction, mainly of bifaces, through time and space.

The recent surge of technological awareness in lithic studies, in contrast to the technical emphasis of replication studies (see

Chapter 4), poses methodological problems for prehistoric archaeologists wishing to reconstruct hunter-gatherer patterns of movement, and the evolution of such patterns. With respect to this study, the technological expectations of Nunamiut settlement and subsistence patterns can be contrasted with those of Interior Plateau ethnographic observations. Since Binford is aware of the biases that can be introduced by "extreme cases" such as the Nunamiut (1979: 255), it can be suggested that Interior Plateau peoples have been less mobile or different from the Nunamiut in certain respects, and appropriate variations in lithic technology can be tested for in this study. This assumes that Binford's (1979) information is accurate and not induced to the informants, and demonstrating common features in the two systems may be rendered difficult by a lack of direct ethnographic evidence from contemporary Plateau peoples.

Cross-cultural research in lithic technology has reached a level of awareness such that "traditional" problem assemblage complexes appear to exhibit patterns comparable to independently derived deductions. One such pattern or problem is that revealed in the Mousterian discussion above and reinforced by Goodyear (1979), where raw material availability strongly determines the character of lithic assemblages, perhaps even masking settlement factors. Binford concludes that major rethinking of current approaches to lithic technology is required, especially in the areas of

... 'cost/benefit' analysis of lithic source reduction strategies, raw materials, tool design, recycling, reuse, and the relative contributions of each to 'assemblage variability'. We should expect different designs and reduction strategies for functionally similar tools, depending upon their intended technological roles, given variable situations of tool demand and adequate gear provisions (Binford 1979: 271).

The Nunamiut settlement system is highly logistic. Men travelling long distances on caribou hunts in a severe environment require caches and good knowledge of their locations, to insure their hunting endeavors against accidents, breakage, and to lighten loads. Binford (1979: 258) estimates that at any point in time, about 60% to 70% of the gear known to a Nunamiut man is passive, or not in use. Thus, providing that the Interior Salish and Chilcotin were somewhat less "logistic" than the Nunamiut, the amount of passive gear would be expected to be lower, since fewer types of situations may exist where separate gear is required.

To continue exploring and evaluating the archaeological foundations of this study, the following chapter presents the ethnographic and archaeological contexts of research in the central and southern Interior of British Columbia. I think that the ethnographic literature, particularly of the Plateau, has not been sufficiently recognized in the general archaeological literature for the detail it provides of a fascinating mobile, salmon procuring, hunting and gathering culture complex. The information reviewed provides empirical evidence that bears directly on the theoretical and methodological issues discussed above, completing the major terms of reference within which the ensuing analyses were undertaken.

## CHAPTER 3

## ETHNOGRAPHIC AND ARCHAEOLOGICAL CONTEXTS

3.1. Regional Ethnography

The archaeological assemblages examined in this study were obtained from four regions of the Interior Plateau (Figure 3) that were historically occupied by the following groups:

1. Chilcotin; 2. Canyon Shuswap; 3. Upper Lillooet; and
4. Upper or Spences Bridge Thompson (Figure 4).

The Chilcotin are an interior Athapaskan speaking group and are currently the most southerly Athapaskans in Canada. The Nicola, now extinct, were the most southerly. The remaining three groups represent linguistic and territorial divisions of Interior Salish peoples. This section describes the subsistence practices and settlement patterns of these people as recorded mainly in the late 19th century, and indicates basic similarities as well as important differences in their lifestyles. Sub-sections discuss the results of recent cross-cultural analyses and briefly review the interior ethnographic record of lithic technology.

The Thompson, Lillooet and Shuswap are relatively well known, mainly through the observations of James Teit (1900, 1906, 1909a), who gathered information for the Jesup North Pacific Expedition under the general direction of Franz Boas. Dawson (1891) also

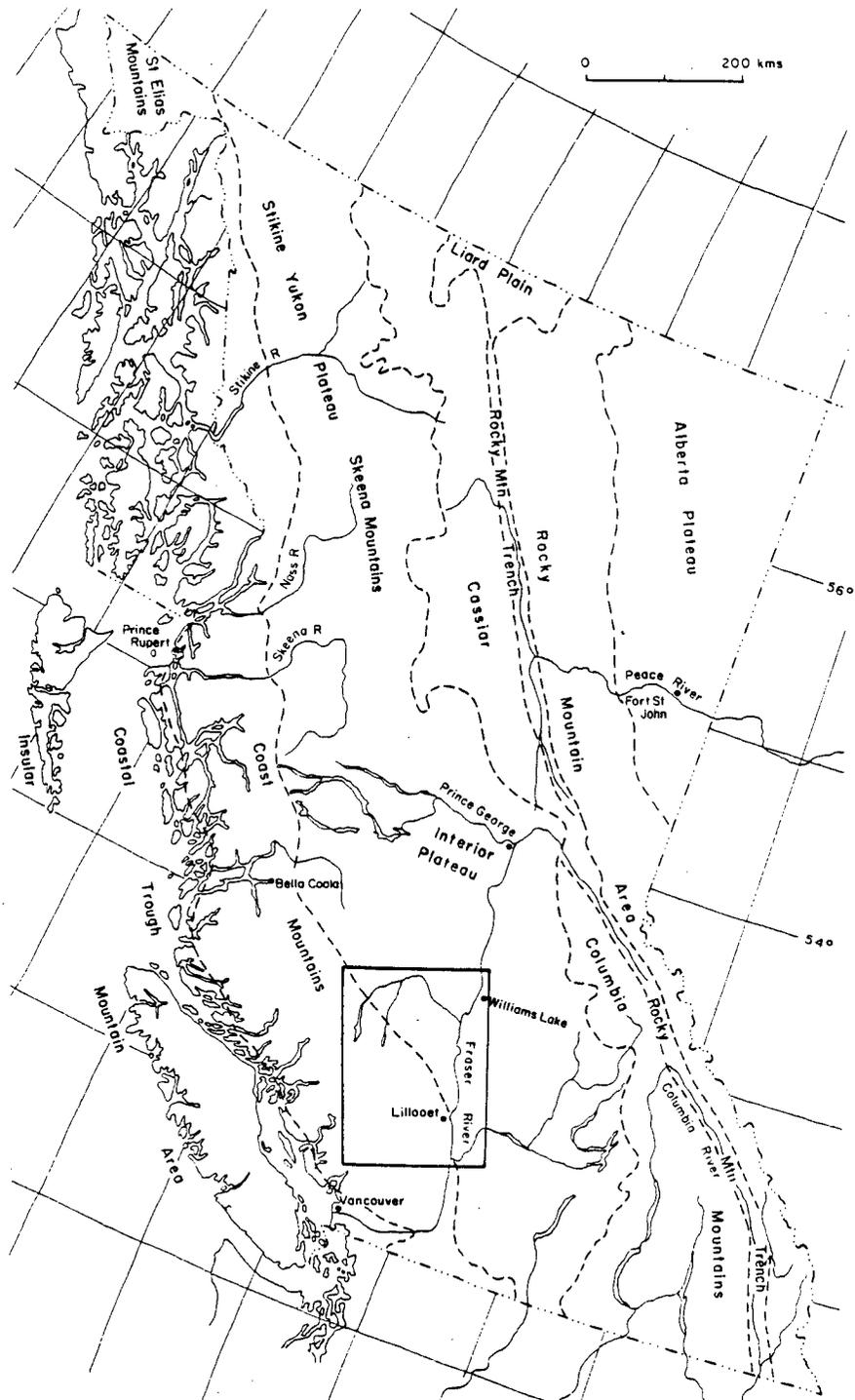


Figure 3. Physiographic zones of British Columbia, showing the area of study. After Holland (1964)

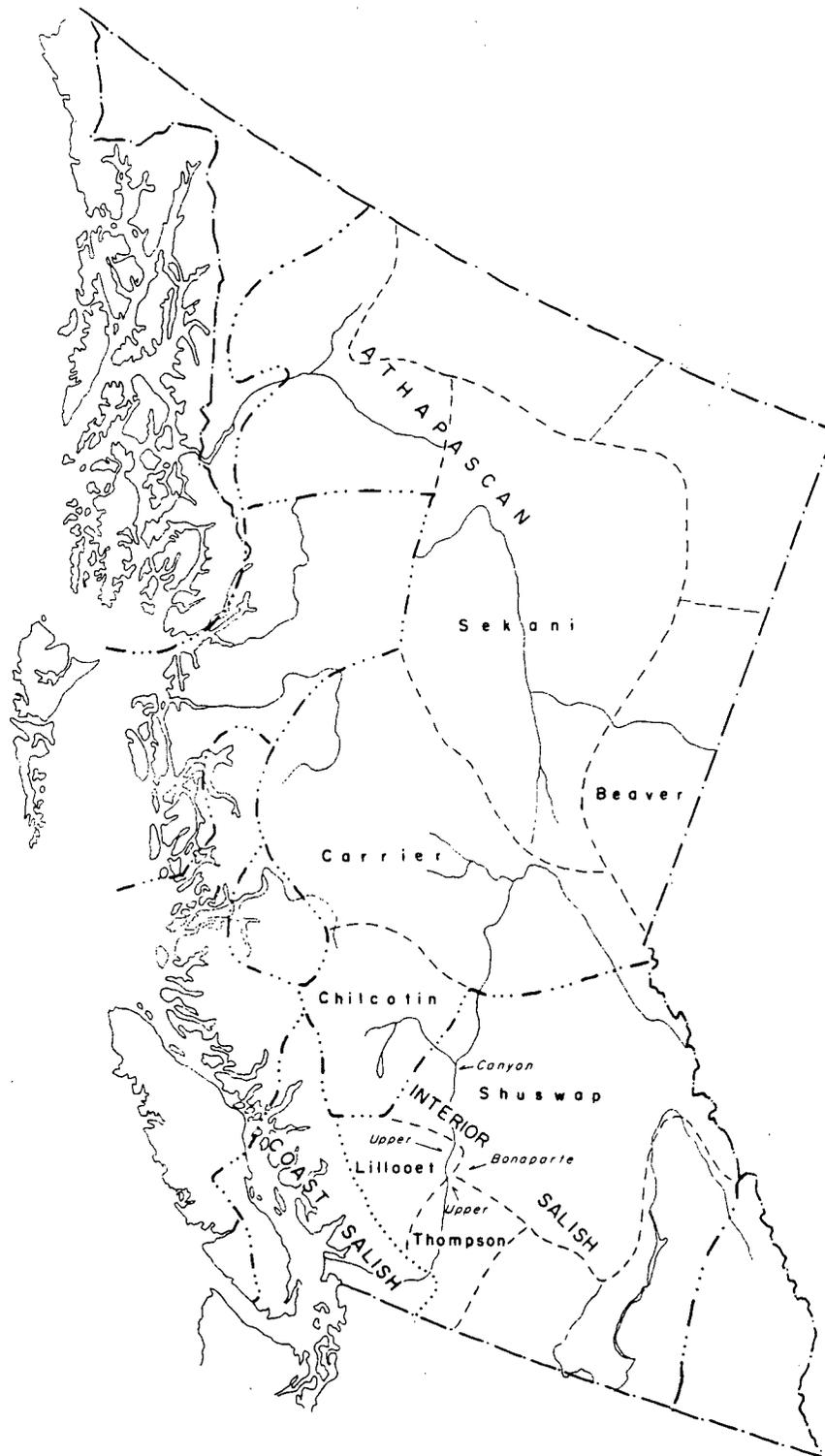


Figure 4. Ethnographic groups of British Columbia, showing the major bands of interest. After Duff (1964).

contributed information on the Shuswap, obtained while undertaking reconnaissance for the Geological Survey of Canada. Teit's work is especially valuable, for it often contains comparisons of material culture, beliefs, shelter and food acquisition.

The Chilcotin are reasonably well described by Lane (1953, 1981), but his research was conducted quite late in time (1951). Teit's (1909b) Chilcotin writings contain only minimal reference to subsistence and settlement, being mostly concerned with basketry and motifs, and Farrand's (1898, 1900) accounts of myths and legends provide little substantive data. Ray (1942) interviewed only one Chilcotin in his Plateau culture traits study, and mentions that he considers his Chilcotin data to be the least reliable of his sample. The Reverend A.G. Morice compiled detailed accounts of the Carrier and Chilcotin during his missionary work; however, his references to Chilcotin are few and often offered in comparison to Carrier (Morice 1893, 1906). Morice's writing also has a strong antiquarian and ethnocentric tone, at times leading one to suspect the accuracy of his statements. A recent study of Chilcotin ethnohistory by Tyhurst (n.d.) presents an in-depth examination of economic circumstances that have led to current eastern Chilcotin culture.

All the classic authors take pains to point out that the cultures described were observed after large-scale decimations in population had occurred, mainly due to smallpox epidemics of the

1860's (see Duff 1964). Yet it is notable that significant aspects of the aboriginal cultures remain today, with respect to the use of plant, fish and mammal resources, and certain oral traditions (Bouchard and Kennedy 1979; Kennedy and Bouchard 1978; Turner, Kennedy and Bouchard 1980; Turner 1977, 1978, 1979).

### 3.1.1. Chilcotin

The Chilcotin occupied the western edge of the Interior Plateau and were western neighbours of the Canyon Shuswap and northern neighbours to the Upper Lillooet. The Chilcotin had access to salmon, both sockeye and kokanee, but Lane (1953: 42) observed that trout, whitefish and suckers were overall of more importance than were either the annual river run or land-locked salmon. Teit (1909b: 779) wrote that the majority of the salmon used by the Chilcotin were obtained through trade with the Bella Coola and Shuswap. Jorgensen (1980) observed that in a sample of 172 western Indian Tribes "...only the Chilcotin acquired more than 10 percent of their total diet from fish gained from their neighbours " (1980: 125).

According to Lane (1953: 172 - 173) the months of July to September were the period of greatest aggregation for the Chilcotin. While engaged in root gathering in the mountains and salmon fishing at favored locations along the Chilko and Chilcotin rivers, several families would camp together and cooperate in

food acquisition, processing and storage. In October, and part of November, individual families would hunt game, and from November through to February, encampments of one or two families would winter together. Individual families would disperse to fishing sites from March to April and from then into July especially productive fishing and berrying locales would be frequented by "semi-bands" comprising several families.

House structures of the Chilcotin are reported originally to have been gabled plank houses, with rectangular and oval outlines. Round semisubterranean pithouses were later copied from the Shuswap (Lane 1953: 146; 1981: 403). Lane's informants claimed that their ancestors built their houses in isolation near lakes, and denied that housepits found near rivers were Chilcotin in origin. Lane photographed an abandoned but standing "bark house" near Puntzi Lake in 1951 (Lane 1981: 403). In the summer, brush shelters were erected, but Lane notes that "...in both summer and the winter, people often camped in the open with no shelter " (1953: 46).

To store salmon and other foods for winter months, caches were constructed that consisted of low log structures that Morice (1893: 179) says were placed on the ground. Morice also noted that these were constructed at some distance from regular villages, but Lane (1953: 46) claims caches were put up at planned future campsites. In neither case is it mentioned whether or not caches were located near winter camps. Proximity of storage facilities

to long term camps is not absolutely necessary. For example, Honigmann (1954) observed that Kaska of northern British Columbia would travel as far as 35 miles to retrieve cached food during winter shortages.

The area of Eagle or Choelquoit Lake is not mentioned specifically in the ethnographic record, and the word "Choelquoit" is not known to have any meaning in Chilcotin or Carrier (Tyhurst 1982, personal communication). Lane (1953) plots a Chilcotin housepit site on the south edge of the lake, but the scale is so innaccurate as to be of no use in differentiating that one site from several others currently known near the lake (Matson et al 1980; Germann 1979).

### 3.1.2. Thompson

Upper Hat Creek Valley was largely a part of the territory claimed by the Spences Bridge division of the Upper Thompson Indians (Teit 1900: 170), but the extreme northern part of the valley and its lower reaches to the Bonaparte River were within Bonaparte Shuswap territory (Teit 1909a: 456). The valley is specifically mentioned by Teit (1900: 170) as being an area near the western limit of the Spences Bridge band. Teit clearly regarded the Upper Thompson and the Bonaparte Shuswap as highly similar in manufactures, subsistence practices and social organization, and in his description of the Shuswap (1909a), makes continual reference to his volume on the Thompson (1900). Strong similarities were also perceived by Jorgensen (1969), whose compre-

hensive quantitative study of Salish culture grouped both into a "Thompson Culture Cluster", within which 70% of technological, social organizational and ideological characteristics were shared. Contemporary Interior Salish informants also consider themselves to be a part of a common cultural pattern (see Brow 1972).

The Upper Thompson and Bonaparte Shuswap both wintered in sheltered major river valleys, with most families occupying pithouses, although mat-covered lodges partly banked with earth were also constructed (Teit 1909a: 493; Boas 1890: 634). Teit saw only a few pithouses still in use by the time he undertook his studies, but he was able to gather much valuable information. For example, for the Thompson, Teit observed:

The existence of numerous ruins of underground houses might be considered as sufficient proof of the decrease of the tribe, were it not that the same family sometimes constructed several of these houses...(1900: 175).

Working together, a group of 20 or 30 people could construct a pithouse in a single day (Teit 1900: 192), and the dwellings were usually inhabited from December until February or March, which for the Thompson and Shuswap was the period of greatest population aggregation (Teit 1900: 194, 238). People relied heavily on foods that had been stored from the summer salmon runs and root and berry crops, but on occasion or in periods of duress, they

would hunt large game and trap smaller mammals. Many kinds of snares, deadfalls and traps were used for both kinds of game, including deer fences and pit traps.

By April, the pithouse village groups had dispersed to lake and stream fishing locations and were engaged in the gathering of roots, new shoots and cambium. The composition of such task groups is not detailed, but in all likelihood single families set out at first, and resource-rich areas of the summer were the scenes of band-level aggregation on the order of 20 to 30 people among two to four families. Hunting and trapping were carried out by men, while women undertook the collection and processing of plant foods (Dawson 1891: 19; Teit 1900: 230). Root resources were especially important during the early summer. These were dug from the rocky soils they favour with the help of digging sticks and processed for immediate consumption and for storage. Root baking or steaming was accomplished by the construction of earth ovens. These were built by both sexes, and were also used to cook mammals (Dawson 1891:9; Ray 1942).

At summer camps where an extended stay was planned, temporary shelters of mats, bark and skins were constructed (Teit 1900: 195 - 197, 1909a: 493). In late summer, about August, people congregated along the major rivers in anticipation of the annual salmon runs. Large camps were set up on the banks of the Thompson and Fraser Rivers, favoured locales being natural narrowings in the waterways.

The ascending salmon were caught with spears, nets and weirs, and dried by air and smoke to be preserved for the winter months. Salmon were also traded among Indian groups, as were oil and other by-products, as well as dried roots. The dried salmon were stored in underground pits that were lined with bark and were usually located close to winter habitation sites (Teit 1900: 198 - 199). The remainder of the year prior to the winter's accumulation of snow, was spent hunting, trapping and gathering late season foods such as white-bark pine and ponderosa pine nutlets (Dawson 1891: 22).

### 3.1.3. Shuswap

Concerning the general pattern of Shuswap subsistence and settlement, Teit wrote:

The Shuswap may be classed as a hunting and fishing tribe; the former occupation, on the whole, predominating. The Fraser River and Canon bands were the most sedentary, the latter being almost entirely so; while the North Thompson bands were the most nomadic (1909a: 513).

The Mouth of the Chilcotin region assemblages that are analysed in Chapter 6 were recovered from the Canyon Shuswap territory at the confluence of the Fraser and Chilcotin rivers. Teit clearly considered them to partake of a lifestyle somewhat different from other Shuswap and neighbouring Chilcotin:

They controlled part of the Chilcotin salmon supply, and the Chilcotin traded extensively with them...they...did very little travelling or hunting (1909a: 535).

Yet it was apparent that overall, Shuswap band composition was fluid, in part because of a very mobile pattern of settlement:

...the small wintering places were frequently changed, and even the main locality or village of a band would have more families one winter and less another. Some families were more nomadic than others, and each band would have people from neighbouring villages living with them every winter (Teit 1909a: 457).

Teit (1909a: 457) was of the opinion that 50 years prior to this time (i.e. about 1850) there were more, and smaller villages in existence. Before the smallpox epidemics of 1860 - 1863, the Canyon division was estimated to number about 700 people in four bands (100 of these in the band at the Mouth of the Chilcotin), and the Bonaparte division was estimated at 700 people in three bands (Teit 1909a: 464 - 465).

As for structures, Teit (1909a: 493 - 495) notes that the following were in use among the Shuswap: conical mat lodges and semi-subterranean lodges for winter dwellings, long double lodges for several families at fishing resorts, trapping lodges built near deer fences, menstrual huts for young women, and sweat houses. It is explicit throughout the Shuswap descriptions

that the Thompson used much the same kinds of shelters.

Fishing in lakes and streams was generally of greater importance to all Shuswap than to Thompson (Teit 1909a: 513), and gathering may have been. Teit (1909a: 513 - 514) lists 15 mammals, 18 varieties of roots, 18 kinds of berries, as well as mosses, lichens, cacti, nuts and the cambium of 8 tree species that were regularly used by the Shuswap. It is likely that more plants than those enumerated were used regularly. Detailed descriptions of floral resource acquisition and processing are provided by Turner (1977).

#### 3.1.4. Lillooet

The Upper or Fraser River band of the Lillooet tribe occupied the east and west sides of the Fraser River from Seton Lake and the present town of Lillooet north to Pavilion Creek and the Fraser River (Teit 1906). Teit (1906: 223) notes that the Upper Lillooet made two kinds of food cellars. One kind was very carefully built, and was employed to store food until spring; the other kind was used for the winter's food supply only, and was less carefully built, near the winter house. Overall, Lillooet culture was much like that of the Thompson and Shuswap, especially the Upper Lillooet, since the Lower Lillooet interacted considerably with the Coast Salish groups (Teit 1906). The Lillooet were known to hunt caribou in the extreme northwest of their hunting grounds, along with mule deer, mountain goat, mountain sheep, hoary marmot and black bear (Teit 1906: 223), a practice uncommon among

Shuswap or Thompson.

It should be noted here that Hill-Tout's (1905) description of the Lillooet does not offer much detail about subsistence or settlement practices of the Fraser River band. Boas (1906) considered Hill-Tout's account to contain inaccuracies in content, relative to Teit's (1906) record of Lillooet culture.

Kennedy and Bouchard (1978) have added to the accounts of pithouses, by interviewing contemporary Lillooet. While most information agrees with Teit's description of the Thompson, it was noted that abandoned pithouses were at times used as workshops for the manufacture of implements (Kennedy and Bouchard 1978: 37), and also that at "potlatches" deer or horses were tossed into pithouses, to be butchered by guests. Elderly people are reported to have resided in pithouses during the summer months. To keep snakes from frequenting the houses, ants' nests were placed about them (Kennedy and Bouchard 1978: 37). Apparently ants secrete a substance that repels snakes.

### 3.1.5. Cross-Cultural Discussion

From a cross-cultural perspective, it is apparent that the four groups under consideration were much alike in technological and economic adaptations. A comparison of the general round of seasonal activities conducted during the "moons" or months of the year for each of the groups, as elicited by Teit (1900, 1906, 1909a, 1909b) and Morice (1893), in a convenient manner to demonstrate their subsistence and settlement patterns (see Table 1). All four

	CHILCOTIN (Morice 1893)	SHUSWAP (Teit 1909a)	THOMPSON (Teit 1900)	LILLOOET (Teit 1906)
JANUARY		sun turns	deer bucks shed antlers does lean	coldest weather
FEBRUARY		chinook winds	spring winds some people leave houses	people come out of houses
MARCH	come out of subterranean huts	leave pit- houses, dig roots	all people come out of houses	some fishing and hunting
APRIL	suckers fished	snow gone from high ground, people dig roots	fish trout with dip nets trap lake fish	
MAY		people fish trout at lakes	root digging	first salmon small fish
JUNE		service berries ripen	young deer born, berries ripen	berries ripen
JULY	kokanee fished	salmon arrive	berries ripen some people hunt	berry picking
AUGUST	salmon	fish all month	sockeye run	salmon run
SEPTEMBER		cache fish hunt	cohos come	boil salmon, make oil
OCTOBER		hunt and trap in mountains	trap, hunt	hunt and trap
NOVEMBER	enter sub- terranean huts	going in time, deer rut	deer rut	going in time
DECEMBER	ice	first real cold	into winter houses	sun turns

TABLE 1. Seasonality of Interior Plateau groups as evidenced by general activities undertaken during "moons". Monthly equivalents provided in the ethnographies cited.

entered pithouses about the month of November, the Thompson possibly waiting until after the deer rut was over. Root digging was a priority activity during the months of March to May, with the Thompson possibly spending more time at this, perhaps because of their access to good root grounds such as Hat Creek. Prior to the arrival of the salmon in August, they spent June and July undertaking a wide range of foraging activities, but focusing on berries, particularly service berry. August and September was the time to catch, process and store salmon, and the month or two prior to the commencement of winter life was the time to hunt large mammals while they were rutting and descending to lower elevations.

Jorgensen's (1980) multivariate study of 172 western Indian tribes includes the most recent and perhaps the most objective comparison of the Chilcotin, Shuswap, Upper Lillooet and Upper Thompson. In relation to the broad range of environments occupied by the Indians of western North America, Jorgensen shows that these four groups had similar resource types and climatic conditions. They had highly similar technologies, as well as relatively strong resemblances in economic and social organization. The subsistence economy of the Chilcotin and Shuswap was somewhat different from that of the Upper Lillooet and Upper Thompson, and it is notable that the Lillooet and Thompson fall into two completely separate clusters in the subsistence economy analysis. The Shuswap, Upper Lillooet and Upper Thompson are similar to each other with respect

to ceremonialism and spiritualism, but the Chilcotin are different from them in both these aspects. Yet the Shuswap and Chilcotin are alike in political organization, and the Upper Lillooet and Upper Thompson diverge from these two groups as well as from each other in this analysis.

For the purposes of this study, these are appealing results of an exhaustive research programme, but Jorgensen's style of the quantitative study renders conclusions difficult. Overall, the four Plateau cultures under consideration show a communality in culture that seems to be more attributable to environment than to language or ideology, and this is not surprising for hunting and gathering societies. The four are loosely grouped in Jorgensen's (1980) analysis of economic and social organization, but this is perhaps where the Interior Plateau ethnographies are weak. The Chilcotin here are somewhat more loosely linked to the three Salish tribes.

In all fairness, it must be recognized that the attributes coded for the groups in Jorgensen's analyses had to be "averaged out" for several bands and in the face of sometimes conflicting evidence, yet some problems do exist with the data codings. For example, Jorgensen (1980: 356) classes the Chilcotin as employing double lean-tos as winter habitations, the Shuswap, Upper Lillooet and Upper Thompson as employing pithouses. This is perhaps acceptable as far as the prehistoric use of such structures is concerned, but it is clear from Morice and Teit as discussed above

that the Chilcotin did live in pithouses, and even though these were "borrowed" from the Shuswap, the Chilcotin clearly had their own patterns of using them, preferring isolated rather than grouped villages, and lake locations rather than rivers. This problem appears to stem from Jorgensen's reliance on Ray's (1942) Chilcotin evidence rather than that of Morice (1893). Perhaps also misleading is the classification of Chilcotin and Upper Lillooet as lacking conical and subconical dwellings, both attributed to the Shuswap and Upper Thompson, with 4-pole foundations. Furthermore the Shuswap are classed as obtaining aquatic animals only as a tertiary contribution to diet, and these are coded as secondary contributors to Chilcotin and Upper Lillooet diets, and as the dominant food source among the Upper Thompson. These codifications are perhaps valid for each "tribe" as a whole, but are not the case for each band, particularly the Canyon Shuswap. In general, Jorgensen's (1980) analyses provide a panorama depicting the groups of interest, and the utility of the volume is only slightly hampered by the few inconsistencies with known occurrences of specific material culture. It is clear that the four groups examined are closely related in most aspects of material culture, technology and economy.

### 3.2. Ethnographic References to Lithic Technology

This dissertation is concerned with prehistoric stone tools, and it is appropriate to review what has been recorded about lithic technology by both the classic and the more recent ethnographers.

No previous compilation of the Interior Plateau lithic technology references exists, and I believe it is useful here as a source of future reference, to lend insight to more complex patterns to be discussed, and for documentation in its own right of this practically extinct set of tool-making techniques. The descriptions of the late 19th century are often more informative and lucid than some of the classic cases in the current archaeological literature such as the Western Desert Aborigines (Gould et al 1971; Gould 1980, Hayden 1978).

Most of the information can be taken as accurate, but some is thought to be marginally so. The following excerpt from a recently collected Shuswap interview about hunting techniques (Willard 1979) is reasonably well informed, yet also unrealistic.

Before the non-Indians came to this country, the Shuswap people used to go to Ta-Ta-CAIL-in, a mountain near Kamloops, to collect flint rocks. The rocks that were rounded on one end were used when they tanned hides, and the thin rocks were used for arrowheads. To make the arrowheads thin and sharp, the rocks were placed in the fire until they were red hot and then they were dipped into some cold water. The chips that broke off when the rock hit the water were very sharp and good for arrowheads. The piece of flint was then fastened to a juniper stick which had been split and whittled. The finished arrow is about three feet long (Willard 1979: 139; emphasis added).

Hill-Tout's informants in the Lytton and Lillooet area appear not to have been familiar with stone tools as subsistence implements, but claimed that they were used in personal scarification (Hill-

Tout 1905: 64).

Teit provides descriptions of quarries, observations on functional specificity of tool types, and a good description of bipolar core reduction:

Arrowheads were made of glassy basalt which was obtained at a certain place north of Thompson River... Many were made out of large chipped heads, which are found in great numbers in the valleys (1900: 241).

...spearheads were similar in shape and material to the arrowheads except that they were larger (1900: 236).

The Indians are still familiar with the art of making arrowheads. When these were to be made from a boulder, the following method was employed. The boulder was split by being laid on a stone and struck with a hand-hammer, generally a pebble of handy size. When a suitable piece had been obtained, its edges were trimmed off with a hard stone. Then it was wrapped in grass or hay, placed on edge on a stone, and large flakes were split off with a hand-hammer. After a suitable piece had been obtained, it was placed on a pad in the left hand and held in position with the fingers. It was given its final shape by means of a flaker made of antler...which was used with a forward and downward pressure (1900: 182).

Teit was aware of the concept of stages in stone tool manufacture, and compared what he witnessed among the Thompson to stone working described by Morice (1893):

The blunt point served for flaking off larger chips, while the smaller one was used for the final stages of the work. In later times, iron flakers were used. The method of holding the flake was the same as that of the Carrier Indians of northern British Columbia (Teit 1900: 182).

Morice's (1893: 51) description of bipolar reduction, which he maintained was used "almost invariably", is comparable to Teit's but lacking in detail. There is also evidence that hafts were not the most valued part of all composite stone tools, contrary to Keeley (1982), who argues that the efforts of rehafting blunt tools are large enough to warrant extensive resharpening prior to discard:

This hafting is temporary as the stone part only of the implement is usually kept among the family chattels (Morice 1893: 51).

Morice is here describing cobble spall hide scrapers, for which contemporary curation of this sort has been recently recorded. Albright (1982) has observed a Tahltan woman in Telegraph Creek using stone hide scrapers and searching for suitable stone while on traplines. The woman keeps her spall tools and has her mother's as well, numbering some five to ten in all. I should note here that a Chilcotin woman of the Nemiah band at Chilko Lake is reported to make and use spall hide scrapers also (D. Lulua, personal communication 1979; see Matson et al 1980: 230).

There are references to traditional names for stone raw materials such as /pis/, which is a "black resonant rock" identified by Dawson as augite-porphyrite (Morice 1893: 53). Morice mentions that the Carrier had six words for suitable chipping stone, including /nalre/ for obsidian (1893: 53), which is also known as /bez/

by Anahim Lake Chilcotin (Wilmeth 1978), and Nemiah Chilcotin (personal observation) and /tse-lkrai/ for chalcedony. There is no real contradiction in the use of /pis/ for dark basaltic rock and /bez/ for obsidian, since the Athapaskan word applies to black rock in general, viz the Baezeko River, Beece Creek, places where quantities of glassy basalt and other volcanics can be found (Tyhurst, personal communication 1982); i.e. these two words are cognates.

Teit (1909a: 473) noted that Shuswap and Thompson stone working techniques were identical, and that while rough spall scrapers were usually employed to scrape hides, occasionally fine basalt was used. This is evidenced archaeologically at the Mouth of the Chilcotin, where a very heavily worn scraper is a fine basalt biface, the broad blunt end being the locus of considerable rounding (Matson, Ham and Bunyan 1979; Ham 1975: 160). Morice, however maintained that such scrapers "receive no polish whatsoever" (1893: 50).

Finally, Morice presents evidence that there was some ownership attached to specific quarries:

The material chosen in preference to fashion arrow or spear heads with was loose, broken pieces of rock such as were found on the surface. Of course, these were confined to a few localities only wherein were situated sorts of quarries which were very jealously guarded against any person, even of the same tribe, whose right to a share in their contents was not fully established. A violation of this traditional law was often considered a casus belli between the co-clansmen of the trespassers and those of the proprietors of the quarry (1893: 65).

This discussion has not attempted to compile all the known references to the craft of stone working as practiced by the ethnographic inhabitants of the Interior Plateau. For example, it offers no description of stone grinding techniques, which to judge by the writings of Teit and Morice, one gets the impression were more in common practice than was stone flaking. The evidence is only slightly analytically relevant to the remainder of this study, but the details of quarries, core reduction, flaking and pressure retouch are provided to illustrate the nature of the available information.

### 3.3. Regional Prehistoric Archaeology

This section reviews the development of prehistoric research in areas of immediate relevance to the present study. The discussion focuses on studies undertaken on the Fraser and Nechako Plateaux, and excludes research reported from the Okanagan and Kootenay regions, as well as work done in the Rocky Mountain and northern Interior areas. The following description of the growth of professional research is structured in terms of early studies, culture history investigations, and settlement pattern research.

#### 3.3.1. Early Studies

The first observations on prehistoric settlement on the Interior Plateau were recorded by George Dawson in 1877 as part of a report on Shuswap ethnography (Dawson 1891). Harlan I. Smith

conducted excavations of several burial sites in the southern Interior near Lytton, Spences Bridge and Kamloops, and he also undertook a limited survey of the Nicola Valley (Smith 1899, 1900). Smith interrelated the burial remains he uncovered with local Indian legends, and recognized the continuity of the prehistoric remains with the culture of the Thompson Indians as described in James Teit's ethnographic research (Teit 1900).

Farther to the north on the central Plateau, the Rev. A.G. Morice (1893) described selected aspects of Carrier prehistory, including stone tools and cultural depressions. Morice disputed any claims for significant antiquity of archaeological materials, citing as evidence the similarity of abandoned sites and artifacts to those in use by the Athapaskans whom he was converting to Christianity (Morice 1893: 39 - 43).

### 3.3.2. Culture History and Classification Studies

#### Central Plateau

No archaeological research was conducted in the central and southern Interior of the province until Borden's surveys of Tweedsmuir Park and the Nechako River system in the early 1950's (Borden 1952a,b). Borden's work was carried out to partially offset environmental impacts caused by the construction of the Kenney Dam by the Aluminum Company of Canada, and can be seen as being inspired by the extensive river basin surveys and salvage archaeology projects that were being carried out by American archaeologists

of the time. Borden's surveys on the central Plateau also prompted him to devise a uniform site recording scheme (Borden 1952c), now known as the Borden system.

The most significant results of Borden's research came from the excavations at Chinlac village (GaRv 1) and Nataalkuz Lake (FiSi 19). Chinlac was recognized as a site occupied during the protohistoric and historic periods, and Nataalkuz Lake revealed two periods of occupation. The lower levels of FiSi 19 contained micro- and macroblades, and were dated to  $2415 \pm 160$  BP. Borden classified the lower part of this site, actually a large hearth feature, as the remains of a non-Carrier or Chilcotin "Nataalkuz Lake Culture", and considered the uppermost remains to represent a late prehistoric Carrier occupation (Borden 1952b).

Chinlac was the site of a historically recorded battle, ca. 1745 (see Wilmeth 1978: 6) between Carrier and Chilcotin (Morice 1906: 14 - 15). The village may have been visited by Simon Fraser sometime around 1806 or 1807 (Lamb 1960; Nechako Valley Historical Society 1979). Wilson Duff's fieldnotes on Carrier Indians (Duff 1951) contain interviews with informants who claim that the site was not reoccupied following the massacre. Duff's (1951) Carrier informants claim that the site was a summer fishing site located near a large weir on the Stewart River.

Chinlac presently consists of ten shallow, large, rectangular depressions in a clearing about an acre in size, with well over 100 cache-pit depressions located in the forest west of the

clearing. In his excavation of one of the larger depressions (House III) at Chinlac, Borden recovered items of iron and copper, glass beads, bark rolls, faunal remains and items of stone and bone manufacture. The materials from this site have never been fully described or analyzed, although a 25 percent sample of the debitage from field bags was examined in a debitage study of several Plateau assemblages by the present author (Magne 1980). Also, 14 of the hundred-odd projectile points from Chinlac were used as "known Athapaskan" items in a study of ethnic homogeneity in small side-notched point styles (Magne and Matson 1982). The entire assemblage is currently undergoing study by Cranny (1982), who thinks that the site is multi-component. It seems rather clear that the House III depression excavated by Borden was built and used by a single Carrier band, although hearth features appear to have been used repeatedly, possibly with seasonal lapses.

As concerns the 130 or so sites that he located in his 1951 survey of some 400 miles of river and lake shores, Borden notes:

Most of the sites... are hunting, fishing, berry-picking and cambium-gathering camps without indications of permanent habitation. Sites are often located at the head or outlet of lakes, near marshes or game crossings, in sheltered bays or coves with sandy beaches, and near head lands affording a sweeping view of the lake. Most sites are found on the north side of the lakes, indicating that a southern exposure was a desirable factor (Borden 1952b: 34).

The Punchaw Lake site (FiRs 1), located 55 km southwest of Prince George, consists of 43 house platforms, 57 storage pits, and a historic trail segment. Two house platforms were excavated at this site (Fladmark 1976; Montgomery 1978). Area A, reported by Fladmark (1976) contained a burial, below which deposits were dated to  $3980 \pm 100$  BP, and "the last major occupation" of the site is thought to have taken place between AD 1700 and AD 1800 (Fladmark 1976: 31). Montgomery's (1978) analysis of the stone tool assemblage from Area C demonstrated that all stages of tool manufacture were present within the deposits.

At the Tezli site (FkSd 1), several of 46 visible cultural depression features were test excavated by Donahue (1977). Donahue posited that the site was first occupied about 2500 BC by people using pithouses as winter habitations. The artifacts from Tezli were classified into many morphological types and compared visually with other collections from western Canada and the U.S. The results led Donahue to assert that no major population displacements have occurred on the Interior Plateau within the last 4500 years, and that continuous cultural evolution has occurred throughout the region (Donahue 1977). It is clear that Donahue also recognized certain "influences" and may have glossed over "diagnostic" artifacts in the Tezli assemblage. In particular, 14 microblades were found at Tezli, 12 of these being from the same stratigraphic layer that yielded a  $3850 \pm 160$  BP date, but "for all intents and purposes" (Donahue 1977: 259) a microlithic technology

is not present. Since Donahue discontinued screening of the site matrix early in the excavation schedule (1977: 119), a bias towards large artifact recovery is not surprising. A significant collection of microblades may yet exist at the site.

Donahue's investigations of Carrier prehistory through the direct historic approach (Steward 1973) were initiated at Ulkatcho, an early historic trading centre for Carrier. Ulkatcho was visited by Mackenzie in 1793 and by Dawson in 1876 (Donahue 1973), and the people of this village were the subjects of Goldman's (1940) ethnographic research.

Wilmeth (1969, 1970, 1971, 1975, 1977, 1978) has investigated several sites in the Anahim Lake area. He has attempted to date the arrival of Athapaskan Chilcotin in the region, and to compile definitive traits of prehistoric Chilcotin material culture also via the direct historical approach. Using evidence obtained from five house remains at the Potlatch site (FcSi 2), two houses from the Goose Point site (FdSi 3), and another from the Daniktco site (FdSi 3), Wilmeth's (1978) current interpretation is that five principal phases, or "component clusters" of human occupation are evident in the area. The earliest of these spans a period of AD 1 to AD 400, and is characterized by microblades, and the second, dating from AD 700 to AD 850, also contains microblades but is distinct by virtue of an apparent temporal hiatus. The third phase dates around AD 1200 to AD 1800. The White River Ash fall in the Yukon that is estimated to have occurred at about AD 700 is said to be the major factor precipitating Chilcotin mi-

gration to the area (Wilmeth 1978: 173).

Elsewhere on the central Plateau, Mitchell (1969, 1970) excavated three sites, assigning each to a different phase of the Nesikep Tradition that is discussed below. Strictly on the basis of rather questionable typological comparisons, Mitchell (1969) placed the Poplar Grove site (FaRx 1) in the Lower Middle period (5000 to 3500 BP), the Horn Lake Southwest site (EkSc 1) in the Upper Middle period (3500 to 2000 BP), and the Natsadalia Crossing site (FdSi 2) in the Late Nesikep period (2000 BP to historic). Wilmeth (1978) considers FdSi 2 to be a Chilcotin occupation.

Prompted by his research at Tezli and Ulkatcho, Donahue (1975) examined collections of surface collected items from 40 locations that had been donated to the National Museum of Man in Ottawa. With lack of good provenience, the resulting catalogue cannot serve as a base for firm conclusions, but the description of a Scottsbluff-Eden point found near Vanderhoof on the Nechako River suggests a potential occupation of the area starting as early as ca. 9000 BP. Wilmeth (1978: 143) notes that an Alberta point made of obsidian was found near Anahim Lake, and in excavations at the Potlatch site he recovered a broken biface that he types as a Pryor Stemmed point, dating to ca. 5610 to 6550 BC in Plains regions. This latter find is questionable given that no radiocarbon dates from the Potlatch site older than AD 80 were obtained (Wilmeth 1978: 154). The possibility of Paleo-Indian peoples in the central

Plateau is also reinforced by the discovery of Pleistocene mammoth remains at Babine Lake (Harrington et al. 1974), although no human artifacts are associated.

Whitlam (1976) analysed materials that were recovered from three sites excavated as part of a highway salvage program, near Williams Lake. All sites were occupied during the Late Nesikep Tradition, and housepit sites FaRn 3 and ElRn 3 each appear to have been occupied twice, at times averaging  $1762 \pm 58$  BP and  $1180 \pm 58$  BP. Whitlam (1976) applied SYMAP programs to the distribution of artifacts obtained from "mounds" at site FaRn 8 in an attempt to discern occupation, stone working and storage activity areas.

In sum, the central Plateau has been the locus of several studies in culture history and artifact typology, but still lacks a cohesive regional scheme with firm horizon markers, except perhaps for the last 1000 years. This, in effect, means that prehistoric cultures that are directly and unquestionably ancestral to ethnographically documented cultures are the only "phase" that can be identified. The utility of temporal horizon markers such as microblades, corner-notched points and small side-notched points is uncertain for several reasons. Perhaps the most critical, maybe even incorrigible reason is a lack of stratified, non-housepit sites such as caves, rockshelters, middens, or intact fluvial/deltaic sites. This problem is discussed in more detail below.

### Southern Plateau

Within the scope of this discussion, contemporary archaeology in the southern Plateau was initiated by Borden. In 1954 and 1956 he excavated a burial site in the vicinity of Cache Creek (Sanger 1968a: 140). David Sanger's involvement with an Interior Plateau prehistory started with a burial survey in the Lillooet and Lytton areas of the Fraser River (Sanger 1963) and excavation of a burial site near Chase (Sanger 1968a).

Sanger's research in the Lochnore-Nesikep locality resulted in the best documented chronological scheme presently available for the entire Interior Plateau (Sanger 1963, 1966, 1969, 1970). This scheme was based on excavations at two deeply stratified housepit sites, Lochnore Creek (EdRk 7) and Nesikep Creek (EdRk 4), as well as two other sites: Cow Springs (EdRk 5) and Lehman (EdRk 8). Sanger (1970) concluded that two major cultural episodes, the Lochnore Complex and the Nesikep Tradition, are represented in the deposits at these sites.

The Lochnore Complex (5000 BC - 3000 BC) is thought by Sanger to represent an initial population moving northward in nearly immediate post-glacial times. Sanger proposed that the Lochnore Complex was derived from the Old Cordilleran Culture as described in the U.S. northwest by Butler (1961). Borden (1969, 1979) refers to this complex as the Protowestern Tradition. The predominant traits of the Lochnore Complex are leaf-shaped bifaces and cobble tools that are at times found with other components, but Lochnore

Complex assemblages are distinct in that other, more recent, complex tool forms are lacking. Such assemblages have been recently reported by Eldridge (1974) and Richards (1978). Near Lillooet, the Terrace site is dated at  $4145 \pm 205$  BP, and contains an assemblage lacking microblades, and exhibits large cobble cores and leaf-shaped points (Richards 1978). Similar evidence is to be found at the Moulton Creek site (Eldridge 1974) on the South Thompson River, where the assemblage was located below Mt. St. Helen's "Y" tephra, dating to about 4000 BP. It should be noted here that Eldridge initially located the currently oldest archaeological site in the Interior Plateau, the Gore Creek skeleton (Cybulski et al 1981). The postcranial remains of a young adult male, apparently caught in a mudslide, were dated at  $8250 \pm 115$  BP.

The Nesikep Tradition is thought to represent a southward movement of people who employed a microblade technology. In Borden's (1969, 1979) terminology, these people are known as carriers of the Early Boreal Tradition. The Early Nesikep Tradition includes as traits distinct projectile points that are thin, relatively large and finely pressure flaked. Sanger (1970) considers these points to be derived from Plano cultures, although exact typological comparisons are not possible. The Lower and Upper periods of the Middle Nesikep Tradition exhibit an abundance of corner-notched points, some with concave bases or shoulder tangs that resemble several Middle Prehistoric or Archaic points from Plains regions. The Plateau Microblade tradition continues to exist through the

Middle period, and is suggested to terminate about 2000 BP. In the Late Nesikep Tradition (2000 BP to AD 1800), Sanger recognizes characteristics of protohistoric and ethnographic inhabitants of the southern Interior, such as large, numerous pithouse villages, small side-notched (Kamloops) projectile points, and a visible bone and antler industry. In the Kamloops Phase of the Late Nesikep Tradition (ca. 1000 BP to 1800), corner-notched points are virtually absent and points with multiple notches on the blades are quite common (Sanger 1970: 122). In total, the 7000 year long development of the Nesikep Tradition is thought to represent the evolution of Salish-speaking cultures of the Plateau.

Research undertaken by Stryd (1970, 1971a,b, 1972, 1973a, 1973b, 1973c, 1978, 1980) in the Fraser River Valley near Lillooet was aimed at clarifying the prehistoric sequence of cultures during the Late Nesikep period. Like Sanger, Stryd focused on excavating housepits and compiling lists of "diagnostic" traits for exclusive cultural phases, supported in part by radiocarbon dates. Stryd (1973a) defined three major components in the housepits of the Lillooet region. The Nicola Phase (2750 BP to 1750 BP) is the earliest of these, the Lillooet Phase (1750 BP to 1150 BP) is intermediate, and the Kamloops Phase (1150 BP to 200 BP) is the latest. According to Stryd (1973a), the Nicola Phase is characterized by a lack of a microblade technology and small arrow points, and contains corner-notched atlatl points (large with wide necks). In the Lillooet Phase,

the bow and arrow was introduced, leading to an abundance of small projectile points, both corner and side-notched, and a lack of large corner-notched points. The Kamloops Phase contains abundant Kamloops projectile points, which are relatively thin and well-made, and a fair number of zoomorphic figures in bone and stone are also present. Stryd later revised this scheme in an unpublished paper (1973b), by deleting the Nicola and Lillooet Phases, and preferring to place greater emphasis simply on the introduction of the bow and arrow at ca. 2400 to 1800 BP. This thus extended the Kamloops Phase to 1800 BP, although Stryd may presently include the Lillooet Phase (Matson, personal communication 1983). This latter scheme is perhaps the most defensible, partially because Stryd no longer stresses the bone and antler industry, and since it is clear that more of such artifacts were present in later assemblages, perhaps preservation factors were being reflected more than cultural ones. Thus, in the final analysis, Stryd's research added detail to the Late Nesikep Tradition as defined by Sanger in terms of material culture, but did little to answer questions pertaining to internal site structure, housepit contemporaneity, or social implications of housepit arrangement within complex sites, that were posed prior to the major portion of his research (Stryd 1971b).

Stryd's latest assessment of the Lillooet region sequence is that microblade technology occurs as late as 1250 BP (1973c: 8), and that housepit structures have two basic forms: small ones with

conical roofs, and larger ones with a different, but undetermined overstructure (1973c: 8). Certain observations by Stryd concerning five of the Lillooet region sites examined in the present study are presented in the site description section of Chapter IV.

In the Kamloops locality, Wilson (1980) defined two prehistoric cultural phases starting at ca. 2500 BP. The Thompson Phase (2500 to 1400 BP) represents the first occupation of the local area. While this phase includes the traits of Stryd's (1973a) Nicola and Lillooet Phases, it also includes macro- and microblades, leaf shaped and stemmed projectile points, and some arrow points (Wilson 1980: 8). Housepits are said to be typically small, round and lacking ridges. The Kamloops Phase is conceptualized by Wilson (1980) as starting ca. 1400 BP, even though the earliest absolute date obtained was  $1140 \pm 100$  BP (1980: 9). The phase is otherwise as defined by Stryd (1973a,b,c), including the presence of large circular and oval housepits with ridges, and cachepits. Wilson maintains that the Kamloops Phase was initiated later in the Kamloops locality "...because initial intensive riverine exploitation of the anadromous salmon occurred much later..." (1980: 9).

C. Carlson (1980) takes Wilson (1980) to task with respect to the differences between the Thompson and Kamloops phases, based on her excavations of two sites (EdRa 22 and EdRa 4) also in the Kamloops locality. Carlson argues that there is no good evidence for a shift from hunting to fishing emphases in the local economy, or population increases. Carlson concludes that the only observable

trend from early to late in prehistory is an increase in frequency of small triangular side-notched points (Carlson 1980: 120). Thus the current Thompson-Kamloops Phase concept may be reflecting changes in a rather small part of material culture (mammal hunting technology) but does not likely represent large scale changes in settlement and subsistence practices. In many respects this is a defensible argument. No case for change in the diet or seasonality of people represented in the Nesikep Tradition has ever been firmly presented. Perhaps the major reason for this is poor preservation of faunal remains, a problem noted by Ham (n.d.) in an analysis of faunal remains from several Lillooet region sites excavated by Stryd. Ham (n.d.) found deer and salmon to be the major species represented in prehistoric assemblages, with deer being replaced by horse in historic period remains (see Stryd 1980).

Whitlam (1980) radiocarbon dated alluvial deposits at Lopez Creek (EeRh 3) near the town of Cache Creek, obtaining an age of  $3920 \pm 65$  BP (1980: 34), corrected to solar years to yield a date of  $4448 \pm 144$  BP. Unfortunately, it is not possible to ascertain whether or not any artifacts are associated with the date. Other serious methodological problems render Whitlam's conclusion that the site exhibits time-transgressive occupation in discrete areas, highly questionable (see Magne 1982).

Culture history in the southern Plateau is currently tenuous before 3000 BP and only reasonably controlled in local areas for components dating since that time. Perhaps the most important

reason for this is the continuing emphasis of housepit excavation. Unlike the Columbia Plateau south of Wisconsinan glaciation, this emphasis is due to natural conditions of the Plateau of British Columbia where few, if any rockshelters or caves suitable for human habitation are available, and where soils nearly everywhere are thinly developed since glacial times, alternatives have rarely been considered. There have been no concerted systematic attempts to discover aeolian sites, for example, nor has a research design to investigate cache pit variability in age, form and location ever been implemented.

As Wilmeth (1978b) has pointed out, the re-occupation of pithouse depressions one or more times can lead to severe disruptions of cultural stratigraphy and this can impede culture-historical methods. Fladmark (1982a) and Von Krogh (1980) also offer thoughts on difficulties associated with such sites, including: the filtering of materials from the roof to the interior; the occurrence of this process once prior fill materials are used as roof insulation; differential decomposition of the structure, with intermittent partial infilling by aeolian, alluvial or fluvial processes; and use of the house or resulting depression for non-habitation purposes such as tool manufacturing or garbage disposal (see also Kennedy and Bouchard 1978). Also, as Fladmark (1982a) points out, housepit excavations will likely never yield data beyond the 4000 years or so within which they are known to exist. Although Sanger (1970) did his best to isolate some general strat-

igraphic zones through arbitrary level recovery, it is probable that Nesikep Tradition materials of earlier and later ages are mixed, the same is probably true of most other multi-component housepit sites that have been excavated. In my opinion, the mere existence of this problem--the continued re-use of site areas by various phases of prehistoric inhabitants of the Plateau--speaks loudly for some degree of continuity in settlement and subsistence patterns, regardless of habitation style or culture "type". A determined effort to fully excavate a time-progressive series of single-component housepits is urgently required.

### 3.3.3. Settlement Pattern Studies

Currently there are only three projects that have contributed substantial data on the entire range of settlement-subsistence patterns of the Interior Plateau. The Shuswap Settlement Patterns project (Matson et al. 1979; Ham 1975), the Hat Creek project (Pokotylo 1978a; Pokotylo and Beirne 1978; Beirne and Pokotylo 1979) and the Eagle Lake project (Matson et al. 1980) all employed regional sampling schemes to provide estimates of the range of site types occurring in fairly large areas. All three of these studies are of direct relevance to the present study since some sites from each of these projects are analysed here.

The purpose of the Shuswap Settlement Patterns project in the southwest area of the confluence of the Chilcotin and Fraser rivers (the Mouth of the Chilcotin) was to study the environmental characteristics of site locations and to use this data and the material

culture evidence to test the applicability of "sedentary" and "mobile" models of Canyon Shuswap settlement as provided in the existing ethnographic record (Teit 1909a). As discussed in the previous ethnographic review section, the Canyon Shuswap may have partaken of a different pattern than other Shuswap, maintaining a prime salmon acquisition territory, acting as trading middlemen between Chilcotin and other Shuswap and possible also between these and Lillooet and Thompson.

The analysis of site context and content by Matson et al. (1979) demonstrated that six site classes are present in the region: ravine cachepit sites, ecotone cachepit sites, housepit sites, riverside sites (all but one with cachepits), chert debitage sites, and unique sites with low artifact frequencies. The chert debitage sites are argued to pre-date the other sites, which are said to be Kamloops Phase, because the artifact analyses show these to be different in most respects, especially in containing large corner-notched points, and also because Sanger (1970) stated that chert is most abundant as total debitage material in pre-Kamloops Phase components of the Nesikep Tradition. Matson et al. (1979) maintain that the distribution and composition of the other assemblages does not fit Teit's (1909a) observation that the Canyon Shuswap lived in four large pithouse villages, and propose that the more generalized, mobile model of Shuswap settlement is applicable to the Kamloops Phase occupations of the region.

The information gathered by the Shuswap Settlement Pattern project was also used by Ham (1975) in an M.A. thesis. Ham (1975: 220 - 222) concluded that during the Kamloops Phase, two major settlement types prevailed: winter pithouse villages located on the upper benches of the Fraser River, and summer fishing camps next to the Fraser River. Ham (1975: 210) also postulated that cache-pit storage sites were the scenes of limited activities strictly focused on salmon procurement, processing and storage.

While Matson et al. (1979) and Ham (1975) present reasonable evidence that the Canyon Shuswap were not entirely sedentary, I think that evidence indicates a kind of settlement pattern that has been overlooked. It is established that there are several kinds of subsistence orientations in evidence within an area of some 40 km<sup>2</sup>. Thus, given a maximum foraging radius of some 6 km, and a centralized radius of about 3 km, rather intensive use of a small area is indicated. This is even more in evidence if the estimated total of 247 sites (Matson et al. 1979) within the grassland zone is taken into consideration.

It is also interesting to extrapolate these figures even further. Subtracting the estimate of 19.5 chert debitage or "pre-Kamloops" phase sites in the grassland zone from the estimated total, it can be estimated that approximately 200 sites were formed in the last 2000 years, or about one site every ten years. Approximately 65 housepit sites were constructed, inhabited and abandoned during this period or one housepit site every 33 years, representing 266 housepits,

or 1.3 houses every ten years. Further, 1046 cachepits are estimated in the grasslands population, representing approximately the use of one every two years, about four cachepits for each housepit. I suggest that these figures are fair estimates of housepit occupation spans and cachepit use spans for the region, and are indicative of repeated use of the region. Unfortunately, these estimates cannot be compared to other areas, let alone other Shuswap occupation regions, but if about 100 people were using the Mouth of the Chilcotin region in pre-smallpox times, as is estimated by Teit (1909a), then perhaps Teit was describing intensive exploitation of a relatively small area by a relatively large group of people in early historic times, rather than purely "sedentary" people.

Clearly, the answer to this problem requires a firm idea at least of housepit contemporaneity. Radiocarbon dating does not seem to be the complete answer, since wide standard deviations in dates and conflicting mean estimates of charcoal ages are the norm for materials within the last 1000 years (Stuiver 1978). A more precise way to deal with the issue is dendrochronology, and as Matson et al. (1980), Stryd (1980), and Matson (personal communication 1982) indicate, the present state of this method looks promising for future research on the Interior Plateau.

Settlement pattern studies in the Upper Hat Creek Valley were initiated as a cultural resource management project designed to systematically recover archaeological data from a region planned

for development as an open pit coal mine and thermal generation plant. The region had not been the focus of any previous professional archaeological research, and was practically archaeologically unknown, yet was noted by Teit (1906) as being near the western edge of Spences Bridge Thompson territory. Currently a great deal of data exists where none existed only seven years ago. Two impact assessment reports (Pokotylo and Beirne 1978; Beirne and Pokotylo 1979) and a Ph.D. dissertation (Pokotylo 1978a) as well as shorter papers (Pokotylo 1978b, 1979a, 1981, Pokotylo and Beirne 1983) have been written that discuss the significance of the 200-odd sites presently known, in a region that has only seen ca. 15% areal sampling. This discussion is limited to the results that bear explicitly on the relationships observed between settlement patterns and lithic technology.

Pokotylo's research goals were stated as follows:

- 1) describe patterns of settlement utilization reflected by byproducts of lithic technology in Upper Hat Creek Valley, and
- 2) compare this with patterns of stone tool deposition (1978a: 2)

As is discussed in previous and following chapters, the analytic methods were pioneering in several ways, particularly in explicitly relating lithic technological processes to the formation of surface lithic scatters. The results indicated that the site classes fall within the range of variability expected from regional ethnographic

accounts, and that the sites are representative of base camps, hunting and butchering of large game and more general activities probably related to root crop acquisition and processing. It was also found that sites with a wide range of tool manufacturing steps are found in areas with high local environmental diversity as measured by nearby vegetation community and drainage characteristics, while sites with more limited tool manufacturing assemblages are found in areas with low levels of environmental variability. Sites that were inferred to represent long term occupations tend to be situated close to permanent sources of water (Pokotylo 1978a: 323). Low sample sizes of site types occurring within discrete environmental zones prevented probabilistic evaluation of these trends, yet overall the study demonstrated quite successfully that subsistence and settlement practices within upper and middle elevation areas of the southern Plateau produce patterns of lithic assemblage variability that can be detected with a combination of technological and typological approaches.

It should be noted in this review that several of the Hat Creek sites analysed contained microblades and formed unifaces (endscrapers), considered representative of Early Nesikep period assemblages. Pokotylo (1978b) considered that 66% of the Hat Creek assemblages collected in 1976 belonged to the Early Nesikep Tradition. Pokotylo's (1978a) analyses showed that unifaces and microblades tend to be mutually exclusive in the Upper Hat Creek Valley. Also, while it is apparent that the debitage from these Early Nesikep

sites indicates either initial tool manufacturing steps, or a wide range of stages, the sites are not associated with a discrete range of environmental variables (Pokotylo 1978a: 328 - 329).

Again, it is valuable to consider the broader implications of the temporal patterns of regional trends. Assuming that the microblade and formed uniface sites are indeed Early Nesikep in age (7000 to 5000 BP), then it appears that two kinds of early sites are present, given the near-mutual exclusiveness of the two artifact types: sites representing the need for cutting tools, and others where scraping (or chiselling and adzing) were required. In the Late Nesikep periods of time, a much wider range of activities were undertaken. This included the establishment of base camps with a large amount of "maintenance" activities, and several kinds of satellite camps at which roots were processed or large game butchered, and quite short term occupation loci used to stalk game, repair tools, or simply manufacture tools from local raw materials. This perhaps reflects a basic difference in settlement patterns, where Early Nesikep populations used Hat Creek Valley as an important but marginal area, and were centered more in major watershed areas such as Lochnore-Nesikep, where microblades and formed uniface are found together and in association with a wide range of other tools. In Middle and Late Nesikep periods, the Hat Creek Valley was a more important range of the settlement pattern, where larger groups of people settled at least temporarily, and organized a complex set of subsistence tasks requiring a greater degree

of technological specificity.

The Eagle Lake project (Matson et al. 1980) was aimed at describing the material culture, settlement and subsistence patterns of Athapaskan-speaking Chilcotin peoples in the southern area of their historically-reported territory. A major aspect of the project was an examination of ways to define archaeologically-observable differences between Chilcotin and Interior Salish patterns, and thus a region that had environmental similarities to those of the Shuswap Settlement Pattern project and the Upper Hat Creek Valley was chosen. In this manner, the open grassland and dry pine forest environments could be used as a kind of constant, implying a limited range of potential subsistence and settlement practices, to enable ethnic differences in material culture to appear more clearly.

An area representing about 7 percent of the region around Eagle or Choelquoit Lake was surveyed using 400 m X 400 m quadrats, randomly sampled with replacement. A total of 35 quadrats yielded 46 sites. Comparison of the numbers of pit features and artifacts recorded within the quadrats showed the Eagle Lake region to be much more similar to the Mouth of the Chilcotin region than to Upper Hat Creek. Cachepits and housepits are relatively common, and lithic scatters usually do not contain a great many tools or debitage. At Hat Creek, cultural depressions other than roasting pits are quite rare, and surface scatters often contain hundreds of items. At Eagle Lake, sites average 46 artifacts, and at the Mouth of the

Chilcotin each site on the average contains 90 artifacts, while in the Hat Creek Valley, sites contain an average of 1450 items (Matson et al 1980: 208).

Since it was important also to be able to date the arrival of the Chilcotin in the area, a survey was conducted along 30 km of the Chilko River, in the eastern end of the study area, in an attempt to locate non-housepit stratified sites that could be reliably dated. No such site was found in the 105 sites recorded. The finding of no microblades and only a few large, or atlatl, projectile points, and late radiocarbon dates from three sites ( $280 \pm 80$  BP;  $360 \pm 80$  BP;  $800 \pm 80$  BP) all appear to indicate that the last half of the Late Nesikep period was the only time of major occupation of the region.

The small size of most assemblages and the lack of good chronological control were limiting factors in terms of project goals, yet despite these drawbacks, significant contributions were made and ethnic differences were perceived. In a multi-variate analysis of projectile points, small, triangular side-notched points were shown to be highly discrete with respect to Salish (Mouth of the Chilcotin and Hat Creek) and Athapaskan (Chinlac and Punchaw Lake) provenience, and Eagle Lake points occur in both these kinds of groups (Magne and Matson 1982). Through this information and other data, specific sites were identified as Athapaskan occupations, including an isolated, shallow, rectangular depression site near a small lake (also with a Kavik-style

point and a blue trade bead), a lithic scatter site, and a small isolated circular housepit site with a single component that has been tentatively dendro-dated to AD 1561 vv (outside very variable; Matson et al 1980; Matson personal communication 1982). Currently proposed research will focus on excavations at the two putative Athapaskan dwellings noted above and at another more typically Kamloops Phase housepit site.

Some of the research undertaken in the Eagle Lake project initiated the present study. The experimental debitage program described in the following chapter was piloted by a biface reduction experiment first reported in the Eagle Lake project (Magne and Pokotylo 1980, 1981), and an analysis of the debitage from 24 Interior Plateau assemblages (Magne 1980) was a trial investigation of large scale technological patterns within settlement types that is more fully developed in Chapter 6.

## CHAPTER 4

## THE EXPERIMENTS IN DEBITAGE CLASSIFICATION

4.1. Introduction

The objective of the experiments described in this chapter is to determine the degree to which general chipped stone tool manufacturing stages can be inferred from lithic debitage. The specific goal of the program is to devise an efficient debitage classification of manufacturing stages that can be applied to archaeological collections.

A secure debitage classification of reduction stages is required to enable intersite comparisons of a multi-regional set of lithic assemblages in explicitly technological terms. Such a classification has relevance well beyond this study. The generalized approach to the experiments is in contrast to the particularistic and precise "replication" concerns that characterize most other lithic experiments (see Johnson 1978). This study, in contrast to others, concentrates on debitage, rather than on specific tool forms, where debitage is defined as non-utilized products of stone tool manufacturing and maintenance.

The lack of attention that has been paid to debitage in lithic technological research is surprising, since it has several qualities that are desirable for reconstructing past processes of lithic reduction and settlement technology, including: 1. Debitage is not

transported, or otherwise curated to the same extent that tools are; 2. Since it results from reductive, rather than additive processes, debitage retain evidence of previous stages of manufacture; and 3. Debitage is very abundant and is thus suited to sampling and statistical procedures (Leach 1969; Collins 1975; 17, 19; Sheets 1975; Fish 1976).

#### 4.2. Experimental Controls

The faults of previous experimental work, as outlined in Chapter 2, and the above issues were kept in mind when designing the following controls for the present experiment:

1. The most important control factor is that flakes removed from cores, blanks, or preforms were gathered in the precise order of their removal, in contrast to studies that have gathered groups of flakes derived from estimated stages of reduction (e.g. Collins 1974; Burton 1980; Stahle and Dunn 1981). Burton (1980: 132) mentions that he numbered flakes consecutively, but apparently this information was not used in his study. This control factor enables reduction stages to be precisely defined in a uniform manner, regardless of the tool form being made (see below).

Each blow that produced flakes is termed an "event" of the reduction sequence, and as can be seen in Table 2, reduction events often produce several flakes. Following each event, all flakes greater than 5 mm in their largest dimension were gathered by a flake retrieval person, placed in order of removal on card-

TOOL TYPE	RAW MATERIAL	# OF EVENTS	FLAKE TOTAL	# OF PRB'S	# OF SHATTER	# OF BRF'S	# OF BPO'S
Large Core	Basalt	42	317	144	173		2
Bipolar Core	Basalt	3	36	1	33		7
Bipolar Core	Basalt	28	62	12	43		2
Bipolar Core	Basalt	7	54	5	47		4
Bipolar Core	Obsidian	4	43	3	36		1
Bipolar Core	Obsidian	6	54	5	48		7
Bipolar Core	Obsidian	12	137	10	118	2	
Large Biface	Basalt	186	399	116	246	37	
Large Biface	Basalt	44	87	33	35	19	
Large Biface	Basalt	97	590	150	425	15	
Large Biface	Obsidian	80	207	45	143	19	
Ovoid Biface	Basalt	60	105	44	52	9	
Ovoid Biface	Obsidian	67	82	37	39	6	
Bimarginal	Basalt	36	43	25	12	6	
Bimarginal	Basalt	35	58	25	23	10	
Ovoid Uniface	Basalt	45	64	29	35		
Ovoid Uniface	Basalt	47	70	43	27		
Ovoid Uniface	Basalt	29	43	11	32		
Endscraper	Basalt	13	21	9	12		
Endscraper	Obsidian	17	21	12	9		
Endscraper	Chert	16	18	11	7		
Unimarginal	Basalt	9	10	6	4		
Unimarginal	Basalt	25	26	22	4		
Unimarginal	Basalt	9	14	9	5		
Unimarginal	Basalt	44	55	32	23		
Unimarginal	Basalt	11	16	6	10		
Unimarginal	Chert	17	25	11	14		
TOTALS			2657	856	1655	123	23
PERCENTAGES OF TOTAL DEBITAGE				32.2	62.3	4.6	0.9

PRB'S = Platform remnant bearing flakes

BRF'S = Biface reduction flakes

BPO'S = Bipolar reduction flakes

TABLE 2. Frequencies of General Flake Classes and Reduction Events for Each Experimental Core and Tool.

board trays, and later catalogued. Since an archaeological sample of several thousand flakes was expected, a size cut-off of 5 mm was maintained in the analysis of the experimental debitage, and this meant that pressure flaking could not be investigated.

2. All procedures involved in knapping were recorded on a standardized reduction form, requiring the knapper to note the event at which he or she prepared platforms, changed technique, and so on (Appendix 1). Only stone hammers and antler billèts were used. Knappers also recorded the event at which they felt to have moved on to a sequent reduction stage, and were asked to note any difficulties experienced. This information was gathered mainly as back-up data, in the event that the objective reduction stages did not produce useful results. The knappers were also asked to provide measurements and scale drawings of cores and blanks prior to reduction as well as of finished products, although not all did so.

3. A total of 13 knappers of widely-ranging expertise produced the materials rather than a single expert. Nine of these were students in a course on archaeological laboratory methods (ANTH 406), instructed by Dr. R.G. Matson, and only the remaining four knappers can be considered truly experienced in the craft. These include R.G. Matson, David Pokotylo, George Kurzenstein, and myself. This may be seen as a "randomizing" process rather than a true control factor, but is desirable to eliminate the potential in systematic error that could occur in trying to apply the experimental results from a single

knapper to archaeological material that must have been produced by many knappers.

4. The knappers were shown physical models and were given written descriptions of the tools they were to attempt to replicate. These included several kinds of bifaces, projectile points, scrapers, and cores from various sites of the Interior Plateau. Several products were quite inadequate replicas and were promptly removed from the analysis.

5. The raw materials employed were those that were used by prehistoric peoples of the regions of interest. The most common material of the Interior Plateau lithic technologies and in the experiments is high quality basalt that ranges in texture from vitreous to granular, and that is available as glacial till cobbles or stream bed cobbles in many areas. The basalt used in this study was obtained from the Upper Hat Creek Valley and from Cache Creek. Obsidian cobbles from Obsidian Creek in the Anahim Lake area, and stream cobble chert derived from the Cache Creek Formation were also used.

6. Debitage that were thought to be of a size suitable for further reduction were removed from the analysis. This practice is meant to control for the efficient use of stone in an active lithic technology. All previous experiments that have used large debitage in their analyses have not considered that such large flakes could be formed into a wide range of items. The cut-off used here is usually 30 grams, but this was not strictly maintained.

#### 4.3. The Pilot Study

An important preliminary step of the experiment was to undertake a pilot study, to enable more complete appreciation of the controls required, to refine the hypotheses to be tested, and to explore the range of variability in debitage in a preliminary fashion. The pilot study also served to familiarize the present researcher with multivariate data analyses, and in some ways can be seen as the sort of exploratory data analysis that is advocated by Clark (1982). A full description of the preliminary study is in Magne and Pokotylo (1981).

Briefly, debitage that resulted from the manufacture of flake blanks and a single biface was analysed. The major factors of quantitative variability were derived from a judgemental, visual comparison of the data for eight flake variables. Instead of this search for major "alignments" with the reduction sequence, a more appropriate solution would have been to regress the raw data against the individual factor scores. On the basis of the preliminary methods, a debitage classification was formulated using criteria of flake weight and platform presence or absence, and scar counts and cortex cover were used as secondary criteria. The classification is now understood to contain logical faults such as non-exclusiveness of certain variables, but it was used to examine seven sites of the 44 that were previously analysed by Pokotylo (1978). The interpretations were very close to those of Pokotylo's original study, and patterns such as bifacial tool production were revealed, which were not previously evident. Overall, the pilot study was moderately successful, given correspon-

dence with Pokotylo's (1978) interpretations, and also independently supported the findings of other studies, such as Burton (1980) that found flake size to be a highly significant factor in debitage variability. However, I thought that the sample size needed enlarging, that bipolar flaking would need to be investigated, and that analytic methods leading to a reliable stage classification of debitage would need to be refined.

#### 4.4. Experimental Products

Seven cores and 20 "tools" were the retained products of the lithic reduction sessions. These include one single platform core, six bipolar cores, six large bifaces, two bi-marginally retouched flakes, three large uniface, three endscrapers, and six uni-marginally retouched flakes. These items are shown in Figures 5 to 10; unfortunately, the single platform core was accidentally reduced by an anonymous person and was not photographed.

After flakes that were thought to be suitable as blanks for further reduction were removed from the debitage, the final actual experimental sample comprised 2657 flakes greater than five millimetres in their largest dimension. Of these, 856 are platform remnant bearing flakes or PRB's (see Knudson 1973); 1655 items are shatter, that is, flakes lacking striking platforms. Another 123 are biface reduction flakes, or BRF's, that are recognized by extensively faceted, narrow angle and often "lipped" platforms (see Crabtree 1972), and 23 are bipolar reduction flakes (BPO's) having evidence of simultaneous percussion from opposite directions, often with crushing.

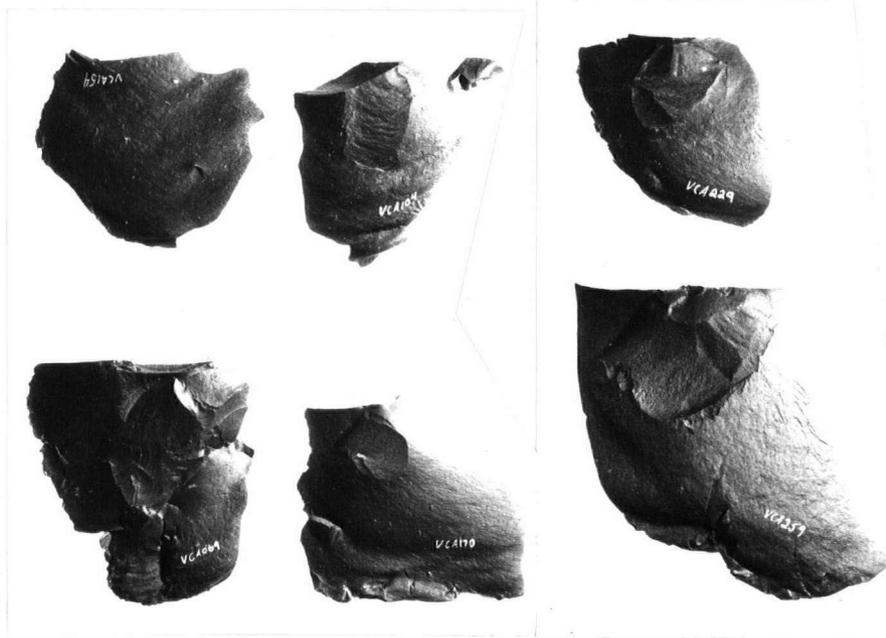


Figure 5. Flake blanks removed from large single-platform basalt core. Not all are shown.

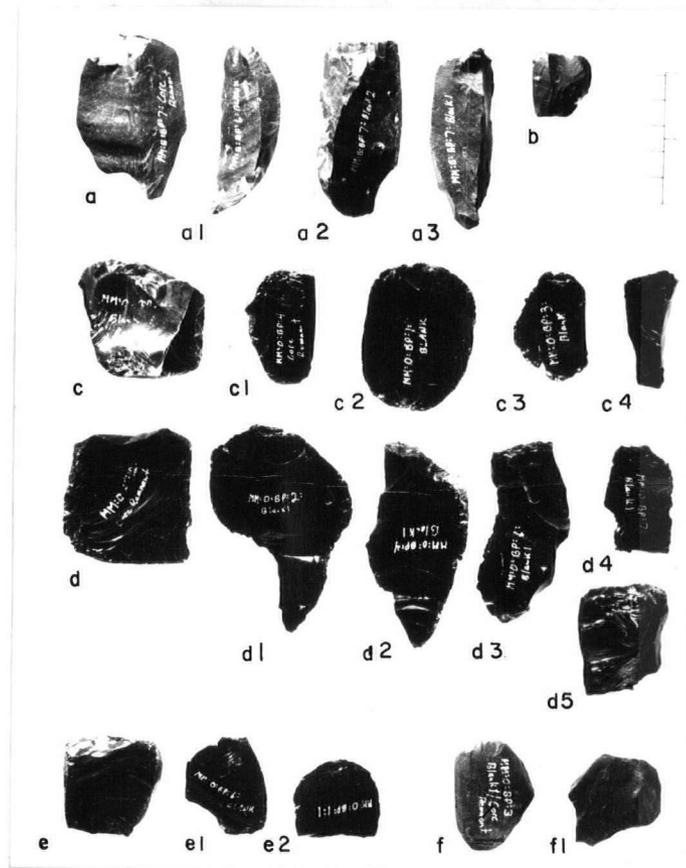


Figure 6. Bipolar cores and derived blanks  
 a,b,d,f: Cache Creek basalt cores.  
 c,e: Obsidian Creek obsidian cores.  
 1-5; blanks

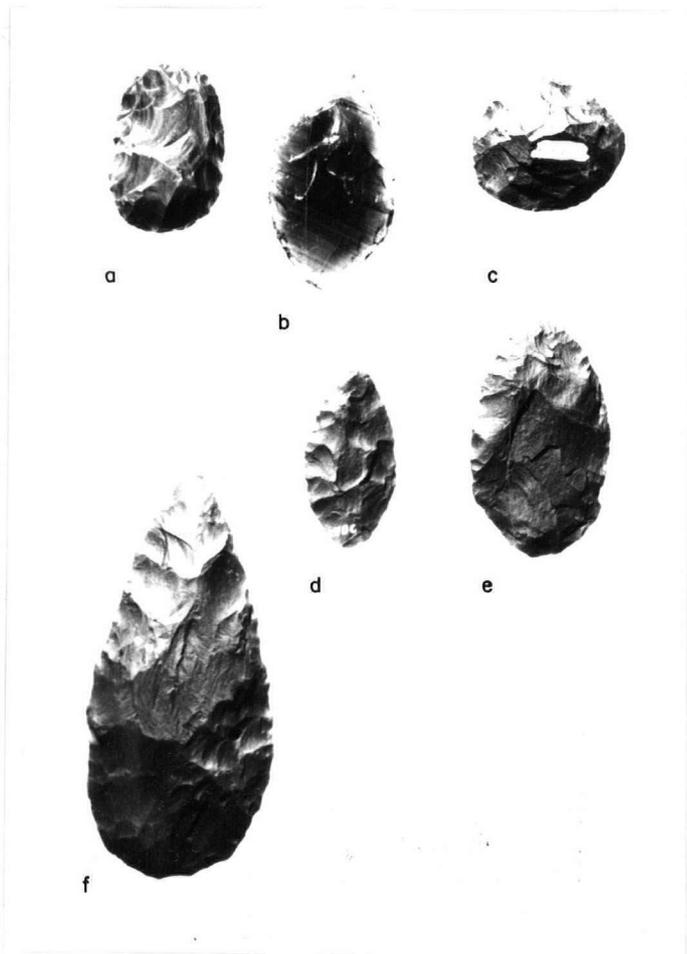


Figure 7. Large bifacial tool products.  
 a,b: Obsidian;  
 c,d,e,f: Vitreous basalt;  
 d is pilot study product.

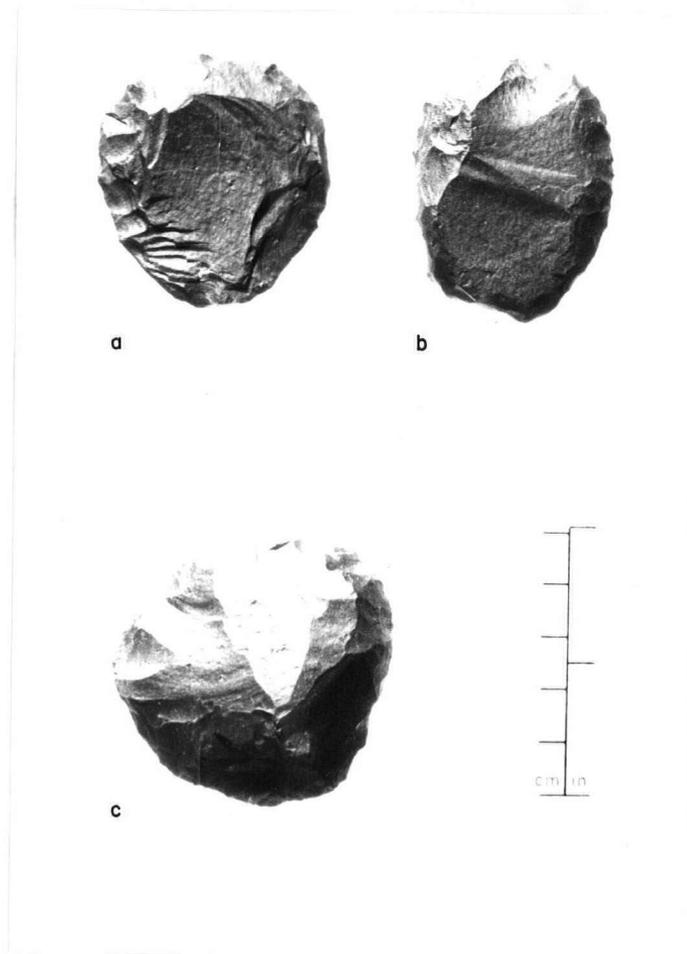


Figure 8. Large unifacial tool products.  
 a,b: Vitreous basalt  
 c: Granular basalt.

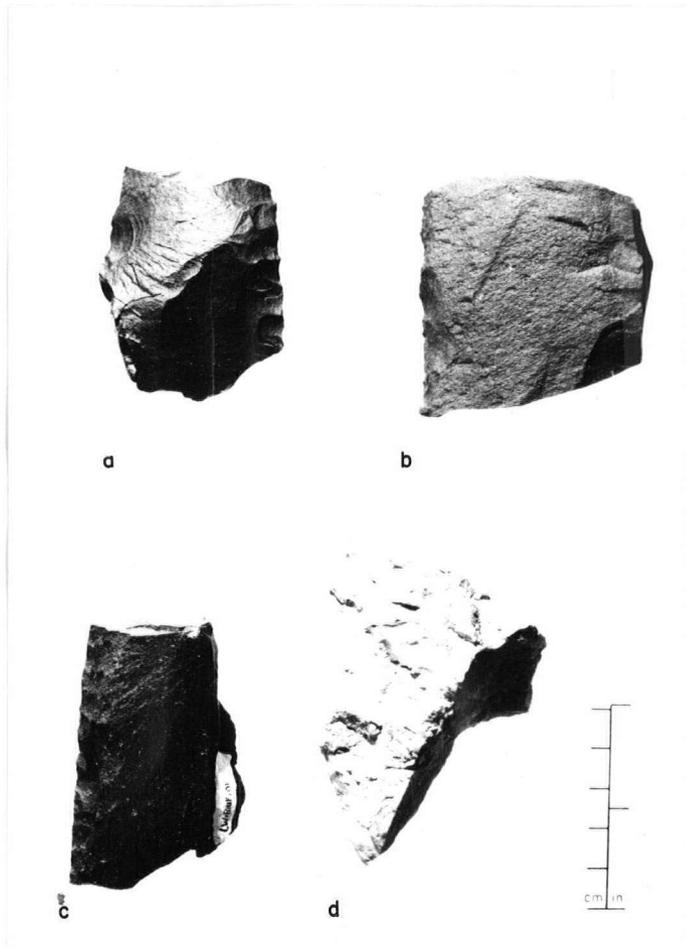


Figure 9. Large marginal tool products  
 a: vitreous basalt, bimarginal  
 b,c: granular basalt, unimarginal  
 d: Cache Creek chert, unimarginal

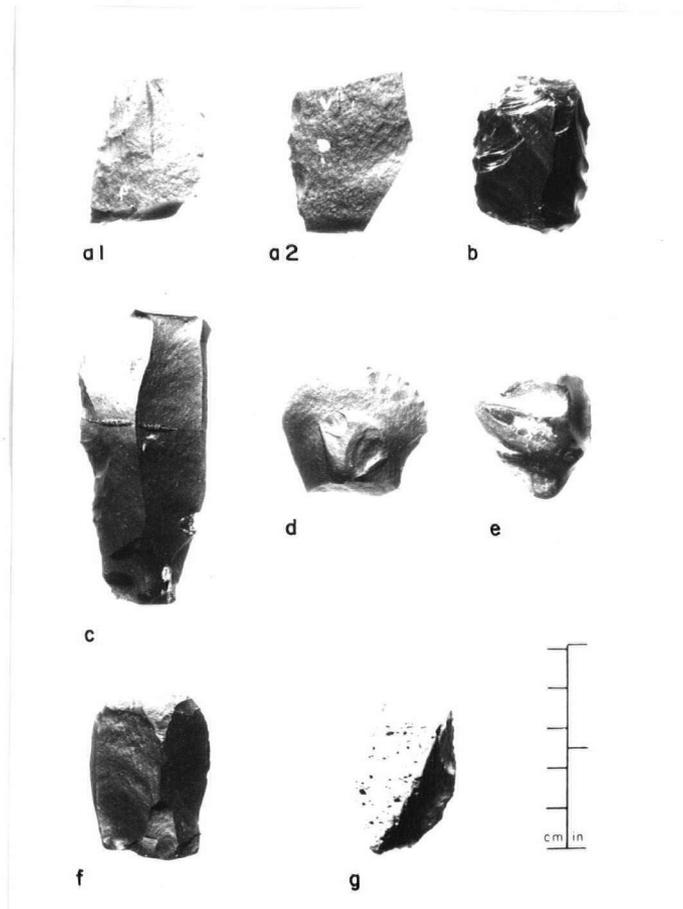


Figure 10. Small marginal tool products  
 a,c,d,e,f: vitreous basalt  
 b: Obsidian;  
 g: Cache Creek chert

The frequencies of these general flake types are provided in Table 2. It can be seen that in the reduction of one of the bipolar cores, two flakes were classed as BRF's. This is not entirely surprising since bipolar reduction, carried to final stages, is often bifacial in nature. Only 32.2% of the flakes exhibit remnant platforms, and it was observed that just 48% of these PRB's have feather terminations. Given that the flakes were produced in laboratory conditions, it is likely that relatively more are "complete" than in most archaeological situations, where trampling may break a large number of flakes. It is evident at any rate, that studies that have selected only "complete" flakes (e.g. Collins 1974; Fish 1976; Stahle and Dunn 1981) for analysis of reduction strategies have likely ignored a great deal of debitage variability.

Table 3 illustrates another interesting pattern. Here the average number of all flakes removed per reduction event and PRB/shatter ratios are tabulated by general reduction type and raw material. It appears that core reduction of any kind produces more flakes per blow than bifacial reduction, which in turn produces more flakes per blow than unifacial reduction. PRB/shatter ratios do not support the same trend observed in the flakes per event tabulations, and may indicate that the control exerted in flaking procedures may not be easily accounted for in archaeological collections. However, it is apparent that bipolar reduction produces very few PRB's in relation to shatter (on the order of 10 shatter per PRB), and that

MEAN # OF ALL FLAKES PER EVENT	PRB/SHATTER RATIO	REDUCTION TYPE/ RAW MATERIAL
10.46	.09	Bipolar Obsidian
7.55	.83	Core Reduction Basalt
4.00	.15	Bipolar Basalt
2.80	.45	Bifacial Basalt
1.97	1.16	Unifacial/marginal Basalt
1.30	1.05	Unifacial/marginal Chert
1.24	1.33	Unifacial/marginal Obsidian

TABLE 3. Mean Number of Flakes Per Reduction Event and PRB/Shatter Ratio, In Grouped Reduction Types by Raw Material.

single platform core reduction, when applied with the purpose of deriving large blanks, can yield about twice as many PRB's per Shatter as bifacial reduction. Unifacial and marginal flaking produce about equal numbers of PRB's and Shatter. These are obviously not reliable trends, since only one unifacial, and no marginal obsidian tools are represented; chert flakes were produced only by unidirectional knapping. Single platform core reduction is only represented by one set of basalt reduction events. These particular data were not further analysed due to these limitations of the sample, and because such trends are aside from the main direction of the experiments.

#### 4.5. Stage Definition

One of the purposes of this study is to construct a debitage classification that accurately reflects reduction stages from a relatively large sample of archaeological materials. It would be highly impractical to divide stages very narrowly. In the extreme, Muto (1971b: 111) has stated that it is possible to regard each reduction event as a "stage". It was therefore decided to test for metric variability in quite general terms, simply: early, middle and late reduction stages.

Early reduction stages are defined as all events of core reduction, including both single platform and bipolar core forms, regardless of the number of events involved. Middle stages are the primary trimming stages of tools, measured as all the reduction events of marginal retouch tools, and the first half of the reduction events of

all other tools, whether unifacial or bifacial. Late stage reduction then, is defined as the latter half of the reduction events of unifacial and bifacial implements. I believe that this is a justifiable way to divide the reduction process, since core reduction is undertaken to derive flake blanks, regardless of method, marginal flaking and initial unifacial and bifacial flaking all involve straightening edges and removing the most of excessive mass, and the later events of unifacial and bifacial flaking are undertaken to refine the intended shape of the tool. This method of defining stages requires no subjectivity as to what exactly constitutes "primary" or "secondary" trimming (e.g. Collins 1975).

The number of events in core reduction ranged from 4 to 42, and from 9 to 186 in tool reduction (Table 2). Middle stage events range from 7 to 93, and late stage events vary in frequency from 8 to 93. These events, it should be noted, are not the dividing points in stages that were noted by individual knappers on the reduction recording forms.

In addition to the three stages, I thought it useful to distinguish bifacial and bipolar reduction flakes objectively. Such a distinction would add to the dimensions of the classification, permitting more refined interpretations of archaeological assemblage variability. Thus while biface reduction flakes (BRF's) do exhibit platforms and are generically "PRB's", several of the analyses to follow attempt to demonstrate the distinctiveness of BRF's.

#### 4.6. Debitage Variables

Several studies report the use of univariate, bivariate and multivariate statistical techniques to reduce debitage variable lists (e.g. Fish 1976; Katz 1976; Pokotylo 1978). Following Pokotylo (1978) and the pilot study (Magne and Pokotylo 1981), I decided to select variables from the results of these, to develop a robust short list of variables. Two weaknesses characterize most approaches to debitage variability: an over-emphasis on discrete, rather than continuous or ordinal variables, and studies of brittle solid fracture dynamics with little explicit behavioral value (e.g. Speth 1972, 1975; Bonnichsen 1977; Patterson and Sollberger 1978).

Barton (1979), Bonnichsen (1977) and Speth (1972) attempt to define variables that can differentiate hard-hammer and soft-hammer percussion, by controlled experiments, the latter two going as far as using cut glass cores. While a difference in this type of knapping may be interesting, there is little attempt to state what differences could mean in behavioral terms. Control over lithic fracture is also the prime concern in Phagan's (1976) notable discussion of the value of 28 different flake variables. However, as in most situations where variables are applied to archaeological debitage without recourse to controlled experiments, the meaning of variability is untested, and merely suggested. Thus, Phagan's (1976) impressionistic, and not statistically inferred results are weakened. Some of the Ayacucho assemblages seemed to have been produced by

specialized groups at long-term occupation sites, but when assemblages are mixed, no interpretations are possible (Phagan 1976: 104 - 110). Phagan notes (1976: 110) his explicit approach to waste flakes and technological systems is a contribution to behavioral approaches to assemblage variability that greatly improves upon traditional tool typological approaches, because it seeks to consider all the technical aspects of flake production.

Two studies that have direct relevance to this study in their orientation and purpose are Pokotylo (1978) and Katz (1976). Pokotylo (1978) applied a 19 variable list to 198 flakes with remaining striking platforms that were obtained from five sites in Upper Hat Creek Valley. An R-mode factor analysis reduced this list to five variables. Nine were finally used to derive settlement pattern and behavioral information for 44 sites. The factor analysis indicated that flake size is the most important metric factor in debitage (PRB) variability, followed by flake angle (platform to dorsal or ventral faces), dorsal flake scar count, dorsal scar patterning, presence of ventral lipping, and bulb of force "saliency" (Pokotylo 1978: 204 - 208).

Katz' (1976) similar study evaluated nine attributes using a sample of 293 flakes from a refuse pit at the Deister site, a Kansas City Hopewell occupation. A Principal Components analysis produced three meaningful vectors, consisting of weight, number of dorsal scars, and platform angle (Katz 1976). Sixteen discrete variables

were evaluated using a non-metric multidimensional scaling procedure, unlike Pokotylo's (1978) data reduction analysis, where continuous and ordinal variables were analysed simultaneously. Three clusters of attributes were derived, including raw material type, applied force, and control over flake removal. (Katz 1976). Katz retained eight variables, and using the presence of cortex to "pin down" the early stages of manufacture, posited a six-stage sequence of lithic manufacturing for the assemblage.

Overall, Katz' and Pokotylo's findings are very similar: the size of flakes, their evidence of prior flake removals, and their platform angles are highly useful in describing tool manufacturing sequences. Both studies have the weakness of deriving short variable lists from archaeological debitage, inferring the meaning of those variables, and then applying them to a larger sample of archaeological debitage from the same region, or even the same site. This is a rather circular process possibly inducing a sample bias, and may have served to affirm the consequent, especially in Katz' (1976) analysis, where only one site is being examined. Both studies, however, present the most robust examinations of debitage variability presently available, yet it is clear that both pin-pointed specific variables that, when used, will reduce overall metric redundancy in archaeological application, but still do not answer the basic question of sequential variability, except by inference gained by co-association of

variables. This problem is especially crucial for weight and size variables. As in the pilot study for the present experiment, both studies indicate that weight or size is the variable that accounts best for overall metric variability in debitage. This means that all other variables co-vary with size better than with other variables, and not necessarily that weight varies in any other, independent direction such as reduction sequence. Such an interpretation then, still remains to be tested by experimental means. Pokotylo and Katz each efficiently reduced the number of variables to be coded on each flake, and found a short hand way of measuring overall debitage variability, with some theoretical grounds for proposing that the selected variables were correlated with reduction stages.

Six variables were retained for use in the present analyses (see Figure 11). These are defined below, with expectations of how each might pattern through sequential reduction. Four-letter abbreviations are also given, to be used as conventions in following discussions. The list is deliberately short. I think that quite enough redundancy has been demonstrated by prior workers, and I needed to keep data gathering time relatively brief, since archaeological analysis was yet to come. The application of this variable list to the experimental debitage required six weeks of almost daily work. I estimate that recording time would have been doubled simply by the addition of two variables such as length and width, that would have required the use of vernier call-

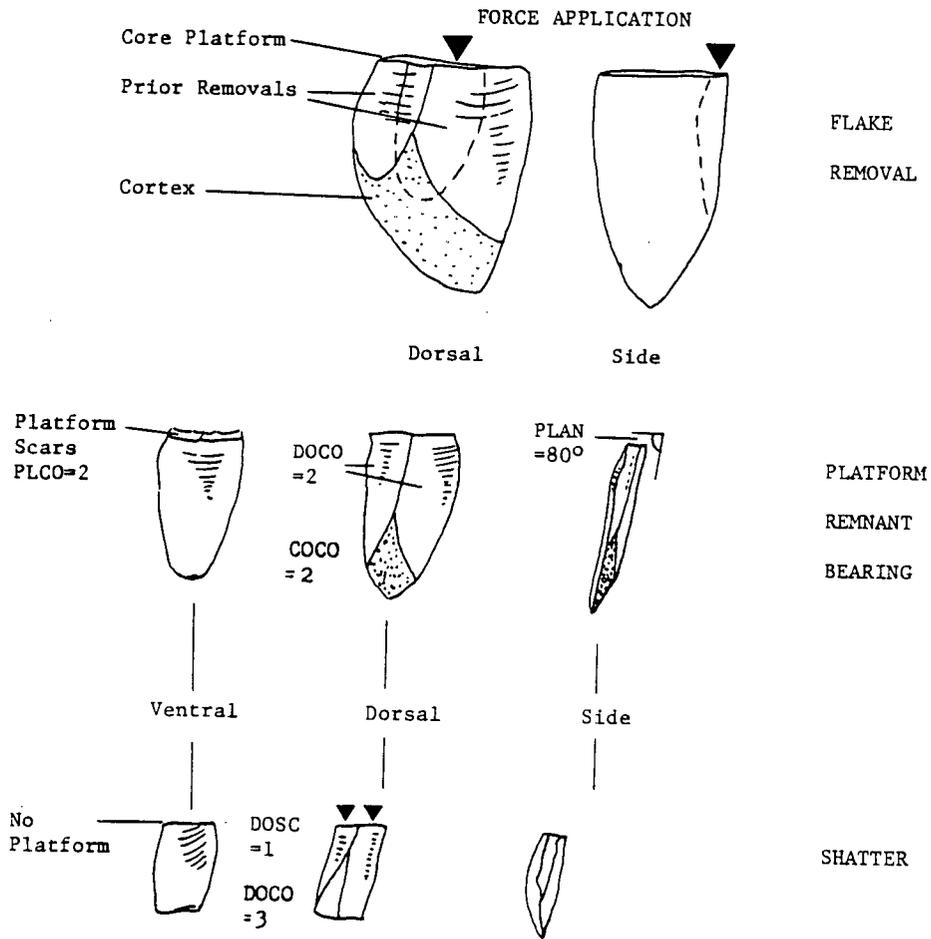


Figure 11. Debitage attributes employed in the experimental program.

ipers. Attributes of the variables were recorded on 80 column computer coding forms, along with flake termination type, knapper, raw material, tool number, event sequence, flake within event (arbitrary), and final flake number (accurate to event only). The data were keypunched and stored as disk files.

1. Weight (WEIT): The weight of each flake was taken to .10 gram with an electronic balance. As reduction proceeds, it can be expected that the weight of individual items will strongly tend to decline. This variable is used as a general measure of size.
2. Dorsal Scar Count (DOCO): This is the number of flake scars visible on the dorsal face of the flakes, counting only those greater than 5 mm in size. One can expect that the number of flake scars on dorsal faces will tend to increase through the reduction process.
3. Dorsal Scar Complexity (DOSC): This is a new variable, modified from that of Munday (1976: 123) and Pokotylo (1978). Here flakes are centered on polar coordinate paper divided into 10 vectors, and the number of directions that flake scars originate from are counted. This measure should increase with reduction sequences. Note that a flake may have several scars, but low complexity.
4. Platform Scar Count (PLCO): This is the number of scars regardless of size actually occurring on the flake platform, and is

applicable to PRB's only. This does not include flake scars formed on the dorsal surface of flakes adjacent to platforms, sometimes referred to as "preparation scars" (Phagan 1976: 49). Recording this variable was facilitated by using a 2X illuminated magnifier, although platforms less than 2 mm deep were often difficult to code, and classed as shatter. This measure is expected to increase as reduction proceeds.

5. Platform Angle (PLAN): The dorsal angle of PRB's is measured to the nearest 5 degrees with a goniometer that makes contact at 1 cm, 5 mm or 2 mm distances along the platform and dorsal faces simultaneously, depending on platform depth. Again, flakes with platforms less than 2 mm deep were difficult to measure and were often coded as shatter. This variable should decrease with sequential flake removal (see Raab, Cande and Stahle 1979), although Katz (1976) inferred that platform angle increases through subsequent stages.

6. Cortex Cover (COCO): This is the amount of weathered surface evident on the flakes' dorsal surfaces, measured in six increments of 25% (including 0% and 100%), and assessed visually. This measure is expected to decrease very sharply following core reduction.

#### 4.7. Hypothesis Testing

Following the completion of the pilot study, and prior to conducting the experiment in its entirety, the following hypotheses were formulated with the goal of demonstrating that stone tool

manufacturing stages can be reconstructed from quantitative analysis of lithic debitage, employing the six continuous and ordinal variables.

H1: The weights of individual flakes are the best indicators of the reduction stages from which they originated.

H2: Bifacial reduction flakes and bipolar reduction flakes are discrete items indicative of each type of reduction and can be accurately identified by the same variables used to predict early, middle and late stages.

H3: Reduction stage quantification is independent of raw material type.

The kind of statistical technique that is required to test these hypotheses, and especially the general stage question is some kind of factor analysis, where the "factors" are known (i.e. stages, BRF's, BPO's), but the significance of variables is not. This technique will also need to be able to identify variables that best sort factors. Also needed is some form of non-normal or non-parametric test of significance to identify discrete patterning of the variables, with respect to stages, so that a classification can be constructed. The two techniques chosen to satisfy these requirements are multiple discriminant analysis (MDA:

Klecka 1975), and the chi-square test of independence in contingency tables (Mendenhall 1975).

Discriminant analyses have been used in lithic experimentation studies by Chandler and Ware (1981), and in a combined experimental and archaeological study by Burton (1980). Stepwise MDA (Wilk's method) was used to see if differences exist between groups, and to discover which variables are most useful. Simply stated, MDA uses the six variables to classify individual flakes into the pre-set classes as defined by within-group co-variance parameters (see Klecka 1975).

#### 4.7.1. Stage Prediction

Five groups were identified for this analysis: early, middle and late stages, as well as biface reduction (BRF) and bipolar reduction (BPO) flakes. The first stepwise discriminant analysis employed all flakes with platforms, including all BRF's and 15 BPO's. (N = 994). An overall accuracy of 58.15% in discriminating the five flake classes was achieved (Table 4). This is a significant result, 38% above the 20% "prior probability" of accurate classification, and this is well above the 25% mark recommended by Hair et al (1979). PLCO is the most important discriminating variable in this analysis, and accounts for 66.7% of the variance of all variables combined, as well as accounting for 95% of the variance of the first canonical discriminant function derived for this sample. Table 4 shows that early PRB's and BRF's are the most accurately classified groups (75% and 84.6% respectively) followed by BPO's (66.7%) and

Actual group	# of cases	Predicted Group Membership				
		EARLY	MIDDLE	LATE	BRF	BPO
EARLY	180	135 75.0%	25 13.9%	3 1.7%	2 1.1%	15 8.3%
MIDDLE	484	96 19.8%	237 49.0%	115 23.8%	15 3.1%	21 4.3%
LATE	192	12 6.3%	57 29.7%	92 47.9%	28 14.6%	3 1.6%
BRF	123	0 0.0%	3 2.4%	16 13.0%	104 84.6%	0 0.0%
BPO	15	2 13.3%	2 13.3%	1 6.7%	0 0.0%	10 66.7%

PERCENT OF GROUPED CASES CORRECTLY CLASSIFIED: 58.15%

TABLE 4. MDA Classification Results of All Flakes with Platforms. N = 994).

Actual group	# of cases	Predicted Group Membership			
		EARLY	MIDDLE	LATE	BRF
EARLY	6	5 83.3%	1 16.7%	0 0.0%	0 0.0%
MIDDLE	12	0 0.0%	9 75.0%	2 16.7%	1 8.3%
LATE	4	0 0.0%	0 0.0%	3 75.0%	1 25.0%
BRF	6	0 0.0%	2 33.3%	1 16.7%	3 50.4%

PERCENT OF GROUPED CASES CORRECTLY CLASSIFIED: 71.43%

TABLE 5. MDA Classification Results of Obsidian PRB's 25% Random Sample (N = 28).

then middle stage PRB's (49%) and late stage PRB's (47.9%).

When sorted into basalt and obsidian raw materials and sampled randomly at a 25% rate, essentially the same result is achieved with basalt PRB's (56.72% overall), but obsidian PRB's are more accurately classified at 71.43% (Table 5). It should be noted here that BPO's were not adequately represented in the sampling to be worth testing in the obsidian sample, nor was the chert sample adequate. PLCO is the best discriminating variable in both these analyses, and as MDA is very prone to more accurate discrimination of small samples (basalt 25% PRB = 201; obsidian 25% PRB = 28; see Magne and Matson 1982), this difference in accuracy of the two analyses does not seem very important.

Analysis of shatter, using only three groups (no BRF's or BPO's) and four variables (no PLCO or PLAN), and sampled at 10% rates, gave very similar results. In basalt shatter, overall correct discrimination was obtained in 54.24% of the flakes (N = 118). In the smaller obsidian sample (N = 33), 78.79% of the shatter were correctly classified. DOCO is the most important discriminating variable in both analyses.

These analyses show that debitage can be assigned to the defined reduction groups with ca. 60% accuracy. However, it is apparent that the results are not very robust, especially in prediction of middle and late stages. To finalize results, only that set of PRB's resulting from the reduction events of experienced knappers were selected, and randomly sampled at 50% (N = 222). In this analysis (Table 6),

Actual group	# of cases	Predicted Group Membership			
		EARLY	MIDDLE	LATE	BRF
EARLY	73	68 93.2%	5 6.8%	0 0.0%	0 0.0%
MIDDLE	73	6 8.3%	51 69.09%	12 16.4%	4 5.5%
LATE	36	0 0.0%	11 30.6%	17 47.2%	8 22.2%
BRF	40	0 0.0%	1 2.5%	6 15.0%	13 82.5%

PERCENT OF GROUPED CASES CORRECTLY CLASSIFIED: 76.13%

TABLE 6. MDA Classification Results, Debitage Produced by Experienced Knappers, 50% random Sample (N = 222).

		STAGE			
		EARLY	MIDDLE	LATE	
P L C O	0-1	139 (87)	65 (90)	14 (41)	218
	2	4 (38)	60 (39)	30 (18)	94
	3 Or more	1 (19)	23 (19)	23 (9)	47
		144	148	67	359

Chi-Square = 146.13, d.f. = 4, p = .001

TABLE 7. Chi-Square contingency table, PLCO by STAGE, PRB's Produced by Experienced Knappers (bracketed values are expected, rounded to nearest whole number).

PRB's were accurately classified at an overall rate of 76.13%, and again PLCO is singled out as the most important discriminating variable. It can be seen in Table 6 that middle and late stage PRB's are the least well classified (69.09% and 47.2%), that these two classes mix moderately among themselves, and that late stage PRB's slightly tend to be classed as BRF's (22.2%).

To ascertain the significance of the variables PLCO and DOCO, chi-square tests were undertaken. Using the chi-square statistic on all PRB's produced by experienced knappers (N = 359, no BRF's or BPO's) and collapsing cells at both extremes of the PLCO range to meet the requirements of the test, the distribution of PLCO by reduction stage is significant at  $p = .001$  (Table 7). The same procedure on shatter from experienced knappers, using the distribution of DOCO by reduction stage, showed significant differences, also at  $p = .001$  (Table 8).

By inspecting the chi-square tables, and the means and medians of PLCO and DOCO within stages (Table 9, Figures 12 and 13), it can be seen that early PRB's can be classed as those having 0 or 1 dorsal scars, middle PRB's have 2, and late PRB's have 3 or more. Early shatter have 0 or 1 dorsal scars, middle shatter have 2, and late shatter have 3 or more. The lesser discriminating power of the weight variable is discussed below.

In sum, the general problem of stage identification is resolved, and ordinal classification of all types of debitage can identify general reduction stages, using platform and dorsal scar

		STAGE			
		EARLY	MIDDLE	LATE	
D O C O	0-1	23 (14)	21 (23)	2 (10)	46
	2	13 (15)	26 (26)	12 (11)	51
	3 or more	6 (14)	24 (23)	16 (10)	46
		42	71	30	143

Chi-Square = 21.73, d.f. = 4, p = .001

TABLE 8. Chi-Square contingency table, DOCO by STAGE  
Shatter produced by Experienced Knappers,  
(Bracketted values are expected, rounded to  
nearest whole number) 50% random sample.

	STAGE	SHATTER		PRB'S	
		Weight (grams)	Dorsal Scar Count	Weight (grams)	Platform Scar Count
EARLY	Mean	1.104	1.514	1.34	0.201
	Median	0.165	1.492	0.227	0.095
	Standard Deviation	3.086	0.906	3.764	0.510
MIDDLE	Mean	0.123	2.409	0.162	1.770
	Median	0.039	2.265	0.069	1.650
	Standard Deviation	0.532	1.446	0.482	0.874
LATE	Mean	0.77	3.320	0.090	2.194
	Median	0.031	3.222	0.032	2.150
	Standard Deviation	0.327	1.498	0.417	0.839
BRF'S	Mean			0.693	3.427
	Median			0.158	3.379
	Standard Deviation			2.541	1.002

TABLE 9. Mean, Median and Standard Deviations of Weight, Platform and Dorsal Scar Counts, Debitage Produced by Experienced Knappers, Broken Down by Stage of Reduction.

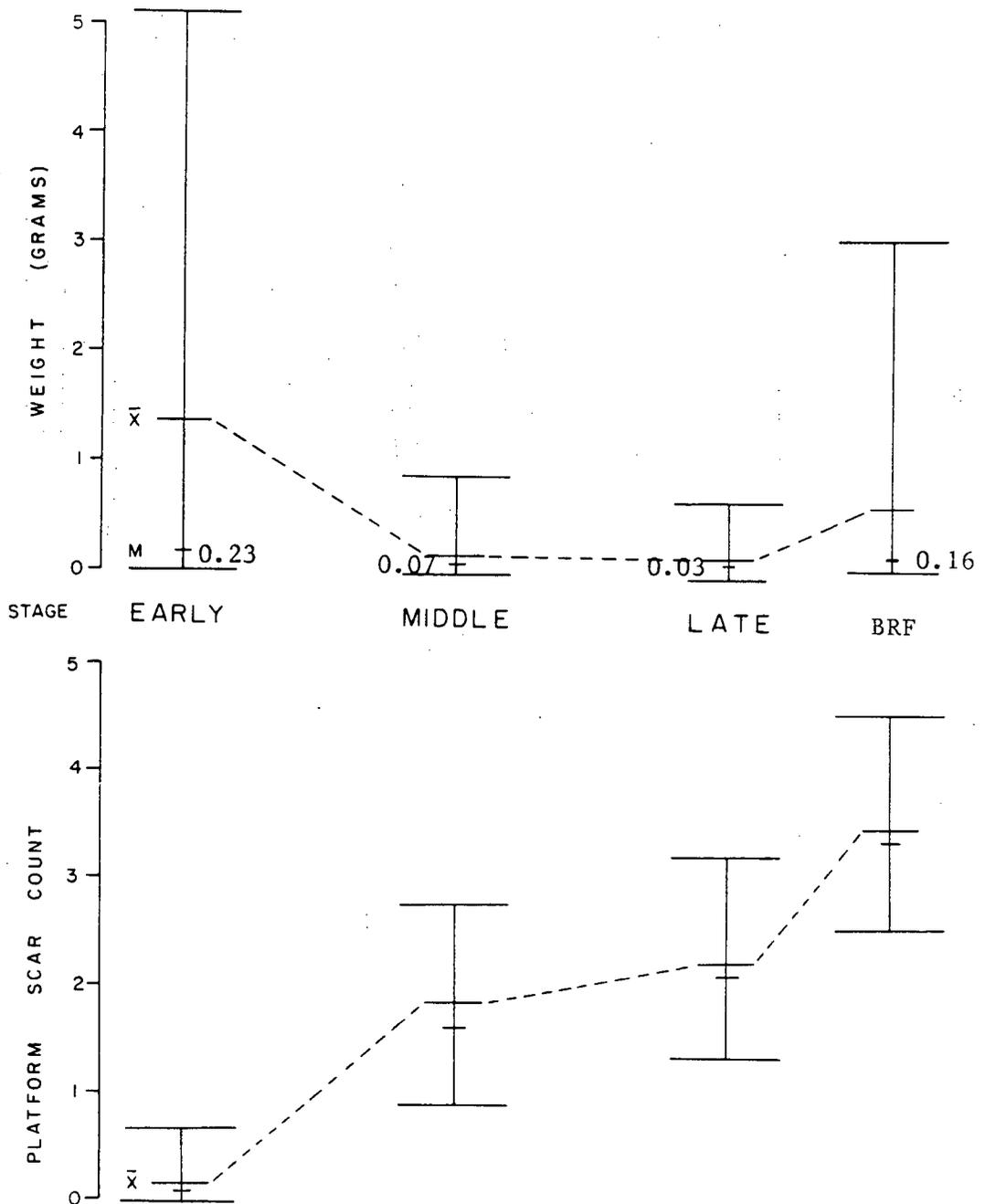


Figure 12. Graph of mean, median and standard deviation values of weight and platform scar count variables, PRB's produced by experienced knappers.

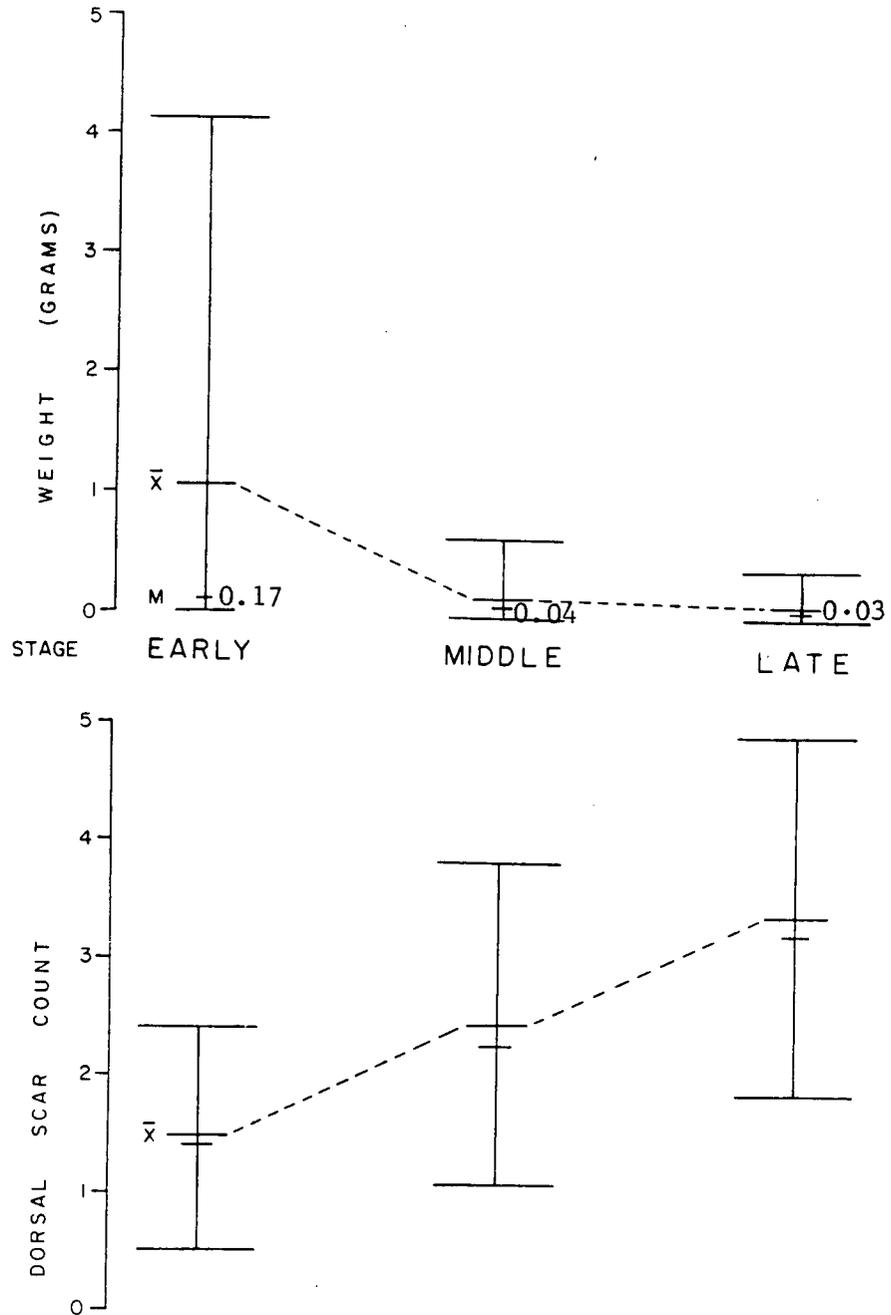


Figure 13. Graph of mean, median and standard deviation values of weight and dorsal scar count variables, Shatter produced by experienced knappers.

counts, and recognition of bifacial and bipolar reduction techniques. The power of the experimental discriminations is apparently higher in the debitage produced by experienced knappers than in that produced by novices.

H1: Weight as a Stage-discriminating variable: Negated

Nowhere in the tests of H1 does the weight of individual flakes appear to be a significant factor in identifying reduction groups. In all the MDA analyses, weight was the third or fourth important variable, contributing less than 5% to overall variance, and achieving correlations on the order of 0.1 with discriminant function coefficients, while PLCO and DOCO contributed on the order of 90% to overall variance, and correlated with discriminant functions with about 0.9 correlations. This contradicts the results of the pilot study, which was in several ways less rigorous than the present one, especially in relying on professional judgement to evaluate variable significance. Thus, while it is only logical that as tools are reduced, they will become smaller, the same is not necessarily true of the debitage. Similar results are reported by Baker (1981) in an experimental analysis of cement block reduction. Furthermore, while other researchers have supported weight as a valid indicator of reduction stages in experimental situations (Burton 1980, Stahle and Dunn 1981), the control factor in this and the pilot study of removing from the analyses all large flakes of debitage that would be suitable for shaping in an "ideal" technological system, as far as I am aware, has

not been previously applied.

Table 9. and Figures 12 and 13 depict the reason why platform scar counts and dorsal scar counts are more accurate reflections of general manufacturing strategies than is weight of debitage. The figures also lend some insight to how the weight factor may be approached in future studies. First of all, it is apparent that weight declines sharply from early to middle stages, and then flattens out to a nearly equal value for late stages, in both PRB and Shatter samples from the experienced knappers. Platform scar counts on PRB's, when plotted by stage (Figure 12), show an increase from early to late that rises slightly to late, and sharply to biface reduction. The shatter flakes show a clearer progress in dorsal scar counts (Figure 13), sharper than do the PRB's curve.

A secondary failing of the weight factor is that the values of the central tendency measures are in 100 ths of grams. This is unwieldy for macro-debitage analysis, and is a clear indication of some data limitations, since weight in this study was recorded to 10 ths of grams only. This finding is also supportive of micro-debitage analysis, and more research along the lines of that undertaken by Fladmark (1982c) is required to determine the utility and stage prediction capabilities of small debitage.

H2: BRF's and BPO's as indicators of bifacial and bipolar reduction:  
Supported

There is ample evidence that BRF's and BPO's are excellent indicators of bifacial and bipolar reduction, respectively (Table 2),

with the slight possibility that some bipolar events will produce BRF's. These classes also seem to be quite objective classes in themselves, with BRF's accurately classified 84.6% of the time and BPO's 66.7% of the time among all PRB's (Table 4). It must be noted that these analyses provide only some indications of how BRF's and BPO's pattern across reduction stages. However, when misclassified in the discriminant analyses, BRF's tend to be "late" and BPO's tend to be "early" (Tables 4 and 6).

### H3: Stage definition as independent of raw materials: Supported

The differences observed between raw materials in stage variability are not very great. There are difficulties in the experiment with the sample sizes of raw materials, especially with chert, for which the sample was considered too small for testing in any case but inclusion in the first MDA evaluation of H1. The slightly better discriminating power of obsidian in comparison to basalt is considered to be a sort of systematic error factor, due to greater facility in actually observing flake scars on the black glossy Anahim Lake region obsidian than on basalt. This factor can be evaluated archaeologically by testing for differences in assemblage complexity by raw materials.

#### 4.8. Summary of Experimental Findings

This experiment was designed to test ideas about using debitage to identify general stone tool manufacturing stages, and to develop units of measure that are technologically meaningful and reliable. Previous work relied on professional judgement and impressions gained from experience in lithic replication. As in the identification of BRF's and BPO's, experience certainly plays a role in any complex

and specialized analysis, but by devising an objective way of classifying debitage types and variables, this role can be greatly diminished. The most meaningful results of the experiment are that stone tool manufacturing stages can be accurately reconstructed with a minimum number of debitage types and variables, and that the weight of individual flakes is unsuitable for this task, while flake platform and dorsal scar counts appear to be much more appropriate.

To apply the results of this experiment to archaeological debitage, the debitage classification in Figure 14 is used. The classification groups all types of debitage into reduction stages, first by sorting flakes into PRB's, Shatter, BRF's and BPO's, having the last two as identifiers of distinct kinds of reduction, and sorting the PRB's and Shatter into early, middle or late stages by their platform and dorsal scar counts. In later chapters, these groups are often lumped or pooled to provide generalized stages. In such cases, BPO's are pooled with early Shatter and PRB's, middle Shatter and PRB's are grouped, and BRF's are added to late Shatter and PRB's.

The results of this experiment were generally predicted by John Speth, a pioneer in controlled lithic experimental research, who commented that:

Further research into the technological aspects of flake production should lead to a significant reduction in the total number of attributes needed to quantify technological variability, and to the replacement of dozens of arbitrarily chosen and redundant measurements presently in vogue with considerably smaller numbers of attributes carefully selected on the basis of sound theoretical principals (Speth 1972: 57).

		STAGE			DISTINCT REDUCTION TYPE	
		EARLY	MIDDLE	LATE	BIFACIAL	BIPOLAR
PRB	Platform Scar Count	0-1 	2 	≥ 3 	BRF  	
	Dorsal Scar Count	0-1 	2 	≥ 3 	BPO  	

Figure 14. The experimental debitage classification, demonstrating flake characteristics required to sort debitage into early, middle and late reduction stages, and also into bifacial and bipolar reduction classes.

## CHAPTER 5

## THE ARCHAEOLOGICAL DATA BASE

In this chapter the archaeological sources of data and the artifact classification scheme are described to provide background information for the following analytic chapter. Each of the 38 sites from the Eagle Lake, Mouth of the Chilcotin, Lillooet and Hat Creek regions of the Interior Plateau (Figure 15) is described; then the artifact classification system is presented.

The reduction stage classification of debitage developed in the previous chapter is used to measure the dominant stages of tool manufacture represented in the 38 assemblages. Several tool classes that are based primarily on the extent of retouch exhibited are defined, and tool attributes that were individually gathered are also described. The frequencies of artifacts are tabulated for each site, and photographs of the tools and cores are presented at the end of this chapter.

### 5.1. Site Descriptions

This section provides descriptions of the locations where the assemblages under study were collected, including the size of the sites, features associated with the sites, the area within the sites that was collected or excavated, the number of tools, cores and debitage analysed in this study, radiocarbon dates if

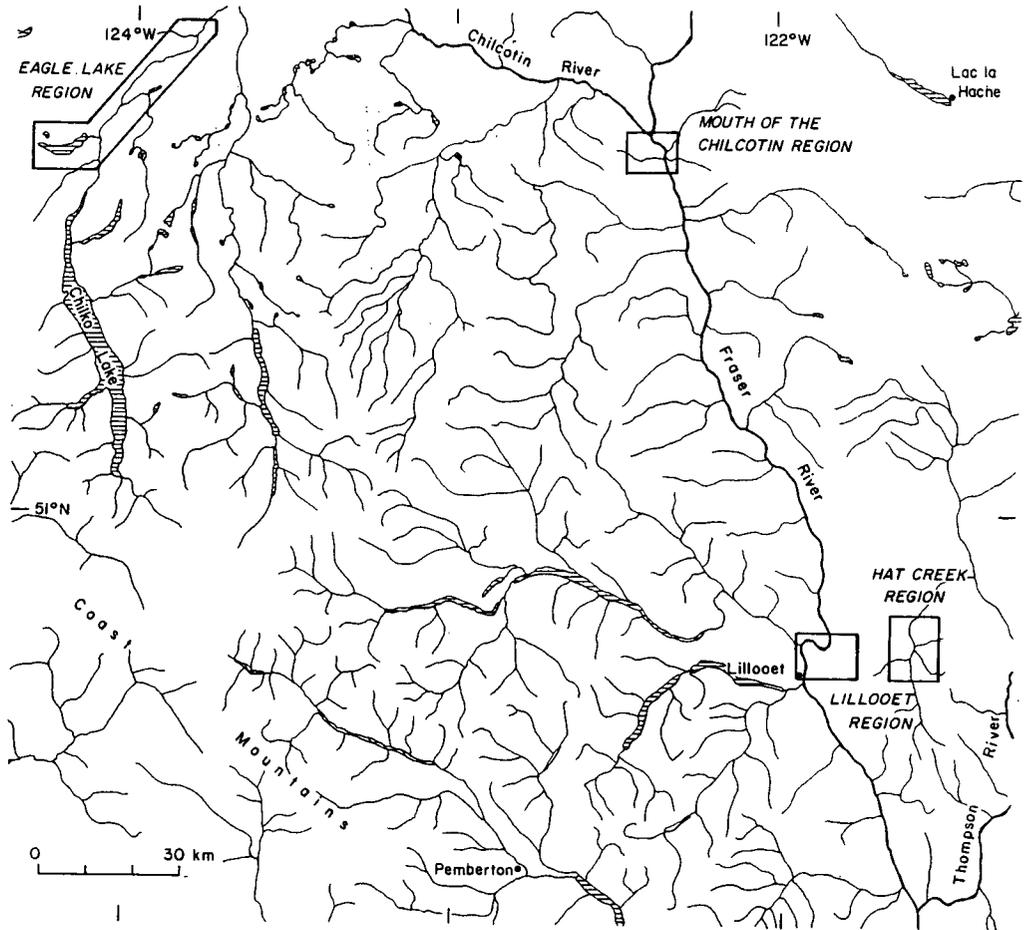


Figure 15. Location of the four regions under study  
This figure is keyed to Figure 3.

such are available, and some general locational information. The information was compiled from various sources including project reports (Matson et al 1979; Matson et al 1980; Pokotylo and Beirne 1978; Beirne and Pokotylo 1979; Stryd 1972), graduate theses (Pokotylo 1978a; Stryd 1973; Ham 1975), B.C. Provincial archaeological site forms (Keddie 1972; others from Eagle Lake, Shuswap Settlement Patterns and Hat Creek Projects), and personal communications with the original collectors of the artifacts. An effort was made to use sites that were late prehistoric in age, or from the Kamloops Phase, although it cannot be certain that all sites analysed here date to within the last 2000 years. Given the current poor state of culture history in the Interior Plateau, this is a weakness of the present data, but does not significantly interfere with the purpose of this study: to examine assemblage variability within and across several regions of the Plateau.

The frequencies of tools, debitage and cores that are given in the following discussion may not match those reported in original reports or detailed analyses for three major reasons. The first of these is that only chipped stone tools, cores, debitage and hammerstones were analysed, and ground stone, bone and antler tools were not. The second reason for possible discrepancies is that the assemblages were completely re-classified for this study, and my tool classifications do not necessarily agree with those of previous researchers. In particular, this study distinguishes be-

tween complete and fragmentary tools, and also classifies many items as debitage that were previously classed as utilized flakes, when edge damage was not continuous. Furthermore, it was apparent that bipolar cores were not well recognized in previous analyses. The third major reason is that this study only analyses debitage greater than 5 mm in size along their largest dimension. This was thought necessary to limit the amount of material that would be studied, to provide continuity with the experimental program, and to provide some control over screen size differences between projects and the size of material that is gathered by different persons in surface collection situations.

The assemblages are referred to by the designations assigned by field investigators, and Borden site numbers are provided as well. In the case of most Eagle Lake, Mouth of the Chilcotin and Hat Creek sites, the identifiers used here refer to quadrats and sites within quadrats. For certain sites within these three project areas and for all Lillooet sites, Borden site numbers are used when the sites were known prior to project surveys. Maps showing individual site locations are found in figures 16, 17, 18, 19 and 20. The assemblages are discussed here simply in the order that they were first examined, and that order is maintained in most further tables. This practice helped to minimize the amount of editing that was required of the data, and is no great impedence to understanding the analyses since site designations are quite arbitrary in any case. Site types, radiocarbon dates (uncorrected, uncalibrated),

site areas and general debitage tool frequencies are shown in Table 10.

In all of the following pages, the kinds of sites from which lithic assemblages were obtained are defined as follows:

1. Housepits: Lithic assemblages have been obtained from excavated housepit depressions.
2. Lithic scatters: These are surface scatters of stone artifacts, with no associated cultural depressions. Occasionally, very small areas of these have been test excavated to depths never exceeding 20 cm.
3. Lithic scatters with housepits: These are surface scatters only at sites that also have associated house depressions.
4. Lithic scatters with cachepits: These sites' assemblages also occur in surface contexts, but with associated cachepits only.
5. Lithic scatters with fire-cracked rock: These are surface scatters of lithic artifacts, with associated fire-related features, usually including fire-cracked rock and burnt mammal bone. One of these from Hat Creek (F8:1) is an actual roasting pit, with associated surface lithic remains.

	SITE	SITE TYPE	C14 AGE (B. P.)	COLLECTION/ EXCAVATION AREA (m <sup>2</sup> )	TOOLS	CORES & DEBITAGE	TOTAL ARTIFACTS
EAGLE LAKE	14:2	LS		168	2	11	3
	16:1	LS		2750	5	32	37
	19:1	LSCP		5000	56	1063	1119
	22:1	LS		150	2	83	85
	26:3	LSCP		9375	4	108	112
	32:1	LSHP		400	13	167	180
	CR28	LSFCR		3575	5	34	39
	CR64	LSFCR		2	0	42	42
	CR40	LSFCR		100	6	117	123
	CR73	HP	360 ± 80	4	4	53	57
EIRw 4	LSHP	280 ± 80	2	19	646	665	
CR92	LSHP	860 ± 80	240	46	1260	1306	
MOUTH OF THE CHILCOTIN	EkRo 18	HP	1290 ± 80	3	17	65	82
	EkRo 31	HP		2	22	130	152
	EkRo 48	HP	870 ± 60				
			1459 ± 75	5	18	330	348
	2:3	LSCP	770 ± 65	1250	37	122	159
	4:2	LS		300	35	954	989
	4:5	LS		6000	16	340	356
	4:1	LSHP		8750	24	122	146
	5:1	LSHP		12500	25	85	110
	9:1	LSHP		9750	12	141	153
	9:2	LSHP		3750	13	151	164
	12:6	LSHP		2500	12	24	36
LILLOOET	EeRk 16	HP	1290 ± 85	5	20	24	44
	EeRl 41	HP	ca. 150	16	29	23	52
	EeRk 7	HP	920 ± 80	36	116	2802	2918
	EeRk 4:38	HP		2	20	218	238
	EeRl 40	HP	395 ± 80	18	76	1300	1376
HAT CREEK	G21:9	LS		2252	26	356	382
	G23:1	LS		284	4	323	327
	G2:12	LS		244	8	259	267
	G31:1	LS		376	22	281	303
	F8:1	LSFCR	2120 ± 65				
			2245 ± 50	1676	53	641	694
	F12:5	LS		84	6	346	352
	J22:2	LS		20	2	12	14
	J38:2	LSFCR		12	7	23	30
	K2:1	LS		33200	10	1142	1152
EeRj 1	HP	140 ± 50	10	69	875	944	

LS - Lithic scatter

HP - Excavated housepit

LSHP - Lithic scatter with housepits

LSCP - Lithic scatter with cache pits

LSFCR - Lithic scatter with firecracked rock

TABLE 10. Summary data for the 38 assemblages under study.

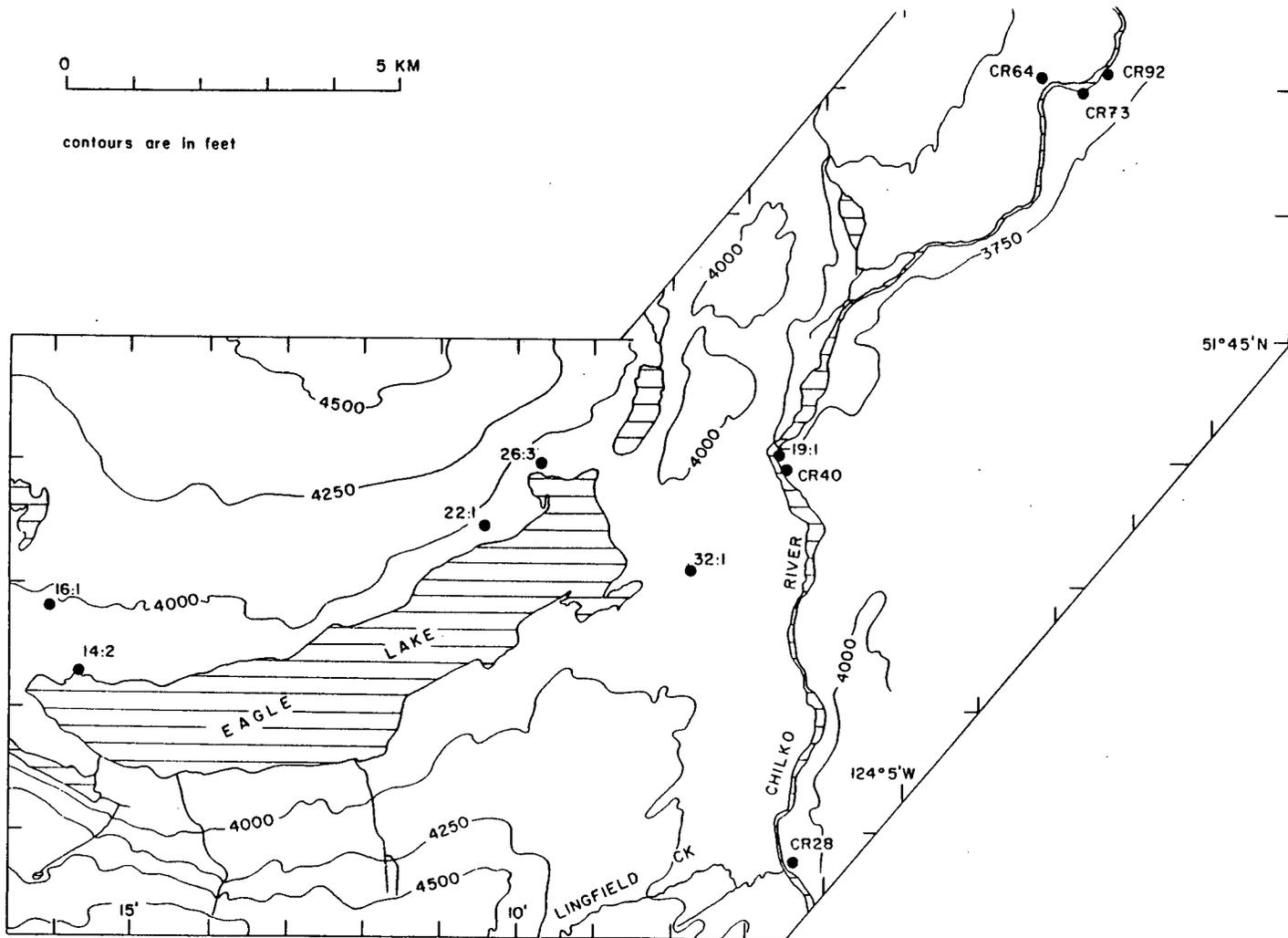


Figure 16. Eagle Lake region sites. Figure 17 joins upper right.

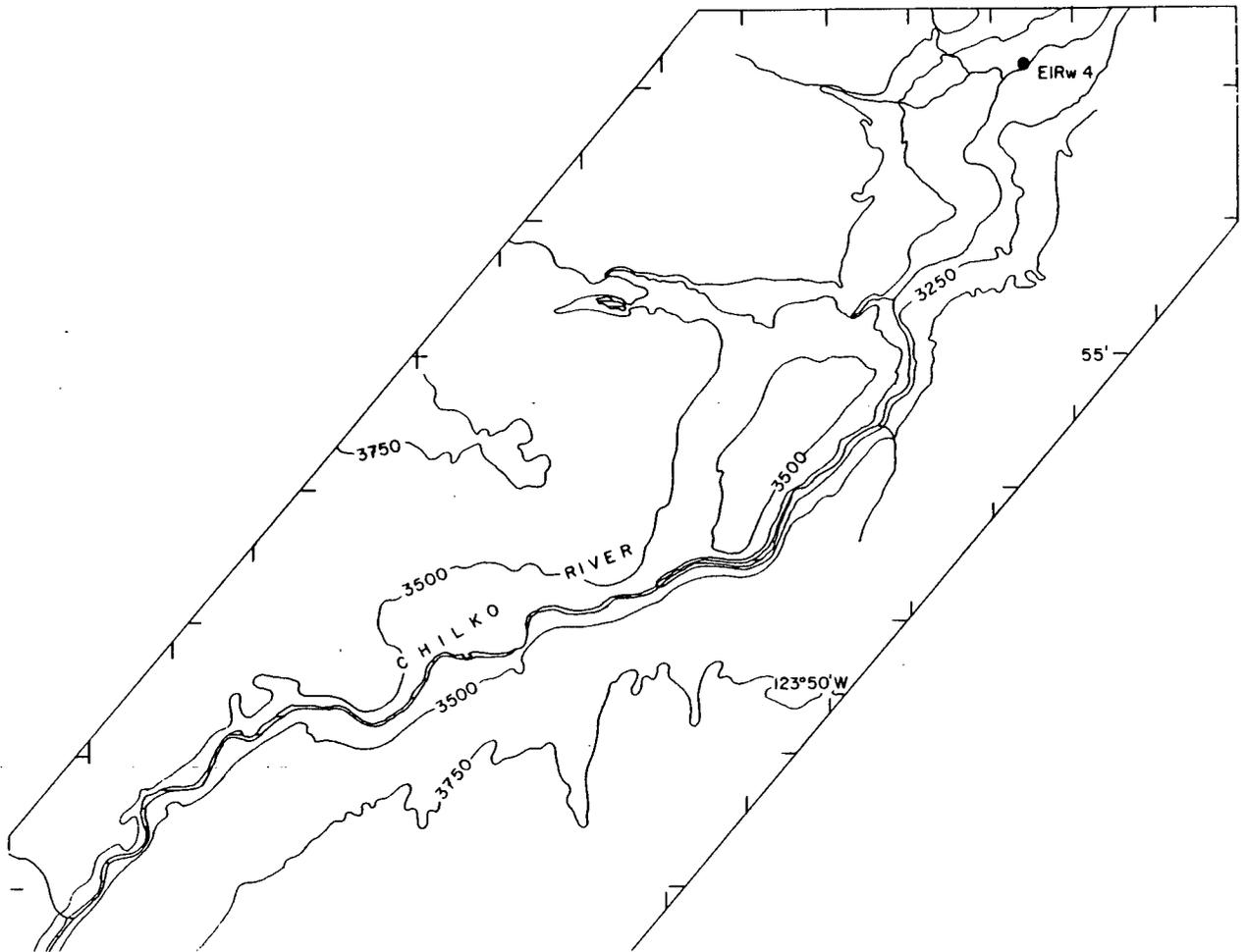


Figure 17. Eagle Lake region site ElRw 4. Joins Figure 16 at bottom left.

### 5.1.1. Eagle Lake Sites

The 12 assemblages from the Eagle Lake region (Figures 16 and 17) that are analysed here were collected during the 1979 season of the Eagle Lake project (Matson et al. 1980). As is discussed in Chapter 3, this project was designed to describe the settlement patterns and material culture of late prehistoric Chilcotin in the area, to date their arrival and to compare the patterns to Mouth of the Chilcotin and Hat Creek regions. For further description see Matson et al. (1980).

#### 1. 14:2 (EkSb 4)

This site is a small (10.5 m X 16 m) lithic scatter located at the western end of Eagle Lake, 25 m north of the lake shore. Located at an elevation of 1190 m a.s.l., the site occurs in grassland environment near discontinuous lodgepole pine and aspen forest near the lake shore. The site was completely surface collected, and the assemblage consists of two tools and 11 pieces of debitage.

#### 2. 16:1 (EkSb 5)

This site is located at the west end of Eagle Lake, at an elevation of 1200 m a.s.l., and at a distance of about 850 m north of the lake shore. An area measuring 75 m X 50 m in a large open meadow was completely surface collected, yielding an assemblage of five tools, five cores, and 27 debitage items.

## 3. 19:1 (EkSa 27)

A large (200 m X 200 m) lithic scatter with associated cache-pits, rock clusters and possible roasting pits, this site is situated on a low terrace of the Chilko River at 1160 m a.s.l., about 2.5 km east of Eagle Lake. The site was completely surface collected, and three adjoining 1 m X 1 m units were excavated to 25 cm depth below surface. One of the excavation units contained an ash feature 15 cm in diameter with extremely fragile calcined bone fragments. This is the second largest assemblage from Eagle Lake, with 56 tools, five large cores, 15 bipolar cores and 1043 pieces of debitage.

## 4. 22:1 (EkSb 6)

This site is located about 200 m from the north shore of Eagle Lake, at 1190 m a.s.l. in an open grassland area near the northeast shore of the lake. The site is small in size (15 m X 10 m) and was completely surface collected, yielding two tools, three large cores, and 80 pieces of debitage.

## 5. 26:3 (EkSa 31)

Located on a small esker-like feature at the east end of Eagle Lake, this site is a lithic scatter measuring 125 m X 75 m in area, at 1190 m a.s.l., and occurs about 25 m. from the lake shore. Complete surface collection of the site produced 3 tools, 108 pieces of debitage, and one hammerstone.

## 6. 32:1 (EkSa 36)

This is a unique site situated 50 m west of a small lake in lodgepole pine forest environment, and about 1 km east of Eagle Lake. The site contains a rectangular shallow house depression, two cachepits, a firecracked rock feature and a lithic scatter. Altogether, the site area is about 40 m X 40 m. The site was tentatively identified as representative of an Athapaskan occupation location, on the basis of the large rectangular feature, the presence of a contracting stem Kavik projectile point and a blue glass trade bead, among other features. The lithic scatter was completely surface collected, yielding 162 flakes, five bipolar cores and 13 tools.

## 7. CR28 (EkSa 98)

This site is a lithic scatter at 1190 m a.s.l. located on a high bluff on the east side of the Chilko River, about 5 km south-southeast of Eagle Lake. Five tools and 34 flakes were collected within an area measuring 55 m X 65 m that also exhibited firecracked rock, burnt bone and a game trail.

## 8. CR64 (EkSa 34)

This site is located on the west side of the Chilko River, at 1070 m a.s.l., about 200 m north of the river's edge, and approximately 10 km northeast of Eagle Lake. The site was revealed in a roadcut exhibiting bone and firecracked rock, and

may have originally extended over an estimated area of 50 m X 40 m. Two excavation units each measuring 1 m X 1 m were dug to depths of about 30 cm below surface, and produced two large cores, one bipolar core, and 39 pieces of debitage, but no tools. Several burnt fragments of large mammal long bone were also recovered from the units.

9. CR40 (EkSa 89)

This site is on the east side of the Chilko River, about 2.5 km east-northeast of Eagle Lake, and is located about 100 m south of site 19:1, at an elevation of 1130 m a.s.l. Complete surface collection of the lithic scatter part of the site produced six tools, and 117 flakes. Altogether, the site encompasses an area measuring 120 m X 90 m.

10. CR73 (EkSa 35)

This site represents the only excavated housepit assemblage from the Eagle Lake region at present. Located at 1080 m a.s.l., on the east side of the Chilko River, approximately 1 km south of the mouth of Brittany Creek, the housepit was partially eroded by the Chilko River, revealing the stratigraphy of the depression. The site includes a small cachepit, and in all covers an area of 40 m X 20 m. Four excavation units 1 m X 1 m in size were dug in the house depression, exposing roof fill material, well preserved burnt roof beams and a single occupation layer. Charcoal from one

of the beams was radiocarbon dated to  $360 \pm 80$  BP (SFU 15), and a dendrochronological date from the beam of AD 1561 vv (outside very variable) was obtained as well. The assemblage from the site consists of four tools and 53 flakes, as well as two net sinkers, and fragments of incised slate and bone, and two small edge fragments of ground stone tools. Faunal remains included fish and mammal bone that have not been identified to species.

11. ElRw 4

This site is located on the north bank of the Chilko River, well outside the immediate area of the Eagle Lake region, but was studied as part of the Eagle Lake project. The site covers an extensive area (about 750 m X 400 m), and contains 169 house-pits, cachepits and possibly other kinds of depression features as well as firecracked rock and a light but extensive lithic scatter. Three 1 m X 1 m excavation units were dug at the site, one on a high terrace and two others on a large slump bank next to the river. Only materials from the lower two units are analysed here, and these include 19 tools, five bipolar cores and 641 flakes. A radiocarbon date of  $280 \pm 80$  BP (SFU 16) was obtained from one of these units.

12. CR92 (EkSa 33)

This site is a large lithic scatter (about 400 m X 100 m) located on the east side of the Chilko River, about 500 m south

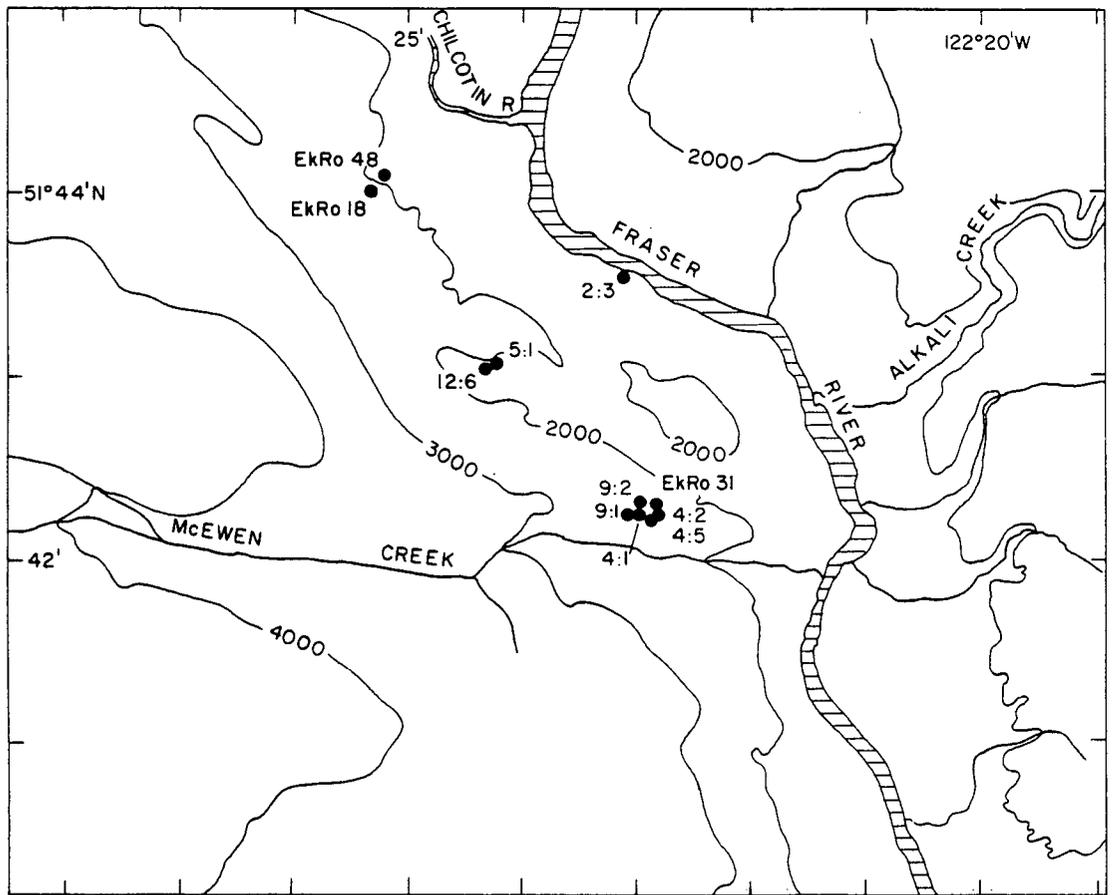
of Brittany Creek. Some 20 cachepits are located nearby (recorded as CR98, but considered here to be a part of CR92), and the materials analysed here were recovered from 250 1 m X 1 m surface units, and from two 1 m X 1 m excavation units. This is the largest assemblage from the Eagle Lake region studied, and it includes 46 tools, one large core, 15 bipolar cores and 1244 pieces of debitage. A radiocarbon date at  $860 \pm 80$  BP (SFU 14) was obtained on charcoal removed from one of the excavation units.

#### 5.1.2. Mouth of the Chilcotin Sites

The 11 sites analysed from the region immediately southwest of the confluence of the Chilcotin and Fraser Rivers are from collections recovered by Matson, Ham and Bunyan (1979). In certain cases different sites recorded within survey quadrats bear identical Borden-site numbers, because they had been previously recorded by Keddie (1972) in a judgemental survey of the area. The original quadrat designations are retained here to facilitate comparisons with the findings of the Shuswap Settlement Pattern project (Figure 18).

##### 1. EkRo 18

This site consists of 15 housepits and eight cachepits in an area measuring approximately 300 m X 80 m. It is located at an elevation of 685 m a.s.l., 1.5 km southwest of the Chilcotin



contours are in feet

0 5 KM

Figure 18. Mouth of the Chilcotin region sites.

and Fraser Rivers confluence in an open rangeland setting. The assemblage studied here constitutes only those materials recovered from three 1 m X 1 m excavation units placed in a housepit depression measuring 4.5 m in diameter. The excavations revealed no horizontally continuous occupation floor, and a date of  $1290 \pm 80$  BP (Gak 5325) was obtained from a charcoal sample. The assemblage includes 17 tools and 65 flakes.

## 2. EkRo 31

This site is located in open grassland, at 595 m a.s.l., approximately 4 km south-southeast of the Mouth of the Chilcotin River. The site features 11 housepits and four cachepits in an area 225 m X 50 m. One of the housepits was test excavated by means of two 1 m X 1 m units, yielding the assemblage studied here, and no radiocarbon samples were processed. The assemblage consists of 22 tools, one bipolar core, and 129 pieces of debitage.

## 3. EkRo 48

This site consists of seven housepits and eight cachepits at 655 m a.s.l. on an open terrace near to site EkRo 18, approximately 1.5 km southwest of the Mouth of the Chilcotin River. EkRo 48 was the most extensively excavated site of the Shuswap Settlement Pattern project in 1974. Five 1 m X 1 m units were excavated in one of the housepits, exposing a continuous floor 3.5 m in diameter. Charcoal from the floor was radiocarbon dated

at  $1459 \pm 75$  BP (Gak 5327) and miscellaneous charcoal from the pit was dated at  $870 \pm 60$  BP (Gak 5326). The materials studied here include 17 tools, one hammerstone, eight bipolar cores and 322 pieces of debitage.

4. 2:3 (EkRo 87)

Site 2:3 is located 1.75 km downstream from the Chilcotin-Fraser rivers' confluence, overlooking the Fraser River at 365 m a.s.l. The site consists of two cachepits and the surface lithic assemblage studied here, within an area measuring 50 m X 25 m. The assemblage was obtained from an eroding bank area, and includes 36 tools, one hammerstone, four cores, four bipolar cores, and 114 flakes. A charcoal sample was removed from the eroding bank, and was dated at  $770 \pm 65$  (Gak 5324). This site was classed as a riverside site in the analyses by Matson *et al.* (1979).

5. 4:2 (EkRo 31)

Site 4:2 is one of three lithic scatters from Quadrat 4 of the Shuswap Settlement Pattern project that are studied here. The scatter occurs here on a low rise near a creek bed, at 550 m a.s.l. The assemblage was collected by means of 12 grid units 25 m X 25 m in size, and was also studied by Bunyan (1974) in a moderately successful attempt to delimit technologically distinct areas within the scatter area. 4:2 is one of the chert debitage sites considered to be "pre-Kamloops" by

Matson et al. (1979) and the materials analysed in this study include 35 tools, one core, two bipolar cores and 951 debitage items.

6. 4:5 (EkRo 31)

This site is a surface lithic scatter located approximately 75 m south of site 4:2, and is also a chert debitage site (Matson et al. 1979). The assemblage was collected from a low hill approximately 100 m X 60 m in area, and consists of 16 tools, two bipolar cores and 338 flakes.

7. 4:1 (EkRo 31)

Site 4:1 is a housepit site (Matson et al. 1979) that occurs near the two hills where the 4:2 and 4:5 assemblages were collected. Eight housepits and four cachepits are located in the low area. The assemblage studied here includes 24 tools, two cores, three bipolar cores and 117 flakes.

8. 5:1 (EkRo 5 and EkRo 10)

This site occurs in open grassland approximately 3 km south of the confluence of the Chilcotin and Fraser Rivers. The site features three housepits and six cachepits in an area measuring approximately 125 m X 100 m, and is partially dissected by a small gully. The artifacts analysed here include 24 tools, one hammerstone, two bipolar cores and 83 pieces of

debitage. Site 5:1 was also classed as a housepit site in Matson et al.'s (1979) final analysis

9. 9:1 (EkRo 31)

Site 9:1 is another housepit site that occurs alongside site 4:1, next to a small and densely forested creek valley. Within an area of about 150 m X 60 m, the site contains three housepits and four cachepits, as well as the surface lithic assemblage studied here, which includes 12 tools, seven bipolar cores and 134 flakes.

10. 9:2 (EkRo 30)

This site is located 250 m north of site 9:1, in an open area approximately 75 m X 50 m in size, between a small road and a forested creek gully. The site may be continuous with site 4:6, a small site that is not addressed here. 9:2 features a single housepit and a surface lithic assemblage, however Keddie (1972) recorded EkRo 30 as exhibiting three housepits and 13 cachepits. The assemblage studied here consists of 13 tools, one core, three bipolar cores and 146 pieces of debitage. 9:2 was considered to be another chert debitage site by Matson et al. (1979).

5.1.3. Lillooet Sites

The five sites from the Lillooet region that are studied here occur on the east bank of the Fraser River near Gibbs Creek

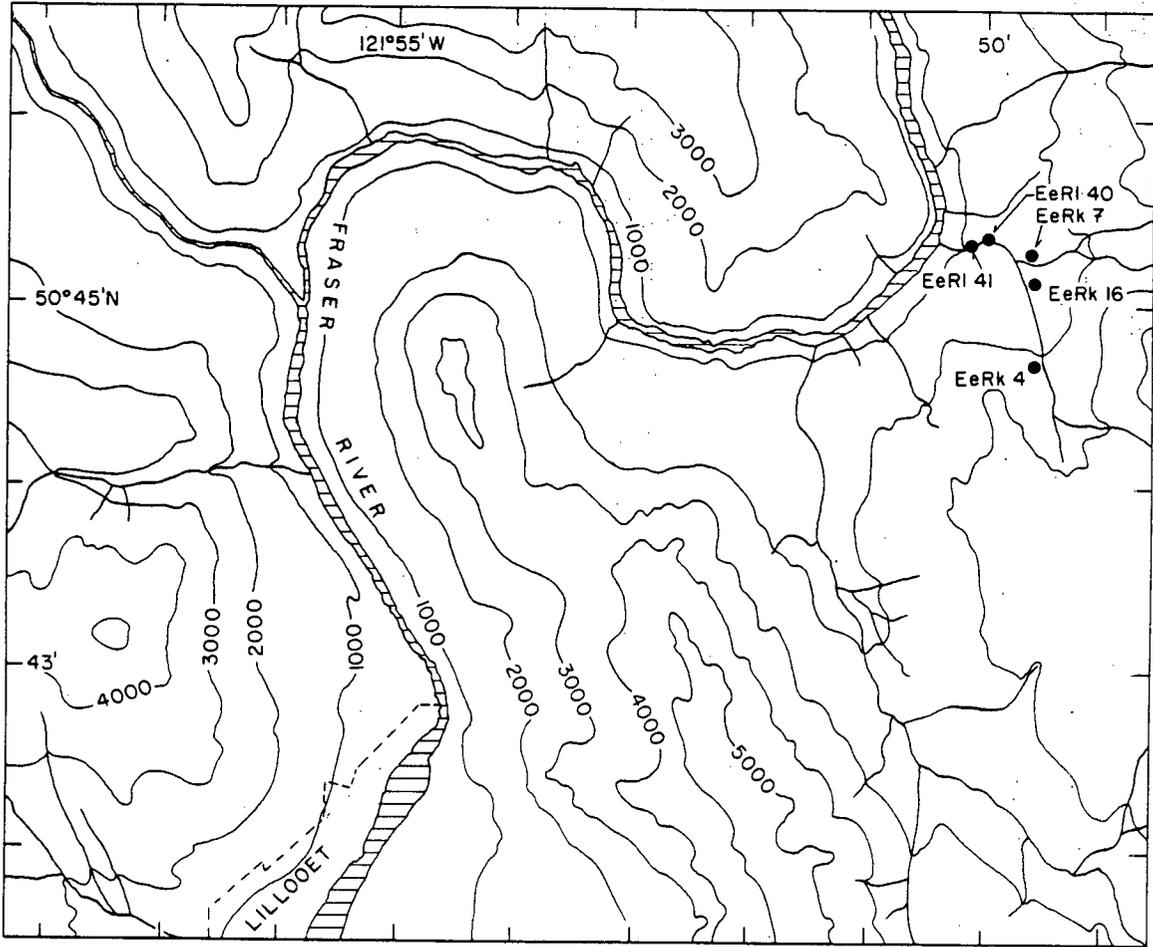
and Kettlebrook Creek (Figure 19). These are all housepits excavated by Stryd at various times throughout his extended research in the area. These sites were chosen from the many that have been excavated, with Stryd's assistance, on the basis of relatively wide excavation areas and single component occupation horizons. Overall, these collections are those with which I am least familiar, yet I chose to study them since this study required several housepit assemblages to contrast with the several lithic scatter sites available from the other three regions.

1. EeRk 16

This is a single housepit site that was excavated in 1973. The excavations are not well described and the exact area excavated is not known. Apparently, a single occupation floor was present, and this was dated to  $1290 \pm 85$  BP (I-8060) (A. Stryd, personal communication). The assemblage from this site that is studied here includes 20 tools and 24 pieces of debitage.

2. EeRl 41

EeRl 41 is a single housepit site, with two exterior cache-pits, that is situated on the south bank of Gibbs Creek at an elevation of 360 m a.s.l. The housepit is 8.8 m X 7.2 m in area, and 90 cm deep, and the cache-pits average 2.5 m in diameter. Excavation of 16 m<sup>2</sup> revealed a single house floor at 30 cm below



contours are in feet

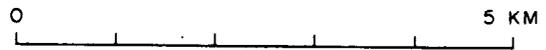


Figure 19. Lillooet region sites.

surface with a cachepit inside the house depression. The occupation is thought to be protohistoric and the assemblage here includes 29 tools, one bipolar core and 23 flakes. Stryd also recovered a beaver incisor tool, an antler wedge, a bird bone bead and an antler haft holding an iron tip. Stryd (1972) considers that EeRl 41 may have been a "specialized task structure" because of high faunal material frequencies and low lithic material frequencies.

### 3. EeRk 7

This site features three housepit depressions on the north bank of Gibbs Creek. An area of 36 m<sup>2</sup> was excavated in Housepit #1, from which the artifacts studied here were obtained. A date of 920 ± 90 BP (Gak 3284) was obtained from the base of the single occupation floor, that occurred 30 cm to 40 cm below surface. This is the largest assemblage from all the sites in this study, with 116 tools, two cores, eight bipolar cores, and 2792 pieces of debitage.

### 4. EeRk 4:38

EeRk 4 is a large site with 28 housepit depressions and numerous cachepits. The assemblage studied here is from Feature #38, a depression approximately 2 m in diameter into which was placed a 1 m X 2 m excavation unit that was dug to a depth of 1.5 m. The presence of firecracked rock in upper levels and a greater

number of artifacts in lower levels lead Stryd (personal communication) to suspect that the depression may have served as a "refuse pit". Unfortunately, no detailed description of the feature is available, and the context of the assemblage was forwarded to me only after the analyses to follow were completed. Thus, throughout the remainder of this study, EeRk 4:38 is treated as a housepit assemblage. The artifacts examined here consist of 20 tools, two bipolar cores, and 216 flakes.

#### 5. EeR1 40

This is a single housepit site with a pit feature measuring 9.6 m X 8.9 m. Several cache-pits are nearby on the same flat above Gibbs Creek. An area of 18 m<sup>2</sup> was excavated in the house-pit, with the occupation floor occurring at 35 cm below surface. A date of 395 ± 80 BP (I-9025) was obtained from the floor deposit. Artifacts examined in this study include 75 tools, one hammerstone, four bipolar cores and 1296 flakes.

#### 5.1.4. Hat Creek Sites

The 10 sites studied from the Hat Creek Valley were all collected as part of the Hat Creek Archaeological project (Figure 20). Most sites recorded during the three year operation were lithic scatters, some of enormous size, and the assemblages analysed here were chosen with the assistance of Dr. David Pokotylo on the basis of probably late prehistoric age, and manageable size.

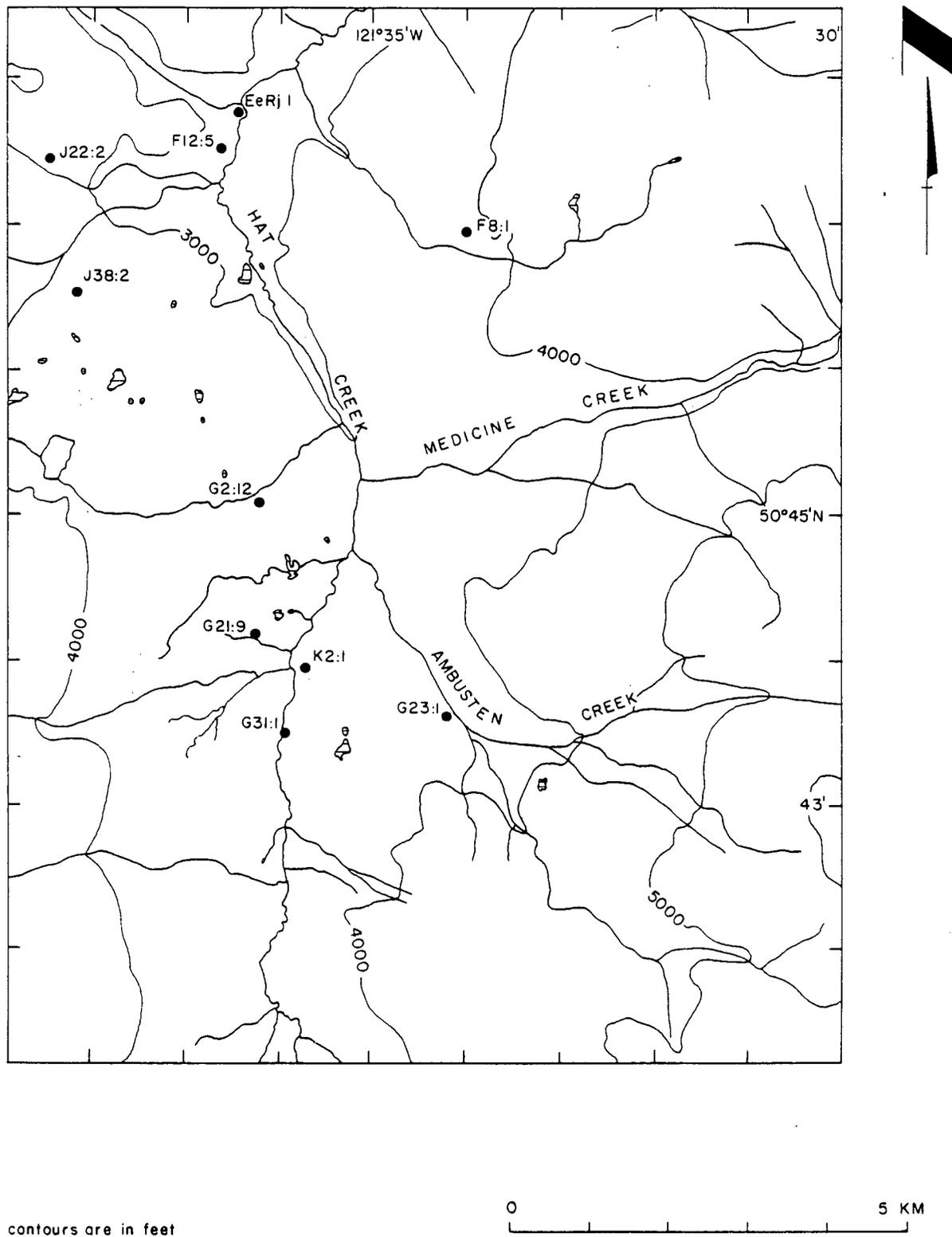


Figure 20. Hat Creek region sites.

Six of these ten were also studied previously by Pokotylo (1978a).

1. G21:9 (EeRj 42)

This site is located on the north site of Anderson Creek in an open grassland area at 1035 m a.s.l. elevation. Lithic materials were surface collected from an area of 2252 m<sup>2</sup>. G21:9 was one of the assemblages studied by Pokotylo (1978a). In that study, the site was characterized as exhibiting a wide range of stone tool manufacturing processes as well as indications of intensive tool use. The assemblage studied here consists of 26 tools, and 359 flakes.

2. G23:1 (EeRj 52)

Surface artifacts from this site were collected from a 284 m<sup>2</sup> area on a high ridge at 1130 m a.s.l., 250 m south of Ambusten Creek. The site also features a rock cairn, the only such feature observed to date in the Hat Creek Valley. Pokotylo's (1978a) analysis characterized this site as featuring debitage indicative of late stages of tool manufacture, and the tool assemblage was inferred to have resulted from short term hunting and butchering activities. The materials included in this study are four tools, five cores, three bipolar cores and 315 flakes.

3. G2:12 (EeRj 20)

G2:12 is a small (244 m<sup>2</sup>) lithic scatter located about 350 m north of Finney Creek at 975 m a.s.l. The site contains no fea-

tures other than the surface lithic assemblage, that consists of eight tools, one bipolar core and 258 pieces of debitage. In Pokotylo's (1978a) analyses, G2:12 was one of the wide-ranging manufacturing assemblages as revealed in the debitage, and the tools were inferred to have resulted from expedient, short-term usage.

#### 4. G31:1 (EeRj 64)

This site is situated on an open grassland bench west of Hat Creek at an elevation of 1005 m a.s.l. Materials were collected from an area measuring 376 m<sup>2</sup>. This site was also included in Pokotylo's (1978a) dissertation, where it was said to exhibit debitage resulting from late stage manufacturing processes, and the tools were part of the cluster of sites inferred to represent a wide range of intensive activities. The assemblage consists of 22 tools, four cores, three bipolar cores and 274 flakes.

#### 5. F8:1 (EeRj 71)

This site was one of the few recorded in the Hat Creek project forest stratum quadrats, although the majority of the site occurs on open ground. F8:1 contains a lithic scatter measuring 1676 m<sup>2</sup> in area, and a circular cultural depression that is 5.6 m in diameter. The depression feature was test excavated by means of four 1 m X 1 m units, that revealed a main firecracked rock

basin and additional smaller rock-lined basins. Charcoal from the primary and secondary basins were dated at  $2120 \pm 65$  BP (S-1453) and  $2245 \pm 50$  BP (S-1642) respectively. The deposits contained faunal bone material of which one specimen was identified as mule deer (Odocoileus hemionus), plus carbonic and plant remains. Thus, the feature appears to have served as a subsistence resource processing location, and the presence of small basins within it indicate that it was used possibly several times.

The F8:1 artifacts from the surface collection were also included in Pokotylo's (1978a) study, where the assemblage was characterized as being similar to that from G21:9. The F8:1 debitage appeared to result from a wide range of reduction activities and the tools were indicative of a wide range of intensive uses. The materials examined in this study include 53 tools, six large cores, six bipolar cores and 629 pieces of debitage.

#### 6. F12:5 (EeRj 8)

This site also occurred in a forest quadrat of the 1976 Hat Creek Project survey. Located at 850 m a.s.l., 250 m west of Hat Creek, the surface artifacts were collected from an area of  $84 \text{ m}^2$ . Pokotylo's (1978a) analysis found this site to exhibit a wide range of debitage characteristics, and a set of tools featuring low diversity, probably indicating a brief period of use. The assemblage analysed here includes six tools, one core, five bipolar cores and 340 flakes.

## 7. J22:2 (EeRj 176)

This small (6 m X 11.5 m) lithic scatter was found in the northwest end of the Hat Creek Valley in an area called the Houth Meadows. The site was not completely surface collected, and artifacts were only removed from a 2 m X 10 m wide transect placed through the center of the surface scatter, across a bulldozed logging road. The site was collected in 1977, and thus is not a part of Pokotylo's (1978a) study. The assemblage consists of two tools, and 12 pieces of debitage.

## 8. J38:2 (EeRj 180)

J38:2 is also a small (7 m X 5 m) lithic scatter in the northwest end of the Hat Creek Valley. The assemblage here was also collected from a transect (2 m X 6 m), rather than completely collected. Also found at this site was a surface feature containing several small fragments of burnt and calcined bone, and fire-cracked rock. The artifacts studied here include seven tools, one core and 22 flakes.

## 9. K2:1 (EeRj 90)

The lithic scatter covers a large area (400 m X 100 m) immediately east of Hat Creek, opposite its confluence with Anderson Creek. An area thought to represent 83% of the site surface was collected by means of 2 m X 2 m grid units. The site occurred along the edge of a survey quadrat and artifacts

are known to extend beyond its artificial boundaries but no attempt was made to record them. The assemblage here consists of 10 tools, six bipolar cores and 1136 pieces of debitage.

#### 10. EeRj 1

EeRj 1 is a complex site approximately 200 m X 200 m in size that is located at the north end of the Hat Creek Valley, just in the bend where the creek turns to flow northeast towards the Bonaparte River. The site exhibits a large lithic scatter approximately 100 m X 100 m in area, and 15 cultural depressions. Four of these depressions are thought to be housepits, the other 11 are inferred to be roasting pits since they contain abundant charcoal and firecracked rock. The assemblage studied here was obtained from test excavations in one of the housepits (Culture Feature #10).

Culture Feature #10 was tested by means of 10, 1 m X 1 m excavation units that were placed in a discontinuous line across the depression. Both traditional stone and bone artifacts and historic age goods were found, as well as many fragments of both floral and faunal materials. The depression also contained at least one hearth feature, from which a radiocarbon date of  $140 \pm 50$  BP (S-1582) was derived. Thus, by all evidence the depression feature appears to have been occupied during the early historic period. The lithic artifacts analysed in this study include 69 tools, one core, four bipolar cores and 870 flakes. This is the

only excavated housepit assemblage from the Hat Creek Valley.

## 5.2 Artifact Classification

The data base of the archaeological component of this study consists of 15,566 chipped stone artifacts, of which 861 are tools, and 14,705 are flake and core debitage. This section provides descriptions of the assemblage classification system, and provides the basic frequency data for the analyses to follow. For all 38 assemblages, as required, the artifact categories were maintained across the five raw material classes: vitreous basalt, granular basalt, obsidian, chert/chalcedony and quartzite/other. In addition to artifact type and raw material, all tools were described by eight continuous and ordinal variables.

Gathering the data took the greater part of about four months of straight laboratory time, and would have been lessened by perhaps no more than 25% if a 10 mm, rather than 5 mm debitage size cut-off had been applied. Debitage collections that were not individually catalogued and wrapped were much faster to tabulate; however, recent damage was noted in assemblages that had been excavated on the order of 10 years ago. Assemblages that have a cumulative history of archaeological collecting also posed some frustrating but resolveable problems by exhibiting changing Borden numbers, altering cataloguing, removed and altered cataloguing, and several means of storage. Data were written onto 80-column by 28 row blank forms onto which appropriate categories had been added.

These were keypunched, and were stored as cards, and as disk files, at the UBC Computing Centre.

#### 5.2.1. Debitage (N = 14705)

The system of general stage classification fordebitage developed in Chapter 4 is applied here, yielding eight classes for flakes and two for cores. To be sorted in early, middle or late reduction stages, flakes are sorted into PRB and Shatter categories. PRB's with cortical or plain platforms are early, those with two platform scars are middle stage, those with three or more platform scars are late stage, and those with three or more platform scars on acute angled platforms are BRF's, or bi-face reduction flakes. Shatter with cortical dorsal faces or with only plain dorsal faces are early stage, Shatter with two dorsal scars are middle, and those with three or more dorsal scars are counted as late. Bipolar reduction flakes (BPO's) are considered Shatter (as opposed to PRB's), because platforms are crushed, and include those flakes with evidence of simultaneous, opposing percussion and at least one dorsal face platform area that exhibits irregular hinge and step scarring. As is discussed in the experimental study, PRB's with platforms less than 2 mm wide were often difficult to code reliably and were often coded as Shatter and stage-evaluated by their dorsal scar counts.

Cores and bipolar cores are alsodebitage. By definition these items bear no evidence of use, or hafting retouch,

and have flake scars adequate to have yielded useful blanks. Hand-held cores (CORES) usually bear cortex, one or two percussion planes, minimal platform preparation and no bifacial flaking. Bipolar cores (BPCO) are pieces with evidence of simultaneous percussion, with full-length scars, and extensively battered platforms.

Pièces esquillées (PEEQ) are addressed as a tool class, and the contentions bearing on their identity are discussed below.

Of the 14,705 pieces of debitage, the PRB and Shatter flake frequencies combined yield 5217 early stage items, 4991 middle stage, and 3325 late stage. BRF's total 595 for the 38 assemblages, and there are a total of 413 BPO's. All together, 164 cores were examined, of which 120 are BPCO's and 44 are CORES. Tables 11 and 12 show the frequency distribution for the debitage of each assemblage, and the percentage of the frequency categories per assemblage.

#### 5.2.2. Tool Classification (N = 861)

Tools are analysed in two manners, each designed to reveal different kinds of trends in implement occurrence, and assemblage complexity. The typological classification of tools combines attributes of retouch and utilization extent (facial, marginal, utilized) with attributes of shape and occasionally, plausible function (e.g. projectile point, endscraper), and size. In and of themselves most classes do not yield much "functional" infor-

Site	PRB				Shatter				Cores			Total
	E	M	L	BR	E	M	L	BP	BC	CO		
14:2	2	1	4	0	1	1	2	0	0	0	11	
16:1	11	0	0	0	11	4	1	0	0	5	32	
19:1	110	107	107	3	273	275	115	53	15	5	1063	
22:1	20	0	0	0	36	21	3	0	0	3	83	
26:3	6	10	23	8	15	18	28	0	0	0	108	
32:1	9	13	10	4	39	37	34	16	5	0	167	
CR28	3	2	4	2	7	4	12	0	0	0	34	
CR64	4	2	3	0	12	7	11	0	1	2	42	
CR40	6	17	13	15	13	24	29	0	0	0	117	
CR73	4	8	9	5	9	9	9	0	0	0	53	
ElRw 4	55	53	52	32	117	161	164	7	5	0	646	
CR92	135	83	57	39	418	256	210	46	15	1	1260	
EkRo 18	16	5	6	9	6	6	16	1	0	0	65	
EkRo 31	10	19	7	8	15	24	39	7	1	0	130	
EkRo 48	33	26	5	13	94	81	47	23	8	0	330	
2:3	6	10	8	8	17	24	31	10	4	4	122	
4:2	45	44	60	22	259	311	192	18	2	1	954	
4:5	20	18	20	3	106	110	56	5	2	0	340	
4:1	7	5	6	2	29	47	20	1	3	2	122	
5:1	4	10	3	0	19	29	17	1	2	0	85	
9:1	8	16	6	0	31	46	19	8	7	0	141	
9:2	10	20	13	4	39	35	25	1	3	1	151	
12:6	6	2	0	0	4	6	0	2	4	0	24	
EeRk 16	1	2	4	0	3	3	11	0	0	0	24	
EeRl 41	4	5	3	1	0	4	5	0	1	0	23	
EeRk 7	467	241	83	22	918	683	279	99	8	2	2802	
EeRk 4:38	26	25	17	8	48	57	27	8	2	0	218	
EeRl 40	138	132	68	51	273	408	194	32	4	0	1300	
21:9	18	54	41	12	49	109	73	0	0	0	356	
23:1	32	16	10	16	85	100	56	0	3	5	323	
2:12	11	37	52	9	27	59	63	0	1	0	259	
31:1	27	11	11	15	72	64	67	7	3	4	281	
F8:1	62	77	64	55	63	140	163	5	6	6	641	
F12:5	52	21	2	5	114	95	46	5	5	1	346	
J22:2	2	1	0	1	5	2	1	0	0	0	12	
J38:2	0	2	0	1	3	9	7	0	0	1	23	
K2:1	68	78	45	133	229	325	231	27	6	0	1142	
EeRj 1	119	77	55	89	201	147	151	31	4	1	875	
TOTALS	1557	1250	871	595	3660	3741	2454	413	120	44		

E = Early  
M = Middle  
L = Late  
BR = Bifacial Reduction  
BP = Bipolar Flakes  
BC = Bipolar Cores  
CO = Cores

TABLE 11. Assemblage debitage classes, raw counts, all raw materials.

Site	PRB				SHATTER				CORES	
	E	M	L	BR	E	M	L	BP	BC	CO
14:2	18.18	9.09	36.36	0	9.09	9.09	18.18	0	0	0
16:1	35.48	0	0	0	35.48	12.90	3.23	0	0	12.90
19:1	10.35	10.07	10.07	28	25.68	25.87	10.82	4.99	1.41	.47
22:1	24.10	0	0	0	43.37	25.30	3.61	0	0	3.61
26:3	5.56	9.26	21.30	7.41	13.89	16.67	25.93	0	0	0
32:1	5.39	7.78	5.99	2.40	23.35	22.16	20.36	9.58	2.00	0
CR28	8.82	5.88	11.76	5.88	20.59	11.76	35.29	0	0	0
CR64	9.52	4.76	7.14	0	28.57	16.67	26.19	0	2.38	4.76
CR40	5.13	14.53	11.11	12.82	11.11	20.51	24.79	0	0	0
CR73	7.55	15.09	16.98	9.43	16.98	16.98	16.98	0	0	0
ElRw 4	8.51	8.20	8.05	4.95	18.11	24.92	25.39	1.08	.77	0
CR92	10.71	6.59	4.52	3.09	33.17	20.32	16.67	3.65	1.19	.08
EkRo 18	24.62	7.69	9.23	13.85	9.23	9.23	24.62	1.54	0	0
EkRo 31	7.69	14.62	5.38	6.15	11.54	18.46	30.00	5.38	.77	0
EkRo 48	10.00	7.88	1.52	3.94	28.48	24.55	14.24	6.97	2.42	0
2:3	4.92	8.20	6.56	6.56	13.93	19.67	25.41	8.20	3.28	3.28
4:2	4.72	4.61	6.29	2.31	27.15	32.60	20.13	1.89	.21	.10
4:5	5.88	5.29	5.88	.88	31.18	32.35	16.47	1.47	.59	0
4:1	5.73	4.10	4.92	1.64	23.77	28.52	16.39	.82	2.46	1.64
5:1	4.71	11.76	3.53	0	22.35	34.12	20.00	1.18	2.35	0
9:1	5.67	11.35	4.26	0	21.99	32.62	13.48	5.67	4.96	0
9:2	6.67	13.33	8.67	2.67	26.00	23.33	16.67	.67	2.00	.67
12:6	25.00	8.33	0	0	16.67	25.00	0	8.33	16.67	0
EeRk 16	4.17	8.33	16.67	0	12.50	12.50	45.83	0	0	0
EeRl 41	17.39	21.74	13.04	4.35	0	17.39	21.74	0	4.35	0
EeRk 7	16.67	8.60	2.96	.79	32.76	24.38	9.96	3.53	.29	.07
EeRk 4:38	11.93	11.47	7.80	3.67	22.02	26.15	12.39	3.67	.92	0
EeRl 40	10.62	10.15	5.23	3.92	21.00	31.38	14.92	2.46	.31	0
21:9	5.06	15.17	11.52	3.37	13.76	30.62	20.51	0	0	0
23:1	9.91	4.95	3.10	4.05	26.32	30.96	17.33	0	.93	1.55
2:12	4.25	14.29	20.08	3.47	10.42	22.78	24.32	0	.39	0
31:1	9.61	3.91	3.91	5.34	25.62	22.78	23.84	2.49	1.07	1.42
F8;1	9.67	12.01	9.98	8.58	9.83	21.84	24.43	.78	.94	.94
F12:5	15.03	6.07	.58	1.45	32.95	27.46	13.29	1.45	1.45	.29
J22:2	16.67	8.33	0	8.33	41.67	16.67	8.33	0	0	0
J38:2	0	8.70	0	4.35	13.04	39.13	30.43	0	0	4.35
K2:1	5.95	6.83	3.94	11.64	20.25	28.46	20.32	2.36	.53	0
EeRj 1	13.60	8.80	6.29	10.17	22.97	16.80	17.26	3.54	.46	.11

E = Early  
 M = Middle  
 L = Late  
 BR = Bifacial Reduction  
 BP = Bipolar Flakes  
 BC = Bipolar Cores  
 CO = Cores

TABLE 12. Assemblage Debitage Classes, Percent by Count, All Raw Materials

mation, (Table 13), but such will be attempted by searching for co-occurrence of types. Fragment type was also recorded for the tools, but in the analyses to follow only a distinction between complete and fragmentary tool classes is maintained. The 23 tool class frequencies across the 38 sites are shown in Table 14. Photographs of the tools and cores, minus some utilized flakes, appear in Figures 21 to 69.

1. Lanceolate bifaces (LANC) and fragments (LABF)

Complex bifaces with straight, or slightly curved edges, and extensive facial flaking (>5 mm from edges).

2. Large bifaces (LABC) and fragments (LABF)

These are bifacial tools in assemblages that are markedly larger than other tools, or if they were complete, would be. There is not a strict limit imposed here, but objects on the order of 10 cm in any dimension, or fragments suggesting such a size are classed as large.

3. Bifaces (BIFC) and fragments (BIFF)

These are items with flaking on two adjoining faces that extend over 5 mm from the edge.

4. Bimarginal tools (BIMC) and fragments (BIMF)

These have adjoining-face retouch that extends between 5 mm and 2 mm from the edge, regardless of the actual number of edges bearing marginal retouch on both faces.

1. Lanceolate biface
2. Large biface
3. Bifacial retouch tool
4. Bimarginal retouch tool
5. Large uniface
6. Unifacial retouch tool
7. Unimarginal retouch tool
8. Utilized flake
9. Projectile point
10. Graver/drill
11. Endscraper
12. Pièce esquillée
13. Spall tool
14. Core tool
15. Hammerstone
16. Utilized bifacial reduction flake

NOTE: Facial retouch is greater than 5 mm; marginal is between 2 mm and 5 mm, and utilized is less than 2 mm lengths of flake scars perpendicular to the edge.

TABLE 13. Tool morphology classes

## TOOL TYPE

Site	LANC	LANF	LABC	LABF	BIFC	BIFF	BIMC	BIMF	LAUN	UNFC	UNFF	UNMC	UNMF	UTIL	PROC	PROF	GRDR	ENDS	PEEQ	SPTO	COTO	HAMM	BRUT	Total	
14:2										1									1					2	
16:1		1				1				1	2														5
19:1		2		1	2	11		2		1	4			5	4	20	1		1	2	1				56
22:1						1				1															2
26:3		1											2									1			4
32:1					1	3					1			1	1	4					2				13
CR28		2		1							1					1									5
CR64																									0
CR40		1			1	2				2															6
CR73						1								1	1	1									4
ELRw 4					1	5					2			4	4	2		1							19
CR92			1		1	15	2	1		2	1		4	2	2	8	1	1	3	2					46
EkRo 18						1					1			12									3		17
EkRo 31						1			1	3	1			4	2	4	1		1	4					22
EkRo 48					1	1		1	2		1	1	1	6		2			1	1		1			18
2:3	1		2	2	6	1				1	1		1	7		6	3			5					37
4:2			1	2		7			2	1			4	9		5			2	1				1	35
4:5		2												8		6									16
4:1		1				2			3	2	2			10	1							1	2		24
5:1			1		2	3	2		2					3	1	2			3	4	1	1			25
9:1		1			1	2	1		1	1			1	1		3									12
9:2					1	3			2					4			1				1		1		13
12:6				1	2	5			2					1					1						12
EeRk 16					2	1				1		1	8	2	1					1			3		20
EeRl 41			1		1	5			2		1			14	2		1	1							29
EeRk 7			2	2	7	9			8	1	1	2	63	4	4	2	4	3	1			1	2		116
EeRk 4:38	1				3	5			2				8		1								1		20
EeRl 40			1	2	2	6	2	2	4				42	3	6	3				2		1			76
G21:9		1	2	2	1	8		3		1	2		2	7		1									26
G23:1						2			1	1															4
G2:12					1	2				1				1		2			1						8
G31:1					3	4				5				7	3										22
F8:1					6	37						2		3	2	2				1					53
F12:5			1			1			2					1									1		6
J22:2													1		1										2
J38:2					1	2									2	1					1				7
K2:1					1	5				1						2							1		10
EeRj 1			1	1	4	13		1	1	4	4	4	2	24	2	2			2				4		69
TOTALS	1	12	11	12	51	165	8	10	3	51	30	13	21	255	38	85	14	7	18	26	4	7	19		861

TABLE 14. Tool type frequencies by site

5. Large unifaces (LAUN)

This is an uncommon tool class, consisting of only two items that are large and exhibit unifacial flaking.

6. Unifaces (UNFC) and fragments (UNFF)

These are items with unifacial retouch that extends greater than 5 mm from the edge.

7. Unimarginal tools (UNMC) and fragments (UNMF)

These are items with retouch between 5 mm and 2 mm from the edge, on one face only, regardless of the number of edges bearing marginal retouch.

8. Utilized flakes without retouch damage that extends over 2 mm from the edge, regardless of number of damaged faces. Continuity along edges must be maintained for the extent of the damage.

9. Projectile points (PROC) and fragments (PROF)

These are projectile points, regardless of type, and side-notched, corner-notched and stemmed points are included in the collections, although types of points do not form analytic units.

10. Gravers/drills (GRDR)

These are items with deliberately retouched projections, and not happenstance durable points.

### 11. Endsrapers (ENDS)

These are items that have been retouched into rounded ends, usually unifacially, and at times only exhibit marginal retouch.

### 12. Pièces esquillées (PEEQ)

These are items that have bipolar battering, where single flake scars do not extend across the entire faces of the artifact. Pièces esquillées often exhibit bipolar flaking from perpendicular axes, with four edges being about equal in length, and others have splits on lateral margins the length of the item. These right-angled splits are not considered to be scars resulting from the detachment of useful blanks.

Pièces esquillées and bipolar cores are a topic of lasting debate in lithic technology (Hayden 1980; Sollberger and Patterson 1976; Binford and Quimby 1963). I will not add to the considerable discussion, but indicate that bipolar reduction is and was a controllable technique for fracturing stone, and that pièces esquillées owe their form to some utilization technique, but that has eluded archaeologists to date.

### 13. Spall Tools (SPTO)

These are large flakes, usually obtained from granular basalts and other dense igneous rocks, that bear retouch in various ways to provide a haft end and a scraping end. The ends in fact are rarely both worked, and often retouch indicates deliberate blunting of the

scraping end. Several of the spall tools studied here have considerable use polish, both actual rounding of the stone and apparent deposition of organic materials (see Ham 1975: 153 - 156).

14. Core Tools (COTO)

These are large items, usually with much original surface of a cobble present, fashioned in a rough manner, and exhibiting lesser retouch than straightened edges, or that resulted from heavy use.

15. Hammerstones (HAMM)

These are not flaked stone pieces, but pebbles and small cobbles of dense rock, that bear battering on one or both ends. Hammerstones were considered frequent enough to add as a potential clue to lithic technological processes by patterns of association with other types, but lacking chipped stone attributes themselves, are not included in all analyses.

16. Utilized Biface Reduction flakes (BRUT)

These are BRF flakes as recognized in the debitage classification, that exhibit utilization or marginal retouch, on flake edges apart from the platform.

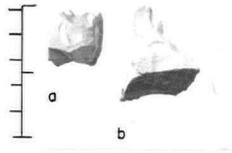


Figure 21 14:2 tools  
 a: pièce esquillée  
 b: uniface

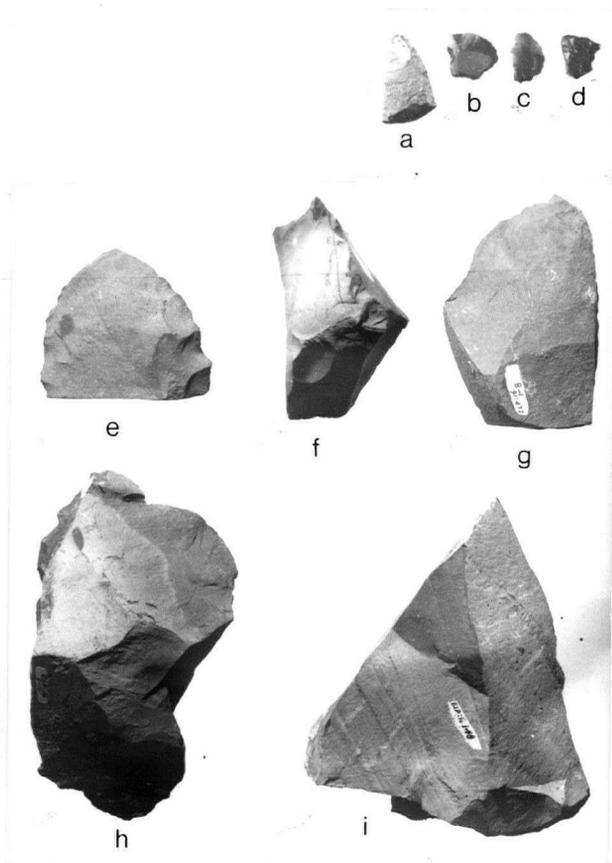


Figure 22 16:1 tools and  
 cores  
 a: lanceolate biface  
 b-d: unifaces  
 e: biface  
 f-i: cores

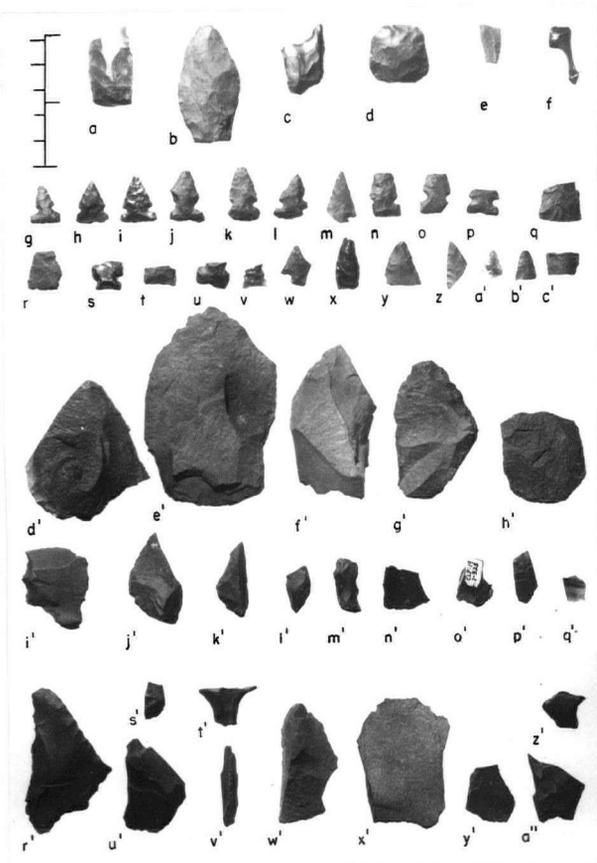


Figure 23 19:1 tools  
 a,b: lanceolate bifaces  
 c: graver/drill  
 d: pièce esquillée  
 e,f: bimarginals  
 g-c': projectile points  
 d'-q': bifaces  
 r'-v': unifaces  
 w'-a'': utilized flakes

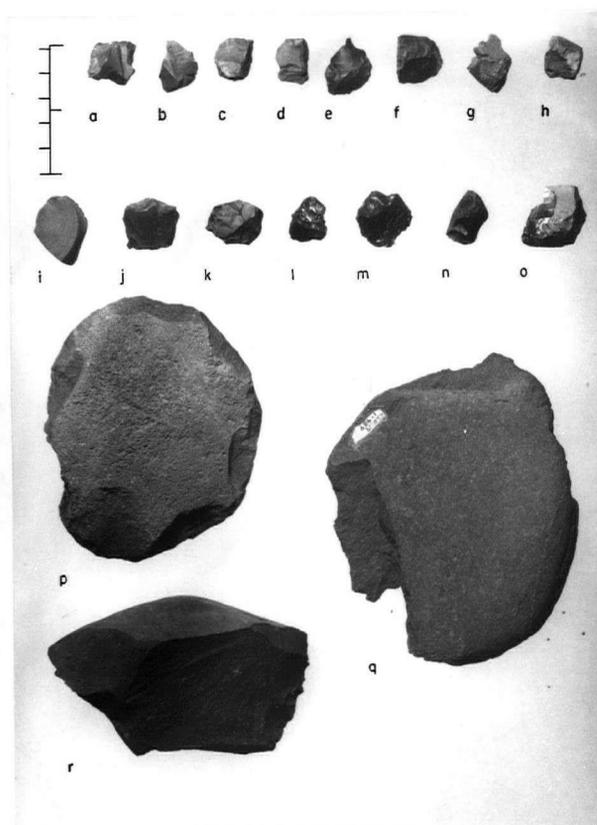


Figure 24 19:1 tools and cores  
 a-o: bipolar cores  
 p,q: spall tools  
 r: core tool

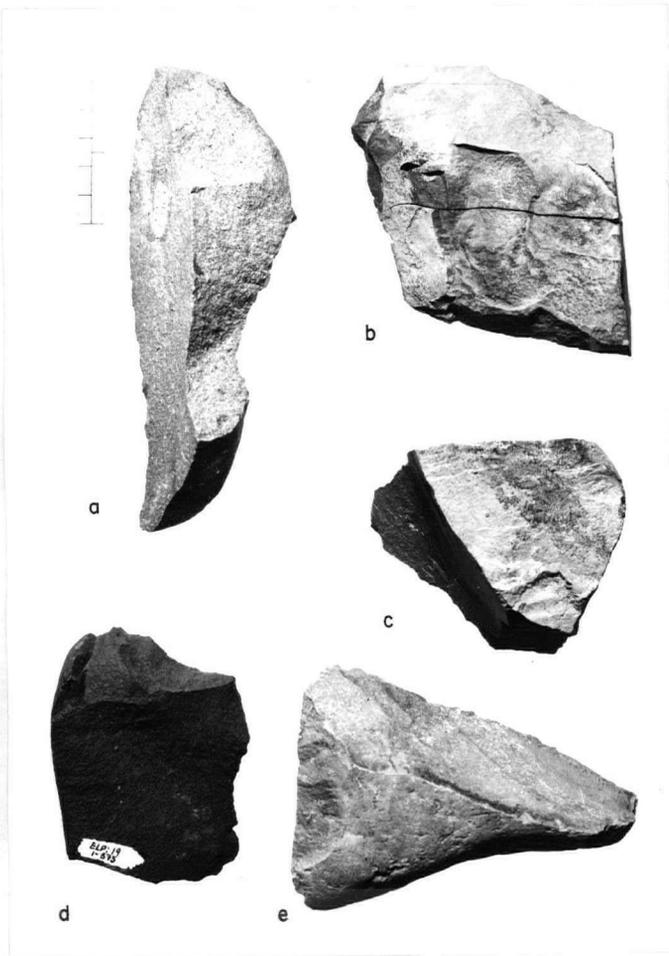


Figure 25 19:1 cores  
a-e: cores

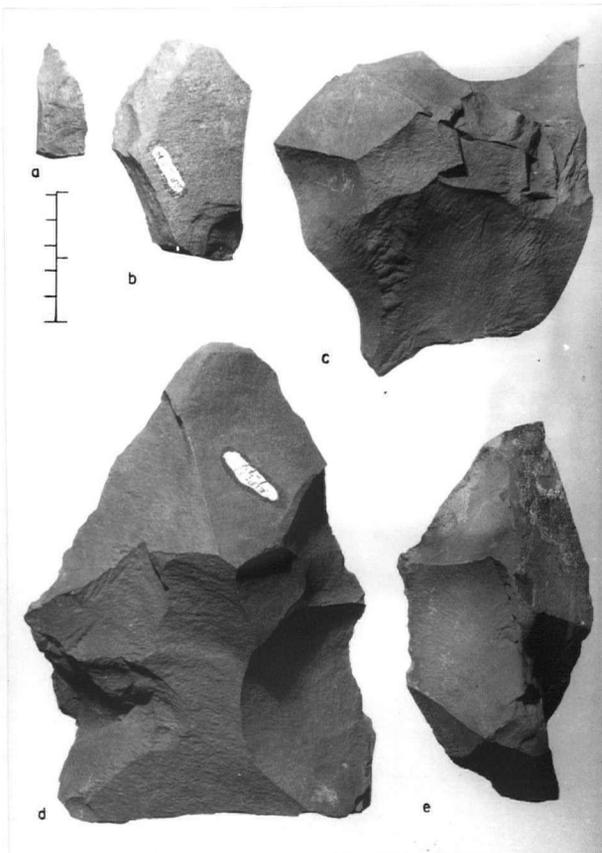


Figure 26 22:1 tools and  
cores  
a: biface  
b: uniface  
c-e: cores



Figure 27 26:3 tools  
 a: lanceolate biface  
 b,c: unimarginals

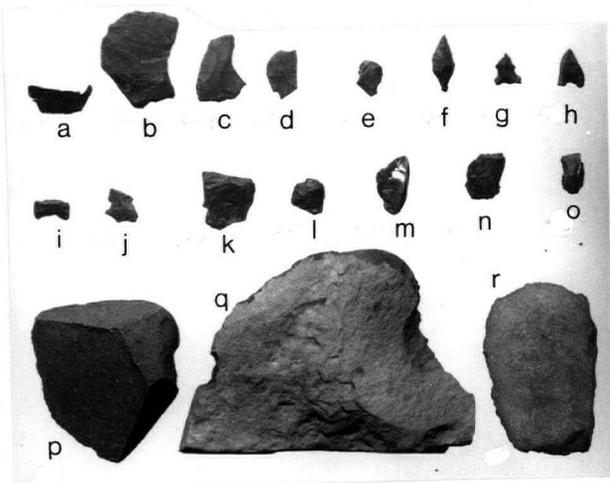


Figure 28 32:1 tools and cores  
 a-d: bifaces  
 e: uniface  
 f-j: projectile points  
 k-o: bipolar cores  
 p: utilized flakes  
 q,r: spall tools

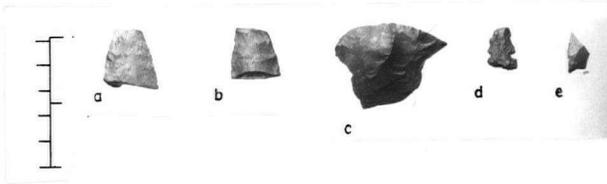


Figure 29 CR28 tools  
 a,b: lanceolate bifaces  
 c: biface  
 d: projectile point  
 e: uniface

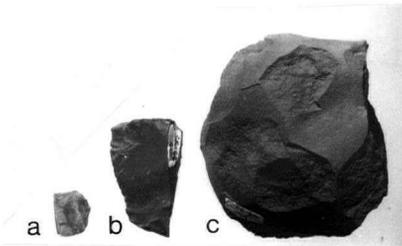


Figure 30 CR64 cores  
 a: bipolar core  
 b,c: cores

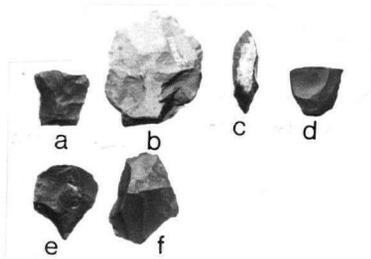


Figure 31 CR40 tools  
 a: lanceolate biface  
 b-d: bifaces  
 e,f: unifaces

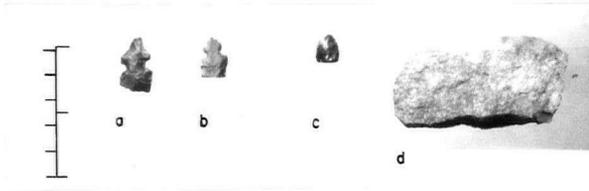


Figure 32 CR73 tools  
 a,b: projectile points  
 c: biface  
 d: utilized flake

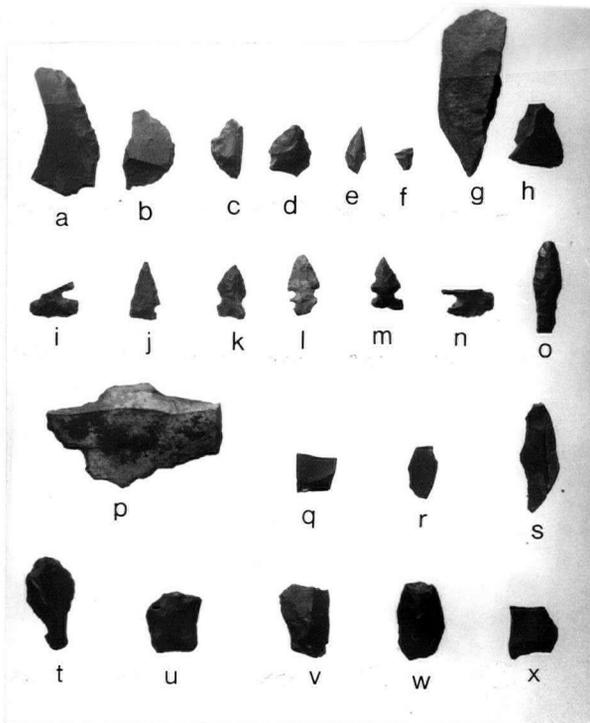


Figure 33 ElRw tools and cores  
 a-f: bifaces  
 g,h: unifaces  
 i-n: projectile points  
 o: graver/drill  
 p-s: utilized flakes  
 t-x: bipolar cores

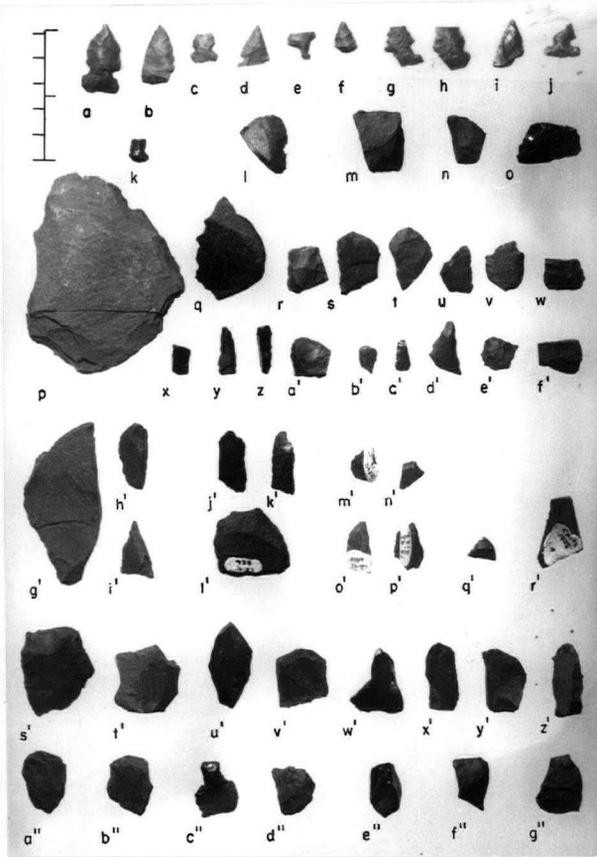


Figure 34 CR92 tools and cores

- a-j: projectile points
- k: graver/drill
- l: endscraper
- m-o: pièces esquillées
- p-f': bifaces
- g'-i': bimarginals
- j'-l': unifaces
- m'-p': unimarginals
- q'-r': utilized flakes
- s'-g'': bipolar cores

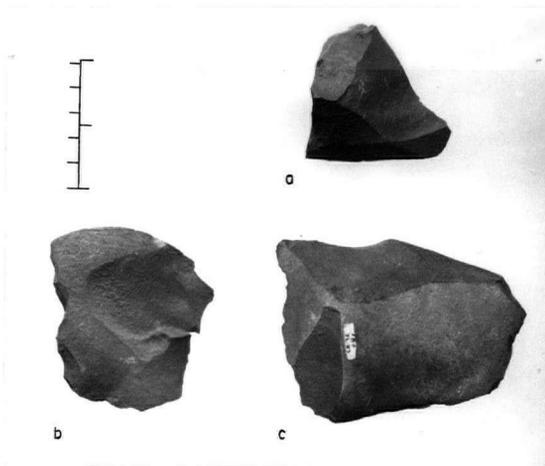


Figure 35 CR92 tools and cores

- a: core
- b,c: spall tools

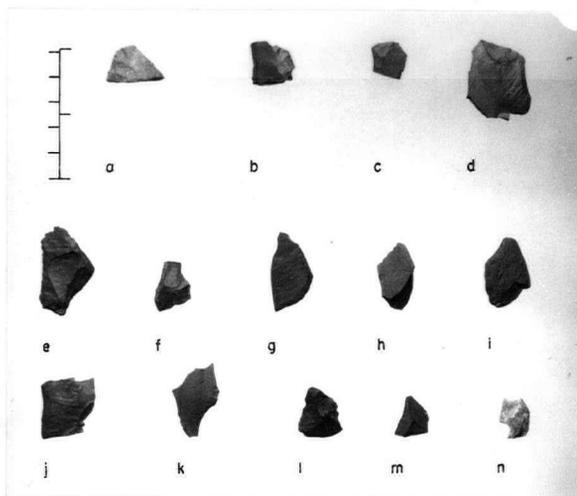


Figure 36 EkRo 18 tools  
 a: biface  
 b: uniface  
 c,d: utilized BRF's  
 e-n: utilized flakes

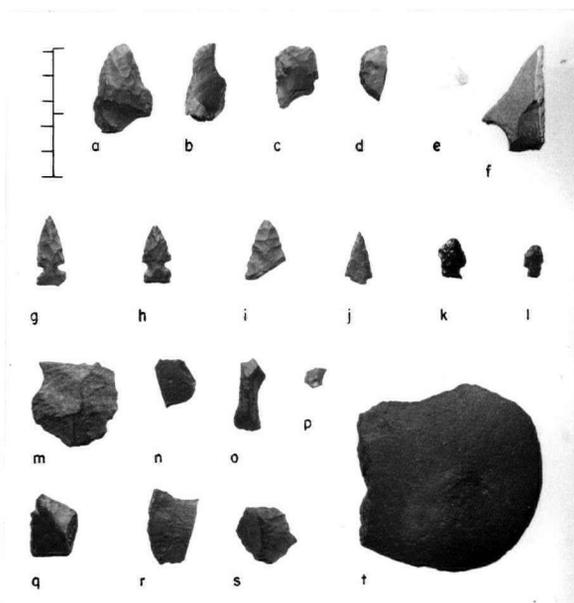


Figure 37 EkRo 31 tools and core  
 a: biface  
 b-e: unifaces  
 f: unimarginal  
 g-l: projectile points  
 m-p: utilized flakes  
 q: pièce esquillée  
 r: graver drill  
 s: bipolar core  
 t: spall tool

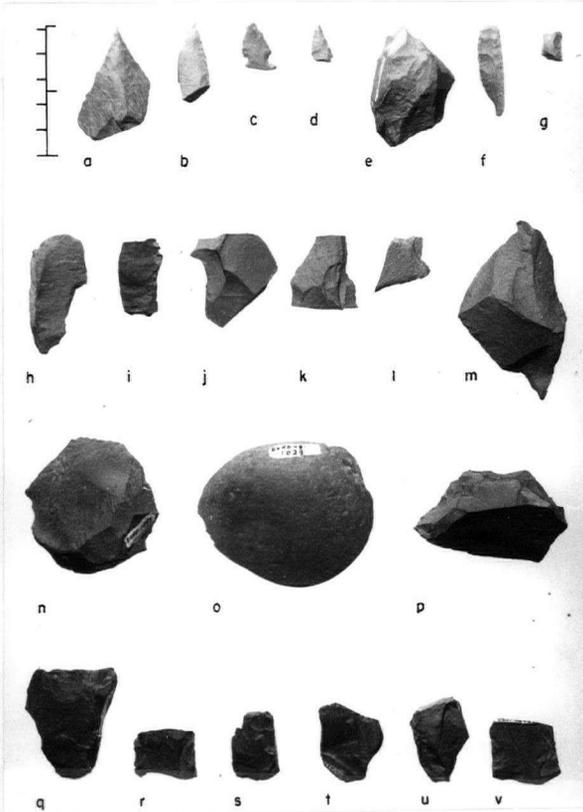


Figure 38 EkRo 48 tools and cores

- a,b: bifaces
- c,d: projectile points
- e,f: unifaces
- g: unimarginal
- h-n: utilized flakes
- o: spall tool
- p: pièce esquillée
- q-v: bipolar cores

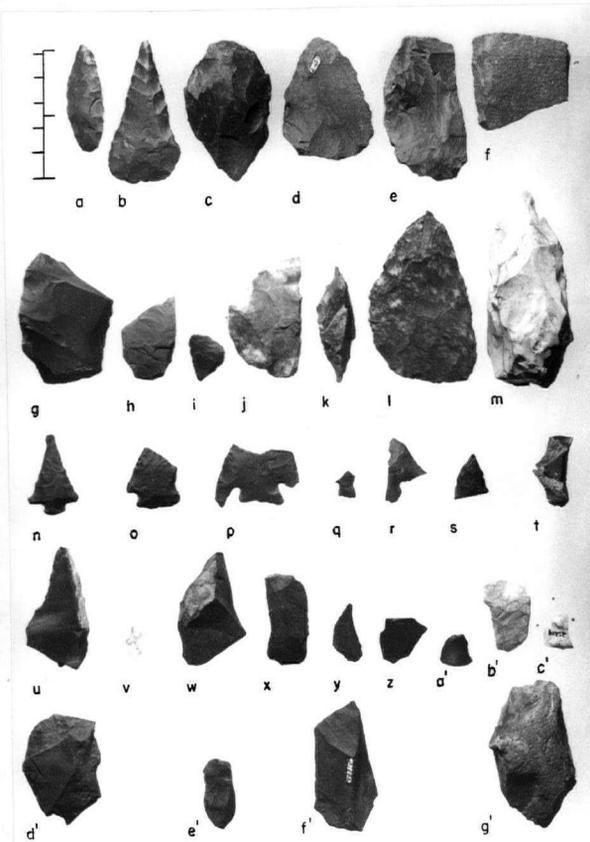


Figure 39 2:3 tools and cores

- a-m: bifaces
- n-s: projectile points
- t: uniface
- u-v: unimarginal
- w-c': utilized flakes
- d'-g': bipolar cores

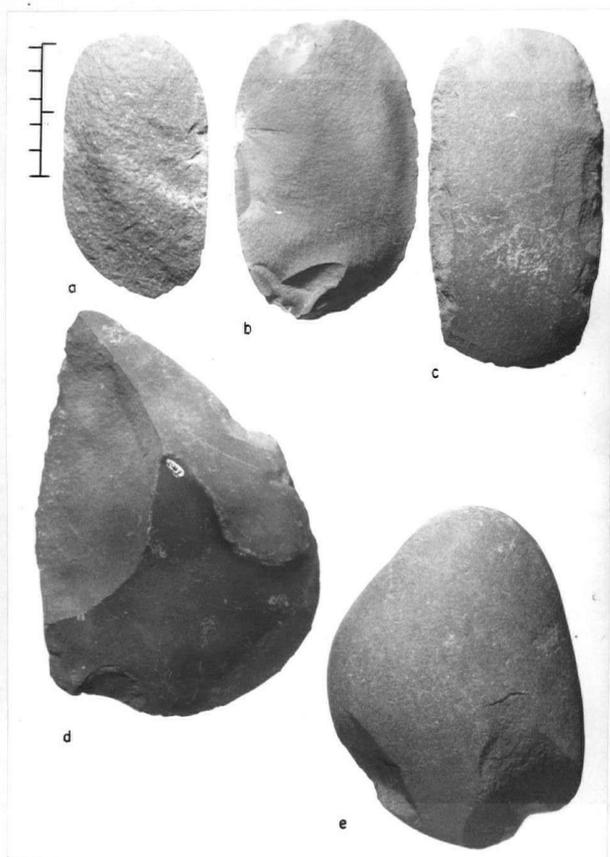


Figure 40 2:3 tools  
 a-d: spall tools  
 e: core tool

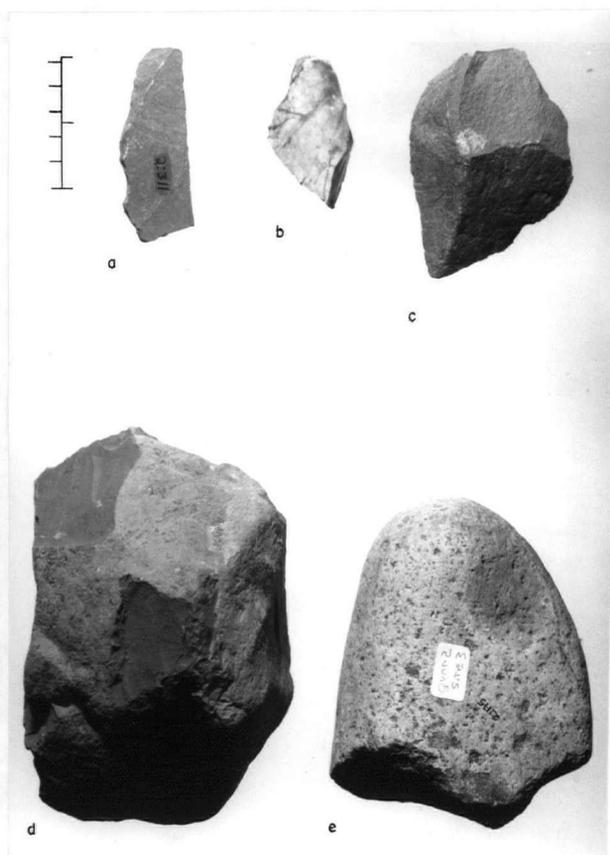


Figure 41 2:3 tools and cores  
 a-d: cores  
 e: core tool

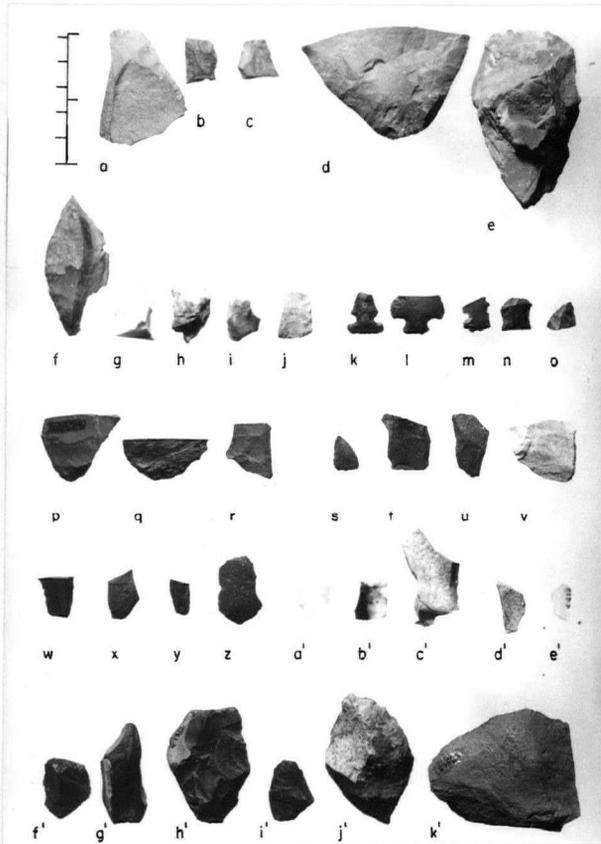


Figure 42 4:2 tools and cores

- a-j: bifaces
- k-o: projectile points
- p-r: uniface
- s-v: unimarginals
- w-e': utilized flakes
- f': utilized BRF
- g'-h': bipolar cores
- i': pièce esquillée
- j': core
- k': spall tool

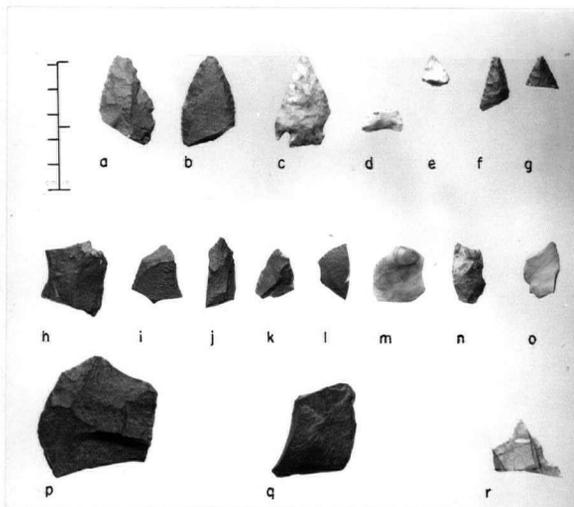


Figure 43 4:5 tools and cores

- a, b: bifaces
- c-g: projectile points
- h-o: utilized flakes
- p, q: bipolar cores
- r: graver/drill

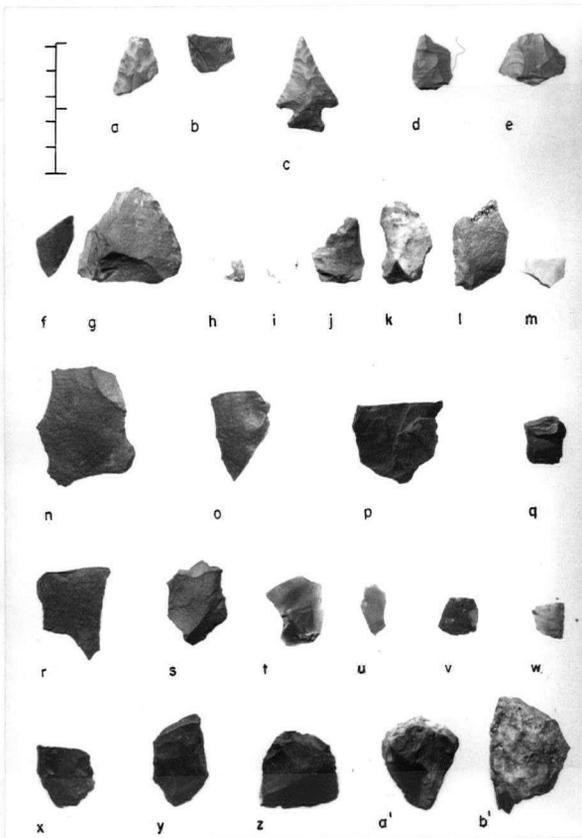


Figure 44 4:1 tools and cores

- a,b: bifaces
- c: projectile point
- d,e: utilized BRF's
- f-k: unifaces
- l,m: unimarginals
- n-w: utilized flakes
- x-z: bipolar cores
- a',b': cores

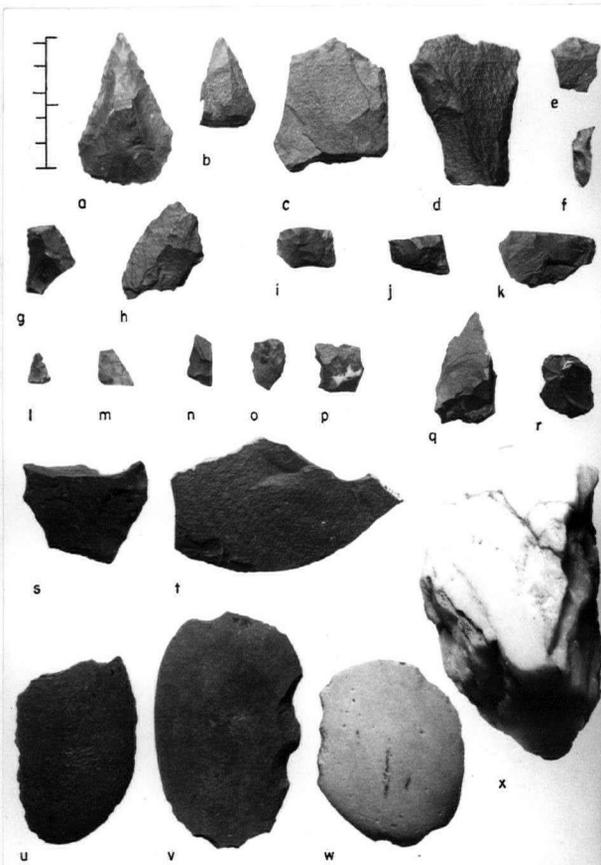


Figure 45 5:1 tools and cores

- a-f: bifaces
- g,h: bimarginals
- i-k: pièces esquillées
- l,m: projectile points
- n-p: utilized flakes
- q,r: bipolar cores
- s,t: unifaces
- u-w: spall tools
- x: core tool

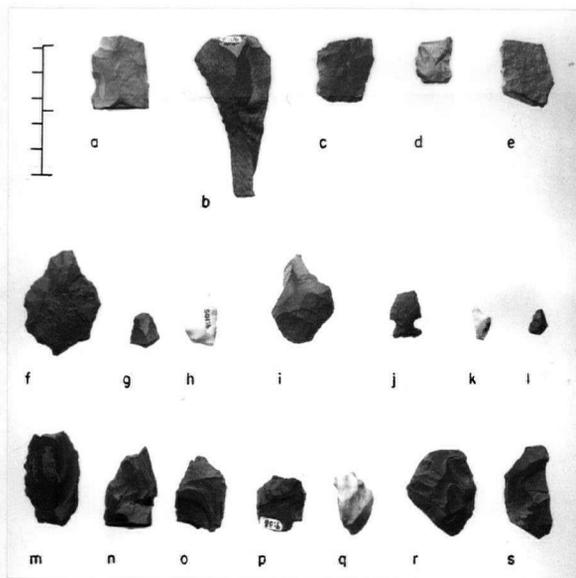


Figure 46 9:1 tools and cores

- a: lanceolate biface
- b-d: bifaces
- e: bimarginal
- f,g: unifaces
- h: unimarginal
- i: utilized flake
- j-l: projectile points
- m-s: bipolar cores

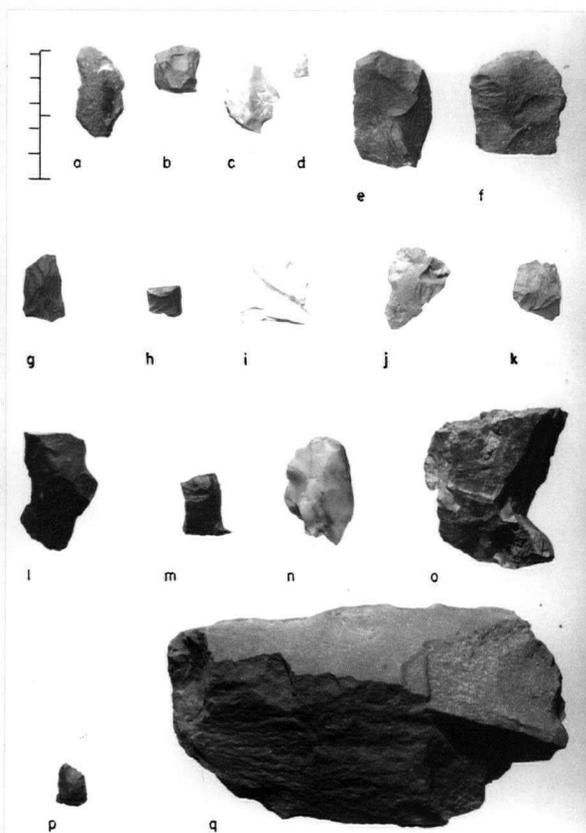


Figure 47 9:2 tools and cores

- a-d: bifaces
- e,f: unifaces
- g-j: utilized flakes
- k: utilized BRF
- l-n: bipolar cores
- o: core
- p: graver/drill
- q: core tool

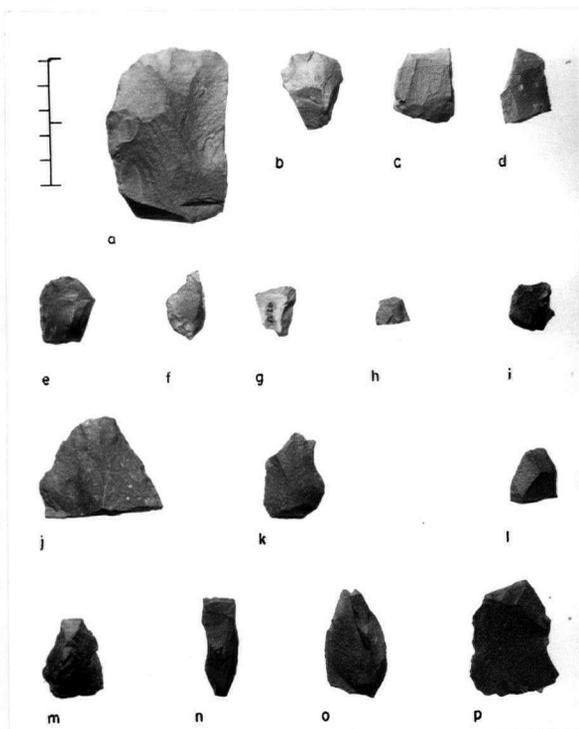


Figure 48 12:6 tools and cores

a-h: bifaces

i: pièce esquillée

j,k: unifaces

l: utilized flake

m-p: bipolar cores

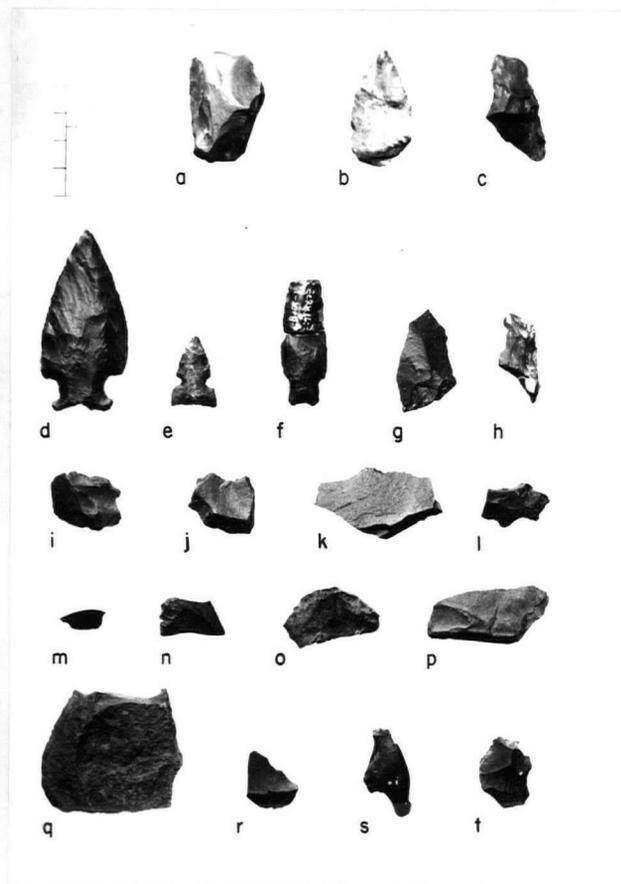


Figure 49 EeRk 16 tools  
 a-c: bifaces  
 d-f: projectile points  
 h: uniface  
 i-p: utilized flakes  
 q: spall tool  
 r-t: utilized BRF's

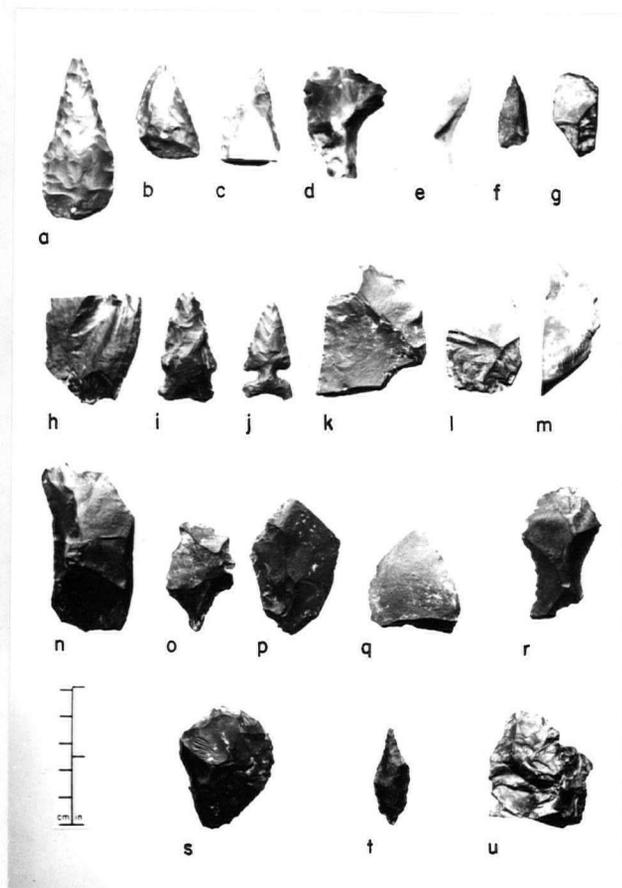


Figure 50 EeRl 41 tools and  
 cores  
 a: large biface  
 b-g: bifaces  
 h: bimarginal  
 i, j: projectile points  
 k: unimarginal  
 l, m: unifaces  
 n-r: utilized flakes  
 s: endscraper  
 t: graver/drill  
 u: bipolar core

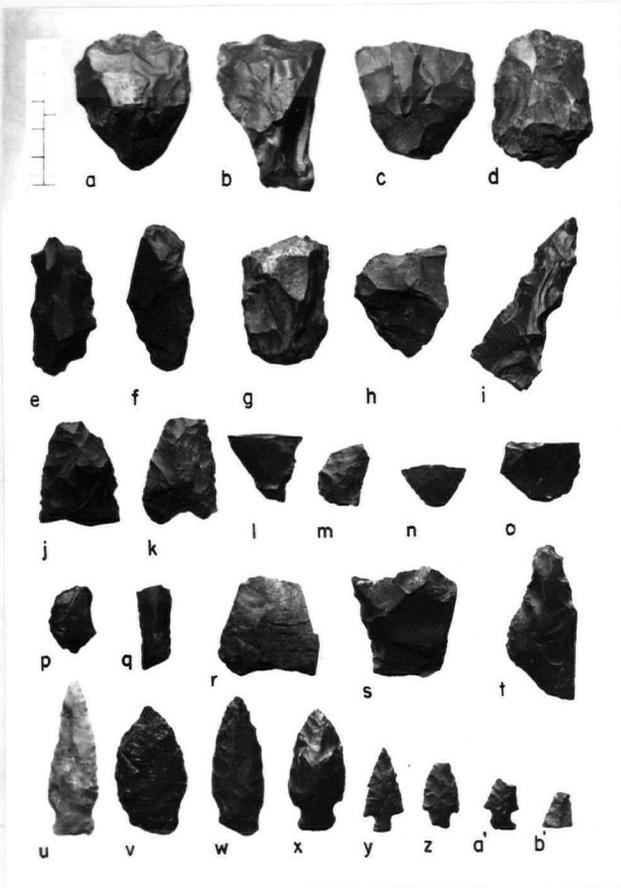


Figure 51 EeRk 7 tools  
 a-d: large bifaces  
 e-t: bifaces  
 u-b': projectile points

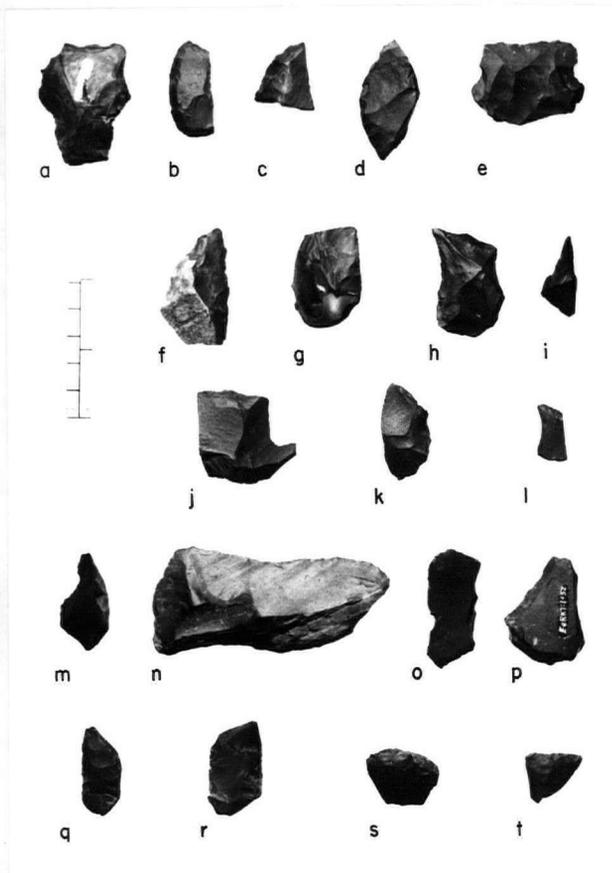


Figure 52 EeRk 7 tools  
 a-l: unifaces  
 j-l: unimarginals  
 m-p: utilized flakes  
 q-t: pièces esquillées

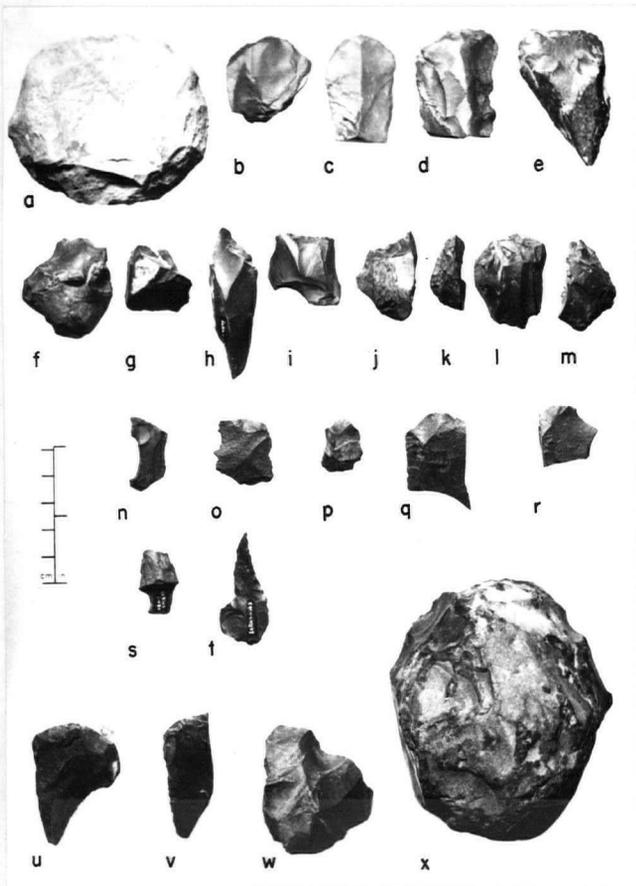


Figure 53 EeRk 7 tools and cores

- a: spall tool
- b-e: endscrapers
- f-m: bipolar cores
- n-r: utilized BRF's
- s,t: graver/drill
- u,v: utilized BRF's
- w,x: cores

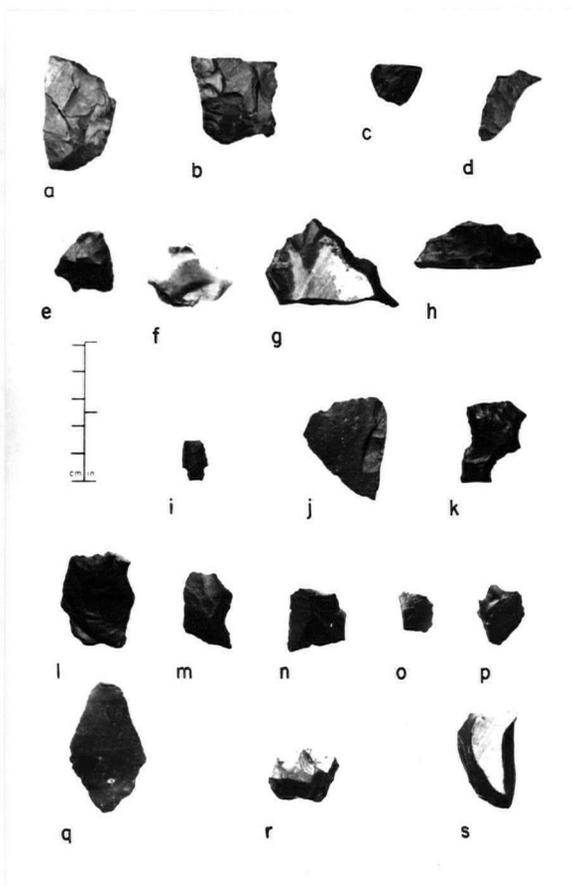


Figure 54 EeRk 4:38 tools and cores

- a-h: bifaces
- i: projectile point
- j-k: unifaces
- l-p: utilized flakes
- q: utilized BRF's
- r,s: bipolar cores

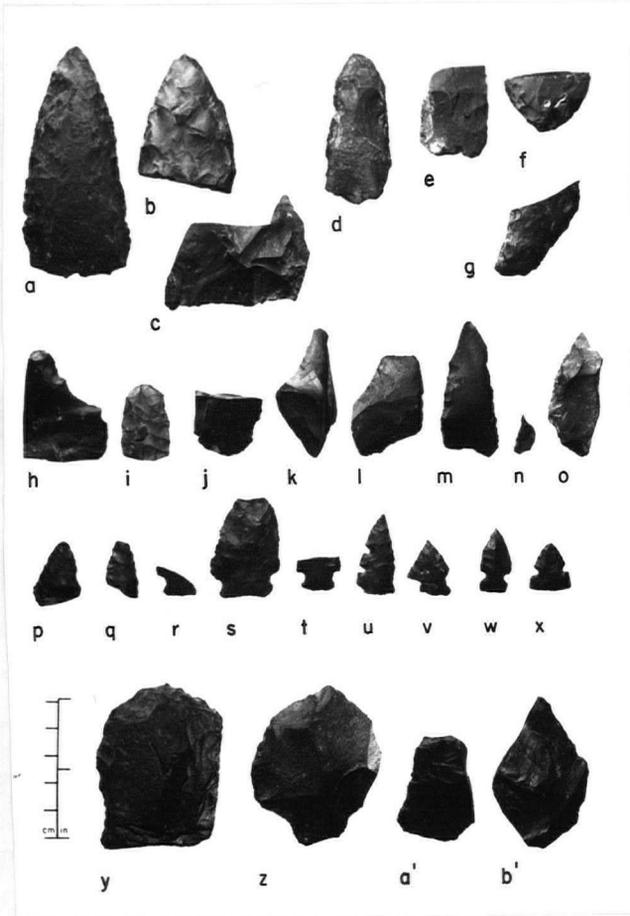


Figure 55 EeR1 40 tools  
 a-c: large bifaces  
 d-k: bifaces  
 l-o: bimarginals  
 p-x: projectile points  
 y-b': unimarginals

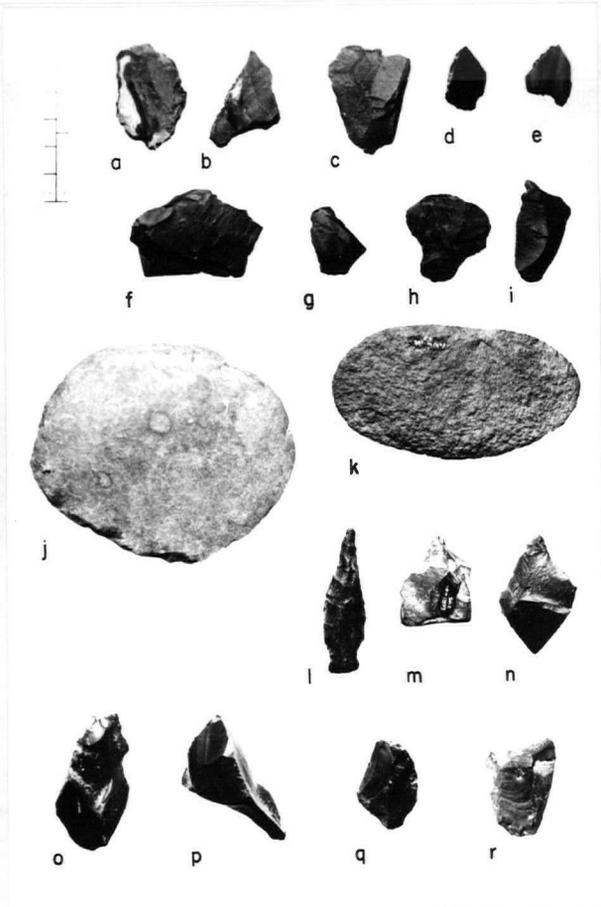


Figure 56 EeR1 40 tools and  
 cores  
 a-i: utilized flakes  
 j,k: spall tools  
 l-n: graver/drills  
 o-r: bipolar cores

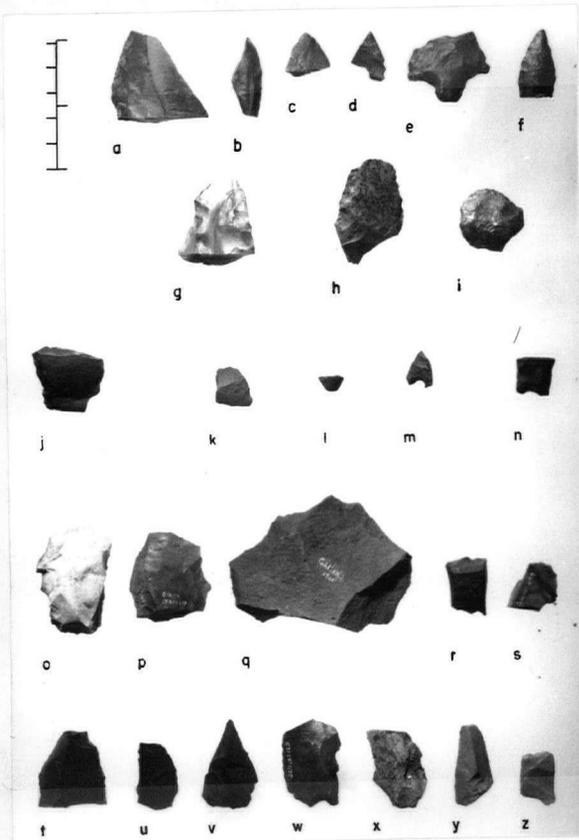


Figure 57 G21:9 tools  
 a-i: bifaces  
 j-l: bimarginals  
 m: projectile point  
 n: lanceolate biface  
 o-q: unifaces  
 r,s: unimarginals  
 t-z: utilized flakes

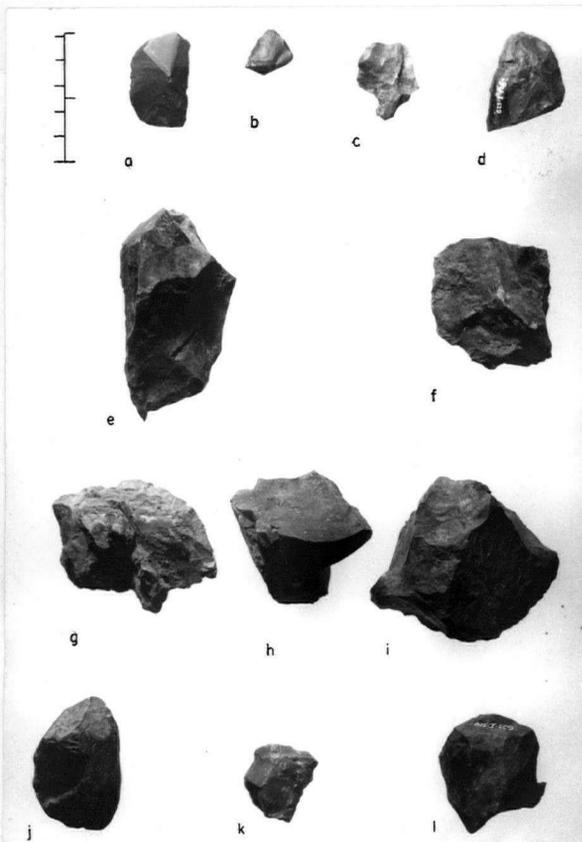


Figure 58 G23:1 tools and cores  
 a,b: bifaces  
 c,d: unifaces  
 e-i: cores  
 j-l: bipolar cores

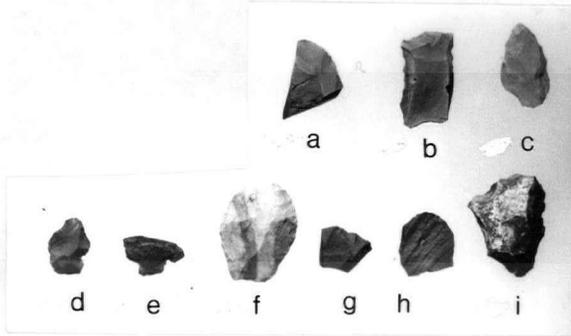


Figure 59 G2:12 tools and cores

- a-c: bifaces
- d,e: projectile points
- f: endscraper
- g: uniface
- h: utilized flake
- i: bipolar core

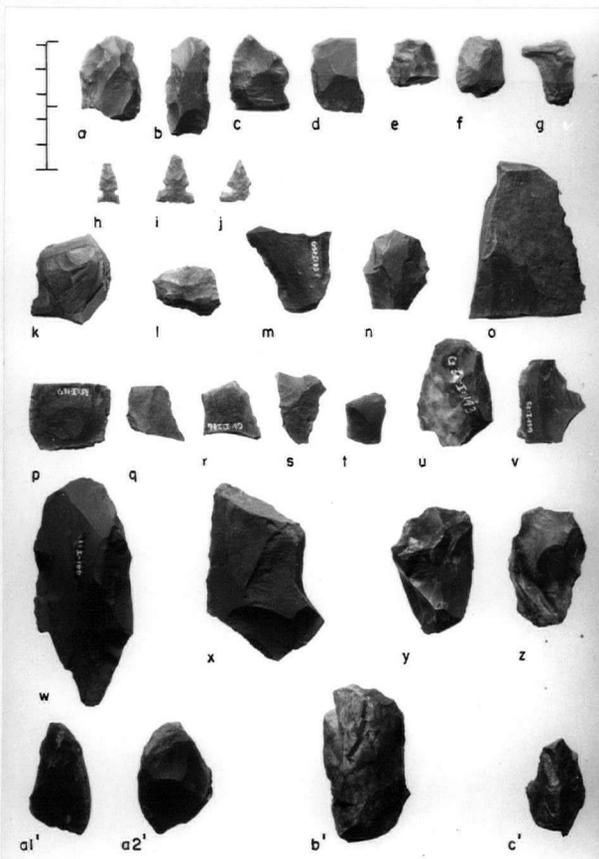


Figure 60 G31:1 tools and cores

- a-g: bifaces
- h-j: projectile points
- k-o: unifaces
- p-v: utilized flakes
- w-z: cores
- a'-c': bipolar cores

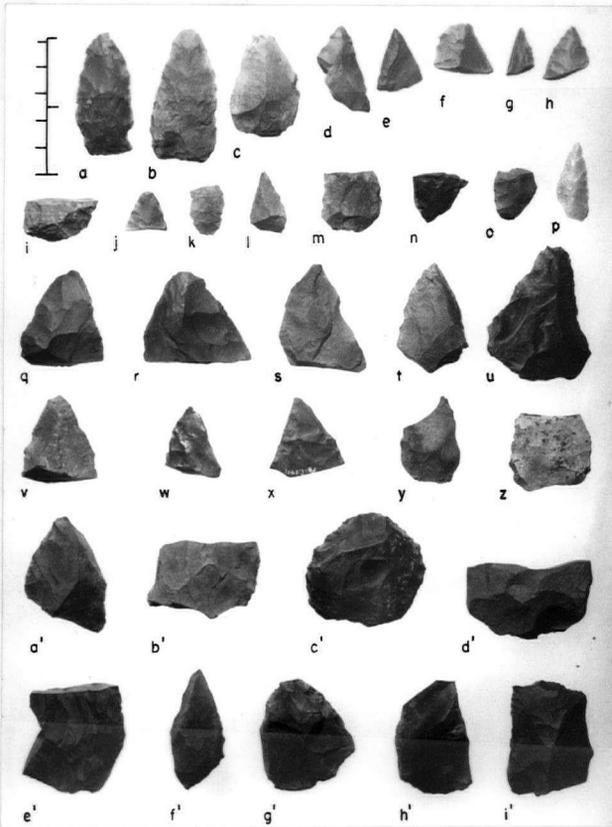


Figure 61 F8:1 tools  
a-i': bifaces

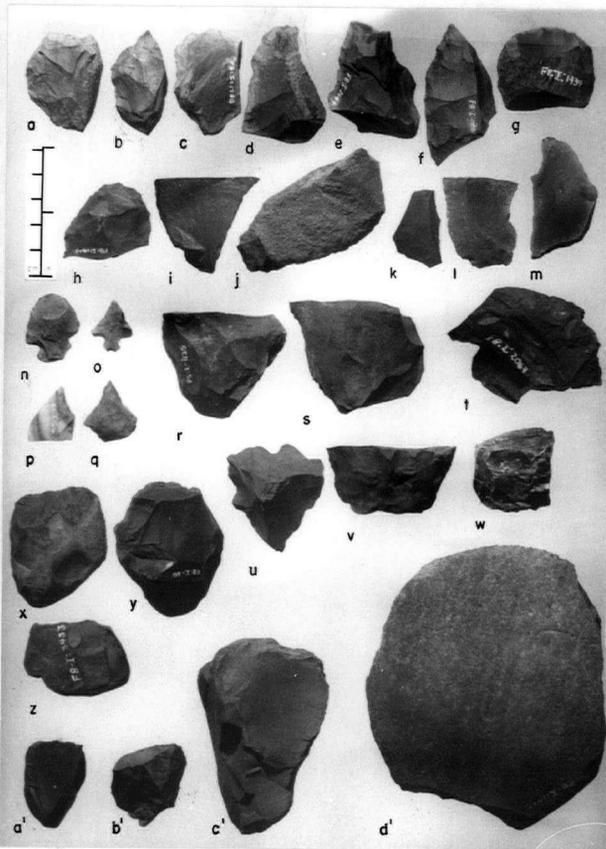


Figure 62 F8:1 tools and cores  
a-h: bifaces  
i,j: unimarginals  
l,m: utilized flakes  
n,o: projectile points  
p,q: graver/drills  
r-w: cores  
x-c': bipolar cores  
d': spall tool

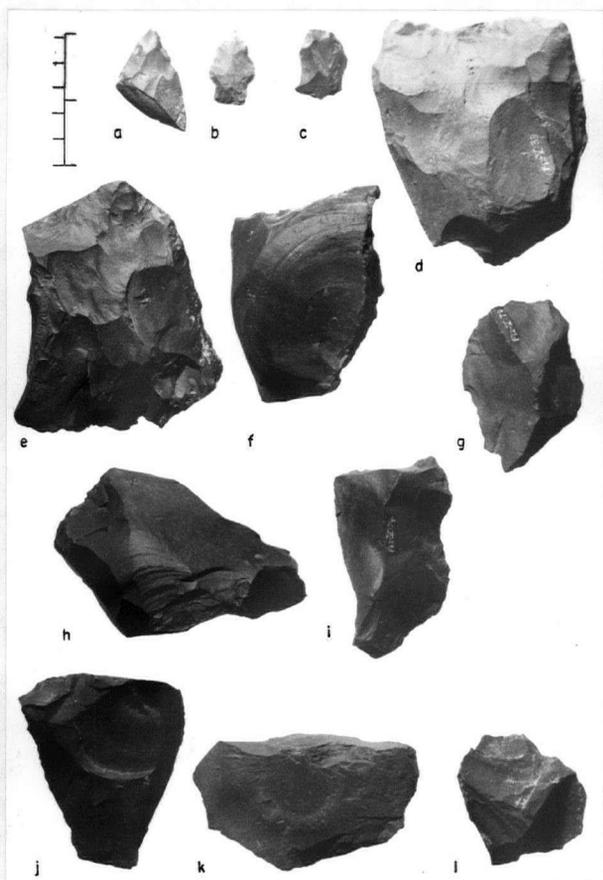


Figure 63 F12:5 tools and  
cores  
a: biface  
b: projectile point  
c: utilized BRF  
d: large biface  
e,f: large unifaces  
g: core  
h-l: bipolar core



Figure 64 J22:2 tools  
a: projectile points  
b: unimarginal

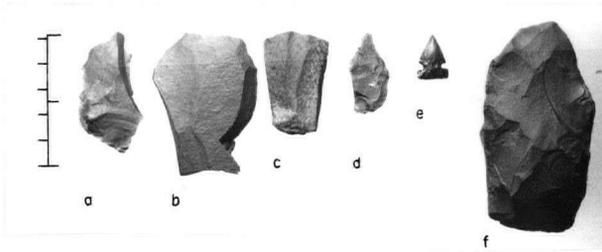


Figure 65 J38:2 tools and cores  
 a-c: bifaces  
 d,e: projectile points  
 f: core

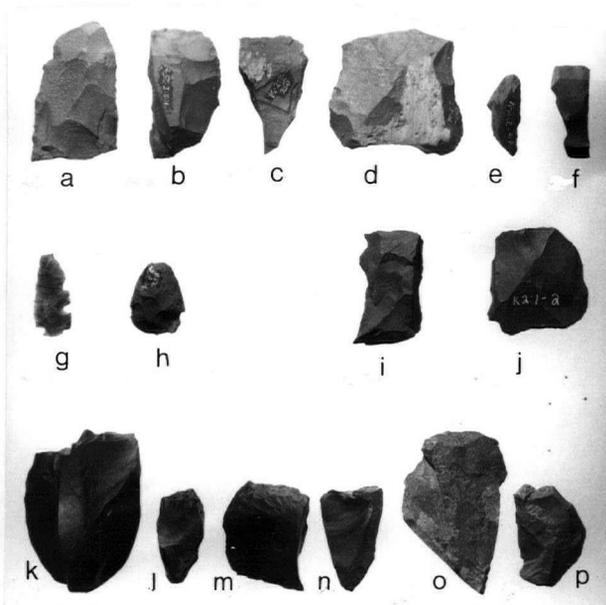


Figure 66 K2:1 tools and cores  
 a-f: bifaces  
 g,h: projectile points  
 i: uniface  
 j: utilized BRP  
 k-p: bipolar cores

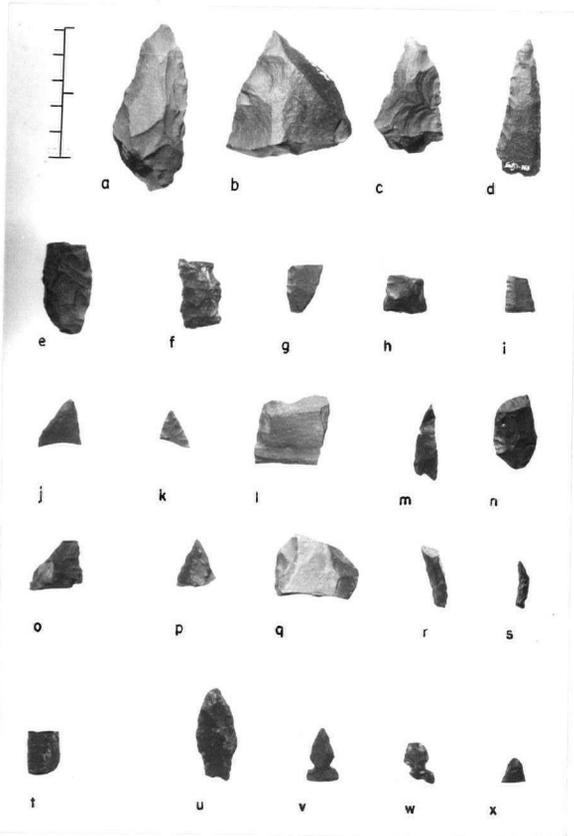


Figure 67 EeRj1 tools  
 a-s: bifaces  
 t: bimarginal  
 u-x: projectile points

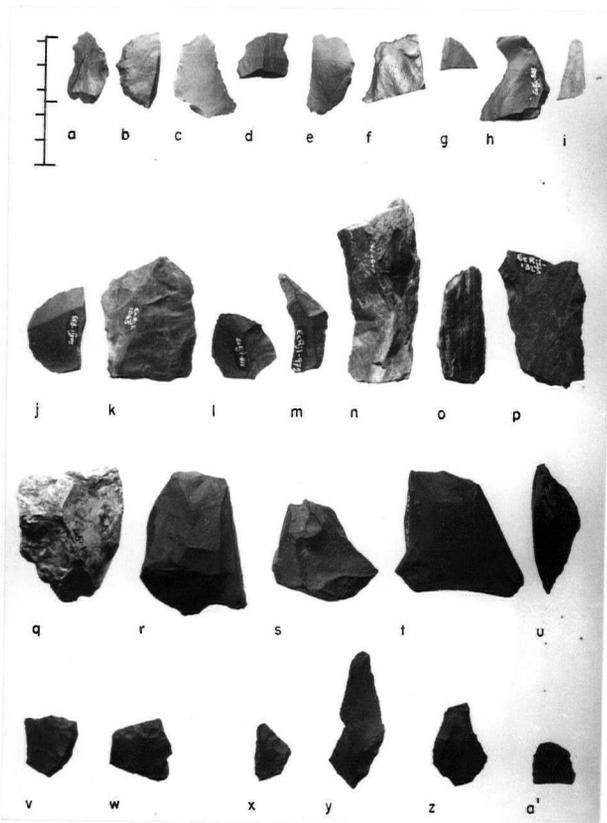


Figure 68 EeRj 1 tools and cores  
 a-p: utilized flakes  
 q: core  
 r-u: bipolar cores  
 v-w: pièces esquillées  
 x-a': utilized BRF's

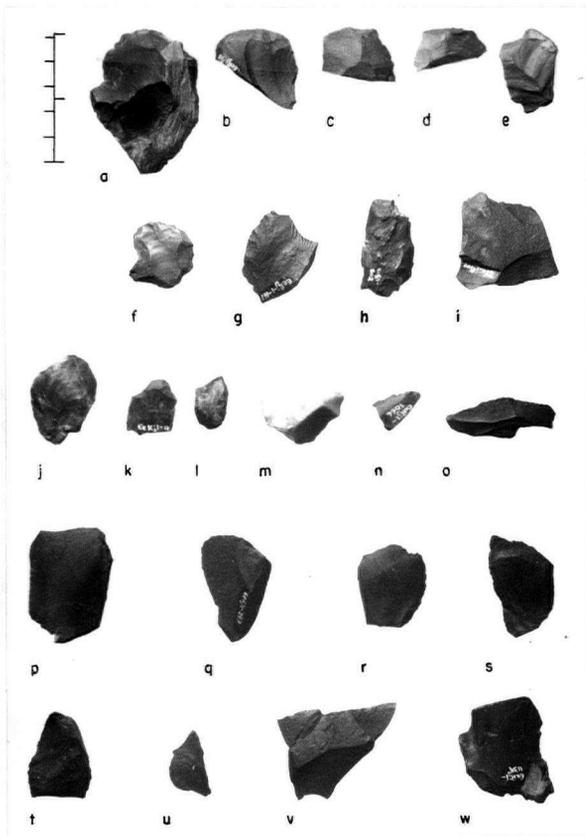


Figure 69 EeRj! tools  
 a-i: unifaces  
 j-o: unimarginals  
 p-w: utilized flakes

## CHAPTER 6

## A MULTIREGIONAL PERSPECTIVE ON LITHIC ASSEMBLAGE VARIABILITY

6.1. Introduction

The theoretical frameworks developed by Binford (1979), Ebert (1979), Goodyear (1979) and Pokotylo (1978) provide the behavioral perspective within which the analyses in this chapter are undertaken. The analyses seek an understanding of the basic causes of lithic assemblage variability in the central and southern Interior Plateau, through the derivation of consistent multivariate and bivariate patterns from which technological strategies can be inferred. The analyses proceed by exploring inter-assemblage variations with respect to major factors thought to determine the character of lithic technological practices, including stages of lithic reduction, kinds of raw materials, tool maintenance, and tool and debitage co-occurrences within major settlement site types.

Three general hypotheses are tested in the following analyses of the context and lithic content of the 38 assemblages from the four regions of study. This part of the study evaluates the utility of the debitage classification that has been formulated in the experimental program of this study as a useful and reliable means of inferring lithic technological strategies that were employed by the prehistoric residents of the central and southern Interior Plateau.

The following hypotheses have been formulated on the basis of the current models of lithic technology and settlement patterns that have been developed by Binford (1979), Ebert (1979) and Goodyear (1979), discussed at length in Chapter 2:

1. Obsidian and chert raw materials exhibit variability that is the result of extensive economizing practices. This is expected because these materials are relatively rare or completely absent within the regions of study, while vitreous basalt is the dominant raw material within all of the regions.
2. Regardless of the importance of raw material factors, lithic maintenance practices are important determinants of the variability of assemblages. These should be emphasized differentially among sites within and across regions.
3. General site occupation purposes across the four regions can be reliably predicted on the basis of debitage and tool co-variations.

#### 6.2. Reduction Factors

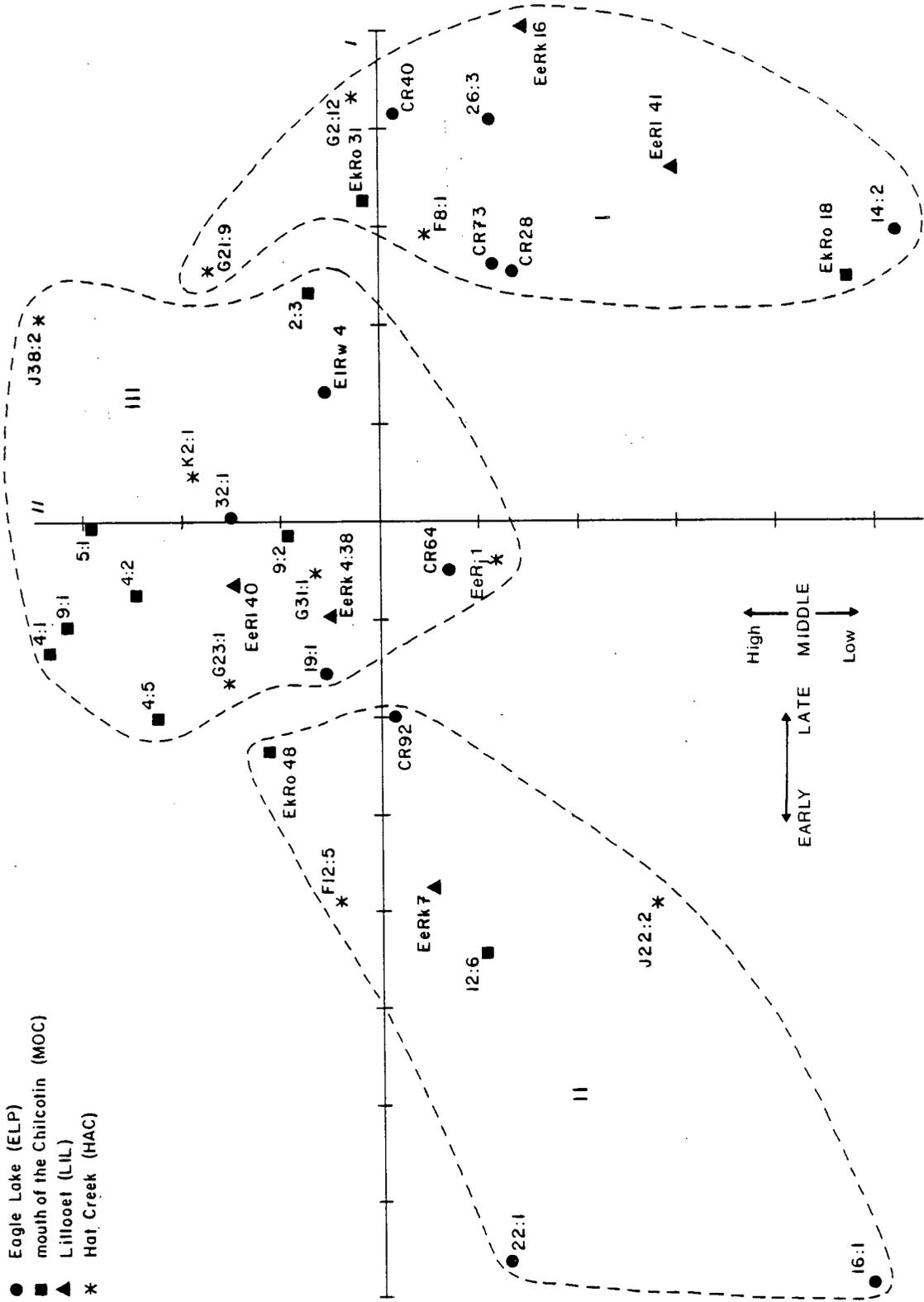
The major issue of inferring lithic technological behavior by means of reduction stage measures of lithic debitage is best answered in a multivariate manner, to derive major factors of variability, from data that can be partitioned in many ways.

In the present case, it is major patterns of inter-assemblage variability that are sought (see Matson 1980), and individual assemblage inferences are offered only after the entire set of hypotheses has been evaluated.

There exist many possible ways of computing similarities between assemblages, including various correlation coefficients and similarity and difference measures (see Sneath and Sokal 1973). I selected a City Block distance measure calculated on standardized percentages of the 10 debitage classes within each assemblage (Table 12). Percentage calculations are necessary because variable sampling rates and wide variation in sample size would otherwise automatically severely bias the analysis. Visual groupings and data reduction or "factoring" are accomplished by first clustering the sites, using Ward's Error Sum of Squares method (Sneath and Sokal 1973), an algorithm option available in a package of cluster routines developed by Wood (1973). The City Block distance matrix was also factored by Metric Multidimensional scaling (Matson 1978; Matson and True 1974; Torgerson 1958), following standardization of the percentage data, in which the mean of each variable becomes zero with a standard deviation of one. It is important that what is being reflected in the multivariate analysis is generalized reduction stage patterning and not sheer abundance of material. Standardization was conducted on the percentage data to emphasize variability within site units, rather than within the debitage variables, because inter-site patterns are being sought

(Sokal and Sneath 1973: 178). When this is done, the problem with size factor biases that is prevalent in scaling and ordination techniques is greatly reduced (Sokal and Sneath 1973: 178). Both the cluster and scaling analyses are conducted in Q-mode fashion where the site cases are grouped on the basis of the debitage variables. For detailed discussion of clustering and scaling techniques, including those used here, see Matson and True (1974), Matson et al. (1979), Matson et al. (1980) and Pokotylo (1978).

The cluster diagram is not reproduced here, but the three major clusters derived in that analysis are shown in the TSCALE plot of the first two dimensions of variability (Figure 70). To interpret the major factors of variability, rank-order correlation coefficients (Spearman's  $r$ ), are computed on the debitage classes' percentages against the position of the assemblages on the dimensions. This reveals that Dimension I accounts best for the amount of late stage debitage in sites, of PRB and Shatter percentages combined ( $r_s = 0.95$ ), and Dimension II is explained by the percentage of combined PRB and Shatter middle stage debitage ( $r_s = 0.76$ ). Both of these correlations are significant at  $p = .005$ . These two dimensions account for 47% and 22% of Trace variability in the data overall. The remaining 31% of Trace requires a further four dimensions, none of which is readily interpretable in terms of the reduction classes. It is notable also in this metric solution, that no triangle inequalities (Anderberg 1973) were violated, adding to the confidence in the interpretations. The solution shows that if general inter-



- Eagle Lake (ELP)
- mouth of the Chilcolin (MOC)
- ▲ Lillooet (LIL)
- \* Hal Creek (HAC)

Figure 70. Torgerson's Metric Multidimensional Scaling of debris class percentages, City Block Distance. Dimension 1 accounts for 47% of Trace, Dimension 2 for 22%. Broken lines indicate Ward's clusters.

assemblage variation is being investigated, it is feasible to reduce the 10-state debitage classification somewhat, to the two major factors of early/late and middle, but it also indicates that general variability in BRF's, BPO's, BPCO's and CORES is harder to account for, and thus these classes should be retained.

The sites from all four regions are distributed across the scaling diagram, with the Eagle Lake sites appearing to exhibit most variability, ranging from 3.23% late debitage to 54.54%, 12.9% to 35.94% middle debitage, and 16.24% to 83.68% early debitage. The Mouth of the Chilcotin sites are also highly variable, ranging from 0% to 35.38% late, 16.92% to 45.88% middle, and 19.23% to 41.67% early stage material. Among the Lillooet sites, variability is constrained, perhaps because only five assemblages are represented, but these are still quite varied in content, with reduction ranges of 12.92% to 62.50% late, 20.83% to 41.53% middle and 16.67% to 49.5% early stage debitage. Among the Hat Creek assemblages, a great deal of variability is also exhibited, with the sites having reduction ranges of 8.33% to 44.04% late, 25.0% to 47.83% middle, and 14.67% to 58.43% early reduction stage items.

Sites 16:1 and 22:1 from Eagle Lake are the extreme cases of early reduction sites. These are low frequency debitage assemblages with large flakes and cores. Sites 14:2, CR28, CR40, CR73 and 26:3 from Eagle Lake are all at the late stage end of the TSCALE diagram. These assemblages have no cores, and are small collections. Site CR92, while within the "early" cluster, is clearly more related to

site 19:1 and sites CR64, 32:1 and ElRw 4. These sites, except for CR64 and 32:1, have relatively abundant artifacts, some cores and/or bipolar cores, and while not exceptionally high on the middle reduction stage scale, exhibit broader spreads of the relative percentages of the debitage classes.

The Mouth of the Chilcotin patterns are different from the ELP case. Here site 12:6 is clearly by itself, with a small assemblage containing a relatively large number of bipolar cores and no late stage debitage at all. EkRo 48 and 9:2 are split in the cluster analysis, but in the TSCALE diagram are related to each other perhaps more than to the group of sites 4:2, 4:5, 5:1 and 9:1. All of these sites exhibit wide ranges of reduction stages within their assemblages, and have cores and/or bipolar cores, but the five latter sites are clearly very similar in most respects, and especially in the high amounts of middle stage debitage present. Sites EkRo 18, EkRo 31 and 2:3 have predominantly late stage trends, however 2:3 contains the greatest percentage of CORES of all of the MOC assemblages.

The five Lillooet assemblages occur in three separate clusters. EeRk 7 emphasizes early stages and has a very abundant assemblage that contains cores, bipolar cores and bipolar flakes in relatively large quantities. EeRl 40 and EeRk 4:38 contain relatively low amounts of late stage debitage, high middle stage percentages, and moderately high early stage percentages of debitage. Both sites have bipolar cores and flakes, but no hand-held cores. EeRl 41 and

EeRk 16 are most interesting, with very little early, and relatively large amounts of late stage debitage. These two sites also contain relatively few core materials.

Among the Hat Creek sites, J22:2 and F12:5 are similar early stage-predominant lithic scatters, both with very little late stage material, but each is very different from the other in terms of actual abundance of total debitage. Sites EeRj 1, G31:1, G23:1, K2:1, and J38:2 all occur within the "middle" stage cluster, but are widely spaced within it. EeRj 1 is relatively low on the middle scale, and J38:2 is the highest middle stage content assemblage of the entire 38 sites. J38:2 also contains a fair amount of late stage material, and has the highest number of CORES for all Hat Creek sites. Sites G21:9, F8:1 and G2:12 are the late stage sites from Hat Creek, with F8:1 being the odd one here with several cores and bipolar cores.

On the whole, the sites clustering in the "middle" cluster have more-or-less evenly spread debitage stage distributions; those in the "early" cluster and in the "late" cluster have more restricted patterns. Most sites in association with late stage reduction have biface reduction flakes, although these range from being relatively common to being completely absent. The following sites are outstanding with regard to the high percentages of BRF's contained in their assemblages: CR40 at ELP, EkRo 18 at MOC, K2:1 and EeRj 1 at HAC, and none are outstanding in the LIL sample.

The assemblages' major patterns of reduction stage variability

can be interpreted as emphasizing early/core reduction, middle/wide range and late/maintenance. When the sites are grouped with respect to these interpretations and by their context, several interesting patterns are apparent (Table 15). No housepits exhibit the extreme of early stage predominance in their assemblages (except possibly EkRo 48), but the 10 excavated housepit assemblages are split between middle/wide ranging and those with late/maintenance predominance. Lithic scatters without features are spread among the three major reduction factors, but other lithic scatters are more limited in content. Lithic scatters with housepits include both early/core reduction and middle/wide ranging assemblages, but only one of these is an early/core reduction type of site. The lithic scatters with cachepits and those with firecracked rock features are spread among the middle/wide ranging factor and the late/maintenance factor.

At this stage of the analyses, the debitage classification appears to have considerable ability to reveal basic patterns of lithic technological processes of assemblage formation. It should be noted here that the patterns revealed among the Hat Creek sites do not completely agree with Pokotylo's (1978a) interpretations of the six sites here that were included in his study. One reason for this apparent discrepancy is that the debitage classification employed in this study is much more definite in its assignment of debitage to stages, whereas Pokotylo's inferences depended on choosing patterns from several variables (1978: 250 - 258).

## ASSEMBLAGE CONTEXT

	Excavated Housepits	Lithic Scatters	Lithic Scatters with Housepits	Lithic Scatters with Cachepits	Lithic Scatters with Firecracked Rock
EARLY/ CORE		16:1 22:1 F12:5 J22:2	12:6		
MAJOR REDUCTION FACTOR MIDDLE/ WIDE RANGE	EkRo 48 EeRk 7 EeRk 4:38 EeRl 40 EeRj 1	4:2 4:5 G23:1 G31:1 K2:1	32:1 E1Rw 4 4:1 5:1 9:1 9:2	19:1 CR92 2:3	CR64 J38:2
LATE/ MAINTEN- ANCE	CR73 EkRo 18 EkRo 31 EeRk 16 EeRl 41	14:2 G21:9 G2:12		26:3	CR28 CR40 F8:1

TABLE 15. Assemblage context compared with major reduction factors.

In a cluster analysis of Hat Creek debitage assemblage attributes, Pokotylo found four of the six sites to occur in a cluster (Cluster 3) interpretable as exhibiting a "wide range" of reduction steps, with no one stage predominating (F8:1, F12:5, G21:9, G2:12). In this study, G21:9, G2:12, and F8:1 appear to contain debitage indicative of late stages. Sites G23:1 and G31:1 are not as extreme in diversion from Pokotylo's findings, in that both here are understood to contain middle stage debitage, and in the purely Hat Creek study both are "wide ranging", with G23:1 trending towards late steps (Pokotylo 1978: 250 - 258). In sum, I think the danger of using large attribute lists is that factors other than reduction stage are being measured, such as core geometry and raw material characteristics. In fact I think it feasible to eventually use other flake morphological characteristics such as platform angles and size variables to reconstruct core and tool shapes, and this is certainly an area where concise experimentation and mathematical derivation is required.

### 6.3. Hypothesis 1: Raw Material Factors

Since vitreous basalt is widely recognized as having been the primary lithic raw material that was used in stone tool manufacture in the Interior Plateau, other raw materials such as cherts and obsidians may have been differentially conserved, or used in different manners, simply by virtue of their relative regional scarcity.

This possibility is worth investigating for what it can tell us about hunter-gatherer mobility, given the arguments of Binford (1979) and Goodyear (1979) discussed in Chapter 2. In this study, I cannot control for precise source locations of any raw materials, although in a separate paper (Magne 1979) I have discussed raw material occurrence in Upper Hat Creek Valley.

Generally, throughout the Interior Plateau, basalt, either vitreous or granular, is found as cobbles in glacial tills or in stream beds. Apparent concentrations of good quality basalt, such as in the Arrowstone Hills east of the Hat Creek Valley, or in the Baezeko River of the north-central Interior, have yet to be studied with a combined geological and archaeological perspective. Within British Columbia, obsidian is known to have two main sources, Mount Edziza in the far northwest (Fladmark 1982b), and Obsidian Creek near Anahim Peak in the central Interior (Nelson and Will 1976). The obsidian materials studied here from the Eagle Lake region are believed to have originated from the Obsidian Creek area, but this is based on macroscopic characteristics, and source studies have not been undertaken. The very few obsidian pieces from the Mouth of the Chilcotin were sourced by X-Ray fluorescence, and probably came from the Obsidian Creek source area. Obsidian is present, but very rare, in sites from the Lillooet and Hat Creek regions. However, it does not occur in any of the assemblages studied here. Chert raw materials occur both as stream and glacial till cobbles, and as outcrops. In the Hat Creek Valley re-

gion, outcrops occur in the northern and eastern parts of the region, in association with jaspers and agates that are actively mined by rockhounds (Danner 1970; Leaming 1971). It is notable that in the Cache Creek streambed east of Hat Creek, both chert and basalt cobbles can be obtained. A comprehensive study of lithic raw material sources of the Interior Plateau is urgently needed, to provide fixed geographical loci from which the spread of materials can be studied, such as Choquette (1981) has initiated in the Kootenay district of southeastern British Columbia.

The proposition that differences in debitage and tool assemblage variability are due to raw materials is tested here, by comparing vitreous basalt to obsidian at Eagle Lake, and to chert at the Mouth of the Chilcotin, Lillooet and Hat Creek. Granular basalts are not tested for differences, since these are already recognized. Granular basalt occurs almost solely as early stage debitage, and in restricted tool classes such as spall tools and core tools. As can be seen in Tables 16 and 17, this raw material comprises most of the 16:1 and 22:1 assemblages (89% and 99%), which are considered predominantly early/core reduction sites, based on the scaling analysis of debitage. Site CR64 contains a moderate amount of granular basalt, as do sites 19:1, CR92 and CR73. Among the Mouth of the Chilcotin sites, EkRo 48 debitage is 95% granular basalt and the other two housepits lack it entirely. Sites 2:3, 5:1 and 9:1 contain moderate amounts of the material. With in the Lillooet and Hat Creek sites, only one assemblage in each re-

gion (EeR1 41 and K2:1) contains a minimal amount of granular basalt (Tables 16,17).

The first question to ask is: Are obsidian and chert conserved? If so, according to Binford's (1979) and Goodyear's (1979) models, then these materials should be late stage debitage more often than vitreous basalt. This question is addressed by Chi-square tests of independence in contingency tables (Mendenhall 1975), where the flakes of each material are grouped into the general early, middle and late stage classes (Tables 18,19, 20, 21). The tests show that among the Eagle Lake, Lillooet and Hat Creek assemblages, there are no significant differences in the stage distribution of debitage by vitreous basalt or obsidian/chert materials. In the Mouth of the Chilcotin sample there are significant differences, and vitreous basalt is brought to late stages proportionately more often than the chert debitage, and the chert materials occur proportionately more often as early stage than is to be expected. Thus it is apparent in the debitage, that obsidian and chert are not extensively maintained, and that in the Mouth of the Chilcotin region, there is a tendency to maintain vitreous basalt, such that it is brought to late stages quite often, while chert materials are used more expediently.

The second question is: Are the patterns of conservation and maintenance evident in the tools left at sites? Again, if chert and obsidian are conserved, then we could expect the tools to be small and complex in relation to those made of vitreous basalt. The tools

		Vitreous Basalt	Granular Basalt	Obsidian	Chert	Quartzite
Eagle Lake	14:2	100	0	0		
	16:1	11.1	88.9	0		
	19:1	61.7	14.9	22.1	1.2	
	22:1	0	98.7	1.2		
	26:3	94.4	1.0	4.6		
	32:1	92.6	1.2	6.2		
	CR28	83.8	0	10.8	5.4	
	CR64	76.9	17.9	5.1		
	CR40	90.6	0	9.4		
	CR73	49.1	9.4	33.9		7.5
E1Rw 4	95.6	0	4.2	0.2		
CR92	70.3	8.8	20.8			
Mouth of the Chilcotin	EkRo 18	63.1	0		36.9	
	EkRo 31	79.1	0	1.6	19.4	
	EkRo 48	4.3	94.7			
	2:3	52.6	21.9		25.4	
	4:2	20.5		.4	79.1	
	4:5	22.2			77.8	
	4:1	40.2	3.4		56.4	
	5:1	78.3	10.8		10.8	
	9:1	70.1	15.7		14.2	
	9:2	42.2			57.8	
12:6	95.0	5.0				
Lillooet	EeRk 16	95.8			4.2	
	EeRl 41	90.9	4.5		4.5	
	EeRk 7	99.5			.1	.4
	EeRk 4:38	94.9			5.1	
	EeRl 40	99.5			.5	
Hat Creek	G21:9	58.8			41.2	
	G23:1	39.0			61.0	
	G2:12	86.0			14.0	
	G31:1	33.2			66.8	
	f8:1	73.3			26.7	
	F12:5	100.0				
	J22:5	100.0				
	J38:2	100.0				
	K2:1	20.2	4.9		74.8	
EeRj 1	76.5			23.5		

TABLE 16. Percent raw material composition of debitage assemblages by counts.

	Site	% Vitreous Basalt	% Granular Basalt	% Obsidian	% Chert	% Other
Eagle Lake	14:2	50.00	50.00			
	16:1	20.00	20.00	60.00		
	19:1	67.86	10.71	21.43		
	22:1		100			
	26:3	75.00				25.00
	32:1	69.23	30.77			
	CR28	100				
	CR64					
	CR40	66.67	16.67	16.67		
	CR73	50.00		25.00		
Mouth of the Chilcotin	ElRw 4	94.74	5.26			
	CR92	67.39	8.70	23.91		
	EkRo 18	76.47			23.53	
	EkRo 31	68.18	18.18	4.55	9.09	
	EkRo 48	35.29	58.82			5.88
	2:3	48.65	22.86		22.86	8.11
	4:2	54.29	5.71		37.14	2.86
	4:5	50.00	12.50		37.50	
	4:1	41.67	12.50		41.67	4.17
	5:1	40.00	40.00		4.00	16.00
Lillooet	9:1	75.00	8.33		16.66	
	9:2	46.15	15.38		38.46	7.69
	12:6	66.67	33.33			
	EeRk 16	85.00	5.00		10.00	
	EeRl 41	79.31			17.24	3.45
	EeRk 7	96.55			1.72	1.72
Hat Creek	EeRk 4:38	90.00			10.00	
	EeRl 40	93.42	1.32		2.63	2.63
	G21:9	57.69	3.85		38.46	
	G23:1	75.00			25.00	
	G2:12	75.00			25.00	
	G31:1	77.27	4.55		18.18	
	F8:1	84.91			13.21	1.39
	F12:5	100				
	J22:2	100				
	J38:2	85.71	14.29			
Hat Creek	K2:1	60.00	40.00			
	EeRj 1	84.06	1.45		14.49	

TABLE 17. Raw material composition of tool assemblages by percentages.

## Debitage General Reduction Stage

		EARLY	MIDDLE	LATE	
Raw Material	Vitreous Basalt	885 (871.55)	844 (843.28)	716 (730.17)	2445
	Obsidian	163 (176.45)	170 (170.72)	162 (147.83)	495
		1048	1014	878	2940
N = 2940		$\chi^2 = 11.07$		p = not significant at .05	

TABLE 18. Chi-square test of Eagle Lakedebitage general reduction stages by raw material.

## Debitage General Reduction Stage

		EARLY	MIDDLE	LATE	
Raw Material	Vitreous Basalt	187 (229.20)	278 (277.34)	228 (186.45)	693
	Chert	451 (408.80)	494 (494.68)	291 (332.55)	1236
		638	772	519	1929
N = 1929		$\chi^2 = 26.58$		p = .05	

TABLE 19. Chi-square test of Mouth of the Chilcotindebitage general reduction stages by raw material.

## Debitage General Reduction Stages

Raw Material	EARLY	MIDDLE	LATE	
	Vitreous Basalt	1869 (1863.45)	1545 (1547.07)	
Chert	4 (9.55)	10 (7.93)	7 (3.51)	21
	1873	1555	691	4119

N = 4119       $\chi^2 = 7.26$       p = not significant  
at .05

TABLE 20. Chi-square test of Lillooetdebitage general reduction stages by raw material.

## Debitage General Reduction Stages

Raw Material	EARLY	MIDDLE	LATE	
	Vitreous Basalt	696 (693.37)	756 (793.97)	
Chert	524 (526.63)	641 (603.03)	452 (487.34)	1617
	1220	1397	1129	3746

N = 3746       $\chi^2 = 8.74$       p = not significant  
at .05

TABLE 21. Chi-square test of Hat Creekdebitage general reduction stages by raw material.

are also analysed by Chi-square tests of independence. Here weights and scar counts are pooled into regular intervals by raw materials (Tables 22, 23, 24, 25, 26, and 27). The Lillooet materials are not analysed because the sample sizes are too small to fit the requirements of the test.

The Chi-square tests demonstrate that there are no statistically significant differences in the sizes or complexity of tools due to raw material factors. This finding generally supports the debitage tests, and indicates that the differences observed between the Mouth of the Chilcotin chert and vitreous basalt are not consistent. The contingency tables do indicate that Eagle Lake obsidians and basalts relate to each other differently than do the Mouth of the Chilcotin and Hat Creek basalt and chert materials. In the Mouth of the Chilcotin and Hat Creek regions (Tables 24, 25, 26 and 27) chert tools tend to be larger and less complex than basalt tools, while at Eagle Lake, both basalt and obsidian tools tend to be small. I suggest that the probability tests are generally reliable, given the variety and size of the entire tool sample, and that separate study is required of variability of such factors within specified tool types. Again, the data have been gathered for such analyses, but their manipulation is currently beyond the scope of this study.

These findings do not necessarily indicate that raw material conservation and maintenance was not practiced, but only that in relation to each other, vitreous basalt and obsidian/chert are re-

## Weight Intervals (Grams)

		0 - 1	2	3	4	≥ 5	
Raw Material	Vitreous Basalt	68 (67.67)	28 (30.69)	25 (15.74)	8 (8.66)	25 (21.25)	144
	Obsidian	18 (18.33)	11 (8.31)	5 (4.26)	3 (2.34)	2 (5.75)	39
		86	39	30	11	27	183

N = 183       $\chi^2 = 4.62$       p = not significant  
at .05

TABLE 22. Chi-square test of Eagle Lake tool sizes by raw material.

## Scar Count Intervals

		0	1 - 5	6 - 10	11 - 15	16 - 20	≥ 21	
Raw Material	Vitreous Basalt	18 (17.31)	12 (16.52)	38 (42.49)	40 (36.20)	22 (18.10)	14 (13.38)	144
	Obsidian	4 (4.69)	9 (4.48)	16 (11.51)	6 (9.80)	1 (4.90)	3 (3.62)	39
		22	21	54	46	23	17	183

N = 183       $\chi^2 = 14.1$       p = not significant  
at .05

TABLE 23. Chi-square test of Eagle Lake tool scar counts by raw material.

## Weight Intervals (Grams)

		0 - 1	2	3	4	≥5	
Raw Material	Vitreous Basalt	54 (50.51)	21 (20.76)	15 (13.15)	16 (14.53)	31 (38.06)	137
	Chert	19 (22.49)	9 (9.24)	4 (5.85)	5 (6.45)	24 (16.94)	61
		73	30	19	21	55	198

N = 198       $\chi^2 = 6.37$       p = not significant  
at .05

TABLE 24. Chi-square test of Mouth of the Chilcotin tool sizes by raw material

## Scar Count Intervals

		0	1 - 5	6 - 10	11 - 15	16 - 20	≥21	
Raw Material	Vitreous Basalt	45 (49.82)	15 (17.30)	30 (29.75)	20 (16.61)	20 (14.53)	7 (8.99)	137
	Chert	27 (22.18)	10 (7.70)	13 (13.25)	4 (7.39)	1 (6.47)	6 (4.01)	61
		72	25	43	24	21	13	198

N = 198       $\chi^2 = 12.88$       p = not significant  
at .05

TABLE 25. Chi-square test of Mouth of the Chilcotin tool scar counts by raw materials.

## Weight Intervals (Grams)

		0 - 1	2	3	4	≥5	
Raw Material	Vitreous Basalt	40 (31.98)	15 (16.38)	21 (17.94)	11 (12.98)	101 (109.21)	188
	Chert	1 (9.02)	6 (4.02)	2 (5.06)	5 (3.52)	39 (30.79)	53
		41	21	23	16	140	241
N = 241		$\chi^2 = 15.65$				p = not significant at .05	

TABLE 26. Chi-square test of Hat Creek tool sizes by raw material

		0	1 - 5	6 - 10	11 - 15	>15	
Raw Material	Vitreous Basalt	47 (48.37)	12 (15.60)	49 (49.93)	42 (42.90)	38 (31.20)	188
	Chert	15 (13.63)	8 (4.40)	15 (14.07)	13 (12.10)	2 (8.80)	53
		62	20	64	55	40	241
N = 241		$\chi^2 = 10.86$				p = not significant at .05	

TABLE 27. Chi-square of Hat Creek tool scar counts by raw material.

duced in the same ways, and used to make tools of the same orders of size and complexity.

What the previous tests do not show is that one raw material may serve to replace another. Consider Figure 71, where the relative amount of debitage composed of vitreous basalt, and the relative amount of tools composed of vitreous basalt are plotted per site. Here and in following figures, lines indicating 2:1, 1:1 and 1:2 ratios are provided to facilitate reference. Sites low on both scales have relatively large amounts of granular basalt (16:1 and EkRo 48), as discussed above, and the "chert debitage" (Matson *et al.* 1979) sites from the Mouth of the Chilcotin (4:1, 4:2, 4:5, 9:2) occur as two groups. One of these groups has relatively high vitreous basalt tool contents and low vitreous basalt debitage contents (4:2, 4:5), and the other two sites are composed of about 50% vitreous basalt tools and also about 40% vitreous basalt debitage. Site K2:1 from Hat Creek occupied a place on this graph that is similar to 4:2 and 4:5, but even though it contains a large amount of chert debitage, no chert tools were found there. Sites G23:1 and G31:1 are also similar to these three sites, but contain relatively more vitreous basalt tools and debitage.

Sites 14:2 and 5:1 are at the opposite ends of the scale, with relatively low numbers of vitreous basalt tools, but relatively large amounts of vitreous basalt debitage. Other sites are not as extreme with respect to these measures, and cluster around the 1:1 line of the graph. CR64 is the exceptional site, in that it contains no tools whatsoever.



From this graph it appears that sites 4:2, 4:5, K2:1, G23:1 and G31:1 are places where the vitreous basalt tools that were deposited were replaced by tools made of chert, while at 16:1 and EkRo 48, granular basalt is the replacement material.

Another way of checking these patterns is to plot the relative amounts of tools versus the relative amounts of debitage that are composed of obsidian or chert (Figure 72). Here we see that at 16:1, obsidian and vitreous basalt tools were replaced by granular basalt, and that sites 4:2, 4:5, G23:1, G31:1 and K2:1 are clearly separated from the other assemblages, in that chert tools appear to have been removed from the sites following their manufacture. Site 9:2 also patterns out in this way, but less strongly so. The other assemblages occur close to the 1:1 line on the graph, or exhibit such low percentages of obsidian/chert debitage and tools as to be beyond accurate interpretations here.

Note that use of the term "replacement" in discussing the above patterns does not imply that such occurred in a single episode of site occupation. Since the present analyses deal only with complete collections, at times from large areas and at others from small site areas, I cannot control for the influences of site re-occupation, but only the combined results of all site occupations. Overall, I assume that sites were reoccupied for the same reasons as their initial establishment, if at all. To a lesser degree, it can also be assumed that succeeding occupants are aware of and use the materials left by prior occupants, whether by design or circum-

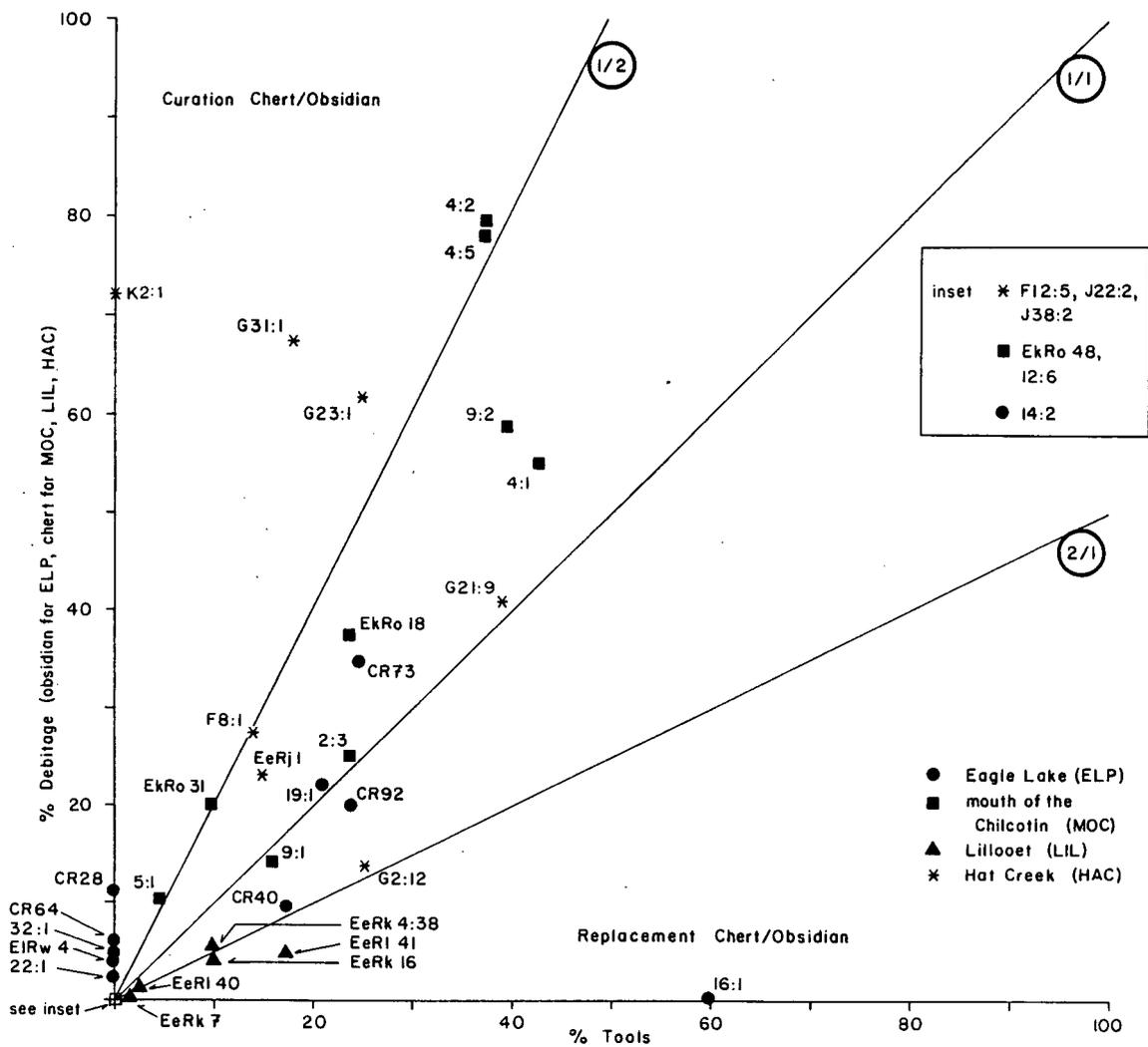


FIGURE 72. Plot of the percent of debitage derived from Chert or Obsidian vs. percent of tools for the same raw material per assemblage.

stance. These ideas do not rule out discovering the relative average duration of site occupations, nor do they eliminate the possibility of comparing site total lengths of occupations. Thus, when raw material X is being replaced by material Y, then in the long run tools of X are being brought in and deposited, while tools of Y are being made and exported. It should be apparent here why precise raw material source locations would be useful in actually mapping mobility and trade patterns.

Overall, the results are appealing because at Eagle Lake sites, where obsidian is imported probably from the Obsidian Creek source area, it can be expected that obsidian would be conserved. Figure 72 shows that this is generally true, with several of the Eagle Lake assemblages exhibiting obsidian tools curation whereas obsidian debitage is being deposited (22:1, 26:3, 32:1, CR28, CR64, E1Rw 4). This is true also of chert tool and debitage patterns at sites EkRo31, 4:2, 4:5 and 5:1 from the Mouth of the Chilcotin and sites G31:1, G23:1, F8:1 and K2:1 at Hat Creek. With respect to those sites that do exhibit meaningful patterns, some substantive conclusions can be drawn. Site 16:1 appears to be an excellent example of Binford's "situational" type of site, where tools of high quality materials were replaced by the coarser granular basalt. As for the Mouth of the Chilcotin "chert debitage" sites, it is possible, in support of Matson et al.'s (1979) position, and contrary to my position in Chapter 3, that the sites are evidence of high mobility, if chert materials from afar were brought into the region, and then used to make tools

that ordinarily would be made of vitreous basalt. Concerning such a possibility, Binford (1979: 260) has written of raw materials that he is convinced "that variability in the proportions of raw materials found at a given site is primarily a function of the scale of the habitat which was exploited from the site location, possibly coupled with a founder effect resulting from discard on the site of items which had been manufactured previously at some other location". On the other hand, given that the Canyon Shuswap were great traders, if these sites are late prehistoric, then it is equally possible that the chert was acquired by trade. Knowing chert source locations would greatly aid in such a debate.

#### 6.4. Hypothesis 2: Implement Maintenance and Curation Factors

Ebert's (1979) model of stone tool variability holds that implements meant to be transported and re-used will tend to be small and complex, while those that are used once and left at the loci of use will tend to be large and simple. In Binford's (1979) terms, the small, complex items are curated personal gear, the larger, simpler tools are expedient types. A sort that Ebert does not consider, site furniture, probably is quite variable in size and complexity, depending on their specific intended purposes. Ebert's (1979) approach to inferring the relative degrees of mobility that produced assemblages relies on size and complexity measures for individual tools. However, it is logical as in Bin-

ford's (1978b) faunal assemblage studies, that similar measures can be applied to entire assemblages to characterize site formation processes at regional and inter-regional scales of comparison.

In Figure 73, are plotted entire assemblage analogs of Ebert's (1979) suggested size and complexity measures (Table 28), with the modification that weight of tools has been substituted for Ebert's size index (volume), since volume can be expected to be nearly perfectly correlated with weight, varying only with specific gravity of the raw materials under consideration. At the scale of analysis undertaken here, it is unlikely that specific gravity of the raw materials varies enough to be a significant determinant of assemblage content.

The figure shows that assemblages vary a great deal with respect to the relative complexity of tools in relation to their size. Sites CR28, ElRw 4, 4:2, 4:5, 9:1, 12:6, G2:12 and J22:2 contain relatively complex tools in relation to their size, while sites 16:1, 22:1, EkRo 31, EkRo 48, 4:1 5:1, EeR1 40, 2:3 and Fl2:5 contain relatively simple, heavy tools. In the latter group of sites, this pattern is due to the presence of granular basalt and/or spall tools in the assemblages. Other sites are not readily interpretable, except as being "typical", clustering along the line of one scar per gram, however sites CR92, EeRj 1, 19:1, F8:1 and EeRk 7 are exceptional in terms of sheer abundance. Thus the relatively complex and small assemblages can be interpreted as the result

SITE	TOTAL WEIT (grams)	TOTAL DOCO (#)	TOTAL COUNT
14:2	15.0	14	2
16:1	101.1	48	5
19:1	648.5	692	56
22:1	114.7	10	2
26:3	1.4	12	4
32:1	152.5	130	13
CR28	15.7	99	5
CR64	0	0	0
CR40	50.7	67	6
CR73	44.8	43	4
E1Rw 4	77.5	182	19
CR92	390.1	406	46
EkRo 18	29.4	15	17
EkRo 31	413.0	151	22
EkRo 48	142.4	65	18
2:3	2728.9	399	37
4:2	245.6	250	35
4:5	32.9	99	16
4:1	322.2	78	24
5:1	778.1	180	25
9:1	51.0	88	12
9:2	63.3	72	13
12:6	43.8	114	12
EeRk 16	106.5	120	20
EeRl 41	211.0	231	29
EeRk 7	1114.9	723	116
EeRk 4:38	92.4	96	20
EeRl 40	685.2	366	76
G21:9	167.0	136	26
G23:1	24.3	33	4
G2:12	38.8	78	8
G31:1	166.4	155	22
F8:1	814.3	725	53
F12:5	675.6	120	6
J22:2	3.9	22	2
J38:2	44.5	63	7
K2:1	156.9	132	10
EeRj 1	441.4	385	69

TABLE 28. Total tool weights and scar counts by site.

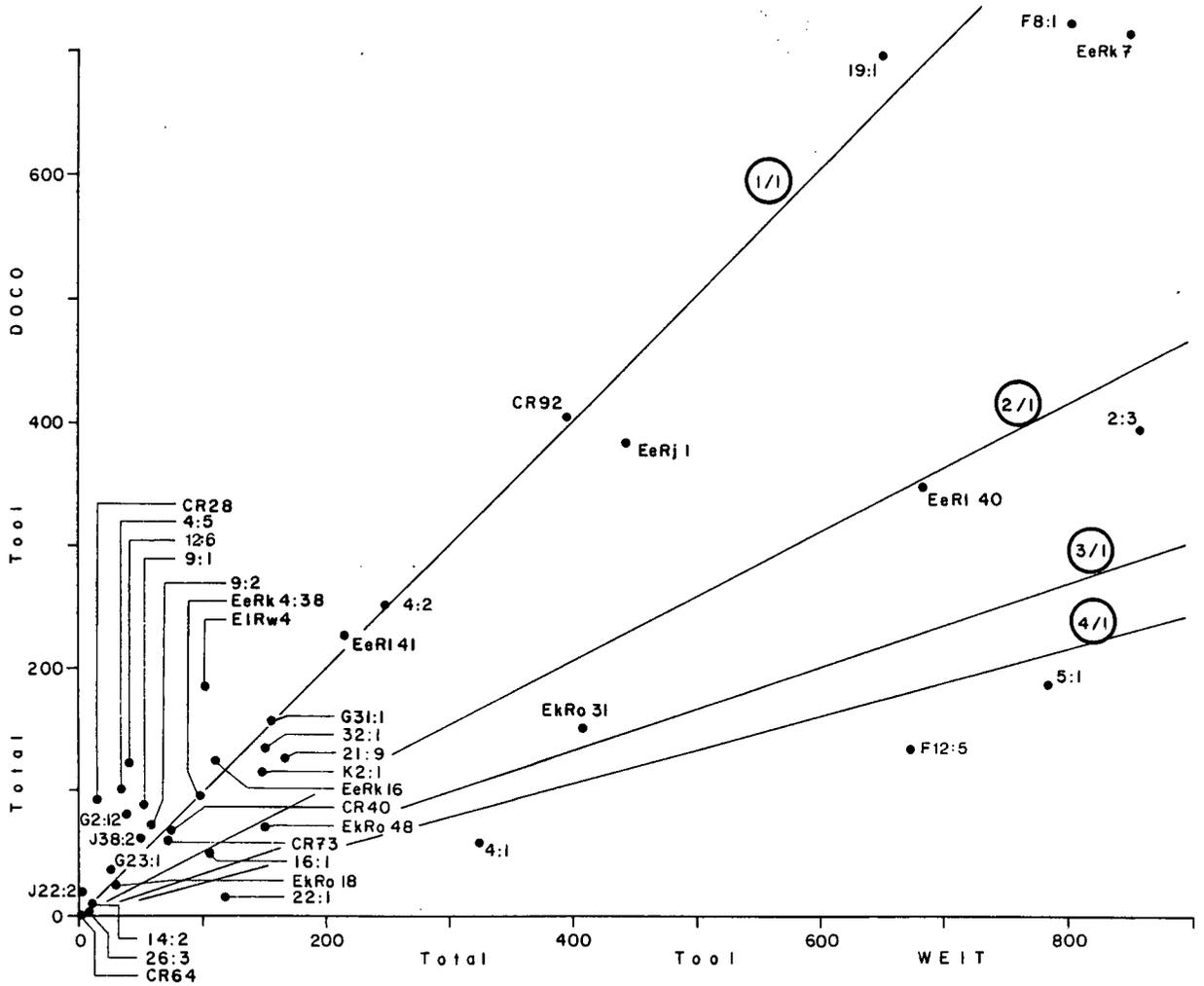


Figure 73. Assemblage total tool weight plotted against total tool scar counts.

of highly mobile tasks, or as the depositional loci of no longer useful personal gear, while the relatively simple, heavy assemblages can be interpreted as the results of expedient tasks or residential generalized tasks, employing furniture along with expedient tools.

One of the problems with Ebert's model is that it does not consider debitage, which reveal immediate deposition patterns at sites. If we consider that tools, regardless of types, are used and deposited, and that late stage debitage can result from the maintenance of tools, then archaeologically-expected relationships between actual numbers of tools at sites, and the relative abundance of late debitage in assemblages, can serve as an inferential model of maintenance and curation behavior with more precision than Ebert's model. In this way, we can understand that assemblages resulting from relatively short-term tool maintenance activities should exhibit few tools, and relatively large amounts of late stage debitage, whereas assemblages that are simply short-term manufacturing loci should exhibit few tools, since the manufacturing products should have been then transported to use-locations.

Sites with many tools and large amounts of late stage debitage should have resulted from re-occupied tool maintenance locations, and assemblages with many tools and little late stage debitage should be the products of long term tool use locations where tool maintenance was not undertaken.

The archaeological situation with respect to the 38 sites is shown in Figure 74. Here sites occur in more or less discrete clus-

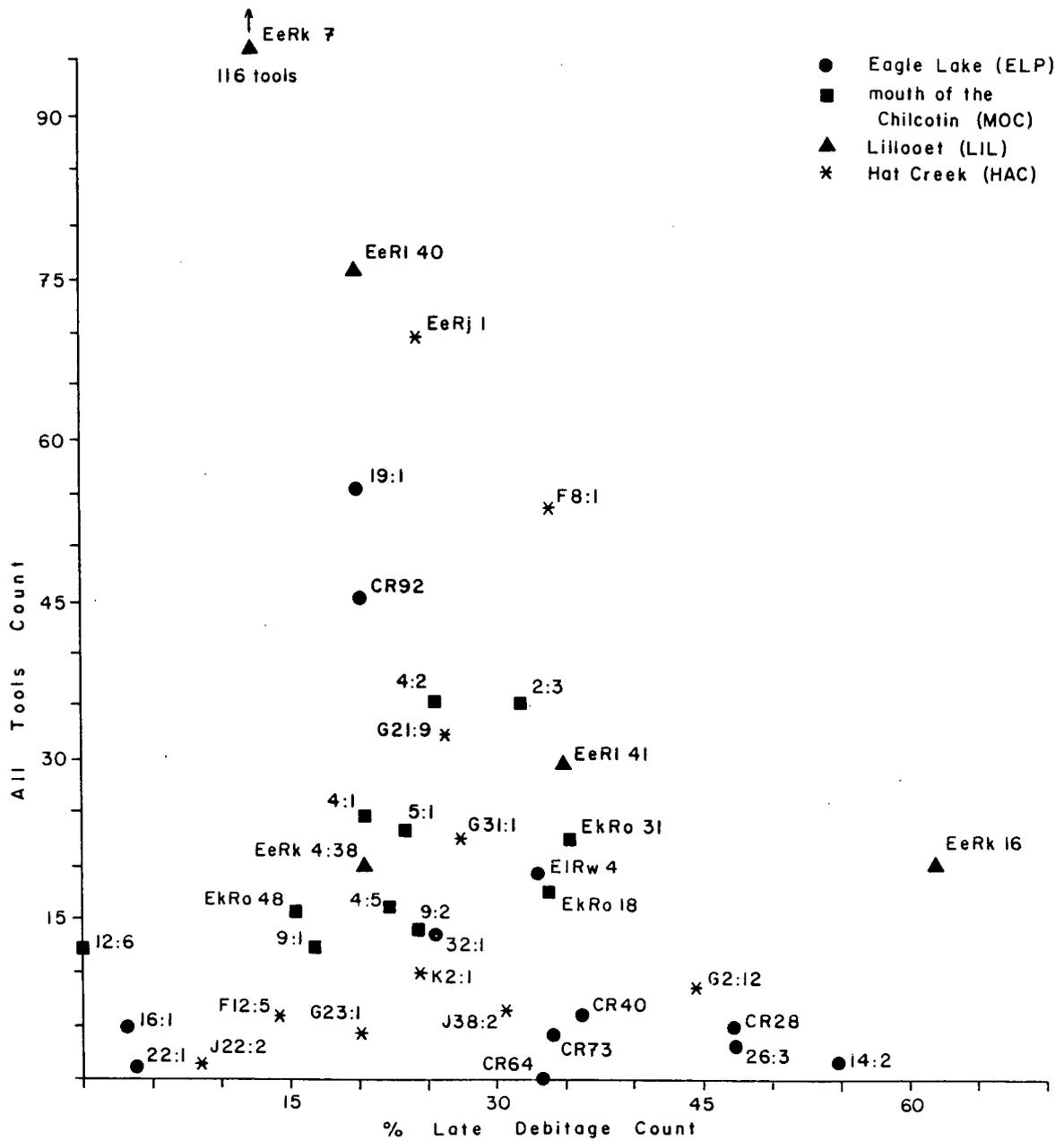


Figure 74. Graph of the total number of tools vs. the percent of late debitage in each assemblage.

ters that are readily interpretable in the terms above. Excavated housepit sites EeRk 7, EeRl 40 and EeRj 1 appear at upper left, with many tools, but relatively little late debitage. However, not all excavated housepit sites follow this pattern expected of long-term residences. Sites EkRo 48 and EeRk 4:38 occur at lower left, with few tools and relatively little late debitage, while sites CR73, EkRo 18, EkRo 31, EeRk 16 and EeRl 41 occur near the lower right, with few tools, but relatively high amounts of late debitage. This pattern is in support of interpretations made in previous sections, that these are different from what is expected on housepit sites, and these are perhaps relatively short-term occupation habitations.

Sites 12:6, 16:1, 22:1, J22:2, F12:5 and G23:1 appear to be locations where tool making was a priority in itself, whereas sites J38:2, CR64, CR73, CR40, G2:12, CR28, 26:3 and 14:2 are locations where tool maintenance and low discard rates occurred in probably relatively short periods of time. Sites 4:1, 5:1, G31:1, 9:1, 4:5, 9:2, 32:1 and K2:1, grouping with EkRo 48 and EeRk 4:38, appear to be occupation locations, but of shorter term than 19:1, F8:1, CR92, 4:2, G21:9 and 2:3. These latter sites, by their positions on this graph, below EeRk 7, EeRl 40 and EeRj 1, must be considered to have resulted from long occupations over several episodes, but in open-air situations. EeRk 16 seems to be a shorter term housepit site, and housepit sites EeRl 41, and EkRo 31 only slightly longer term than EeRk 16, along with lithic scatter and

housepit site ElRw 4.

It should be noted that the raw tool frequency values are highly subject to sampling biases, and these are only partially cancelled by using them against debitage percentages. This is an example of where precise functional tool data is required (but unfortunately not available in this study), for if standardized measures of functional tool groups were compared to the debitage stage values, then the range of lithic tool related tasks that occur in different kinds of sites would be much better understood. For example, greater or lesser occurrences of chopping, scraping or cutting tools in relation to resharpening stages would yield relative data on the rates at which tools are exhausted in various tasks. Regardless of the sampling bias, I think that the resolution of the patterns is high and would no doubt be increased with fuller samples, especially from the excavated housepit sites. The problem could perhaps be resolved by multiplying the samples obtained by the appropriate portion of site area that they represent, but such requires assuming homogeneity across site areas and would be most reliable if more sample units were available. In an ideal full sample or equally random sampled set of sites, I would expect that the graph in Figure 74 would sort housepit sites more discretely, but would not substantially alter the interpretations of most of the lithic scatters with or without features. Site 2:3 from the Mouth of the Chilcotin and possibly other grassland sites could be biased by thick grass growth and poor surface visibility, but as at Eagle

Lake and most Hat Creek sites, an attempt was made to collect all visible lithic remains. With the 5 mm cut-off applied in this study, this bias should not be serious.

In sum, a model of assemblage formation that is based on the abundance of tools at sites in relation to the amount of maintenance debitage present appears to have greater interpretive ability than one that is based solely on the size and complexity of tools. This is because immediate deposition processes as revealed in debitage are considered along with tool deposition processes, which theoretically are not as immediate and more influenced by curation and transport. The new model has the ability to allow inferences that include the lengths of occupation of sites, where length of occupation includes all of the separate durations of site occupations. It is apparent that there is a great deal of overlap in lengths of occupation by site type, but this is easily explained, since for example a total of 10 separate years of four month housepit occupations (40 month length of occupation) is in this sense equal to 20 occurrences of two month stays at fishing or root gathering camps, where these be annual or multiple annual in nature.

The evidence presented in this section demonstrates that tool maintenance and curation factors strongly affect the character of lithic tool and debitage assemblages, and it also shows that readily interpretable patterns can be obtained here also with relatively simple measures, once reduction stages are known from debitage.

Therefore, while sampling biases should be considered in future studies, the second hypothesis is supported and the value of the experimental study is again evident.

#### 6.5. Hypothesis 3: Settlement Strategy Factors

Before I offer site formation interpretations for each site, and prior to discussing the similarities and differences of technological strategies of the four regions of study, I think it is necessary to consider the general hypothesis that settlement strategies can be predicted on the basis of lithic content of the assemblages. It is hypothesized that the 38 assemblages can be consistently interpreted as resulting from five settlement strategies on the basis of their context and presence of site features alone: 1. Excavated housepits, which represent winter habitations; 2. Lithic scatters without features, which represent short-term occupations, or possibly pre-housepit habitation areas; 3. Lithic scatters with associated housepit features, which represent long-term open air habitation loci, perhaps in early historic times when housepits were no longer constructed, yet stone tools were still used, or representing outdoor activities conducted during winter pithouse occupations; 4. Lithic scatters with associated cache pits, which represent salmon processing and storage loci; and 5. Lithic scatters with firecracked rock, which represent possibly large mammal and floral resource processing locations.

The analysis requires that tools be considered along with debitage so that all aspects of the lithic technology are included in "predicting" site types, and thus a meaningful classification of tools, in functional terms, is required. This is accomplished by R-mode cluster analysis in so that meaning can be assigned to groups of tool types on the basis of their co-association. The cluster analysis is performed on those tool types and site features that occur greater than five times across the 38 sites, to reduce the probability of spurious associations, and is thus based on 21 classes (see Table 14). The analysis is based on the presence or absence of the classes, and uses Jaccard's Complement (Sneath and Sokal 1973), as a pseudo-distance measure. The Furthest Neighbour clustering routine (Wood 1973) is used to produce the groups of classes. The dendrogram is shown in Figure 75 where four clusters of tools and features are identified. Features are included with the lithic tools because such was the practice with Matson et al. (1979), in a similar R-mode analysis. Thus comparisons can be made between the two studies, and since features in general represent more labour input than stone tool manipulation per se, features can be expected to be associated with "labour intensive" tools.

Cluster I consists of unimarginal fragments, pieces esquillees, bimarginal fragments, utilized BRF's, and lanceolate biface fragments. These can be interpreted as exhausted, fragmented, fully used items that would be incapable of participating further in subsistence tasks,

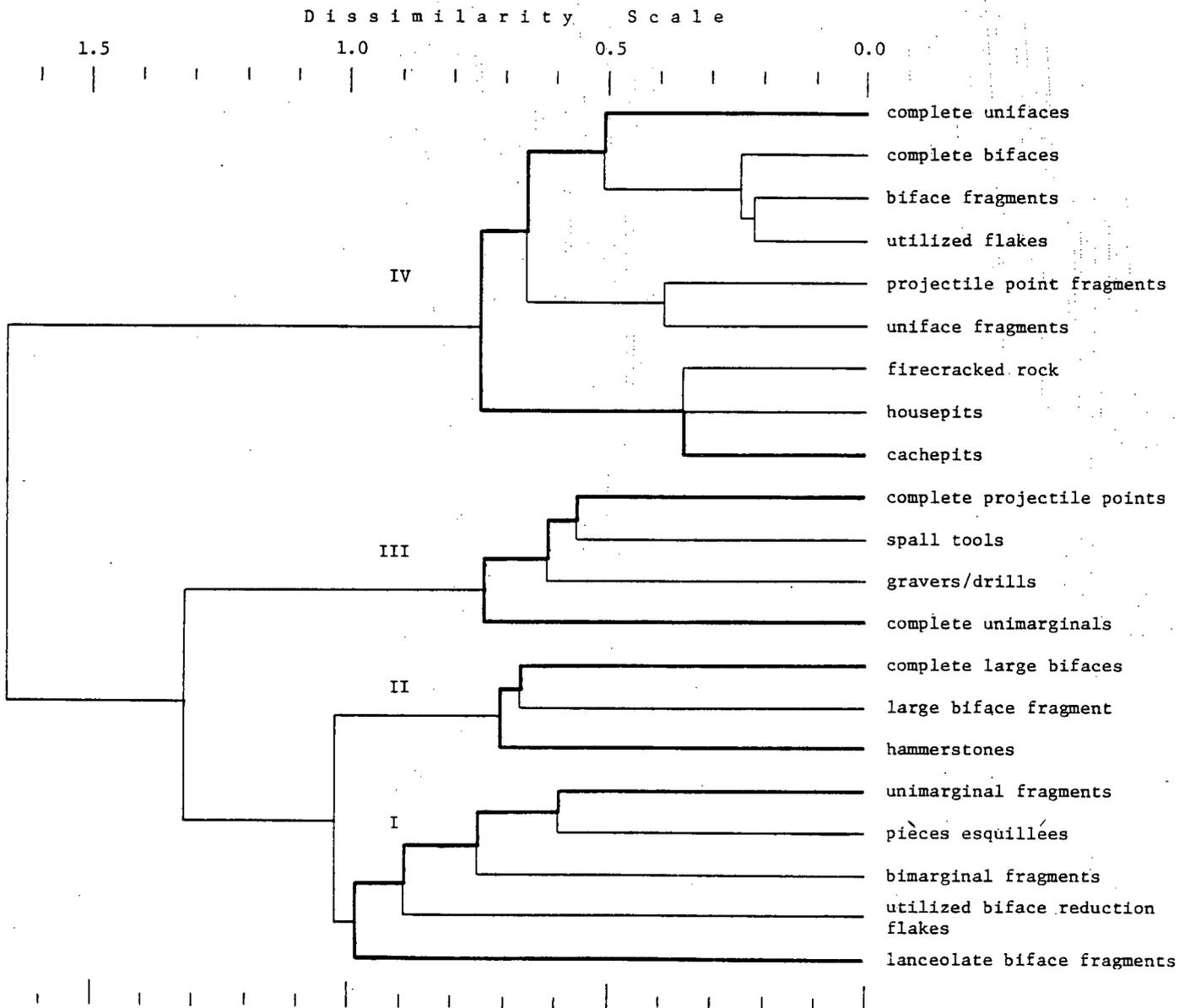


Figure 75. R-Mode analysis of the presence or absence of 21 tool classes and site features in the 38 assemblages.

and would not be worth further curation. Cluster II contains complete and fragmentary large bifaces, and hammerstones. This appears to be a group of large items, possibly reflecting the use of large bifaces as cores for the derivation of useful flakes. This cluster can be interpreted as the closest there is to "site furniture" items that are left at sites because they are too bulky to transport, yet that are useful in settlement strategies for particular purposes at either residential or special-purpose sites (Binford 1979). Cluster III is composed of complete projectile points, spall tools, graver/drills, and complete unimarginal tools. These items can be interpreted as large mammal hunting and processing equipment, and also as "personal gear", that is extensively curated and maintained. Cluster IV contains a sub-cluster of site features, and a larger cluster of complete unifaces, complete bifaces, biface fragments, utilized flakes, projectile point fragments, and uniface fragments. These are interpreted as general purpose items that are useful in several kinds of tasks, although the projectile point fragments are difficult to interpret in this sense, and this cluster may contain personal gear that is discarded once it has been replaced or repaired. Generally, Cluster IV items are those that are present in most assemblages, but the association of the tools with the site features, along with the co-associations of complete and fragmentary bifaces and unifaces, allows the interpretation that these items result from generalized activities.

The R-Mode analysis by Matson et al. (1979) at the Mouth of the Chilcotin derived "maintenance", "specialized", and abundance factors, comparable to those derived above. Their Cluster 4 is close to the above Cluster IV, except without site features, which are classified separately in the Mouth of the Chilcotin sample alone, and these are a good "maintenance/generalized" grouping. The above Cluster I exhausted, discarded tools may be partially subsumed in Matson et al.'s (1979) Cluster IV, and the remaining clusters of each study appear mixed, although the separate tool typologies that were applied is an uncertainty.

Using the condensed tool classification, minus site features and the condensed debitage classification (Table 29), the proposition of assemblage variability being related to settlement strategies is tested with multiple discriminant analysis (Klecka 1975) that was introduced in Chapter 4. In this application, the known groups are the five site types as identified by features, and a stepwise discriminant method (Wilks) is used that attempts to identify the site types on the basis of the frequencies of items within condensed tool and debitage classes.

Table 30 shows that overall correct discrimination is achieved at a rate of 74%, which is a good solution, since this is 54% above the "prior probability" of accurate classification (Hair et al. 1979). The stepwise technique indicates that tool clusters III and bipolar cores are the most important discriminating variables, followed by cores, and middle stage debitage.



## Predicted Group Membership

Actual Group	# of Cases	Housepit	Lithic Scatter	Lithic Scatter w/ Housepits	Lithic Scatter w/ Cachepifs	Lithic Scatter w/ Firecracked Rock
HP	10	8 (80%)	0	0	1 (10%)	1 (10%)
LS	12	0	7 (58.3%)	0	0	5 (41.7%)
LSHP	7	0	0	6 (85.7%)	0	1 (14.3%)
LSCP	4	0	1 (25%)	0	3 (75%)	0
LSFCR	5	0	1 (20%)	0	0	4 (80%)

Overall Correct Classification: 73.68%

TABLE 30. Results of multiple discriminant analysis based on functional tool classes and condensed debitage classes.

Overall, lithic scatters with housepits are most accurately classified (85.7%) followed by housepits and lithic scatters with firecracked rock (each 80%), lithic scatters with cachepits (75%), and finally lithic scatters (58.3%). The individual classification results are shown in Table 29 also.

The stepwise discriminant analysis showed that four functions were derived to discriminate the five groups. Of these, the first two functions account for 90% of variance of the solution. The highest loading variable in the first function is tool Cluster III, and for the second function is bipolar cores. The analysis appears to have selected the opposition of highly curated personal gear with early stage bipolar core reduction, to be the most efficient way of distinguishing the site types, but note that classification of unknown sites would require entering as many as five more variables (Tool 1, Tool 4, middle debitage, bipolar flakes and single platform cores).

It is valuable in this case to consider which sites have been misclassified. Table 29 shows first of all, that most misclassifications are lithic scatters, which tend to be classed as lithic scatters with firecracked rock (41.7%). One excavated housepit (CR73) and one lithic scatter with housepits (9:2) are also classified as lithic scatters with firecracked rock. EkRo 48 is classed as a lithic scatter with cachepits, and 26:3 (LSCP) and site CR64 (LSFCR) are classed as lithic scatters alone. It is also important to note that except for housepits, the site type classes are all improperly classified into one other class at the most. Yet the housepit class is secure, since no other site classes are improperly classed into it.

The power of the two variables derived by the discriminant analysis to demonstrate significant differences among the settlement components is tested by the chi-square test of independence in contingency tables in Table 31. The table shows that the null hypothesis of no difference in relative proportions of tool Cluster III and bipolar cores is attributable to site type, is rejected at the level of  $p = .01$ . The table also can be read as showing that almost 40% of the chi-square value achieved is taken up by the HP/BCO cell. It appears that the LSHP, LSCP and LSFCR cells do not contribute significantly to the observed tool and core frequencies. Again, this analysis has factored out extremes, in house-pit sites and lithic scatters.

It is thus not surprising that the chi-square test does not reject  $H_0$  at the  $p = .001$  level ( $X^2 > 18.46$  required). Thus, interpretations on the table cannot be pushed much beyond observing that housepits contain more personal gear and fewer bipolar cores than is to be expected, while lithic scatters without features exhibit less personal gear than is expected, and more bipolar cores. These findings mesh very well with Binford's (1979) Nunamiut Eskimo expectations, that personal gear is eventually deposited at residences, while the bipolar core factor is a clear indication of ample use of local small materials at lithic scatter sites.

To further confirm the reliability of the functional tool classification and the condensed debitage classification in prediction of settlement site types, another discriminant analysis of the

	TOOL CLUSTER III	BIPOLAR CORES	
Housepits	39 (28.7)	28 (38.3)	67
Lithic Scatters	6 (12)	22 (12.6)	28
Lithic Scatters with Housepits	17 (19.7)	29 (26.3)	46
Lithic Scatters with Cachepits	21 (23.6)	34 (31.4)	55
Lithic Scatters with Firecracked Rock	7 (6)	7 (8)	14
	90	120	210

$$X^2 = \frac{(O - E)^2}{E} = 3.69 + 2.76 + 30 + 7.01 + .37 + .28 + .29 + .22 + .17 + .13$$

$$X^2 = 17.92, \quad H_0 \text{ is rejected at } p = .01 \quad (X^2 > 13.28)$$

TABLE 31. Chi-square test of independence, five settlement types by personal gear and bipolar cores

same five site types is undertaken. In this analysis, site F8:1 has been removed from the lithic scatter with firecracked rock group, and thus only 37 assemblages are included. F8:1 is removed here even though it is not misclassified in the first discriminant analysis, because it clearly contains a lithic assemblage in association with a roasting pit with plant and mammal remains, it is probably on the order of 500 to 1000 years older than most other sites here, and its assemblage size renders it much different from other small lithic scatters with firecracked rock. Note that F8:1 is removed from this analysis completely, and is not entered as an unknown to see where it is classed.

The result obtained in this second discriminant analysis, (Table 33), also Wilk's stepwise method, is indeed cleaner than the first. Here, overall correct classification is 81.08%, and again Tool class III and bipolar cores are the most significant variables in the first two functions, which account for 88% of the variance among the four functions. Again, most misclassifications (Table 29) are into the lithic scatter with firecracked rock class, and most of these are lithic scatters without features (14:2, 4:5, G2:12, J22:2). G31:1 is properly classified at this time, and 26:3 is again misclassified as a lithic scatter with firecracked rock. The only other misclassification is again EkRo 48, which in this run is classed as a lithic scatter with housepits. However, now lithic scatters with housepits are all correctly identified, as are the actual lithic scatters with firecracked rock.

## Predicted Group Membership

Actual Group	# of Cases	Housepit	Lithic Scatter	Lithic Scatter w/ Housepits	Lithic Scatter w/ Cachepits	Lithic Scatter w/ Firecracked Rock
HP	10	8 (80%)	0	1 (10%)	0	1 (10%)
LS	12	0	8 (66.7%)	0	0	4 (33.3%)
LSHP	7	0	0	7 (100%)	0	0
LSCP	4	0	0	0	3 (75%)	1 (25%)
LSFCR	4	0	0	0	0	4 (100%)

Overall Correct Classification: 81.08%

TABLE 32. Results of multiple discriminant analysis based on functional tool classes and condensed debitage classes, with F8:1 removed.

The chi-square test performed on the data with F8:1 removed, by tool Cluster III and bipolar cores (Table 34), shows that the five site types are significantly different with respect to the proportional frequencies of these artifact classes. Again, the major portions of the chi-square value are obtained in the top four cells of the table. Also, the chi-square value barely achieves a level significant at  $p = .01$ , and does not pass at  $p = .001$ . I believe that this is not as important as demonstrating that the directions of variation are consistent with those of the first discriminant analysis, which they are.

The multiple discriminant analyses performed above have their greatest value in overall results, since large-scale patterns are being sought. The analyses do achieve high success rates in assigning assemblages to pre-defined classes on the basis of tool and debitage classes obtained by independent lines of evidence. The mathematical manipulations required to achieve these results are much more complex than the bivariate analyses of raw material factors and tool maintenance and curation processes, however, the discriminant analyses operate on multiple covariation measures and are thus not as subject to sampling biases. In sum, it is apparent that settlement categories of sites can be discretely identified by the methods employed in this section of the study.

	TOOL CLUSTER III	BIPOLAR CORES	
Housepits	39 (28.62)	28 (38.38)	67
Lithic Scatters	6 (11.96)	22 (16.04)	28
Lithic Scatters w/ Housepits	17 (19.65)	29 (26.35)	46
Lithic Scatters w/ Cachepits	21 (23.49)	34 (31.51)	55
Lithic Scatters w/ Firecracked Rock	2 (1.28)	1. (1.72)	3
	85	114	199

$$\frac{\chi^2 = \sum \frac{(O-E)^2}{E}}{E} = 3.76 + 2.81 + 2.97 + 2.21 + .36 + .27 + .26 + .20 + .41 + .30 = 13.55$$

$$\chi^2 = 13.55, \quad H_0 \text{ is rejected at } p = .01 \quad (\chi^2 > 13.28)$$

TABLE 33. Chi-square test of independence, five settlement types without F8:1, by personal gear and bipolar cores.

#### 6.6. Assemblage Formation Summaries

The preceding analyses have examined the nature of general technological factors that have contributed to interassemblage variability, and have successfully related lithic technological processes and patterns of tool deposition to settlement strategies. The presence of features at many of the sites serves as a control factor, through ethnographic analogy, against which the technological and functional variations show consistent patterning. Excavated housepit assemblages provide the firmest association of context with assemblage deposition, and the variability that is exhibited within this site type, and the similarity of housepit assemblages to others provides insight to site occupation processes that would be otherwise difficult to infer.

Schiffer (1975) has discussed in a theoretical manner, the kinds of behavior that could lead to marked differences in content of sites, when similar activities are undertaken at them, and concluded that "occupation span", the length of time that a site is occupied at any one time, and "curate behavior", the removal of artifacts from sites, should be the most important and visible determinants of assemblage differences. The methods of analysis employed in this study very closely parallel those that Schiffer (1975: 268) suggested would be of use to the study of occupation span.

Schiffer (1975: 268) proposed that "debitage, utilized flakes and waste products of various kinds" are of the greatest utility in inferring site functions, and as we have seen,debitage reduction

stages, cores and personal gear discards are quite useful. Secondly, Schiffer offered that "if curate behavior is widespread, then the variety of items present at sites should vary with occupation span" (1975: 268). In terms of the assemblage measures employed in this study, it is apparent that sites vary a great deal in the predominance and intra-assemblage spread of reduction stages, and that some of this variability is due to economizing behavior, where tools of one raw material were replaced with those from other raw materials.

Schiffer's (1975) suggestion to study tool "uselives" is only barely considered in this study in the examination of Ebert's (1979) model, yet comparing assemblages in terms of tool quantities and variety of debitage, as Schiffer suggests, does relate to sites' lengths of occupation and perhaps provides the clearest ordering of sites along these lines (Figure 74). The point that sites' assemblages may be the products of several occupations appears to me to require a refinement of Schiffer's (1975) definition of occupation span, where I would define it as the sum of occupation durations, and not as the duration of single episodes of use.

The following summaries present each assemblage within a general group, representing major assemblage formation processes with respect to tool manufacturing stages, tool maintenance and curation, and occupation span as evidenced in the variations of the lithic technological patterns within site types containing cultural depressions or firecracked rock features.

1. Long Term Housepits: EeRk 7, EeRl 40, EeRj 1

These three assemblages are distinct in their similarities to each other in all analyses, being abundant, wide-ranging in manufacturing stages, and containing diverse tool types. These assemblages do not exhibit marked patterns of tool curation or conservation, and can be considered to be "typical" assemblages that resulted from repeated winter occupations.

2. Moderate Term Housepits: EkRo 48, EeRk 4:38

These two sites exhibit debitage that is wide-ranging in reduction stage, but that tends to early, and these also contain relatively sparse tool assemblages. I would suggest, from the "refuse pit" context of EeRk 4:38, that both assemblages received their final character as the result of deliberate disposal processes, and not from in-house habitation activities.

3. Short Term Housepits: CR73, EkRo 18, EkRo 31, EeRk 16, EeRl 41

These assemblages have predominantly late stage debitage and sparse tool content for housepits. Excavation area sampled is not a factor here, since EeRl 41 is a relatively large area excavation, much larger than EkRo 48 and EeRk 4:38 above. EeRk 16 is somewhat of an anomaly and is perhaps the briefest occupation housepit of the lot.

4. Moderate Term Lithic Scatters: 4:2, 4:5, G21:9, G31:1, K2:1

These are relatively abundant assemblages with wide-ranging reduction stages evidenced in the debitage. 4:2, 4:5, G31:1 and K2:1 exhibit chert tool manufacture and curation, while G21:9 ex-

hibits the manufacture and disposal of about equal amounts of vitreous basalt and chert tools. These appear to be sites in the Mouth of the Chilcotin and Hat Creek regions that were re-occupied several times.

5. Short Term Lithic Scatters: 14:2, 16:1, 22:1, G23:1, G2:12,  
F12:5, J22:2

These sites are of two basic kinds. 1. Late stage/tool maintenance sites 14:2 and G2:12, where granular basalt and chert tools were replaced by vitreous basalt tools, which were then maintained and curated. 2. Early reduction/replacement sites 16:1, 22:1, G23:1, F12:5 and J22:2, where early reduction stages predominate. At 16:1 and 22:1, obsidian and vitreous basalt tools were replaced by granular basalt, and at G23:1, chert tools were made, then exported. At F12:5 and J22:2, only vitreous basalt was employed, but in a replacement situation at J22:2, while F12:5 appears to be a good example of a simple "quarrying/manufacturing" location.

6. Moderate Term Lithic Scatters with Housepits: 32:1, ElRw 4,  
4:1, 5:1, 9:1, 9:2

These are relatively abundant surface assemblages with wide-ranging reduction stages, that all exhibit the curation of chert or obsidian from them, but not in the extreme. I would suggest that the assemblages result principally from activities that were undertaken prior to winter pithouse occupations, including "gearing up" for long-distance hunts, and the maintenance of the pithouses themselves.

7. Short Term Lithic Scatters with Housepits: 12:6

12:6 is an assemblage much like 16:1 and 22:1, except with housepits present. In this case, the curation of vitreous basalt tools and the import of granular basalt tools does not seem to be associated with the housepit features, but the site was properly classified in both the MDA analyses, whereas site 9:2 was not. This, along with with presence of several spall tools, lends support to the idea that short-term occupations may not leave entirely representative materials behind, and that such is achieved only with repeated occupations (Schiffer 1975).

8. Long Term Lithic Scatters with Cachepits: 19:1, CR92, 2:3

These assemblages exhibit wide ranges of tool manufacture, diverse and abundant tool assemblages, and no extreme patterns of tool curation or import. These sites were likely occupied to process salmon resources, and also likely served as large mammal hunting base camps.

9. Short Term Lithic Scatters with Cachepits: 26:3

This assemblage is interesting in being similar in several respects (late debitage predominant, improper MDA classification into LSF CR) to sites CR28 and CR40, also from the Eagle Lake sample (see below). Sites 26:3 and CR28 exhibit obsidian maintenance and export, while CR40 is a location of obsidian tool deposition. I suggest that the important difference is that 26:3 is located adjacent to Eagle Lake with cachepits, while CR28 and CR40 are lo-

cated next to the Chilko River, with firecracked rock features. If the associations are correct, then perhaps 26:3 resulted from the same kind of acquisition activity at CR28 and CR40, but the resource was cached rather than immediately processed. Unfortunately, more information is required of the actual resource being obtained.

10. Long Term Lithic Scatter with Firecracked Rock: F8:1

This is a unique assemblage, with abundant tools and late stage debitage in association with a reused roasting pit. Multiple discriminant analysis of settlement components was significantly improved when this site was removed from consideration. F8:1 appears to be a biface manufacturing location, where chert tools tend to replace vitreous basalt tools. That is, basalt bifaces are being left at the site with late stage debitage, and early stage chert debitage is also being deposited. Possibly these patterns each relate to a separate episode of site occupation, yet I believe that the parsimonious explanation is that upon exhaustion, available basalt resources were replaced by local chert materials.

11. Short Term Lithic Scatters with Firecracked Rock: CR28, CR64, CR40, J38:2

These are small assemblages, each with restricted ranges of debitage reduction stages. CR28 and CR40 emphasize late/maintenance stages, CR64 emphasizes early/core reduction stages, and J38:2 emphasizes middle reduction stages. All of these appear to be the result of single occupations. At CR64, vitreous basalt tools were

manufactured and removed, whereas at CR28, obsidian tools were made and exported, at CR40 obsidian tools were maintained and deposited, and at J38:2 chert tools were imported but not maintained. I suggest that all of these sites are related to large mammal procurement and processing.

#### 6.7. Summary

The analyses of inter-regional variability in stone tool and debitage assemblages have yielded results in support of previous research and current theoretical models, and also results that are inconsistent with such. The debitage classification produced in the experimental program of Chapter 4 is of great utility in allowing inferences to be made concerning technological processes of assemblage formation, especially when extremes of the reduction processes are considered in relation to tool occurrence patterns. As such, the general proposition stated at the outset of this chapter is supported.

The first hypothesis does not fare nearly as well. In all four regions, obsidian and chert raw materials appear to have been reduced and used to make tools no differently than vitreous basalt. Overall, this indicates that regardless of source, raw material acquisition was not a major subsistence activity in itself, but was undertaken during the course of other activities. The novel approach of comparing the relative amounts of tools and debitage that are made of particular raw materials is a very useful means of inferring replacement and curation behaviors, and again is most revealing when extremes of the patterns are considered.

Tool maintenance behavior is seen as being a major determinant of lithic assemblage variability. Ebert's (1979) model of the effects of mobility on tools is not an entirely satisfactory way of accounting for variability, and a refined model that considers the mere amounts of tools in comparison to the amounts of maintenance debitage in assemblages is a much more revealing method of understanding assemblage formation processes. In particular, this new model appears to be able to gauge the total lengths of time that sites were occupied, but may be sensitive to sampling restrictions.

Finally, general settlement strategies can be reliably predicted from lithic assemblages, in a complex mathematical manner. This requires tools to be assigned functional meaning, and also requires debitage reduction stages to be considered simultaneously with the tool types. The site occupation purposes predicted on the basis of these kinds of variables are of greater precision than those achieved solely on the basis of bivariate tool and debitage variables.

## CHAPTER 7

## SUMMARY AND CONCLUSIONS

7.1. Summary

The objective of this study was to examine the nature of lithic assemblage variability in relation to late pre-historic settlement patterns of the Interior Plateau of British Columbia. The research has proceeded with a behavioral perspective that assumes the major conditioners of assemblage variations are human activities. The development of behavioral approaches to lithic collections has been reviewed, and shown to have reached a level of sophistication where several models are available for empirical verification. Collins' (1975) general model of the operations of lithic technologies is encompassed by current models of the relationships between stone tools and settlement behavior, especially those of Binford (1979), Ebert (1979), Goodyear (1979), and Pokotylo (1978). These models, varying in explicitness, argue that the mobility of human groups directly and indirectly causes variations in assemblages and that the operations of settlement systems can be monitored by the application of non-arbitrary measures designed to reveal regional spatial variations in manufacturing stages, curation patterns, and disposal processes.

The ethnographic literature of the Interior Plateau immediately relevant to the area of study has been reviewed with the objective of showing that the early historic Chilcôtin and Interior Salish had very similar lifestyles. The Chilcôtin, Canyon Shuswap, Upper Thompson and Upper Lillooet hunted and gathered essentially the same resources, obtained anadromous salmon as a principal food supply, had a well-developed storage technology, and wintered in pithouses. It is recognized that the ethnographies do not provide a complete picture of pre-contact settlement systems. Nonetheless, they contain much invaluable, if often indirect information. A separate review of ethnographic records of stone tool manufacturing has been included here, and again, while the data are not fully pristine, and detail is a problem, manufacturing techniques and ownership of lithic resource locations have been described with a clarity equal to that found in most other North American sources.

The development of Interior Plateau prehistoric research has focused primarily on culture history. Most previous research has sought to derive consistent typological patterns of tool occurrence with respect to the age of the assemblages. The problems associated with housepit archaeology, and a lack of cave and rockshelter assemblages have seriously hampered culture history schemes. Only the last 2000 years of occupation can be reliably identified. Settlement pattern archaeology of the Interior Plateau has a shorter history than culture historic investigation, but appears to be on a surer

methodological footing. Based firmly on the direct historic approach, through the application of direct ethnographic analogy, Interior Plateau settlement pattern research appears to have strong predictive abilities, and the ability to test ethnographic models. In particular, Matson et al. (1979) argue that the late prehistoric Canyon Shuswap had a highly mobile settlement pattern, in contrast to the "sedentary" pattern that can be inferred from Teit's (1909a) descriptions. I argue that the evidence indicates settlement behavior that was both mobile and intensive in a relatively small area. Also, estimates of housepit and cachepit use-spans were obtained by extrapolating data obtained in the Shuswap Settlement Patterns project. Pokotylo (1978) studied previously unstudied middle elevation environments, using a technological approach to stone tools and debitage to demonstrate settlement strategies analogous to Bonaparte Shuswap and Upper Thompson summer and fall subsistence practices. Pokotylo's (1978a) research was innovative in using a large number of surface assemblages, and also in the explicit application of lithic debitage variables to yield important clues to the past operations of mobile group subsistence tasks. More recently, the Eagle Lake project (Matson et al. 1980) was directed at describing the settlement patterns of late prehistoric Chilcotin in environments directly comparable to those studied in the Shuswap Settlement Patterns and Hat Creek projects. This research provided preliminary means of identifying the ethnic identities of site inhabitants, and also served as a pilot study for

the current study (Magne 1980).

One important aspect of the Eagle Lake research was a preliminary investigation of variability in lithic debitage that is produced in various reduction stages of chipped stone tools. The pilot study (Magne and Pokotylo 1981) was much enlarged in scope and sample size in the present study, with the purpose of providing a reliable means of classifying debitage into stages of reduction. This goal was achieved, and it was found that the weight of flakes is not a good predictor of reduction stages, and that platform scar counts and dorsal scar counts allow about 80% reliability in stage classification when debitage are sorted into PRB's and shatter flakes. Bifacial and bipolar types of reduction are also very discrete, and although there are problems with sample sizes, vitreous basalt, obsidian and chert raw materials appear to vary in similar fashion. The classification of debitage that is formulated as a result of the experimental program is considered adequate for the large scale applications in this study, but is certainly in need of independent verification.

While some doubt may be expressed as to the reliability of identifying middle and late stages of reduction, this problem is minimized when BRP's are classed separately, and also because early stage flakes appear to be highly discrete. Certainly, the classification is not completely foolproof in that mistakes in identification will occur, but in low relative frequency. So long as this is acceptable and extreme concern with particulars is avoided,

then this study has been successful. I think it is quite likely that future research employing a similar research design, also with precise flake removal control, perhaps new variables, and greater control over raw material samples, will enable more precise reconstruction of stone tool manufacturing behavior. Particularly required are more studies of raw material factors, pressure flaking events, sub-stage variability, use-resharpening stages, microblade manufacture and other sorts of specialized tool manufacture.

Experimental work must clearly continue to enable refinement of the ideas developed here, yet the study is a precedent in controlled lithics experimentation, and the need for a classification of this kind is witnessed in its application to assemblages from Texas (Katz, personal communication 1982), Alberta (Stryd, personal communication 1982), northern B. C. (Magne 1982a) and Lower Mainland B. C. (Peacock 1982).

The archaeological assemblages that are analyzed in this study were collected in the Eagle Lake, Mouth of the Chilcotin, Lillooet and Hat Creek regions. In total, 14,541 flakes of debitage, 164 cores and 861 tools have been examined. Descriptions of each site, and summary tabulations of artifact frequencies have been provided.

The analyses were undertaken to investigate three general hypotheses, using the debitage classification as a useful means of obtaining patterns of assemblage variability that are interpretable. Assemblage variability in terms of reduction stages is examined by

means of multivariate clustering and scaling techniques, and sites are grouped on the basis of early, middle and late reduction stages, while at this point of the study, bifacial and bipolar reduction do not here appear to be important factors in variability at the multiregional level of interpretation. When sites are grouped on the basis of predominant reduction stages and presence or absence of housepits, cachepits and firecracked rock, several interesting patterns emerge. Housepits exhibit both wide-ranging and late reduction stages, lithic scatters exhibit early/core reduction, wide-ranging and late/maintenance patterns, lithic scatters with housepits exhibit early/core reduction and middle/wide ranging patterns, and lithic scatters with cachepits and lithic scatters with firecracked rock exhibit both middle/wide ranging and late/maintenance patterns of stone tool manufacture.

The first hypothesis examined is that chert and obsidian raw materials should exhibit extensive curation and maintenance patterns in relation to vitreous basalt, since in the regions studied, natural sources of cherts and obsidians are relatively rare. This proposition is not supported, and in the Mouth of the Chilcotin region, there is a slight tendency for vitreous basalt materials to be carried to later stages of reduction than chert material. However, the Mouth of the Chilcotin tools are all of essentially comparable size and complexity, regardless of raw material. This analysis demonstrates that the acquisition of raw materials is largely embedded in other settlement and subsistence ac-

tivities. This is not to say that tools were not economically made nor curated; bivariate graphs of the raw material composition of debitage and tool assemblages demonstrate definite tool curation and tool replacement patterns.

The second hypothesis tested is that regardless of raw material factors, curation and maintenance of tools was a major determinant of assemblage composition. This proposition is partially supported in the raw material bivariate graph analysis, and is also supported in an application of Ebert's (1979) model of tool variability. In this analysis, sites are essentially split between those with small, complex tools and those with larger, simpler tools. A new model of assemblage variability in relation to group mobility is presented, where debitage figure prominently in relation to the simple abundance of tools in assemblages. I suggest that the total length of time that a site is occupied will determine how much late stage/maintenance debitage, in relation to other debitage, will be deposited, and also that the number of tools deposited at sites, regardless of type, is also determined by length of occupation. This analysis provides groupings of assemblages that are most interesting in that housepits appear to be of three different sorts: long term, moderate term and short term. Other assemblages are interpreted in similar fashion by their similarity to the various housepit assemblages.

The final hypothesis tested is that a set of five site occupation purposes across the four regions can be reliably predicted on the

basis of tool and debitage co-associations. The first step here is to devise a shortened, functionally interpretable tool classification from the original list of tool types. This is accomplished by a presence/absence cluster analysis of most tool types, and four clusters of tools are interpretable, using Binford's (1979) terms of reference. Tool clusters are inferred to be personal gear, site furniture, generalized maintenance tools, and broken, exhausted tools.

These tool groups are then combined with a condensed debitage classification as suggested in the reduction factors analysis, and used to predict site types of housepits, lithic scatters, lithic scatters with housepits, lithic scatters with cachepits, and lithic scatters with firecracked rock. An overall success rate of 73.68% accurate classification is achieved with stepwise multiple discriminant analysis, that shows personal gear and bipolar cores are the most useful variables in the analysis. The significance of these variables is then tested with a chi-square test, which offers support for the more complex mathematical solution of the discriminant analysis. The significance of Binford's suggested variables of personal gear, and core reduction variables are supported in this analysis. Finally, the analysis attempts discriminant analysis of the five site types using the same variables and sites, but without site F8:1. Classification accuracy now rises to 81.08%, and again personal gear and bipolar cores are the significant variables obtained.

The most significant findings of the multiregional analyses are the tool curation and replacement patterns evidenced in the raw material analysis, and the occupation duration findings of the evaluation of Ebert's (1979) model. Most findings are in agreement with Binford's (1979) expectations for assemblage variability based on his Nunamiut Eskimo studies, except that his expectation that residential locations should demonstrate the least amount of variability (1979: 267) is contradicted here. It is clear in the analyses that excavated housepit assemblages are highly variable. If lithic scatters with housepits are also considered residential sites, then residential assemblages among Interior Plateau groups are much different from Nunamiut Eskimo patterns. If the Interior Plateau peoples were less mobile than the Nunamiut, then more kinds of activities, and thus greater variability, is expected at residences.

To summarize the findings of the multiregional analyses, housepit variability patterns are used as a "baseline" to group sites by inferred occupation spans and presence or absence of housepit/cache-pit and firecracked rock features. Small, short term sites offer the best evidence of discrete activities, since tool replacement and curation processes are clear when only a few items are left at sites. Large, long term assemblages such as those resulting from extended housepit occupations are essentially a blend of multiple technological and subsistence processes. Short term housepit occupations reveal specific instances of the kinds of behavior that re-occurred in housepits. This appears mainly to be "gearing up" activity, but housepits also evidence instances of outright garbage disposal.

Lithic scatters resulting from the activities associated with processing and storing salmon and probably large mammal resources must be considered a different sort of residential residue, but these also evidence extreme patterns. Those lithic scatters with cachepits that are inferred to result from short term occupations seem to be more clearly related to those with firecracked rock features in that they contain relatively large amounts of maintenance residues.

In all cases, the curation, replacement and repair of tools made of different raw materials is a complicating factor in understanding the effects of settlement strategies on lithic assemblages. It is important to know characteristics of abandoned versus curated tools. Unfortunately, time limitations precluded a study of the tools that would identify relative stages of exhaustion. In any event, while all raw materials except granular basalt appear to be equally maintained and used to make similar kinds of tools, curation and maintenance appear to operate independently of settlement strategy, except in the short term occupation situations.

## 7.2. Conclusions

This study has made two major contributions to current archaeological research in general and to Interior Plateau archaeology in particular. The first is the demonstration that general manufacturing stages of chipped stone tools of several forms can be reliably inferred from the quantitative analysis of lithic debitage. The second is that reduction stage information is a very informative

means of inferring past processes of assemblage formation due to lithic technology and settlement strategy factors. The research shows that there are many cross-regional regularities in such processes, and implies that large scale attempts to derive reliable culture histories can use multiregional data, yet need to consider more fully the kinds of sites that the information is retrieved from. The most reliable data would appear to be in small assemblages, regardless of context. I would suggest that future studies be directed more intensively at small sites, so that the cumulative assemblages at larger sites can be better understood. The point is that since the analyses in the present study have shown lithic technology to be largely embedded in settlement strategies, lithic remains can be expected to change as the operations of settlement and subsistence systems change, and in predictable fashions.

The reduction stage classification can be seen as being analogous to Binford's (1978a) "utility indices" for caribou anatomy. The reduction stage model and measures enable technological strategies to be modelled in new ways, and like the "bulk" and "gourmet" curves of caribou usage, the curation and replacement graphs for tools and debitage of various raw materials provide fine-grained evidence of the operational characteristics of settlement systems in general.

I would suggest that future research on the Interior Plateau be directed to providing detailed information on lithic raw material sources, so that patterns of mobility can be tied to constant

locations. Secondly, more experimentation along the lines of that in this study needs to be undertaken, tool forms need to be more closely related to debitage variability, and raw material factors need to be more intensively examined.

This study has several deficiencies that can be corrected with future work at separate locations, and with the assemblages analysed here. The most severe of these concerns data, sampling and the representativeness of the individual lithic assemblages as well as that of the sites within the separate regions, and across the central and southern Interior Plateau in general. Some of the interpretations offered here for the transect-collected Hat Creek sites would perhaps be altered with more complete samples. Equally important is the completeness of the regional samples. The Eagle Lake, Mouth of the Chilcotin, and Hat Creek sites were located with regional sampling methods, but the Lillooet assemblages were not. Furthermore, most ELP surface lithic assemblages, and MOC assemblages have been studied, only about 1/20 of the known HAC sites and very few LIL region sites have been analysed here. The rationale in all cases was to study sites believed to be late prehistoric or "Kamloops Phase" (less than about 2000 years) in age, but this is by no means certain for most sites.

As for methodological shortcomings, the debitage reduction stage classification relies on a meagre sample of tools in relation to the quantity of archaeological material that was analysed, yet the sample of 2657 experimental flakes is 18% of the archaeological sam-

ple of 14,541 archaeological flake debitage. However, the relative proportion here is spread across several kinds of tool products in the experiments, and is thus more representative than any other reported lithic reduction experiment.

Time limitations and the desire to investigate large-scale patterns precluded more intensive manipulation of the data base. Two particular kinds of analysis were not undertaken. The first is attribute analysis of the tool assemblages. Using the variables gathered for each tool, major patterns of variability could have been examined to allow tools to be classified on the basis of reduction and use-related factors. The second analysis that was omitted is detailed examination of the reduction stages evident in each raw material at each site. This approach would have tripled the debitage data presented here, and greatly complicated interpretations. I believe that the debitage vs. tool raw material composition analyses alleviate most of the lack of information that could have been obtained in such analyses, but this should be regarded as a proposition for future study.

The research presented in the preceding pages has shown how archaeological awareness of meaning in lithic assemblages has developed, from normative origins where inferences were framed in culture-historical and organic evolutionary terms, to current models of assemblage variability in relation to hunter-gatherer settlement mobility. The current study has added evidence of the importance of tool maintenance and curation factors, such as have been noted in

Mousterian (Fish 1976, Munday 1976), Acheulian, Archaic (Collins 1974), Paleo-Indian (Goodyear 1979) and the Hat Creek (Pokotylo 1978) assemblages, and has provided an advanced method of reconstructing tool and debitage manufacturing, maintenance and disposal patterns with complete samples of archaeological materials. The Mousterian problem is not unique to European Middle Paleolithic cultures, but is basic to lithic assemblages everywhere. Stone tool remains can be used to inform us of historical, ideological, social and technological processes, but relevance and accuracy in reconstruction require adequate empirical criteria. Furthermore, those criteria are subject to change, and both new models and proper analytic methods cannot be constructed in isolation from archaeological history itself.

## CHAPTER 8

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APPENDIX I.

ANTHROPOLOGY 406

Reduction Experiment Outline

October 1980

## Anthropology 406

Analytical Techniques in Archaeology: R. G. Matson, Professor

LABORATORY ASSIGNMENT OUTLINE - October 27

LITHIC REDUCTION ANALYSIS

(with Marty Magne, ANSO 0307)

The purpose of this lab assignment is to teach you ways of recognizing stages in the reduction - manufacture of chipped stone tools. We will be conducting controlled experiments in tool making and debitage recovery, using methods I have previously used and found to be very informative.

By this time, you should be sufficiently familiar with chipped stone tool making to be able to understand the importance of platform preparation, decisions to use soft or hard hammers, how to remove thick spots from bifaces, and the slight differences in technique required to work obsidian and basalt. If you feel you are still having problems that are not simply related to lack of acquired skill, for example, if you don't understand the mechanical logic behind platform preparation, then please do not hesitate to consult myself or Dr. Matson.

The goal of these experiments is to provide information towards increasing the reliability of reconstructing tool manufacturing stages using lithic debitage, and at the same time decreasing the amount of time required to undertake debitage analysis. This assignment requires you to undertake an initial step of the experiments - I will be taking the analysis to further and final steps.

Outlined in the following pages are the kinds of tools I want you to make, the procedures you are to follow while making the tools and recovering the debitage, and the classification of debitage that will complete your participation in the experiments.

A. Tools to make: Each person should try to make at least two of the following tools: one from obsidian, the other from basalt. Please, no mini-tools resulting from multiple errors in manufacture. In this business, knowing where to stop is just as important as knowing where to begin.

<u>Tool Code</u>	<u>Description</u>
UF	Flake, unifacially retouched along one straight margin.
BF	Flake, bifacially retouched along one straight margin
EF	Flake, made into an endscraper, unifacially retouched at least along one end which is convex in plan view.
UC	Ovoid uniface, circumferentially retouched.
BC	Ovoid biface, circumferentially retouched.
BL	Lanceolate biface, extensively flaked, thinned
PP	Stemmed or notched projectile point, this need not be too complex
BP	Bipolar core - using bipolar reduction, remove flakes which you feel would be suitable for use as cutting/whittling tools.
PE	Pièce esquillée - make tools you feel would be suitable for use as wedges used to split open wood or bone materials.

## B. Procedures:

### 1. Core Reduction:

- I. Select basalt and obsidian cores, 1 of each large enough to supply you with the material needed to make the tools, plus, two small pebbles for bipolar reduction.
- II. Weigh, measure, and draw the cores. Include a scale on your drawings, but do not attempt too much detail.
- III. Lay out a clean canvas tarp or plastic over which to do the flaking. At this point teams will be made up consisting of two people each - one to do the flaking, another to recover each flake upon its removal and place the flakes from each reduction event in individual cardboard trays. Each team should also have an assortment of hammerstones, antler hammers, leather pads, goggles, (to be worn by both team members), small cardboard trays, and recording forms. The forms are to be used by the knapper, to indicate by flake number at which point in the manufacturing process he/she feels they are changing technique or moving to a distinct new stage of manufacture. There is also ample room for rough notes detailing difficulties, changes in hammer type, etc.

It is quite probable that at some time during the experiment, the person recovering debitage will not be sure of the order of removal of certain flakes. The best way to solve this problem is to place the flakes back on the core or blank being reduced, but do not stall for long trying to

figure this out. The knapper should try not to overload the recovery person. Again, note any trouble you have, on the forms. It is also likely that some blows will remove more than one flake simultaneously, or that flakes will break upon removal. Here assignment may be arbitrary.

At the completion of core reduction, each team should have several stacks of trays (do not pile them so high they tip over), ordered first to last from bottom to top, with slips of paper in the trays numbering the flakes. Be sure to identify your stacks by your last name.

## 2. Blank Reduction

- I. From the core debitage, select the blanks you intend to use for further reduction, writing down which flakes you have removed.
- II. Weigh, measure and draw these blanks. In drawing, concentrate on accurately outlining flake scars on the dorsal faces of the blanks. Do not attempt any kind of shading even if you are a gifted artist.
- III. Reduce each blank to the desired tool form, using the two-man procedure. Use the forms again to note any platform preparation, type of percussor, pressure flakers, etc. If breakage occurs, do not attempt to salvage the piece

unless it is quite large, but keep the debitage produced up to that point intact - it is still useful information. IV. At the end of this part of the experiment, each team should have a set of trays for each tool produced, each set of trays clearly labelled as to knapper, tool, and order of flake removal, and a set of forms detailing the knapping methods.

### C. Cataloguing:

Now you will have to catalogue the materials, so that they can be used in the latter part of this assignment with no fear of losing provenience. Cataloguing should proceed using a set of codes, as follows:

	Basalt	Event		obsidian	flake number
	/	/		/	/
M:	B:	UF:	36:	1	
/	/	/		OR:	M:
your ID	tool	flake no.		ID	Core
(Magne)	(unifacial	within event			reduction
	ret. flake)				

Catalogue only those flakes greater than 5 mm. in any dimension, on their ventral faces. Flakes smaller than 5mm. but larger than 2 mm. should be individually bagged with catalogue numbers placed on a piece of paper. Flakes smaller than 2 mm. can be catalogued together, by core or blank from which they were produced.

D. Analysis - (The results of this are not used in the dissertation)

Once everyone has completed a set of tools and debitage, the next step will be to swap debitage (not tools) with another person from another team.

I. Take the debitage given to you, and sort the debitage into flakes with remnant striking platforms (PRB's), and flakes without striking platforms (Shatter).

II. Weigh each piece of debitage to the nearest gram, and sort the debitage into the following classes:

less than	1 - 2	2 - 5	5 - 10	greater than
1 gm.	grams	grams	grams	10 grams.

SHATTER

PRB's

III. Count and weigh the debitage falling into each class.

IV. Using raw counts and weights, and relative measures such as percentages or indices, what inferences can you make concerning the kinds of tools made, the stages of reduction represented, and techniques used?

Completing the "Reduction Recording Form"

1. Event: The use of these rows and columns should become clear in the reading of the remainder of this note. Briefly, whenever you start a new stage in tool manufacture, OR change technique, circle the appropriate flake number, which should be available from the debitage recovery person.
  
2. Stage: In general, follow Collins' (1975) use of the terms "primary" and "secondary" trimming. I suggest the following stage cut-offs for the tools you are going to be making:
  - UF: Stage 1: Retouch the flake along one margin. COMPLETE
  - BF: Stage 1: Retouch the flake bifacially along one margin. COMPLETE
  - EF: Stage 1: Retouch the flake along the right and left lateral margins to produce an elongate, symmetrical form in plan view.
    - Stage 2: Choose either the distal or proximal end to retouch unifacially to an edge which is convex in plan view. COMPLETE (Note: endscrapers often have intact striking platforms, with the "scraper" formed at the distal end of the flake, but choose whichever end seems easiest.)
  - UC: Stage 1: Retouch the flake on all margins unifacially. COMPLETE

- BC: Stage 1: Retouch the flake on all margins unifacially.
- Stage 2: Retouch the flake on the opposite face, on all margins. COMPLETE
- BL: Stage 1: Retouch the flake on whatever margins or faces required to produce a generalized lanceolate form in plan view. Do not bother here with thinning procedures. Platform Preparation may be required (see Below).
- Stage 2: Using appropriate platform preparation (SEE BELOW), remove flakes required to thin the biface, while retaining a lanceolate outline.
- Stage 3: Straighten edges, align and sharpen point, prepare platforms as required. (Note: you may find that you need more "stages" to complete your biface. Describe these in "additional comments".)
- PP: Stage 1: Retouch a flake along whatever margins, or faces required to produce a triangular form in plan view. This flake should be fairly thin to begin with. Use platform preparation as required.
- Stage 2: Remove flake required to thin the flake blank bifacially. Use appropriate platform preparation.
- Stage 3: Make notches, stem using pressure flaking. This requires careful isolation of flake platforms.
- Stage 4: Straighten edges, pressure flake the faces of the point. COMPLETE (Note: Again, you may find that

you go through more stages than outlined here, but please try to keep it simple. For a good idea of how far one can go in detailing stages of manufacture of complex items, see: Flenniken, J. Jeffrey; "Reevaluation of the Lindenmeier Folsom: A Replication Experiment in Lithic Technology." American Antiquity 43 (3): 473 - 480. 1978. Don't even try to copy Flenniken!)

BP: Stage 1: Seat the pebble on a firm anvil, preferably with a "pit" so the cobble will not slip. Strike the proximal end of the pebble with a hard hammer, remove flakes.

Stage 2: The pebble can be rotated, or more blows can be directed from the same orientation as in Stage 1. Continue until you can no longer hold the core for fear of damaging your fingers. You might try to think of ways the core could be held with no danger of harming yourself. Use here the "other" column in "technical details", to mark those flakes you think would be useful as blanks for other tools.

PE: Stage 1: Use the bipolar technique described above, but this time your intention is to form a tool that can be used as a wedge.

Stage 2: Any retouch you need to straighten the edges of the tool.

3. Technical Details: Technical details are to be checked off in rows corresponding to the "flake numbers" of flakes produced while the particular detail is operative. These details are not mutually exclusive; usually several columns will be checked off for any single flake number. For example, if an antler billet is used to remove flakes from the proximal end, dorsal surface of a flake blank, then the three columns "soft-hammer", "proximal mar.", and "dorsal" would be checked off. Any techniques you used that are not covered here, can be added in either of the three columns left in "other".

Hard-hammer: Using a stone to remove flakes by percussion.

Soft-hammer: Using an antler billet to remove flakes by pressure.

Pressure: Using a pointed antler tool to remove flakes by pressure.

Platform Preparation: The terms "platform preparation" encompass several ways of modifying flake blank (or "preform") edges to provide more secure platforms for either percussion or pressure flaking. Edges can be abraded or "scrubbed" unifacially or bifacially with a rough stone, starting at one end of the blank and working to the other, or circumferentially; individual platforms can be "strengthened" for pressure flaking or the removal of thick spots by removing material which overhangs the dorsal face of the flake you intend to remove, using either a stone or antler. Crabtree (1972: 84) defines platform preparation as follows:

" The grinding, polishing, facetting, bevelling of that part of the platform to receive the applied force. Usually done to strengthen the platform in order to carry off a larger flake."

Isolated: This is meant to be in opposition to "circumferential", or lateral or end margins when these are used to indicate that a technique has been applied all along that particular margin. For example, if you are removing a thick spot with soft-hammer percussion, and that thick spot is on the distal margin, then the columns "soft-hammer", "isolated", and "distal mar." will be checked off.

Right margin: This refers to the right margin of the flake blank when the ventral face of the flake is facing you. Can be used alone to indicate that the particular technique was applied along the margin, or in conjunction with "isolated" to indicate that the technique was applied to a specific location.

Left margin: Similar to above, but referring to left margin of the blank when its ventral face is facing you.

Proximal margin: The end with the striking platform, or in the case of flake shatter, the end of the flake where the platforms should be, as indicated by ripples or what is left of the bulb of percussion.

Distal margin: Similar to above, but refers to the end opposite the platform.

Circumferential: This column is to be checked when you apply a technique to all the edges of a flake blank.

Dorsal: Refers to the dorsal face of the flake blank; the face bearing evidence of previous flake removals.

Ventral: Refers to the ventral face of the flake blank; the face that is fresh from the core; bears no evidence of previous flake removals, and exhibits the bulb of percussion, ripples and perhaps erailure flakes or hackles.

Thinning: This column is to be checked off whenever you are attempting, by percussion or pressure, to conciously thin the cross-section of any of the tools.

Notching: Check this column off when you start to produce the notches or stem of your projectile point, by either percussion or pressure flaking.

Other: There are here three potential columns that you can use to indicate techniques that are not covered here. Check with me or Dr. Matson before you try anything too original.

# of Flakes: The number of debitage items produced each time the "core" is struck, or each time reduction of some sort is even attempted. Only flakes greater than 5 mm. should be counted.

ANTH. 406 REDUCTION RECORDING FORM

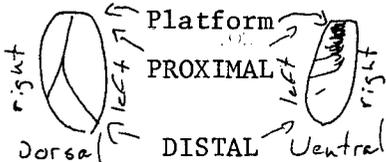
Knapper \_\_\_\_\_ Recorder \_\_\_\_\_

Item being Reduced (Material, Core or Blank No.) \_\_\_\_\_

Item being Manufactured (Tool Code) \_\_\_\_\_

Reduction Event Number	Circle Row Number	Stage (Check off stage init- iation in same row as flake number					Technical Details															
		1	2	3	4	5	Hard-hammer	Soft-hammer	Pressure	Platform Prep.	Isolated	Right Margin	Left Margin	Proximal Mar.	Distal Mar.	Circumferential	Dorsal Face	Ventral Face	Thinning	Notching	Other # of Flakes ↙	
1	21																					
2	22																					
3	23																					
4	24																					
5	25																					
6	26																					
7	27																					
8	28																					
9	29																					
10	30																					
11	31																					
12	32																					
13	33																					
14	34																					
15	35																					
16	36																					
17	37																					
18	38																					
19	39																					
20	40																					

Flake Blank Orientation



Additional Comments:

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