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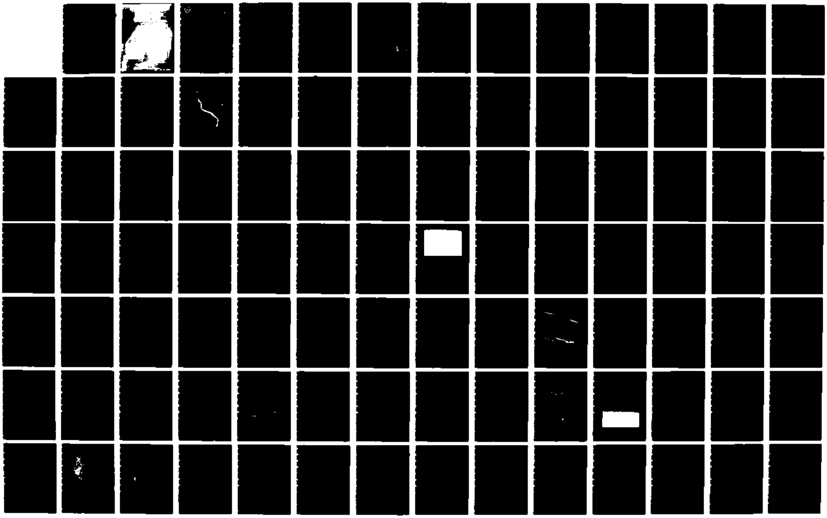

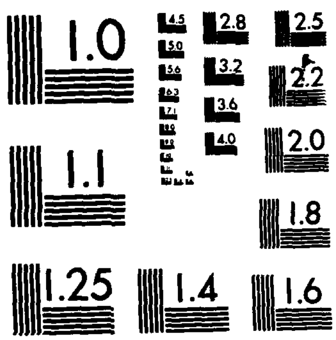

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REPLY TO
ATTENTION OF

SEP 26 1985

Planning Branch

Enclosed for your information is a report of a recent cultural resource testing program at the Chief Joseph Dam Project (enclosure 1) at north central Washington state. If you have questions about this report, please call Mr. Lawr V. Salo at (206) 764-3630.

Sincerely,

STEVEN F. DICE
Chief, Environmental Resources
Section

Enclosure

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

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Item 20.

Abstract

During 1982 and 1983, Central Washington Archaeological Survey conducted extensive text excavations at prehistoric archaeological sites 45OK196 and 45OK197, north central Washington. Funding was provided by the U.S. Army, Corps of Engineers, Seattle District as a part of the Chief Joseph Dam Cultural Resources Program. The study was conducted to assess the sites' cultural significance and to determine whether sediments at 45OK197 could provide data on the periodicity of flooding on the Columbia River during the past two millenia.

Site 45OK196 contained disturbed components of the Frenchman Springs and Cayuse Phases and is not deemed significant. 45OK197 is highly significant, consisting of 28 fluvial strata with 22 occupations dating from 1870 BP to the 20th century. Occupations, which rest on the surfaces of individual flood deposits, represent short-term hunting camps, spring base camps, a warriors' bivouac and a modern berry drying encampment. All occupations are little disturbed and contain well-preserved biotic remains and discrete artifact patterning. Mitigation is recommended.

The report focuses on the study of hunter-gatherer site structure. Nine dimensions are offered as potential means for inferring prehistoric resource utilization strategies from the archaeological record. The utility of those dimensions is evaluated by comparing expected values generated from the Sanpoil-Nespelem ethnographic model with data from 45OK197 occupations assumed to correspond to site-types in the ethnographic model. Most dimensions perform according to expectation; those that do not are discussed.

An appendix is included describing flood periodicity on the Columbia River, analyzed by comparing actual sedimentation frequencies at 45OK197 with hypothetical models of sedimentation to determine whether flood frequencies have varied during the last 1900 years. Results show that floods occurred more often before AD 1400.

DIMENSIONS OF SITE STRUCTURE;

THE ARCHAEOLOGICAL RECORD FROM TWO SITES IN OKANOGAN COUNTY, WASHINGTON

By
James C. Chatters

With Contributions By

Carol Ellick Chuan-Kun Ho Karin Hoover
Daris Swindler Hartmut Krentz John Blaisdel
Steve Lipsky Dianne Semko David Rhode

This report was prepared under Contract No. DACW67-82-C-0062 between Central Washington Archaeological Survey, Central Washington University and the Seattle District, U.S. Army Corps of Engineers.

The technical findings and conclusions in this report do not necessarily reflect the views or concurrence of the funding agency.

Abstract

During 1982 and 1983, Central Washington Archaeological Survey conducted extensive text excavations at prehistoric archaeological sites 45OK196 and 45OK197, north central Washington. Funding was provided by the U.S. Army, Corps of Engineers, Seattle District as a part of the Chief Joseph Dam Cultural Resources Program. The study was conducted to assess the sites' cultural significance and to determine whether sediments at 45OK197 could provide data on the periodicity of flooding on the Columbia River during the past two millenia.

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resource utilizatin strategies at least in the sizes of groups occupying camps, the duration and frequency of site occupancy, the numbers of plant and animal species (niche breadth), the degree of planning (i.e., storage) in utilization of exploited species, the complexity and degree of specialization in technologies and the variation among camps in the use of tools and species. We can be sure, that the archaeological record of hunter-gatherers reflects this multidimensionality; the search for one dimension in which we can always infer resource utilization strategies from the archaeological record is likely to be fruitless (Nelson 1984). In this report I explore the multidimensionality of archaeological data in an effort to isolate those dimensions with the greatest potential for the elucidation of resource utilization strategies of prehistoric hunter-gatherers.

Dimensions

Working from the dimensions of behavioral variability listed above, I offer 9 dimensions in which that variability might be expressed archaeologically. The behavioral dimensions and their possible entailments are as follows:

Group sizes: occupation area.

Duration and frequency of occupancy: discreteness of features, sizes of fire broken rock, and bone fragments, seasonal duration as indicated by floras and faunas.

Species utilization and intensifications (niche breadth): faunal/floral diversity.

Resource use planning: seasonal and/or geographic displacement of species.

Complexity and specialization of technologies:[1] diversity of tool and feature assemblages.

Variation in use of implements, facilities and species: variation in tool, feature and species composition within and among site types.

The relationship between each archaeological dimension and its presumed behavioral correlate is discussed below. Table 1 presents expected expression of each dimension in types of sites produced by forager- and collector-type resource utilization strategies. Anatomic part frequencies have been explored by others as a means for assessing mobility strategies so will not be used here.

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[1] *I do not include tool curation as a dimension here, since there is still considerable confusion over the meaning of that concept and its archaeological measurement (Nelson 1984).*

To summarize, collectors use logistical mobility and pursuit-type predation strategies to generate surplus foods during seasons of abundance for use in leaner times. It is little surprise, then, that collector strategies are characteristic of environments with geographic and/or seasonal disparities in resource distribution (Binford 1980). Specializing in a few resources (relative to availability), collectors have developed more formalized (curated), specialized technologies which they use in spatially distinct settings. Relying heavily on resource predictability and planning, they develop distinct patterns of land use that can result in the frequent, seasonal reuse of sites for specific purposes.

Caveats

Binford (1980) considers collector and forager types of resource utilization to be extremes, which he has described as a heuristic means for discussion adaptive strategies of hunter-gatherers. In reality most hunter-gatherers, especially in the temperate latitudes, are likely to belong somewhere between the extremes. It is productive to think of the annual subsistence cycle of human groups as a mixture of seasonal adaptive tactics which may range in their characteristics from forager-like to collector-like. Taken as a whole this combination of tactics is a behavioral representation of the group's overall resource utilization strategy (see also Davidson 1983, Torrence 1983). This will become clear when I have presented the resource use tactics of the 19th century Sanpoil-Nespelem and the expected archaeological record of those tactics.

Archaeological Referents of Resource Utilization Tactics

Binford (1977, 1978a, 1982) has shown how the patterns of ungulate procurement, butchering and consumption, patterns in land use and the extent to which a technology is curated tools are used, may vary within and between sites occupied by both foraging and collecting peoples. Following his lead lithic analysts (e.g., Fish 1981; Kelly 1984; Magne 1984; Nelson 1984; Camilli 1984, and others) have attempted to identify foragers and collectors or field and base camps from analyses of debitage or lithic raw materials. There is also renewed interest in butchering patterns and spatial partitioning among anatomical elements of ungulate skeletons (e.g., Davidson 1983; Speth 1984). Each of these efforts attempts to identify resource utilization or at least mobility strategy in materials produced by prehistoric peoples using but one dimension of variability in the archaeological data base.

Adaptive behavior of hunter-gatherers is, however, multidimensional. In the foregoing discussion, I have indicated that, all other things being equal, there is variation between and within bases and simply used, along with expedient tools, at field camps. The curated/expedient dichotomy, or at least an analog to it also exists among dwelling structures. At base camps, especially among sedentary or semi-sedentary hunter-gatherers, dwellings are often formalized, complex, permanent and made of components (poles, skins, mats, planks) requiring extensive preparation. All (Plains tipis) or part (mats of Plateau peoples, planks of Northwest Coast) may be carried from base to base or from bases to field camps where they comprise part of temporary structures. House sizes also vary between residential bases and between bases and field camps, depending on size of the economic unit and planned duration of stay. Residential bases ordinarily are larger than at field camps, a difference that seems to become more and more accentuated as hunter-gatherers become more sedentary.

Duration of site occupancy and frequency of site reuse are dependent on factors such as the duration of resource abundance, predictability of food resources and the distribution of fuel and water. Residential bases are generally used longer than field camps during the annual cycle. As resources become more predictable and spatially restricted, site reuse will become more frequent, with sedentism or near-sedentism the eventual result (Binford 1982). As base camps are moved throughout the year and as patterns of land use vary slightly between years, sites once used as residential bases may become field camps and field camps used for one purpose may become residential bases or field camps occupied for other purposes (Binford 1982). A trend toward sedentism will reduce this annual and long-term variation in the use of space.

Locations are the actual sites of resource procurement, and because collectors focus their attention on predictable, aggregated species of prey, some locations, such as the bison jumps of the plains, may be frequently reused by collectors whereas others may be used but once.

Binford (1980) suggests that collectors produce five kinds of sites: residential bases or "base camps", field camps, locations, caches and stations. Base camps, field camps, and locations have already been discussed and, as I have noted, these may be variable in size, activity content, and frequency and duration of use. Caches and stations are characteristics of collector-type predation and mobility strategies oriented toward extending the seasonal abundance of foodstuffs through amassing predictable, abundant resources. Stations are spots from which prey - specifically large ungulates - are monitored and caches are where the spoils of successful harvesting are stored for later use. Stations are not likely to be used by all collectors, since monitoring of game from a few points is more possible in woodland, marine, or treeless terrestrial environments of than it is in densely forested regions.

Collectors

Whereas foragers adapt to variable plant and animal distribution by moving people to resources, the mobility strategy of collectors is designed to amass resources and bring them to people. Dubbed logistical mobility (Binford, 1978a; 1980) this strategy is characterized by a low degree of movement by the entire group residing together, or low residential movement. This lack of residential movement and consequent distance maintained between consumers and resources is compensated for through the movement of subgroups or "task groups" (Binford 1978a) from the residential base to locations of high resource density. There the task group sets up a secondary or "field camp" from which members range individually or collectively to harvest foodstuffs. The products of task group labor are brought back to the field camp where they are mass-processed and prepared for storage in formal cache sites. This strategy allows a residential group to procure spatially separated but seasonally coincident foods in quantity, rather than choose between foods as foragers would have to do. Although Binford does not specifically mention the matter, it is clear from his formulation and from the literature on various Northwest hunter-gatherers, that in some cases resources can be amassed by groups or individuals working out from residential bases rather than secondary, field camps (e.g., fishing camps and root collection camps among Plateau peoples [Ray 1933], or seasonal villages along Northwest Coast and Puget Sound [Smith 1940; Haeberlin and Gunther 1939]).

Because of the aggregation and dispersal pattern of collector strategies, the size of groups in both residential bases and field camps varies markedly depending on the degree of spatial aggregation among seasonally available resources and the relative value of resources being collected simultaneously in different geographic areas.

A reliance on mass procurement and processing of foods for future use requires a high degree of advance planning and extensive monitoring of resource movements (fish, game, food), ripenings and locations. Accordingly, the predation strategy of collectors is consciously directed toward a few harvestable species. People move to specific places for particular foods which they actively seek. This is what Binford (1978a) has named a pursuit strategy (see also Pianka 1974:109 for a similar distinction between pursuers [collectors] and searchers [foragers]).

Complex facilities (wiers, game drives, ovens, drying racks, storage structures) and specialized implements (nets, leisters, root-grinding and seed-grinding implements) characterize a collector technology. Some facilities, such as game drives or wiers are situated not in camps but at resource collection locations, making some collector locations much larger in surface area than residential camps. There is a tendency toward use of curated tools, with tools being manufactured, repaired, recycled and discarded in residential environment than would a deposit left by collectors. This is not to say that foragers must by definition utilize all available species. The animals and plants upon which any group of people feeds will depend greatly on their concept of appropriate foods. It would not be at all unreasonable to think of big game hunters, such as those of the Clovis Phase of North America or Middle and Upper Paleolithic or Europe as foragers focused on large mammals.

The size of forager groups varies with local resource abundance, both geographically (compare for example the Hadza [Tomita 1966] with !Kung San [Lee 1979; Yellen 1977]), and seasonally (e.g., wet and dry season camps of Dobe !Kung [Yellen 1977]). The frequency of movement, and therefore the length of stay at each locality is variable depending on a large number of factors ranging from available biomass to the number of places suitable for settlement (Kelly 1983). The camp is a locus of all or nearly all manufacturing, maintenance, food and raw materials processing, consumption, and other domestic activities. The mix of these various activity types and the mix of specific activities within each type is likely to vary among camps differentially, depending on the degree of seasonal variation among plant and animal resources and the diversity in anatomical structure, body size and processing requirements among resources. Given the high mobility and opportunistic, predation strategy of foragers, implement technologies are themselves generalized and portable. As Yellen (1977) says of the !Kung, most of the forager household's possessions can be carried by one adult. Binford (1977, 1979) distinguishes between curated tools, items manufactured before they are needed, which are then maintained, repaired and recycled for repeated use and expedient tools which are made on-the-spot to fulfill immediate needs. He suggests that curated tools would be uncommon in proportion to expedient tools among highly mobile foragers. Certainly this is the case with dwellings, which are small, usually single-family affairs made quickly of local materials at each campsite (!Kung, MButi, Alyawara). Facilities (e.g., hearths) are generalized in form so that they can be used in processing most of the diverse foods foragers utilize.

To summarize, foragers employ a "mapping-on" mobility strategy, exploit suitable prey opportunistically, and therefore make extensive use of a wide range of species. They employ simple, generalized, largely-expedient technologies with variations in activity mix from camp to camp in proportion to the diversity and characteristics of species exploited. Depending on whether they are "tethered" to rare spots where critical resources can be found (water, fuel) or have available a large number of equally appropriate habitation areas, foragers may more or less frequently reoccupy specific localities (Kelly 1984). The duration of occupancy at each locality is also variable. According to Binford (1980) foragers commonly produce only two kinds of sites: residential bases ("base camps") and locations. Locations are places where resource acquisition takes place. A place where roots are dug or an animal is killed are examples of locations.

Resource Exploitation Strategies

The adaptive strategy for any human group will consist of various components including (minimally) interaction with conspecifics, prevention of hypo- or hyper-thermia, and resource exploitation. I will be looking at archaeological site structure and its formation from the perspective only of resource exploitation strategies.

Binford (1980) has identified two kinds of resource exploitation strategies, these he calls the forager and collector types. The main distinction between these strategies is their degree of future orientation. Foragers, such as the !Kung San of southern Africa (Yellen 1977) and the central Australian Alyawara (O'Connell and Hawkes 1981), gather their food during daily expeditions and consume it more or less immediately. Collectors operate with a future orientation, gathering and processing food in amounts far in excess of their immediate needs and storing the surplus. By mass processing and storage, collectors extend the time during which seasonally available foods can be consumed. The Nunamuit Eskimo are Binford's (1978a, 1980) classic example of collectors.

We can conceive of resource exploitation strategies as having at least two primary dimensions: mobility, or seasonal movements of people across a landscape (Kelly 1983:277) and predation, the activities by which animal and plant species are captured or collected and consumed.

Foragers and collectors are characterized below in terms of their mobility and predation strategies as well as variables in those dimensions, including group size, technology, activity variability among occupation areas, the frequency and duration with which individual occupation sites might be used and the number of different site types produced.

Foragers

Binford (1980) suggests that foragers utilize what he calls a "mapping-on" mobility strategy: that is, a strategy in which people move their residence from one resource area to another, bringing the residence as close as possible to the resources to be gathered during a series of daily excursions. The predation strategy is opportunistic, or what Binford (1978a) calls the "encounter" type in which acceptable prey animals or plants are taken in proportion to their occurrence in the environment; this has also been characterized as a "fine grained" use of environment (Pianka 1974:206). Certainly, under encounter-type predation we can expect that the actual pursuit and capture of prey species will be proportional to the net yield of animals (Pianka 1974:207) as well as to their seasonal abundance or availability in the local biotic community. Thus an archaeological deposit of biotic remains left by foragers is unlikely to reflect more closely the proportionate abundance of prey species in the local

In the following pages I present a systematic discussion of Binford's opposite forms of resource use strategy including the associated technology, group size, niche breadth, place use frequency and duration and intra-place variability in activity performance. Next,I will discuss the kinds of site created by each strategy, and predict the characteristics expected in each site in terms of 9 dimensions. I then compile data on the resource use tactics of the Sanpoil-Nespelem (modern native hunter-gatherers of the 45OK197 vicinity) in order to expose behavioral patterns that would affect structure of the archaeological record and model the structure of sites produced in various seasons by the Sanpoil-Nespelem based on the aforementioned nine dimensions. Finally, I analyze the data from 45OK197, use systematic analogy to identify occupation assemblages from that site with site types in ethnographic model (Chapter VII), measure those dimensions perceivable in each occupation (Chapter VIII) and compare results against expectations to determine which variables have the most potential as indicators of adaptive strategy (Chapter IX).

There are two facts here that may compromise the value of my results. First, we have not completely excavated any of the available assemblage; results are bound to be affected by sampling error. Second, the Sanpoil-Nespelem ethnography was written nearly 150 years after Eurasian diseases struck the area and over 80 years after the people were forced onto reservations. The assemblages from 45OK197 vary in age from a few decades to several centuries. The adaptive behavior of local peoples may have been severely affected by population decline and Euroamerican contact (Chatters 1981; Chatters, Dunnell and Grayson 1980, Campbell 1984; Ramenofsky 1982) as well as by evolution over a period of frequent climatic variation. This problem is mitigated somewhat when we consider ethnographies of other plateau peoples (e.g., Nez Perces, [Marshall 1971]; Yakimas [Schuster 1979]) and find similar patterns of resource use altered somewhat by enhanced mobility of horse transportation.

If the archaeological record expected to occur in sites produced by the Sanpoil-Nespelem adaptive strategy correlates closely with data from 45OK197, then the archaeological variables for discerning resource use strategies of the past have some utility. If there is no conformation, many reasons are possible, some of which can be singled out. They are: the inaccuracy of ethnographies, inappropriateness of the variables, the narrow range of activities or seasonal uses at the site, sampling error; others may be unknown.

CHAPTER II

ADAPTIVE STRATEGIES AND ARCHAEOLOGICAL SITE STRUCTURE

The strategies by which hunting and gathering peoples have adapted to their environments and the processes and conditions affecting evolution of those adaptations are currently holding the interest of both archeologists and cultural ecologists (e.g., Bettinger 1980; Jochim 1976, 1979; Keene 1981; Winterhalder and Smith 1981; Thomas 1983). Beginning with ethnoarchaeological studies of modern hunter-gatherers, investigators such as Binford (e.g., 1977, 1978a, b, 1979, 1981), Thomas (1983) and Yellen (1977) have attempted to generate an understanding of how adaptive behavior leads to formation of the archaeological record. They suggest that once we have knowledge of the differential forms of archaeological deposits - site structure - created by people with divergent strategies for coping with the environment, we can use this knowledge to infer adaptive strategies from the material residues of prehistoric peoples whose actions are not directly observable. Using such findings in conjunction with reconstructions of paleoecology for the cultural periods in which we are interested, we may proximally develop a scientific understanding of the conditions selecting for specific forms of adaptive strategy and, ultimately, understand the process of general evolution in hunter-gatherer adaptations.

The site structure approach is still in its infancy. Binford, the most influential architect of this line of inquiry, has initiated work on the subject by comparing ethnographic data on a wide range of historic hunter-gatherers and offering two extreme resource use strategy types. For each strategy type he has proposed a model of the kinds of archaeological sites produced (Binford 1980), the technologies utilized (Binford 1977; 1979), and the affects of faunal dismemberment practices and dispersal patterns on bone assemblages (Binford 1978a). However, we are still a long way from operationizing Binford's many provocative ideas with any degree of confidence in our results (e.g., Kelly 1984; Magne 1984; Nelson 1984). Before we can effectively proceed, we need a methodology for inferring forms of adaptive strategy from patterns in the archaeological record.

discussion of Sanpoil-Nespelem adaptive strategy; 2) a description of the sites and environs with focus on resources accessible from the site, plus a brief statement on previous investigations at these sites only; 3) description of data recovery procedures; 4) analysis pursuant to the ideas outlined in the conceptual framework; 5) description of data, including stratigraphic correlations and identification of occupation zones, fauna, flora, features, and lithics; 6) evaluation of the conceptual framework's utility; 7) conclusion; and 8) appendices including site evaluation, classifications, raw data, and reports of specialists.

level excavations, analysis and reporting over a period of seven years. Central Washington Archaeological Survey became involved in 1982, after the finalization of negotiations with local land owner Barney Owsley and with the Bureau of Reclamation made a new series of sites available for evaluation (Chatters 1984). The Chief Joseph Dam Cultural Resources Program has recorded 251 historic and prehistoric sites, evaluated 92 of these and conducted data recovery excavations at 18 prehistoric and historic sites. The result of this program will certainly enhance our knowledge of Columbia Plateau Prehistory, the Colville Tribe's knowledge of their past, and eventually, will lead to an expanded understanding of processes involved in the evolution of hunter-gatherer adaptations.

Report Format

This report is directed toward an understanding both of local prehistory and the interpretation of variability among artifact assemblages produced by people who subsist on wild food resources. The report is therefore methodologically oriented, presenting data on site content in the context of a problem important to the discipline of archaeology. As a result of this orientation, much of the raw data on which summary statements are made are presented as appendices, as is the evaluation of the sites' research potential. I have approached the data from this standpoint for two reasons: 1) to provide strong substantiation for arguments of site potential and importance; and 2) to demonstrate that discussions of broader scientific interest can be presented in a report basically designed to present data and site evaluation.

In keeping with this approach, I have elected to alter the reporting format to minimize rote presentation of topics such as environmental background, local history and history of regional research that so often appear in reports oriented toward description of a specific set of data. In so many instances, government agencies and private organizations pay substantial sums for "laundry lists" of biotic, geologic and cultural historical data that do not bear directly on the project at hand and that are not used in interpretation of site content. Such information can usually be found in readily available books or reports, some already paid for by the current funding agency. In the present case, I have previously presented such a background description, focused on local history, paleoecology, regional prehistory and geomorphology with other findings of the RM 590 project (Chatters 1984). Members of the Office of Public Archaeology's team have developed thorough, interesting documents summarizing the local environment (Leeds et al. n.d.) and previous archaeological research (Campbell 1983). None of these requires reiteration here.

Therefore, rather than follow the report format of the common cultural resources evaluation report (e.g., Niquette 1984), this document is comprised of the following parts: 1) an extensive chapter on the conceptual framework of this study, including an expanded

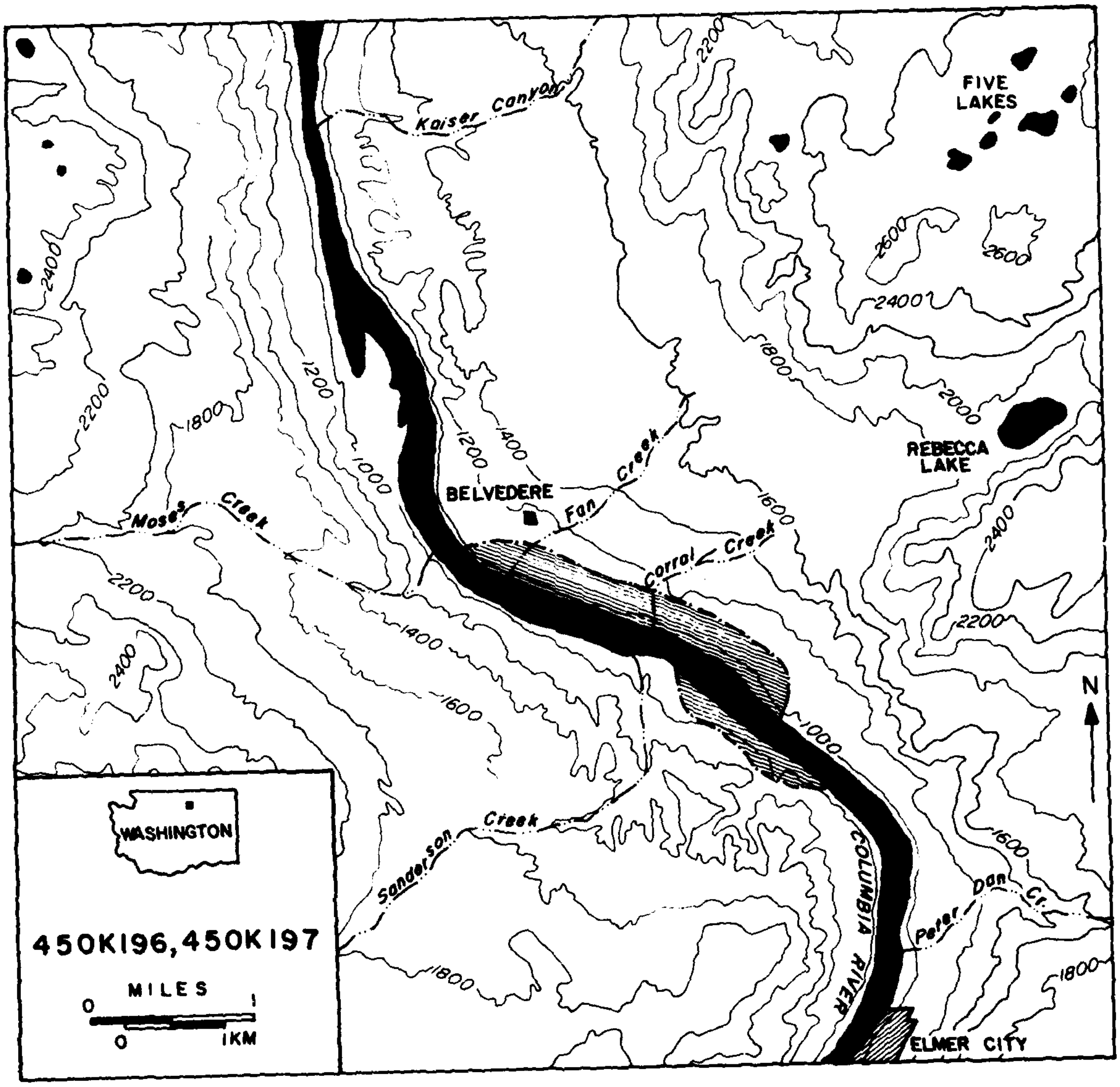

Figure 1. The RM 590 Study Area (shaded) and vicinity. Sites 450K196 and 450K197 are on the Columbia's north bank, adjacent to Corral Creek.

CHAPTER I

INTRODUCTION

Test excavations were conducted at archaeological sites 45OK196 and 45OK197 during the summer of 1982 and early fall, 1983. Central Washington Archaeological Survey, Central Washington University conducted the research under contract with the U.S. Army Corps of Engineers, Seattle District (Contract No. DACW67-82-C-0062, and amendments). The purpose of this investigation was to determine whether these sites might potentially provide information valuable to the scientific understanding of Plateau prehistory in general and local Columbia River prehistory in particular. Specifically, we were to determine the horizontal extent of each site; the number, depth and age of occupation zones contained therein; and to assess the information value (significance under 36 CFR 800.10) of each of these occupation zones. Under a modification executed in July 1982, we were also to remove, analyze and take responsibility for reburial of a human skeleton found at 45OK197. Under the terms of a July 1983 modification we were to include a consideration of the sites' potential to extend the Corps of Engineers understanding of the frequency and periodicity of flooding on the Columbia River beyond historic limits. Test excavations at these sites are part of a more extensive testing program that included 15 prehistoric sites in the vicinity of Columbia River Mile 590, north central Washington (Figure 1).

The Chief Joseph Dam Cultural Resources Program

Planning for the raising of the level of Rufus Woods Lake, the reservoir behind Chief Joseph Dam, occasioned the most intensive cultural resources evaluation and mitigation program yet seen in the northwestern United States. Corps of Engineers archaeologists began with an inventory of the reservoir's margins in 1976 (Munsell and Salo, 1977), and in 1977 the Office of Public Archaeology, University of Washington, received a contract for further inventory and site evaluations (Leeds et al. n.d.). Since that time the Office of Public Archaeology has continued a program including data recovery

Acknowledgements

Funding for this project was provided by the U.S. Army, Corps of Engineers, Seattle District under Contract No. DACW-67-82-C-0062 as a part of the Chief Joseph Dam Cultural Resources Program. Corps archaeologists David Munsell, Lawr Salo and Jonathan Maas have been consistently helpful in their desire to ensure that scientific archaeology can be accomplished in a CRM framework. We appreciate the latitude that allowed us to report 45OK197 data in a methodological format.

The Colville Confederated Tribes are to be praised for their genuinely sincere and forthright interest in maintaining a record of their past for future generations. Tribal Historian, Adeline Fredin has been especially active and successful in this endeavor.

As the cover indicates, this report is the product of many hands. Two field crews braved hawthorns, poison ivy, rattlesnakes and an often sauna-like atmosphere to quickly but carefully excavate each occupation surface. Gregory Cleveland supervised both crews with help from Jim Leavitt. John Flettre, Dianne Semko and Jennifer Yazzie maintained the unusually detailed plan maps, and Natalie Cadoret did a beautiful job recording stratigraphy. Laboratory Directors were Renee Pepoy and Alicia Schuster (Field) and Dianne Semko (CWU). The various analyses were conducted by Steve Lipsky and John Benson (lithics), David Rhode (plant microfossils), Darris Swindler, Hartmut Krentz and John Blaisdel (human osteology), Karin Hoover (sediments) and Ms. Semko and myself (fauna).

The report production crew was led by Carol Ellick, who illustrated profiles and artifacts. Chuan-Kun Ho prepared most of the other graphics, designed the cover and proofed various versions of text. Tables are the work of Barbara Porter; Larry Watson did an excellent job on photo reproduction of illustrations. Muffie Ekiss successfully did battle with a stubborn computer in preparing an attractive text.

I am especially indebted to William C. Smith for his encouragement of this methodological exercise, and to C.K. Ho for his many insightful comments on the content of the site-structure discussions. The report also benefited from comments by Drs. Kenneth Ames, Kenneth Reed and Mr. Salo. Remaining flaws in logic, scholarship and verbiage are, of course, my own.

Dr. James Crosby was consulting with us on the study of flood periodicity at the time of his death. He was a cheerful man with a sincere, lifelong interest in geological method; we will miss his companionship and thoughtful comment. This report is dedicated to him.

LIST OF APPENDICES

Table 1. Assemblage variation among site types produced by forager and collector strategies.

Dimension	Strategy	Site Type	Assemblage Characteristics
Occupation Area	Forager	Base	Uniform but may be characterized by nucleation and dispersal dependent on seasonal resource density.
		Location	Small to very small.
	Collector	Base	Variable with size greatest in seasons of resource concentrations, e.g., fuel and water resources.
		Field Camp	Variable but generally small, dependent on size of task group and spatial needs of processing technology.
		Location	Variable depending on natural or people-created resource concentrations, e.g., game drives can be quite large (Frison 1977).
		Cache	Variable due to suitability of conditions (situational).
		Station	Small.
Duration by Seasons	Forager	Base	Short to moderate (weeks to 2-3 mo.) dependent on resource dispersal.
		Location	Short.
	Collector	Base	Long but variable with frequency of residential moves (1-12 mo.)
		Field Camp	Short but variable up to 3 mo. (Binford 1980).
		Location	Very short.
		Cache	Not applicable.
		Station	Very short.
Floral and Faunal Diversity	Collector	Base	High diversity transcending seasonal limits. Moderate evenness with focus on a few species harvestable in quantity (situational component minimal).
		Field Camp	Low diversity, low evenness, focus on seasonally available species (one or a few: situational). Depends on focus of camp; if animals, plants diverse.
		Location	Single species.
		Cache	Low diversity, high evenness (lots of a few species)
		Station	Variable
Seasonal/ Geographical Displacement	Forager	Base	Absent.
		Location	Absent.
	Collector	Base	Common. Both seasonal and geographic, increasing with intensification and sedentism
		Field Camp	May be present or absent.
		Location	Absent.
		Cache	Always present.
		Station	Present or absent.
Firebroken Pock	Forager	Base	Dependent on frequency of reuse episodes between events of geologic deposition. If frequently used: small. If used once: large to moderate, dependent on duration of occupancy.
		Location	Probably none.
	Collector	Base	Small because of duration of occupancy, frequency of reuse.
		Field Camp	Larger than base, but variable with reoccupation frequency and *occupancy duration*.
		Location	Probably none.
		Cache	None.
		Station	Variable (if any), dependent on reuse, but generally larger than base.
Faunal Fragment Size	Forager	Base	Small due to complete consumption and possibly shortage due to lack of stored, backup resources.
		Location	Large, if any, due to minimal processing and short-term occupancy.
	Collector	Base	Very small due to complete processing as response to protein and fat shortage during prolonged occupancy.
		Field Camp	Variable. Large at hunting camps, fishing camps. Small at plant gathering camps due to fat/protein shortage.
		Location	Large.
		Cache	Large, if any. Complete joints or spinal columns (see Binford 1978a)
		Station	Variable?
Discreteness of Features	Forager	Base	Variable with reuse frequency but single occupation would result in highly discrete features.
		Location	*None*
	Collector	Base	Low due to both long duration and frequent reoccupation of sites.
		Field Camp	Variable, dependent on reuse, but single occupation episode would result in highly discrete features.
		Location	Same as field camp, but reuse of facilities such as drive lanes and fish concentration devices (e.g., Munsell, personal communication - Grays Harbor) may effect reduction in discreteness because of unity in purpose of activities and limitation of geographic setting.
		Cache	Variable with reuse (e.g., Rice 1968).
		Station	Moderate to low (Binford 1978b).
Faunal and Floral Diversity	Forager	Base	High diversity within seasonal limits. High evenness with pattern of species proportion dependent on net gain of each species (Pianka 1974).
		Location	Single species.
Tool/Feature Diversity	Forager	Base	Tools: Richness equivalent among bases with some seasonal variation in types represented. Equivalent in evenness of distribution. Features: Low among all bases, all seasons due to generalized processinn technology.
		Location	Minimal. Low richness, minimum evenness.

Dimension	Strategy	Site Type	Assemblage Characteristics
	Collector	Base	High richness, especially long-term bases. High evenness due to variety in activities performed (manufacture, maintenance, processing, consumption, domestic activity, tool discard).
		Field Camp	Tools: Variable between sites. Long duration: higher richness as number of alternate actvities increases. Low evenness. Short duration: low richness, evenness. Features: Low richness, low evenness. Features specialized for capture and/or processing of a narrow range of foodstuff and for consumption.
		Location	Minimum richness, minimum evenness.
		Cache	Tools: None expected if food cache, otherwise highly variable (tool kit vs. trading inventory), (e.g., Binford 1979). Features: Low richness but even use of all types
		Station	Tools: Variable. Features: Similar to foraging bases, mostly fires (Binford 1978b)
Interassemblage Variation in Tools, Features and Species	Forager	Base	Tools: Low variation within, moderate between seasons. Features: Low in all cases. Species: high due to opportunism of predation.
		Location	Tools and Species: High variation. Features: None expected.
	Collector	Base	Moderate between base types, moderate within base types with reduction in variation with increasing sedentism (Binford 1982).
		Field Camp	Tools and Features: High between type, low within type (i.e., a tendency to form discrete clusters in a dendrogram).
		Location	As in field camp.
		Cache	Tools: Highly variable due to rarity of tools in caches. Features: Low among all caches. Species Low to moderate due to narrow range of species amassed for storage.
		Station	High between and within site because of randomness of task performance (Binford 1978b).

Occupation area. This dimension is taken as a measure of the geographic space intensively used by people around their camps. Indirectly, it is used as a rough measure of the relative sizes of social groups occupying a site for a continuous period of time (Cook and Heizer 1965; Yellen 1977; c.f. Hassan 1981). Since one of the variable characteristics among camps and other sites used by hunter-gatherers is group size, occupation area is a dimension of site variability.

Fire broken rock. Stone boiling and the use of stones as a heat-radiating source for cooking and drying of foodstuffs both result in stone breakage. Like the stone in the previous example, fire broken rocks may be used repeatedly, until they are too small to effectively serve the intended purpose. Scavenging of rocks in camp debris will occur during both continued occupancy at a site and repeated visits to the same place. If rocks for cooking are locally rare, the longer a site is occupied or reused, the smaller the mean size of fire broken rocks may become and this figure might be a good measure of occupancy duration and repetition. As a measure it should be limited to sites of similar function as indicated by tool inventories, faunal and floral remains and features; the various purposes for which rocks can be heated may and often do require stones of different size (small stones for boiling, large ones as heat radiators).

Bone fragment size. Bones are broken up by various means: butchering (Binford 1978a; Schroedl 1973), marrow extraction, bone grease or collagen extraction (Binford 1978a; White 1952), gnawing by domestic or wild carnivores (Brain 1982; various others), trampling, and exfoliation (Behrensmeyer and Hill 1980). Exfoliation and carnivore breakage are distinguishable from human-caused breakage (Binford 1981; Brain 1982), but I know of no effective means of sorting out the effects of trampling. Ignoring for a moment the imponderables, the size into which bones of a taxon or anatomically similar taxa are broken is a rough measure of the degree of processing bones have undergone. As Binford (1978a) found in his Nunamuit study, bone is most broken up in areas of a site (or in sites) where joints and shafts are crushed before boiling out the collagen and grease; they are less broken up but still methodically shattered for marrow and less broken still by most butchering procedures (cf. Schroedl 1973). The degree to which bone is broken may therefore be an indicator of where a site falls along a trajectory from procurement to consumption, assuming that consumption is an activity of residential bases. We might also anticipate that bone fragment size would be proportionate to food or at least fat and protein shortage, since the net energy gain from bone crushing, which produces grease and collagen (gelatin) is considerably less than that from marrow extraction and less still from the stripping of meat off a carcass (Binford 1978a).

<u>Discreteness of features</u>. A feature created as people perform one <u>activity a single time</u> should be discrete and easily discerned archaeologically. As the same activity is performed in the same site area during continuous occupancy, however, some smearing of feature boundaries is likely to occur. After the passage of time, when people revisit the same site they may perform that activity in another place, robbing parts of the original feature (stones, poles) for use elsewhere and through other activities, disrupting the position of the feature's constituents. As more reoccupation of the same surface occur, disruption continues until the feature is obliterated. Consider for example the typical stone-surrounded campfire of modern Euroamericans. After the first use of a campsite, the stone circle is distinct and completely encompasses charcoal, charred wrappers and bones. If the group remains several weeks the hearth size grows and its position is altered slightly for better position relative to shifting winds. The entire stone ring, or parts of it may be moved, leaving a lens of ashes and trash to be trampled by the campers, scavenged by their dogs or blown about by the wind. After the site has been used for several seasons, there is a general scatter of rocks, ashes and hearth trash with one or more stone rings in various states of repair. Thus discreteness of features is an indication of both duration and repetition of site use. Repetition of site occupancy will lead to greater disruption of feature integrity than will continuous habitation.

Discreteness is a subjective assessment. I have devised a simple four-level discreteness measure based on the degree of horizontal displacement among hearth and shell/bone feature contents (Figure 24). Level 4 is most discrete, being the representative of a single event, brief occupation that has been left undisturbed. Level 3 shows some changes in fire positions and scatter of debris clusters resulting from a longer term occupation, but still represents a single period of occupancy. Level 2 is the result of a re-occupation of the same area, with construction of fires in new places, plus smearing and scatter of residue from the previous occupation. Level 1 is the result of multiple re-occupations; no pattern remains in what Binford (1982) would call a palimpsest.

<u>Duration of occupancy, by seasons</u>. This dimension uses the same sort of data as is employed to identify seasonality of site use (see Monks 1981). Duration of site occupancy is measured as the continuous set of months represented by faunal and floral indicators that occur in an occupation assemblage (see Chang 1972). We anticipate that foragers, especially in environments with inaccessible biomass or low biomass, will move residential bases more frequently than collectors in similar circumstances or than either collectors or foragers in highly accessible, high biomass environments (Kelly 1983). These distinctions may be discernable using this measure of occupancy duration. The measure is far from perfect, suffering from all the weaknesses of seasonality studies in general (e.g., Monks 1981).

Floral/Faunal Diversity Taxonomic richness (number of plant or animal species present) and evenness (proportionate representation among taxa present) of faunal and floral assemblages can be expected to vary between and within different resource exploitation strategies. The taxonomic diversity of floral and/or faunal assemblages produced by foragers should differ from that produced by collectors. Foragers employ an opportunistic or encounter-type predation strategy and should, therefore, utilize a wider range of species or utilize species in more nearly equal proportions than would collectors, whose strategy tends toward specialization. In a faunal assemblage produced by foragers, we would expect, overall, a richer taxonomic composition and a more even proportional representation of each taxon.

Among collectors, we would also expect extreme variation in both richness and evenness of the assemblages occurring at residential bases, various types of field camps and caches. Organized for the mass harvesting of one or a small set of plant or animal species, task groups operating at field camps away from the residential base can be expected to process and consume members of that set of species more often than any other foods. They would, therefore, leave behind archaeological assemblages the remains of those few species in far greater amounts than any other species consumed in camp. This contrasts with residential bases, from which some foraging may take place on an opportunistic basis. The residue of opportunistic predation will be mixed with remains of all species brought in by task groups working from that base plus all sorted foods. At caches, we would expect to find the few species on which people focus their subsistence, and each species would be well represented. Thus, we would find poor, uneven; rich and moderately even, and poor but even assemblages in field camps, bases and caches of collectors, respectively, while all forager bases would be rich and even.

Theoretical plant ecologists have developed various mathematically derived measures of taxonomic diversity that attempt to express the phenomenon in a single index (see Pielou 1969). These indices combine two dimensions of diversity, richness and evenness, an act that can generate spurious results. Kintigh (1984), Grayson (1984) and others (e.g., Conkey 1980; Wolff 1973) have pointed out that class or taxonomic richness of an assemblage varies positively with sample size, but diversity indices fail to take this fact into account.

While sample size affects measures of diversity regardless of the nature of classes being counted (i.e., lithics, ceramics or biota), three additional factors compromise the reliability of numerical indices of taxonomic diversity in archaeofaunal assemblages. These are both related to the differential identifiability of taxa at varying degrees of skeletal element fragmentation. First, given complete skeletal elements, not all members of every vertebrate class are identifiable to the same taxonomic level. Partially because of their greater size and the consequent visibility of distinguishing landmarks, bones of large mammals are nearly all identifiable by most analysts to at least genus level. As body size declines and behaviors become less disparate, as with small murid, cricetid and heteromyid rodents (mice) declining numbers of elements are identifiable below the levels of family or order. This problem is pronounced in fishes, where few elements of even the largest species can be identified below the family. In cyprinid and catostomid fishes (minnows and suckers), few vertebrae are identifiable even to family and most must be designated as order cypriformes. Pharyngeal bones of animals in the same fish families, however, can often be identified to genus or species level. Thus, whether or not a taxon is identified in an archaeofaunal assemblage and ultimately the reported diversity of that assemblage depends to a great degree on the skeletal elements present.

The second problem is differential identifiability of fragmentary bones from animals of varying size. Bones of larger animals, with more visible landmarks, can be identified at much smaller fragment sizes than their counterparts from smaller animals. Likewise, fenestrated salmonid vertebrae are identifiable in pin-head size fragments, whereas vertebrae of cypriform fishes are not recognizable unless an articular surface and at least one of various processes is present. An upshot of these facts is that more readily identifiable taxa, smashed into small fragments, may produce a number of identified specimens far larger than the actual number of skeletal elements contributing to the assemblage and may comprise a deceptively large proportion of identified bones. If bones of a taxon are unbroken or merely split in one assemblage while they occur as tiny fragments in another, that taxon might represent a larger proportion of the latter assemblage even if the actual proportion of the taxon among elements contributing to both assemblages was identical. Because of these factors, faunal richness may depend partially on the skeletal elements present <u>and</u> the sizes of taxa present; evenness is partly affected by taxonomic composition of an assemblage and the degree of fragmentation among elements of various taxa. These are problems when NISP is used (e.g., Grayson 1979) and will also be present to a nearly equal degree if MNI is the quantification measure. Add to these matters the problem of differential skill, confidence or chutzpah among faunal analysts, and the meaning of faunal counts from analyst to analyst and assemblage to assemblage could vary considerably even if the assemblages contained identical numbers of elements from each taxon.

Sample size, differential identifiability, differential fragmentation, and analyst bias are ignored by diversity indices. If indices (mathematical contructs) are used by archaeologists, we may devleop a false sense of security in the comparability of our results.

I have chosen to deal with these problems as follows: 1) comparisons among assemblages are ordinal only (i.e., A is less or more diverse than B; see Grayson 1979 for the same conclusion in regard to environmental reconstructions from archaeofaunas) <u>within</u> the set of data I have produced; 2) by representing evenness and richness graphically and making judgements of difference both mathematically (richness) and subjectively (evenness); 3) by grouping taxa according to anatomical and behavioral similarity and 4) using both MNI nad NISP values in separate assessments of both richness and evenness.

Grayson (1984) and others (e.g., Kintigh 1984; Conkey 1980) have used a two-dimensional plot to remove the sample size problem from assessments of richness. If sample size is the only factor affecting variation in the numbers of taxa among assemblages, a semi-log function plotting log NISP or log MNI (y) against taxonomic richness (x) should accurately describe the distribution of data points. Points falling significantly below or above the lines are more or less diverse, respectively.

Seasonal/Geographical Displacement By employing food processing and storage techniques, people using a collector strategy increase the period of time during which various taxa are available for consumption. Preservation of food can also increase its spatial utility, in that otherwise perishable items can be transported far from their point of origin for consumption elsewhere. As a result of these changes in the time- and space-utility of some resources, we should expect to find in archaeological assemblages left by collectors some taxa that are geographically and/or seasonally incongruous with other members of the assemblage. Thus, where bones or charred bits from a taxon occur in a context far removed from their known habitats or where such specimens indicate a season disjunct from that expressed in other taxa in the assemblage, we have seasonal/geographic displacement, an indication of food preservation. For example, excavators found salmon vertebrae at a site in the Columbia Basin 60 km (40 mi.) from the nearest perennial stream and by all other evidence occupied in early spring (Chatters 1980). Because adult salmon are anadromous and occur in area streams only from late spring to early fall and since perennial streams are necessary for survival of the eggs and fry, this occurrence is clearly an indication of the preservation and transport of salmon during the period of site occupancy.

Tool and feature diversity. I assume here that more complex, specialized technologies employ a greater diversity of tools and facilities than more generalized technologies, but that spatially segregated specialized activities would require but a few, task specific tools and facilities. Collectors' base camps, where tools of various technologies are produced, repaired and discarded, and where processing, storage, consumption and long term residence take place, should show higher diversity than forager bases, where from a more generalized technology is maintained. Both kinds of bases should have higher tool diversity than field camps, or locations or caches. Locations where single resources are obtained, either singly or en-masse should exhibit the lowest diversity.

Diversity can be measured in the same manner as faunal/floral diversity, being equally affected by problems of sample size.

Variation within and between site types. As people focus increasingly on a few resources, the degree of specialization and elaboration of technologies should also intensify. A comparison of the fishing techniques of aboriginal Northwest North America (e.g., Stewart 1977) with that of Nevada Paiute (Steward 1938) is a good example of this phenomenon. This elaboration and specialization should lead to differences in the characteristics of intra- and interassemblage variation among sites used by foragers and collectors. With their tendency toward intensification on a few, harvestable, storable resources, collectors should produce more and distinct kinds of technologies for use by task-oriented groups. We would, therefore, expect more variation among assemblages produced by collectors at field camps and a tendency for those assemblages to cluster more discretely into types. This is true of both features and tools as well as associated floral and faunal remains. Assemblages produced by foragers should, conversely be more variable with less tendency to cluster. Opportunistic foraging may produce one set of taxa in one instance, but another set of taxa in another instance, even in camps occupied simultaneously in the same environment. To the extent that various prey species require distinct procurement and processing techniques, tool inventories that are the byproducts of site residence may vary with the taxa acquired. Some other expectations are given in Table 1, where expectation for flora/fauna, tools and features are given separately.

Sanpoil-Nespelem Resource Use and Site Structure

The following discussion of Sanopil-Nespelem subsistence behavior is based primarily on Ray (1933:27-28, 57-108), Cline and others (1938). In it, I present the annual round of the RM 590 area's native population, with specific attention to patterns of mobility, predation, and mass harvesting and storage of foodstuffs. My purpose here is to generate a model of expected values for each of the aforementioned dimensions for each type of site produced by this Native American group.

Winter

During the coldest months, December through February, the Sanpoil-Nespelem dwelled in semi-subterranean pithouses usually clustered into village aggregates. In the RM 590 area there were three such winter settlements. Salqua'xuwi'x (glossed as "where the trail meets the river") was situated on the lower end of a point bar on the Columbia's north bank at approximately River Mile 590.2. The largest of the Sanpoil-Nespelem villages in this stretch of river, Salqua'xuwi'x, consisted of 15 houses occupied in winter by about 150 people (Ray 1933:16). There were two much smaller villages a short distance upriver: Ski'xu, about a mile (1.6km) above Salqua'xuwi'x, and Mxsxsa'lcmx' 1.5 (2.4km) miles farther. There were two or three houses and 40-50 inhabitants in each village. I shall refer particularly to the people of Salqua'xuwi'x, because of their habitation within the project area, and because their activities are most extensively documented.

While in the winter villages, people subsisted mainly on stored foodstuffs collected during more productive seasons of the year, (particularly dried roots, berries and salmon). These provisions had been amassed during the season(s) when they occurred in abundance, generally in more or less dense concentrations.

The only subsistence activity of any moment engaged in by winter village inhabitants was hunting. As with other important resources, (fish, roots) game are most efficiently sought during the season when they are concentrated. Snow and cold at higher elevations concentrate mobile, non-hibernating mammals at low altitudes, especially along river systems coursing through montane, or in this case peripherally montane environments. Snow also can hinder animal movement and enhance people's ability to find game and to follow wounded animals. Thus, because large mammals are geographically focused and more easily found in winter, people can minimize the energy costs of searching for and pursuing prey while maximizing the amount of food and raw materials (hide, bone, antler) obtained.

Winter hunting was an activity of *groups* of men occasionally accompanied by women, and was most often done as spring approached and stored provisions were becoming depleted. Many hunting trips were merely day-long forays from the village, but occasional trips took people from one to three days walk from home (Ray 1933). They carried few provisions, usually only a little dried salmon, planning to live off the products of their labor. Organized and led by hunters with recognized success and an appropriate guardian spirit, hunting parties would set up a camp of small, tipi-like mat huts at the mouth of a draw or canyon chosen for the hunt.

Hunting followed a pursuit strategy in which specific species were actively sought. Deer were the principal quarry, although the rarer elk were more desirable when they could be found. Not mentioned by Ray (1933), mountain sheep could also have been found in some numbers along the rocky bluffs of the Columbia.

The common procedure was a type of drive. With the best bowmen stationed at the head of the valley or draw, the other hunters and their dogs would drive the animals upslope to be killed. Hunters used an alternative technique along the Columbia River, where they would drive animals in the reverse direction, forcing them into the water where men in canoes could dispatch them. If, after several days, game could not be found, the hunt leader might designate one man to seek a smaller, substitute animal which this person would kill and the party would consume in an effort to change their fortune.

Successful hunts lasted up to two weeks because animal processing took place at the hunt camp. Animals were butchered either at the site of the kill if it was considered too far to carry or drag the animal, or back in camp. The animal's feet were first cut off, then the skin was removed. The animal was then stripped of its meat, the meat cut into thin slices and both meat and bones were dried on an open platform built over a slow, willow fire. After drying, bones were stripped of their meat, wrapped in mats and hung in trees for later use. Ray does not mention marrow extraction and/or consumption, but reports that the processing crew lived off products of the hunt. Considering the poor preservability of marrow in the bone (Binford 1978), it does seem likely that at least some longbones were broken for their marrow. Dried meat was taken to the winter village and consumed.

Skin processing, which required the use of brains for tanning may also have taken place at hunting camps, but Ray is not specific. Certainly this would have depended not only on the length of time spent at the hunting camp, but also on whether women, who performed this task, were members of the hunting party. Skin processing required use of two tools: scrapers of rib to remove fat, flesh and hair, and beamers of schist fractured by heating and attached to wooden handles.

Other animals were also hunted, but less frequently and by individual effort. Most carnivores were taken by dead fall. Entrances to dens of muskrats were marked in fall for hunters, who lay in wait in winter to shoot them as they emerged. River mussels were eaten at this time as, most likely, were some resident fishes such as sucker, chiselmouth and whitefish.

Early Spring

For people living off stored food and products of the hunt for large artiodactyls, early spring was the leanest period. As weather improved, game would begin to disperse from its winter range just as stores of fish, meat and vegetables were at their lowest. In late February or early March as the temperature warmed, people abandoned their underground existence for scattered, open camps nearby. There they lived in mat huts, foraging for whatever food was available. Men collected mussels from the streams and river, and hunted various animals while the women gathered roots and greens that sprouted earliest along the canyon walls.

Hunting, in fact all subsistence, seems to have been opportunistic at this time of year. Single hunters stalked increasingly sparse and scattered deer, hunted marmots, and took other small game, including grouse, when encountered. Some small, resident fish, presumably members of the trout, whitefish, minnow, sucker and perhaps cod families also were caught by net or spear.

Mid Spring

The leanest time came to an end around April, when the abundant roots of the upland reached the condition optimal for collecting. Various species of _Lomatium_, or biscuit root, bitter root (_Lewisia rediviva_), numerous species of _Allium_ (wild onion), and a variety of other plants with edible roots or tubers grow in rocky soils, where they exploit the fleeting moisture supplied by melted snow and early spring rains. Although they are both recognizable and edible as soon as they have sprouted and may have been among the roots collected while people foraged in early spring, these plants cannot be efficiently processed until later. Not until the ground around them has begun to dry and the seeds have set can one slip the black papery skins from the biscuit root. Soon after that the leaves dry, the stalks separate from roots and the plants can no longer be found. This period of availability and efficient processing is between early to mid April and mid May. Likewise, bitter root skins do not slip so easily until soil dries, but they must be dug before the flowers form or they become too bitter for palatability. Their optimal period is similar to that of biscuit root. Since members of these species are both large and abundant their characteristics may have occasioned the people's decision to wait until April before migrating to root digging grounds.

The semiarid, rocky soils of the plateaus and coulees south of the Columbia River are ideal spring root digging gounds and it was to this area that most people moved. Dispersed in groups of four or five families (Ray 1932:97) they set up temporary mat shelters using frameworks made from sticks obtained on the spot. Women of all ages proceeded to the root fields each day, gathering as much as a bushel of roots (here they were almost certainly taking the large biscuit root) using only a hardwood stick and collecting basket. Back in camp the roots were peeled and laid on mats to dry, if not consumed immediately. Digging sticks, if dulled by abrasion and impact with sharp stones, would have been sharpened by burning and scraping for the next day's work (Ray 1933:98).

While women gathered the year's supply of roots, men were reportedly either idle or engaged singly in hunting pronghorn, rabbits and other small game. Like earlier spring hunts, these daylight forays from the root camps were opportunistic. Although larger game may have been sought, it is clear that any animal would serve the purpose of a protein adjunct to an otherwise starch and roughage diet. This is again the encounter strategy of predation.

It has been suggested that men and women, active as they were in the basaltic lithosols of the Columbia Basin, frequently encountered microcrystalline, silicate stone in the course of spring activities (Leeds et al. n.d.). Men probably were involved in quarrying of stone for cutting and piercing tools and in the preliminary processing of this stone during the spring months. Men may also have served as an uncommitted labor force for transporting dried roots back to the river, where they were stored.

Since energetic diggers could quickly deplete local root stocks, camps were moved frequently, perhaps as often as every five to eight days, depending on local abundance of plants. For most, the root harvest lasted from 30-40 days, but some older women would remain to dig roots throughout the summer (Ray 1933:98, 99).

Other old and otherwise infirm people had remained with a few able bodied adults in the winter villages. Leeds, Dancey and Jermann (n.d.) suggest that these less-mobile people served as convenient guards for the growing stores of roots. How these individuals subsisted is left open to the imagination, but a tactic including opportunistic foraging by caretakers and consumption of roots supplied by relatives is probable.

Late Spring, Early Summer

Ethnographic reports are a bit ambiguous at this point. Ray (1933) states that people returned in May to rapids and stream confluences along the river to prepare for the approaching runs of steelhead (*Salmo gairdneri*) and spring chinook salmon (*Oncorhynchus tschawytscha*). He also states however, that camas (*Camassia quamash*) and other roots such as the ecologically associated wild carrot (*Daucus carota*) which bloom in May and June, were among the roots most important to the Sanpoil and Nespelem. These plants are most abundant in damp meadows at higher elevations, especially at mountain meadows near the steppe-forest ecotone. Either people divided into root digging and fishing groups or the two activities were conducted from the same home base.

Taking Ray's (1933) findings as more accurate than speculation, I suspect that the latter might be true. Sanpoil-Nespelem territory lies along the steppe-forest ecotone, and damp meadows occur in the Goose Lake, Nespelem Valley and Rebecca Lake areas north of the river and the kettle lake - dotted Waterville Plateau to the south. Parties of camas-gathering women could make daily sojourns into the meadowlands for roots while their men fished or prepared to do so. Small groups may also have periodically left the base camp and set up root camps when distance precluded commuting.

Larger than root or early spring camps, fishing camps were aggregations up to several hundred people (eg. at the mouth of the Sanpoil [Elliot 1914; Ray 1933:23]). There were from 60-70 people at Salquaxuwil during this season. Lodges were mat covered frames; no mention is made of summer habitation of the dark, probably damp pithouses, even when fishing camps coincided with village locations.

Men spent the early part of the fishing season catching suckers, whitefish, chub (actually chiselmouth [Acrocheilus acuteus] chub [Gila sp.] are not resident to this part of the Columbia), and other resident fish while preparing the riverbed for the larger anadromous species. Preparation consisted of constructing rock fences and channels to focus fish into narrow routes, and scaffolding from which these fish could be speared. Weirs also were constructed across tributaries to the Columbia, but no such streams existed in the RM 590 area. Fish spears incorporating detatchable, composite bone or antler tips and leisters were both used primarily for larger fish. Dip nets served for catching small fish and for obtaining salmon in rough or murkey water. Nets would have been the preferred tool during the June freshet, when rivers rose, increased their velocity and became clouded with sediment.

Summer steelhead and chinooks began to arrive in the latter part of May and people set about the summer's task of fish harvesting, processing and storage. All species of fish and eels were air dried, but salmon were the center of attention. The entire gutted carcass was dried, head and body separately, packed into tule bags and transported to the winter village for storage. Many fish were consumed on the spot, prepared by boiling or roasting of the flesh or by combining scrap parts in a soup with roots and berries.

Root diggers, also engaged in provisioning for winter, processed their harvest either in field camps or, if, they worked from the fishing camp, in the camp itself. Roots were either dried or, as in the case of camas, had to be baked in underground ovens to render them digestible. Columbia Platetau camas ovens were shallow basins a meter and more in diameter, lined with super heated cobbles or small boulders, covered by earth and grass or mats over which was lain the food to be cooked. Another layer of grass or mats was placed over the food, covered with earth and a fire was set over the hole. After many hours of baking the camas was black, sugary and ready for drying. Roots were pulverized with a basalt mortar and pestle and shaped into cakes which were dried in the sun. The result was a rock-hard cookie-sized object that had to be either boiled a long time or re-pulverized for consumption.

Late Summer

Salmon runs slackened toward August and people diversified their activities at this time. Some moved to other fishing spots in the hope of an improved catch and all fishermen took increasing amounts of whitefish (Prosopium williamsoni), sturgeon (Acipenser transmontanus) and probably various members of the minnow family (Cyprinidae). Suckers were considered indigestible at this time.

Women, freed temporarily from the task of preparing salmon for storage, spent much of this time gathering service berries (Amelanchier spp.), currants and gooseberries (Ribes spp.), hawthorn berries (Crataegus spp.), wild black berries (Rubus spectabilis) and other early ripening fruits. These berries are abundant in the riparian zone and canyon walls along the Columbia River. Some women left the base camps on brief berrying trips into mountains or to riverine groves some distance away.

Little hunting was conducted in summer. Most larger prey, especially deer, would be scattered and living at higher elevations (Erickson et al. 1977) and hunting would thus be a laborious and unpredictable proposition. The species Ray reports as having been actively sought at this time was the black bear, which fed from the same riparian groves as the women frequented, and for the same reasons. Bears, pronghorn and small game were hunted by lone bowmen on day trips using what was apparently an encounter strategy of predation. Ethnographers do not mention where animals were butchered and/or how the meat was processed.

Early Fall

By the beginning of September the salmon runs resumed, this time principally the silver (*Oncorhynchus keta*) and dog (*O. nerka*) salmon. Likewise, berries of the mountain habitats had begun to ripen. Already dispersed among various late summer fishing and berrying camps along the river, people disbanded further into small groups. Some moved to fall fishing camps to spear or net salmon. Seines were sometimes used in this endeavor, where the water was of even depth and the bottom smooth (Ray 1933:69). Fish were dried over fires in the huts during this season, because cooling temperatures did not allow for sufficiently rapid drying.

Other groups moved into the mountains to gather and dry large quantities of berries, dig roots and hunt. The roots collected at this time, called masa.wi by Ray's (1932:100) informant were roasted in the type of earth oven previously described. Hunters worked singly, stalking large mammals that were still dispersed over their range. There is insufficient information in Ray's narrative for me to state whether hunting was opportunistic or was focused only on such animals as deer and elk. Post (in Cline et al. 1938) states that hunters sought to provide a store of dried meat for winter, but Ray implies this was a winter activity.

Because of the dispersal of game animals, and small-scale patchiness of root beds and berry-rich groves, these small camps would have been moved frequently during the one to two months people remained in the highlands.

Late Fall

With the cooling of temperatures began the migration into winter quarters. Men, women and children laden with dried berries, fish, meat and no doubt raw materials such as antler, tule, Indian hemp and various woods and fibers treked back to the winter village sites. Houses had to be built, rebuilt or repaired, storage areas secured and

CHAPTER IV

TEST EXCAVATION TECHNIQUES

Work at 450K196 and 450K197 was accomplished during two field seasons: July, 1982 and September and October, 1983. Because of improvements in our knowledge of site contents after the first season's work and improvements in CWAS equipment and technique inventories, techniques differed from year to year. In general, work followed the two-stage procedure of preliminary and localized testing described previously (Chatters 1984). The preliminary testing phase included excavation of small, dispersed pits over the site's surface to locate and evaluate integrity of various artifact containing strata. Localized testing was an expansion of small test units in selected portions of a site to explore features or to increase our sample of artifacts and other data. In the paragraphs that follow, I describe the procedures followed at each site during each of the field seasons.

1982 Season

At the start of 1982 testing, the extent of our knowledge of the site consisted of notes from the April 1982 tests by the COE and Bureau of Reclamation, plus knowledge gained from a boat tour along the overgrown, undercut shoreline of 450K197 and a walk on the surface of 450K196. Our observations were: artifacts weathering from several buried soils in 450K197 were abundantly scattered on the reservoir bottom near the mouth of Corral Creek; at 450K196 there was no indication of former human habitation beyond a few mussel shell fragments and fire broken rocks on Corral Creek's cobbly alluvial fan.

Access to 450K197 was severely limited. A dense thicket of thorn brush and other riparian growth, interlaced with poison ivy and inhabited by large rattlesnakes made surface inspection nearly

In early 1982, representatives from the Seattle District, COE and Boise Regional Office of the Bureau of Reclamation put small shovel tests into 45OK196, 45OK197 and other sites in the RM 590 area to determine which should be tested further. They found enough materials of interest -- burned soils, bones, fire broken rocks and charcoal at 45OK197; shell and rock at 45OK196 -- that the COE included both sites under the test excavation contract with Central Washington University.

Aerial photographs of these sites taken in 1930 compare closely with pictures from a 1982 overflight. Neither portion of the T0 appears to have been much wider than today. The river's wide, flood scoured channel extended up slope to an elevation approximating the base of the present cutbank. Strata dip sharply near the cutbank, also indicating that original fluvial sediments of the T0 ended a short distance from what is now the terrace edge. Little if any of the site seems to have been eroded prior to the 1981 lake-level rise; extant sediments contain most of the artifacts originally deposited at the site. Exceptions to this high degree of site integrity are discussed in Chapter V.

Previous Research On The Sites

A Washington State University reconnaissance team originally noted these sites during a shoreline inventory conducted in the early 1970s after the initial development of Rufus Woods Lake (Lyman 1976). Believing this site and a similar area just upstream to be the last remnants of the 45OK6 recorded in 1949 (Osborne et al 1952), they conceived of the site as residual and of little significance. Lyman excavated two testpits in the area upstream from what we now call 45OK196 and found a mixed, cobbly, artifact rich matrix. Interpreting this as a secondary deposit washed down from 45OK165, he concluded that what remained of this site was probably of little value. However, neither 45OK197, 45OK196, nor the area Lyman tested (still designated 45OK6) was actually part of the site recorded by Osborne. What Osborne had reported was a large site (over 200m in length) containing numerous pithouses: this was the ethnographic village of Salquaxuwil (Ray 1933), which is over 1km above 45OK196, 197, and the present 45OK6. Had this confusion not existed, 45OK197 might have received more attention and even have been recognized as an important site much earlier.

Separate treatment was accorded all site areas when archaeologists from the Seattle District Corps of Engineers re-surveyed the shoreline in 1976 (Munsell and Salo 1977). These investigations reported a housepit and midden debris at 45OK197 and mussel shell and fire broken rock at 45OK196. Bryant (1978), evaluating the impact of tailwaters from the third Grand Coulee powerhouse on the cultural resources downstream, re-inspected 45OK197 and 45OK196. He identified a dark layer seen in the cutbank at 45OK197 as a possible housepit floor and assigned the site a high priority for further attention because of its extreme erosibility.

Conflicts between government agents and the owner of both sites, Barney Owsley, prevented the Office of Public Archaeology from testing this site in 1977; it was not until 1982 that the Corps of Engineers acquired easement rights over the property.

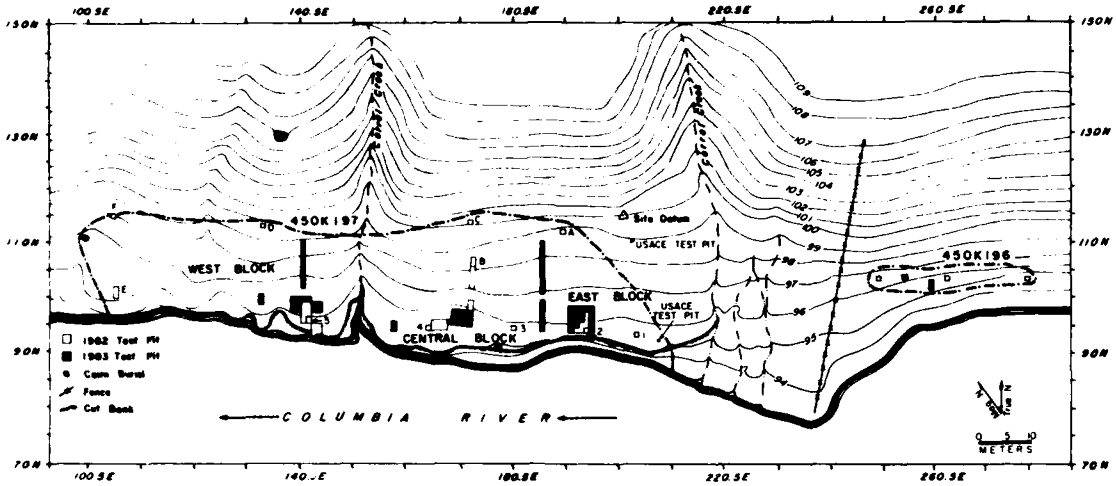

Figure 3. Sites 450K196 and 450K197, showing 1982 and 1983 excavations. Elevations are relative to a datum of 100m. Contour interval is 1m.

approaching level. The mean gradient of 450K197 is only 20 percent, and three nearly-level areas exist (east, central and west). The east area begins 15m downstream from Corral Creek and is 15m long by 7m wide. Separated from the east area by a small, spring-fed surface streamlet, the central area is the site's largest flat. It is 23mx7m and slopes at less than 7 percent. Much of this area is, literally flat. A secondary, spring-enhanced channel of Corral Creek has cut through terrace sediments, separating central and west areas. Averaging 0.5m higher than the central, west area is the smallest "flat" at 12mx8m. Its slope averages 12 percent with no truly level spots. Test excavations and observations of cutbank profiles have shown that human occupancy of 450K197 concentrated on these level areas throughout the site's history.

The fine sands of 450K197 have been eroding rapidly because of an eddy current that developed below Corral Creek's alluvial fan when Rufus Woods Lake was raised 10 feet. A test pit excavated 1m from the bank near Corral Creek in spring 1982, had been completely washed out by June of the same year. Erosion has slowed down somewhat since then, but over 50cm of bank was lost in some places during 1983. 450K196 shows little erosion, partly because its slope dissipates wave action, partially because its higher, gravel substrate is immune to undercutting, and partially because there is no strong current adjacent to the bank. Stratified fluvial deposits, with numerous buried soils and associated ones, fire broken rock and mussel shell can be seen weathering from the cutbanks of 450K197, especially in the east area adjacent to Corral Creek. Only a few mussel shells and fire broken rocks, again near Corral Creek attested to former human occupation at 450K196 before we began our testing. There was no evidence of housepits, either showing on the surface or in cutbanks.

live in open steppe areas of the high lava plateau; wolf and cougar were once commonly seen, but are now locally extinct and rare, respectively.

Cottontail rabbits live in sagebrush and riparian thickets, jackrabbits inhabit steppes and snowshoe hares occur in forests. Numerous small rodents, from ground squirrels to voles and pocket mice feed on steppe vegetation and there are Douglas squirrels and various mice in upland forests. Gophers are common. Large rodents include the aquatic muskrat and beaver, both found in pools and small streams but probably rare on the Columbia's mainstem because of its fluctuating water levels. Packrats inhabit most terrestrial environments (including brushy 45OK197); there are marmots in rocky or silt slopes and porcupines in thicket and forest.

Both anadromous and resident fish swam the rivers before Chief Joseph Dam stopped the migrations but now only a few residents and various introduced spiny-ray species inhabit the reservoir. Formerly, steelhead and chinook salmon migrated into the area in late spring and summer to spawn; coho and sockeye arrived from late August through October. Resident fish were (and still are) various suckers, squawfish, peamouth, chiselmouth, whitefish, cutthroat trout, dolly varden trout and burbot. Suckers always occur in shallow or near-shore settings, but others occupy a wide range of habitats, and only concentrate near shore or in shallow streams during spawning seasons (McPhail and Lindsey 1970). There are two species of river mussel (both rare in the area today): the freshwater pearl mussel (Margaritifera falcata) and a species with no common name, Gonidea angulata. Margaritifera inhabits areas of rapid, clear water and stable bottom, while Gonidea will tolerate siltier, slower water and can survive on a shifting substrate (Vannote and Minshall 1982). All the species I have mentioned would have been accessible within 2-3 hours walk from 45OK196 and 45OK197.

Site Descriptions

Sites 45OK196 and 45OK197 are separated only by Corral Creek, the small perennial stream that debouches across a small, rocky alluvial fan (Figure 3). The larger 45OK197 lies downstream, extending from 10m below the stream for over 70m. Its maximum width, in fact the maximum width of the T0, is 15m. The smaller 45OK196 is only 30m long and 10m wide. Both sites have elevations of 294-297m (954-963 ft. a.s.l.). Surface topography differs between the sites as does their geology (see Chapter V).

45OK196 slopes more or less continuously at a gradient of 33 percent, beginning at the base of a much steeper slope from the T3 level, and extending below the level of Rufus Woods Lake. Except for the alluvial fan just downstream, there are no surfaces even sagebrush and bunchgrasses; sites on higher elevation with similar topography support grasses. Bitterbrush (bunchgrass) replaces sagebrush on moister slopes, while dry, stony soils (lithosols) are briefly green in spring from leaves of a multitude of species, many of them growing from starchy, edible roots (e.g., biscuitroot, yellow bells, bitterroot, onion, garlic). There are moist meadows, small ponds and other depressions which may once have contained such edible roots as black camas and Indian carrot. Marshes in similar areas contain cattail and tule; Rebecca Lake is nearly filled by these plants. Conifer forest is rare, occurring only in low, protected areas and steep north facing slopes. Dominated by ponderosa pine, this community covers well under 1 percent of the land surface. Dense, nearly continuous forests of Douglas fir and pine begin just beyond the 8km perimeter.

Because of its tendency for erosive annual floods punctuating periods of greatly reduced flow, the Columbia supported little growth of riparian flora. Instead, bank vegetation varied from scattered pines in shaded areas to steppe and grasses. It is only where springs and streams provide year-round ground moisture that dense stands of deciduous brush occur. This riparian flora fills small draws and stream canyons, covering no more than 1 percent of the land within 8km of the sites. 45OK196 and 45OK197 are at the mouth of the Corral Creek draw system; assisted by the small spring, the water from Corral Creek has made possible development of dense growth of hawthorn, dogwood, serviceberry, chokecherry, wild rose, sumac, blackberry and various vines. The luxuriant growth has produced a thick mat of litter on the terrace surface, leading to incipient soil development in the sediments from 19th and 20th century floods. Vegetation on 45OK196 is entirely grasses, sumac, wild rose and various forbs.

Native faunas have been disrupted by increased human populations, agricultural development, introduction and maintenance of domestic stock, and creation of Rufus Woods Lake. Erickson and others (1977) and Leeds, Dancy and Jermann (n.d.) present a detailed discussion of local fish and wildlife, considering the seasonal presence and abundance of each species. I will not attempt to duplicate their efforts, offering only a summary.

Mule deer are still common in draws, bitterbrush steppes and open forests. They are most concentrated along the river bottom in winter, when average group sizes are over six individuals; otherwise they are more or less dispersed (Erickson et al. 1977). Elk were once present in open forest and grassland but are now largely restricted to unpopulated, forest regions. The varied, rugged terrain of canyon walls once supported herds of bighorn sheep and pronghorn roamed the steppes south and east of the river in early historic times. Bear are present in riparian thickets and mountain forests; coyotes, river otters, bobcats and various smaller carnivores are also found. Badger

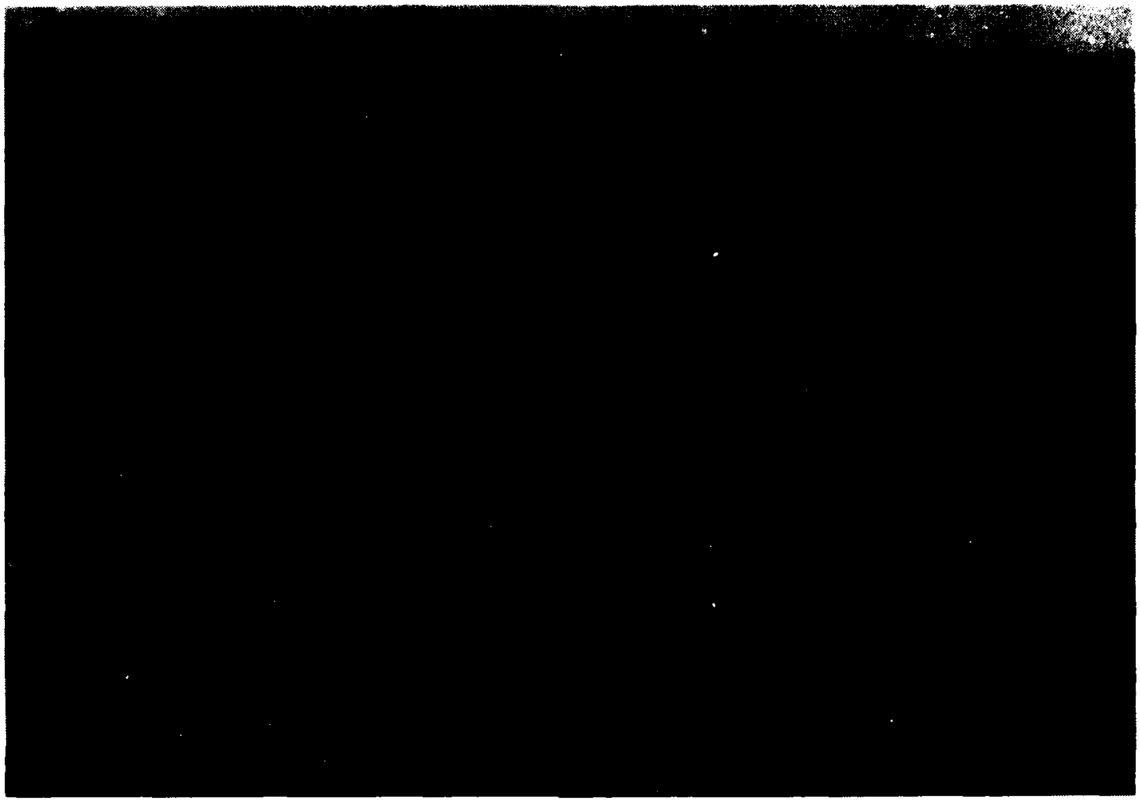

Figure 2. Environmental context of sites 45OK196 and 45OK197.

45OK197 are broad flats, steep escarpments, kettle depressions, narrow draws, broad canyons, and ridges of varying steepness and aspect. Most of the area, however, consists of slopes varying in steepness from near level to sheer cliffs; local relief is 627m (2037 ft., from 932-2939 ft. a.s.l.).

Apart from the Columbia River, with its mean annual flow of 110,000 cubic feet per second, there are four perennial streams on the river's north-east side (Kaiser, Fan, Corral, Peter Dam) and one on the south bank (Sanderson). Three of these are within the RM 590 study area (Figure 1) and one of them (Corral Creek) divides 45OK196 from 45OK197. In addition, there are twenty lakes and ponds within 8km of the river on both sides, and over thirty more within 13km to the west. Largest among the lakes are Buffalo, McGinnis and Rebecca, none of which have outlets flowing year around. Apparently originating from these lakes, ground water emerges above the river as small springs and seeps between Koontzville and Belvedere; one such spring flows from the slope between T3 and T0 terraces onto 45OK197.

Vegetation is a complex mosaic of communities, each with its particular topographic and hydrologic requirements (Figure 2). Over 90 percent of the land surface is covered by some form of steppe. On broad flats and other dry surfaces, there is a predominance of

CHAPTER III

THE SITES AND THEIR ENVIRONMENTAL SETTINGS

The River Mile 590 study area is a rough two-mile stretch of Columbia River Canyon between 9 and 11km (6-8 mi.) below Grand Coulee Dam (Figure 1). The biophysical environment is best characterized as a transition zone between the granitic Okanogan Highlands and basaltic Columbia Basin, between mountains and erosion-scarred plains, and between forest and steppe. To the north and east are the low, ancient mountains of the Okanogan Orogeny, with their more or less open forests of ponderosa pine and douglas fir. South and west are high lava plains, rimrocks, and exposures of more ancient granitic hills beneath the basalt flows, all covered by varying combinations of sagebrush, bitterbrush, and grasses. During the Fraser glaciation, which began to recede after 14,000 years ago, the area was buried under glacial ice that extended south across the plateau and left behind gravelly morraines, and a pockmarked landscape of kettle lakes and ponds. As the glaciers melted, an ice dam restricted outflow and the Columbia's canyon filled with a lake that left behind deep soft deposits of silt. Once freed from its constraining dam of ice, the river cut rapidly through the silts, reaching a level near that of today by around 10,000 years ago (Hibbert 1980). As it cut, the river created a series of terraces, the most prominent of which occur at an elevation of 440m (1430 ft.), 300m (1235 ft.), 325m (1100 ft.) and 310m (1000 ft.) above mean sea level. I have designated the lowest two as the T3 anad T2 levels, respectively (Chatters 1984). The broad, level T3 terrace is locally called Owsley's Bench. There are two lower terraces which are depositional in nature, both having been formed of fluvial deposits after 10,000 years ago. The higher of these, or T1, dates between 4700 and 2500 years; the lower, T0 terrace began forming around 2000 years ago and was still receiving flood sediment in this century. Artifact deposits at sites 45OK196 and 45OK197 occur in or beneath sediments of the T0 terrace.

The variable topography, differing rock substrates, glacial and postglacial history of the river have combined to create an environment of great complexity. Within 8km (5 mi.) of 45OK196 and

Camp Type	Dimension	Expected Assemblage Characteristics and Explanation
Early Fall Berrying/ Hunting (field camp)	Occupation Size	Small with family or small multifamily groups in residence. Reuse of sites probably infrequent along water courses.
	Duration by Seasons	Short. 1-3 week stay, than move during September, October.
	FCR Size	Large but dependent on reuse.
	Bone Fragment Size	Large-moderate, similar to winter hunting camps.
	Feature Discreteness	High but dependent on reuse.
	Floral/Faunal Diversity	Flora: Moderate with some roots and many species of berry consumed. Fauna: Low evenness, moderate-low richness. Focus at this time was on large ungulates, especially deer and elk. Some smaller animals and bears certainly taken as well.
	Seasonal/Geographic Displacement	Possible but would be rare. It is conceivable dried fish were taken along at the outset of this season, but would have been consumed rapidly. Expect subsistence on locally collected foods.
	Tool/Feature Diversity	Moderate, although activities are focused on a few resources, berries, roots and game that require distinct processing and harvest technologies. Some maintenance and repair of tools is expected.
	Interassemblage Variation in Tools, Features and Species	High-moderate with varying proportions of different resource-gathering tasks represented during each occupancy period. Would resemble spring root camps but without emphasis on storage technology.

Camp Type	Dimension	Expected Assemblage Characteristics and Explanation
Late Spring/ Early Summer Fishing Camps (base camps)	Occupation Size	As large or larger than winter villages.
	Duration by Seasons	2-5 months, extending May-July or even until September.
	FCR Size	Small because of frequent reuse and long duration of occupancy.
	Bone Fragment Size	Large in proportion to animal size with whole, articulated vertebral columns and skulls likely.
	Feature Discreteness	Low because of frequent reuse and long duration of occupancy.
	Floral/Faunal Diversity	Fauna: Low diversity, low evenness. Expect an extreme dominance of salmonid *fish with a smattering of non-salmonid* fishes. Terrestrial game is likely to be rare. Flora: Variable dependent on duration.
	Seasonal/Geographic Displacement	None likely, only roots taken at some distance and then these are available close to camp as well. Some displacement of roots grown in lithosols possible but unlikely to be seen since most of these were not cooked directly in fires.
	Tool/Feature Diversity	Moderate, both in richness and evenness with the extreme focus on fish acquisition and processing, and tool maintenance. However, some tools, features used in summer root gathering and/or berry pro*cessing might be found.*
	Interassemblage Variation in Tools, Features and Species	Low among sites of type because of focus on fishes in spite of vegetable food gathering. Should appear to be distinct from all other assemblage types.
Late Spring/ Early Summer Root Camp (field camp)	Occupation Size	Small. Among smallest in system because of the size of task group.
	Duration by Seasons	Brief, one or two weeks in May and/or early June.
	FCR Size	Large unless site frequently reused.
	Bone Fragment Size	No hunting likely. Fish bones may be whole because of ready supply from base camp.
	Feature Discreteness	High because of brief occupancy unless frequently used.
	Floral/Faunal Diversity	Low richness and evenness. Focus at this time is on a few species with large roots, especially camas and carrot.
	Seasonal/Geographic Displacement	*Geographic displacement of some fish* is probable, especially salmon is likely since these task groups moved out from fishing camps.
	Tool/Feature Diversity	Low. Largely limited to cooking hearths and root-baking ovens and tools associated with digging stick maintenance and root processing (hopper mortars for example) Neither rich nor even.
	Interassemblage Variation in Tools, Features and Species	Lowest among sites in system because of unity in purpose, simplicity of tool/facility inventory. Should be distinct from all other site types at a high similarity level.
Late Summer Fishing (residential base)	Occupation Size	Moderate-small because of fission of early summer *fishing groups into smaller units* to explore new fishing areas.
	Duration by Seasons	Brief. Two weeks to one month in August with frequent moves possible.
	FCR Size	Medium-small. Short duration reoccupancy but probability of frequent reuse of favorable locations.
	Bone Fragment Size	Fish: Large because of relative abundance. Mammal: Medium-small? due to lower rate of kill compared to fall and winter.
	Feature Discreteness	Moderate. Short duration reoccupancy but probability of frequent reuse of favorable locations.
	Floral/Faunal Diversity	High-moderate with fairly rich and even fish and terrestrial faunas exploited opportunistically at this time when compared with early summer. Berry species numerous with some focus on service berry and chokecherry.
	Seasonal/Geographic Displacement	Difficult to distinguish. May include spring and early summer root species and salmonids of the same period, either of which could have been taken from camps of this season in small amounts.
	Tool/Feature Diversity	Moderate. May resemble early spring camps in this dimension.
	Interassemblage Variation in Tools, Features and Species	Like early spring but with higher within-type similarity because of focus on fish and berries.
Early Fall Fishing Camp	Occupation Size	Moderate. Groups concentrated at optimal fishing localities.
	Duration by Seasons	1-2 months in September and October.
	FCR Size	Small-moderate because of duration of occupation and high site use frequency.
	Bone Fragment Size	Large for fishes, terrestrial mammals little used, but size may be small (consumption intensive).
	Feature Discreteness	Low-moderate because of duration of occupation and high site use frequency.
	Floral/Faunal Diversity	Low. Focus at this time on fishes, especially the smaller salmon species. Little hunting but some berrying. Richness and evenness both low.
	Seasonal/Geographic Displacement	May be present in roots but difficult to distinguish among salmonid species.
	Tool/Feature Diversity	Same as with early summer fishing but berries may replace roots as the vegetal material processed.
	Interassemblage Variation in Tools, Features and Species	Same as early summer fishing.

Table 2. Characteristics expected in sites produced during the annual round of the Sanpoil-Nespelem.

Camp Type	Dimension	Expected Assemblage Characteristics and Explanation
Winter Village (residential base)	Occupation Size	Large, due to group size.
	Duration by Seasons	3 months to year-round.
	FCR Size	Small because of frequent, long-duration use.
	Bone Fragment Size	Very small from complete processing, especially as winter food. This includes both fish and mammals.
	Feature Discreteness	Low because of frequent, long-duration use.
	Floral/Faunal Diversity	High richness because of local foraging, seasonal and geographic smear, but moderate-low evenness due to focus on salmon, deer, service berry, chokecherry, and a few species of roots.
	Seasonal/Geographic Displacement	Common. A large proportion of remains may be from foods acquired elsewhere in productive seasons and stored for winter consumption.
	Tool/Feature Diversity	Highest of sites in this group as a result of complex manufacturing, tool maintenance, discard, processing of winter and summer prey, consumption especially of dried foods, construction of houses. Greater duration of occupancy across seasons, especially use as winter and summer residence results in performance of many seasonally-related tasks with specialized tool kits.
	Interassemblage Variation in Tools, Features and Species	Low because of averaging effect of frequent reuse and the wide range of activities. Might expect two kinds of villages; those used in winter only (but a few old people) and those used in winter and summer as fishing camps. Should be distinct from all other site types.
Winter Hunt Camp	Occupation Size	Smallest of camps in system.
	Duration by Seasons	Brief, not over 1 month; among briefest occupancy of sites in system.
	FCR Size	Large-moderate dependent on proportion of reuse events to geologic deposition events.
	Bone Fragment Size	Larger fragments present here than in any other assemblage in system. Mean size will, with time, be expended in processing and drying harvest (and attendant on-site consumption).
	Feature Discreteness	High-moderate dependent on frequency of reuse in proportion to geologic deposition rates.
	Floral/Faunal Diversity	Lowest among non-fishing sites. Expect low richness (variable with the number of small animals taken to improve "luck") and low evenness. Large ungulates may be only animals present.
	Seasonal/Geographic Displacement	May be present in form of salmon bone.
	Tool/Feature Diversity	Low with concentration on tools to kill and dismember large mammals and dry or cook their parts for consumption of meat and marrow. Some repair and discard of projectile points is expected, especially if camp lasts many days. Some hide-working may be included. Assemblage should have low richness and low evenness.
	Interassemblage Variation in Tools, Features and Species	Low within-type: similarity of tasks performed, some variation because of differential performance maintenance, skin processing and consumption activities. Should be distinct from all other site types.
Early Spring (residential base)	Occupation Size	Small. Village population dispersed into camps near winter village.
	Duration by Seasons	Reported duration, 2 weeks to 1 month.
	FCR Size	Between hunting camps and winter villages, with size dependent on reuse frequency.
	Bone Fragment Size	Low. This is a season of maximum scarcity; we would expect bone to be processed to its limits of utility.
	Feature Discreteness	Dependent entirely on reuse frequency, but given short duration of occupancy, should be more discrete than winter villages, less discrete than hunting or summer root camps.
	Floral/Faunal Diversity	High. Rich and even (with consideration of net energy gain) with some expected skewing toward deer, fishes found near shore, river mussels and the earliest available root plants with good return/plant.
	Seasonal/Geographic Displacement	Possibly present if salmon stores lasted the winter. No displacement of root plants would be visible since these were taken in small amounts by camp occupants.
	Tool/Feature Diversity	Moderate because of the diversity of species in prey and variable processing activities associated with each.
	Interassemblage Variation in Tools, Features and Species	Moderate because of year to year variation in proportions of prey taken and the differential processing and consumption activities associated with each. Features should vary little, tools and species much more.
Mid-Spring Root Camp (field camp/residential base)	Occupation Size	Small, from single occupation by 3-5 families but larger than hunting camps. May appear larger because of reoccupation at most reliable water sources (e.g., Chatters 1979).
	Duration by Seasons	Brief, 1-2 months.
	FCR Size	Large unless area reused repeatedly.
	Bone Fragment Size	Small due to shortage of protein in diet consisting largely of roots.
	Feature Discreteness	High unless area reused repeatedly.
	Floral/Faunal Diversity	Variable for plants and animals. Plants should show high richness but low evenness with skewing to *Lomatium*, *Allium*, *Lewisia* and *Camassia*. Fauna should be both moderately rich (terrestrial game) and even because of opportunistic pattern of hunting.
	Seasonal/Geographic Displacement	Possible that some fish could occur, both salmon and non-salmon (e.g., Chatters 1980); not likely to be common because of seasonal position between winter use and summer replenishment of salmon stores.
	Tool/Feature Diversity	Tools: moderate diversity because men hunting, processing game, perhaps maintaining equipment plus primary reduction of quarried lithic material for transport to winter village and other seasonal camps. Features: Low diversity, niether rich nor even, with root processing ovens the predominant feature besides fires (e.g., Dancey 1975).
	Interassemblage Variation in Tools, Features and Species	Moderate because of varying amounts of lithic processing opportunistic and hunting activity. Expect a lower amount of variation but difficulty in distinguishing sites of this season from late spring root camps and except for ovens, early spring base camps.

adaptive strategy that supported a substantial population at apparently fairly stable (short term) levels in a largely semiarid environment.

Each of the activities performed in camps during each of the seven seasons would have resulted in an archaeological record that at least partially reflected the duration and repetition of occupation and the resource utilization tactics of its season. The values of each dimension of site structure expected from the ethnographic model are presented in Table 2.

Summary

To understand the conditions leading to evolution of various forms of hunter-gatherer adaptive strategy, archaeologists must first devise means for inferring those strategies from the residues of human behavior. Because of the multidimensionality of human behavior, we are unlikely to find a single dimension in our data that will in all cases enable us to identify without question the form of a prehistoric adaptation. Additionally, because archaeological deposits differ in the kinds and quality of data they preserve, expression of a single dimension may not always occur in the form required for acceptable inference. Therefore, what we need is an assortment of alternative measures, each of which may inform about one or more dimensions of adaptive behavior.

In the foregoing pages, I have offered nine dimensions of variability in the structure of archaeological sites, the measurement in which may provide the needed information. A discussion was presented of how each dimension might vary among sites produced by Binford's (1980) typical forager and collector types of resource utilization strategy. I have then laid the groundwork for a preliminary evaluation of each dimension's utility by presenting a summary of the seasonal resource utilization tactics of the Sanpoil Nespelem and the probable value of each dimension for sites produced by these tactics. Following a presentation of data from sites 45OK196 and 45OK197 and identification of occupations from the latter site with ethnographically defined site types, I compare actual occupation values with predicted values to assess each dimension's usefulness.

all else battened for the long, cold lean season of winter. Ray (1933) implies for the Sanpoil and Nespelem and Post, in Cline et al. (1938) states for the neighboring Sinkaietk that some people did not return to their accustomed winter places. Rather, they remained in the mountainous areas to hunt, trading with people who stayed on the river: fresh meat for dried fish and vegetable foods. Ray does not locate the non-village Sanpoil and Nespelem, but winter inhabitants of the mountains probably behaved much like hunting parties working from the base camp, necessarily moving camp several times in the season. Mobile groups probably would not have expended the labor to build pithouses (although Perry [1983] has found pithouses on Curlew Lake, in a mountainous portion of Sanpoil territory).

Discussion

From winter the native people dwelling in the RM 590 study area followed a complex seasonal round, each family moving its residence as few as six and as many as 14 or more times. During each of the seven seasons in this round, late fall-winter, early spring, mid spring, late spring-early summer, late summer, and early fall, family groups aggregated and dispersed as the resources they sought (roots, game, berries, fish, shelter) themselves varied in their positions and aggregation. During some seasons, such as early spring and, to a lesser extent late summer, resource acquisition would be best characterized as opportunistic foraging. A diversity of prey species was exploited, each in low frequency and all or most species were consumed immediately. During other seasons, such as group hunting in winter and fishing and camas gathering of summer, activity focused on amassing of foodstuffs for delayed consumption. In yet another set of seasons, mid spring and early fall (especially the former), we see a combination of activities. In mid spring, for example, women collected roots while men foraged opportunistically for a variety of game to be consumed immediately.

During all these seasons, plants and animals were gathered or caught for immediate consumption and in at least four seasons large amounts of food were processed for storage; specialized tools (harpoons) and facilities (weirs, ovens) were constructed for the mass acquisition or processing of resources for storage while more generalized tools and facilities (bows, simple hearths, knives) were used for obtaining and processing a variety of foodstuffs; shelters were constructed with varying degrees of complexity and permanence in field camps (hunting, summer berrying and root digging) and permanent (winter villages) and temporary (spring root digging, summer fishing, fall berrying) base camps. Sizes of groups inhabiting base or field camps varied with the aggregation and accessibility of the resource or resources sought seasonally in each environmental zone. With this combination of specialized and opportunistic seasonal strategies, group flexibility and set of alternatives seasonal strategies available to all members, Sanpoil-Nespelem society maintained a viable impossible without extraordinary measures. There were no contour maps of the area indicating its topography, so the size of the site was unknown. Our first action, therefore, was to clear paths the length of the site as parallel as possible to the riverbank. Paths across the terrace were also cut. These natural conditions and our response to them had a strong effect on the procedure for testing this site. The grassy 45OK196 posed no such tactical problems. Procedures are described below.

Preliminary Testing

Preliminary testing was a two-stage procedure, but because of time constraints and problems of movement in an overgrown environment, both steps were accomplished simultaneously. Stages were 1) mapping and grid placement and 2) excavation.

Mapping and grid placement. We chose the highest spot on the TO as datum for both 45OK196 and 45OK197. This concrete-filled PVC tube with a rebar center was buried flush with the ground surface at the back of the terrace 17m downstream from Corral Creek's primary channel. Two attempts were made to produce a contour map of the site and create an accurate 5m interval grid, both of which failed. It was not until 1983, when underbrush had been almost entirely removed from among the thorn trees, that a replicable map of the area was produced. For this reason all of the grid coordinates on excavation units deviate more or less from precise 1m grid intersections (e.g., 1.95 S and 3.90 W is located in the east level area).

Excavation. Two rows of test pits were excavated approximately 15-20m apart and parallel with the reservoir shoreline in 45OK197. There is only one row along the narrower, 45OK196 portion of the terrace. Spacing betwen tests varies from 10m on the river-side row near Corral Creek on 45OK197 to nearly 40m at the downstream end of the same site (Figure 3). Differential spacing was partly planned (with more tests in areas where artifacts appeared in the cutbank), and partly dictated by topographic (ravines, steep slopes) and floral considerations (thorn trees).

Tests were either 1x1m or 1x2m in size, with the decision dependent on anticipated depth and perceived sediment stability. Where deposits were likely to be deep and sediment appeared soft and loose, the larger 1x2m pits were excavated to improve the chances for excavator safety, should a cave-in occur. Regardless of test pit size, the maximum horizontal unit for artifact collection and record keeping was one meter.

Preliminary tests were excavated in arbitrary levels 10cm or 20cm thick. The thicker levels were used to explore into deep, apparently sterile sediments and to probe the edges of the site for information about the extent of the occupation area. Where we already had evidence of artifact deposits in an area, 10cm units were used exclusively.

Matrix was excavated by shovel and dry-screened through 1/4 inch mesh. All stone tools, waste flakes, bone, and mussel shell hinges were saved for analysis. Fire broken rocks were counted, weighed and discarded. For each level containing artifacts, a one liter bulk sample was saved for later flotation and identification of charred plant material. Charcoal, when observed by excavators, was collected and saved in aluminum foil or plastic containers for potential radiocarbon analysis. Artifacts were mapped in situ whenever possible; features, when perceived in these narrow pits, were mapped, photographed and sampled in the same manner as were artifact-containing levels.

One wall of each pit was profiled and described, unless sediments appeared homogeneous. Color (Munsell system), texture, compactness, plasticity and stratum boundaries were described.

Preliminary testing also included bank facing and profiling. Five bank cuts were made in the eroded bank of 45OK197. We had hoped that profiles from these cuts would enhance our ability to follow natural strata within the site, but that was not the case. The original terrace bank had sloped so steeply here that only the uppermost strata were included in profiles, but these could not be correlated with any confidence to strata in the test pits.

Ten test pits were excavated in 45OK197 and another three in 45OK196. At 45OK197 depths ranged from 40cm in the gummy, humic ooze of pit C, to 240cm in the nearly-sterile, silt colluvium of pit E. Forty and 120cm were the extremes in 45OK196 (test pits 1 and 3, respectively). Artifacts were rare in test pit 2 at 45OK196 and in the entire back row of 45OK197. Tests 1 and F were nearly sterile at the latter site, while little was found in test pit 3. In 45OK197 the majority of artifacts occurred throughout test pit 2 (east area), while there were concentrations above and below one meter in depth in pits 4 (central area) and 5 (west area). At 45OK196, the vertical distribution of artifacts was nearly uniform in the shallow test pit 1, and concentrated between 80 and 120cm in test pit 3.

Stratigraphically, 45OK196 consisted of a massive fine sand overlying river cobbles. There were no buried soils and no stratigraphic boundaries were visible. This pattern was repeated, for the most part, along the back test pit row at 45OK197, except that sediments there were either a uniform very dark brown silty sand or colluvial silt and included wedges of gravel or silt colluvium at various depths. Between the west area (test 5) and east area (tests 1 and 2) of 45OK197, stratigraphy was complex and detailed, including many buried soils and little bioturbation. Artifacts occurred in many of the buried soils and at surfaces of some strata lacking soil development.

Localized Testing

After consultation with COE archaeologists, we decided that 45OK196 did not warrant further testing efforts, but that 45OK197, a potential storehouse of information, should receive more attention. Localized tests consisted of three excavation blocks (designated west, central and east) developed contiguous to test pits 2, 4 and 5. Of particular interest in these areas were three occupation surfaces in the west area containing dense concentrations of broken bone from large ungulates, one shallow occupation near the modern ground surface in central area, and eight occupation surfaces in the east area. In addition, a trench was begun from test pit B and extended toward the reservoir's edge in order to provide a stratigraphic connection between the two rows of test pits.

Procedures used in excavating these blocks differed in many respects from preliminary testing. One meter maximum horizontal provenience was maintained and a 1/4" mesh was used; the same samples and materials were collected. Other aspects of the work differed. All artifacts (bone, stone, shell, fire broken rock), over 2cm in their largest dimension, were carefully excavated by trowel and piece plotted on soil or stratum surfaces. Each bone and stone tool found in situ was given a field specimen number and collected separately. Shell and materials found in the screen were collected in bulk by natural stratum or by 10cm units within the natural stratum when thickness exceeded 15cm. Water was used in screening, whenever possible.

Light permitting (extremely dark conditions often prevented accurate observation of strata), profiles were drawn of at least one north-south wall and one east-west wall in each block. Walls that were not drawn were, like drawn walls, photographed with a line level and scale. Soil monoliths were removed from east and west blocks for later study.

In all, 29 square meters were included in the localized tests. Of these, eleven were in west block, six in central block, six in east block, and six in the stratigraphy trench (central trench). Excavation was taken to water in east and west blocks, to gravels in the central trench, but only to the seventh stratum, or 1.2m in central block. East block excavations led to the discovery of four new occupation surfaces below the eight already recognized there.

At the close of the 1982 season, test pits and blocks were backfilled as much as possible with brush and earth. Because water was used in screening, there was a definite shortage of fill dirt and near-surface parts of all pits were left only partially filled. The result was some slumping (up to 20cm from excavated walls) in several of the blocks.

1983 Excavations

Upon reconsideration of the data from 450K196, the COE and CWAS agreed that preliminary tests at that site had not provided sufficient information from which to evaluate the site. This was also true of 450K197, especially with respect to the potential of site sediments as a record of flood history. We returned to these sites in September 1983 with the following objectives: 1) to excavate tests in areas of both sites not sufficiently probed in the preliminary phase of 1982; 2) to expand block excavations at 450K197, recover a larger artifact sample and expose larger areas of occupation surfaces; 3) to excavate stratigraphic trenches at 450K197 and read a history of flooding from the sediments.

Procedures

Procedures varied little from work in the 1982 season. Exceptions (apart from the excavation of trenches) were in techniques used to map occupation surfaces, screen sediment, and collect samples for paleobotanical analysis.

As in 1983, block excavations (and smaller test pits) were excavated by natural strata, with each stratum being completely exposed, mapped, and photographed before any objects were removed (Appendix E). One person was in charge of producing block-wide maps of each stratum from the notes of excavators. These maps could then be checked against excavator's short-term memories, thereby catching any data recording irregularities before facts were forgotten. Only strata with occupation debris were excavated in this way. Therefore, we sacrificed a few artifacts from low-density scatters. Occupations XIE, XIIIE and XIV, all in the east block, were the only ones treated this way. Excavation at 450K196 was by 10cm arbitrary levels.

Samples were taken from the northwest corner of each 1x1m unit in each stratum and from each feature. If a feature was larger than 1m square, a sample was taken in each grid unit in which the feature occurred. Samples of measured volume (called constant volume samples or CVS) 15cm square, were taken to the depth of the geologic stratum on which occupation had occurred or the thickness of feature constituents. These CVS samples were tied in mosquito netting (mesh size 0.5mm) and the fine sediments washed out. The residue was sorted into bones, shell, lithics, FCR, wood charcoal, and other charcoal; each constituent was counted and/or weighed.

All sediments were screened wet with the aid of gasoline pumps. Materials, therefore, were recovered more consistently during this second season, and may not e entirely comparable with those from 1982. Smaller bones anc stones can be more easily missed in dry screened, gummy sediments, so smaller flakes and bones, especially fish, may be underrepresented in 1982 samples.

The only exception to careful excavation was in the long stratigraphic trenches, which were shovel excavated and not screened. Fortunately, profiles show that far less cultural material occurred in these trenches than was found in the nearby block areas. There were exceptions; a large earth oven intersected by the easternmost trench.

All pit walls were photographed to scale and profiles were drawn of two trenches (a third had filled completely with ground water) and at least one key wall of each block. Photos and elevations recorded on maps of occupation surfaces provide enough information for reconstruction of other profiles should this ever prove to be necessary.

In 1983, 45 square meters were excavated in blocks, 4 square meters in test pits, and 27 square meters in stratigraphic trenches at 45OK197. Only 3 square meters, all in test pits, were required at 45OK196.

CHAPTER V

CHRONOLOGY OF OCCUPATION AND SEDIMENTATION EPISODES

Chronological ordering of occupation and sedimentation episodes was accomplished by 1) distinction of occupations and 2) cross-dating using accepted geological and archaeological methods (Harris 1979).

Distinguishing Occupations

There is not always a direct correlation between assemblages of artifacts and the episodes of human occupation of which they are a residue (Binford 1982). Any surface can be occupied repeatedly before it is buried by a new episode of sedimentation and a fresh surface is exposed for use. The tempos of sedimentation and occupation are rarely if ever equal: one surface may be occupied many times and another only once. Occasionally it is possible through analytic means to separate assemblages into sets of artifacts attributable to individual occupation events with some degree of confidence (Chatters 1982), but we can never be certain that each artifact in a set was deposited during the same continuous period of site use as every other artifact. What we call occupations are often more properly conceived of as analytically distinguished units of comparison rather than the artifacts left by a single group of people during a continuous period of residence at a site (Dunnell 1973:15). This is certainly true at 45OK196 and other sites in the RM 590 study, however, because of the rapidity with which sediment layers were deposited at 45OK197 (one stratum every 34 to 137 years) and the largely undisturbed character of those deposits, artifacts occurred almost exclusively at sediment surfaces and exhibited a high degree of pattern discreteness. Many of the artifact assemblages collected from 45OK197, therefore, are properly conceived of as the products of one or a very few visits to the site.

I have utilized two means to distinguish occupations: 1) direct observation of spatially and geologically separate surfaces on which artifacts occur as discernable from test pits, trenches, blocks and bank expsoure; and 2) plotting of the vertical distribution of artifacts in a geologically uniform deposit and identifying the frequency modes as vertically smeared occupations (Chatters 1984: Figure 7; Wilmsen 1974). I have used the first method at both sites and the second only at 45OK196.

Twenty-two occupations occurred as horizontally and/or vertically distinguishable artifact scatters and associated features in finely-layered fluvial sediments at 45OK197. Except for Occupation II, which had been more subject to bioturbation than other sediments, all occupations were essentially two dimensional, with all artifacts occurring on or within 5cm below the surface of discrete geologic strata. Horizontal bourdaries of occupations were determined from block, trench and test pit data. Where a gap in artifact distribution occurred in a stratum such as in the lower strata 16 strata in test pits between East and West Blocks and in all strata between Central and West Block, then two occupation numbers were assigned (with the subscript E and W). Thus there is a single stratum associated with each occupation, but two occupations exist in many strata. In light of the multitude of occupations so easily distinguished, I chose to avoid creating occupations which could not be treated as equivalent units during analyses. These artifacts are all left in the limbo of the "unassigned". Occupation areas were determined on the assumption that unassigned artifacts from depths near those of assigned artifats were part of the same episode of site use.

In 45OK196 where discrete surfaces were not distinguishable during excavation, there were five readily distinguishable modes in vertical frequency of artifact distribution in three of the test pits. These modes often coincided with stratigraphic layers or the boundaries between layers, so a combination of the two approaches proved fruitful here. Again, artifacts from pits in which no modes or surfaces were seen (Tests 1 and 2) were left unassigned.

Stratigraphic Chronology

Based on excavations at thirteen other sites in the RM 590 area and on preliminary descriptions of some sites excavated by the University of Washington, I devised a sequence of 14 time-stratigraphic geologic units for the T3 to T0 terrace levels (Chatters 1984:38-58). The sequence for the last 4700 years, comprising all sediments on the T1 and T0 levels, includes: X, fluvial cobbles and gravels laid down by the Columbia River between 3900 and 4700 BP; XIa and b, finer fluvial sediments deposited in lower and upper bar settings, respectively, between 4700 and 2500 BP and forming the T1; XIc, d, aeolean and clastic deposits on T2 and T3 levels corresponding in age with XIa, b; XII, colluvium postdating 2500 BP and attributed to increased surface erosion resulting from warming and drying that followed the Temple Lake stade of neoglaciation; XIII, fluvial deposits of the T0, deposited after about 2000 BP. Time stratigraphic Unit (TSU) XIII occurs only at 45OK196 and 45OK197 in the RM 590 study area. Based on this sequence, I assumed at the outset that all deposits at both sites post-dated 2500 BP. This has proved to be an incorrect assumption.

The geologic stratigraphy of each site will be discussed below. Ages of various strata were determined by stratigraphic cross-dating based on radiocarbon analysis and projectile point chronology, with and without reference to the master chronology of Time Stratigraphic Units.

<u>45OK196</u>

The 1.7m of sediment at 45OK196 consists of seven strata (1-7 from the top: Figure 4). Stratum 7 is a mass of fluvial cobble gravel and coarse sand, the surface of which contains a few fragments of mussel shell. Above this (the apparent source of the shells) is a series of interfingered, massive fluvial beds of silty fine to medium sand, olive gray in color (5Y4/2). These strata, Numbers 6 and 5, contain at least three anastomosing lenses of mussel shell, mammal bone and stone artifacts, including two hearth areas. This cultural material constitutes Occupation V.

An especially interesting aspect of Strata 5 and 6 is that both shell and bone are extensively weathered. Bones are deeply etched by acids from plant roots, as if a root mat from sod-type grasses had formerly extended into this stratum from a well-developed, overlying soil. Sod-type grasses are characteristic of wet meadows in the riparian habitat and elsewhere, and this deep etching strongly indicates the presence of such a habitat where bunch grasses and low brush now occur.

It is quite clear why no buried A horizon is evident from which roots had penetrated. The surface of Stratum 5 has been eroded, truncating one of the shell lenses, and is unconformably overlain by a jumbled mass of sub-rounded and rounded cobbles and gravel in a matrix of silty medium-coarse sand. This colluvial Stratum 4 contains large amounts of lithics and fire broken rock, but little bone or mussel shell. Evidently, artifacts in this stratum (Occupation IV) are a secondary deposit either washed from the early occupations on T3 or deflated in place from cultural strata once overlying Occupation IV. Styles of projectile points from Occupation IV support the second interpretation.

Above this colluvial layer are up to 1.2m of silty fine-very fine sand with a few larger particles, separable into three massive strata (1-3); colors are olive (5Y4/3) to dark olive gray (5Y3/2). There

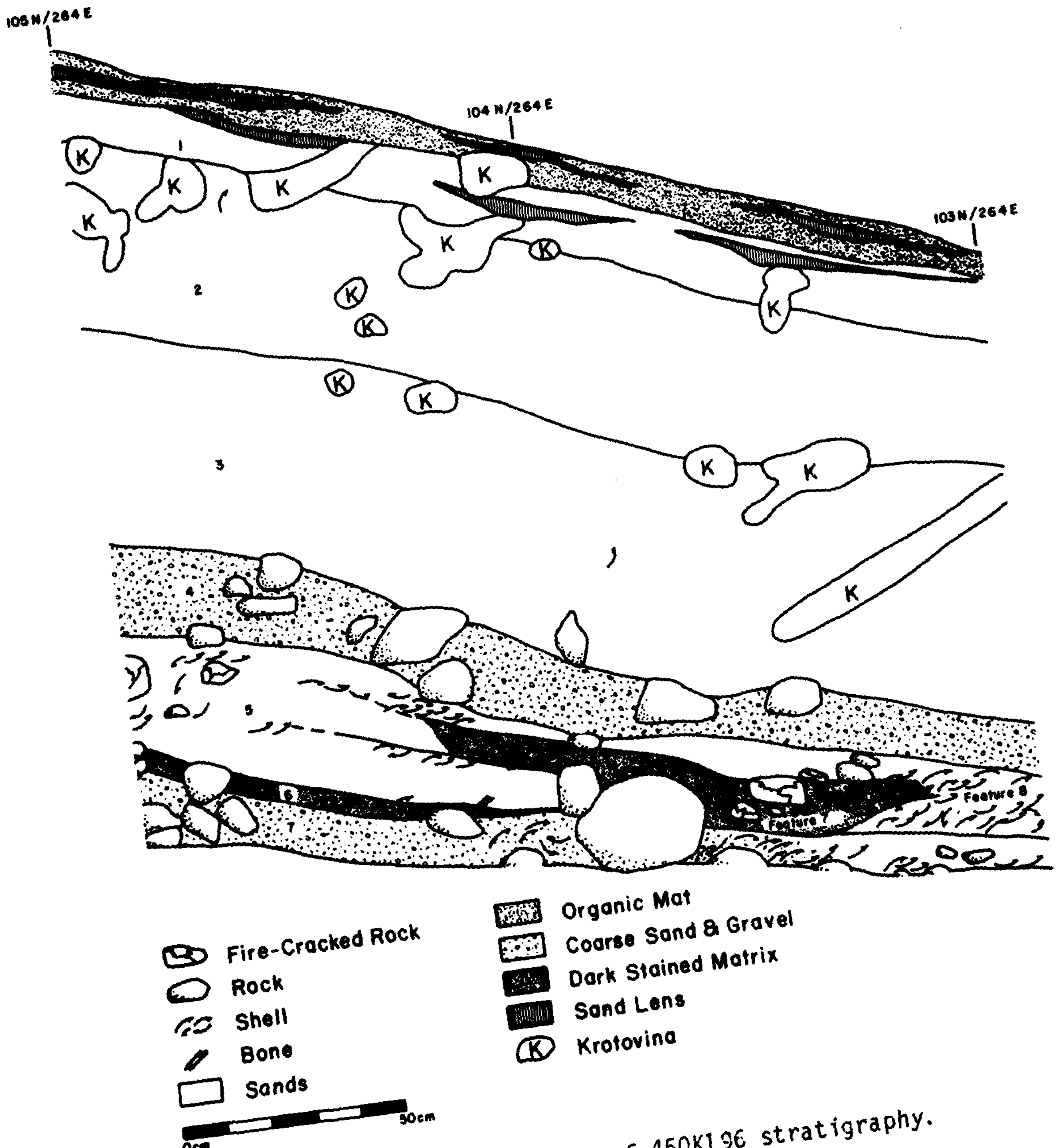

Figure 4. Example of 45OK196 stratigraphy.

are thin lenses of fine sand in Stratum 1 that appear to be the result of sheet wash from the bank behind this site. In fact, all three strata appear to be a combination of that sheet wash colluvium and wind-reworked fluvial sediment of the kind found in upper bar settings. Artifacts cluster at three levels in these silty sands: Occupation I at the surface of Stratum 2; Occupation II at the surface of Stratum 3; and Occupation III midway through Stratum 3. All consist of fire broken rock, a few mussel shells, and occasional organic staining.

Radiocarbon dates. Charcoal was sparse to nonexistent in this site; only one hearth contained enough for dating. This sample (B5257, from Feature 1 in Occupation III) and a sample of shell (B8810, from Feature 7 in Occupation V) were submitted to Beta Analytic, Inc. for analysis. The shell date was corrected for isotopic fractionation. Results were not encouraging (Table 3). Feature 1 dates 940+-70 BP; Feature 7, 4590+-80 BP. Since this terrace is supposed to postdate 2500 BP, the shell date appeared at first to be anomalous. Mussel shell is not an especially reliable dating medium; dates from it have a tendency for erratic variation (Olsen 1970). Note the extreme differences between shell and charcoal dates from strata at 45OK197 (Table 3). However, when this date is considered in light of data on projectile point style (see below), and thus in its time-stratigraphic position at the base of T1 sediments, the result becomes more acceptable.

Projectile point styles. Eight projectile points and fragments were found, five of them in Occupations IV and V. Four of these could be assigned to one or another of the types developed by Lohse (1983); the rest resemble members of a set of similar, contemporary types but were too fragmentary for secure assignment. Because it is unclear how Lohse distinguishes between "small" and "large" types in a similar shape class, I have combined some types which have identical time spans. Thus the types represented are 7/8, 9, 5 and 17 (Table 4, Figure 5). Some fragments belong to 7/8, 9 or 11/12 (Table 4), but they cannot be precisely typed.

Chronologically, types 7/8, 9 and 11/12 all occur from 4500-1600 BP (Lohse 1983). Type 17 is most common from 2500 BP to 1600 BP, occurring occasionally in later deposits. Thus, we could conclude that all sediments at the site predate 1600 BP, were it not for the single radiocarbon date of 940 BP (B5257). However, Strata 1, 2 and 3 are extensively disturbed, especially in test units 1 and 3, in which the type 9 and 17 specimens were found. Over 50 percent of test unit 3 was disturbed, top to bottom. The pre-1600 BP types of projectile points probably occur in sediments dated younger than 1000 BP because of mixing. Occupations IV and V, though, apparently date 1600-2500 years or older (since they are deflated, quite a long time span is likely) and 4500-2500 BP, respectively.

Table 3. Radiocarbon dates obtained from 450K196 and 450K197.

Site	Sample No.	Unit/ Block	Block Stratum	Occupa-tion	Material	Radiocarbon Age	Actual Age[2]	Beta No.	Consistent with strat context?
45-OK-196	82-31/32	Unit 3	3	III	Charcoal	940± 70	AD 920-1230	5257	Yes
	83-2	N104 E263	3	V	Mussel shell	4590± 80		8810	Possibly
45-OK-197		Central	2	II	Human bone[1]	170±110	AD 1500-1950	6532	
	83-24	Central	4	IVA	Charcoal	560± 60	AD 1315-1420	8817	Yes
	82-79	Central	8	VI	Charcoal	750± 80	AD 1210-1330	5895	Yes
	83-25	East	10	VI	Charcoal	800± 70	AD 1160-1295	8818	Yes
	83-23	East	10	VIE	Mussel shell	1840± 70		8816	No
	82-25	East	12	VII	Charcoal	500± 90		5258	No
	83-22	East	12	VII	Mussel shell	2600± 70		8815	No
	82-103	East	17	IX	Charcoal	980±140	AD 780-1265	5266	Yes
	83-21	East	17	IX	Mussel shell	2310± 70		8814	No
	83-28	East	18	XIE	Charcoal	1170±120	AD 770-1190	5261	Yes
	83-20	East	19	XIIE	Mussel shell	4330± 70		8813	No
	82-44	East	20	XIIIE	Charcoal	1440±120	AD 400- 775	5259	Yes
	82-88	East	21	XIV	Charcoal	1410± 90	AD 435- 785	5263	Yes
	82-90	East	23	XV	Charcoal	1680±100	AD 65- 580	5264	Yes
	82-91	East	25	XVI	Charcoal	1660± 90	AD 70- 585	5265	Yes
	82-106	East	26	XVII	Charcoal	1870±120	140 BC-AD 355	5268	Yes
	83-9/11	West	6	X	Charcoal	1240± 90	AD 600- 915	8811	Yes
	82-104	West	7	XIW	Charcoal	1220±110	AD 665-1010	5267	Yes
	83-16	West	8	XIIW	Charcoal	1110± 70	AD 785-1035	8812	Yes
	82-50	West	9	XIIIW	Charcoal	1320±110	AD 575- 885	5262	Yes

[1] From Burial 1.

[2] Based on Klein et al. 1982, 95% confidence intervals.

Table 4. List of 45-OK-196 projectile points.

Occupation	5	7/8	9	17	7/8/9/11/12
I					
II			1[1]		
III				1[1]	1[1]
IV				1	2
V	1	1			

[1] Disturbed context, may not be in original geologic position.

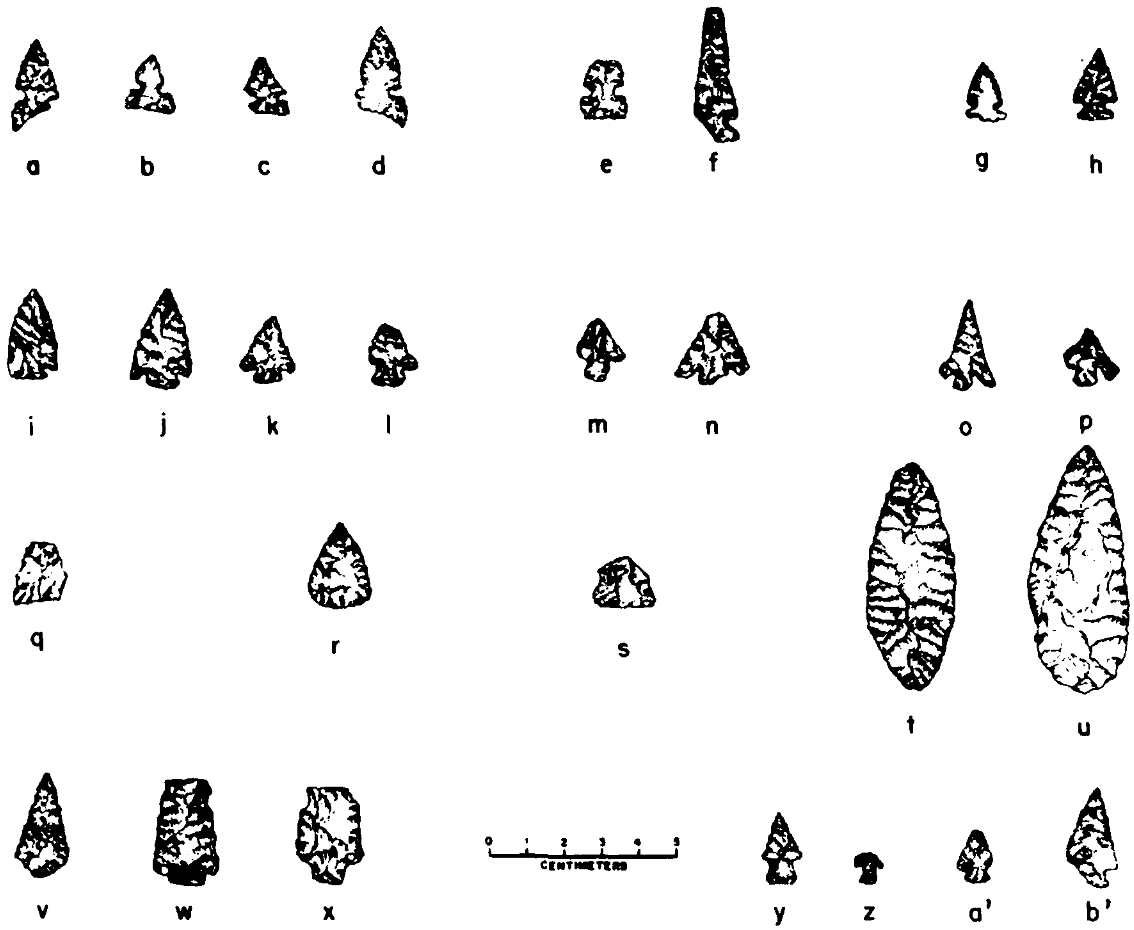

Figure 5. A sample of projectile points recovered from 45OK196 (s, v, w) and 45OK197 (a-r, t, u, x-b'). Types represented are type 4a (a-d), 4b (e-f), 4c (g-h), type 2b (r), type 17 (s), type 5 (t-u), type 7 (v-x) and type 10 (y-b').

Classification

We experienced difficulties in deciding where features began and ended in the complex artifact-littered surfaces in 45OK197. This contrasted with 45OK196, where no such "living floors" remained intact, and where any dense concentration was isolated from a surrounding, rodent-homogenized matrix. At 45OK197 there were no such convenient feature boundaries; we had to make arbitrary decisions about feature edges, and ignored the more or less dense clusters of fire broken rock and bone splinters that are often given feature status. Consequently, we identified only the following as features: 1) mussel shell middens wherein shells were actually touching each other, covering an area 50cm or more in diameter (Figure 11); 2) hearths (areas of in situ burning with or without associated burned rock, shell or bone; Figures 12 and 13); 3) pits (actual excavations through underlying sediments, lacking charcoal or other evidence of burning); 4) earth ovens (shallow pits over 75cm in any dimension and filled with charcoal and a few fire broken rocks); 5) bone heaps (concentrations of 10 or more contiguous bone splinters covering an area over 25cm in any dimension; Figure 12); and 6) burials (Appendix F). Definitions are given in Table 7. Hearths were further subdivided into hearth scatters (areas of amorphous plan over 1m in any dimension associated with dispersed, burned) and discrete hearths (smaller, roughly circular burned areas with burned materials more or less concentrated within the burned area. Bone heaps were not identified as features in the field, so their number has been reconstructed from notes and plan maps).

Results

Summaries of feature counts for each occupation are shown in Tables 8 and 9. Thirty-five features were identified in 17 occupations at 45OK197 and eight in 45OK196. Most were discrete hearths or hearth scatters, shell middens, and bone heap. In all, hearths of some kind occur in thirteen occupations, middens in eight, and bone heaps in eight. Earth ovens occur only in 45OK197, Occupation I and <u>possibly</u> in 45OK196, Occupation V.

Note the near complementarity in the distribution of bone and shell midden features at 45OK197. All occupations older than 1000 BP contain bone features, while most shell middens occur after that date. A closer look shows that in Occupations XIIE, IX and V, the bone heaps are tiny fragments showing common characteristics of boiled bone. In the other occupations, fragments are large splinters, complete articular ends of longbones and other whole elements (e.g., Figure 12). Clearly, midden features (sometimes associated with small-fragment bone heaps) and bone heap features containing primarily large splinters represent different kinds of activities on-site. The single occupation with earth ovens is a third, different kind of occupation.

CHAPTER VI

ARTIFACT AND FEATURE ANALYSIS: RESULTS

This chapter presents both the analytical procedures applied to 45OK197 artifacts and features, and a summary of the results of some of those analyses. Appendices A, B, C and D provide classifications and compendia of results from all levels of analysis.

The procedures presented below were designed not only as a means for generating data useful to the research problem outlined in Chapter II, but also to provide a description useful for the purposes of others. In Chapter VII, summary data are used initially to separate occupations into settlement classes (see Chatters 1984:Chapter IX); and the members of each settlement class are examined from the standpoint of the nine dimensions described in Chapter II. A general listing of occupation contents appears as Appendix E, Part 3).

Features

Features are non-portable, non-discrete associations of artifacts (e.g., stains, clusters of tools and detritus; bone, shell or charcoal concentrations; Dunnell 1971). Features have a close association with activity performance. They are in fact, the centers of activity, the material residue of concentrated resource acquisition (weirs, quarries), processing (ovens, drying racks), consumption (cooking and heating fires), discard (middens), and storage/life maintenance (caches, houses). As suggested in Chapter II, the degree of feature redundancy and apparent specialization among assemblages is an important indicator of the range of activities performed at a site and therefore of the position of an assemblage in the resource exploitation strategy of a human group.

Vertically and horizontally distinct assemblages of artifacts and features have been identified through study of stratigraphic position, vertical frequencies of artifacts and the horizontal distribution of artifacts at the surfaces of individual strata.

The sedimentary sequence at 450K196 and 450K197 begins with deposition of the gravel substrate of TSU X at 450K196, sometime around 4500-3900 BP. A period of aggradation (TSU IX, T1 Terrace) ensued, lasting until the Columbia River and Corral Creek began eroding the terrace after 2500 BP. Aggradation forming TSU XII (T0 Terrace level) began slowly just prior to 1900 BP, accelerating to a maximum rate between 1000 and 550 BP; the deposition rate slowed thereafter.

Using vertical artifact distribution only, I distinguished five occupations at 450K196. Occupation V, the lowest, lies near the base of T1 sediments and dates around 4500 BP. Occupation IV occurs in secondary context in a lag deposit of eroded Upper T1 strata and the highly disturbed Occupation III, II and I postdate 1000 BP in massive sediments of the T0 Terrace.

Site 450K197 contains at least 25 fluvial strata dating between 2 BP (AD 1948) and 1870 BP, plus a 20th century deposit of colluvium on the surface. The twenty-two occupations distinguished here were all primary and represent one or a very few visits by people, and occur as two dimensional scatters on surfaces of flood deposits. Artifacts that could not be correlated with stratum surfaces were left unassigned. This act did not, however, affect interpretations of horizontal occupation distributions. These horizontal distributions indicate shifts in the position of camps on the T0 Terrace.

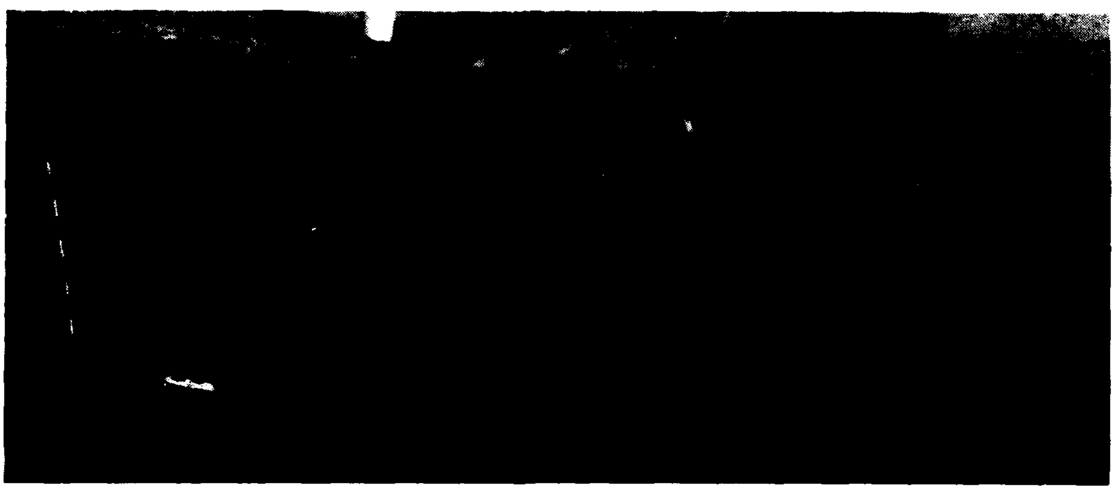

Figure 10. East Wall East Block 450K197 (.10E 1.96S-6.96S).

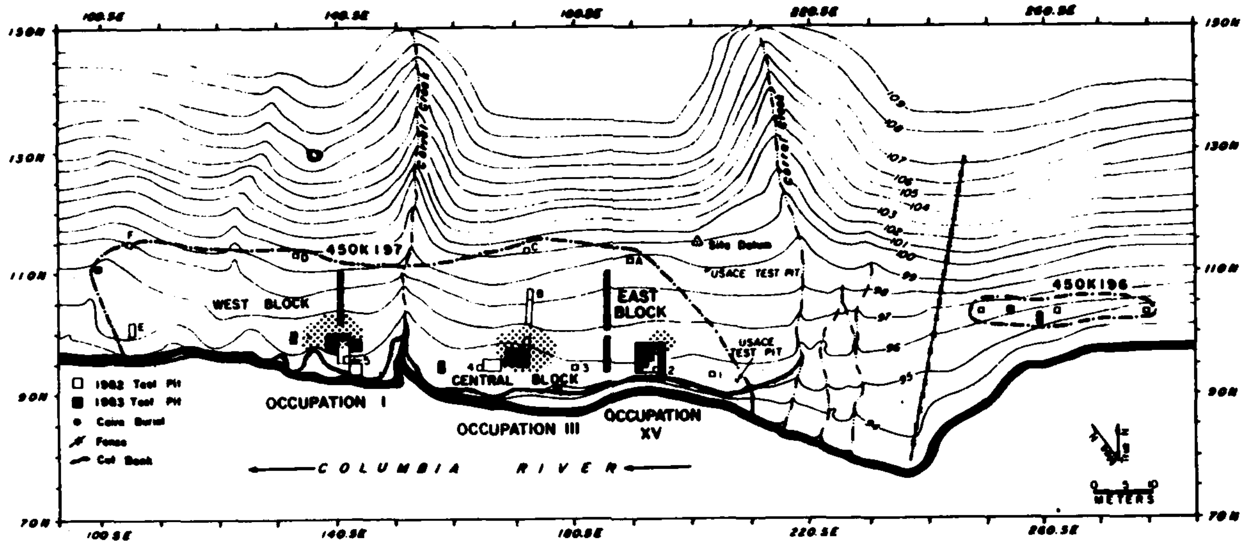

Figure 8. Approximate spatial distributions of Occupations I, III and XV at 450K197 (stippled). Compare the sizes with Occupation VI shown in Figure 9.

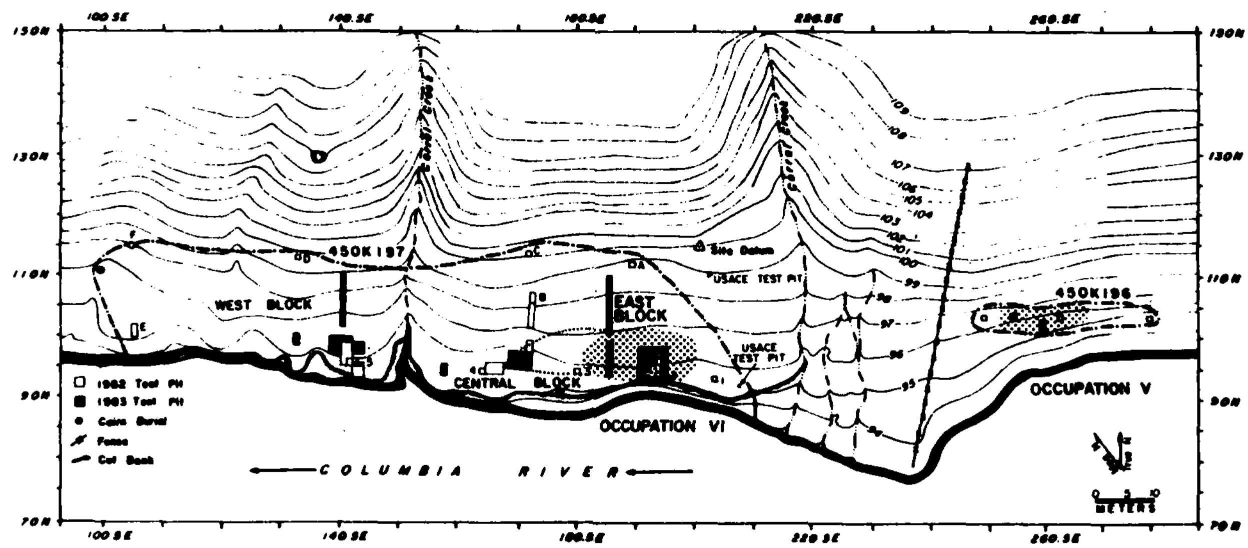

Figure 9. Spatial distribution of Occupation IV, 450K197 and Occupation V, 450K196 (stippled). Dotted line indicates the extent of the low density artifact scatter extending west of Occupation VI.

Table 6. Stratigraphic position and age of 45OK197 occupations.

Occupation	Stratigraphic Position	Area Excavated in m^2 [1]	Radiocarbon Age	Probable Age
IW	Surface of W1	18	None	Post 50 BP
IE	Surface of E3	25	None	Post 50 BP
II	Surface of C2	18	170 ± 110 BP [2]	50- 200 BP
III	Surface of C3	18		200- 500 BP
IVA	Surface of C4	12	560 ± 60 BP	500- 600 BP
IV	Surface of C5	18		500- 600 BP
V	Surface of C6	12		550- 750 BP
VI	Surface of C8 Surface of E10	37	750 ± 80 BP, 800 ± 70 BP	750- 800 BP
VII	Surface of E11, 12[3]	25	500 ± 90 BP	800- 900 BP
VIII	Surface of E13, 14[3]	25		850- 950 BP
IX	Surface of E17	25	980 ± 140 BP	900-1100 BP
X	Surface of W6	14	1240 ± 90 BP	1200-1300 BP
XIW	Surface of W7	16	1170 ± 120 BP	1200-1300 BP
XIE	Surface of E18	7	1220 ± 120 BP	1200-1300 BP
XIIW	Surface of W8	16	1110 ± 70 BP	1200-1400 BP
XIIE	Surface of E19	25		1200-1400 BP
XIIIW	Surface of W9	16	1320 ± 110 BP	1300-1450 BP
XIIIE	Surface of E20	7	1440 ± 120 BP	1300-1450 BP
XIV	Surface of E21	2	1410 ± 90 BP	1350-1500 BP
XV	Surface of E23	16	1680 ± 100 BP	1600-1750 BP
XVI	Surface of E25	1	1660 ± 90 BP	1600-1750 BP
XVII	Surface of E26	1	1870 ± 120 BP	1800-1950 BP

[1] Because occupations are surfaces, they are essentially 2 dimensional; volume is approximately area x 0.1m thickness.

[2] From Burial No. 1, evidently originating from Stratum C2.

[3] Distribution of E1 1 and 13 are irregular; in same areas Occupation VII lies on the surface of Stratum 11, sometimes 12 but never occurs in both at one point on the surface. The same is true of Occupation VIII.

Occupation chronology. The 21 occupations from 45OK197 are listed in Table 6 along with their stratigraphic positions, radiocarbon dates and approximate ages. Occupations are numbered I through XVII, with subscript designations of C, W or E, depending on the blocks in which contemporaneous occupations were found. The area excavated into each occupation is given in Table 6. The average area excavated for each occupation was 17 square meters, ranging from 1 square meter for the largely unreachable Occupation XVI deep in the East Block, to 37 square meters for Occupation VI in East and Central blocks. Surprisingly, there is only one case (Occupation VI) where an occupation occurred in two adjacent blocks (the roughly contemporary XI, XII, XIII also occur in two blocks, but are spatially distinct). Tests and trenches between block areas contained very little in the way of artifacts, except for a large earth oven in the eastern trench in (Occupation IE) and small amounts of mussel shell and occasional bone fragments in upper strata at the lower end of the same trench (Occupations VI and IX). Most occupations were very small, covering areas that appear to have been no larger than 50-100 square meters. Some, such as Occupation XV probably were not much larger than the area excavated. Figures 8 and 9 show the range of estimated sizes (see Appendix E for all occupation distributions).

Occupations IW, VII and VIII occur in two strata each, a fact that would seem to contradict my assertion that occupations are two dimensional. However, Occupation VII was deposited after Stratum E11, a layer of irregular distribution, and thus occurs on Stratum 12 where 11 is absent. The same is true of Occupation VIII and Strata 13 and 14. Occupation IW consists mainly of two earth ovens buried by flood waters, apparently while in use (both contain charred fruits and much wood). Both were reused immediately after the flood, seemingly without a long break in site occupancy.

The focus of habitation changed from area to area throughout the site's history. First use was in the east area only (Occupations XVII to XIV). Around 1300-1400 BP the emphasis shifted to the west area, with contemporary minor activity in the east. Then again, after 1200 BP, people returned to the east area and moved to central area after 800 BP. There was minor activity in West Block throughout this time, indicated by artifacts scattered through massive strata. Finally, the central area was abandoned in favor of west and east areas. Some use of 45OK196 certainly coincided with habitation of 45OK197, but precise cross-dating is impossible.

Summary

The sequences of natural strata at 45OK196 and 45OK197 have been determined by studies of lithology and crossdating on the basis of that lithology, radiocarbon dating and projectile point style.

Table 5. Quasi-seriation of 450K197 occupations, based on projectile point styles.

Occupation	Projectile Point Types 2 a	2 b	5 c	4 a	4 b	4 c	18 a	18 b	18 c	10	17	7	9	Total	C^{14} Date
IIC		1		7	1									9	
IIC, B1				3	1	1								5	170±110
III1		1		1										2	
III5				1										1	
VIE				1						1				2	800± 70
VII				1										1	500± 90
VIII										1				1	
IXE					1	2	2			(1+)				6	980±140
X							1							1	1240± 90
XIE							1							1	1220±120
XIW	1		1				1	2	3			1		9	1170±120
XIIE			1				2			1				4	
XIIW								1		1				2	1110± 70
XIIIE							1							1	1440±120

base. Type 4 is divided into: a (expanding base with concave or straight basal margin), b (nonexpanding base with straight basal margin) and c (no lateral margin on base, convex basal margin). Types 18a, b and c have expanding, straight, unnotched; expanding, convex, notched and contracting, convex, unnotched stems, respectively. The resulting, broader classification provides for greater precision in seriation.

There were 45 classifiable projectile points from 13 occupations at the site. Six of these are from the body of Burial 1. Another five points were associated with the burial, but because they are apparently exotic to this region, they have not been used for chronology (see Appendix F).

Occupations are arranged in a quasi-seriation such that those from each block remain in their proper stratigraphic order (Table 5). Note that results are entirely consistent with the cross-dated order of sediments shown in Figure 7.

There are some interesting side effects of this analysis that may help to clarify the local chronology. First, there is the anachronistic appearance of types 5 and 7 (both supposedly out of fashion after 1600) in sediments 1000-1200 years old. Rather than revival of old styles or continuity in their manufacture, what this phenomenon may represent is scavenging of tools from earlier artifact deposits. It is curious that all these anachronisms appear at about the same time (1100-1200 BP). Erosion may have exposed an old habitation site in these people's annual range and made the older tools accessible.

Second, note that side-notched points came into use no earlier than 100 BP and that their corner- and basal-notched counterparts do not occur after 1000 BP. This is in contradiction to Lohse's general findings and may reflect either the lack of mixing here compared to that occurring in other sites or merely to sampling error. Corner-notched and corner-removed points were at least rare after 800 BP. Third, there are two forms of side-notched points with complementary temporal distributions: those with long, expanding stems and straight or concave bases (type 4a), and those with short stems and straight sided, convex bases (type 4b). The type 4a subset is most common in the last 800 years, while the b type seems to predominate, if not be the sole type, before that time. A similar pattern is seen in triangular points (type 2). The straight-based form occurs with side-notched types, the convex-based form with corner-notched types. Both are probably unfinished specimens of the contemporary, notched projectile points.

Finally, there is a conspicuous lack of large (neck width greater than 10mm) corner-notched points. Either these were absent after 1600 BP, or they were not a part of activities people performed at the site or while gathering food in the vicinity.

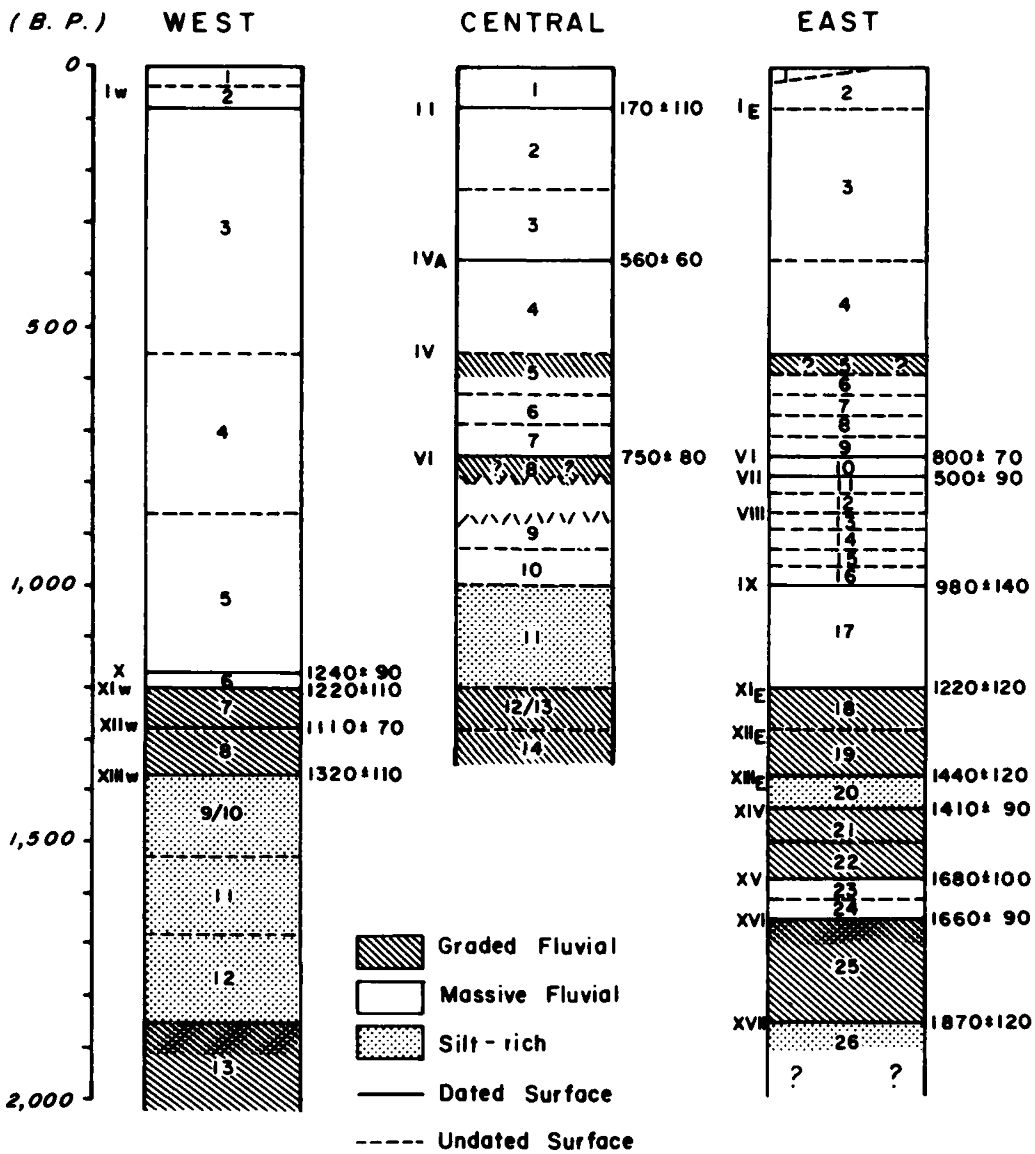

Figure 7. Cross-dated schematic profiles from 45OK197 block excavations. Note that the vertical dimension is time, not elevation.

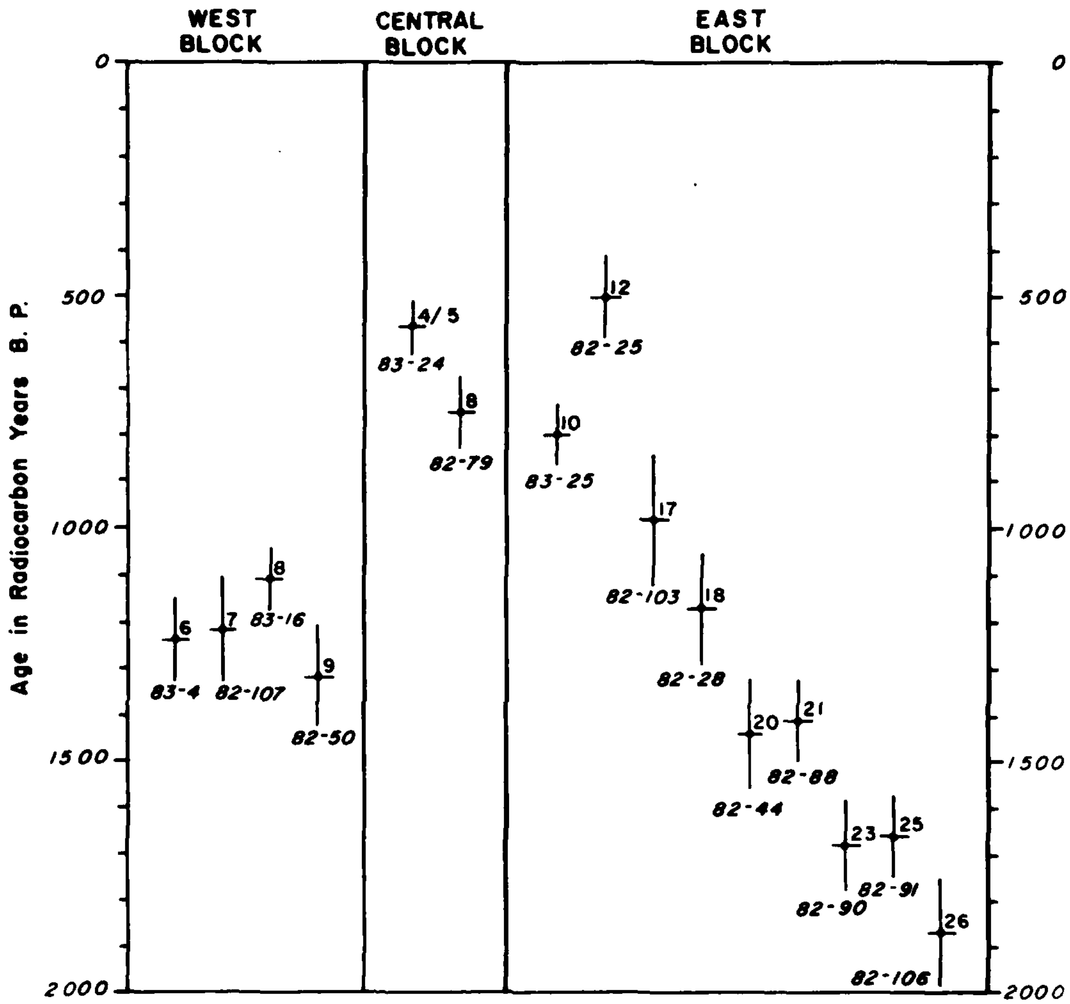

Figure 6. Temporal distribution of radiocarbon dates from block excavations at 45OK197. Block stratum numbers are to the upper right of each date's mean point; sample numbers are below each date, in italics.

is to use a combination of radiocarbon dates (Figure 6) and sediment characteristics to create a master chronology of sediments. Figure 7 shows the results of that effort. I checked the master chronology against the vertical distribution of projectile point styles as an independent means of confirmation. Only the block areas could be cross-dated; no dates were obtained from trenches or most of the test pits, and cross-dating was difficult. We were however, able to correlate cultural strata in East Block and Central Block with cultural layers in nearby trenches and test units. These latter cultural deposits were rare, however.

Note that Figure 7, while showing a schematic of stratigraphy from the three blocks, is not drawn to a vertical scale: the y axis in that Figure is <u>time</u>, not sediment thickness. Thickness was too variable to be of much utility for tracing individual beds.

There are at least 28 strata discernable in excavations at 45OK197. The first two (not far above basal gravels, but how far we did not determine) are graded beds of silty fine-medium sand. Overlying them are two thin, massive layers of similar material followed by five more graded beds. Above this are 13 massive deposits of silty fine sand, one possibly graded bed, and then four more massive layers. A thin lens of colluvial sand and gravel, postdating the last massive flood (probably 1948) caps the deposit only in the East Block area.

Thus we have deposition of graded beds from before 1870 BP until about 1100-1200 BP, and massive deposition thereafter except for one graded stratum dating 750-800 BP. The colluvial cap may have resulted indirectly from farming on the T3 terrace in the mid-twentieth century (Barney Owsley, personal communication).

<u>Projectile point style</u>. In the chronology developed by Lohse, 1983, there are few projectile point styles that commonly occur in assemblages dated younger than 1600 BP. These are types 2 (small triangular), 4 (small side-notched), 10 (small, square-shouldered with expanding stem), and 15-18 (corner-to-basal-notched, shouldered and barbed forms of various sizes). As it turned out, 45OK197 contained only a few of these types, 2, 4, 10, and 18, plus representatives of types 5 (large lanceolate) and 7 (large, square shouldered with a contracting stem [Figure 5]). In our analysis (Appendix G), we noted that there was considerable variation among members of the small corner- and side-notched types and that the variation appeared to have some temporal meaning. We therefore have broken types 18 (small, barbed with corner-to-basal notching), 4, and 2 into subsets according to the characteristics of the stem. Dimensions added here are the shape of lateral stem margins (expanding, straight or contracting) and base plan (convex, straight, notched). On this basis, Type 18 (small, barbed, stemmed), Type 2 (small, triangular) and Type 4 (small, side-notched) are divided into subtypes with distinct temporal distributions. Type 2a has a convex basal margin; Type 4b a straight

beyond worm burrowing, and unconformities were surprisingly rare. Pits around the secondary channel of Corral Creek showed numerous episodes of cut and fill; several strata had been excised from the central block area. This latter event probably was river-caused; the flat character of this area of the site is different from the site as a whole. Given the erosion of strata previously existing between Central Block strata 8 and 9, and the flat topography of this small area, central area appears to have been a reentrant or slight embayment created during an especially severe episode of flooding. Otherwise, except for a tendency for lensing and discontinuity among upper strata (a characteristic common to upper bar settings) most strata are undeformed. We seem to have evidence of most if not all floods that ever deposited sediment on this site.

The clarity of stratigraphy declined to zero toward the back of the terrace, where sediments were wet and a nearly uniform very dark brown. Clarity and the numbers of distinguishable strata increased toward the terrace edge, where layers abruptly dipped. This dipping is evidence that most of the T0 is still intact.

Radiocarbon dates. Soil surfaces are rich in charcoal and other residue of human habitation. We submitted 20 samples to Beta Analytic, Inc., including 14 of charcoal, four of mussel shell, and one of bone (Table 3). Shell samples were not necessary for dating, but I wished to learn how reliable shell dates area from sites containing no charcoal; as most RM 590 sites were in this category. My conclusion: reliability is low. Of the four dates, not one is closer than 1000 years to the charcoal date from the same stratum. One date is nearly 3000 years too old. Therefore, I make no use of shell dates from this site. The single bone sample was from a burial that lacked associated charcoal.

Dates range from 1870+-120 for Stratum E26, a graded bed, to 170+-110 BP for Stratum C2. Only one set of charcoal dates shows a stratigraphic inconsistency beyond one standard deviation. Dates on samples Beta 8818, from East Block, Stratum E10, and Beta 5258, from East Block, Stratum E12 are reversed. The upper date is 800+-70 and the lower, 500+-90; at least one of them is anomalous. Charcoal from Stratum E10 came from two constant volume samples and can be thought of as an average date for the stratum. Stratum E12 charcoal was from a single lump found in a disturbed portion of that surface. Therefore, the Stratum E10 date of 800 BP is more likely the correct one; Beta 5258 is rejected as inconsistent and probably intrusive.

Cross Dating

Except for the two uppermost strata (C, E, and W, 1 and 2), and one silt layer (E20, W9/10), it was difficult to follow individual fluvial deposits from one pit to the next. This was true even of units within a few meters of each other. The uniformity among deposits in color, texture and structure frustrated our efforts to cross date among blocks by geologic evidence alone. What I have done

Discussion/summary. Now consider the sequence in light of other RM 590 data. The gravel substrate, Stratum 7, is apparently TSU X; the overlying strata 5 and 6 represent TSU XIa and/or b. Taking this into consideration the 4500 year date on Occupation V is not beyond the realm of possibility. How deep these sediments once were is a matter of conjecture, but at 45DO190/191 and 45DO394 TSU XIa and b were 2 to 4m in thickness (Chatters 1984:appendix A).

Sometime shortly after 2500 BP, when flooding that created the T1 had ceased and downcutting had begun, either floods from Corral Creek (or degradation by the Columbia, or both) eroded away most of the TSU XI fluvial sediments, leaving behind a lag deposit of colluvium, fire cracked rock and lithics. This deflation surface almost certainly corresponds to the interval between 2500 and 1850 BP. Sedimentation at 45OK197 began just before the later date. Stratum 4 is thus equivalent to TSU XII. The colluvial/fluvial sediments of strata 1, 2 and 3 (TSU XIII) began to form after 1850 BP and prior to 1000 BP.

45OK197

Stratigraphy. The situation at 45OK197 appears to be more complex than that at 45OK196, partly as a result of the larger number of excavation units at the former. Sediments begin on basal gravels, evidently river-deposited (although we could never observe gravels carefully because of the ground water that covered them). Above these are varying numbers of fluvial layers, some graded, others massive. Each block and each trench contain different numbers of strata; not all were taken to basal gravels because of ground water. We observed 26 separate strata in East Block, 13 in West Block and 14 in the much-shallower excavations at Central Block. Strata were numbered separately for each block. Descriptions and profiles are in Appendix K.

In general, basal gravels are overlain by graded fluvial sediments consisting of silty fine to medium sands. Bands of silt, apparently massive but possibly with unperceived grading are interspersed among graded sediments. The common color is olive (5Y4/2). Fossil A horizons occur at the surfaces of many layers.

Graded beds are overlain by 6 to 17 massive strata consisting of silty, fine to very fine sands with dark gray-brown to dark olive colors. Most of these strata are topped by incipient A horizons. There are occasional, apparently graded beds among these layers. Textural analysis (Appendix J) of the East Block sequence shows that all strata below E1 result from the same process; probably overbank flooding

Toward the back of the T0, an occasional wedge of colluvium intrudes between fluvial beds, consisting of cobbles and gravel, a clastic flow of Nespelem formation silt, or both. Disturbance is relatively rare when compared to other sites in the region. Except for the central block, we observed little evidence of bioturbation

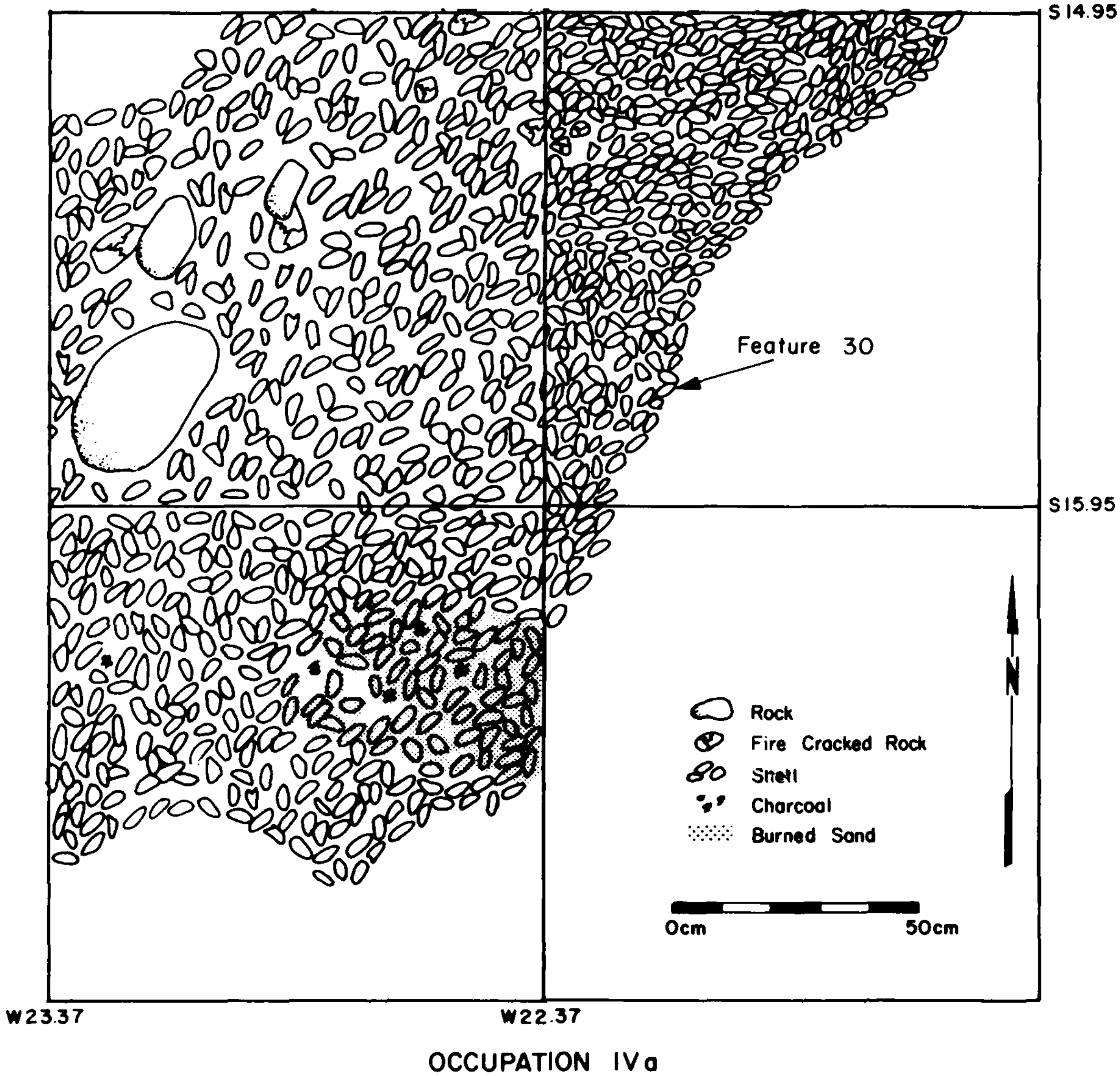

Figure 11. Plan of Feature 30, a shell midden in Occupation IVa, 450K197.

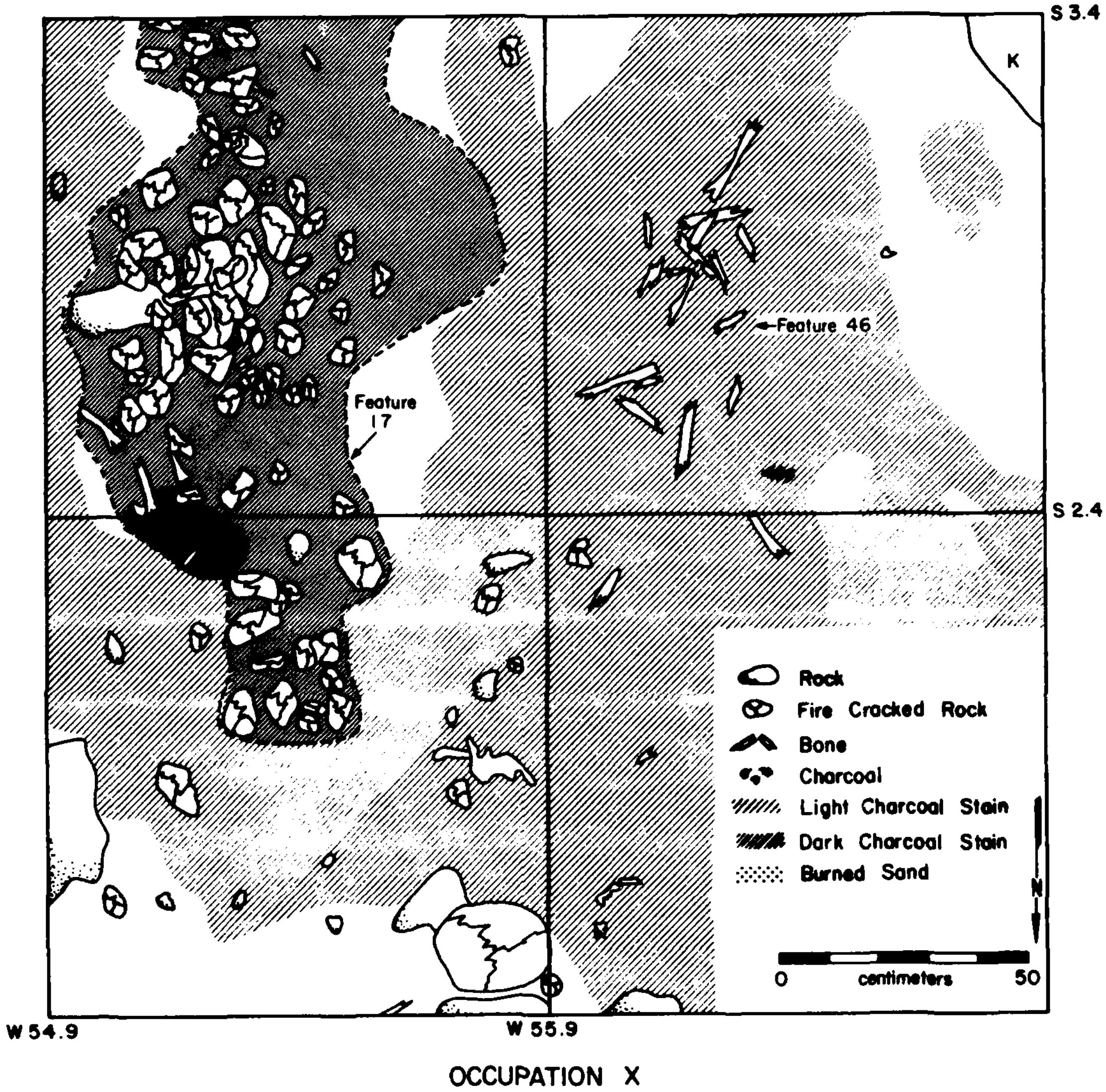

Figure 12. Examples of a hearth (Feature 17) and a large-bone heap (Feature 46) from Occupation X, 45OK197.

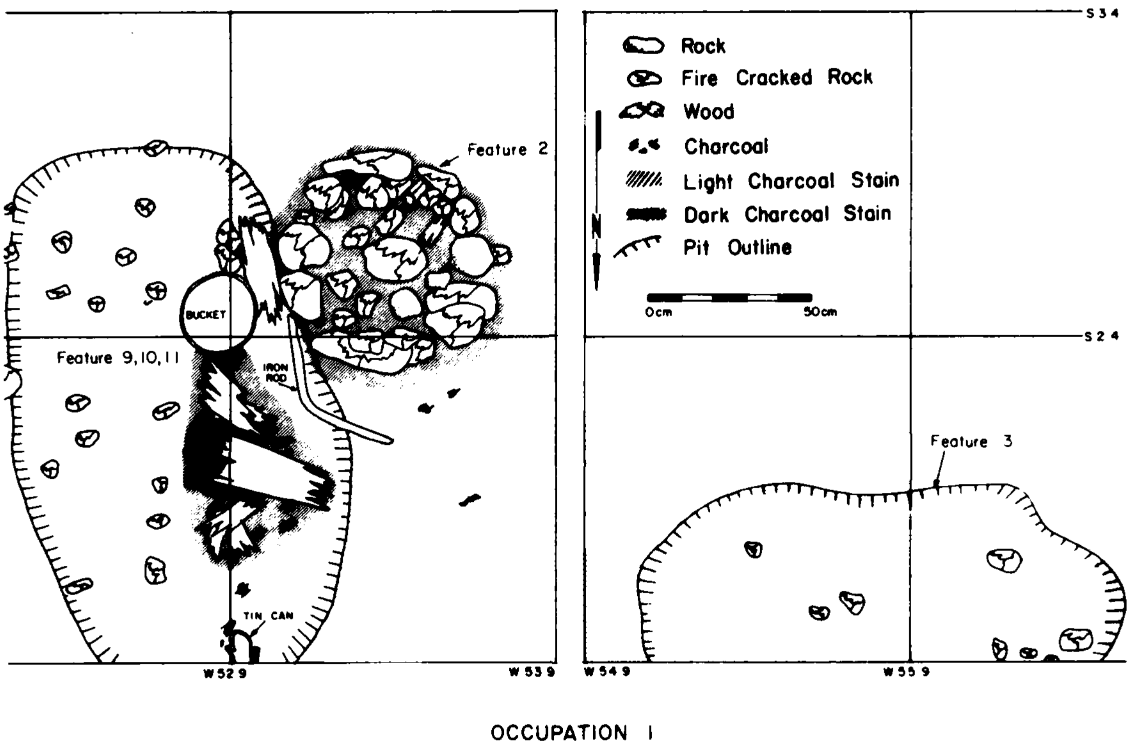

Figure 13. Earth ovens (Features 3 and 9, 10, 11) and a hearth (Feature 2) in West Block Occupation I. Note the metal objects and boards in one oven feature.

Table 7. Feature Definitions.

Feature	Definition
Hearth[1]	Any feature on the occupation surface less than 2m in diameter showing evidence of *in situ* fire as indicated by a cluster of fire-modified stones and/or charred bone and/or charcoal *and* oxidized earth.
Earth Oven	A basin-shaped pit of varying depth filled with charcoal and fire-broken stones and showing evidence of *in situ* fire, and greater than 1m in larger dimension.
Shell Midden	A continuous layer of varying thickness consisting of mussel shell and various other debris covering an area of at least 50cm in diameter.
Pit	An excavated pit of varying shape (regular or otherwise) under 4m in diameter and lacking the hearths and debris characteristic of housepits.
Bone Heap	A continuous layer of 10 or more bone fragments covering an area at least 25cm in larger dimension.
Burial	Human grave.

[1] Separated into discrete hearths and hearth scatters.

Table 8. Features observed in 45-OK-196 occupations.

Occupation	Hearths (both types)	Earth Oven	Pit	Shell Midden	Bone Heap	Burial	Total
I			1[1]				1
II							
III	1						1
IV	1[2]						1
V	3		1[3]	1			5

[1] May be remnant of midden area isolated by bioturbation.

[2] May be only a fortuitous concentration of lagged artifacts and burned sand.

[3] Only partially excavated, could simply be a hearth, but profile similar to that of earth oven (Figure S196).

Table 9. Features observed in 45OK197 occupations.

Occupation	Discrete Hearth	Hearth Scatter	Earth Oven	Pit	Shell Midden	Bone Heap	Burial	Total
I	1		4[2]					5
II							1	1
III		1			1			2
IVA					1			1
IV	1							1
V						1		1
VI	1	1			1[3]			3
VII	1				1			2
VIII	1				1			2
IX	(1)[4]	1			4	1		6
X	1					1		2
XIW	1	2		1		+[5]		4
XIIE					2	2		4
XIIW						+[5]		+
XIIIW						+[5]		+
XV	1					+[5]		1+

[1] No features were observed in Occupations XIIIE, XIV, XVI, and XVII.

[2] Actually 2, both were used twice.

[3] Several coalescing midden piles.

[4] Portion of hearth scatter with rock cluster and most intense burning.

[5] Numerous large bone piles present but not yet counted.

Lithics

Lithics are chipped, pecked or ground stone artifacts (debitage and tools). As with other RM 590 sites, we conducted an extensive analysis of lithic artifacts, recording for each object its material, size, reduction state (flake type and other technological characteristics), use-wear characteristics, and common sense "functional" term (Cleveland and Benson in Chatters 1984, Appendix D). The purpose of this analysis was to collect data that might inform us about changes in tool technologies and the nature of activities performed here and elsewhere in the study area. The results are used in definition of settlement classes and in the consideration of tool diversity and interassemblage variability as a means for discerning the position of occupations in a system of resource exploitation tactics. In addition, with a more detailed set of material type classes, some of the data may later be used for study of the degree of curation versus expediency among assemblages, an important consideration in studies of hunter-gatherer site structure (Binford 1977, 1979; Kelly 1984; Nelson 1984).

Classification

Details and rationale of the analyses are presented in an earlier report (Chatters 1984) and will not be repeated here. For ready reference, the use wear classification, including type definitions, is reprinted here (Table 10). The complete lithic classification coding system is in Appendix B.

We have made one change in analysis, a refinement of the existing classification that does not reduce comparability of data presented here with that from earlier testing at RM 590. Material type and reduction state dimensions have been intersected into a classification of reduction states for each stone type. This data will show variations in technological activities performed in each occupation, which I hope can eventually be part of an analysis of technological organization in occupation assemblages.

Results

Results of the analyses are given in detail in Appendix B; summaries are presented here (Tables 11, 12, 13, 14, 15, 16, 17, 18).

Material type. Gross totals of lithic raw material differ little between 45OK196 and 45OK197 (Tables 11, 12). Of the 1691 lithics from Occupations I through XV at 45OK197, nearly two-thirds (1047) are some form of cryptocrystalline (jasper, chalcedony, chert) and another one-fifth are quartzite (311). Other materials occur in smaller amounts: basalt (127), opal (102), obsidian (41), quartzofeldspathic schist (10). The pattern is similar at 45OK196, with cryptocrystalline (405) and quartzite (81) occurring as nearly 50

Table 10. Grouping of use wear classes to reduce the effect of small sample sizes on comparisons among assemblages.

Group	Use Wear Class	Definition
A	1, 9	Unifacial chipped or chipped and polished wear on a concave edge.
B	2, 4	Bifacial chipped wear on a concave or convex edge.
C	3, 10	Unifacial chipped or chipped and polished wear on a convex edge.
D	5, 11	Chipping or polish on a point.
E	7, 14	Crushing on a convex edge or surface, or chipping and crushing on a point.
F	8, 17, 18	Crushing and/or abrasion on a concave or flat surface.
G	12	Bifacial chipped and abraded or polished and abraded edges.
H	13, 15	Unifacial chipping and crushing on an edge.
I	16	Bifacial chipping and crushing on an edge.

Table 11. Summary of lithic raw material from 45-OK-196.

Occupation	Obsidian	Opal/Opaline	C.C.Q.[1]	Basalt	Quartzite	Schist	Nephrite	Mudstone	Granite	Indeterminate	Other	Total per Occupation
	Material Type											
I		2	7	2	2							13
II			8	2		1		4			1	16
III		3	3	16	13	4		5	4		3	51
IV		5	38	5	22	1		12	2			85
V		24	349	16	44	28		13	5		1	680
Total		34	406	52	81	34		35	12		5	

[1] Cryptocrystalline quartz; includes materials jasper, chalcedony and petrified wood.

Table 12. Summary of lithic raw material from 45-OK-197.

	Material Type											
Occupation	Obsidian	Opal/Opaline	C.C.Q.[1]	Basalt	Quartzite	Schist	Nephrite	Argillite	Granite	Indeterminate	Other	Total
I		2	10	1	2						1	16
II	27	29	108	3	17			1				185
III	13	2	50	59	23	4		3	2			156
IVA		1	2									3
IV	1	6	43	6	10	10			3			79
V			1		1							2
VI		35	213	4	2	2		2				258
VII		3	38	8	1	1	1		2			54
VIII		2	43	3		2		4				54
IX		10	289	8	19	8			3	1		338
X		6	63	4	7	4						84
XIE		2	6		1							9
XIW		3	100	10	48	1		3	1			166
XIIE		2	26	2	8	2		1				41
XIIW		1	15	12	1							29
XIIIE		15	12	1	3							31
XIIIW			2	4					1			7
XIV												0
XV		1	44	3	1							49
Total	41	120	1065	128	144	34	1	14	12	1	1	1561

[1] Cryptocrystalline quartz; includes materials jasper, chalcedony and petrified wood.

Table 13. Distribution of use wear tool categories among 45-OK-196 occupations.

Occupation	Use Wear Category																		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	Total
I			1													2				3
II			1	1											1	1				4
III			3	2				1	1	2						2			1	12
IV	1		4	10			1		9[1]	3						6			3	37
V	1	3	13	16			1			1			1			9			2	47
Total	2	3	22	29			2	1	10	6			1		1	20			6	108

[1] The unusually high frequency of this type is probably a result of geologic process; this is a deflated assemblage.

Table 14. Distribution of use wear tool categories among 45-OK-197 occupations.

Occupation	Use Wear Category																			
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	Total
I			2	3					1	1					1	1				9
II	2		5	2											1	5			35	50
III	1		5	1			2			1						6	1		4	21
IVA				1												1				2
IV			7	1			1						1			2			2	14
V							1									2				3
VI			6	8	2		1			1		1				2	2		3	26
VII			1	7	3			2						1	4	1			3	22
VIII	1		6	4											1				5	17
IX	4	4	18	16	2		4			5					1	4	7		10	75
X	1	2	3	2						2				2	2	5			1	20
XIE																1			1	2
XIW	1	2	11	9	3		2		1	2			3		1	9			11	55
XIIE			4	2						1					1	1			4	13
XIIW																			2	2
XIIIE			2	1															2	5
XIIIW							2									3				5
XV	4		8	7			1			3	3					1		1	2	30
Totals	14	8	78	64	10	0	14	2	2	16	3	1	4	3	12	44	10	1	51	371

Table 15. Summary of lithic reduction state for two material groups, 45OK196.[1, 2]

Occupation	Cores CCQ[2]	Cores CS	Conchoidal/linear CCQ	Conchoidal/linear CS	Bifacial thinning CCQ	Bifacial thinning CS	Shatter CCQ	Shatter CS	Tabular CCQ	Tabular CS	Totals CCQ	Totals CS
I			6	2	1		2			2	9	4
II			5	4	2		1	1		3	8	8
III		2	6	21	1		2	9		6	9	36
IV		2	29	29	3		7	9	1	14	40	52
V	1		282	46	16		66	16	1	42	349	104

Reduction State by Material

[1] The "other" category is not listed, so totals may differ from those in Table 11.

[2] Cryptocrystalline quartz; includes materials jaspar, calcedony and petrified wood.

Table 16. Summary of lithic reduction states for three material groups, 450K197.[1, 2, 3]

	Reduction State by Material																	
	Cores			Conchoidal/ linear			Bifacial thinning			Shatter			Tabular			Totals		
Occupation	O	CCQ[3]	CS	O	CCQ	CS	O	CCQ	CS	O	CCQ	CS	O	CCQ	CS	O	CCQ	CS
I					8	1					2				2		10	3
II		1		3	30		21	88	3	2	9	1		1	18	5	129	32
III					36	11	13	17	1		7	11				13	60	23
IVA					1						2						3	
IV		1	1		32	12	1	6			10	6		1	14	1	50	33
V											1				1		1	1
VI					215	5		18			10				4		243	8
VII					20	5		15			2	2		1	3		38	10
VIII			1		29	4		8			4	1		1	2		42	8
IX		1			183	13		75			30	3		1	19		290	35
X					59	7		8			2				5		69	12
XIE					1		2	3						1	1		5	1
XIW					74	32		14			13	7		2	22		103	61
XIIE		1			15	1		6			5	1			10		26	13
XIIW					1	12		7			5				1		13	13
XIIIE		1			1		10	5		1	1				4	11	8	4
XIIIW					1	3		1									2	3
XV					22			10			8				3		40	3
XVII							2	13			1					2	14	

1 The "other" category is not listed, so totals may differ from those in Table 12.

2 Occupations XIV and XVI are not included; no lithics were recovered.

3 Cryptocrystalline quartz; includes materials jaspar, calcedony and petrified wood.

AD-A159 823 DIMENSIONS OF SITE STRUCTURE; THE ARCHAEOLOGICAL RECORD FROM TWO SITES IN (U) CENTRAL WASHINGTON ARCHAELOGICAL SURVEY ELLENSBURG J C CHATTERS ET AL. SEP 84 2/4

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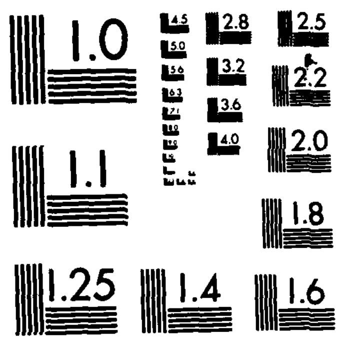

MICROCOPY RESOLUTION TEST CHART
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Table 17. Common sense tool inventory for 45OK196.

Occupation	Common Sense Tool Categories: Flakes	Utilized Flake/Chunk	Unifacially Retouched Flake	Bifacially Retouched Flake	Amorphously Flaked Object	Biface	Projectile Point (whole)	Projectile Point (base)	Projectile Point (tip)	Drill	Scraper	Core	Tabular Knife	Hammerstone	Edge Battered Cobble	Chopper	Peripherally Flaked Cobble	Total
I	11			1							1							13
II	13	1		1							1							16
III	40	4	4		1				1	1	1	1		1			1	55
IV	80	11	1	1		1	1	2				1	4			1	1	104
V	483	19	4			2	1	1				1	10			1		522
Unassigned	10	2	2									1			1			16
Total	637	37	11	3	1	3	2	3	1	1	3	4	14	1	1	2	2	

Table 18. Common sense tool inventory for 45OK197.

Occupation	Common Sense Tool Categories																					Total
	Flakes	Utilized Flake	Unifacially Retouched Flake	Bifacially Retouched Flake	Amorphously Flaked Object	Biface	Projectile Point (whole)	Projectile Point (base)	Projectile Point (tip)	Drill	Scraper	Spokeshave	Core	Tabular Knife	Hammerstone	Maul	Edge Battered Cobble	Chopper	Peripherally Falked Cobble	Hopper Mortar Base	Anvil	Other	
I	9	4				1								2								1	17
II	149	3	1	2	1	3	11	17	6		1		1	5									200
III	142	3	1	1		1	2	2						3			3						158
IVA	1	1		1																			3
IV	71	7		1		1	1		2				1	4			1		1				90
V	3													1				1					5
VI	230	10	4	2		1	2	1	1								2					2	255
VII	37	3		3	1	1	1	2			2			2		1	1	1					55
VIII	38	6	1			1	1	3	1				1	2					1	2	2		59
IX	284	27	2	1		3	9	1	2		1		1	4								1	336
X	71	2	2				1							4			2						82
XIE	9						1							1									11
XIW	129	6	5			1	10	1	1	3	2			13								1	172
XIIE	34	5		1	2	3	1				1			1									48
XIIW	26		1			3	1																31
XIIIE	27	2			1		1		1					1									33
XIIIW	6											1			1							1	9
XV	35	1	2	3		9		1	1	1	1		1			1	1						57
Total	1301	80	19	15	5	28	42	28	15	4	8	1	5	43	1	2	10	2	2	2	2	6	1621

percent and nearly 10 percent respectively of the 859 items. Basalt, mudstone, opal and quartzofeldspathic schist are present in near equal proportions of around 5 percent each. There is no obsidian.

Obsidian, in fact, occurs in quantity only in Occupations II and III at 450K197. It is interesting to consider that this is the only obsidian found in RM 590 occupations younger than 4600 BP. Trace element analysis of obsidian from Occupation II indicated the source area as Tucker Hill, Oregon (Sappington 1984, in Chatters 1984, Appendix E). Both Occupation II and III are recent, with Occupation II, at least, dating within the equestrian period. It may be that increased mobility made possible by introduction of the horse extended the annual range of the Sanpoil or, more likely, resulted in expansion of existing trade networks among peoples of the region.

Two observations are noteworthy in the case of 450K196. Occupation III (with a small assemblage) is predominantly basalt and mudstone. In fact, all but six items in that assemblage are of coarse material Occupation IV also contains a high proportion of coarse flakes. Usually larger than the objects made from cryptocrystallines, flakes of coarse-material are common in lag deposits, such as this one.

Assemblages from 450K197 are so variable that they almost defy description. Generally speaking, most assemblages consist primarily of cryptocrystallines with small numbers of flakes and tools made from other materials. Occupations II, III, VI, XIW, and XIIW deviate from the pattern. In addition to obsidian, Occupation II has far more opal and quartzite than the norm. It is, in fact, the most diverse assemblage in terms of evenness. Occupation III is a close second, with high proportions of basalt and quartzite; basalt is the dominant material here.

Quartzite is in unusually high proportion in Occupation XIW and basalt is very common in the small XIIW assemblage. These occurrences are interesting in otherwise uneven assemblages.

Use Wear

Based on the idea of a tool as a co-occurring set of wear attributes, (Dunnell 1978), we have defined 19 tool classes for the RM 590 study area (Table 10). Classes 3, 4, and 16 are among the most commonly occurring at both sites (Tables 13, 14). Of the 103 tools at 450K196, these four classes comprise 71 percent (73 items); at 450K197 they make up 50 percent (180) of the 360 tools. Wear patterns on these tools are unifacial chipping on a convex edge, bifacial chipping on a convex edge, and bifacial chipping and crushing on a convex edge, respectively. Functions represented are light scraping and light cutting of soft material, and chopping or cutting of harder material. Projectile points (19) are the most common class actually occurring on 450K197; they are rare at 450K196.

Types that are also present in some frequency at 450K197, both in amounts and occurrence in assemblages, are classes 1 (concave-edged scraping of soft material), 7 (hammer stones), 10 (chipping and polishing on a convex edge; light cutting of fibrous material), and 15 (unifacial chipping and crushing on convex edge; scraping of tough material). All other types are quite rare. Stones with ground surfaces (food grinding) are present only in III, VI, and IX, all shell-midden occupations. There is only one anvil (class 18), found in Occupation XV.

Classes 19, 7, and 10 are also commonly present, though in low frequency, at 450K196. There is an unusually large proportion of polished-edged tools (classes 9 and 10) in Occupation IV. This is another indication of the secondary character of that deflated deposit.

Variable characteristics of tool assemblages are covered in Chapter VII.

Common Sense Tool Types

A summary of common sense "functional" types of tools is presented in Tables 15 and 16 (for definitions, see Appendix A). Utilized flakes and tabular knives of quartzofeldspathic schist (often incorrectly labled quartzite) are the most common non-projectile point artifacts at both sites. Projectile points rival numbers of utilized flakes at 450K197.

Notable at 450K197 are the high proportions of tools to waste flakes. Ratios (tool/flake) range as high as .70 and above (Occupations I and XV) and are commonly between .15 and .50. Only two assemblages (III and VI) have ratios of .10 or less. Similar high ratios of tools to flakes can be seen in the later three occupations of 450K196. The ratio for 450K196V is under .10; high ratios of tools to flakes in Occupation IV are probably due to removal of the small, flat waste flakes during the erosion process.

I make no further use of common sense tool categories; examples of items found in the larger assemblages are shown in Figures 14-16.

Reduction State

Breakage patterns in lithics is partially conditioned by the amount and direction of force applied to a core, and partially due to the characteristics of the raw material itself (see papers in Hayden 1979). A consideration of the technological characteristics of lithics (reduction states) must, therefore, factor out raw material before any meaning can be drawn from counts of various debitage forms. In this instance we recorded characteristics including: cores, bipolar cores, nonlinear conchoidal unipolar flakes, linear conchoidal (blade like) flakes, tabular flakes, bipolar flakes, biface thinning flakes, shatter and other (e.g., heat spalls). See Appendix A for

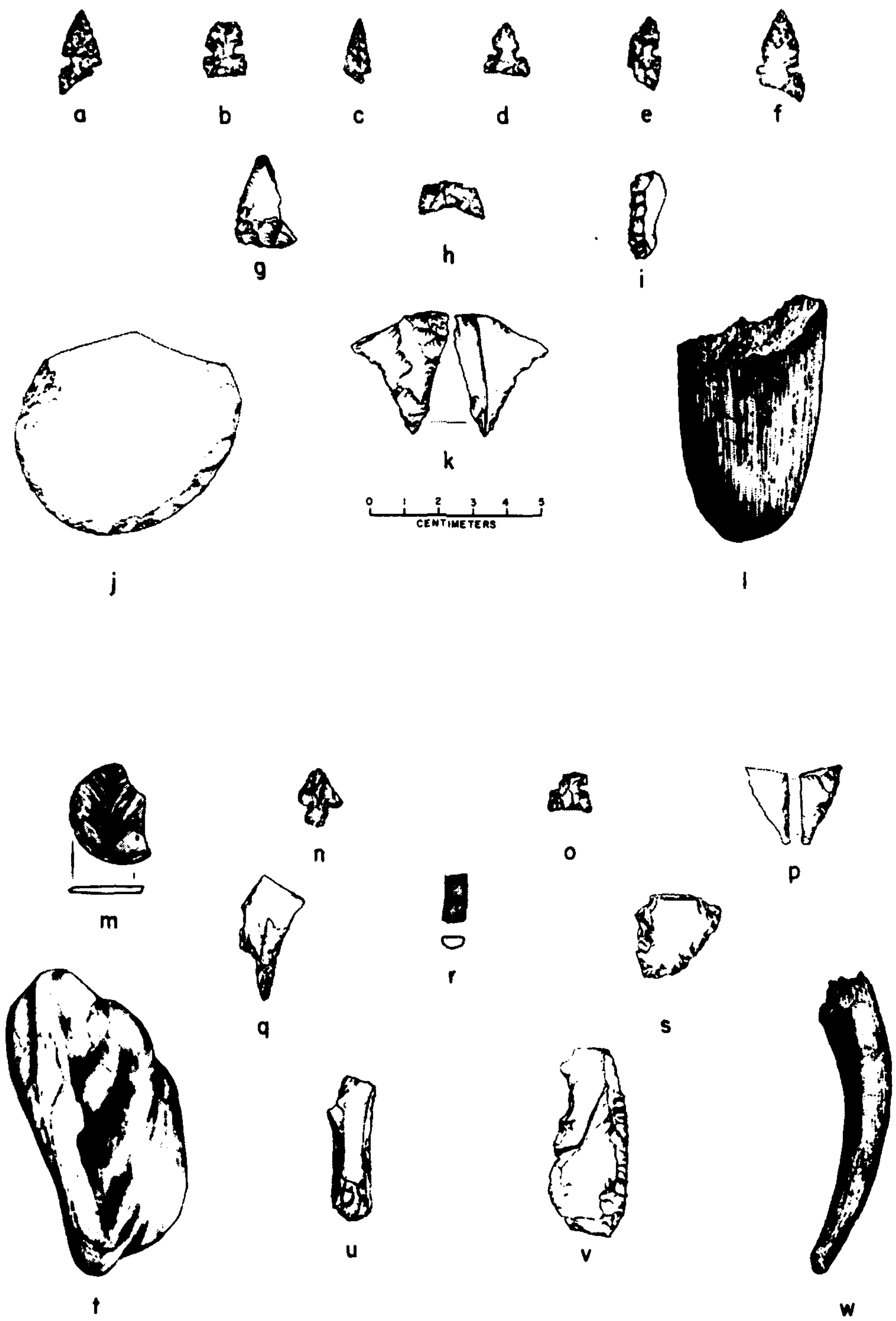

Figure 14. A sample of stone and bone tools from Occupations II (a-l) and VI (m-w), 45OK197. Included are projectile points (a-f, h, n, o), tabular knife (j), antler wedge (l), flakes (w), bone shaft fragment (r), hammer stone (t), an incised clay disc (m), drill (g) and assorted flake tools.

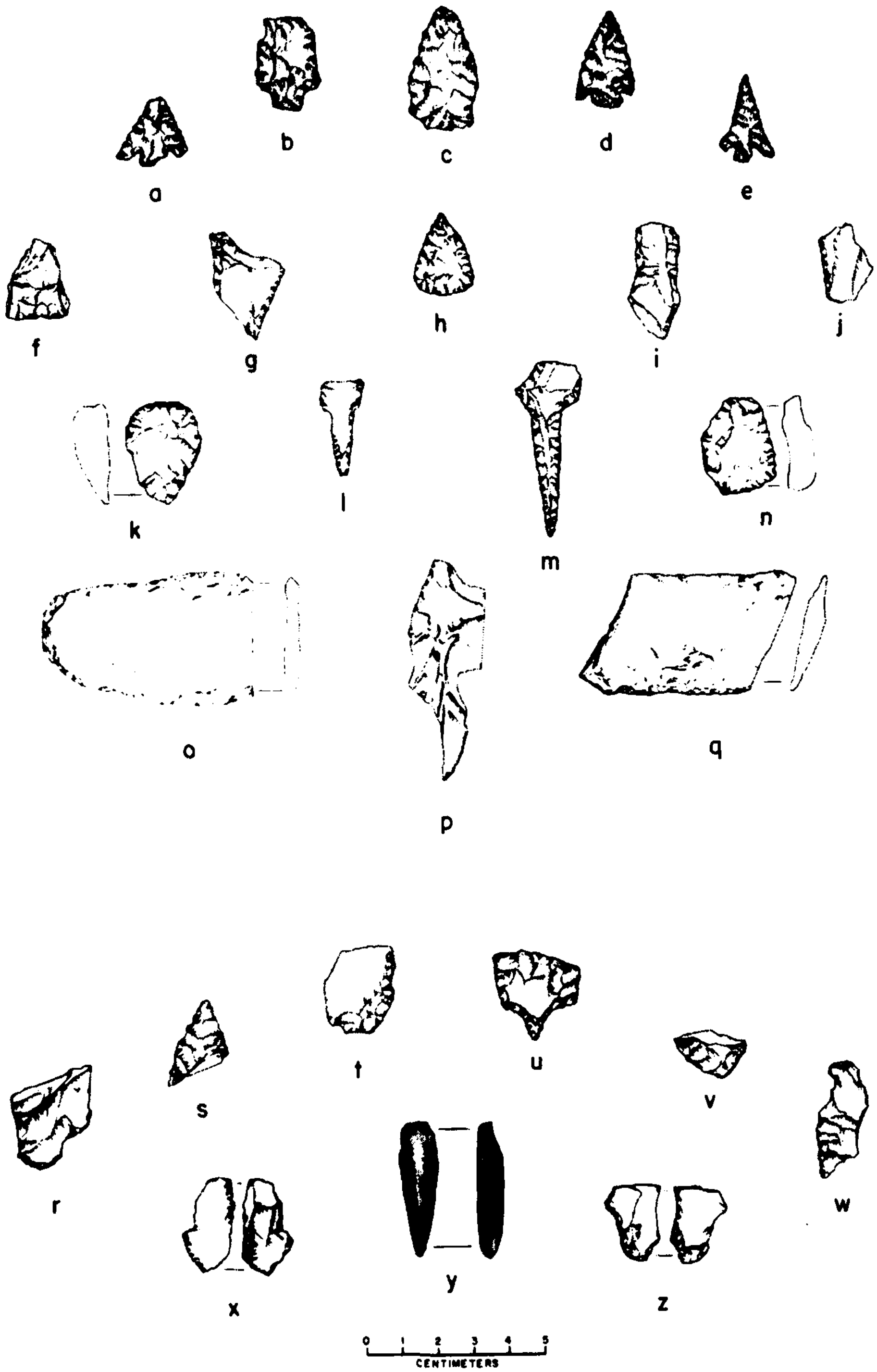

Figure 15. Examples of tools from Occupations XIw (a-q) and XV (r-z), 45OK197. From Occupation XIw are projectile points (a-e, h), drills (l, m), scrapers (k, n), tabular knives (o-q) and various flake tools; knife fragments (s, v, w), a harpoon valve (y) and flake tools comprise the Occupation XV group.

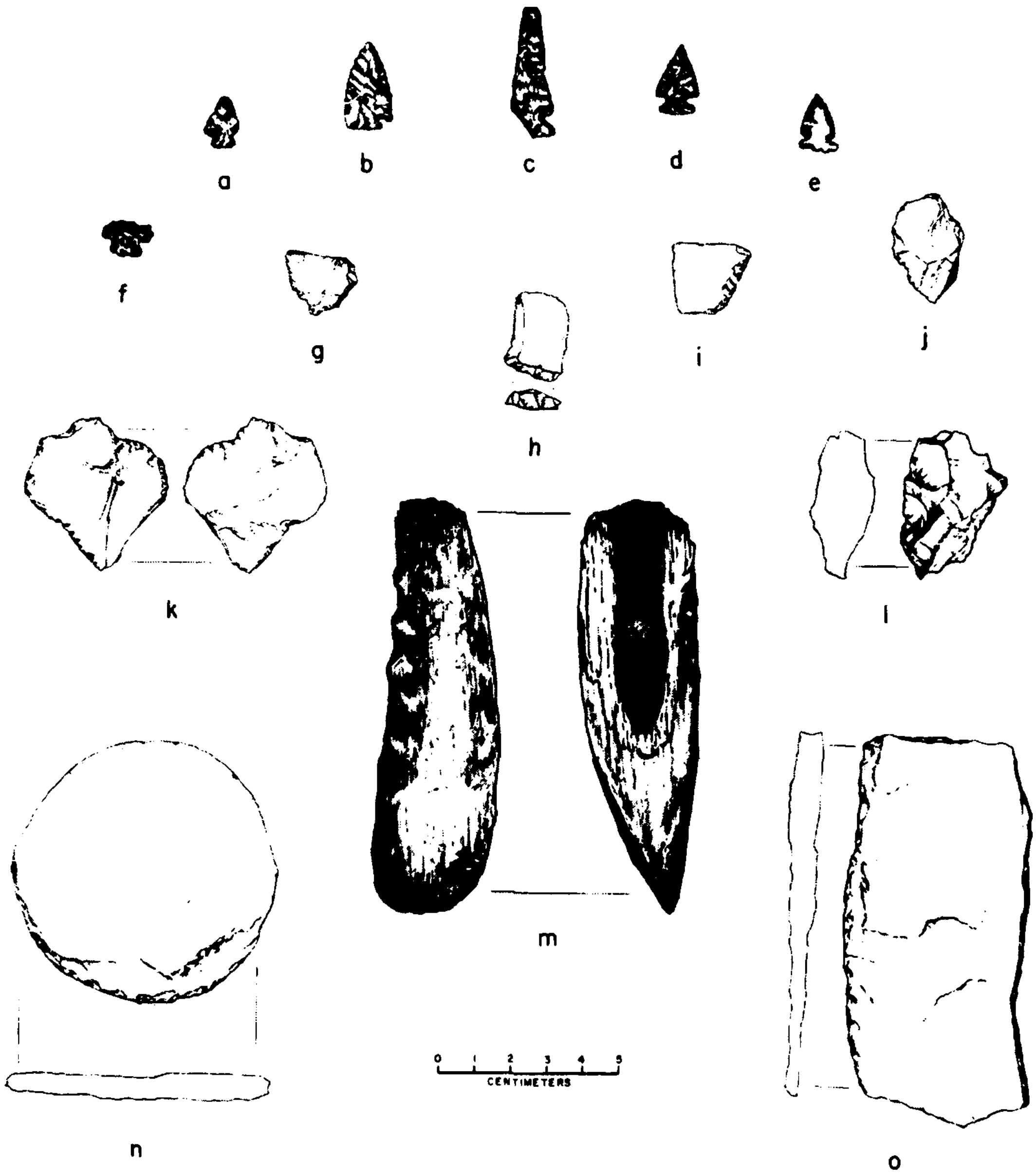

Figure 16. A portion of the tool assemblage from Occupation IX, 450K197, including a wedge (m), tabular knives (n, o), projectile points (a-f) and an assortment of utilized and retouched flakes.

definitions; Appendix B for a full listing of data. Tables 17 and 18 summarize the results of our analysis. For simplicity, I have grouped all conchoidal flakes together and have grouped material by coarseness of grain into obsidian, cryptocrystalline silica (opal and cryptocrystalline) and coarse (all other materials). Bipolar flake and core are deleted from the tables; only one item was found with bipolar characteristics (in 45OK196 Occupation V, cryptocrystalline).

45OK197. Coarse materials are, in most cases, more or less evenly distributed between conchoidal, and tabular flakes, with low proportions of shatter; biface thinning flakes are rare. Exceptions to this pattern probably are due to variation in proportions of quartzite and schist to basalt.

Obsidian is almost entirely represented by biface thinning flakes in all assemblages in which it occurs. Obsidian was apparently reserved for biface tools, probably projectile points; fragments of obsidian projectile points, apparently broken in manufacture, do occur in the Occupation II tool assemblage.

Biface thinning flakes also dominate the cryptocrystallines of Occupation II (68%) but are secondary to conchoidal flakes in all other assemblages. In fact, except for the small Occupation VII, biface thinning flakes are in all other cases under 30% of cryptocrystalline lithics. Occupation II stands out as a limited activity assemblage. That activity was the manufacture of arrow points and the repair of arrows (see Table 18).

45OK196. Biface thinning flakes are rare among cryptocrystallines in the larger occupation assemblages. And, unlike most 45OK197 assemblages, biface thinning flakes are much less common than shatter. Lithic fragments from coarse material exhibit a pattern similar to 45OK197, with conchoidal and tabular flakes occurring in the highest frequencies in most cases.

Worked Bone

Twenty-five worked bone items occur in 10 assemblages from 45OK197 (Table 19); none were found in 45OK196. Tools include, in order of abundance, antler wedges (6, Figure 14l, 16m), points (3, probably the central portions of composite harpoon points, Figure 14r), utilized marmot incisors (3), antler flakers (Figure 15w), bone shaft fragments (probably from composite harpoon points), awls (2 each), and an antler pick and a valve from a composite harpoon point (Figure 15y). Debitage from tool manufacture is rare, constituting only one-fifth of all bone items (5).

Table 19. Worked bone from 45-OK-197.

	Tools								Debitage			
Occupation	Antler wedge	Antler flaker	Antler pick	Harpoon valve	Point	Awl	Shaft fragment	Utilized marmot incisor	Cut/incised	Chopped	Abraded	Total
II	1											1
III	1											1
VI	1	1				1	1	2	2	1	1	10
VII					1							1
VIII					2							2
IX	3	1					1				1	6
XIW								1				1
XIE			1									1
XIIIE						1						1
XV				1								1
Total	6	2	1	1	3	2	2	3	2	1	2	25

The distribution of tools and debitage among the various occupations is decidedly uneven, with nearly two-thirds of all items and all pieces of debitage coming from Occupations VI (10) and IX (6). Except for one utilized marmot incisor in Occupation XIW, all worked bone comes from East (22) and Central (2) Blocks.

Flora and Fauna

Floral and faunal artifacts are the most direct evidence of prehistoric subsistence behavior available in the archaeological record. Data on these artifact categories provides insights into the importance of different species to peoples' diets and technology, processing and consumption behavior, predation strategies, and seasonality of site occupancy. In the present study I apply these data to 1) define settlement classes; 2) identify the predation strategies of site occupants during their tenancy; 3) determine the extent to which animal food was processed on site at various times; 4) provide a data base for conclusions of other kinds, such as a reconstruction of peoples' behavior at the locality during various times in the past.

Flora

There is a large amount of charcoal scattered over many of the occupied and unoccupied sediment surfaces at 450K197, as compared with other sites in the study area (Leney in Chatters 1984). Therefore the site at first appeared to be a good source of data for studies of plant utilization by late-prehistoric inhabitants of the region. However, when forming this naive picture of the site's promise, we neglected to consider the setting. This is a riparian thicket, a dense concentration of the very bushes and trees from which native people gathered most of the berries and other fruits in their diet. There are hawthorn, serviceberry, chokecherry, dogwood, rose, wild blackberry, and oregon grape, to name the most obvious. The terrace is also a catchment for driftwood carried downstream from as far away as southern British Columbia, Alberta, and northwestern Montana. There is still driftwood on the surface from a flood that occurred in 1948. Seeds and sticks can, therefore, occur in the site, burned by natural fire or left unaltered, in the total absence of human intervention.

To have taken the identifications of the charcoal from each occupation surface (collected in CVS samples) and treated these as indicative of plant exploitation would have been ludicrous at best. Such data may be useful for a study of vegetation history on the site, but that is, unfortunately, not our mission at RM 590. The only plants that we can consider to have been deposited on site by human beings are those which could not have occurred in this habitat.

We have chosen to circumvent the problem of endemic flora by 1) submitting for analysis only seed and root fragments found in those samples taken directly from hearth or oven features; and 2) scanning a sample of other CVS samples for tissue of edible root plants and non-endemic seeds. Very little woody material can be considered non-endemic, because of the driftwood problem. The problem of endemic seeds still exists, however. When fires are built on a forest floor, their heat can be expected to result in the unintentional burning of plant seeds and dead wood fragments that naturally occur there. Therefore, the limitation of analysis to seeds from apparently cultural contexts (hearths) will not result in a thoroughly reliable estimate of the kinds of plants processed or consumed at this site.

Identification. Samples were submitted to David Rhode of the Univesity of Washington who has identified them with comparative collection from the University's herbarium.

Results. Samples from upper occupations at 45OK197 consist entirely of seeds from four taxa plus one root fragment (Table 20; Appendix F). All genera represented in the seed assemblage (*Craetagus*, *Purshia*, *Prunus* and *Cornus*) are endemic to the site in its environs. Therefore, their low frequency occurence in floral samples cannot be taken as evidence for human consumption. Only in Features 9 and 11, in which the seeds of *Craetagus* (hawthorn) and *Cornus* (dogwood) occur in large numbers can we conclude that people were processing berries of these species. The single root from Occupation IX is probably not an endemic, but since it has not been identified, we cannot be certain of this.

Fauna

Over 35,000 bone fragments were recovered from 45OK197 and another 1159 came from 45OK196 (see Appendix E). There were also over 32,000 mussel shell hinges from 45OK197 and 5070 from 45OK196. Identification of this material is complete, but we have performed only a few of the analyses possible on such a massive data base. Information recorded for each bone included: identification to the nearest possible taxon, element, portion, side, sex, age, modification (whether human shaping, rodent or carnivore gnawing or digestion and biotic chemical modification or mechanical weathering) burning, size, and other pertinent comments. We have also measured the mussel shell hinges from a sample of the middens and identified each hinge to the genus level.

Identifications. Faunal specimens were sorted by Ms. Semko. Fragments believed to be identifiable were set aside, and I performed the identifications using comparative collections of Central Washington Archaeological survey and the CWU Department of Biology. The only questionable identification is the vertebrae of salmonid. Except for whitefish (*Prosopium*), vertebrae from the three local salmonid genera are all very similar, as are their non-vertebral

Table 20. Seeds and roots from 45-OK-197 features and a sample of nonfeature occupation contents.

		Seeds										Roots		
		Crataegus		*Prunus virginiana*		*Purshia tridentata*		*Cornus sp.*		Unknown				
Occupation	Feature	Unburnt	Burnt	Unburnt	Burnt	Unburnt	Burnt	Unburnt	Burnt	Unburnt	Burnt	Unburnt	Burnt	Total
I	9	8												8
I	11		9	4				4	18		1			36
II		2						2			11			15
III					1						7			8
IV						1		1			5			7
V											1			1
IX													1	1

study of change in site utilization (although the latter is an unplanned side effect; Chapter X).

450K196

Of the five occupations at 450K196, I, II and III contain assemblages that are comparable in age to later strata in 450K197, but are much younger than the 2200+ year old occupations from other RM 590 sites. In addition, samples are very small and appear to be extensively disturbed. Therefore, they are not appropriately classified with either 450K197 or earlier RM 590 area occupations and will not be considered further. Likewise, Occupation IV is an eroded, apparently water deflated assemblage and probably consists of a spurious association of artifacts from multiple occupation events. Only Occupation V will be classified.

Occupation V is comparable in age, data quality, sample size and excavated area with the earlier occupations found at other RM 590 area sites (Chatters 1984:Table 10) and is appropriately classified using the system devised for those occupations.

The settlement classification used with other RM 590 occupations consisted of three dimensions: features, lithics and faunas. Occupations were first organized into groups based on the presence and absence of shell midden, hearth and housepit features and the proportionate representation of various use-wear tool classes and vertebrate taxa. Then they were classified paradigmatically (see Dunnell 1971) according to their membership in each group. The most populous settlement classes were class HOM (pithouse sites with a diverse fauna consisting mainly of deer, salmon and turtle and class S-N (nonpithouse sites with shell middens and a faunal assemblage containing large ungulates and sometimes marmot). Lithic assemblages of S-N type sites were rarely large enough to permit grouping.

Occupation 450K196 V is a member of settlement class S-N. It contains shell middens and, as Figure 17 shows, the faunal assemblage fits the pattern of group N (Chatters 1984:Figure 16). The use-wear tool assemblage is not comparable with the assemblage from any other occupation from the RM 590 sites. Containing classes 3, 4 and 16 to the near exclusion of all others, this assemblage indicates that tasks requiring scraping of soft material (3) cutting of soft material (4) and chopping of tough materials such as wood or bone characterized activities at this site up to 4500 years ago. This finding compares favorably with the deer and mountain sheep dominated fauna to indicate a focus on the butchering and probable consumption of large mammals.

CHAPTER VII

SETTLEMENT CLASSIFICATION

The purpose of this brief chapter is the classification of occupations from 45OK196 and 45OK197 for further analyses. I have used two classification schemes, one for 45OK196 and the other for some occupations at 45OK19 because 1) the sample from 45OK196 is much smaller than that from 45OK197 and is appropriately treated along with other RM 590 sites for which a small sample classification scheme was used and 2) research goals differ from site to site.

In an earlier report (Chatters 1984), I devised a settlement classification based on groupings of occupations in three dimensions. Samples of lithics and faunal remains from those occupations were in all cases derived from very small (ca. >5%) samples of site area; occupations in all cases exhibited extensive bioturbation and mixing and often appeared to have included remains from long periods of site reuse. Neither condition obtains with 45OK197. Except for Occupation II, each occupation from 45OK197 consisted of artifacts on a largely undisturbed surface that was exposed only from 34 to 137 years and occupations all have the appearance of single or low count multiple events of site habitations. More importantly, we have obtained much larger samples of apparent occupation areas (ca. >20%) using a sampling procedure with a much greater purposive component, therefore results from 45OK197 excavations are not comparable to and should not be classified using the same system as that applied to other sites in the RM 590 study.

More important, is the difference in research goals. The RM 590 classification was directed at studying settlement pattern change among a large group of localities, a semi-regional approach. The analysis of 45OK197 presented here is strictly methodological. Classification is designed to generate settlement classes that correspond with site types described in the ethnographic record so that observed site structure can be compared with an ethnographically based set of expectations. Evaluation of method is the purpose, not the classification of all occupations observed at the site nor the

Table 24. Summary of seasonal information from 450K196 and 450K197.

	Method						
	Available Taxa						
Occupation	Marmot	Turtle	Salmon[2]	Fish Bone % New Growth[3]	Mussel Shell Season[4]	Foetal Ungulates	Seasons Minimum
45-OK-196							
I			1				Unknown
II							Unknown
III							Unknown
V	+						March - July
45-OK-197							
I			0	30; 50			Summer
II	+		0				March - April
III			0	0; _			Late Winter, Early Spring
IVA			0	15; 20, 30		+	March - May
IV	+		0		Late Winter, Early Spring	+	March - May
V							Unknown
VI	Common		0	10, 20; 25	Late Winter, Early Spring	+	March - May
VII	Common		0	_; 0			Feb. - May
VIII	+	+	0			+	March - May
IX	+	+		0, 60; _	Spring	+	March - May
X	+		0	0; _		+ (young)	Jan. - March
XIE	+					+	Feb. - May
XIW	+		0	0; _		+ (young)	Jan. - March
XIIE	+				Late Winter, Early Spring		Jan. - March
XIIW							Unknown
XIIIE	+						March - July[5]
XIIIW							Unknown
XV	+		1				March - July[6]

[1] Non-carapace only.

[2] Ratio of cranial to postcranial bone.

[3] Ranges for catostomid and cyprinid taxa shown separately; with the most frequent figure in each range underlined. Order of presentation is catostomid; cyprinid.

[4] Preliminary estimate, techniques not fully developed.

[5] Only three marmot bone and a single salmon tooth were found among 344 bones from 8 *pronghorn. The association may, therefore, be spurious.*

Animal Ages

Several phenomena can be considered under this heading (epiphyseal union, tooth eruption and wear, annular growth structures, foetal development). In this case there were too few complete mandibles with teeth (4) to provide any clear indication of season from tooth eruption; epiphyseal union is really only useful with articulated skeletons, and study of annular structures in teeth requires equipment unavailable to CWAS. What I used here was the presence of foetal ungulates as an indicator of season. All foetal bone found was well developed but small, indicating that either deer, sheep or pronghorn were represented. Because the vast majority of elements identified from all occupation surfaces were from deer, most, if not all, foetal elements probably represent that animal. Both mule deer and white-tails breed in November and early December and gestation lasts approximately 6.5 months (Anderson 1981; Rue 1979). Short (1970) studied foetal skeletons of white-tailed deer by whole body x-rays of pregnant does, and found that ossification began in the longbones by 50-69 days and in scapula, pelvis, sternum, and phalanges by 70-79 days. Nearly the entire skeleton is ossified by 180-189 days of the 200-day average gestation (Anderson 1981). Mineralization of premolars begins by 130 days (Anderson 1981). The foetuses in our collections died between the end of January and the end of May.

Results

Seasonality data are summarized in Table 24. Most 450K197 occupations represent winter or spring (Table 23). Occupations X, XIW and XIIE were inhabited in January-March and most others for which seasonality can be assigned with some confidence represent latest winter and early spring (III, IVA, IV, VI, VII, VIII, IX, XIE). Occupation I occurred in what probably was early summer: seasonality is difficult to assign to Occupation XV. There are no foetuses among the eight pronghorn in our assemblage, in spite of the presence of females indicated by distinct size differences among the bones of adults. Neither are there any juveniles. The only seasonal indicators are three marmot bones and a single salmon tooth; hardly a strong case for summer.

At 450K196 only Occupation V at 450K196 contained any seasonal indicators (marmot) and a <u>very</u> tentative spring-summer season is assigned.

bones of the skull as wide, alternating, opaque bands and narrow, translucent bands. The narrow bands, also known as "rest lines", occur during cold seasons. Because of these characteristics, it is possible to determine the approximate season of year a fish died from the amount of new growth evident since formation of the last rest line.

I have assumed here that, after waters begin to warm (around late February or early March in this area), bone growth in fishes will gradually accelerate until maximum temperatures are attained (in July or August) and decline thereafter until water again reaches a temperature near the freezing point (December). Given this, I assume that approximately 25 percent of a fish's annual growth occurs from March to May, another 50 percent from June through August, and the final 25 percent during September through November. There would be essentially no growth from December through February, when air temperatures are below freezing most of the time. An uncertainty factor of +- 2 months should be assumed. The percentage of growth, and thus the season of death is calculated here by dividing the amount of new growth by the mean growth of the previous three years. New growth divided by the mean growth of the previous 3 years. Elements used are the quadrate pharyngeal, operculum, preoperculum, proatlas and all vertebrae. Of these, the operculum is considered most reliable (Casteel 1972). This technique is applied here only to resident fishes, including suckers, whitefish and members of the minnow family. Bones of anadremous salmonids display patterns of growth which reflect more than seasonal variation in food availability and temperature.

River mussel growth. Mussels also are poikilotherms, and grow in proportion to water temperature and food availability. Annual shell growth appears as a set of one opaque (rest) and one translucent line (growth). Shell growth in mollusks has been used extensively as a seasonal indicator in both saltwater and freshwater environments (see references in Monks 1981), and the existence of annular growth lines in the shells of Margaretafera and Gonidea have been reported in biological literature for over 200 years. However, no one has yet attempted to use mussel shell growth to infer season of occupancy at sites in the Columbia Plateau.

We have made such an attempt using shells from various sites. However, technical problems and difficulty in obtaining specimens of known death-date have hampered our efforts. We, however, have made some preliminary estimates of season with a small collection of specimens from Occupations IVA, VI and VIII at 450K197, making a similar assumption and using a similar procedure to that applied with fish.

not necessarily to the occupancy of sites, where the carapaces occur, during that season. However, if we find non-carapace turtle bone, the likelihood is much greater that the site was occupied between March and October.

Salmonids

Anadromous salmonid fishes, various species of salmon and the steelhead trout were formerly present on this stretch of the Columbia from May through mid-November (Fulton 1968, 1970). Actually, runs begin slowly at first, the fish having entered the Columbia's mouth beginning in early April and working their way 800 miles upstream. The first few fish might have reached RM 590 by mid-late April, but the runs did not reach full force until May and June. Salmon were stored extensively by native peoples, at least in historic times, and the presence of salmon bone *per se* is not a good indicator of the season of site occupancy. Here we may consider stored foodstuffs from a viewpoint similar to Binford's (1977) discussion of stone tools, wherein he divides assemblages into curated (made in advance at base camp, transported to task locations, repaired, and discarded in base camp) and expedient (made in field camp or base camp for immediate use and discarded). Stored foods are analogous to curated tools, having been collected, processed and transported for later use. Immediately consumed foods are expedient. If people are storing (curating) portions of animals, we would expect those portions to have the highest meat to bone ratios. Transport and storage costs are high and a meat-poor anatomical part would be unlikely to occur in a site far from the location of kill (Binford 1978a). In salmon the portion of the animal with the most food value is not the head but the section of muscle attached to the vertebrae and ribs. Thus, we would expect to see bones of the skull *primarily* at sites in which fish were processed for storage. Where stored fish parts *only* were used, a disproportionate amount of postcranial bone would be expected, especially in comparison with other species of fish. Salmonid fish (especially *Oncochynchus*) bone is therefore a useful indicator of season of occupancy only when the proportions of cranial-postcranial bone are considered relative to other fish found in the site. The period May-November is indicated by relatively high ratios of cranial bone to postcranial; late November through April is indicated by a low ratio.

Annular Growth Increments In Fish Vertebrae

This approach has been described by Casteel (1972). Fish are poikilotherms (cold-blooded animals): the temperature of their bodies varies with that of the external environment. Because the animals' growth varies positively with body temperature, fish grow more rapidly in warm seasons (especially because of greater prey availability) and more slowly in cold seasons. In fact, growth may appear to stop in water temperatures near the freezing point. In addition, most bones of fishes grow such that little remodeling or resorption of bone takes place. The variations in growth appear on scales, vertebrae, and some to 1600 BP (Livingston 1983). Especially surprising is the larger quantity of individuals of that species in Occupation XV, although the 1600-year-old date fits other data.

Seasonality

Like faunal quantification, methods for determining the season of site occupancy have been studied extensively (Monks 1981). I will not go into the discussion except to repeat the obligatory caveat that seasonal indicators only inform about the seasons during which they are present and do not necessarily represent all seasons of occupancy. They show some period or periods during which a site was certainly occupied, but other seasons are possible as well.

I have used the following methods: 1) the presence of seasonally available taxa; 2) incremental growth structures in fish bones and mollusk shells (discussed separately); and animal age (presence of foetal ungulates).

Presence

There are three taxa of animals in the project area that are present or available only seasonally and that are represented frequently in archaeological sites: anadromous salmonids (salmon and steelhead trout), marmots, and the western painted turtle (*Chrysemys picta*).

Marmot. Marmot live in the area year-round but are only active for a short period. They emerge from their deep, rocky burrows in early March and return to hibernation in August or September (Bailey 1936; Mac Clintock 1970). Marmots should, therefore, be a good indicator of spring-summer residency. However, Thompson (Elliot 1914) reports that a smoked and dried animal resembling a marmot was offered to him in trade by members of a camp at the Sanpoil River mouth. His visit occurred in summer, however, and we have no evidence that dried marmot were systematically stored for winter. Nonetheless, we must consider this possibility when small amounts of marmot occur in an assemblage. A moderate to high proportion of marmot in a faunal assemblage should, however, be an indication of a spring or summer phenomenon.

Painted turtle. Painted turtles also hibernate, emerging in early March or April and returning to hibernation in October (Lyman and Livingston in Leeds et al. n.d.). Here again, however, we have a curation problem: turtle carapaces make useful containers and bowls. They commonly occur in archaeological sites of this region without any non-carapace bones. The presence of turtle carapace attests merely to the fact that people were in turtle country in spring and summer, and

Table 23. Continued.

Occupation												
IX	X	XIE	XIW	XIIE	XIIW	XIIIE	XIIIW	XIV	XV	XVI	XVII	Totals
												1(1)
												1(1)
												1(1)
2(1)												3(2)
3(1)	1(1)		3(1)	1(1)		2(1)			3(1)			67(12)
				3(1)								6(2)
												1(1)
	1(1)											3(2)
		1(1)		5								12(3)
												1(1)
			1(1)	1(1)								2(2)
												2(2)
90(3)	63(4)	5(1)	143(5)	88(3)	27(1)	3(1)	10(1)	2(1)	4(1)			669(39)
1(1)			4(1)	1(1)	29(2)	9(1)	21(3)				1(1)	78(16)
3(1)	4(1)		8(2)	13(1)	3(1)	3	1(1)	2(1)	4(1)			73(15)
				2(1)								2(1)
		1(1)		5(1)			12(2)		344(7)		1(1)	367(14)
												21(1)
46(1)			2(1)	3(1)	23	59(1)	1(1)					186(8)
												1(1)
			1(1)									1(1)
1	1(1)		2(1)					1(1)	1(1)			25(6)
1(1)												27(8)
												2(1)
9	3		5	1								36
1												20(2)
												3(3)
1(1)												3(3)
13(3)	10(3)		5(2)	1(1)	1(1)							102(25)
7(1)				5(2)	1	2	4(1)					46(14)
176(14)	83(11)	7(3)	174(15)	129(14)	84(5)	78(4)	49(9)	5(3)	356(11)	0	2(2)	1762(188)
3	1		1	6		4	1					83
3833	1		2	833	18	1						32,773
												0

Table 23. Summary of faunal data from 45-OK-197[1].

Taxon	Occupation I	II	III	IVA	IV	V	VI	VII	VIII
MAMMALIA									
Cricetidae									
Ondatra zibethica							1(1)		
Leporidae					1(1)				
Lepus									1(1)
Sylvilagus							1(1)		
Sciuridae									
Marmota flaviventris	2(1)				2(1)		36(2)	12(1)	2(1)
Castoridae									
Castor canadensis							3(1)		
Mustelidae									
Lutra canadensis						1(1)			
Canidae							2(1)		
Canis	2		2(1)		2(1)				
lupus		1(1)							
familiaris/latrans									
Ursidae									
Ursus americanus			1(1)					1(1)	
Cervidae									
Odocoileus	13(1)	21(2)	24(1)	21(1)	24(2)	28(3)	57(5)	26(1)	20(2)
Cervus canadensis			1(1)		5(1)	2(1)	2(1)	1(1)	1(1)
Bovidae									
Ovis canadensis	2(1)				1(1)		14(1)	11(2)	4(1)
Bison bison									
Antilocapridae									
Antilocapra americana	2(1)						2(1)		
Equidae									
Equus caballus	21(1)								
REPTILIA									
Chelydridae									
Chrysemys picta							22(1)	17(1)	13(1)
Colubridae					1(1)				
Vipuridae (Crotallus)									
PISCES									
Salmonidae	4	1	4	1(1)	4(1)	1	4		
Onchorhynchus	3(1)	2(1)	4(1)			4(1)	9(1)	3(1)	1(1)
Prosopium	2(1)								
Cypriformes	5			9			4		
Cyprinidae	2		1(1)			6(1)	9	1	
Acrocheilus alutaceus							1(1)	1(1)	1(1)
Ptychocheilus oregonensis	1(1)							1(1)	
Catostomidae Catostomus	13(2)		3(1)	8(3)	3(1)	5(2)	27(4)	2(1)	11(1)
AVES	3(1)	3(1)	2(1)	1(1)	3(1)	2(2)	5(1)	7(1)	1(1)
Total non-endemic vertebrates	75(11)	28(5)	42(8)	40(6)	46(11)	49(11)	199(22)	83(12)	55(11)
Total endemic rodents[2]	1	6	16		14	25	4	1	
MOLLUSCA									
Margaritifera falcata	37	533	1109	2393	63		11,668	7582	4700
Gonidea angulata									

[1] Figures are NISP (MNI)

[2] Endemic rodents are not listed to taxon.

Table 22. Summary of faunal data from 45OK196[1]

Taxon	Occupation I	II	III	IV	V
MAMMALIA					
Cervidae					
Odocoilius	5(1)	2(1)		2(1)	13(1)
Cervus canadensis			2(1)		2(1)
Antilocapridae					
Antilocapra americana					1(1)
Sciuridae					
Marmota flaviventris				1(1)	1(1)
Total non-endemic vertebrates	5(1)	2(1)	2(1)	3(2)	27(4)
Total endemic rodents		1			
MOLLUSCA					
Margaritifera falcata	471	1157	135	701	2606
Gonidea angulata					1

[1] Figures are NISP (MNI).

rodent gnawing marks and rounding and pitting resulting from exposure to digestive acids in carnivore stomachs.

With one exception, the impact of naturally occurring bone or taxonomic frequency is negligible. Most elements are from deer (Odocoileus) and other large ungulates and except where a taxon is already in low frequency, the number of bones with presumably non-cultural origin is under 12 percent. The exception found in Occupation I, where all 21 elements from a single horse were deeply weathered and/or gnawed by scavengers.

In all instances except the horse, the impact of non-human factors is treated as negligible and I have not changed taxonomic counts in later analyses. I have, however, removed the horse as totally non-cultural; it is not incorporated into calculations discussed in Chapter VII.

Results. Tables 22 and 23 summarize the results of our identifications to taxon; unidentified bone counts are listed in Appendix E, Part 3. Endemic rodents (Chatters 1984) are not included because of the probability they are present regardless of human activity. Frequencies of taxa in the seven faunal groups are discussed in the next chapter, as are bone sizes.

There are 26 taxa, (identified to various levels) in the 45OK197 collections, only 3 taxa in 45OK196. Included are six species of artiodactyl (bison, deer, pronghorn, mountain sheep, domestic sheep, elk), three large rodents (beaver, muskrat, marmot), hares and cottontails, two genera of carnivores (dog/coyote/wolf, and bear), turtles and two families of snake (probably endemic), at least three genera of salmonid fishes (salmon, trout and whitefish), two cyprinids (chisselmouth, squawfish), suckers, and birds. Gophers, pocket mice, deer mice, voles, and packrat comprise the endemic rodent collection. Only deer, mountain sheep and marmot occur at 45OK196.

There are two mussel species, but Gonidea is rare. This slower-water, shifting-bottom preferring species (Vannote and Minshall 1982) occurs as a single specimen in 45OK196, Occupation V. All other individuals are Margaritifera.

Of the taxa identified, the most common are deer and salmonid fishes, mostly salmon. As expected from their high trophic level, carnivores are rare; so are large rodents and rabbits. As proof of the undisturbed condition of the deposits, domestic sheep and horse appear only in Occupations I and II.

One noteworthy occurrence is the frequent presence of pronghorn (Antilocapra) on the north bank of the Columbia. In all assemblages identified by analysts for the Office of Public Archaeology, pronghorn were a frequest occurrence only on the Columbia's south bank and prior

Table 21. Number of bone fragments modified by weathering, carnivore digestion and animal gnawing.[1, 2]

Taxon	Occupation									
	I	III	IV	VI	VII	VIII	IX	X	XIW	XIIW	XIIE
Equus	21(100)										
Odocoileus	1(8)	3(12)	2(8)	5(9)	1(4)	2(10)	4(3)	1(2)	1(1)	1(4)	3(3)
Ovis											2(15)
Antilocapra	1(50)										1(20)
Canis											2(40)
Marmota									1(33)		
Total	23	3	2	5	1	2	4	1	2	1	8

[1] Only those strata containing modified bone are included here.

[2] Numbers in parentheses are percentages of elements from that taxon showing modification.

1) Large ungulates. All are more or less gregarious, especially in winter, have high net yield, similar anatomical structure and were hunted with a single technology (bow) and often a pursuit predation strategy.

2) Carnivores. These generally were solitary, taken by deadfall, used for skins more than meat, and have a variable net yield.

3) Large rodents and lagomorphs (rabbits and hares). All are fairly solitary, most live in dens, have similar anatomy and small body size and moderate-low net yield. They were hunted by the Nespelem using an encounter strategy.

4) Turtles. These have apparently been used both for food and for some other, yet unknown purpose. Their size is small, yield low, anatomy distinct, they are solitary and were probably taken by an encounter strategy.

5) Large salmonids (salmon and steelhead). Most of these fish schools, are anadromous, and are larger and have a higher net yield than the area's other bony fishes. Most were taken by a pursuit strategy and stored with bones intact.

6) Resident fishes (suckers, minnows, small salmonids). These fishes are smaller in body size, and have a lower net yield than salmonids, they are present year-round, occasionally occur in schools, were usually taken by an encounter strategy (unless their capture was embedded in the tactics for taking anadromous fish) and they were usually consumed immediately.

7) Birds. Birds have unique anatomy, behavior and low net yield. An encounter strategy was used in their capture during the ethnographic period.

Bone size. Rather than measure every one of the 26,500 bone fragments, we categorized fragments with reference to an interval scale of 5-10cm increments. Bone 0-5mm in maximum dimension was in the 5mm class; 5-10mm was 10mm; 10-20, 20mm and so on. All fragments from 1983 excavations were measured in this way.

Modification. Like the burned plant fragments there is a strong possibility that at least some of the faunas recovered at 45OK197 arrived on site independent of human activity. As they cleared the site, excavators noticed scattered, complete bones from deer, domestic sheep, horses and cattle. Consequently, the possibility exists that any one of the faunal assemblages from occupation zones at this site may consist in large part of non-cultural bone. Credibility of the results of diversity analysis could be compromised by this possibility. To ascertain the severity of the non-cultural bone problem, I have tallied the bones showing some sort of non-human caused modification (Table 21). Non-human caused modification includes cracking and exfoliation due to weathering, carnivore and bones. In an attempt to distinguish trout (Salmo, Salvelinus) from salmon (Oncorhynchus), I focused on bone consistency and the distribution of fenestrae in the vertebral body. The genus Oncorhynchus (salmon) does not feed in fresh water, and after 600 miles or more of upstream swimming, is depleting its own calcium stores. Thus, the bone appears papery and exfoliated. By contrast, bones from Salvelinus (dolly varden trout) and Salmo (cutthroat or steelhead trout) have not been robbed of calcium and appear as firm as bone from other, resident fishes. Fenestration of trout vertebrae consists of smaller holes and is not as extensive as that of salmon. Bones from unassigned excavation units were not identified, only counted and weighed. Mussel shells with intact hinges were identified by Steven Lipsky, using a complete comparative collection.

Quantification. Problems of faunal quantification have been thoroughly treated by Grayson (1979) and need no elaboration here. Neither of the common quantification measures (number of identified specimens or NISP and minimum number of individuals or MNI) is without its advantages and flaws. However, MNI is greatly influenced by sample size and is, in fact, a function of NISP (Casteel n.d.). It is, therefore, a less reliable measure of taxonamic abundance than NISP in those cases where a complete faunal assemblage cannot be obtained from a site.

Here, however, we have an unusual circumstance; two issues are important. First, 450K197 consists in most cases of discrete, apparently single-occupation living floors. There is a strong possibility that in many cases only one animal of a species was killed and consumed. Second, bones of larger mammals are rich in collagen and fat (marrow, bone grease) and often have been pulverized to the extent that even the phalanges and carpals have been broken. Each of those fragments is an identifiable element. When these facts are combined, we have a clear possibility, if not a probability, that large mammals will be over represented. MNI might, in this instance, be the better measure of quantities of animals utilized. Many of the mammals are so large, however, NISP may be giving us a better approximation of the relative importance of each species in the diet.

Because of MNI's tendency to be affected by sample size and characteristics of the assemblages from 450K197, I have chosen to use both NISP and MNI.

In addition to presenting a complete taxonomic breakdown of non-endemic vertebrate faunas, I have also combined taxa according to their anatomical structure, seasonal pattern of presence, body size, net yield, and behavior patterns (gregarious or non-gregarious). The reason for this breakdown is to transcend some of the variation among relatively small (N<250) assemblages that is often due only to sample size, to reduce the impact of differential fragmentation, and identifiability of various taxa on diversity measures, and to create faunal categories with meaning in terms of procurement strategies. The categories are as follows:

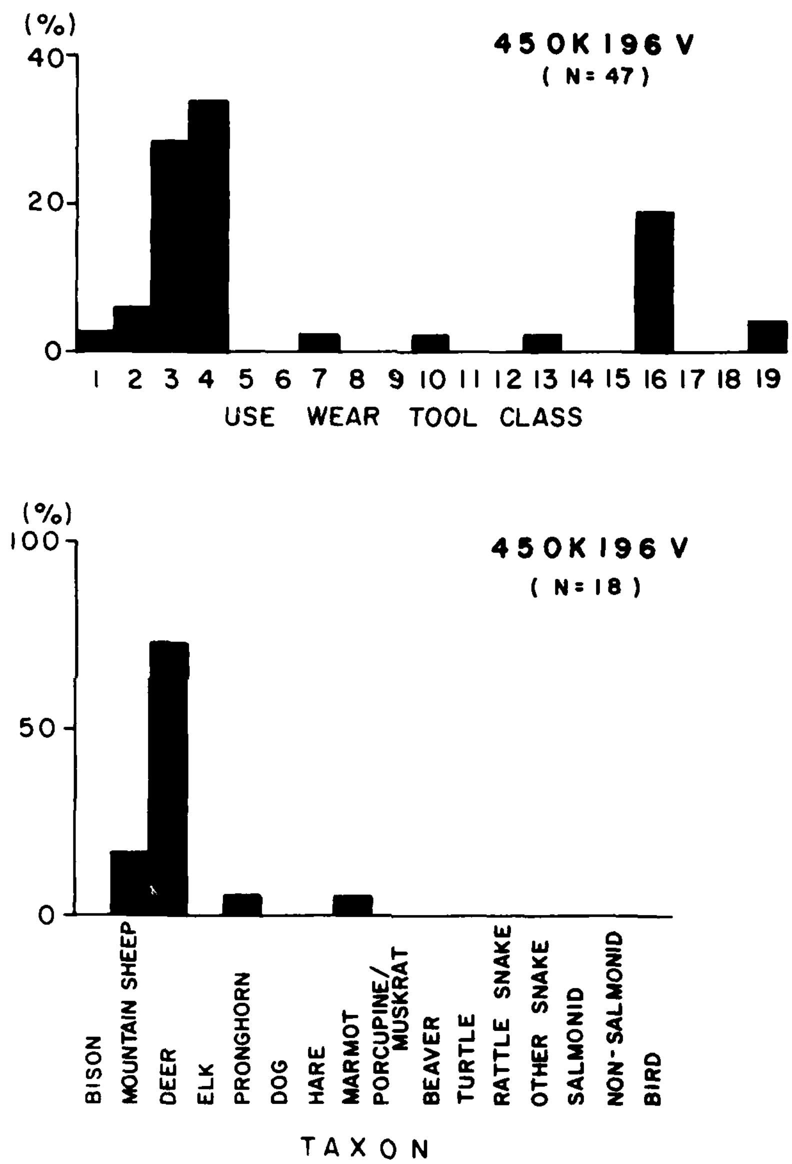

Figure 17. Percentage histograms of use-wear tools and faunal taxa found in Occupation V, 450K196. The faunal graph is typical of Settlement Class S-N in the formulation of Chatters (1984:Figure 16).

45OK197

Definition of settlement classes is a necessary precursor to the analysis of site structure, since the variable dimensions presented in Table 1 require a comparison of assemblages within and between various types of sites. There are two important considerations that condition the choice of dimensions for use in settlement classification. First, dimensions used in the definition of settlement classes must necessarily be distinct from dimensions later to be used for inter- and intra-settlement class comparisons. It would thus be inappropriate for me to use two of the dimensions included in the classification of other RM 590 assemblages, taxonomic frequencies among faunal remains and use-wear tool frequencies. Faunal diversity and tool diversity are two of the important variables of site structure.

Second, because I wish to compare the structure of 45OK197 occupations against a model of site structure based on ethnographic records of the Sanpoil-Nespelem, settlement classes must be defined such that they can be unambiguously identified with site types derived from ethnographic data (Table 2).

To accommodate these considerations, 45OK197 occupations are defined among two dimensions only: 1) season of occupancy and 2) feature content. Although <u>duration</u> of occupation based on seasonal indicators is one dimension of site structure, the actual season or seasons during which a site was occupied is not. Feature diversity is, however, a variable as is feature variation within a settlement class. Ordinarily we would exclude the feature content dimension from classification of settlements, but in this instance features serve to identify camp types in the ethnographic model; in any case features are so few in number that analyses of diversity and variation could not be performed.

The variables used in each dimension are listed in Table 25. Feature type is broken down into four variables (eight possible but not all present) based on the presence and absence of earth ovens, shell middens, and large-bone piles (heaps). Season is derived from seasonality data just presented in Chyapter VI and is divided into late winter, late winter-spring (February-May) and summer.

Not all 22 occupations can be classified. Eight lack any evidence of seasonality (IE, II, V, XIIW, XIIIW, XIV, XVI, XVII) and two others lack features of any kind (XIE, XIIIE). Little was excavated from most of these occupations (less than or equal to 12 square meters were excavated from seven of the ten) and samples of tools and faunas are consequently very small (see Chapter VI). In choosing the remaining 12 occupations I am concerned with assuring as much as possible the highest level of interassemblage comparability without biasing the results of the analysis. The problem here, as with most excavated sites, is that we have excavated only a portion of

Table 25. Dimensions used in classification of 45-OK-197 occupations.

Feature Type (all include hearths)	
R	Earth oven present, shell midden and large bone pile absent (I).
S	Earth oven absent, shell midden present, large bone pile absent (III, VI, VII, VIII, IX, XIIE).
H	Earth oven absent, shell midden absent, large bone pile present (X, XIE, XV).
T	Earth oven absent, shell midden absent, large bone pile absent (IV).
Season	
C	Winter (January - March)
R	February - May
G	Summer (May - July)

each occupation and we cannot, without total data recovery, know the exact portion of each we have obtained.

In order to minimize this blind man-elephant effect I make the final cut between assemblages to be used in the method evaluation and those not used on the basis of observed versus presumed but unobserrved content. Each of the twelve occupations includes fire broken rock in some amount, so fires were made by all occupants. Yet we uncovered hearths in only 10 occupations. Occupations IVA and XIIE lacked evidence of in situ burning. In those two cases, hearths probably exist, perhaps 2cm from our pit walls, perhaps several meters away; we cannot know. We do not know from where in the habitation area we have taken the sample. Therefore, it is reasonable to assume that excavated samples containing hearths coming from homologous parts of the habitation area are more comparable to each other than they are to occupations lacking hearths. We are touching the same part of the elephant.

Only hearth-containing occupations with features and seasonality information are classified and are the data against which expectations drawn from the the ethnographic record will be compared.

Five classes are represented at 45OK197 (Table 26). Class RG includes Occupation I, a summer camp with earth ovens containing many charred berries and evidently an example of a mid-summer berry picking camp. Occupations III, VI, VII, VIII, and IX, are members of Class SR, early spring camps with shell middens that meet the criteria of early spring base camps. Class HC, including Occupation X and XIW, represents late winter habitation with large-bone heaps which corresponds to the ethnographic winter hunting camp. Occupation XV is the sole member of Class HG, a summer(?) hunting camp with ungulates exclusively represented and large-bone piles and appears to be the residue of a summer-early fall antelope hunt camp (see Ray 1933:1983). Occupation IV, a spring camp lacking any non-hearth features (Class TR) seems to have no ethnographic referent, but may be a variant of the early spring base camp at which mussels were not consumed.

Table 26. Classification of 450K197 occupations.

Occupation	Feature Type	Season
I	R	G
III	S	R
IV	T	R
VI	S	R
VII	S	R
VIII	S	R
IX	S	R
X	H	C
XIW	H	C
XV	H	G(?)

CHAPTER VIII

SITE STRUCTURE OF SETTLEMENT CLASSES: 450K197

This chapter presents the analysis of variation in occupation assemblages in the dimensions outlined in Chapter II, along with the results of those measurements. Part of the tool/feature diversity dimension is left out; feature diversity is an important dimension of settlement classification and its inclusion at this point would merely be a tautological exercise. I make comparisons here between settlement classes and among members of each class, according to the requirements of the dimension. Settlement Classes SR and HC receive the most thorough attention because they are the only classes with multiple members and results of their comparison are more meaningful.

Occupation Area

Occupation area is the areal coverage of the occupation measured from distribution maps (Appendix E), which are best estimates derived from test pit trench and block excavation results. Note that spring camps of settlement Classes SR and TR are almost uniformly larger (mean, 123 sq.m.; range 80-200 sq.m.) than the more specialized field camp-type occupations of other settlement classes (mean, 55 sq.m.; range, 30-80 sq.m.).

Fire Broken Rock Sizes

Size of fire broken rock is measured here as the mean weight of all collected fragments. The results are highly variable and not at all as expected (Table 27). Except for slightly smaller fragments in the less discrete winter hunting camp (Class HC, XI) than in the more discrete and probably more briefly occupied winter hunting camp (X), the expectation that fire broken rock would be smaller in camps inhabited for longer periods or inhabited repeatedly is not met in

Table 27. 45-OK-197 site structure summary.

Settlement Type	Occupation	Occupation Area in meters	FCR Size $\bar{x}$ wt. (kg)	Artiodactyl Bone Size	Feature Discreteness[2]	Season Duration (months)	Faunal Diversity: Faunal Richness	Faunal Diversity: Faunal Evenness	Seasonal/ Geographical Displacement	Tool Diversity: Tool Richness	Tool Diversity: Tool Evenness	Variation $\bar{x}$ Similarity: Fauna	Variation $\bar{x}$ Similarity: Tools
RG	I	50	.043	40.0	4	3	high	moderate	-	moderate	moderate-low	-	-
SR	III	90	.121	26.7	3	3	high	moderate	+	moderate	moderate	121	98
	VI	180+	.169	29.7	2	3	high	moderate	+	moderate	moderate-low	143	136
	VII	90	.199	28.6	3	3	high	moderate	+	moderate	moderate	148	104
	VIII	80	.123	30.0	3	3	high	moderate	+	moderate	moderate-low[1]	152	113
	IX	200+	.029	52.0	2	3	high-moderate	moderate	+	moderate	moderate-low	152	132
TR	IV	100	-	23.0	4	3	high	low	+	moderate	low	-	-
HC	X	60	.143	54.9	4	3	moderate	low	+	moderate	moderate-high	177[3]	146[3]
	XIW	80	.078	49.0	3	3	moderate	low	+	moderate	moderate-high	184[3]	160[3]
HG	XV	30	.142	32.3	4	3	low	very low	-	moderate	moderate	182[3]	134[3]

[1] Lowest sample size

[2] 4 is maximum discreteness

[3] Combined classes HG and HC

these data. Perhaps if these assemblages were compared with winter residential bases, there would be some systematic difference; perhaps not.

Size of Bone Fragments

This dimension measures differential degrees of bone fragmentation between settlement classes. The bone used in this analysis is exclusively from the small ungulates: deer, mountain sheep and pronghorn. These animals were chosen because they have equivalent size and anatomy and their bones are readily identifiable even in a highly fragmented condition. An additional consideration is that these animals comprise the majority of identified specimens from all occupations except number I.

The results indicate a systematic, although not uniform difference in size distributions among bone fragments from representatives of Classes SR versus HC and HG (Table 28). Mean, median and mode tend to be smaller in the spring base camps (SR) and larger in the hunting camps (HC and HG), although there is overlap among the extreme values in each case. The individual members of Classes TR and RG also contain relatively small bone fragments. These results are very much as expected (Table 2). Large mammal parts are more completely processed in spring base camps and berrying camps, from which ungulate procurement was not conducted, than in the short-term hunting camps occupied specifically for butchering and initial processing of carcasses.

Feature Discreteness

Discreteness of 450K197 occupations has been determined by comparing maps of occupation surfaces against the templates in Figure 18 (Table 27). In an effort to control for the subjectivity of this measure, evaluations were made independently by myself and an associate; results were identical. For a personal check on our evaluations, the reader can refer to plan maps of occupations (Appedix E).

Class SR members clearly are less discrete than those of other classes, with a single exception. But for Occupation X (HC) which has a discreteness level of 3, all RG, TR, HC and HG occupations evidently were occupied only once for a brief interval of time (Level 4). In contrast, SR occupations are all either discreteness level 2 or 3. Incidentally, Occupations VI and IX, with the lowest discreteness (2), also have the largest occupation areas (Table 27). We might conclude from these results that spring base camps were occupied longer than most other settlement classes represented at 450K197 and that two occupations of this class (VI and IX) represent habitation of the site on more than one occasion. I also suggest that Occupation IV, sole member of Class TR, which resembles members of Class SR in many dimensions, was actually a very briefly occupied spring base camp.

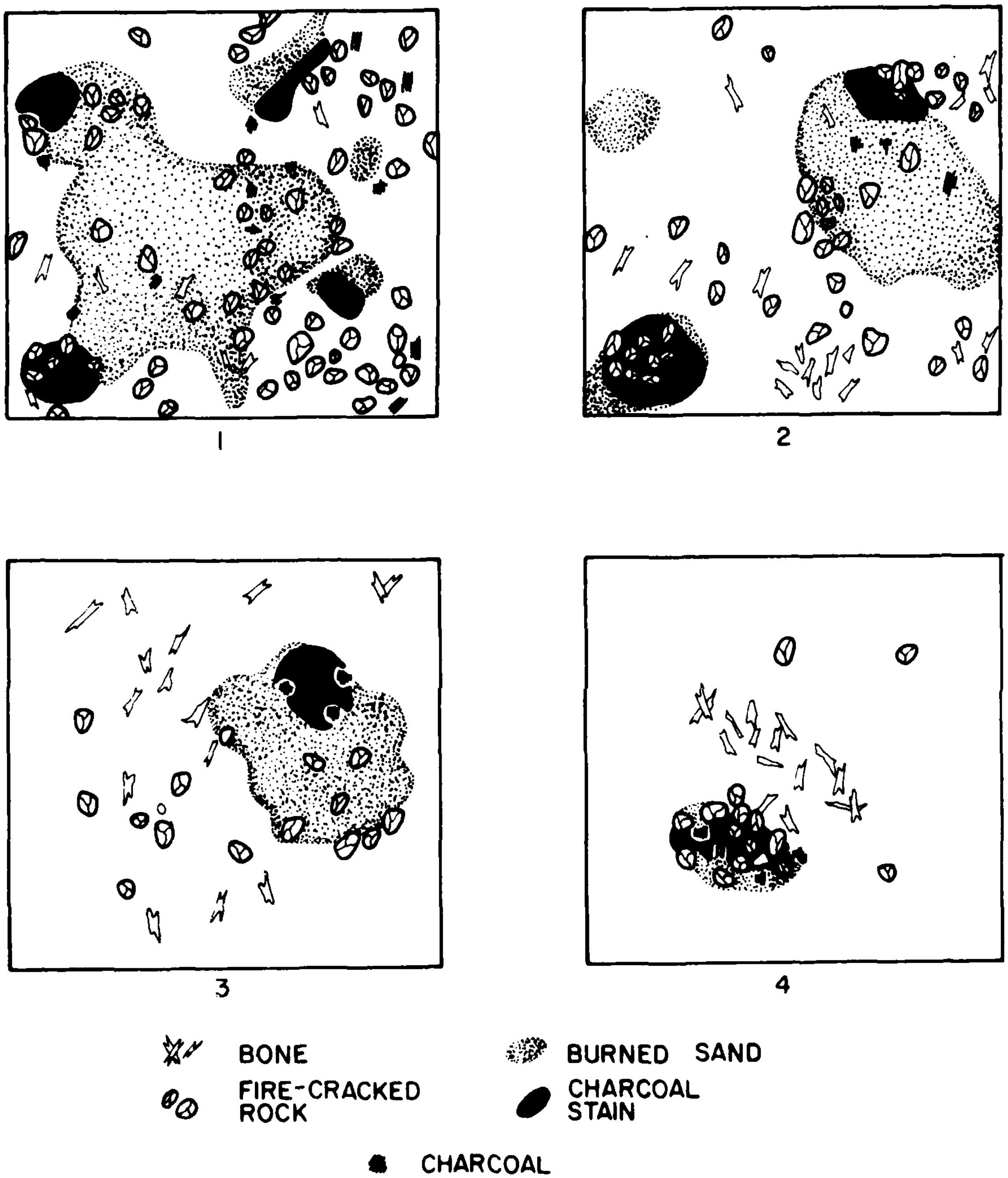

Figure 18. Templates ideally representing various degrees of feature discreteness. 4 is most discrete, 1 is least. All are at the same scale.

Table 28. Summary of ungulate bone fragment sizes.[1]

Class	Occupation	Number Measured	Mean	Mode	Median	Range
RG	I	14	40.0	20	20	10-160
SR	III	19	26.7	20	20	10-140
SR	VI	48	29.7	20	20	10-150
SR	VII	36	28.6	20	20	10-90
SR	VIII	22	30.0	10, 30, 50	30	10-60
SR	IX	71	52.0	20, 90	30	10-240
TR	IV	23	23.0	20	20	10-40
HC	X	38	54.9	30	40	10-170
HC	XIW	128	49.0	40/50	40	10-150
HG	XV	183	32.3	30	30	10-100

[1] Based on deer-size ungulates identified to genus, at minimum. All measurements are in millimeters.

Seasonal Duration

This is the number of months during which a site may have been occupied continuously and is based on seasonality data (Table 24). Because such data are so imprecise (Monks 1981), seasonal duration is measured in periods a minimum of three months long. There was no evidence that any occupation represented habitation for more than the minimum interval, so settlement classes show no variation in this dimension. A comparison of these data with settlements containing pithouses or evidence of intensive fishing activity will be a more productive test of this dimension's utility.

Faunal Diversity

Richness

Richness is a count of the least inclusive taxa identified within each family. In this case I have calculated the linear semi-log function through data points from occupations of Class SR and compare other settlement classes against this line (Figures 19 and 20). The shaded area represents one standard deviation from the line. Note that in both NISP and MNI plots, Occupations I and IV, of settlement Classes TR and RG, respectively, fall virtually on the line, while the occupations of Classes HC and HG are all well above the line and outside 90% confidence limits. Faunal assemblages from settlement Classes SR, RG and TR are significantly richer than assemblages of Classes HC and HG.

Evenness

Evenness is assessed subjectively through observation of bar graphs in which faunal groups are arranged in rank order of percentage frequency. A distribution with maximum evenness is one in which all groups occur in equal frequency and each bar is of equal height. Minimum evenness would be achieved when only one group was present and the first bar reached 100%. A "moderately" even distribution is one in which bars representing successively less frequent groups become progressively shorter in stair-step fashion, but all groups are represented. Low evenness occurs when one group comprises nearly the total assemblage, but a few other groups are present in low frequency.

Evenness graphs based on NISP (Figure 21) are distinctly patterned by class. Members of settlement Class SR (III, VI, VII, VIII, IX) and RG (I) are far more even (moderate) than Classes HC, HG and TR (X, XIw, XV and IV, respectively). Occupation XV approaches maximum evenness; nearly 100% of elements are bones of pronghorn. Graphs of MNI produced the same results (not illustrated; see Table 23).

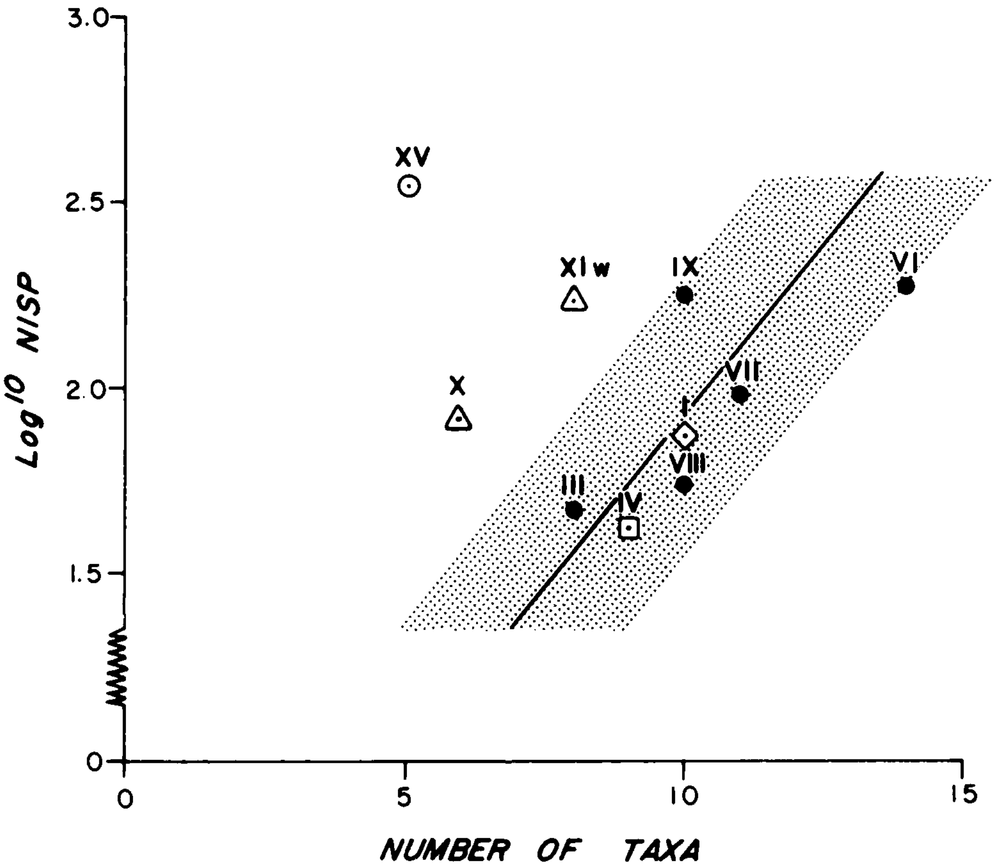

Figure 19. Plot of taxonomic richness (x) against the number of identified specimens (y) from 450K197 faunal assemblages. Solid circles represent Settlement Class SR; the line describes their distribution and the shaded area covers one standard deviation from that line. Note that while occupations of Settlement Classes TR (square) and RG (diamond) fall within the Class SR distribution, Classes HC- (open circle) and HC (triangles) are above the line and can be considered less diverse.

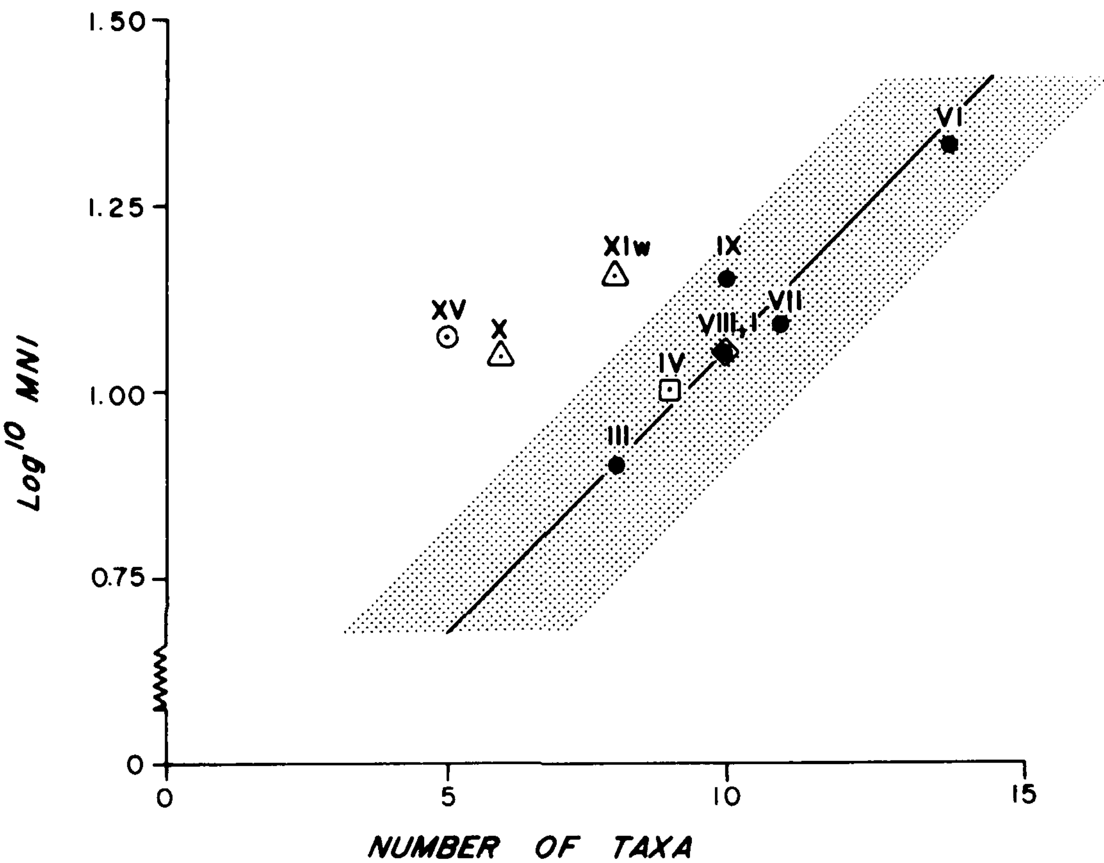

Figure 20. Plot of taxonomic richness (x) against the minimum number of individuals (y) from 450K197 faunas. Note that the pattern exhibited with NISP is even more pronounced here.

CHAPTER X

SUMMARY AND SITE EVALUATIONS

Test excavations were conducted at sites 45OK196 and 45OK197 for two purposes: 1) to assess the sites' potential to provide information significant to the study of local and regional prehistory and 2) to determine whether stratigraphic analysis of 45OK197 sediments could provide data on the periodicity of Columbia River flooding that might be used for planning purposes by the U.S. Army Corps of Engineers. I have endeavored to demonstrate 45OK197's information potential by using it as a test case for evaluating dimensions of site structure as means for discerning strategies of resource exploitation among prehistoric hunter-gatherers. That study has provided the conceptual framework of this report. The flood periodicity question is discussed in Appendix J; conclusions are incorporated below.

45OK197

During 1982 and 1983, CWAS archaeologists excavated 22 square meters of test pits and another 50 square meters in horizontal exposures. The total earth moved, exclusive of hand-dug stratigraphic control trenches exceeded 140 cubic meters. Over 1500 stone tools and debitage and over 15,000 bone fragments were recovered. Artifacts were piece-plotted in the horizontally exposed areas.

Twenty-two geologically or horizontally separated occupations were distinguishable in a distinctly stratified deposit containing sediments from at least 28 flooding episodes. Fifteen of those episodes have been dated and have provided evidence that flood frequencies have changed at least twice in the last 1900 years.

Once the dimensions I have suggested have been more thoroughly evaluated using data from the Plateau region, the most generally useful ones can be applied to hunter-gatherer sites from any region, including the Great Basin, in which the requisite data categories are available.

Conclusion

At least seven of the nine dimensions of site structure offered in Chapter I have proven to be accurate measures of variation in seasonal tactics of resource exploitation. These are occupation area, seasonal/geographic displacement, faunal diversity, bone fragment size, tool diversity, within settlement class variation and feature discreteness. Results are inconclusive for seasonal duration, which was equivalent among the occupations used in this study, and fire broken rock did not prove to be useful. Because feature content was used in settlement class definitions, the feature diversity subdimension was not an independent variable of site structure and could not be evaluated.

Thus far, I have only been able to apply the dimensions to the archaeological records of two site types. Before concluding that these measures can be applied to an older archaeological record with no correlates in the ethnographic present, the range of site types must first be expanded to include, at least, one or more late prehistoric pithouse occupations such as 45OK2 (Campbell 1983; in the Chief Joseph Project Area) or 45DO372 (currently being analyzed by Central Washington Archaeological Survey). Inclusion of sites representing spring root camps would be preferable, but none have been extensively excavated in the vicinity. Once this evaluation procedure is complete, the measures will be used to interpret earlier periods of Plateau prehistory, beginning with data from the Wells Reservoir area (Chatters 1984b).

Thomas (1983) is applying a similar approach to the Monitor Valley of Nevada. As in Chapter II of this report, he has presented an analysis of site formation from a thorough reading of Great Basin ethnographies. In contrast, however, Thomas does not propose generally applicable measures of site structure with which to interpret his archaeological data. He offers, on the one hand, general statements of site content (e.g., specialized subsistence, generalized tool kits) and on the other an account of the specific tool types expected in sites of various types in each of several ecological zones.

Thomas (1983:80, 81) is not optimistic about the potential for discerning some site types in the archaeological record of Monitor Valley. While suggesting, as I do here, that field camps should contain a lower diversity of tools, floral/faunal remains and debitage than should base camps, he concludes that the two site types will be very difficult if not impossible to distinguish archaeologically (Thomas 1983:80, 81). The results presented indicate that where sites have not been reoccupied at a faster rate than geologic processes can bury debris from each occupation event, field camps can indeed be distinguished from base camps.

at base camps and variability among hunting camps should be low, both of these because of the narrow range of activites performed and the concentration on ungulate procurement.

Observations

All expectations were met except that fire broken rock sizes do not vary with feature discreteness and Class HC tool assemblages are more diverse (i.e., even) than SR assemblages. Spring-inhabited SR occupations are larger, more visible, less discrete, more diverse in faunas, more variable in tool and faunal assemblages and, on the average, contain smaller fragments of ungulate bone. As expected, the two settlement types are not distinguishably different in duration and both contain seasonally displaced salmonid remains.

Discussion: Unmet Expectations

There are divergent reasons why tool diversity and fire broken rock sizes did not perform according to expectations. In the first case it may be a misapprehension on my part and the part of others (e.g., Thomas 1983:80) that specialized tasks require a small number of tools. We might alternatively conclude, and certainly with support of 45OK197 data, that more specialized activities require a larger, more precisely designed set of tools and that each kind of tool was used repeatedly in task performance. Torrence (1983) has argued effectively that this is the case. Certainly it is true of our modern adaptation. The average householder may keep a wide range of tools in his kitchen drawer, but most often will use the screwdriver and hammer to perform a variety of tasks from chiseling or cracking nuts to driving screws or nails. A carpenter, by contrast, keeps an equal range of tools, but uses each in the task for which it is intended. Thus, the tools of the carpenter receive more even use than those of householder because of specializations in task performance and tool design in response to the need for greater efficiency. The tool diversity measure is a useful indicator of varied task performance (hunting camps and base camps differ) but the expectations were erroneous.

Fire broken rock size may simply be a useless measure. Stones useful for boiling are rarely in short supply, so cooks probably used stones only so long as they were complete or near-optimum in size. A further test of this measure in a stone-poor area might prove more fruitful.

occupancy in the 20th century, probably after Ray (1933) wrote his ethnography based on memory culture. Not a part of the 19th century ethnographic model, this riverbank berry picking camp probably was articulated with a 20th century, Nespelem City-based, Euro-American influenced pattern of behavior. Class TR may simply be a spring base camp occupied more briefly than others in its class.

Expectations Versus Observations

Expected Site Structure

Early spring base camp. Occupations produced from early spring base camps should be small (but larger than hunting camps) and the period of site occupancy should be brief (less than the three-month minimum resolution of seasonal measures). Because of a longer duration of occupancy and repeated site use, features should be less discrete than in the more briefly occupied hunting camps. Fire broken rock sizes should vary positively with the degree of discreteness. Evidence of seasonal displacement may occur, but if stores were used up before early spring, no displacement would be evident. Floral/faunal diversity should be higher than any other site type, due to application of an encounter-type predation strategy. Shortage of food in this season and the base camp character of the site both should lead to more intensive processing of ungulate bone and, thus, smaller mean sizes of bone fragments than are found in hunting camps. Tool diversity should be higher than in hunting camps because of manufacture and maintenance functions presumed to be performed in base camps; assemblage variation among sites of this type should be greater than hunting camps because of variations in processing and manufacturing associated with opportunistic predation.

Winter/summer hunting camps. These campsites should be the smallest of all occurring in the settlement pattern, with the lowest visibility due to their size, brief occupancy and small amounts of debitage and midden debris. Occupancy duration as indicated by seasonal data would be brief (under the 3 month minimum) but with no perceptible difference from spring base camps. The sites were more briefly occupied and, if not revisited, should contain more discrete features and fire broken rocks should generally be large, but varying with feature discreteness. Seasonal displacement of large salmonid fish is to be expected, especially in sites occupied in earlier winter. Faunal diversity would be lower than in spring camps because these camps were occupied specifically for procurement and processing of large ungulates. Some smaller animals might also occur, consumed by hunters until they had achieved their objective. Because of brief occupancy and because activities focused on processing of meat for storage, bone fragments should be larger on the average than they are in spring base camp assemblages. Tool diversity should be lower than

CHAPTER IX

EVALUATION OF SITE STRUCTURE DIMENSIONS

The purpose of the foregoing analysis has been to provide data for assessing the utility of nine dimensions of site structure as means for discerning forms of prehistoric resource exploitation strategies from the archeological record. In Chapter II, I outlined the values of each dimension expected to be observed in various types of sites produced by the forager and collector extremes in the exploitation strategy continuum. Then I presented values expected to be expressed in sites inhabited during the various points in the annual subsistence round of the Sanpoil-Nespelem. Third, after the hearth-containing occupations had been grouped by settlement class (Chapter VII), they were analyzed in the dimensions and subdimensions not used in class definition (Chapter VIII). Expectations are now compared with observations.

It is important to recognize that I am not attempting to interpret site function through ethnographic analogy based on site structure dimensions. Because of the chronological proximity of occupations at 45OK197 to the ethnographic period and given the general agreement among Plateau archaeologists that regional adaptations have been essentially stable for nearly 2000 years, I have <u>assumed</u> that settlement classes correspond to various seasonal camps of the Sanpoil-Nespelem. Each settlement class is expected to conform to its ethnographic counterpart <u>if</u> the dimensions are usable measures of resource exploitation tactics at the seasonal level, <u>assuming</u> that the dimension values are correctly predicted from the ethnographic model. Those dimensions for which observations and expectations are equivalent are accepted as more useful measures; those which do not conform are looked at in more detail.

<u>Ethnographic Sites and Settlement Classes</u>. Settlement Class SR is an early spring base camp and settlement Classes HC and HG are winter and summer/fall hunting camps. The two remaining settlement classes, with one member each, seem to have no ethnographic counterparts. This is understandable in the case of Class RG since it represents

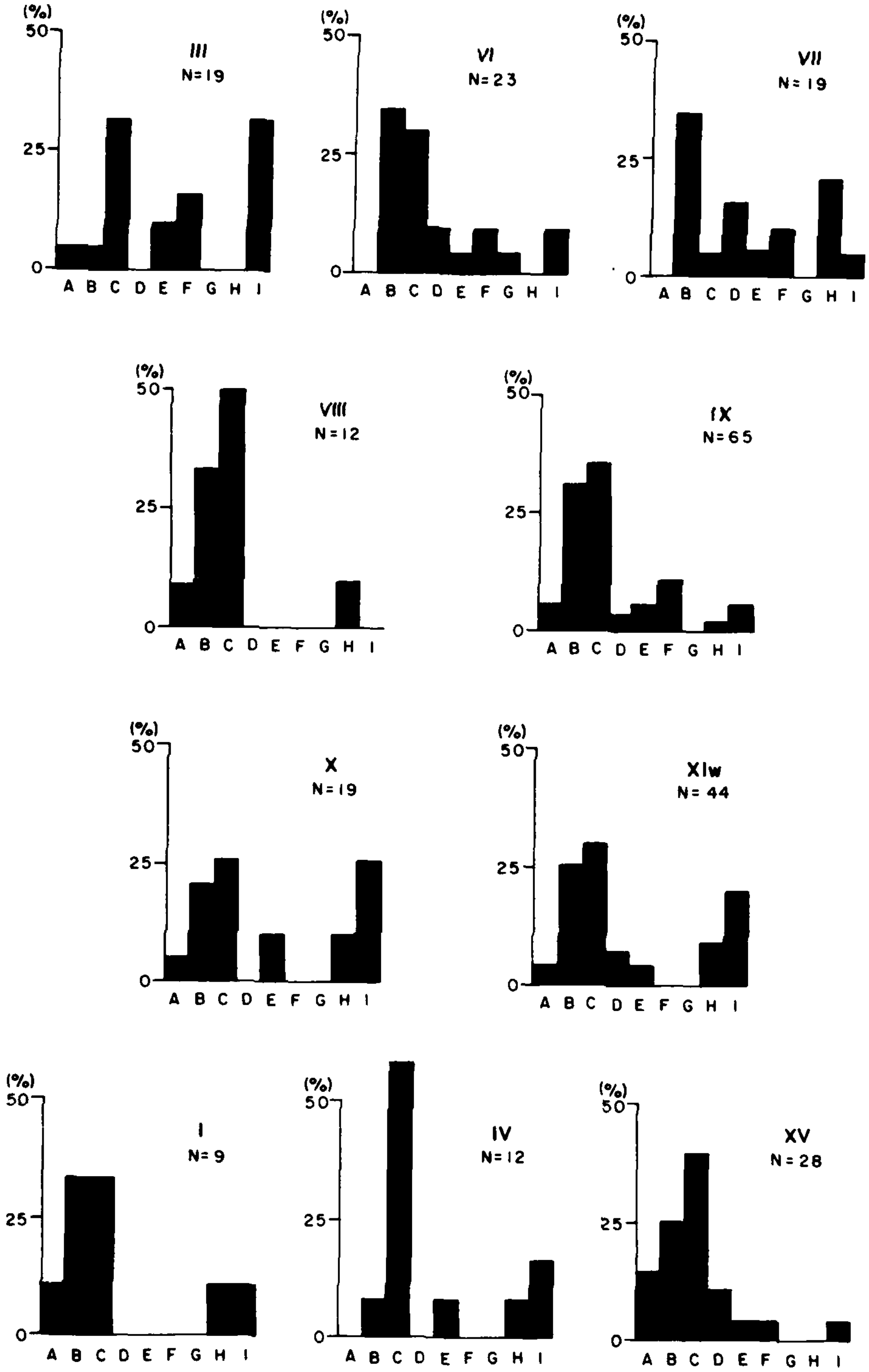

Figure 24. Frequency distributions of use-wear tool groups among 45OK197 occupations. Members of Settlement Class HC (X, XIW) are nearly identical, while Class SR occupations (III, VI-IX) are much more variable. Note the similarity of Occupation XV to the left portion of both Class HC graphs.

assemblages of SR occupations are much more variable than those of the HC/HG group.

Use-Wear Tool Variation

Again, the mean variation among HC/HG assemblages is lower, but the difference is not so striking (Tables 27 and 29). Occupations X and XIw are, again, also more similar than any other pair of occupations (171 versus 168 for Occupations VI and IX). The mean similarity for all of the SR group is only 119, while for HC/HG it is 147. Sampling error may be partially responsible for this result; the mean coefficient for the most similar three SR occupations is 148 (VI, VIII, IX).

Percentage histograms of all occupations (Figure 24) show the HC occupations to be nearly identical, with highest frequencies of tool groups B, C, and I, with group C the most abundant. Except for the variety of group I tools, Occupation XV is much like the Class HC pair, but the entire group appears no more alike than Occupations VI, VIII and IX. This appears to indicate a noteworthy difference between the two classes of hunting camps. However, when we consider common sense tool categories, the difference may be more a function of tool material. A high proportion of Occupation X and XIw tools are tabular knives, whereas knife fragments in Occupation XV are cryptocrystalline (see Figure 15). Quartzite edges crush under the same conditions that cause cryptocrystalline edges to chip; these attributes constitute the main difference between tool groups C and I. Thus, if Occupation XV knives had been made from quartzite, a similar histogram to those of settlement Class HC might have resulted.

Table 29. Brainerd-Robinson similarity matrices of settlement class SR and combined classes HC and HG based on grouped faunal taxa and use-wear tool groups.

Faunal Groups

Class SR

	III	VI	VII	VIII	IX
III	200				
VI	116	200			
VII	119	157	200		
VIII	117	159	160	200	
IX	135	142	156	174	200

Classes HC and HG

	X	XI	XV
X	200		
XI	180	200	
XV	174	188	200

Tool Groups

Class SR

	III	VI	VII	VIII	IX
III	200				
VI	115	200			
VII	62	135	200		
VIII	85	128	95	200	
IX	130	168	124	149	200

Classes HC and HG

	X	XIw	XV
X	200		
XI	171	200	
XV	121	148	200

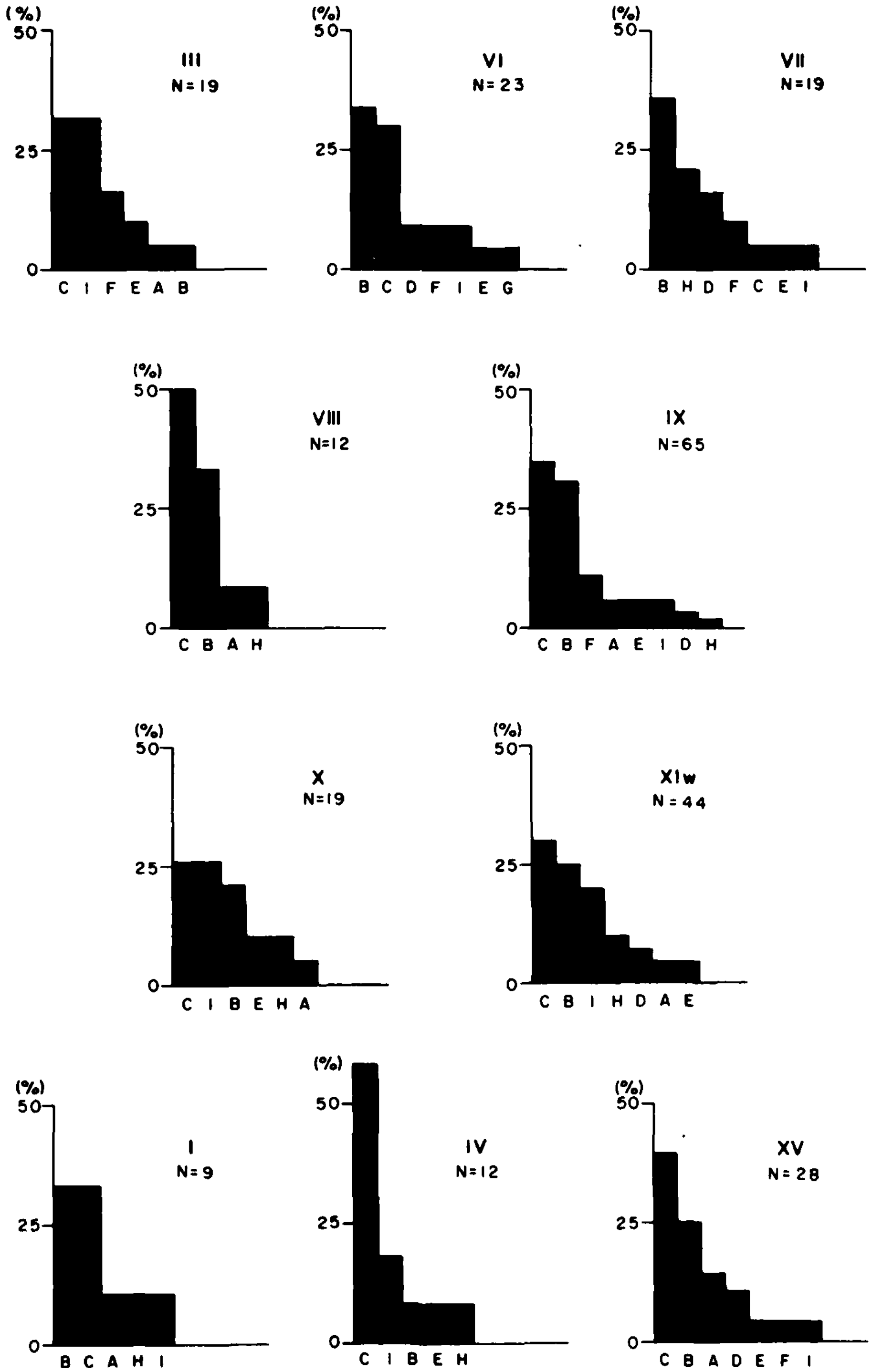

Figure 23. Graphs of evenness for use-wear tool groups from 45OK197 occupations. Note that Occupations X and XIW (Class HC) are more even than any others.

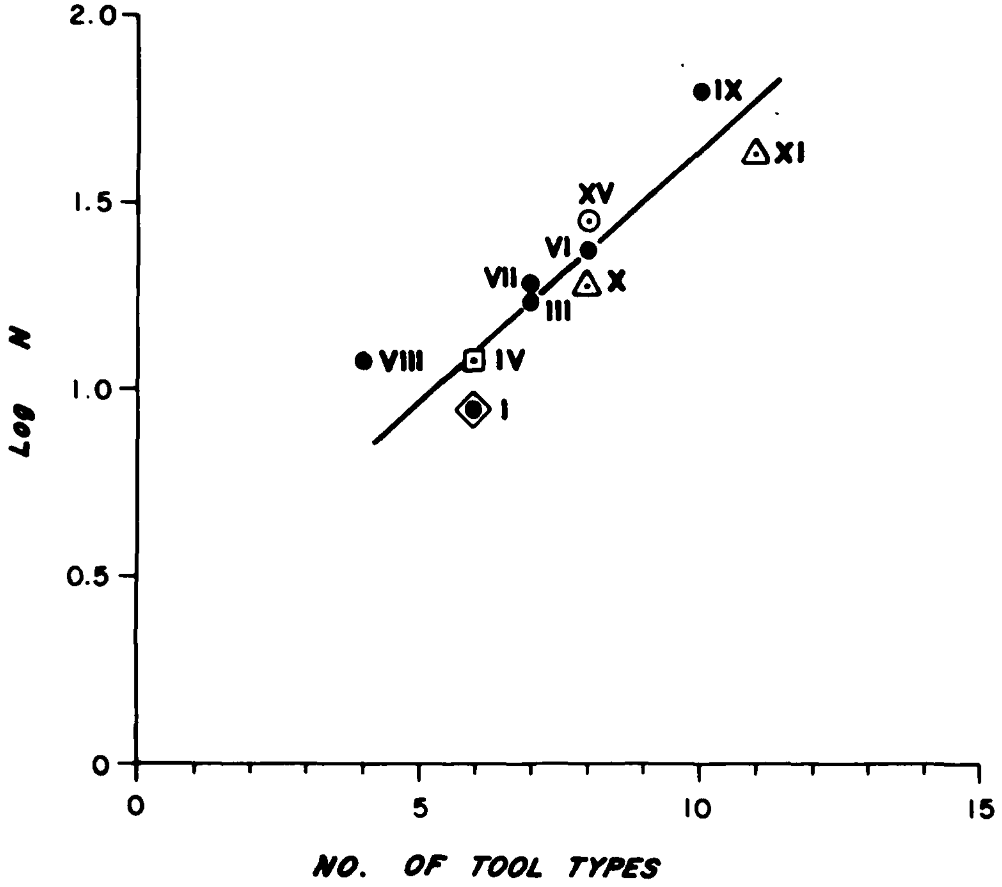

Figure 22. Plot of class richness versus sample size for use-wear tools from 450K197 occupations. No significant variation is evident. Symbols are defined in Figure 18.

material; E, pound; F, be pounded or ground upon; G, cut abrasive materials; H, scrape tough material; or I, cut tough material (Appendix A, Table A-3). Projectile points are left out of this analysis with recognition of the fact that they were probably not used on-site, but rather represent repair or manufacture activities. They are more properly grouped with debitage.

Richness

There is no variation in class richness among settlement classes when all use-wear tool classes are used. All data points cluster closely along a single line (Figure 22). These results echo the findings of Jones (1984) among assemblages from surface sites in the Steens Mountain area of Oregon.

Evenness

All but two occupations show a similar pattern with two or occasionally one class dominating the assemblage (e.g., VI, IX, IV; Figure 23). In the Class HC occupations X and XIw, the distributions are moderate to moderately high on the evenness scale, with the three most common classes in each assemblage occurring in nearly equal proportions. Thus, members of Class HC contain more even tool assemblages than those of other classes.

Variation Among Members of a Settlement Class

The mean similarity between each member of a class and all other members can be used as a measure of the degree of variation within that class. Internal variation among class members is measured here in two data categories: vertebrate faunal groups and use-wear tool groups. The similarity index used is the Brainerd-Robinson coefficient (Brainerd 1951; Robinson 1951). Settlement Clases SR and HC, the only categories with multiple members, provide the data for testing this dimension of site structure. Occupation XV, of settlement Class HG, is secondarily included with the HC group because both are hunting camps an exhibit similar characteristics in other dimensions. With this addition, the HC sample more closely approaches the size of the SR group, allowing more confidence in conclusions about relative degrees of variation between them.

Faunal Assemblage Variation

The similarity in faunal groups between members of Class HC (X, XIw) is 180, higher than the similarity coefficients between any two occupations of Class RS (maximum 174 between IX and VIII; Table 29). Mean similarities among the HC/HG group are higher as well, ranging from 177 to 184 versus the 121-152 range for the SR group. Faunal

Summary

There are clear differences in faunal diversity among 45OK197 occupations. Members of settlement Class SR and RG are relatively rich and moderately even; Classes HC and HG are relatively poor and uneven. Occupation IV (TR), alone, is divergent, being rich but uneven.

Seasonal/Geographic Displacement

This dimension addresses the presence in a faunal or floral assemblage of taxa which should, on the basis of all other evidence, occur in some other locality or in some other season than that represented in the occupation as a whole. Large, anadromous salmonid fishes, appearing as vertebrae only, are the sole evidence of seasonal displacement (see discussion of seasonality, Chapter VI). They occur in every one of the winter (HC) and spring (TR, SR) occupations, indicating the extensive storage of this resource. Occupations of Classes HG nd RG lack any evidence of displacement; their salmon remains are easily accounted for as fresh catches during the times of site habitation (summer and fall). In truth, because of the timing of occupancy and availability of resources at varying elevations one-half day's walk from the site in summer, there are no taxa except for a few root plants that could be taken as seasonally or geographically displaced in these occupations.

Tool Diversity

In this case, the tools analyzed are lithic use-wear tool classes. Diversity among tool assemblages is measured in the same manner as that of faunas. Although problems of identification and fragmentation do not attend the analysis of tools to the extent that they affect faunas, sample size is still a factor. It is, in fact, a more important factor in this case, since sample sizes range from 9 to 65 items with a mean of only 25. There are 19 tool classes in the lithic use-wear classification (Table 10), and few sample sizes (4) exceed the number of classes. This fact will not impede the measurement of class richness, but may result in a very even distribution of tools in all settlement classes. To improve perception of variations in evenness that might exist among assemblages, I have combined lithic tool classes into groups of classes representing similar activities. The nine groups are as follows: tools used to A, scrape soft, convex objects; B, cut tough materials; C, scrape soft, flat or concave materials; D, pierce soft

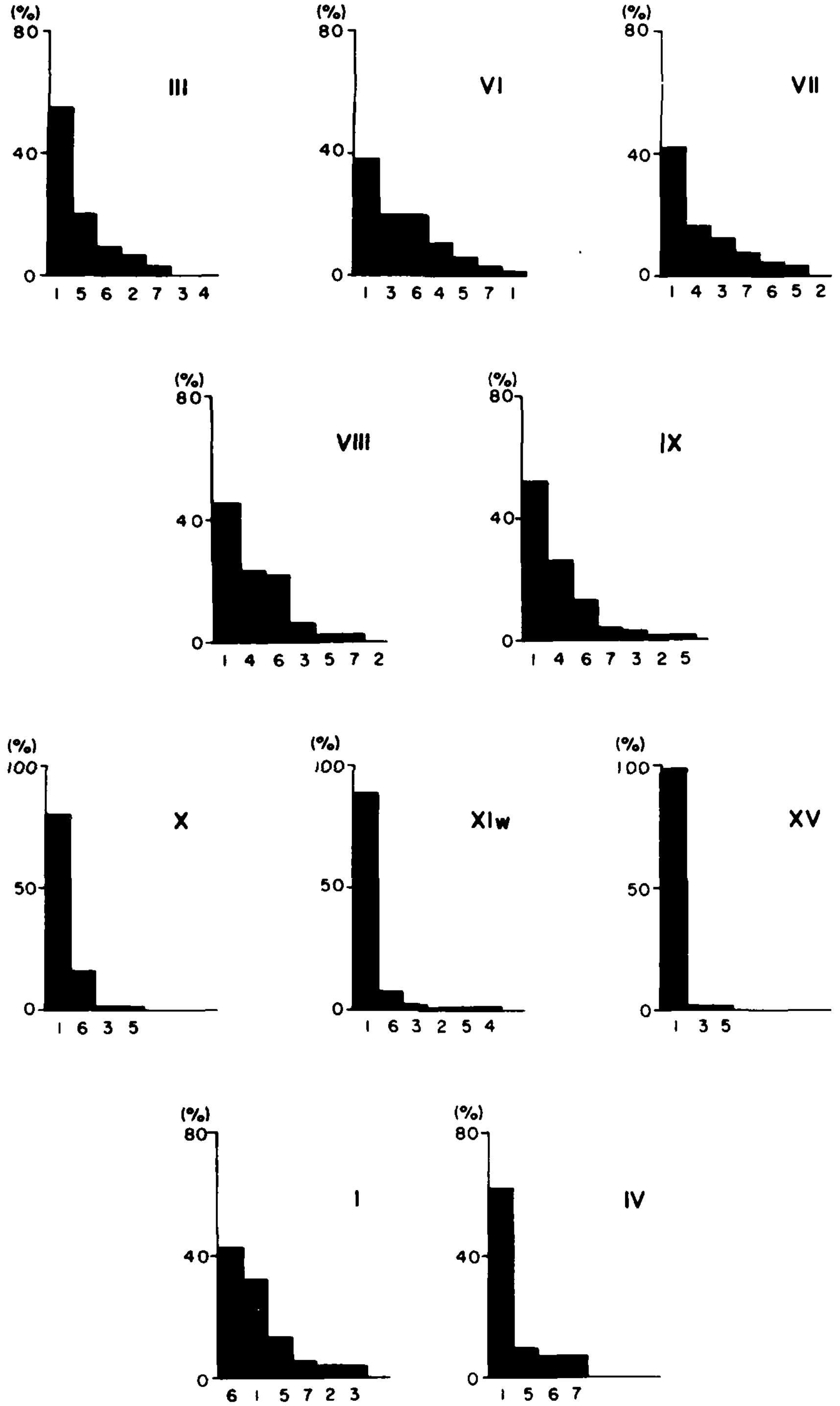

Figure 21. Evenness plots for faunas from ten 45OK197 occupations. Occupations I, III and VI-IX are moderately even, while IV, X, XIW and XV are distinctly uneven.

Floods severe enough to reach the 954.5 ft. level have occurred approximately once every 135 years, since 560 BP (AD 1390), but were much more frequent before that time.

Twenty-one of the 22 occupations (Occupation II excepted) lay at the surface of a layer of flood sediment and had been capped by another such layer shortly after abandonment; bioturbation was rare. Consequently, the integrity of each occupation is high; there is very little evidence of mixing between superimposed occupations and the patterning among artifacts and features is often so discrete that the distribution of prehistoric activities can be distinguished merely by scanning plan maps of occupation surfaces. Fifteen of the occupations provided enough data to warrant the descriptions that follow. Ten of those contained hearth features and were used in the evaluation of site structure dimensions. The evaluation demonstrated that occupation area, duration by seasons, floral/faunal and tool diversity, bone fragment size, seasonal/geographic displacement of plant/animal taxa, feature discreteness and differences in intra-settlement class variation were all measures of site structure useful for interpreting adaptive strategies of prehistoric peoples. Results were inconclusive or negative for two other dimensions.

Occupation Descriptions

Occupation I. This consists of two horizontally separated areas, west and east, of which only the west area was excavated. Dating to sometime in the early twentieth century, this is a pair of camps with large, ovoid hearth basins (earth ovens) containing charred seeds and fruits of dogwood and hawthorn. In addition to berries, the inhabitants ate fish, including sucker, whitefish and salmon, deer and a variety of other animals. An enamelware bucket, steel can and iron rod occur along with stone tools and indicate these people were interacting with Euro-American society. This camp does not correspond with any in ethnographic descriptions and thus represents a change in adaptive strategies of local people.

Occupation II. This 170 year-old occupation is unique among all those I have seen in the Columbia Plateau. It includes a grave of a 13 year old who died from arrow wounds. In his torso were 6 arrow points of local style and outside his body were five others that are more similar to Northern Plains specimens. On the terrace behind the grave we found a stone assemblage including fragments of 36 projectile points of local style, small chips from manufacture and repair of projectile points, and little else. We might speculate that the young man's assailants had buried his body and then proceeded to repair their weapons. Horse bones in the same stratum and characteristics of the dead man's musculature show that these warriors may have been mounted.

Occupations III, and VI to IX. These are early spring base camps from about 300 to 980 years. Using the site on repeated occasions, people stayed here during the brief, apparently hungry period, after leaving the confinement of pithouses and before starting their annual migration to root grounds. While there, they foraged opportunistically for large and small mammals, birds, turtles, suckers, chiselmouth, and river mussel, plus at least one species of edible root. Piles of tiny bone fragments, made spongy by boiling for soup, attest to the shortage of food. All these camps contain shell middens, hearths and an assortment of tools. These are the only occupations containing bone awls, antler wedges, flakers and debris from bone tool making, which attest to the fact that tool fabrication and other manufacturing activities took place. Such activities are typical of base camps (Binford 1980).

Occupations IVa, IV and IXXe. These occupations all share some characteristics with the spring base camps. All were inhabited in early spring and XIIe and IVa contain shell middens, but IV and XIIe differ from other spring camps in their faunal assemblages. Both contain a predominance of deer bone and low frequencies of small mammals, fish and other creatures. There are few bones or tools from Occupation IVa.

Occupations X, XIw, XIIw, XIIIw and XV. These are hunting camps, the first two occupied in late winter, the fifth in summer or early fall. Each was inhabited by a small group of hunters who built one fire, stayed long enough to kill several deer, mountain sheep, pronghorn or elk, processed their kill and left the site. There seems to be some chronological variation in the animals killed. Occupation XV, dated 1680 BP, consists of over 300 bones from pronghorn. The 1300-1400 year old Occupation XIIIw includes deer, elk and pronghorn; there are deer and elk in Occupation XIIw and primarily deer in X and XIw (1100 to 1200 years BP).

Change in Patterns of Site Use and Local Settlement Pattern

Use of 45OK197 has changed over the last 1680 years from hunting camp (1680+ to 1100 BP) to spring base camp (1100 to ca., 300 BP), to bivouac of equestrian warriors (?) to a berry processing camp of partially acculturated, 20th century members of the Colville Confederated Tribes. Whereas the later two changes can be tied to contact with white men or their domesticated stock, the reason for the earlier change is obscure. During the nineteenth century and probably for centuries before that, the villages of Salqua'xuwi'x was situated less than a mile upstream from 45OK197. Since this would place 45OK197 within daily foraging distance of a main village, it is unlikely that hunters would make their camp at this site, preferring a more remote, less heavily hunted location. Spring camps on the other hand, were characteristically situated near winter villages and merely represented a change of scene from dark pithouses. It is likely, therefore, that Salqua'xuwi'x village did not exist in its present location before about 1100 years ago.

45OK196

We excavated six square meters of testpits here for just over 8 cubic meters volume. Upper occupations, corresponding in age to the spring base camps at 45OK196 were extensively disturbed by bioturbation and provided little data. Below them, in a partially deflated remnant of T1 (4500-2500 BP) sediments were one secondary assemblage (Occupation IV) and one partially intact occupation, V. Occupation V contains shell midden features, a hearth and a narrow range of faunal remains and tools. Deer, mountain sheep, pronghorn and marmot occur along with butchering and scraping tools. This occupation is a hunting camp of a different sort from those at 45OK197, but is assignable to settlement Class S-N of the Frenchman Springs Phase. Other occupations of this class occur at sites 45DO394 and 45OK219 in the RM 590 project area (Chatters 1984).

Evaluations

Sites cannot be identified as significant simply by virtue of their survival into the present time. Regulation 36CFR800.10 gives four criteria, the last of which is most applicable to archaeological resources: the potential to provide information important to the scientific understanding of history or prehistory. The key word here is "important". In order to be important, the data contained in a newly evaluated site must potentially provide information of kind or quality we do not already have or of which we have very little.

Site 45OK196 does not meet this criterion. Most of the sites excavated by the Chief Joseph Dam Cultural Resources Program, of which this study is a part, contained occupations dating between 4500 and 2500 BP. This included both pithouse and non-pithouse occupations. It is unlikely that, after reporting of those excavations is completed, 45OK196 will differ substantially from most other non-pithouse sites of its age. In addition, the site is severely eroded, which lowers its information potential even further.

The same is not true of 45OK197. With its stratification, integrity of deposits, preservation of floral and faunal remains and the obviously short duration non-winter habitations, this site is unique in the upper Columbia Region from Wells Dam to the Canadian border. Data from this site can contribute new, valuable insights into the content and layout of hunting camps and spring base camps. These site-types have rarely been excavated in the Columbia Plateau because archaeologists have been more attracted to larger, more productive pithouse occupations. Data on camp layout would improve reconstructions of past lifeways, providing a valuable addition to the Colville Tribes' knowledge about its past and Euro-Americans' understanding of the people who lived here before them. Third, as I have already demonstrated in Chapters II, VIII and IX, data from 45OK197 can be used to test methods for recognizing types of adaptive strategies in the archaeological record, an issue currently of interest among archaeologists worldwide. Finally, shifting from archaeology to economic practicality, more detailed analysis and dating of site deposits can improve hydrologists' knowledge of flood frequency on the Columbia River, contributing to more accurate predictions of river behavior.

Recommendation

Site 45OK196 in unlikely to provide any new information about local prehistory and requires no special management considerations. Because of its significance to Native-American ethnic history, local and regional prehistory, archaeological methodology and Columbia River hydrology, 45OK197 should receive special attention. Once the Bureau of Reclamation begins its twice daily surges of water through the turbines at Grand Coulee Dam, erosion of this entire site will be rapid. Either the bank should be bermed to prevent sediment slippage, or the site should be excavated to recover more complete data on the 22 occupations than was recovered during our extensive testing program. If the site is allowed to wash away, an unusually valuable source of scientific information about prehistory will be lost.

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APPENDIX A

LITHICS CLASSIFICATIONS

Table A-3. Revision of lithic use-wear classes into use-wear groups for similarity analysis in Chapter VIII.

Group	Class	Revised Definition
A	1, 9	Unifacial chipped and chipped and polished wear on a concave edge.
B	2, 4	Bifacial chipped wear on concave and convex edges.
C	3, 10	Unifacial chipped or chipped and polished wear on a convex edge.
D	5, 11	Chipping or polish or both on a point.
E	7, 14	Crushing on an edge or convex surface or chipping and crushing on a point.
F	8, 17, 18	Crushing and/or abrasion on a concave or flat surface.
G	12	Chipped and abraded or polished and abraded objects.
H	13, 15	Unifacial chipped and crushed, concave or convex edges.
I	16	Bifacial chipping and crushing on a convex edge.

Field #25
Shape of Worn Area
(Column 57)

<u>Code 1-4</u>

1	Concave	Indentation of edge or surface with a width greater than twice the depth.
2	Notch/Pit	Indentation of edge or surface with width less than twice the depth.
3	Convex	Edge or surface inscribes area of zero or more degrees. Includes flat surface and straight line.
4	None	

Field #26
Faciality
(Column 58)

<u>Code 1-4</u>

1	Unifacial or unimarginal	Wear on one surface or one side of edge only.
2	Bifacial	Wear is coincident on two sides of edge or two opposing surfaces.
3	Alternate	Wear is on alternate sides of parallel or intersecting edges.

Field #27
Angle
(Column 59)

<u>Code 1-2</u>

1	60^{o}
2	60^{o}

Field #23
Kind of Wear
(Column 55)

Code 1-7

1	Chipping	Three or more hertzian cones within less than 5mm of one another, less than 30 percent of which have hinge or step terminations.
2	Abrading	Three or more parallel striations less than 1mm apart and greater than 4mm long.
3	Polishing	A high sheen confined to only a portion of an object. Sheen on all artifact edges or an entire surface is considered to be a natural condition.
4	Crushing	Small, irregular fragments removed over 5mm of edge or one square cm of surface or more.
5	Chipping and polishing	Combination of 1 and 3.
6	Chipping and abrading	Combination of 1 and 2.
7	Abrading and polishing	Combination of 2 and 3.

Field #24
Location of Wear
(Column 56)

Code 1-3

1	Edge	Wear on the intersection of two planes.
2	Point	Wear on the intersection of three or more planes, continuing onto adjacent edges.
3		Wear on a flat surface
4		None

Field #21
Commonsense Categories
(Columns 49, 50, 51)

Code 001-999

001	Utilized flake/chunk
002	Unifacially retouched flake
003	Bifacially retouched flake
004	Resharpening flake
005	Amorphously flaked object
006	Burin spall
007	Biface
008	Projectile point, whole
009	Projectile point, base
010	Projectile point, tip
011	Blade
012	Microblade
013	Flake off blade core
014	Microblade core
015	Drills
016	Graver
017	Burin
018	Scraper
019	Spokeshave
020	Core
021	Tabular knives
022	Hammerstone
023	Maul
024	Pestle
025	Edge-ground cobble
026	Netsinker
027	Chopper
028	Peripherally flaked cobble
029	Amorphously flaked cobble
030	Millingstone, flat or ind.
031	Hopper mortar
032	Anvil stone
033	Shaft abrader
034	Bead
035	Pipe
036	Blades, 10mm in width
037	Blade core, 10mm in width
038	Cascade core
039	Cascade flake
040	Cascade blade

Field #15
Heat
(Column 29)

Code 1 and 2

1	No evidence	
2	Crazing, pot lidding, or possible color and texture change	Crazing is minute fracture lines caused by differential cooling of the stone. Pot lidding is the catastrophic sloughing of conchoidal or round flakes, probably due to differential cooling/heating and exacerbated by impurities in the stone itself. Possible color and textural changes are third level data (totally subjective at this point).

Field #20
Completeness
(Column 48)

Code 1 and 2

1	Complete	Somewhat subjective evaluation of whether or not an object is whole. Used to key on broken items for possible future breakage analysis.
2	Partial	
3	Rejuvenated	A once-broken item showing signs of repair.

Field #13
Secondary Modification (Manufacture)
(Column 27)

<u>Code 1-5</u>

1 Unifacial or unimarginal retouch (removal of excess material in the shaping process either by percussion or pressure flaking from one face, 2 negative bulbs).

2 Bifacial or bimarginal retouch (removal of excess material in the shaping process either by percussion or pressure flaking from both faces of an edge).

3 Pecking, grinding, abraiding (primitives).

4 1 and 2.

5 1, 2 and 3.

Field #14
Cortex
(Column 28)

<u>Code 1-4</u>

1	None	No original weathered surface visible.
2	Partial	Some original weathered surface visible.
3	Complete	All original weathered surface visible.
4	N/A	Not applicable.

Field #12
Various Reduction States
(Columns 25, 26)

Code 01-08

01	Core	Evidence of platform preparation and 1 negative bulbs of percussion.
02	Conchoidal flake	Conchoidal nonlinear or nonblade-like flake. Has 1 flake attributes.
03	Linear or blade-like flake	Exhibits blade-like characteristics, see Tixier (1974). Has 1 flake attributes.
04	Bifacial thinning flake	A detritus detached from a biface in the process of shaping or thinning that retains a curved longitudinal profile with the bifacial striking platform displaying 2 negative bulbs of percussion on each face.
05	Tabular flake	Flake or detritus that has striking platform and at least one planar surface resulting from separation along inherent cleavage of stone.
06	Chunk shatter	A fragment with at least one flake attribute but also cleavage along craze lines, weathering planes or incipient weaknesses popularly known as "gobline."
07	Bipolar core	A core, often a cobble, displaying 180° opposed striking platforms, negative bulbs of percussion and crushing on the platforms.
08	Bipolar flake	A flake or other fragment of detritus that exhibits 180° opposed striking platform remnants, positive bulbs of percussion and crushing.
00	Other	

Some of these states are impressionistic more or less and are thought of as keys to pattern recognition and further analysis.

Field #11
Raw Material
(Columns 23, 24)

Code 01 - 11

01 Obsidian

02 Opal/Opaline

03 Jasper/Petrified Wood/Chalcedony

04 Basalt

05 Quartzite

06 Quartzofeldspathic Schist

07 Nephrite/Steatite

08 Mudstone/Siltstone (argillite)

09 Granodiorite/Granite

10 Indeterminate

11 Other

Field #7
Level Number
(Columns 14, 15)

Code		Code	
1-50	10cm levels	51-67	20 cm levels
1 =	0 - 10	51 =	0 - 20
2 =	10 - 20	52 =	20 - 40
3 =	20 - 30	53 =	40 - 60
4 =	30 - 40	54 =	60 - 80
5 =	40 - 50	55 =	80 - 100
6 =	50 - 60	56 =	100 - 120
7 =	60 - 70	57 =	120 - 140
8 =	70 - 80	58 =	140 - 160
9 =	80 - 90	59 =	160 - 180
10 =	90 - 100	60 =	180 - 200
11 =	100 - 110	61 =	200 - 220
12 =	110 - 120	62 =	220 - 240
13 =	120 - 130	63 =	240 - 260
14 =	130 - 140	64 =	260 - 280
15 =	140 - 150	65 =	280 - 300
16 =	150 - 160	66 =	300 - 320
17 =	160 - 170	67 =	320 - 340
18 =	170 - 180		
19 =	180 - 190		
20 =	190 - 200		
21 =	200 - 210		
22 =	210 - 220		
23 =	220 - 230		
24 =	230 - 240		
25 =	240 - 250		
26 =	250 - 260		
27 =	260 - 270		
28 =	270 - 280		
29 =	280 - 290		
30 =	290 - 300		

Field	Code	Description
29. Area (Columns 63, 64, 65)	001 through 999	Size of worn area in cm^2. Length of worn edge and area are exclusive.

Columns 66 through 76 repeat the functional analysis of attributes on Tool #2 or the second worn edge or area on the artifact. When more than two tools exist on the item in hand, the following line is redundant up to the subheading "Tool #1", at which time attributes for Tool #3 are recorded, and so on.

Columns 76 through 80 are left open for future use.

Field	Code	Description
19. Maximum weight in grams (Columns 42, 43, 44, 45, 46)	00001 through 99999	Weight of an object in grams.
20. C (completeness) (Column 48)	1 through 9	A judgmental assessment of the "wholeness" of an item; particularly useful in monitoring breakage patterns.
21. Commonsense Categories (Columns 49, 50, 51)	001 through 999	Popular terms, often composite that denote object type, often in assumed functional terms, e.g., "tabular knife."
22. Quantity (N) (Columns 52, 53, 54)	001 through 999	The number of items in a particular class per excavation unit per level.

Functional Attributes
(adapted from Chatters 1982a)
Tool #(1-X)

Field	Code	Description
23. Tool #1 K (Kind of wear) (Column 55)	1 through 9	An attribute set based on use mode and the resultant modification of a stone artifact surface.
24. L (Location of wear) (Column 56)	1 through 9	An attribute set based on the locus of wear in relation to artifact surfaces or planes, e.g., "edge" is "wear on the intersection of two planes."
25. S (Shape of worn area) (Column 57)	1 through 9	An attribute set based on measurable relationships on the artifact's worn surface in a curved plane.
26. F (Faciality) (Column 58)	1 through 9	An attribute set based on proximity of worn area (tool) to planar surfaces and their intersection.
27. A (Angle) (Column 59)	1 through 9	Intersection of artifact planes with wear greater than 60 degrees and less than 60 degrees.
28. LGTH (Length) (Columns 60, 61, 62)	001 through 999	Length of worn edge measured to nearest 2mm.

Field	Code	Description
9. Stratum/Occupation (Columns 18, 19)	01 through 99	Numbers assigned sequentially top to bottom of excavated grid units designating occupation layers.
10. Artifact catalog number (Columns 20, 21, 22)	001 through 999	Numbers assigned sequentially in Field Lab to the more obvious worn/manufactured items.
11. Raw material (Columns 23, 24)	01 through 99	Number designates a specific lithic raw material
12. Various reduction states (Columns 25, 26)	01 through 99	Selected arbitrary categories of purposeful breakage of stone and resultant debitage. "State" or stage of breakage carries useful technological information. Not necessarily mutually exclusive categories here.
13. Secondary modification (manufacture) (Column 27)	1 through 9	Categories of purposeful retouch and/or shaping of manufactured items.
14. Cortex (Column 28)	1 through 9	The amount of original weathered surface on an item.
15. Heat (Column 29)	1 through 9	Selected attributes of thermal alteration on stone.
16. Maximum length (Columns 30, 31, 32)	001 through 999	Flake length to nearest 2mm measured on axis of force, i.e., from striking platform to tip of flake. Longest dimension for nonflakes.
17. Maximum width (Columns 34, 35, 36)	001 through 999	Flake width to nearest 2mm measured at widest point perpendicular to axis of force. Other types of objects are measured at maximum point perpendicular to axis of length.
18. Maximum thickness (Columns 38, 39, 40)	001 through 999	Flake thickness is measured at the maximum point on the object perpendicular to the length and width axes.

Table A-2.

RM 590 Project, Lithic Analysis Data Coding Key

Field	Code	Description
1. Site Number (Columns 1, 2)	01	45-DO-189
	02	45-DO-190
	03	45-DO-191
	04	45-DO-394
	05	12M
	06	45-OK-165
	07	45-OK-193
	08	45-OK-196
	09	45-OK-197
	10	45-OK-198
	11	45-OK-199
	12	45-OK-205
	13	45-OK-207
	14	45-OK-208
	15	45-OK-219
2. Area (Column 3)	01	Area A
	02	Area B
	03	Area C
3. Grid unit numeric designation, X coordinates (Columns 4, 5, 6)	001 through 999	Map coordinate on N/S axis at NW corner of excavated 1x1m^2 quad
4. North/South designator (Column 7)	1	North of 0,0 on grid
	2	South of 0,0 on grid
5. Grid unit numeric designation, Y coordinates	001 through 999	Map coordinate on E/W axis at NW corner of excavated 1x1m^2 quad
6. East/West designator (Column 12)	1	East of 0,0 on grid
	2	West of 0,0 on grid
7. Level number (Columns 14, 15)	01 through 99	Arbitrary 10cm or 20cm levels excavated parallel to natural or cultural strata/um. Arbitrary 10cm levels excavated within massive strata at 45-OK-197.
8. Feature number (Columns 16, 17)	01 through 99	Numbers assigned sequentially top to bottom of excavated grid units designating recorded associations of artifacts.

Table A-1. Morphological classification of projectile points: dimensions and attributes.

Dimension No.	Dimension Name		Attributes	Dimension No.	Dimension Name		Attributes
1	Blade stem juncture	1	Not separate	6	Cross Section	1	Planoconvex
		2	Side-notched			2	Biconvex
		3	Shouldered			3	Diamond
		4	Squared			4	Trapezoidal
		5	Barbed			5	Indeterminate
		6	Indeterminate				
2	Outline	1	Triangular	7	Serration	1	Not serrated
		2	Lanceolate			2	Serrated
		3	Indeterminate			3	Indeterminate
3	Stem edge orientation	0	Not applicable	8	*Edge grinding*	1	Not ground
		1	Straight			2	Blade edge
		2	Contracting			3	Stem edge
		3	Expanding			4	Blade and stem edge
		4	Indeterminate			5	Indeterminate
4	Basal edge shape	0	Not applicable				
		1	Straight	9	Basal edge thinning	0	Not applicable
		2	Convex			1	Not thinned
		3	Concave			2	Short flake scars
		4	Point			3	Long flake scars
		5	Notched			4	Indeterminate
		6	Indeterminate				
5	Blade edge shape	1	Straight				
		2	Convex				
		3	Concave				
		4	Reworked				
		5	Indeterminate				

Table A-4. Common Sense Tool Categories: Definitions

Name	Definition
Flakes	Primary or secondary detritus resulting from lithic manufacture.
Utilized Flakes	Flake, or flake fragment that shows utilization (wear) along the edges of one surface.
Unifacially	Flake that shows retouch along the Retouched Flakes edge of one surface. Retouch is defined as scars of intentionally removed flakes, larger than scars left by utilization, but smaller than flakes removed to thin the center of an object. This category subsumes unifaces.
Bifacially Retouched Flake	Flake or chunk that shows retouch along both surfaces of an edge. Retouch is defined above under unifacially retouched flakes, and differs from bifacial thinning in that bifacial thinning includes the whole surface of a flake as opposed to just an edge. If original flake surface is present items are classified as bifacially retouched flakes. Small biface fragments may have been included in this category.
Amorphously Flaked Object	Objects with scattered flake scars, which although intentionally retouched do not meet criteria for other classes.
Bifaces	All or portion of a bifacially worked object. Bifaces have large flakes removed to thin the surface. Some objects coded as bifaces may be portions of projectile points, but in questionable cases were coded as bifaces. Bifaces are distinguished from projectile points by shape; having broader outlines and lacking formed stems.
Projectile Point	A whole or mostly whole point.
Projectile Point Base	All or most of a base.
Projectile Point Tip	Tip of a projectile point, as opposed to that of a biface which is broader.

Table A-4. (2 of 4)

Drill	Objects in the drill class include shaped (worked) drills and objects utilized in a drilling fashion. Shaped drills range from totally manufactured objects to those with only the bit shaped. The manufacture to produce the bit is usually bifacial producing a diamond-shaped cross section, and, wear should be distributed on at least two of these surfaces. Wear can be alternating unifacial or bifacial on both edges. Alternating wear shows the direction of use -- clockwise or counterclockwise.
Scraper	Flake with steep edged, unifacial retouch that forms a convex edge. The manufacture must significantly alter the shape of the original flake, with most of an edge of being involved.
Spokeshave	Object with deeply concave unifacially retouched edge. Utilization results in an abundance of hinged/ stepped wear flakes.
Core	What remains of a cobble after a lithic reduction sequence. Ideally, a core should have a prepared platform with at least two flake scars removed from it. Cores without prepared platforms occur, but all must show two or more flake scars. The scars should also be large enough so that the flakes removed could serve some purpose beyond the retouch of the core.
Tabular Knife	A wafer, usually of quartzite but sometimes of tabular or laminar material. The edges are unifacially retouched, which in combination with wear is the minimal requirement for tabular knives. Wear on tabular knives is classified as crushing and chipping because quartzite does not produce flaking, but individual crystals are removed.
Hammerstones	Hand sized cobbles that are unmodified, but utilized. Utilization takes the form of crushing/pecking wear, usually on the terminal surface. Some hammerstones exhibit modification, usually flaking, probably a form of damage. Some larger cobbles exhibiting the same features are also called hammerstones.
Maul	A cone- or pear-shaped object with a large "rough" working end.
Edge Battered Cobble	Flat, round cobbles with continuous crunching and abrasion along one or more edges. These differ from hammerstones in that they often have a bevelled edge, while hammerstones have distinct flat areas of wear.

Table A-4. (3 of 4)

Chopper	Cobble usually of quartzite or basalt but also sometimes chert, with flakes removed to form a large, fairly steep angled edge. Ideally the edge is sharp enough to "cut," unlike the blunt end or edge of a hammerstone, which would crush the material being worked on. Wear on a chopper usually manifest itself in crushing, hinged fractures, and sometimes with prolonged use, a crushed effect.
Peripherally Flaked Cobble	Large cobble with the edges removed by chipping.
Hopper Mortar	Large cobble or rock with crushing and abrasion in a circular area at least 7cm in diameter.
Anvil	Large rock or cobble with wear and/or manufacture present. Anvil stones have convex worn surfaces.
Other	Miscellaneous itmes not included in above definitions.
Antler Wedge	Portion of antler with one end bevelled to a wedge shape. The other end has been crushed and chipped from being struck. The bevelled end usually exhibits polish from use.
Antler Flaker	Antler tine with point rounded by abrasion from use in lithic manufacture.
Antler Pick	Antler with crushing and chipping on the distal tine.
Harpoon Valve	Valve portion of a composite harpoon point. Pointed or bipointed object with concave-convex cross section. Concave surface results from modification to create grooves into which a bone point and harpoon shaft were inserted.
Point	Cylindrical, pointed object with oval to round cross section. Often has chip an/or crushing on pointed end.
Awl	Sharply pointed bone tip with handle (single item) and polish on and along sides adjacent to point. Point may or may not have been modified by abrasion. The handle is blunt, often the joint end of a mammal long bone.
Shaft Fragment	Cylindrical objects of oval or cylindrical cross sections from which both ends have been broken. May be parts of bone points or awls.

Table A-4. (4 of 4)

Utilized Incisor	Incisor showing signs of use wear on the occlusal surface. Wear may be chipping, abrasion/polish or a combination.
Debitage	Bones which show signs of modification but are products from manufacture of bone tools.

Raw Material X Reduction State
45-OK-197
Occupation VI

Material	0	1	2	3	4	5	6	7	8
	Reduction State								
Obsidian									
Opal			25	4	4		2		
CCQ	5		159	27	14		8		
Basalt	1		3						
Quartzite			1			1			
Schist	1					1			
Nephrite									
Mudstone						2			
Granite									
Indeterminate									
Other									
Total	7		188	31	18	4	10		

Raw Material X Reduction State
45-OK-197
Occupation VII
East Block

Material	0	1	2	3	4	5	6	7	8
	Reduction State								
Obsidian									
Opal			2		1				
CCQ	3		13	5	14	1	2		
Basalt	2		4				2		
Quartzite						1			
Schist						1			
Nephrite			1						
Mudstone									
Granite	1					1			
Indeterminate									
Other									
Total	6		20	5	15	[illegible]	4		

Raw Material X Reduction State
45-OK-197
Occupation VIII
East Block

Material	0	1	2	3	4	5	6	7	8
	Reduction State								
Obsidian									
Opal			1		1				
CCQ	3		20	8	7	1	4		
Basalt	1		2						
Quartzite									
Schist						2			
Nephrite									
Mudstone		1	2				1		
Granite									
Indeterminate									
Other									
Total	4	1	25	8	8	3	5		

Raw Material X Reduction State
45-OK-197
Occupation IX
East Block

Material	0	1	2	3	4	5	6	7	8
	Reduction State								
Obsidian									
Opal	1		6		2		2		
CCQ	10	1	163	14	73	1	28		
Basalt	2		5				1		
Quartzite			6			12	1		
Schist						7			
Nephrite									
Mudstone	1		2						
Granite	2						1		
Indeterminate									
Other									
Total	16	1	182	14	75	20	33		

Raw Material X Reduction State
45-OK-197
Occupation XIII
West Block

Material	0	1	2	3	4	5	6	7	8
	Reduction State								
Obsidian									
Opal									
CCQ			1		1				
Basalt	1		3						
Quartzite									
Schist									
Nephrite									
Mudstone									
Granite	1								
Indeterminate									
Other									
Total	2		4		1				

Raw Material X Reduction State
45-OK-197
Occupation XV
East Block

Material	0	1	2	3	4	5	6	7	8
	Reduction State								
Obsidian									
Opal					1				
CCQ	4		20	3	9		8		
Basalt	1					2			
Quartzite						1			
Schist									
Nephrite									
Mudstone									
Granite									
Indeterminate									
Other									
Total	5		20	3	10	3	8		

Raw Material X Reduction State
45-OK-197
Occupation XI
East Block

Material	0	1	2	3	4	5	6	7	8
	Reduction State								
Obsidian									
Opal					2				
CCQ				1	3				
Basalt									
Quartzite						1			
Schist									
Nephrite									
Mudstone									
Granite									
Indeterminate									
Other									
Total				1	5	1			

Raw Material X Reduction State
45-OK-197
Occupation XIII
East Block

Material	0	1	2	3	4	5	6	7	8
	Reduction State								
Obsidian									
Opal					10		1		
CCQ		1		1	5		1		
Basalt						1			
Quartzite						3			
Schist									
Nephrite									
Mudstone									
Granite									
Indeterminate									
Other									
Total		1		1	15	4	2		

Raw Material X Reduction State
45-OK-197
Occupation X
West Block

	Reduction State								
Material	0	1	2	3	4	5	6	7	8
Obsidian									
Opal			5	1					
CCQ			46	7	8		2		
Basalt	3		1						
Quartzite			6			1			
Schist						4			
Nephrite									
Mudstone									
Granite									
Indeterminate									
Other									
Total	3		58	8	8	5	2		

Raw Material X Reduction State
45-OK-197
Occupation XI
West Block

	Reduction State								
Material	0	1	2	3	4	5	6	7	8
Obsidian									
Opal			2				1		
CCQ	1		64	8	14	2	11		
Basalt	1		7				2		
Quartzite			21	1	1	21	4		
Schist						1			
Nephrite									
Mudstone			2				1		
Granite			1						
Indeterminate									
Other									
Total	2		97	9	15	24	19		

Raw Material X Reduction State
45-OK-197
Occupation XII
East Block

	Reduction State								
Material	0	1	2	3	4	5	6	7	8
Obsidian									
Opal			1				1		
CCQ	2		11	3	6		4		
Basalt		1	1						
Quartzite						8			
Schist						2			
Nephrite									
Mudstone							1		
Granite									
Indeterminate									
Other									
Total	2	1	13	3	6	10	6		

Raw Material X Reduction State
45-OK-197
Occupation XII
West Block

	Reduction State								
Material	0	1	2	3	4	5	6	7	8
Obsidian									
Opal							1		
CCQ	3		1		7		4		
Basalt			11	1					
Quartzite						1			
Schist									
Nephrite									
Mudstone									
Granite									
Indeterminate									
Other									
Total	3		11	1	7	1	5		

Raw Material X Reduction State
45-OK-197
Occupation III
Central Block

Material	0	1	2	3	4	5	6	7	8
	Reduction State								
Obsidian					13				
Opal					2				
CCQ	4		21	2	15	1	7		
Basalt	43		13	1			2		
Quartzite			7		1	8	7		
Schist			1			2	1		
Nephrite									
Mudstone				1		1			
Granite			1				1		
Indeterminate									
Other									
Total	47		43	7	31	13	18		

Raw Material X Reduction State
45-OK-197
Occupation IVA
Central Block

Material	0	1	2	3	4	5	6	7	8
	Reduction State								
Obsidian									
Opal							1		
CCQ			1				1		
Basalt									
Quartzite									
Schist									
Nephrite									
Mudstone									
Granite									
Indeterminate									
Other									
Total			1				2		

Raw Material X Reduction State
45-OK-197
Occupation IV
Central Block

Material	0	1	2	3	4	5	6	7	8
	Reduction State								
Obsidian					1				
Opal					2		2		
CCQ	3	1	26		4	1	8		
Basalt	5	1	5						
Quartzite			4	1		6	4		
Schist			1			8	1		
Nephrite									
Mudstone									
Granite	1		1				1		
Indeterminate									
Other									
Total	9	2	37	1	7	15	16		

Raw Material X Reduction State
45-OK-197
Occupation V
Central Block

Material	0	1	2	3	4	5	6	7	8
	Reduction State								
Obsidian									
Opal									
CCQ							1		
Basalt									
Quartzite						3			
Schist									
Nephrite									
Mudstone									
Granite									
Indeterminate									
Other									
Total						3	1		

Raw Material X Reduction State
45-OK-197
Occupation I

Material	Reduction State 0	1	2	3	4	5	6	7	8
Obsidian									
Opal			1				1		
CCQ	2		6	1			1		
Basalt			1						
Quartzite						2			
Schist									
Nephrite									
Mudstone									
Granite									
Indeterminate									
Other	1								
Total	3		8	1		2	2		

Raw Material X Reduction State
45-OK-197
Occupation II

Material	Reduction State 0	1	2	3	4	5	6	7	8
Obsidian	1		3		21		2		
Opal			2		26		1		
CCQ	8	1	27	1	62	1	8		
Basalt					3				
Quartzite						18			
Schist									
Nephrite									
Mudstone							1		
Granite									
Indeterminate									
Other									
Total	9	1	32	1	112	19	12		

Raw Material X Reduction State
45-OK-196
Occupation V
1983 Tests Only

Material	Reduction State 0	1	2	3	4	5	6	7	8
Obsidian									
Opal			2		2		19	1	
CCQ	5	1	257	24	14	1	47		
Basalt			12	1			1		
Quartzite			12	1		22	9		
Schist			7			16	5		
Nephrite									
Mudstone			12			1			
Granite			2			2	1		
Indeterminate									
Other						1			
Total	5	1	304	26	16	43	82	1	

Raw Material X Reduction State
45-OK-196
Occupation Unassigned
1983 Tests Only

Material	Reduction State 0	1	2	3	4	5	6	7	8
Obsidian									
Opal									
CCQ			1						
Basalt		2	6	1			2		
Quartzite									
Schist									
Nephrite									
Mudstone			1	1					
Granite						1			
Indeterminate									
Other									
Total		2	8	2		1	2		

Raw Material X Reduction State
45-OK-196
Occupation III
1983 Tests Only

	Reduction State								
Material	0	1	2	3	4	5	6	7	8
Obsidian									
Opal	1		1						
CCQ	1		5		1		2		
Basalt	1		12	2			1		
Quartzite	1	1				2	4		
Schist						1	3		
Nephrite									
Mudstone			4			1			
Granite		1	2				1		
Indeterminate									
Other			1			2			
Total	4	2	25	2	1	6	11		

Raw Material X Reduction State
45-OK-196
Occupation IV
1983 Tests Only

	Reduction State								
Material	0	1	2	3	4	5	6	7	8
Obsidian									
Opal			1		1		3		
CCQ	3		24	4	2	1	4		
Basalt	1	1	1	1			1		
Quartzite		1	7			11	4		
Schist						1			
Nephrite									
Mudstone			16	2		2	4		
Granite			2						
Indeterminate									
Other									
Total	4	2	51	7	3	15	16		

Raw Material X Reduction State
45-OK-196
Occupation I
1983 Tests Only

	Reduction State								
Material	0	1	2	3	4	5	6	7	8
Obsidian									
Opal			2						
CCQ			2	2	1		2		
Basalt			2						
Quartzite						2			
Schist									
Nephrite									
Mudstone									
Granite									
Indeterminate									
Other									
Total			6	2	1	2	2		

Raw Material X Reduction State
45-OK-196
Occupation II
1983 Tests Only

	Reduction State								
Material	0	1	2	3	4	5	6	7	8
Obsidian									
Opal									
CCQ			5		2		1		
Basalt			2						
Quartzite									
Schist						1			
Nephrite									
Mudstone			1	1		1	1		
Granite									
Indeterminate									
Other						1			
Total			8	1	2	3	2		

APPENDIX C

FEATURE DESCRIPTIONS

Compiled by
Dianne E. Semko

Table C-1. Content of samples from 45-OK-197 features[1].

Feature No.	Feature Type	Occupation	Block	Stratum	Constant Volume Sample Contents: No. of lithic debitage	Unburnt Bone ct.	Unburnt Bone wt.	Burnt Bone ct.	Burnt Bone wt.	Unburnt Mussel Shell ct.	Unburnt Mussel Shell wt.	Burnt Mussel Shell ct.	Burnt Mussel Shell wt.	Other Unburnt Shell ct.	Other Unburnt Shell wt.	Charcoal wt.	F.C.R. ct.	F.C.R. wt.
2	Dscr. Hearth	I	West	1														
3	Earth Oven	I	West	1				2	.05g							.6g	6	3.9g
9	Earth Oven	I	West	1,2,3		9	.1g	2	.05g					2	.1g	.2g	4	.1g
10	Earth Oven	I	West	3	1	4	1.3g							3	.1g	.6g		
11	Earth Oven	I	West	3		32	.2g	3	.5g					3	.05g	2.5g	4	.2g
UA	Burial	II	Bank	2														
4	Hearth Sctr.	III	Cen.	3		9	1.1g	2	.1g	6	6.7g			1	.01g	.2g	4	.5g
37	Shell Midden	III	Cen.	3		12	.3g	11	.2g	4	8.4g					.5g	3	.1g
30	Shell Midden	IVA	Cen.	4		36	1.7g	8	3.6g	56	181.6g					3.1g	54	57.8g
11	Dscr. Hearth	IV	Cen.	5														
UA	Bone Heap	V	Cen.	6														
31	Dscr. Hearth	VI	East	10														
32	Shell Midden	VI	East	10		11	2.2g			37	121.1g					.2g		
33	Hearth Sctr.	VI	East	10														
36	Shell Midden	VII	East	11,12														
13	Dscr. Hearth	VII	East	11,12														
35	Dscr. Hearth	VIII	East	13,14														
36	Shell Midden	VIII	East	13,14														
19	Hearth Sctr.	IX	East	17	5	105	17.3g	11	2.4g							4.4g	179	1368g
40	Bone Heap	IX	East	17														
41	Shell Midden	IX	East	17														
42	Shell Midden	IX	East	17		3	.1g	2	.6g	28	85.7g					.2g	1	.4g
43	Shell Midden	IX	East	17														
44	Shell Midden	IX	East	17	5	110	12.7g	6	1.7g	9	40.1g	1	.1g	2	.01g	.4g	40	55.4g
17	Dscr. Hearth	X	West	6	3	16	.5g	3	.3g							.1g	7	5.5g
46	Bone Heap	X	West	6	11	22	2.1g	4	.1g							.5g	9	1.3g
21	Dscr. Hearth	XI	West	7														
20	Pit	XI	West	7		29	.5g	6	.2g								1	.2g
25	Hearth Sctr.	XI	West	7		23	23.1g	4	.2g							.1g	3	.1g
47	Hearth Sctr.	XI	West	7														
UA	Bone Heap	XII	East	19														
34	Bone Heap	XII	East	19														
38	Shell Midden	XII	East	19		112	34.5g	3	1.3g	40	113g					.1g	1	2.8g
39	Shell Midden	XII	East	19	1	10	.2g	1	.05g							.1g	11	.2g
7	Dscr. Hearth	XV	East	23														

[1] See plan maps for provenience, size and shape (Appendix E).

Table C-2. Content of samples from 45-OK-196 features.

Feature No.	Feature Type	Occupation	Unit	No. of lithic debitage	Constant Volume Sample Contents: Unburnt Bone ct.	Unburnt Bone wt.	Burnt Bone ct.	Burnt Bone wt.	Unburnt Mussel Shell ct.	Unburnt Mussel Shell wt.	Burnt Mussel Shell ct.	Burnt Mussel Shell wt.	Other Unburnt Shell ct.	Other Unburnt Shell wt.	Charcoal wt.	F.C.R. ct.	F.C.R. wt.
2	Pit	II	N104 E258	1	13	3.4g			40	121.3g					.3g	44	102.6g
1	Dscr. Hearth	III	Unit #3														
3	Dscr. Hearth	IV	N104 E258														
6	Dscr. Hearth	V	N104 E258												.1g	21	89.1g
6.1	Pit/Earth Oven	V	N104 E258														
7	Dscr. Hearth	V	N104/105 E258		2	1.8g			34	36.2g			8	.7g	.1g	92	236.5g
8	Shell Midden	V	N104 E263						67	114.8g			6	.3g		15	275.3g

APPENDIX D

COMPLETE LISTING OF FAUNAL REMAINS, 45OK196 and 45OK197

Compiled by

James C. Chatters
and
Dianne E. Semko

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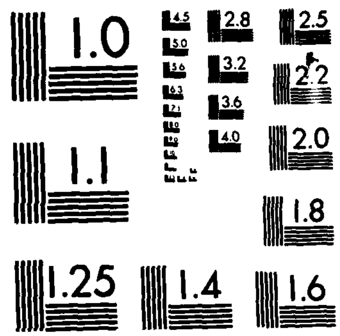
AD-A159 823 DIMENSIONS OF SITE STRUCTURE; THE ARCHAEOLOGICAL RECORD FROM TWO SITES IN. (U) CENTRAL WASHINGTON ARCHAELOGICAL SURVEY ELLENSBURG J C CHATTERS ET AL SEP 84 3/4

UNCLASSIFIED DACW67-82-C-0062 F/G 13/2 NL



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

APPENDIX E

OCCUPATION DATA NOT INCLUDED IN TEXT FIGURES OR TABLES

CONTENTS INCLUDE

1. OCCUPATION AREA MAPS, 45OK197

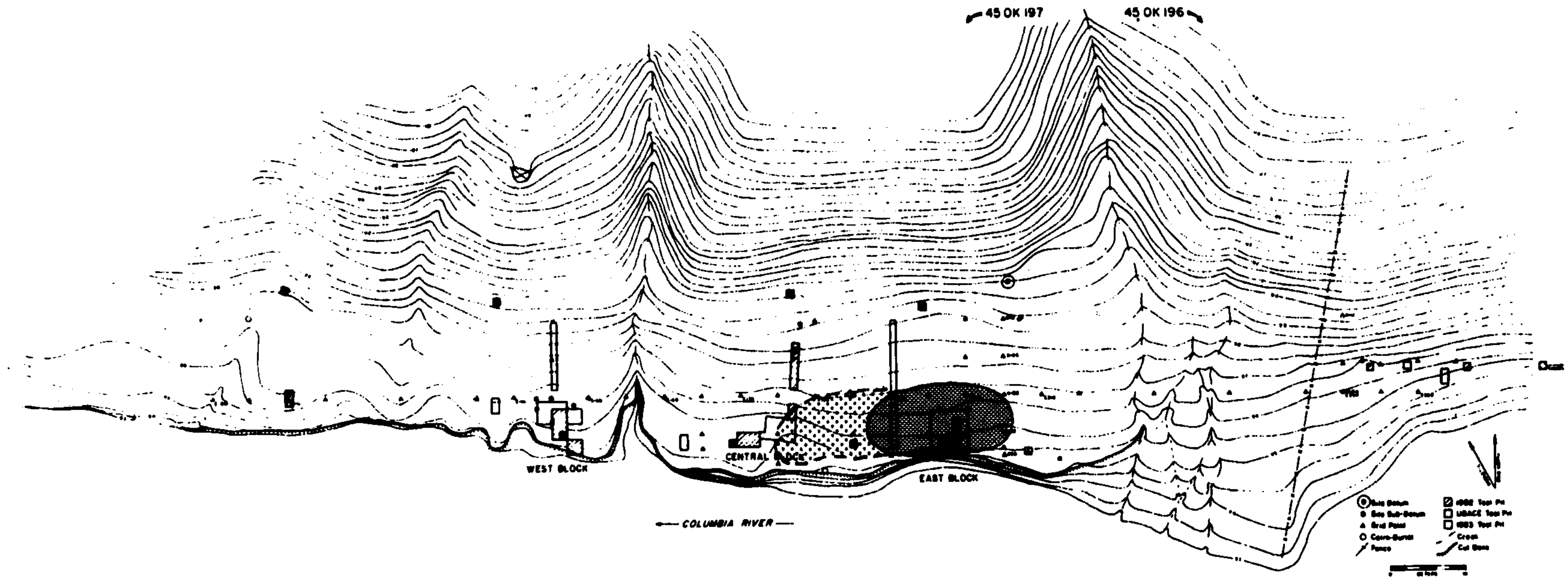
Prepared by
Carol Ellick

2. PLAN MAPS, 45OK197

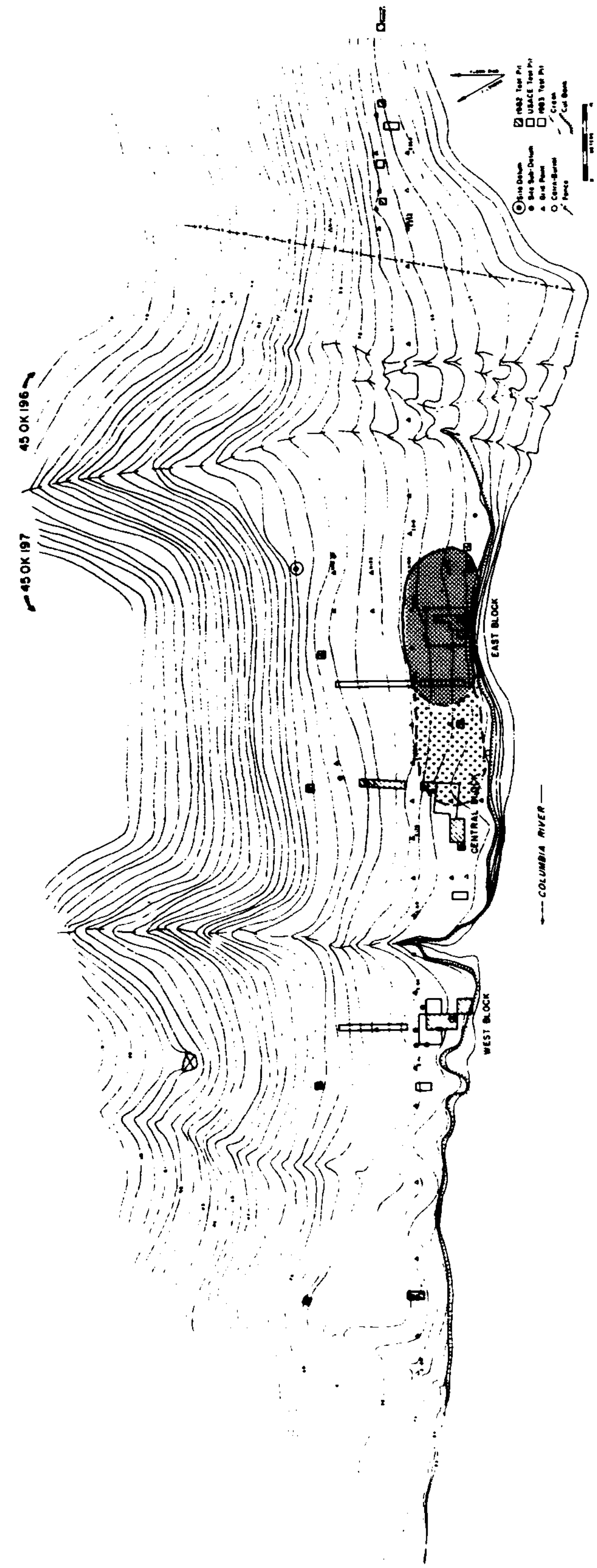
Prepared by
Carol Ellick

3. SUMMARY TABLES OF OCCUPATION CONTENTS, 45OK196 AND 45OK197

Compiled by
Dianne E. Semko



450K197, OCCUPATION VI



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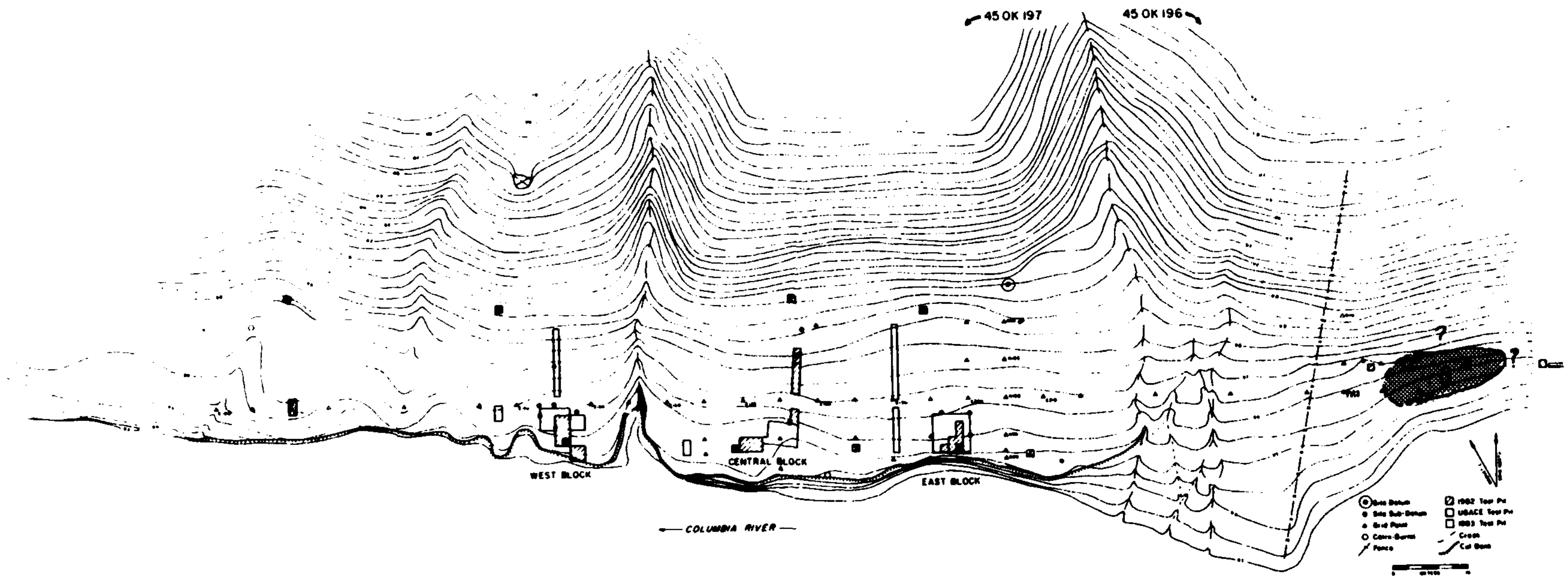

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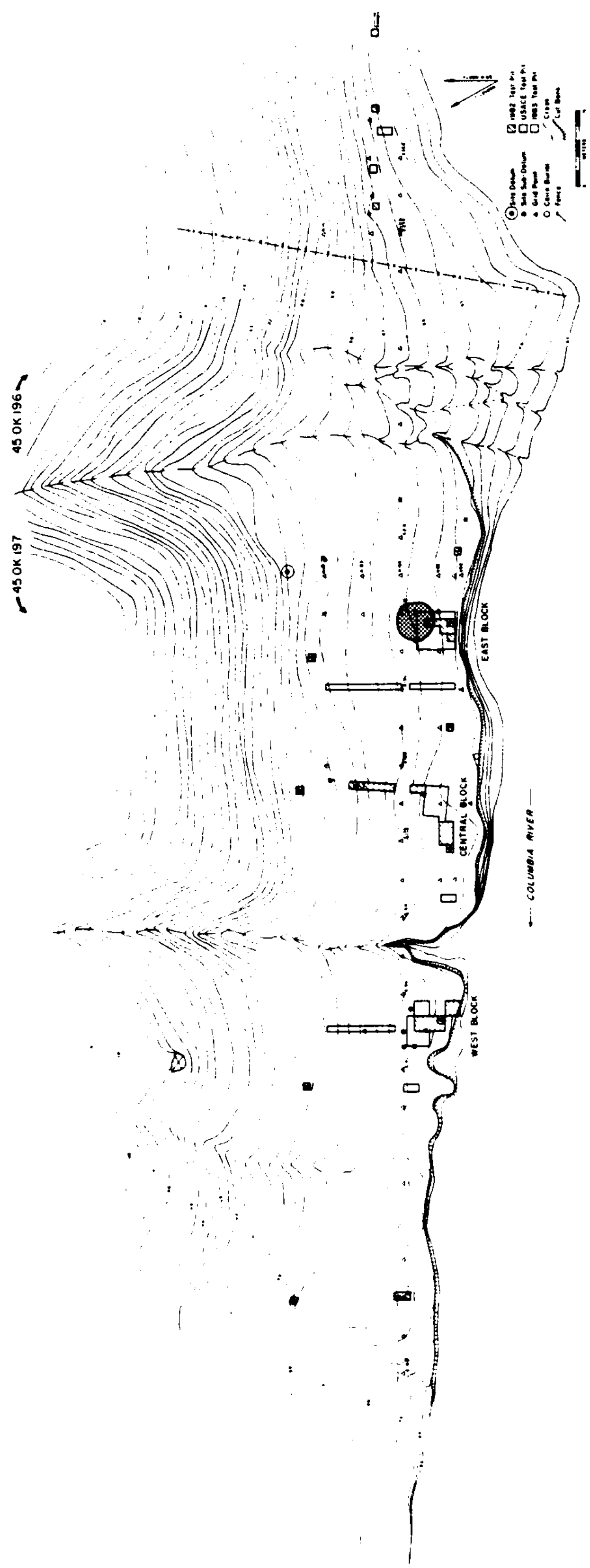

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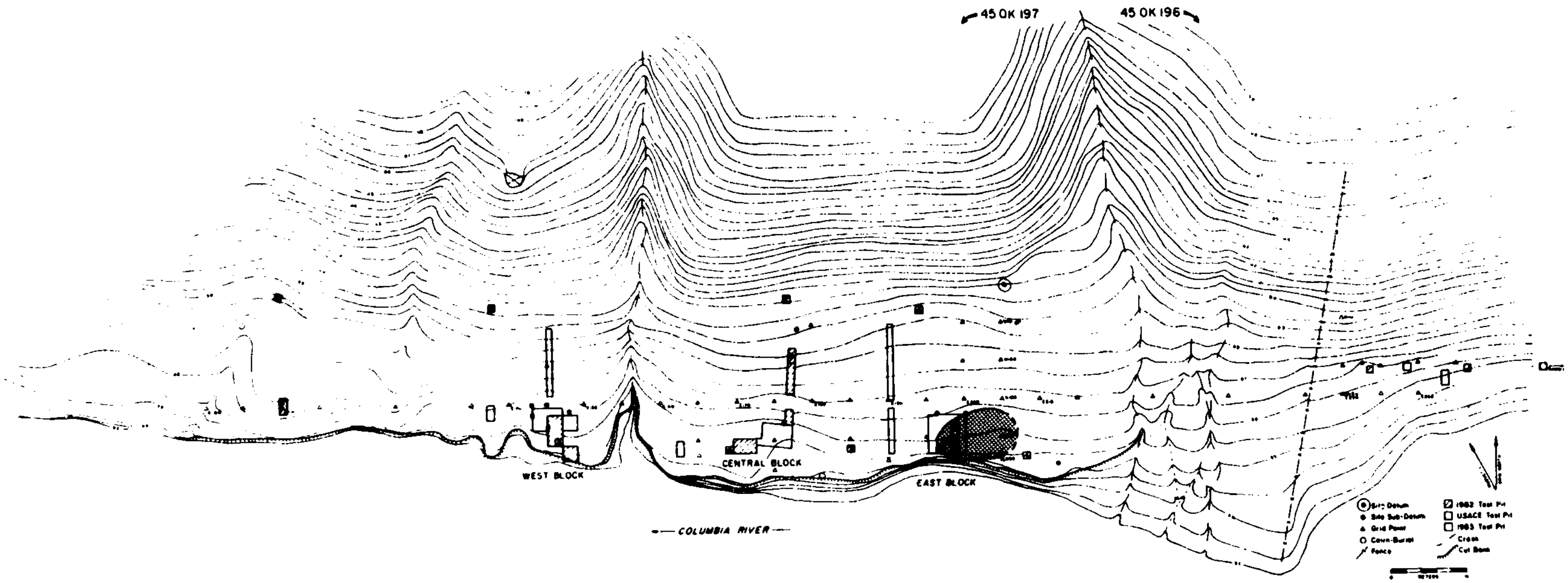

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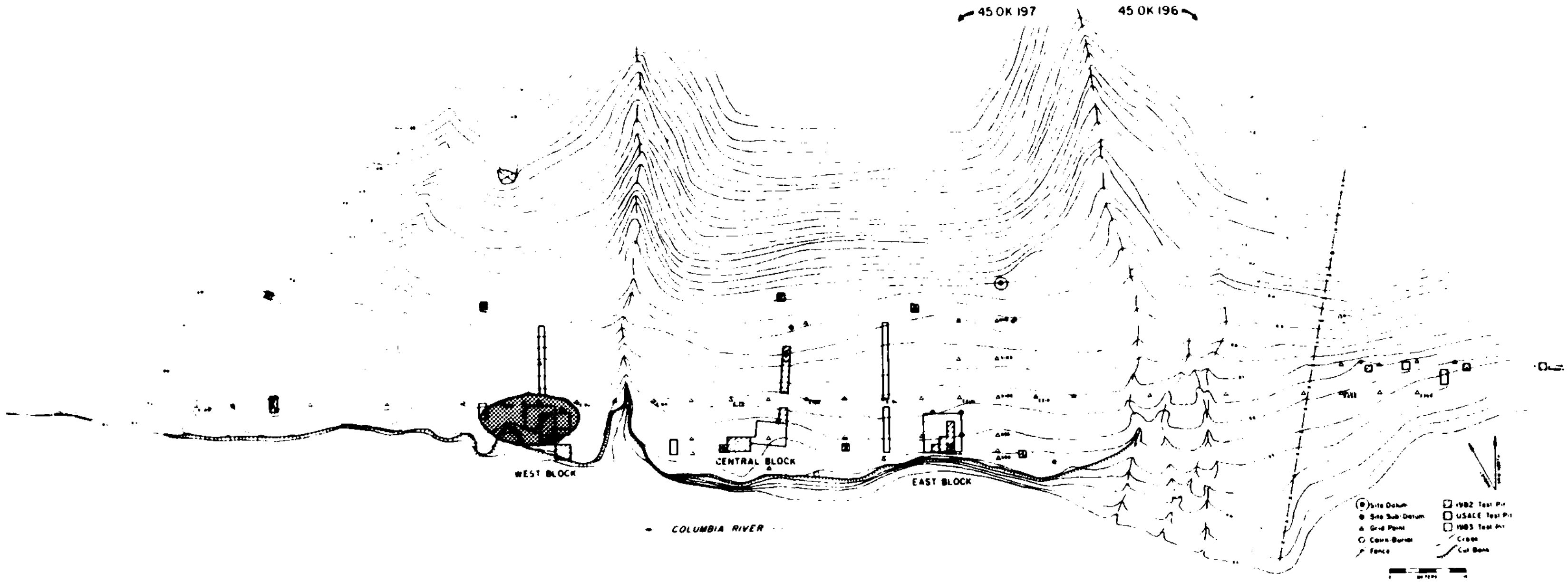

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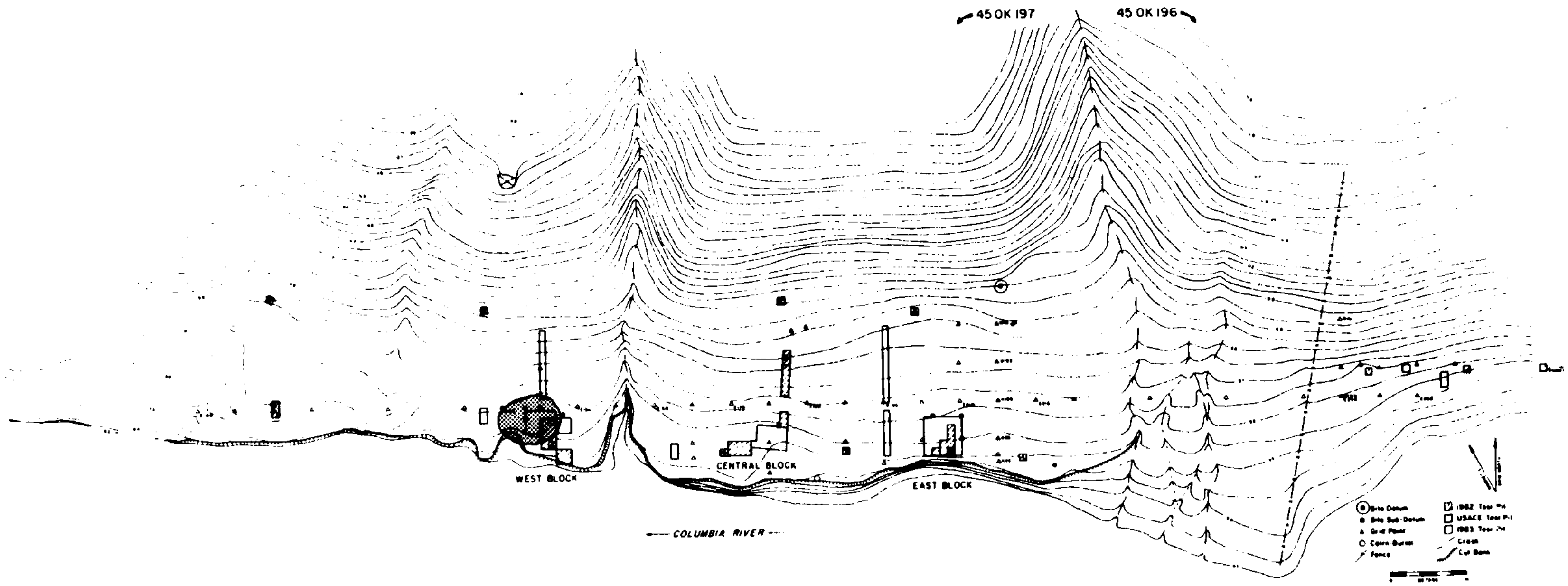

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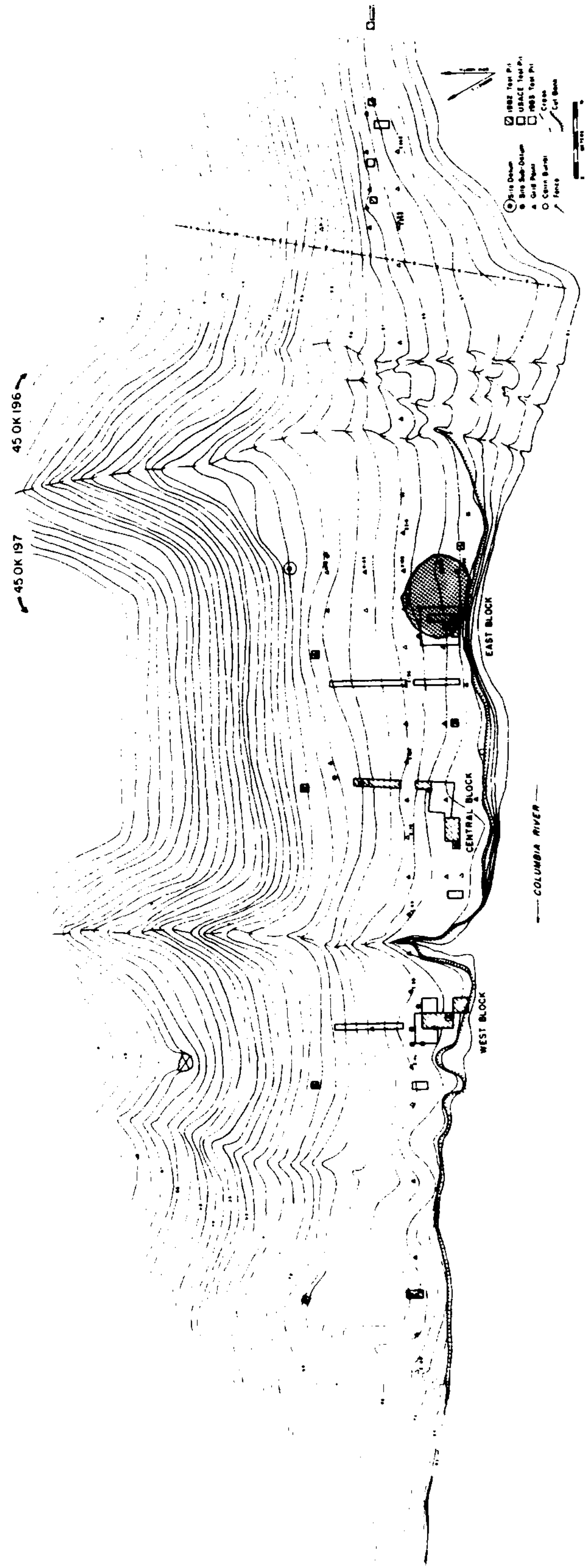

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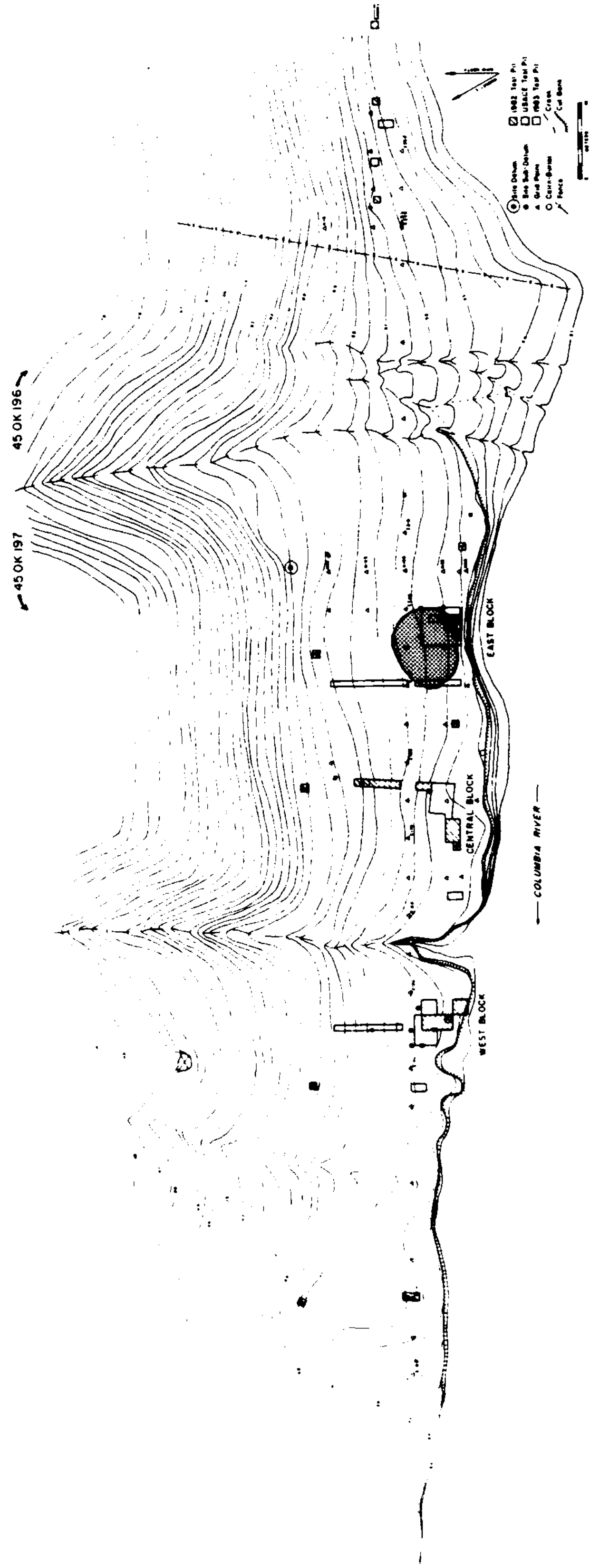

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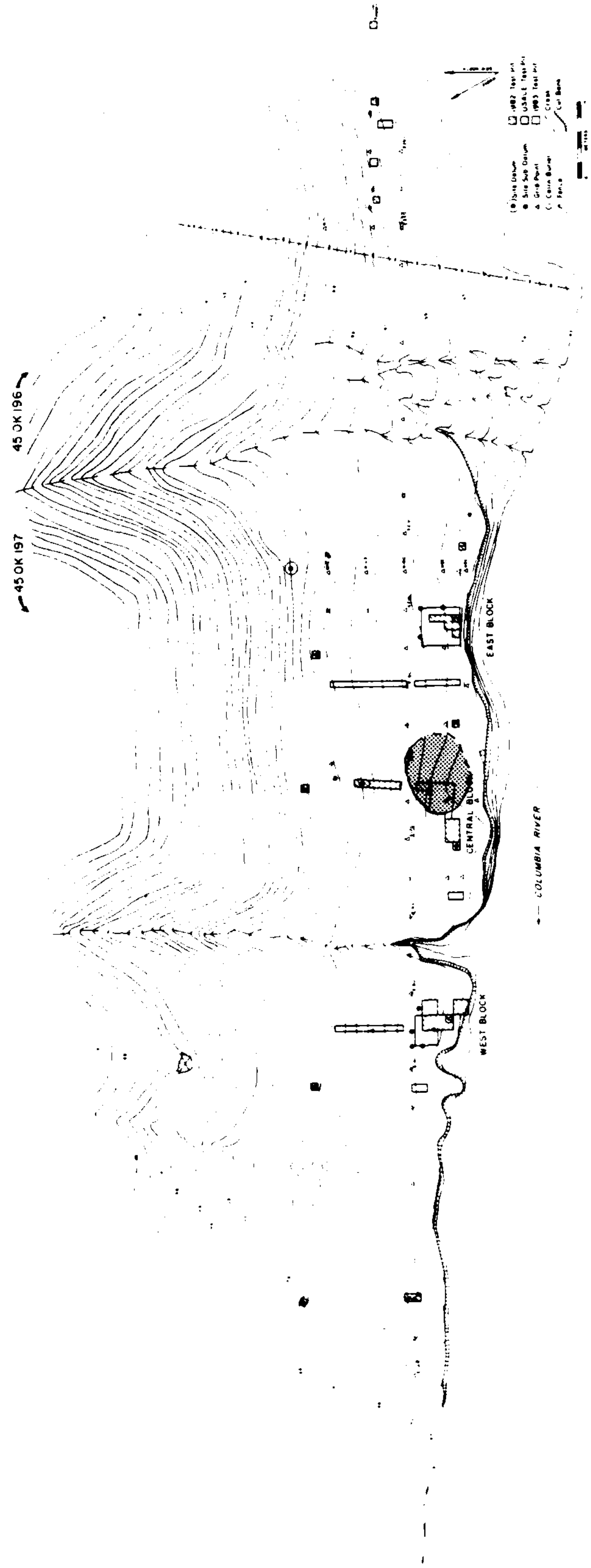

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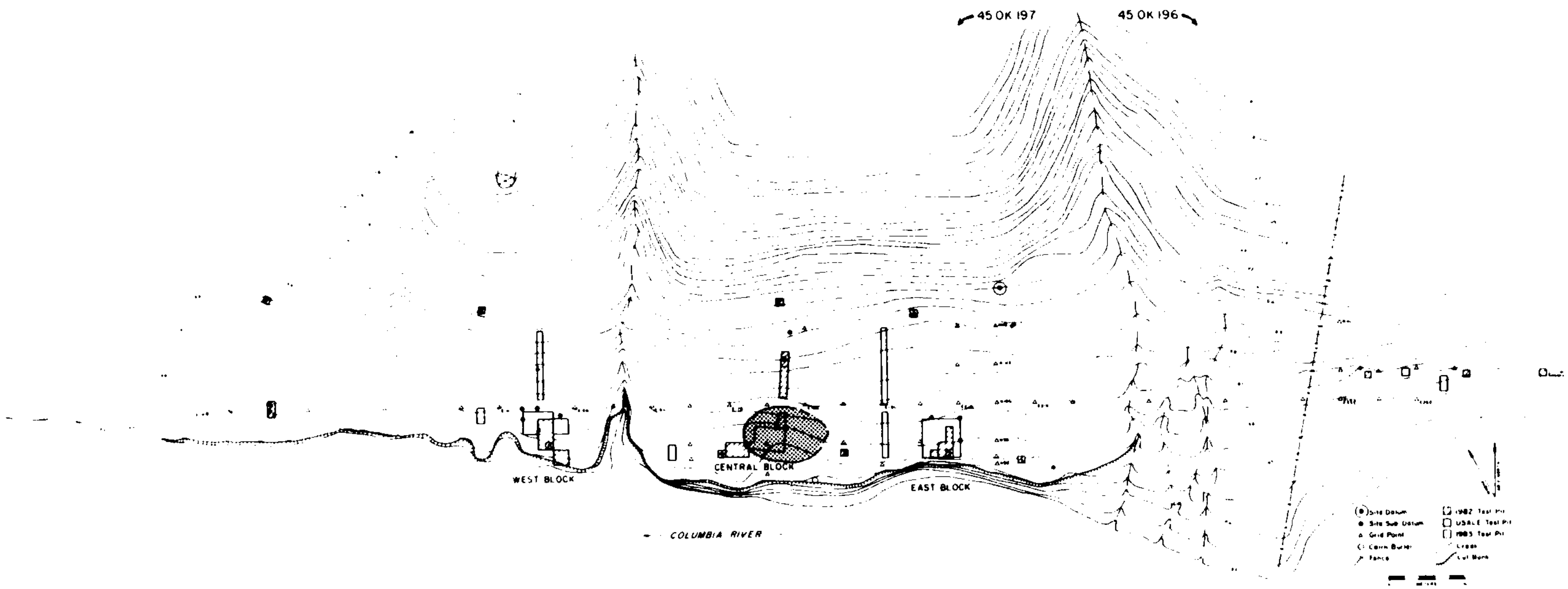

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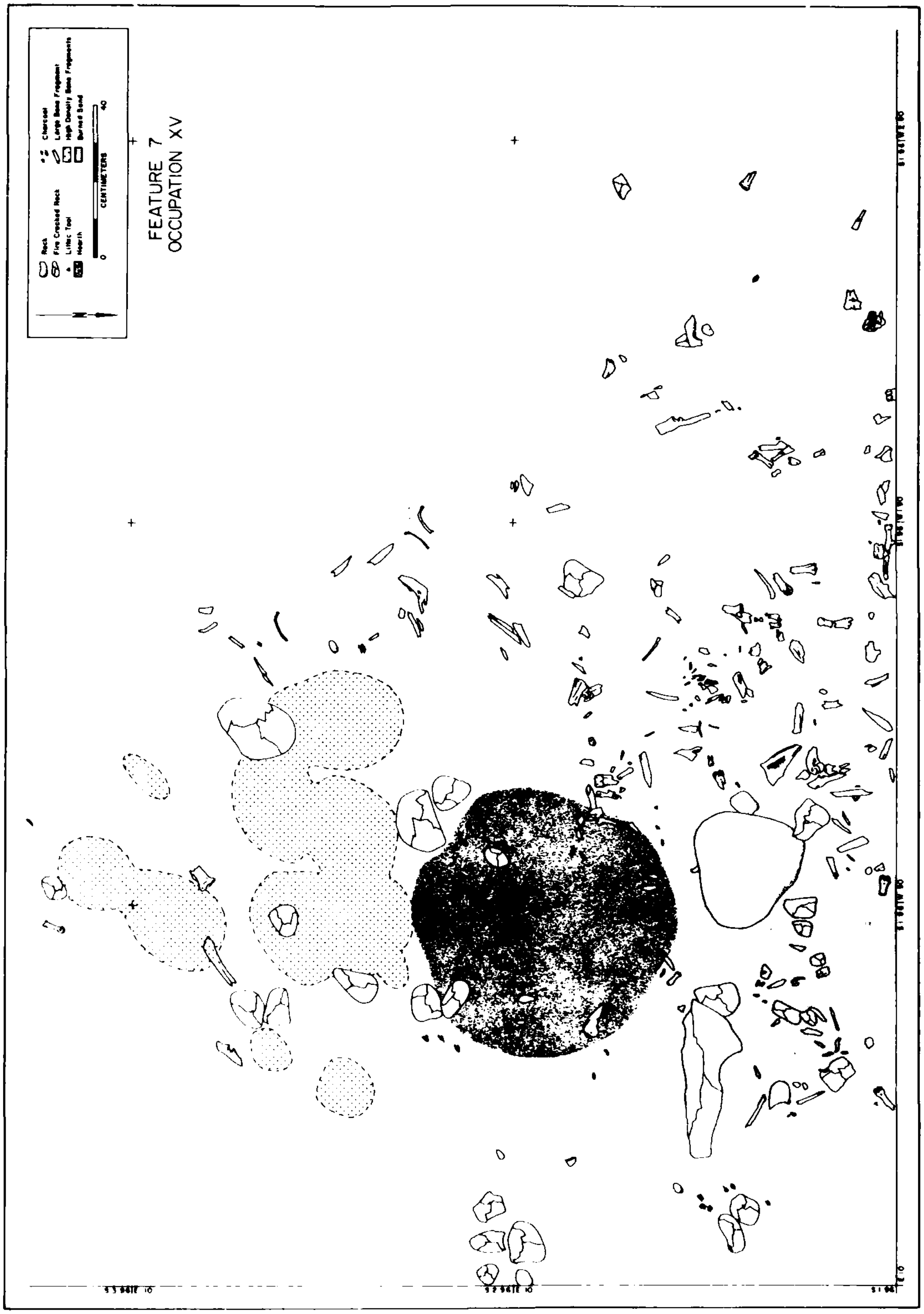
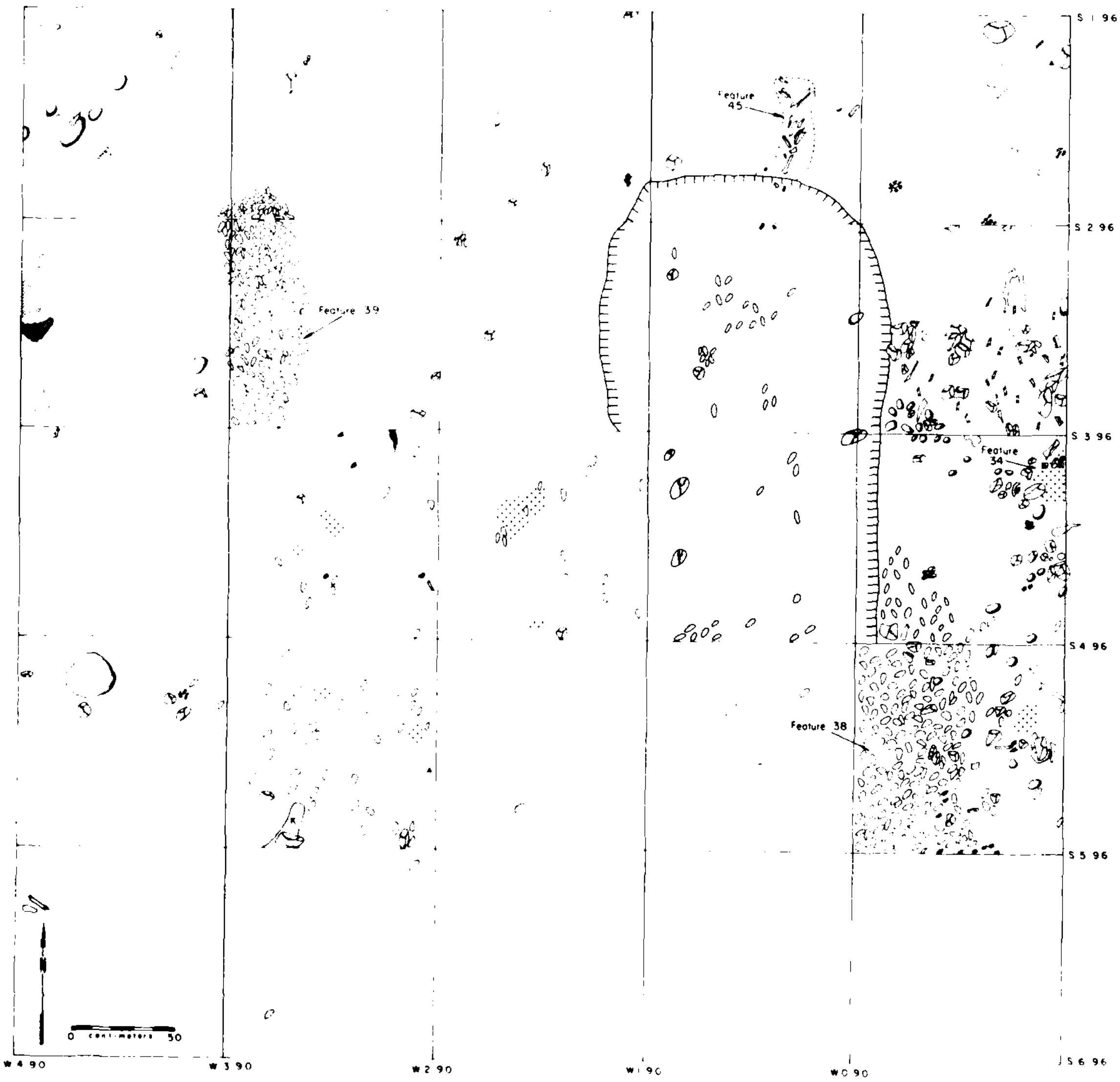
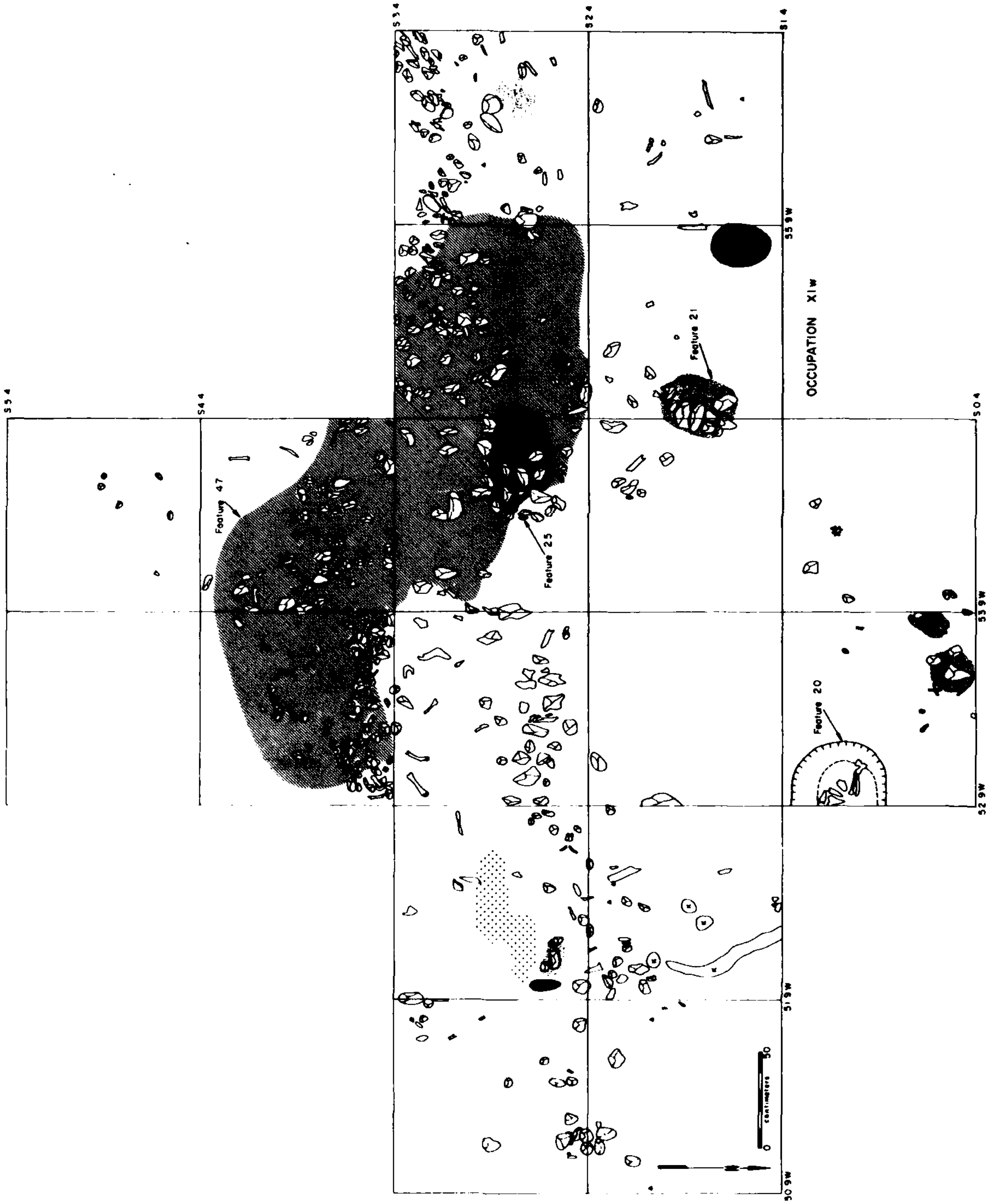
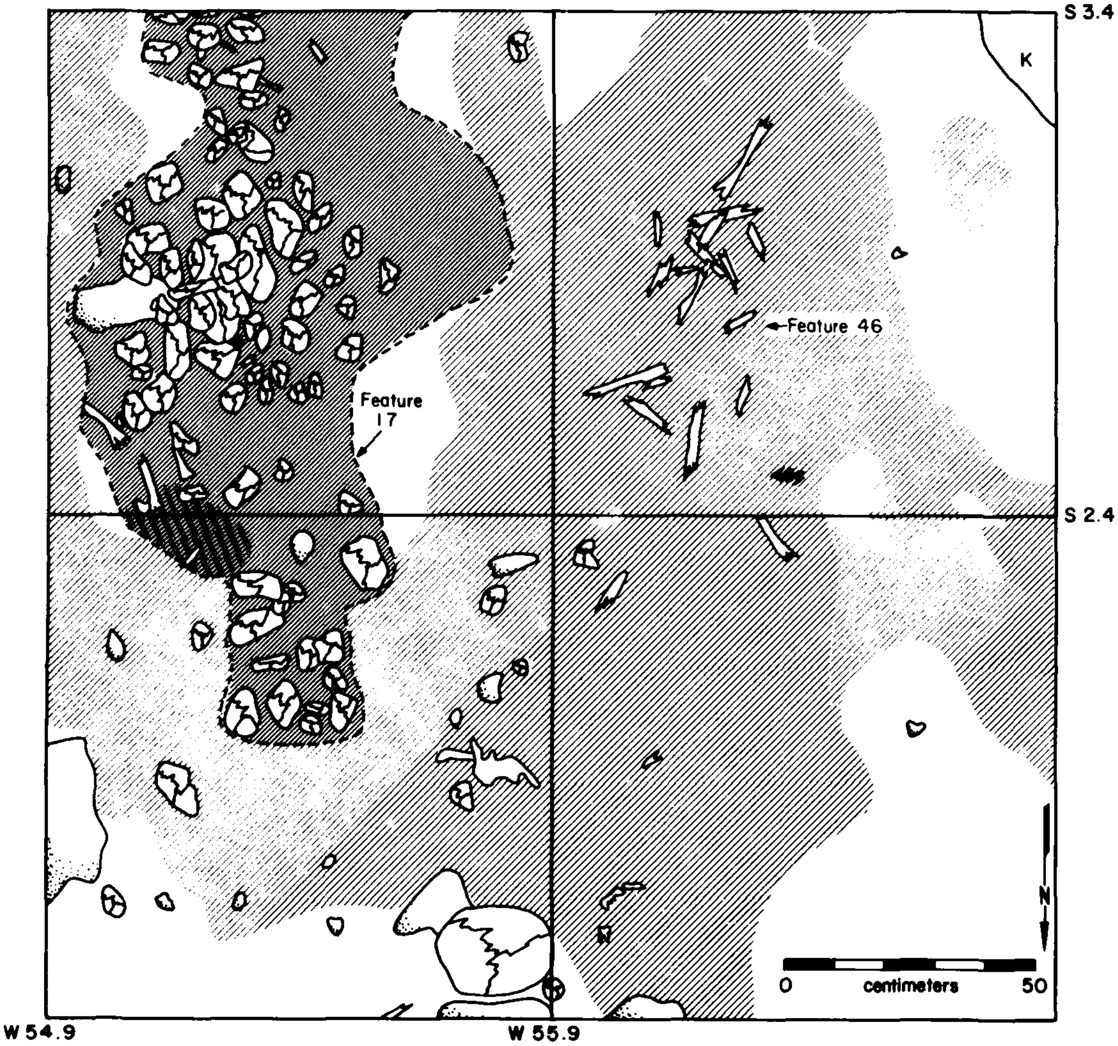

FEATURE 7
OCCUPATION XV
Rock
Fire Cracked Rock
Lithic Tool
Hearth
Charcoal
Large Bone Fragment
High Density Bone Fragments
Burned Sand
0
CENTIMETERS
40



OCCUPATION XII


OCCUPATION XIw
Feature 21
Feature 47
Feature 25
Feature 20
centimeters



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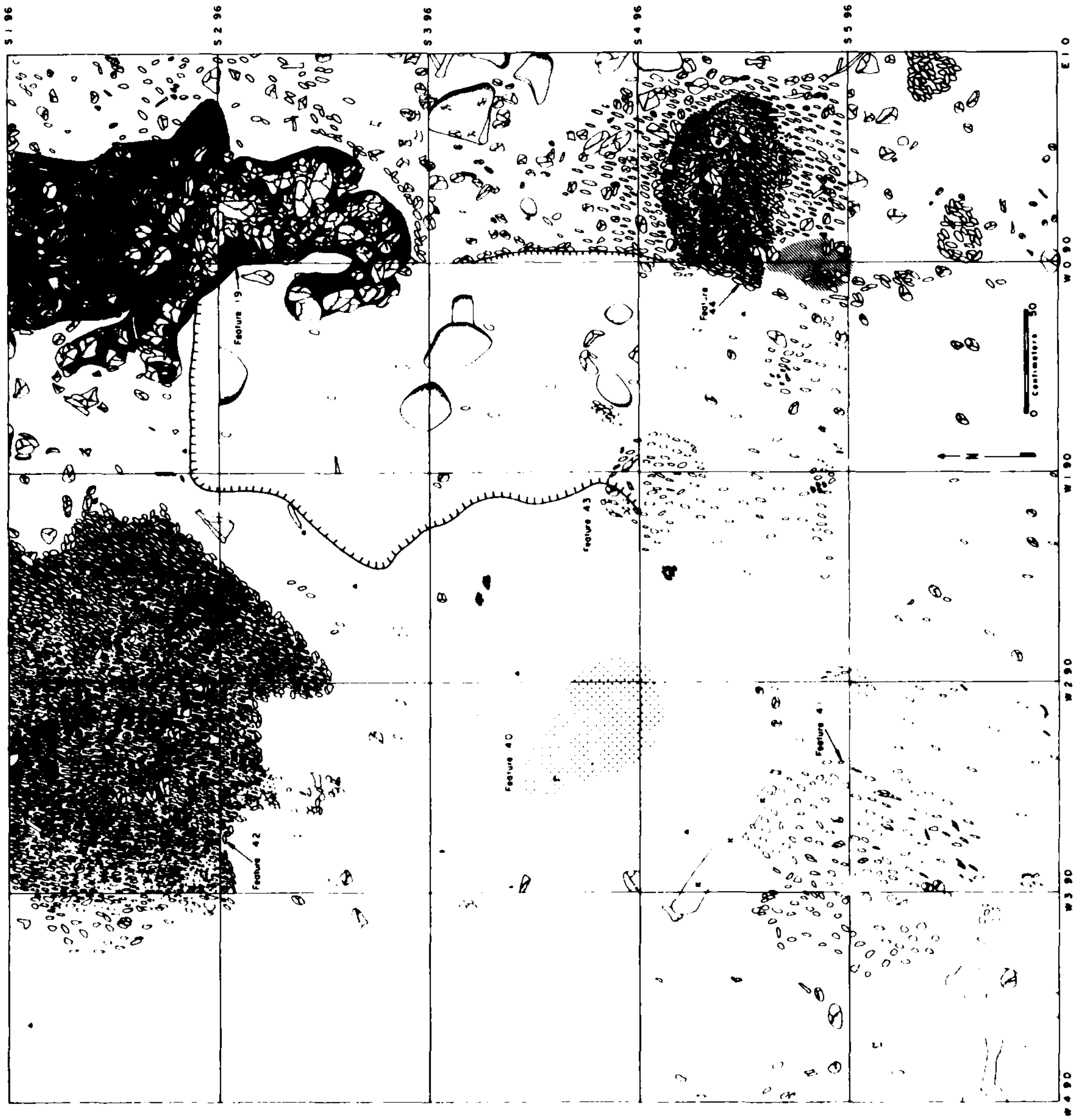

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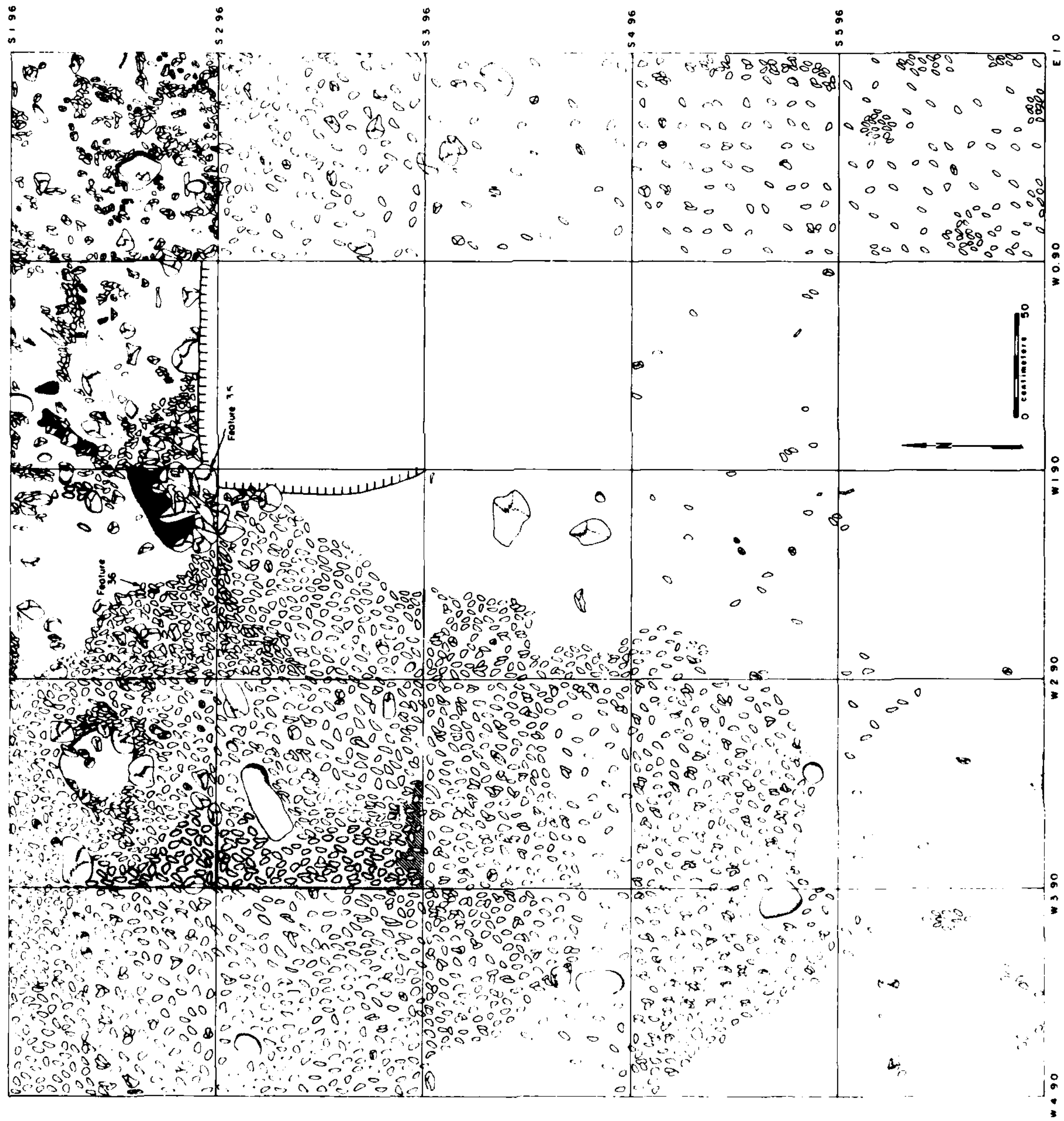
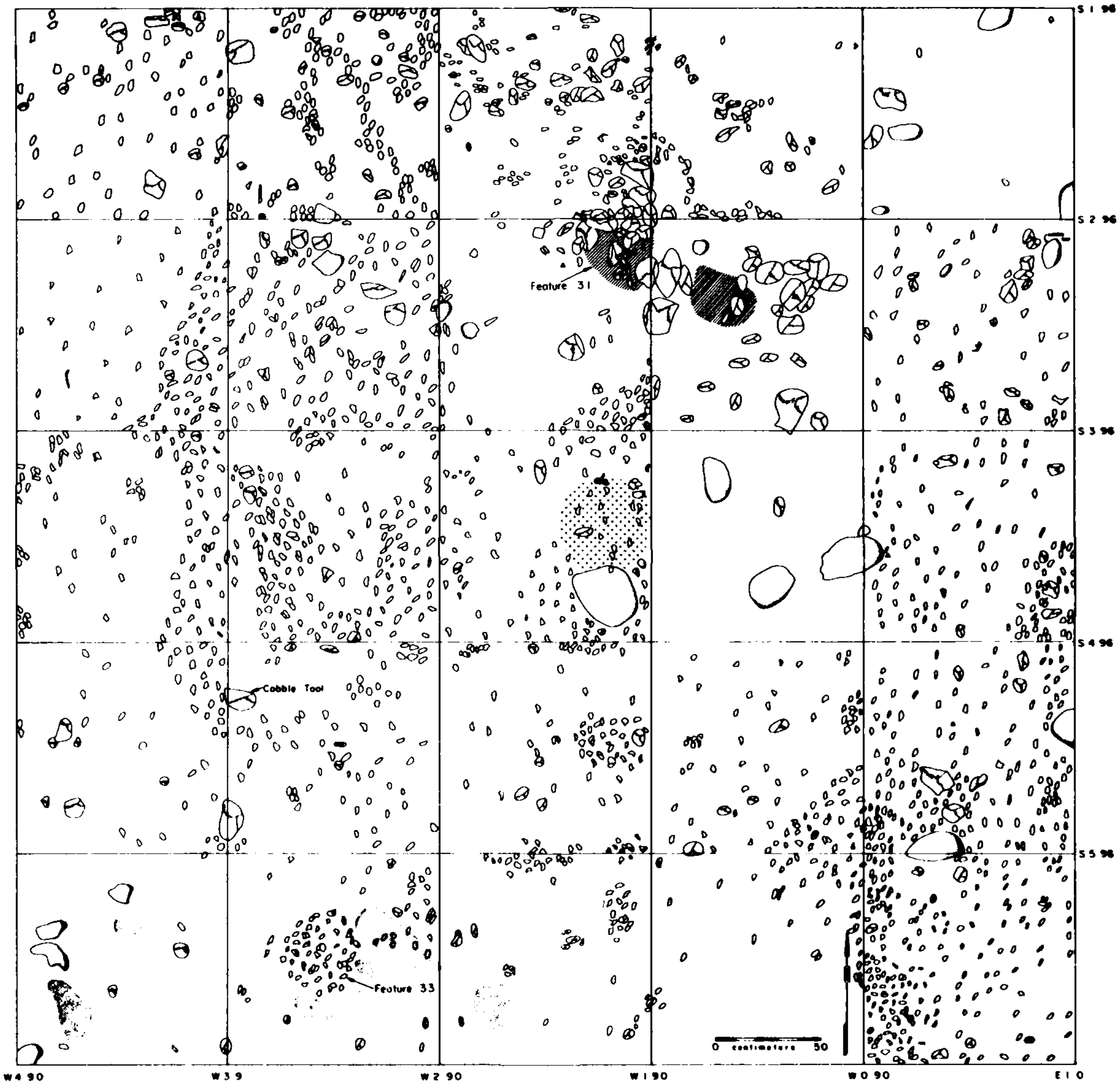
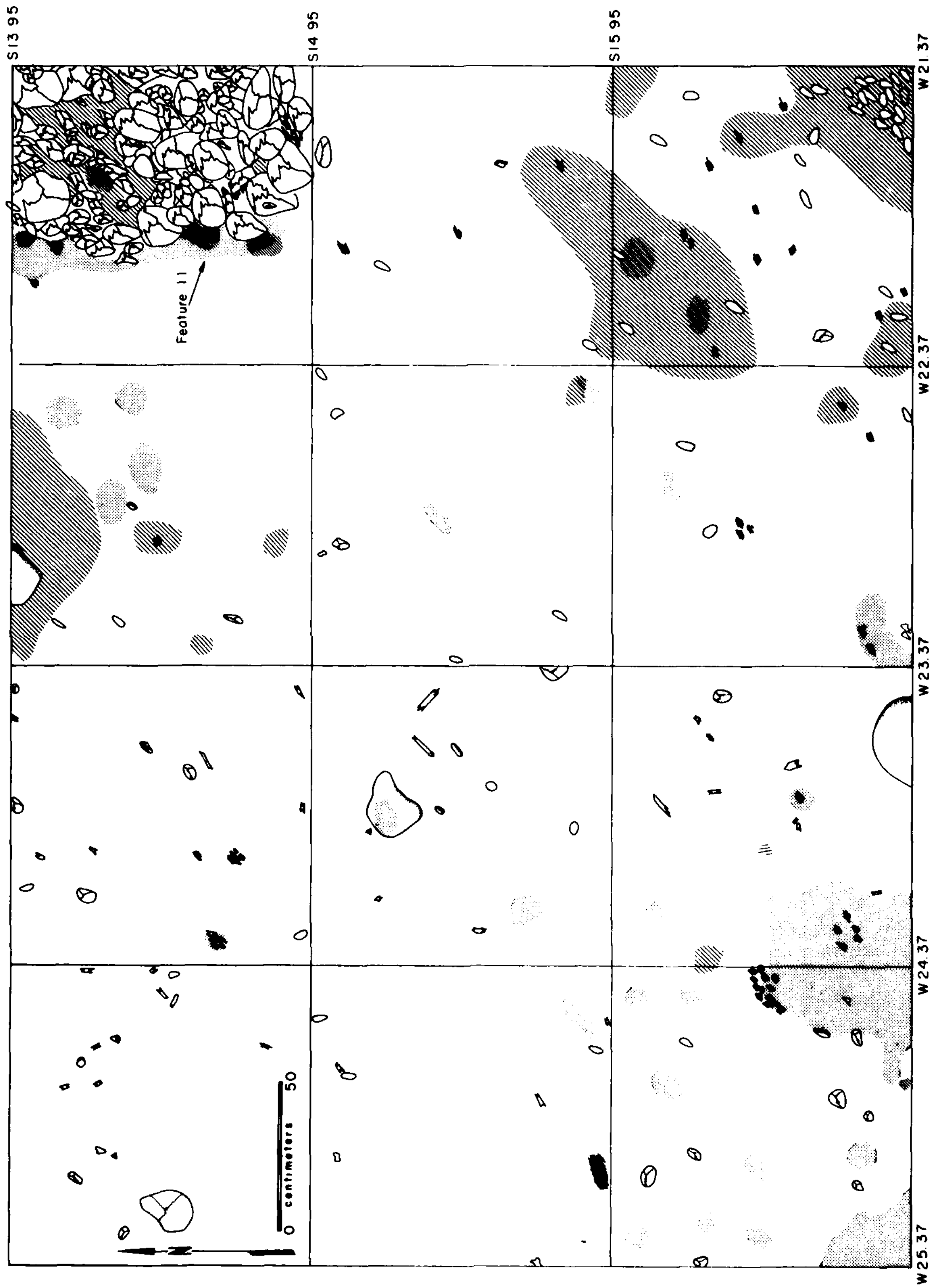


OCCUPATION VII & VIII



OCCUPATION VIe



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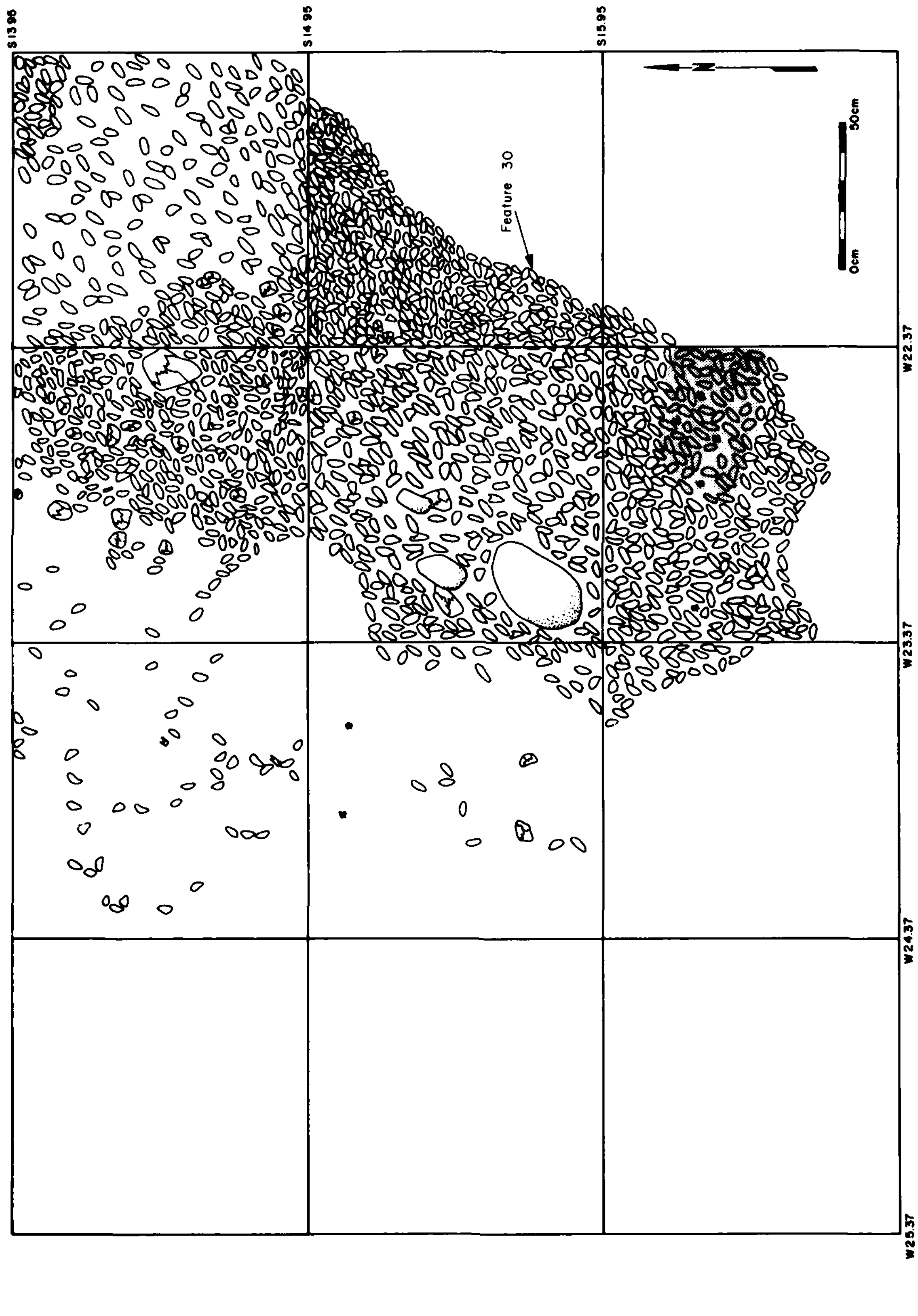
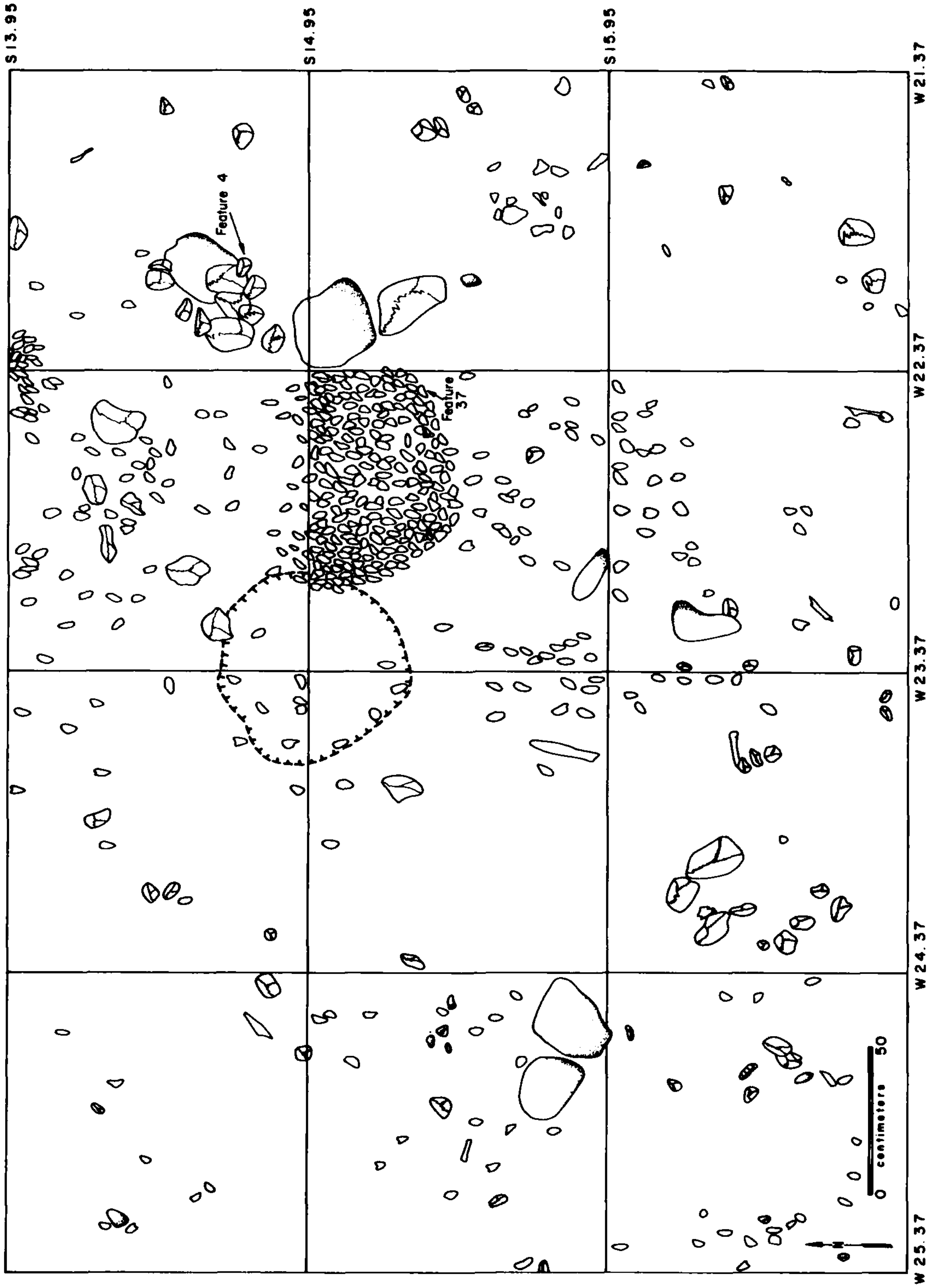
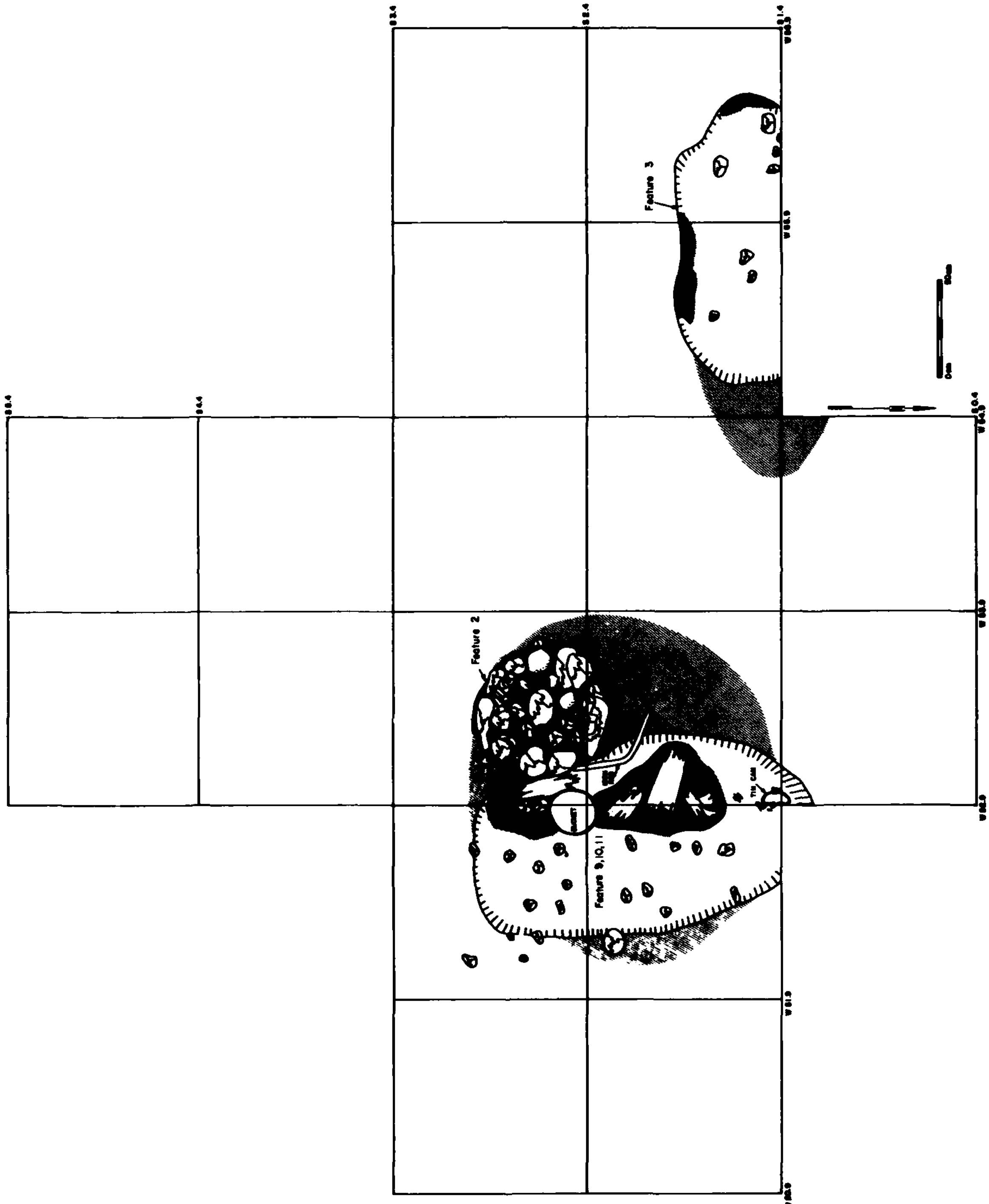


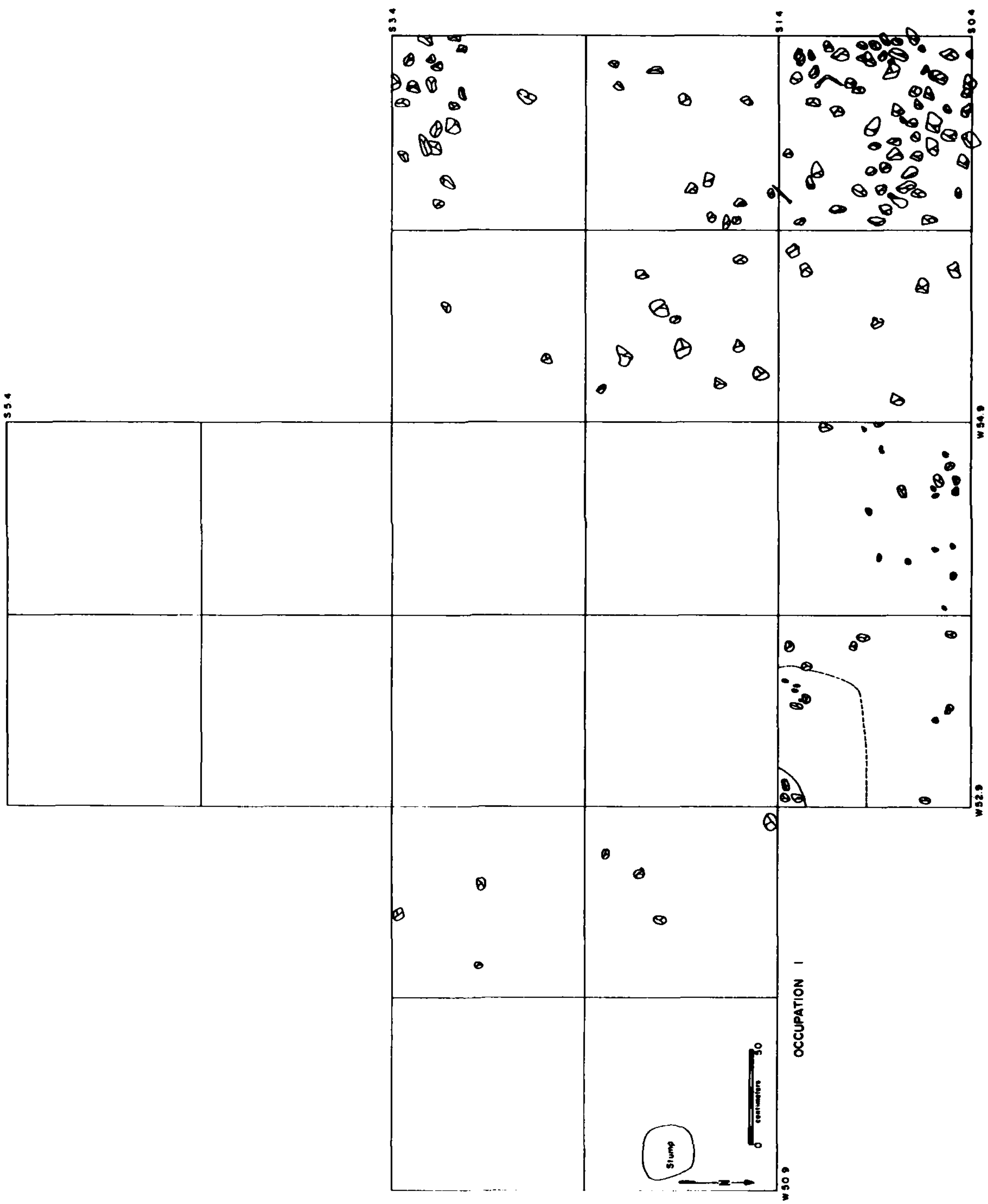
OCCUPATION IVa



OCCUPATION III



OCCUPATION I

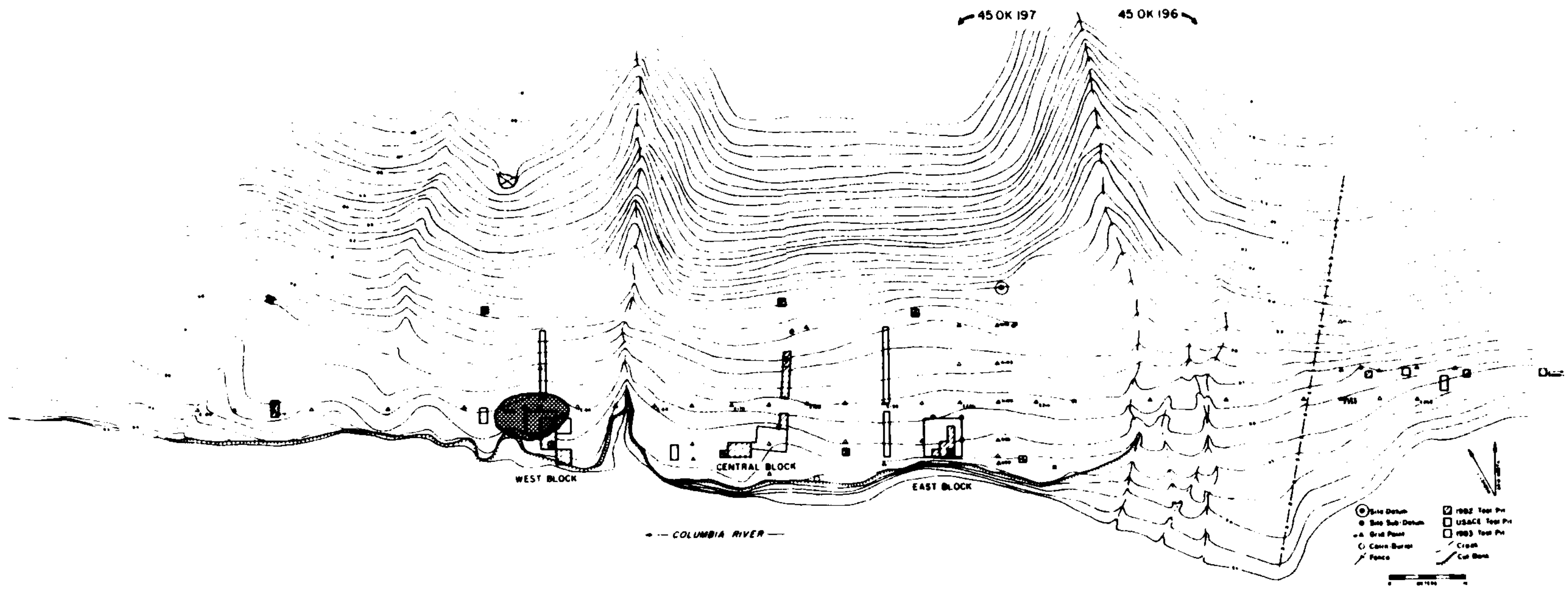

OCCUPATION I
Stump

45 OK 197

Plan Maps of Occupation Surfaces

Legend

- Lithic Debris/Tool
- Rock
- Fire Cracked Rock
- Charcoal
- Shell
- Bone
- Tooth
- Burned Wood
- Bone Fragment Scatter
- Burned Matrix
- Light Charcoal Stain
- Dark Charcoal Stain
- Pit Boundry
- Feature Boundry
- Krotovina



450K197, OCCUPATION I

Table E-1. Summary of Occupation Contents, 45-OK-196.

Occ.	Strat.	(BP) C14 Date	# Lithic Debris	# Lithic Tools	Bone #	Bone wt (g)	# Bone Tools	# Shell	FCR #	FCR wt(kg)	Total	# Feat.	(m^2) Area[1]
I	2		11	2	140	43.4	0	471	158	6.97	782	1	5
II	2		13	3	90	42.0	0	1157	133	6.77	1396	0	5
III	3	940±70	40	15	224	29.6	0	135	339	26.7	753	1	5
IV	4		80	24	99	47.9	0	701	580	85.3	1484	1	5
V	5-7	4590±80	483	39	661	293.6	0	2607	550	204.0	4340	5	5
Unass.			10	6	227		0	1011	92	6.87	1346	0	

[1] Excavated area, not area of occupation.

Table E-2. Summary of Occupation Contents, 45-OK-197.

Occ.	Strat.	(BP) C14 Date	# Lithic Debris	# Lithic Tools	Bone #	Bone wt (g)	# Bone Tools	# Shell	FCR #	FCR wt (kg)	Total	# Feat.	(m^2) Area[1]
I	W1	None	9	8	469	543.3	0	37	709	30.70	1232	5	18
II	C2	170±110*	149	51	184	195.0	1	533	52	3.10	970	1	18
III	C3		6	2	415	598.0	1	1109	171	21.45	1704	2	18
IVA	C4	560±60	142	16	747	557.0	0	2393	240	3.37	3538	1	18
IV	C5		1	2	572	174.0	0	63	49	4.64	687	1	12
V	C6		71	19	1311	433.0	0	0	12	1.75	1413	1	12
VI	C7,E10	950±80 800±70	3	2	1733	1002.5	10	11,668	583	64.97	13,999	3	37
VII	E11,12	500±90	230	25	1626	872.4	1	7582	400	79.70	9846	2	25
VIII	E13,14		37	18	691	410.0	2	4700	222	27.30	5670	2	25
IX	E17	980±140	38	21	2971	1921.3	6	3833	938	127.00	7807	6	25
X	W6	1120±90	284	52	1654	906.0	0	1	185	26.40	2176	2	7
XIW	W7	1170±120	71	11	5553	3393.0	1	2	416	32.50	6054	4	16
XIE	E18	1220±120	9	2	20	185.2	1	0	0	0	32	+[2]	25
XIIE	E19		129	43	2021	1330.0	0	833	131	19.10	3157	4	25
XIIW	W8	1110±70	26	5	1330	1194.0	0	18	12	1.07	1391	+	18
XIIIW	W9	1320±110	6	3	261	538.4	0	0	21	2.74	291	+	18
XIIIE	E20	1440±120	27	6	327	149.0	1	1	5	.83	367	1+	7
XIV	E21	1410±90	6	3	44	299.0	0	0	15	3.80	68	0	2
XV	E23	1680±100	35	22	6841	3630.0	1	0	67	6.89	6965	1+	16
XVI	E25	1660±90	0	0	0	0	0	0	0	0	0	0	1
XVII	E26	1870±120	0	0	84	64.0	0	0	0	0	84	0	1
Unass.			386	25	11,839	65,371	4	4881	1564	325.90	18,699	0	

[1] Excavated area, not area of occupation.

[2] The plus sign refers to the presence of bone heaps that for various reasons could not be tallied precisely.

APPENDIX F

BURIAL ANALYSIS

BURIAL 1, 45OK197

by

James C. Chatters

OSTEOLOGICAL REPORT

by

Daris R. Swindler, Hartmut B. Krentz

and

John Blaisdel

45-OK-197
BURIAL 1

During initial testing of 45-OK-197, part of the excavation strategy was to clean off cutbanks for profiles of site strata. In the course of one such cutbank operation, an excavator encountered a human tibia near the base of his excavation and brought it to my attention. At the time, Chief Joseph Dam Reservoir was drawn down five feet below normal pool and was due to rise the next afternoon. The tibia was found just below ground water level and only 30cm (1 ft.) above the level of the drawdown pool. Clearly, an emergency existed. Our bank clearing operation had exposed a grave that would be quickly washed out.

By good fortune, David Munsell, archaeologist for the Seattle District, USACE, and several members of the Colville Confederated Tribes' Council were due for an on-site inspection the day of the find. After they were apprised of the situation, Munsell asked how the Tribe wanted us to deal with this burial. Removal, analysis and reinterment with appropriate ceremony were their requests.

The next morning, after a brief ceremony by Tribal elder Dutch Monaghan of Keller, the burial was excavated by Sharlene Sam (a Colville), Eric Gleason, and myself. Subsequently, cleaned bones were submitted to Dr. Daris Swindler of the University of Washington for description and forensic analysis. The following is a brief report describing the grave, its contents, and the characteristics, cause of death and possible geographic origin of the occupant.

Exhumation Technique

Excavation of this grave was necessarily hasty because the reservoir level was to rise and cover the locality by 4:30 p.m. To compound the situation, the matrix around the bones was waterlogged and the bones themselves were wet and soft. Normal methods of trowel, dental pick and brush were too slow and damaging to be appropriate in this context. We first skimmed with shovels to the level of the bones, then used fine water spray and careful loosening of soil with flat sticks to expose the skeleton and associated artifacts.

Observations were recorded in photographs and cryptic notes; there was no time for measured drawings. Once removed, bones were supported by dishes of aluminum foil, taken to the lab and cleaned when they were thoroughly dry.

Horizontal and Stratigraphic Position

The grave was located at grid coordinates 86.3 to 86.9N, 180.4 to 181.7E on the eroding reservoir bank. Dipping of strata in all areas indicates that the present cutbank was also the edge of terrace level T1, the historic riverbank at normal flood stage.

Bones were found between 95cm and 108cm below the modern land surface, but no grave pit could be seen. Cutbank facing had removed all pit fill, had any existed, and color or texture differences between sediments around the bones and in presumably intact fluvial beds were entirely obscured. However, in the cutbank directly north of the skeleton we did find evidence that the individual had been buried and ascertained from which stratum the grave had been excavated (Figure F-1).

Bones occurred at the depth of strata C7 and C8 but had been interred from a much later surface. In Figure F-1, two facts are worthy of note. First, strata C3 and C4 have been truncated and the resultant low areas filled with sediment of stratum C2. Second, a small boulder occurs in stratum C2 directly above, if slightly north of, the grave's head end. Two other boulders had fallen from the bank in this same vicinity and lay on the beach surface, just below.

If truncation of sediments is taken as evidence of inhumation and the boulders as a grave marker, then it is likely that Burial 1 was excavated from stratum C2 and marked with at least three boulders. Thus, the grave pit was between 50cm and 80cm (20-32 in.) deep.

Burial Description

The skeleton lay in a semi-flexed position with the head oriented to the east (upriver, Figure F-2). The torso and head were face down, the skull crushed by weight of sediments. The right arm was extended under the rib cage and pelvis and the left arm was flexed, its forearm perpendicular to the spine.

Both femora (thigh bones) were oriented perpendicular to the torso, to the body's left. The right lower leg and foot were partially flexed and nearly parallel with the spinal column; the left lower leg was tightly flexed to the femur.

Bones were in poor condition, having been long exposed to dissolution from ground water originating in springs upslope. Rodent burrowing had scattered many rib fragments and small bones of hands and feet.

Artifacts

The only artifacts found in association with Burial 1 were projectile points, eleven of them. All were side-notched forms common to the late prehistoric and protohistoric periods of the Northwest and neighboring regions. Figure F-2 shows their distribution; Table B-1 describes the projectile points, their condition and location.

Numbers 1 through 5 were located in or around upper parts of the body. Number 1 was embedded in the posterior portion of the proximal left humerus shaft, which it had entered from behind and slightly to the right (Figure F-3). Numbers 2 and 3 were inside the rib cage near the posterior portion of the left seventh and ninth ribs, just below the scapula (shoulder blade). Number 4 lay against the tenth thoracic vertebra, to the right of the spinous process. Number 5 was in the vicinity of the right twelfth rib and right elbow. The sixth projectile point was between left and right femora near the proximal one-third of both bones. Numbers 1, 2, 3 and 6 have impact fractured tips; Number 5 has been shattered.

The remaining five projectile points (Numbers 7 through 11) were tightly clustered in a 7cm x 30cm area around the right buttocks and the sole of the right foot. All have needle sharp tips; none are broken.

Dating

Stratigraphic position and artifact associations clearly place this burial in the late prehistoric period. Stratum C2 dates within the last 200-500 years and small, triangular, side-notched projectile points postdate 800 BP at this site (see Chapter 4). The lack of iron or other trade goods indicates burial prior to AD 1811. Therefore, by association alone, Burial 1 dates between 140 and 500 BP (AD 1811 to 1450).

A radiocarbon date on rib and vertebra fragments taken from the skeleton is 170±110 BP (Beta 6532) or about AD 1780. A date of death in the mid- to late eighteenth century is probable.

Characteristics of the Skeleton

The Burial 1 skeleton was studied and described by Dr. Daris Swindler of the University of Washington and his students, Hartmut Krentz and John Blaisdel (see Appendix F-2). The following is a summary of their findings and my interpretation thereof.

This individual was a Native American male in his early teens (13±1 years). He stood 159.86cm±3.80cm or 5 ft. 3 in. tall, and had a wide face, round head and an upper incisor that projected slightly forward, giving him a snaggle-toothed appearance.

Musculature

He was well-muscled for a 13-year old, but development was decidedly uneven, indicating a narrow scope of activity. Beginning with the head, he had pronounced masseter and pterygoid muscles, and a strong neck. In the torso, there is bilateral development of both pectoralis major and teres major, but otherwise the musculature is unbalanced. The right deltoid, bicep and trapezius are more heavily developed than the left, and in general there is more development in the right arm. Specifically, the brachialis, pronator quadratus, extensor carpi radialis, anterior extensors, supinator brevis and flexor and extensor policis had the greatest amounts of use. In the left, the pronator teres and palmar interossei were strongest. Conspicuously underdeveloped were muscles for extending the arm (specifically the triceps), and for drawing shoulders back and downward (the latissimus dorsi).

In the hips and legs, he made most use of gluteus maximus, adductor magnus, obturator, poplitus, soleus magnus and flexor digitorum.

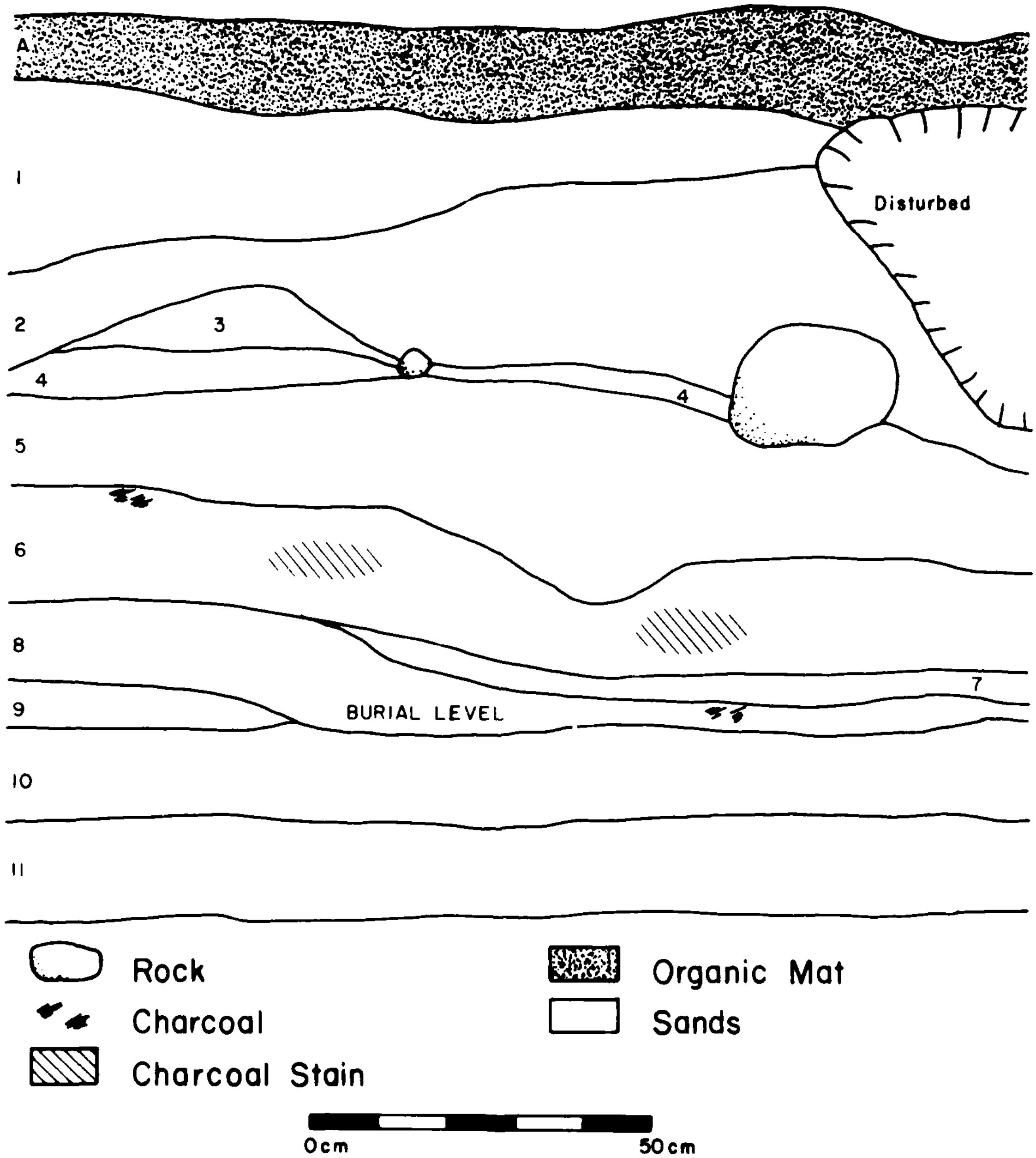


Figure F-1. Profile of sediments adjacent to Burial 1, 45-OK-197. Note the unconformity above stratum 3 and 4 and the small boulder in stratum 2.

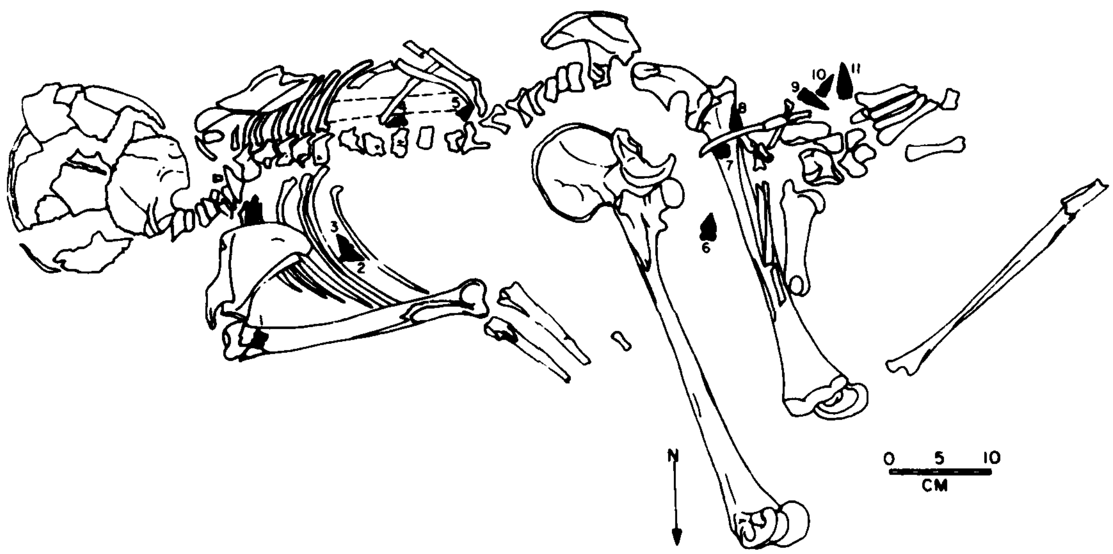


Figure F-2. Plan of Burial 1, showing the distribution of projectile points about the body.

Figure F-3. The left shoulder of the Burial 1 skeleton. Projectile point 1 is embeded in the head of the proximal humerus (lower center).

The behavioral meaning of this pattern of development is as follows: He most often used the muscles that pulled upper arms together and downward in front, flexed and raised the right shoulder, flexed the right forearm, lifted the right hand upward or back at the wrist, and flexed and extended the right thumb. In his left arm, his strongest muscle turned or held the hand palm inward; his left hand had a more powerful grip than the right.

He did not use his legs much for running. Attachments for the biceps femoris, quadriceps and lower leg muscles are not roughened, indicating proportionately little flexion and extension of lower leg or extension of the foot. Rather, he was accustomed to much flexing and extending of his thighs and to pressing his thighs together. His feet were generally kept with toes firmly pointed.

Given this musculature and its meaning in behavioral terms, I suggest that this young man performed two activities far more often than any others. First, the strong left grip and powerful right wrist, upper arm and shoulder musculature fit the pattern expected of a right-handed person drawing a bow. Second, he walked and ran far less than he sat, rolling his hips to maintain balance on a moving seat that required him to grip with his thighs and feet; he rode a horse.

Pathologies

There is little evidence for disease or injury in this person's skeleton prior to his death. There is, however, evidence of malnutrition in the form of rickets, which results from poor calcium metabolism during long-term vitamin D deficiency. This is a significant observation.

Vitamin D forms in the skin during contact with sunlight. It is also common in oils, especially fish oils. Rickets would be a winter affliction of people living in areas where oils were not a common part of the diet. On the Columbia Plateau, where dried, oil-rich salmon comprised a large proportion of the winter diet (e.g., Ray 1933, Schuster 1979), rickets should have been an uncommon affliction. In the RM 590 area, starvation from acute lack of food would have been more likely than long-term vitamin D deficiency, unless supplies of fish were inadequate for several years running.

The most important pathologies in this individual were acute -- an arrow wound and a possible skull fracture. I have already mentioned the arrow point embedded in the left shoulder. There is also a slight, apparently green-bone fracture to the left parietal bone of the skull. Neither wound shows any sign of healing.

Cause of Death

This young man was killed in a skirmish. The distribution of arrow points shows one that is contributory to death and four others that probably caused corporal damage of varying severity. The two arrow points (Numbers 2 and 3) lodged inside the rib cage lie in the vicinity of the aorta and left pulmonary artery and very likely caused massive internal bleeding. The skull fracture resulted from a blow to the head, perhaps during a fall caused by arrow wounds or from a blow administered by an assailant.

The positions of the two points from which the arrows' direction of flight can be ascertained (Numbers 1 and 4) indicate penetration of the shoulder and back muscles from behind. The victim was apparently fleeing his assailants when some of his wounds were sustained.

Discussion

Two matters pertaining to this burial warrant discussion: 1) ethnic affiliation of the individual, and 2) pacifism of Columbia Plateau peoples.

Ethnic Affiliation

It is extremely difficult to assign an ethnic identity to bones, unless a skeleton possesses congenital characteristics or skeletal abnormalities of cultural origin that are known to have been geographically restricted or is associated with artifacts of a style peculiar to one ethnic group.

Skeletal anomalies are of no use in this instance. No one has yet compiled or statistically analyzed data on congenital characteristics among Columbia Plateau peoples and their neighbors. Dr. James Alexander, who has studied many skeletons recovered from this region, notes only that dental anomalies occur frequently. This may be true of other regions of the Northwest as well, so the extra upper incisor in this young man does not help to determine his geographic origin.

Burial practices and projectile point styles do, however, provide clues that this individual was not a resident of the RM 590 area. The skeleton was oriented to the east and face down; neither of these characteristics is common to the north central Columbia Plateau, although both occur in low frequencies (Sprague 1967, Sprague and Birkby 1970, Sprague and Malinski 1980).

Projectile point style is the best indicator of this person's origin. There are two groups of points: one in the torso (A) and the other between buttocks and left foot (B). Members of these groups are of distinctly different form (Figure F-4). Group A includes short, relatively broad points with short, triangular blades and bases usually wider than the blades. Neck widths of complete, non-reworked specimens are all greater than or equal to 6.9mm. All are made of chert, opal-like jasper or opalized wood and all but one are impact-fractured or shattered. By contrast, the unresharpened Group B specimens are long and narrow with long, biconvex triangular blades and bases generally narrower than the blades. Neck widths are all less than or equal to 6.3mm. Materials are chalcedony (including "moss agate"), jasper and chalcedony, and silicified wood. All specimens have needle sharp tips.

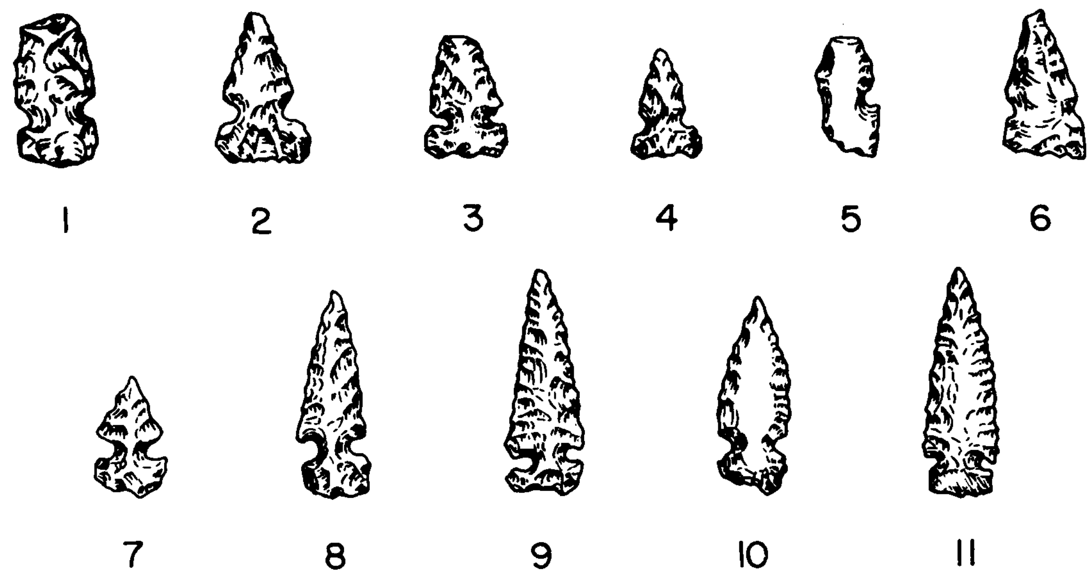


Figure F-4. Projectile points found associated with Burial 1, 45-OK-197. Note the difference in blade form and length between un-resharpened specimens in the upper and lower groups.

Table F-1. Characteristics of projectile points from Burial 1.

Number	Catalog Number	Material	Maximum Length	Stem Length	Blade Width	Stem Width	Neck Width	Maximum Thickness	Weight	Blade Form	Stem Plan. Lateral	Stem Plan. Proximal	Breakage	Location
1	15f	white chert	—	6.4	11.3	11.1	7.1	3.7	0.91	triangular	str.	convex	impact on tip	prox. left humerus
2	15b	grey chert	19.8	6.8	9.6	13.4	7.2	3.1	0.67	triangular	exp.	straight	impact on tip	left ribcage
3	15e	chalcedony	19.5[2]	5.9	8.7	11.0	6.9	3.1	0.74	triangular	str.	convex	impact on tip	left ribcage
4	15d	jasper (opal)	14.1[3]	5.0[3]	7.3[3]	10.9[3]	5.9[3]	2.9	0.40	triangular	exp.	straight	none (reworked)	rear 10th thoracic
5	15c	jasper (opal)	—	—	—	—	—	2.2	(0.40)	—	—	—	shattered	rt. 12th rib, elbow
6	15a	opalized wood	19.7	5.8	10.1	12.6	8.9	3.1	0.74	triangular	exp.	straight	impact on tip	between femora
7	16e	chalcedony	15.4[4]	5.9	8.7[4]	11.1	4.8	3.6	0.45	biconcave triangular	str.	convex	none (resharpened)	beside right femur, proximal
8	16c	silicified wood	27.1	6.6	9.8	9.8	5.9	3.3	0.87	biconvex triangular	str.	straight	none	beside right femur, proximal
9	16d	dendritic chalcedony	25.9	5.8	10.0	9.3	6.2	3.1	0.83	biconvex triangular	str.	straight	none	between pelvis and left foot
10	16a	jasper (chalcedony)	29.2	4.0	11.1	10.2	6.3	3.5	1.00	biconvex triangular	contr.	straight	none	between pelvis and left foot
11	16b	chalcedony	30.7	3.2	10.3	8.1	5.9	3.8	1.07	biconvex triangular	str.	straight	none	between pelvis and left foot

1. all measurements in millimeters.

2 broken, estimated maximum length.

3 Renotched blade.

4 Resharpened blade.

The short, broad, triangular form of points in Group A is common to the RM 590 area, and the western Columbia Plateau in general (Grabert 1968, Leonhardy and Rice 1970). Opalized wood and opal-like jasper can be found in hills around the site. Therefore, it appears that the projectile points that killed this young man were shot by local people.

Long, narrow, side-notched points of the style in Group B are not common to the Plateau. In fact, only Group B, No. 8 has a counterpart in any illustrated collections from this region. That is a member of Grabert's Group IIIb, found at 450K66 (1968, Pl 32, O). Likewise, styles to the south, north and west of the western Plateau are of the same short, triangular form. Therefore, Group B points can only be from the east. Frison (1977) illustrates points of similar form, specifically the Old Woman's type from the Northwestern Plains.

Certainly the needle sharp tips and raw material from which the points were made support the idea of a Northwestern Plains origin. Sharpened tips are a characteristic of Plains points throughout prehistory (Frison 1977). Dendritic chalcedony, silicified wood and jasper with chalcedony inclusions are not materials common to the Plateau, but all are found in the central Rocky Mountains (Chatters 1982a).

Based on projectile point styles, I conclude that the young man in Burial 1 was not a local, but came from some distance to the east, possibly the Northern Plains. He was, however, killed by local people. The fact that he had had rickets, an affliction that should not be common to Plateau people, supports the idea of a non-Plateau origin.

Carbon 13/12 Ratios and the Question of Origins

I am comparing two hypotheses here: (1) Burial 1 is the skeleton of a person from an area east of the Columbia Plateau (i.e., an alien) and (2) he was a local inhabitant or at least a member of some Plateau group (a native). The styles of associated projectile points and presence of rickets both support the "alien" hypothesis, but neither conclusively refutes the alternative. A further test can be made by comparing the young man's diet with that expected for each prospective area of origin. The ratio of Carbon-13 to Carbon-12 in bone collagen has been proven effective for inferring the proportions of maize, marine species or terrestrial freshwater species in prehistoric diets (Chisholm et al. 1982, Tauber 1981; Vogel and Van der Merwe 1977). If the young man was from the Plains, his diet would consist almost entirely of terrestrial plants and animals; a marine component (salmon, steelhead) would be expected in Plateau diets.

Marine plants are approximately 7 per mil richer in Carbon 13 than most terrestrial plants growing in temperate climates. This difference is carried up the food chain and exists in almost unaltered proportions in the muscle tissue of animals. Chisholm, Nelson and Schwarcz (1982) found that terrestrial animals from British Columbia had a δC-13 averaging -25.7 per mil while marine animals averaged -17.8 per mil. This approximately 7 per mil difference is perpetuated in bone collagen of human beings, but the collagen is enriched approximately 5 per mil over the δC-13 of the diet. Thus mesolithic Danes, modern greenland Eskimos

(Tauber 1981) and prehistoric coastal Indians of British Columbia (Chisholm et al. 1983) had an average δ C-13 of -13 (range -12 to -15) while Neolithic, Iron Age and Bronze Age Danes (Tauber 1981), and Eastern Archaic Indians (Chisholm et al. 1982; Vogel and Van der Merwe 1977) with a terrestrial diet, had mean δ C-13 values of -20 (range -18 to -27).

There are nine examples of δ C-13 values from the Columbia-Fraser Plateau. Five are from the Lillooet area of southern British Columbia (Chisholm et al. 1982) and four are from near Nespelem, Washington (45-OK-159; Sprague and Mulinski 1980; S.K. Campbell, pers. com.). The Nespelem examples all date within the last 600 years (580 ± 60 to 180 ± 60 BP; Beta 2655 and 2657, respectively). These people had a mean δ C-13 of -16.5 (Lillooet mean -15.4 ± 0.3, Nespelem -17.8 ± 1.9; some of the difference may result from variation in laboratory procedures).

If from the Plains, Burial 1 should have a significantly higher value than those from the Plateau. Result: δ C-13 = -26.93 (Beta 10517). The alien hypothesis stands.

Columbia Plateau Pacifism

It is generally believed that the Sanpoil and other interior Salish of North Central Washington were pacifistic, disinclined toward organized intergroup conflict. Ray (1933, 1939) stresses this pacifism as a hallmark of Plateau culture:

> "The Sanpoil, at the geographic center of the Plateau emphasize no other value in life more than pacifism, unless it be the fundamental equality of men. Warfare is virtually unknown to them and has been since time immemorial. No living man can recount as instance of conflict even from traditional history." (Ray 1933:35)

One should not get from this description the idea that the Sanpoil were defenseless nor that they never engaged in internecine or intergroup conflict. Ray (1939) implies that conflict would have taken two forms: 1) raids and occasional small-scale feuds initiated and led by individuals against villages on their own or other tribes, and 2) defensive actions. The pacific, less-nomadic Sanpoil invited raids from more warlike neighbors, some of which have been recounted to ethnographers.

> "If legends have any basis in history, the Spokanes at an early time attacked the defenseless Sanpoils." (Ruby and Brown (1970:15)

Larry Fredin, of Nespelem, tells of a story related to him by Dutch Monoghan of Keller in which a band of Nez Perce raided a Sanpoil village in early fall, while most adults were in the mountains picking berries. Alerted by a runner, the Sanpoil caught up with the attackers and killed all but one. According to Adeline Fredin, historian for the Colville Tribes, an associate of hers from the Blackfeet tribe reported tales of raids on people of the Upper Columbia region by his ancestors.

On the right ilium they are seen on the medial surface of the blade just anterior to the sacral articulations, while on the left ilium they are seen on the lateral surface of the blade just over the sciatic notch.

Right Leg.

Femur. The right femoral shaft is largely intact except for some minor chipping and a circumferential fracture approximately 5.5mm from the distal epiphyseal center anteriorly and 8.8mm from this center posteriorly. All the epiphyses for the head, greater trochanter, lesser trochanter and the distal end, are unfused. Also, there is an area of extreme roughening and bone flattening in the area of the attachment surface for the gluteus maximus and the adductor magnus muscles. Scratches also are seen on the posterior side of the distal end and below them is another area of possible abrasion. All of this is seen in the popliteal space. The epiphyseal centers for the distal end and the head are still present and, except for mild chipping craniallly, the epiphyseal center for the head is intact. Unfortunately, the medial half of the distal epiphyseal center is missing but the lateral half is intact.

Patella. Only the right patella is present and the lateral edge of it is missing. The anterior surface exhibits moderate pitting and the attachment sites for the quadriceps muscles are not well defined.

Tibia. The right tibia is generally less intact than the right femur. The proximal end, where the epiphyseal center attaches, is badly chipped and the proximal epiphyseal gone. The distal end of the bone is broken off and there is no distal epiphyseal center. The bone itself shows extreme medio-lateral flattening and antero-posterior bowing (a case of possible ricketts). Numerous scratches are seen on the lateral side of the bone in the area of the nutrient foramen and on the posterio-medial side. Also, small cuts resembling gnawing are seen in the area of attachment of the popliteus muscle and the groove for the extensor digitorium longus is very well established, but the other muscle markings are unremarkable.

Fibula. The proximal end of the right fibula is seen but the proximal epiphyseal center is absent. There is no distal end as the bone is fractured approximately half way distally. There is also seen a fracture between what appears to be gnawing marks on the anterior neck region.

Tarsals. Only three tarsal bones are seen: The right calcaneus, of which only the articular surface for the talus remains; the right talus, missing the bulk of its posterio-medial surface; and the right cuboid, which is largely intact. The bones all show numerous pits and minor chipping is seen on both around the convex surface (of the talus). No obvious extreme muscle markings or pathology are seen.

All five metatarsals are present for the right foot. The first is broken off at the proximal end and shows chipping on the phalangeal articular surface at the distal end. The second, except for a small hole proximal end while the fourth is missing most of the proximal and a dorsal section of the distal end. Additionally, ten phalanges (and possibly more) are observed. They consist of four proximal, four medial, and two distal. The proximal phalanges correspond to those of the first, second, third and the fifth. The proximal phalange of the fifth digit and the medial phalanges of the third and fourth digits are missing their proximal ends. On the third proximal phalanx a medio-proximal section is gone while in the fourth the entire end is missing. Of the two distal phalanges, the first exhibits latero-proximal chipping while the other (as yet undetermined but possibly of the third or fourth digit) is intact. The phalanges, and to a lesser extent, the metacarpals, show more roughening on the palmar than the dorsal side, possibly indicating a strong set of palmar interossei and hence a strong power grip. Finally, for all the hand bones, no pathological growth is seen and the epiphyses are all open.

Pelvis.

The pelvis on the whole is somewhat fragmentary in nature. Moreover, none of the epiphyseal joints have fused, so each of the three bones -- ilium, ischium and pubis -- maintains its own integrity.

Right Ilium. This bone appears much more intact than the left, consisting of most of the blade and the acetabulum. A small chip of the medial side of the blade and a section consisting of the posterior superior and posterior inferior iliac spines are missing. In addition, the area laterally around the circumference of the acetabulum appears pitted with numerous small holes. Finally, neither the epiphysis for the iliac crest nor the acetabulum have fused. The right ischium, like the right ilium, shows no evidence of epiphyseal fusion and a small section is missing just cranially to the developing epiphysis.

Left Ilium. This bone is not in as good shape as the right. While both sacral and muscle articulations are seen, the blade itself is in generally poor shape. A section consisting of both anterior superior and anterior inferior spines is missing and another consisting of all the iliac crest is gone. Finally, a section which made up both posterior superior and posterior inferior iliac spines is also gone. The left ischium, on the other hand, is more complete than the right ischium and consists not only of the acetabular center and the iliac articulating surface but most of the pubic articulating surface as well.

On both these bones, neither the sacral articular ligament markings nor the markings for the muscles appear extensive and the same pitting seen around the acetabular center on the right ilium is seen on the left bones, only here it is between the ischial-acetabular center and the pubic articular center. The left ilium does show some roughening in the area of the gluteus minimus articular surface and roughening is also seen on this ilium and both ischia in the area of the obturator internus articular surface. Finally, there are scratches seen on both iliac bones.

There is a point of an arrowhead approximately 1cm below the diaphyseal-epiphyseal joint lateral to the bicepital tuberosity and just below the greater tuberosity. The arrowhead itself caused damage to the area below the greater tuberosity in a triangular area approximately 1.5 x 2.0 x 2.0 cm. The arrowhead point itself is seen on the medial side of this triangle approximately half way between the apex and the side bordering the epiphyseal-diaphyseal plate.

There is strong ridging in the area of the insertion for the pectoralis major and further development in the area of insertion for the teres major. The deltoid tuberosity is extensive but not really pronounced and there is extensive ridging seen. The nutrient foramina on the medial and posterior surface are open and there is good demarcation for the insertion of the external and internal heads of the triceps but no lines of muscle marking.

The third section consists largely of the medial side of the distal end of the humerus. Here, the epiphyseal-diaphyseal joint is also not fused. The bone is broken off anteriorly just between the trochlea and the capitulum and posteriorly approximately half way through the olecranon fossa. The shaft of the humerus on this fragment of bone extends approximately 4cm above the medial trochlea anteriorly and approximately 3cm above the posterior trochlea posteriorly. A foramen is seen in the coronoid depression extending into the medial side of the olecranon depression. According to Hrdlicka, 1932, the foramen is of medium size. The attachment for the flexors on the medial epicondyle are not well developed and the epicondyles epiphysis is not fused.

Ulna. In addition to the distal half, the head of the ulna is also missing. Only the very smallest fragment of the dorsal olecranon remains. Additionally, a post-mortem fracture is seen 3.2mm above the now distal end and a chip appears missing on the ventro-medial side approximately 3.0mm above the fracture. Generally, the muscle markings are unremarkable while the nutrient foramen is open. Finally, the distal epiphysis is present for this bone, thus indicating there was no fusion of it at the time of death.

Radius. What remains of the radius is in two sections. The first consists of a section of bone going from about midshaft to just below the radial tuberosity. The nutrient canal is open and the site of attachment for the pronator teres muscle is roughened. The second sections seems to be the lower third from just above the distal epiphysis to about 3.0mm below the fractured end of the upper section. While the areas of attachment for the flexor pollicus longus and the pronator quadratus are distinguishable, they are not particularly developed.

To date, only one carpal bone, the capitate, is recognizable for the left hand and while minor pitting is seen on it, this bone appears generally unremarkable. Two metacarpals, the first and fourth, are possibly seen but neither is completed. The first is missing most of the occurred shortly before death, but we are not sure. The bicipital tuberosity is well developed and somewhat roughened and roughening is also seen at the sites of attachment of the pronator quadratus, supinator brevis and the extensor pollicus muscle. The epiphyseal plate is not fused to the head and the nutrient foramen is open.

Right Hand Bones. At present, only a lunate and possibly a scaphoid bone can be identified for the right hand. The medial side of the lunate is missing and the palmar side exhibits extensive wear. The scaphoid, if it is one, shows extreme deformation. The area of articulation for the trapezium and the trapezoid show a palmar-dorsal elongation while the tuberosity and radial articulation exhibit extreme roughening.

At present, only one metacarpal can be identified -- the first, and of this only the distal end is left; the proximal end has been broken post-mortem. The head exhibits moderate roughening, especially in the area where the sesamoid bone attaches. The surface attachment for the flexor pollicus muscle is roughened and the nutrient foramen is open. In addition, six right phalanges can be accounted for and they consist of three proximal, and three distal phalanges. One of the proximal phalanges appears to be that for the thumb and the other two proximal may correspond to the third and fourth fingers respectively, but again we cannot be positive. The three distal phalanges correspond to the second, fourth and fifth fingers. The proximal phalanx of the third finger is missing its distal end, which was broken post-mortem. In addition, the distal phalanx of the fourth finger is missing its proximal end which also appears to be broken post-mortem. The phalanges themselves appear normal with no pathological growth and no signs of epiphyseal closure. Finally, there are two more phalanges that may belong to the right side, but their fragmentary nature makes positive determination impossible.

Left Arm.

The insertion for the deltoid, teres major and the pectoralis major are more pronounced and the bicepital groove is more developed on the left humerus than the right humerus. The left arm is in worse condition than the right. The radius and the ulna are reduced to fragments, with approximately the distal half missing for the ulna and the radius broken into two small sections.

Humerus. The left humerus is in three sections: the first section consists of the epiphyseal section of the head. The left posterior side on this section is badly chipped and pitted. Additionally, a large, somewhat symmetrical, pit is in evidence on the anterior plane in the area where it meets the surgical neck. The head itself is in a roughened condition with numerous large pits in evidence. The bicepital groove is very prominent.

The next section is that of the shaft proper. This section is broken off distally, approximately 5cm below the deltoid tuberosity laterally and approximately 5cm below the nutrient foramen medially.

The left clavicle is missing both ends and again chipping is seen in the area of attachment of the deltoid muscle. Scratches also are seen just above this chipping on the acromional end of the bone. The muscle markings are unremarkable.

Ribs.

The heads are seen for nine ribs on the left side and eleven ribs on the right side. The ribs themselves are extremely fragmentary and no one rib (with possibly the exception of the left first) is complete. No evidence of trauma is seen and the muscle markings, while present, are unremarkable.

Right Arm.

Humerus. The right humerus, while present, is moderately damaged. The head is entirely missing along with the greater tuberosity. The lesser tuberosity is present but the epiphysis is not fused. A large hole, in evidence where the head was, generally follows the circumference of the surgical neck, leaving only the diaphyseal end of the lesser tuberosity. Also, a slight fracture is in evidence running from the lowest edge of the surgical neck posterio-laterally approximately one-half the way around the bone. Both the deltoid tuberosity and the bicipital groove are well developed, though the groove appears more wide and shallow than narrow and deep. While the distal end reveals what was an unfused trochlear epiphysis, both the internal and the external condyles are chipped, thus making it impossible to determine the extent of their epiphyseal fusion. Both the radial and the coronoid depressions are shallow while the olecranon depression is both deep and extensive.

The surfaces of insertion for the deltoideus and pectoralis major and origin of extensor carpi radialis are extremely well developed. Finally, the nutrient foramen, seen on the medial side of the bone just distal to the level of the deltoid tuberosity, is open.

Right Ulna. Except for the distal end, which is missing just above the site of attachment for the pronator quadratus, the ulna is intact. The epiphysis for the olecranon is not fused while the lesser sigmoid cavity is chipped and roughened. Also, the epiphysis for the sigmoid cavity is not fused and, probably due to early age, the olecranon cavity is shallow and poorly developed. The attachment sites for the brachialis, anterior extensor and the pronator quadratus muscle are well-defined. The nutrient foramen, seen ventrally about midshaft and directed toward the head, is open. Finally, a post-morten fracture, running the circumference of the bone, is seen approximately 4.0mm distal to the nutrient foramen.

Right Radius. It is missing its distal end just below the site of insertion for the pronator quadratus. In addition, a fracture is also seen running circumferentially around the bone with an opening 1.2 x .5mm. There seems to be some partial healing of this fracture, suggesting it

L.V. #3 is missing the left transverse process and most of the body. The right transverse process is chipped and a fracture is seen through the lamina. Finally, from what little remains of the body, it is evident that the epiphyseal plates were not fused and there was an absence of pathology.

L.V. #4 is missing most of the body and the right transverse process. The left lamina is fractured and the left transverse process is chipped. Finally, from the little body that remains, it is evident that the epiphyseal plates were not fused and there was no pathology.

L.V. #5 consists almost entirely of the two laminae, the left pedicle, left superior articulating process and a small section of body. The left pedicle was fractured post-mortem and the epiphyseal plate was not fused on the body. Finally, from what little remains, there appears to be an absence of pathology.

Sacrum. One and possibly two sacral vertebrae appear to be present. The most complete appears to be the second; the other is unidentifiable but may have been the third or fourth. With the most complete vertebra, the right half of the body, part of the right articular surface and the right superior articular process are present. Minor chipping is seen on the inferior side of the body and the epiphyseal plates are not fused. On the ventral surface the attachment surface for the piriformis muscle is extensive and well-demarcated. The other section, probably from S-3 or S-4, consists only of both laminae and a fracture is seen in the left lamina. No extraordinary growths or pathologies are seen.

Scapulae and Clavicles.

The right scapula is in two pieces. The first section includes most of the axillary border and approximately one-third of the superior border. The glenoid cavity is intact but the acromion and coracoid processes are broken. The spine of the scapula is badly chipped and none of the epiphyseal plates are fused. The second section includes approximately 2.8mm of the superior border and 3.0mm of the spine, all of which are chipped. With the exception of the areas of insertion for the trapezius and the teres major muscles, none of the other muscle attachment surfaces are very extensive.

The right clavicle is missing both its ends and minor chipping is seen in the area of the deltoid articulation. Again, the muscle markings are not very pronounced.

The left scapula consists of approximately half of the axillary border, the coracoid process-epiphyseal plate (unfused), the glenoid-epiphyseal plate (also unfused), and a very small section of the inferior border which terminates at the origin of the coracoid process. The acromion process is missing but evidence is present that suggests its plate was unfused, too. Muscle markings are indistinct.

T.V. #6 is missing all the spinous and transverse processes. The right superior aspect and the left side of the body are chipped; one fracture is seen through both laminae at the position of the superior articular process and another through the left pedicle. The epiphyseal plates are not fused and no pathology is seen.

T.V. #7 is missing both transverse processes and a section of the spinous process. Major chipping and pitting is seen on the inferior and superior surfaces of the body. The epiphyseal plates are not fused and no pathology is seen.

T.V. #8 is fractured through both laminae and both of the transverse and spinous processes are missing. Also, the left inferior articular process is partially chipped. The body is intact but shows no evidence of epiphyseal fusion or pathology. Finally, pitting is seen inferiorly at the origin of the pedicles.

T.V. #9 is missing both transverse processes, both inferior articular processes and most of the spinous process. The body shows minor chipping superiorly and more extensive chipping inferiorly. The epiphyseal plates are not fused and no pathology is seen.

T.V. #10 is missing both its transverse and spinous processes. In addition, fractures are seen in both laminae just below the superior articular processes and in the left pedicle minor chipping is seen anterio-inferiorly. From the remains of the body it is evident that the epiphyseal plates were not fused. There was an absence of pathology.

T.V. #11 exhibits a complete body, both pedicles, both superior articular processes, both laminae and the right inferior articular process. Fractures are seen in both laminae just below the superior articular processes. Finally, the body is intact but the plates have not fused and pathology is absent.

T.V. #12 shows both laminae, both inferior and the left superior articulating processes, the left pedicle (badly chipped) and a small section of the left side of the body. The pedicle remaining is fractured and the body indicates no fusion of the epiphyseal plates and no pathology.

Lumbar. While all five lumbar vertebrae can be accounted for, all are missing their bodies.

L.V. #1 is missing the body, left pedicle and both transverse processes. The right superior articulating process is chipped, the spinous process is fractured and there is no evidence of epiphyseal plate fusion. No pathology is in evidence.

L.V. #2 is missing the bulk of the body and both transverse processes. In addition, a complete fracture is seen in the left lamina. There is no evidence of pathology and no evidence of epiphyseal fusion.

C.V. #5 is missing its entire body and both transverse processes, but the spinous processes are intact. Finally while both vertebral arterial foramina are in evidence and no obstruction is seen, a fracture is seen through the right vertebral foramen near the spinous process.

C.V. #6 is fractured in two areas: through the body and through the right lamina, and the spinous process is broken off. Except for that and minor chipping around the vertebral foramina and on the spinous process, the vertebra is intact. Both vertebral foramina are in evidence and exhibit no occlusions.

C.V. #7 is in a number of pieces, with one fracture seen through the left pedicle and another fracture at the base of the spinous process. Both the spinous process, the right pedicle and the left transverse process are missing. The right vertebral foramen is present and shows no evidence of occlusion.

No lipping or pathology is seen on any of the cervical vertebrae.

Thoracic or Dorsal. These vertebrae also are all represented although they are generally not in as good condition as the cervical vertebrae.

T.V. #1 is generally intact except for chipping in the spinous process and both rib tubercles. This vertebra was fractured in four places: through the body, the right pedicle, the right lamina, and the left lamina just below the rib tubercle. The epiphyseal plates have not fused on the body and no lipping or any other pathology is seen.

T.V. #2 consists of the body, right pedicle, right superior and inferior articulating processes, right lamina and the spinous process. The body is fractured through the center and the lamina are fractured below the superior articulating processes. The transverse process shows minor chipping and the epiphyseal plates have not fused.

T.V. #3 consists of the body, left pedicle, left superior and part of the left inferior articulating process, left lamina and approximately the right half of the spinous process. The rest of the vertebra is missing. The body is largely intact, no lipping or pathology is seen, and the epiphyseal plates have not fused.

T.V. #4 is missing both transverse processes and its rib tubercles. In addition, fractures are seen in both laminae just below the superior articular processes. There is also seen chipping on the su[illegible]-anterior aspect of the body. The epiphyseal plates are not fused and no pathology is seen.

T.V. #5 is missing both transverse processes and its rib tubercles. Also the left superior surface of the body is chipped. Fractures also are seen through both laminae just below the superior articular processes. Finally the left superior articular process is missing. Again, the epiphyseal plates are not fused.

The only severe pathology occurs in the left humerus. There is a stone arrowpoint embedded in the posterior lateral area of the proximal diaphysis. The blade had entered from behind the individual and slightly to his right, penetrated into cancellous tissue and snapped. The proximal portion of the blade then was deflected laterally, shearing a 7mm wide, 18mm long strip of compact bone tissue almost completely free of the diaphysis. Both portions of the point remained in the humerus at the time of discovery, but the bone strip and proximal portion of the arrow blade had separated from the larger bone by the time of our study.

Skeletal Characteristics*

Vertebrae.

Cervical. In one form or another all the cervical vertebrae are represented. Unfortunately many are very fragmentary; none exhibit epiphyseal-diaphyseal fusion on their bodies.

The atlas, while present, is in two pieces, fractured in a dorso-ventral plane through both the anterior arch and the posterior arch. The vast majority of the anterior arch and the section of the posterior arch with the rudimentary spinous process are missing. Both transverse processes, though intact, are chipped at the ends. The foramina for the vertebral arteries are both intact and exhibit no extraordinary obstructions or occulusions. Finally, the groove for the first cervical nerve is more pronounced on the left than the right side.

The axis is completely intact though minor chipping is in evidence on the cranial surface of the right lamina, the caudal surfaces of both the transverse and the spinous process and the caudal surface of the body. The right foramen for the vertebral artery is smaller and more occluded than that for the left and the articular surface for the transverse ligament is well-defined with something of a right side inclination.

The next five cervical vertebrae are in various degrees of completeness:

C.V. #3 is in three sections; the body, the right lamina and associated articular surfaces, and the left lamina and associated articular surfaces. Approximately half of the left lamina and the left transverse process are missing. Both foramina for the vertebral arteries are present, and exhibit no evidence of obstruction.

C.V. #4 is intact except for both transverse processes and the spinous process. A fracture is seen through the left pedicle and another through the right side of the body and right pedicle. A third fracture is seen in the area of the spinous process. Finally both vertebral arterial foramina are in evidence and exhibit no signs of occlusion.

*Note: unless noted, all damage will be considered post-mortem.

Sex

Assessment of sex is made difficult by the fact that many of the sexing criteria normally used (i.e., general robustness of the bones, the ischio-pubic index, the shape of the orturator foramen, etc.) occur only as a result of the adolescent growth spurt during puberty. However, there are some "inborn" differences, especially in the innominate and cranial bones. The shape of the sciatic notch, the absence of a preauricular groove and the extent of the sacral articular surface, for example, can indicate maleness.

In this skeleton, the preauricular sulcus is missing. The sciatic notch is inconclusive as a characteristic of sex here. The pelvic bones have not yet fused, thus providing little information on the shape of the basin.

The major criteria used here to determine sex was the "squareness" and the robustness of the mandible. This tends to indicate maleness. The zygomatic portions of the temporal bones extends over the external auditory meatus, a characteristic which also tends to be more prevalent in males.

We feel this individual was male.

Stature

Estimate of stature was taken from the most complete long bone; the left femur. Both the proximal and distal epiphyses were present and fitted easily on the diaphysis. The length of the femur with the epiphyses is 40.6cm. Stature estimates thus give a height of 159.86 $\pm$ 3.80 cm (63 in.). Once again, caution must be used because the growth spurt not only affects individuals differently but also affects various bones differentially. The formula used to derive this stature estimate was based upon adult long bones, so this estimate may be high.

Pathology

There was very little evidence of any pathologies on the bones. The skull shows no signs of pathologies. There is some pitting around the premolars on the left side of the mandible which may indicate the beginnings of abcess. No cavities are noted in the teeth, although wear is heavy. An extra, full-sized upper second incisor is present behind the right second incisor.

The axial and appendicular skeleton shows no pathologies except on the distal, posterior side of the left femur which shows a slight concavity. It is ovoid in shape and approximately 2.5cm in length, .75cm in width, and .5cm deep. It does not penetrate into the medullary canal of the femur. This concavity may indicate a periosteal infection of some type.

APPENDIX F
Part 2

OSTEOLOGICAL REPORT
BURIAL 1, 45-OK-197

by
Daris R. Swindler, Hartmut B. Krentz and John Blaisdel

Department of Anthropology, University of Washington

The bones from one subadult human skeleton were presented to us for assessment of age, sex, stature and other attributes. Many of the bones were fragmented. Most of the bones of the skull were disarticulated or broken. However, careful reconstruction of these bones produced a nearly complete calvarium. The right and left maxillae are complete and all the teeth are present. The mandible is also complete. Most of the vertebrae are present, though fragmentary. Only the superiormost segment of the sacrum remains. All the long bones are represented. In all the long bones the epiphyses have not yet fused. Thus, this individual was definitely a subadult. This poses problems for the assessment of age, stature and sex, because most characteristics used for determining these traits are based upon adult skeletons.

Age

Assessment of exact adolescent or subadolescent age is made difficult due to the variation seen in the growth spurt within individuals of this age. This spurt varies depending on genetics, nutrition, and sex of the individual, plus other factors. However, it is possible to set the upper and lower limits of age.

The union of the epiphyses occurs at a fairly set rate though there is still much individual variation. One of the first major unions occurs among the three pelvic bones. The ilium fuses with the ischium and pubus between the ages of 10.5 to 18 with a mean of 15 years of age. Other early fusions occur in the distal humerus, the medial epicondyle of the humerus, the distal tibia and the proximal femur (among others). The early range of union for these occurs between 13 to 15 years of age. In the subject skeleton, none of these epiphyses have yet fused. This indicates an upper limit of 13 to 15 years of age.

All the teeth are present in this individual and all are adult teeth. The first molars and the second molars have erupted. The first molars show heavy wear while the second molars exhibit very minimal wear. All four third molars are seen but have not yet erupted. The second molars generally erupt at the age of 12 $\pm$ 1 year, while the third molars came in at 18+ years.

We believe that, due to the nonunion of any of the epiphyseal ends and the appearance of the second molar, the age of this individual is 13 $\pm$ 1 years of age.

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The young man from Burial 1 at 45-OK-197 attests to two facts. First, the Sanpoil and Nespelem could not always adhere to their ideal of pacifism and second, they were not, as Ruby and Brown suggest, defenseless.

Summary and Conclusion

Burial 1 at 45-OK-197 contained the remains of a 13-year old male and eleven whole or fragmentary projectile points. Six of the points were in his torso, including one embedded in the left humerus. These six are of a style common to the project area, while the remaining five, unbroken points are stylistically similar to points from the Northwestern Plains or Montana Rockies. Rib and vertebra fragments have been dated to 170 ± 110 BP.

From these facts, skeletal pathology and diet reconstructed from carbon isotope ratios in bone collagen, I conclude that this young man was a horseman who visited Sanpoil-Nespelem territory in the mid- to late eighteenth century with a party from the Plains. He was killed in a skirmish with local people.

The remains will be reinterred by the Colville Confederated Tribes at a time and place of their choosing and marked with a bronze plaque bearing the inscription:

YOUNG MAN

Age 13 yrs.

Died, mid-18th century

Exhumed 1983

45-OK-197.

at the distal end, is intact. The third exhibits a moderate-to-large hole on the medio-proximal aspect while the fourth exhibits a moderate hole on the latero-distal aspect and chipping on the latero-proximal aspect. The fifth metatarsal is intact.

The second, third and fourth metatarsals exhibit a dorso-palmar bowing but no extreme muscle markings. On the first, the medio-palmar surface of the distal end exhibits a spur of bone growth but no extraordinary muscle markings. Finally, none of the epiphyses are fused on the distal ends of the second through fourth or the proximal end of the first metacarpals. No left phalanges appear to be in evidence though pieces of unidentifiable phalanges are present.

Left Leg.

Femur. The left femur is not generally in as good shape as the right one. A large section on the proximo-lateral side, encompassing the greater trochanter, is missing. This hole extends approximately 4.0mm distally beyond the lesser trochanter. In addition, at least two fractures are seen, one at approximately midshaft and the second in the lower third of the shaft, just below the distal nutrient canal. Both are circumferential. Additionally, a small ovoid opening is seen disto-laterally just above the outer tuberosity. The opening strongly resembles a nutrient canal but does not extend into the marrow of the bone and while it appears too symmetrical, it could be an abcess due to osteomyelitis. Finally, the lateral edge of the outer condyle exhibits some chipping and damage.

Just like the right femur, this bone exhibits external roughening in the area of the gluteal attachment. Also, the attachment site for the adductor magnus is well-defined. Minor pitting is seen around the circumference of the condylar articular surface. The epiphyses for both the head and the condyles are present. In addition, the articular surface for the patella exhibits a cube-shaped depression and pitting is in evidence in the intercondylar notch.

Tibia. While ends of the tibia are present, a major section is missing anteriorly from approximately the external and internal tuberosities to about midshaft. Like the right tibia, this one also exhibits a medio-lateral flattening and a well-established discontinuity between the attachment sites for popliteus muscle and the flexor digitorium longus. Finally, both the proximal and distal epiphyses are present, though the proximal epiphysis is missing its interior half. There is also a shallow depression on the outer tuberosity with minor pitting present. The distal epiphysis is intact.

Fibula. The shaft of the fibula is largely intact, but the proximal ends exhibit chipping and the distal end is broken off. The proximal epiphysis is not fused and the distal epiphyseal-diaphyseal end is missing. Finally, the bone seems to show a lateral bowing at approximately midshaft. In addition, there is a groove or depression which seems to correspond to the site of attachment of the soleus muscle.

Tarsals. Five tarsal bones have been identified from the left foot. They are the calcaneus, talus, navicular and two cuneiform bones -- the internal and the medial. The calcaneus' posterior end is incompletely fused and the lateral side is missing. In addition, minor chipping is seen on the superior surface of the body just behind the articular surface for the talus. Finally, minor scratches are seen in the area of the articular surface for the tibialis posterior. The talus, except for pitting seen between the convex surface and the navicular articular surface, is complete. The pits are numerous and fairly large and many closely resemble nutrient foramina. The navicular bone, except for slight chipping, is also complete. A spur is seen though, at the lower limit, medially, at the position for the articulation with the calcaneus. The bone itself shows a medio-lateral decrease in length and a dorso-palmar increase in height. The internal cuneiform is also intact, with only minor chipping, but there seems to be an increase in width and a decrease in height in this bone as compared to other internal cuneiforms. The medial cuneiform is not in as good shape as the internal. Its medial surface is extremely pitted and the palmar edge is missing a section approximately 1.5 x 1.0mm in size. Minor chipping is also evident on the lateral surface, but is not as extensive as on the medial surface. All five tarsal bones show no obvious muscle attachment sites with the possible exception of the tibialis posterior on the navicular and the first cuneiform.

Metatarsals and Phalanges. The five metatarsals are present, and except for minor pitting, all are intact. None show fusion of the epiphyseal joints. Also, none exhibit bowing and no muscle markings are clearly evident. Finally, fourteen phalanges are seen, four distal and ten medial and proximal. Unfortunately, except for the distal ones, all are in a fragmentary condition.

Skull.

Mandible. The mandible is complete but has been broken post-mortem. The left condyle is chipped posteriorly but the right side of the mandible, except for a small chip missing at the angle of the ramus, is complete. Both the mandibular and the mental foramena are unoccluded. The mandible itself exhibits a strong and very square chin, a somewhat low ramus, a shallow mandibular notch and a short body, squarish in cross-section. The site of attachment for the medial pterygoids is extremely roughened but the mylohyoid line is not well defined.

Small, somewhat symmetrical holes are seen on the inner side of the chin and the areas around the mandibular foramina are somewhat pitted. The area corresponding to the attachment site for the masseter muscle is well defined. Scratches are seen just above the internal mental process and extend onto the internal surface of the left ramus. The teeth are all present and show varying degrees of wear. The third molars appear to have erupted through the alveolar process but not through the gingiva and the left second premolar is laterally out of alignment with the rest of the teeth. The first right and the second left incisors and the left canine all show moderate-to-heavy wear with secondary dentine beginning to appear. By contrast, the right first molar's wear pattern is far more extreme than that of the left first molar and the rest of the teeth show little or no wear. Finally, no cavities or abcesses are present.

Sphenoid Bone. This bone is somewhat incomplete but still recognizable. On both sides the greater and lesser wings are largely fragmentary and the left pterygoid process is entirely missing. The right pterygoid process exhibits only the root. The optic canals are both evident and seem enlarged. Both foramen rotunda are also evident and appear normal as do the pterygoid canals. Finally, the site of attachment for the external pterygoid muscle on the right side appears roughened as does the site of attachment of the pterygoid with the occipital bone.

Occipital Bone. This bone is in two sections. the first section would correspond developmentally to the baso-occipital and the exo-occipital bones while the second section corresponds to the supraoccipital bone. This section exhibits somewhat of a twisting, probably due to reconstruction. While the external-occipital protuberance is not well-defined, both inferior curved lines are. Also, the sites of attachment for the neck muscles are moderately pronounced, especially for the rectus capitus posterior minor. Finally, there does seem to be an increased development of the left side over the right externally.

Internally, again there seems to be malpositioning or slight bone deformation. The depression for the falx cerebelli is well-defined, just as is the tarcular merophilus, or the internal occupital protuberance. Within the sulci for the lateral sinuses there seems, or appears, to be malalignment with the right, passing above the tarcular herophilus and the left originating below it. Since this section of bone was initially complete, this is not due to reconstruction practices. The sulcus for the lateral sinus on the right side runs into the sulcus for the falx cerebrei, which runs just to the right of the tarcular herophilus. The bone itself exhibits no roughening or pathology. That section which corresponds to the baso-occipital bone is intact with the occipital condyles generally symmetrical and no evidence of chipping, pitting or extraordinary growth. The areas of attachment for the rectus capitus lateralis muscle are roughened and both the posterior and the anterior condyloid foramina are open. The right posterior condyle appears more superficial than the left, but both sets appear generally symmetrical.

Calvarium. The main part of the skull consists of the parietals, temporals, and the frontal bone. Of these, only the temporals were originally complete, all the rest were largely fragmented. The calvarium itself appears to be very brachyocephalic and except for a possible fracture in the left parietal bone, exhibits no ante-mortum damage or traumatic injury. Both orbits are incomplete, the left more so than the right. Both the external and the internal auditory meatuses in the temporal bones are unobstructed. On the right side the subarcuate fossa is better developed than that of the left side, with the aqueduct of vestibuli more pronounced on the left than the right side. When the baso-occupital is articulated posteriorly with both temporals, the jugular foramina are obvious and appear fairly symmetrical. The foramen spinosum is evident on the left temporal but missing on the right and both temporals show evidence that their carotid canals were unobstructed and symmetrical.

Both parietals have grooves for the middle meningeal arteries and both sets appear approximately the same. Incidentally, the internal surface of the left parietal is stained with a greyish-black substance, probably from the soil. The frontal bone evidences a well-developed superior longitudinal sulcus. While the markings for the temporal muscles are generally unimpressive, those for the masseter muscles are more distinct. Finally, on the frontal bone, both supra-orbital notches are incompletely closed.

The maxilla consists of the two maxillary bones and pieces from both zygomatic bones. The palate is incomplete with a section missing from the right posterior side. The teeth are all present in the maxilla but the third molars have not yet erupted through the gingiva. The palate itself evidences numerous pitting marks and both post-palatine foramina are unobstructed with the right appearing larger than the left. Interestingly, the right side exhibits an extra incisor, thus making three; only two incisors are seen on the left side. The incisors and the first molars appear to be the only teeth evidencing wear, far more pronounced on the right incisors than the left and far more pronounced on the left molar than the right. All incisors show characteristic shovel-shaping.

Both maxillary sinuses are in evidence and both show a greyish discoloration. Both infraorbital foramina are unobstructed with the left larger than the right. Also, both lacrimal grooves are present with no evidence of pathology. The maxillary bones show no real distinct muscle markings but both zygomatics show distinct roughening in the area of the masseter muscle attachment.

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TABLE F-2. Metric characteristics of the teeth from Burial 1.

Maxilla	Crown H6*	(a) Meso-Distal Diameter	(b) Bucco-Lingual Diameter	(c) Crown Module $(\frac{a+b}{2} = c)$
Right:				
I^1 (ss)	10.6	9.2	7.1	8.15
I^2 (ss)	9.8	7.5	6.1	6.80
*I^2 extra (ss)	11.1	7.5	7.2	7.35
C	9.0	8.7	8.5	8.60
PM^1	8.3	7.9	9.8	8.85
PM^2	7.5	7.0	9.8	8.40
M^1	6.0	11.5	11.7	11.60
M^2	7.5	10.0	11.2	10.60
M^3 not yet erupted				
Left:				
I^1	10.5	9.0	7.8	8.40
I^2	9.0	8.4	7.2	7.80
C	10.6	8.6	8.0	8.30
PM^1	9.0	7.8	9.1	8.45
PM^2	7.5	7.5	9.5	8.50
M^1	6.1	11.2	12.0	11.60
M^2	6.8	10.1	12.0	11.05
M^3 not yet erupted				
Mandible				
Right:				
I_1 (ss)	7.0	6.0	6.0	
I_2	9.1	6.6	6.6	
C	12.5	7.8	7.8	
PM_1	9.0	7.5	7.9	
PM_2	7.0	8.0	8.5	
M_1	5.0	11.0	12.5	
M_2	6.2	10.5	11.3	
M_3 not yet erupted				
Left:				
I_1 (ss)	6.6	6.9	5.9	
I_2 (ss)	7.6	7.5	6.0	
C	11.9	8.0	7.8	
PM_1	8.5	7.5	8.0	
PM_2	8.2	7.9	9.0	
M_1	6.1	13.0	10.5	
M_2	7.1	11.7	11.5	
M_3 not yet erupted				

(ss) = Shovel-shaped
Taken from crown-root junction

Table F-3. Morphometry of the Burial 1 skull.

Skull

Maximum length:	156.0mm*
Maximum breadth:	147.0mm*
Minimum frontal breadth:	94.0mm*
Facial width:	139.0mm*
Cranial Index:	94.23

*estimated from reconstruction

Mandible

Bicondylar breadth:	123.0mm
Bigondial breadth:	103.0mm
Height of ascending ramus:	54.5mm
Minimum breadth of ascending ramus:	36.5mm
Height of mandible symphysis:	30.0mm

Femur (left)

Maximum length: 40.6cm (with epiphyses)

F35

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REPORT OF RADIOCARBON DATING ANALYSES

FOR: James C. Chatters
Central Washington University

DATE RECEIVED: March 2, 1983

DATE REPORTED: March 21, 1983

BILLED TO SUBMITTER'S INVOICE NUMBER

OUR LAB NUMBER	YOUR SAMPLE NUMBER	C-14 AGE YEARS B.P. ± 1σ
Beta-6532	45OK197	170 ± 110 B.P.

These dates are reported as RCYBP (radiocarbon years before 1950 A.D.). By international convention, the half-life of radiocarbon is taken as 5568 years and 95% of the activity of the National Bureau of Standards Oxalic Acid (original batch) used as the modern standard. The quoted errors are from the counting of the modern standard, background, and sample being analyzed. They represent one standard deviation statistics (68% probability), based on the random nature of the radioactive disintegration process. Also by international convention, no corrections are made for DeVries effect, reservoir effect, or isotope fractionation in nature, unless specifically noted above. Stable carbon ratios are measured on request and are calculated relative to the PDB-1 international standard, the adjusted ages are normalized to -25 per mil carbon 13.

APPENDIX G

PROJECTILE POINT DATA

Compiled by
Steven D. Lipsky

Table G-1. 1 of 4
projectile point attributes from all excavations, 45-OK-196 and 45-OK-197.

Site	Grid N/S	Grid E/W	Field level Strat	Cat. Number	Max. Length	Stem Length	Blade Width	Stem Width	Neck Width	Max. Thick.	Weight (g)	Descriptive Dimensions 1 2 3 4 5 6 7 8 9 10
45-OK-197	S 5.74	W 31.52	53	.1, 76	Ind	0.62	Ind	Ind	0.73	0.33	0.35	2 1 3 2 5 1 3 5
	S 5.74	W 31.52	55	9	Ind	0.61	Ind	0.73	0.44	0.41	0.66	4 1 3 2 5 2 1 1
	S 5.96	W 3.90	XII	10C	1.80	0.32	1.52	0.71	0.61	0.42	0.72	5 1 3 1 3 2 1 1
	S 5.96	W 3.90	XII	10D	1.90	0.39	Ind	0.31	0.63	0.40	0.72	5 1 3 1 3 2 1 1
	Burial 1	Shoulder	—	15F	Ind	0.64	1.13	1.11	0.71	0.37	0.91	2 1 1 2 2 2 1 1
	Burial 1	Body	—	15A	1.97	0.58	1.01	1.26	0.89	0.31	0.74	2 1 3 1 1 1 1 1
	Burial 1	Body	—	15B	1.98	0.68	0.96	1.34	0.72	0.31	0.67	2 1 3 3 1 2 1 1
	Burial 1	Body	—	15C	Ind	Ind	Ind	Ind	Ind	0.22	0.40	2 1 3 6 5 5 1 1
	Burial 1	Body	—	15D	1.41	0.50	0.73	1.09	0.59	0.29	0.40	2 1 3 3 1 2 1 1
	Burial 1	Body	—	15E	Ind	0.46	1.09	1.22	0.69	0.28	0.54	2 1 1 1 1 1 1 1
	Burial 1	Rt. hand	—	16A	2.92	0.40	1.11	1.02	0.63	0.35	1.00	2 1 2 1 1 2 1 1
	Burial 1	Rt. hand	—	16B	3.07	0.32	1.03	0.81	0.59	0.38	1.07	2 1 1 1 2 2 1 1
	Burial 1	Rt. hand	—	16C	2.71	0.66	0.98	0.98	0.59	0.33	0.87	2 1 1 2 2 1 1 1
	Burial 1	Rt. hand	—	16D	2.59	0.58	1.00	0.93	0.62	0.31	0.83	2 1 2 2 2 2 1 1
	Burial 1	Rt. hand	—	16E	1.54	0.59	0.87	1.10	0.48	0.36	0.45	2 1 2 2 4 2 1 1
	S 2.4	W 53.90	VIIA	26	3.26	0.41	1.59	0.61	0.56	0.42	1.23	5 1 1 2 1 2 1 1
	S 2.45	W 53.90	IX	28	2.70	0.32	1.98	Ind	0.59	0.40	1.21	3 1 3 6 2 2 1 1
	Test Unit B		58	38	Ind	0.51	1.90	0.95	0.95	0.21		3 1 2 1 5 5 1 1
	S 4.96	W 1.90	XIV	43	1.69	0.39	Ind	1.00	0.72	0.39	0.60	5 1 3 1 1 2 1 1
	S 3.96	W 1.90	II, III	46	Ind	Ind	Ind	Ind	Ind	0.41	0.56	6 3 4 6 5 2 3 5 4 7
	S 3.96	W 1.90	IX	47	1.27	0.44	Ind	0.71	0.59	0.29	0.32	5 1 3 1 1 2 1 1
	S 5.96	W 2.90	VI	52B	1.56	0.48	1.13	1.10	0.56	0.24	0.91	2 1 3 3 3 2 1 1
	S 5.90	W 2.90	2	55	2.61	0.60	Ind	0.99	Ind	0.70	2.99	4 1 1 1 1 1 1 1

Table G-1. 2 of 4

Site	Grid N/S	Grid E/W	Field level Strat	Cat. Number	Max. Length	Stem Length	Blade Width	Stem Width	Neck Width	Max. Thick.	Weight (g)	Descriptive Dimensions 1 2 3 4 5 6 7 8 9 10
45-OK-197	S 5.40	W 57.90	IX	62	Ind	0.50	Ind	Ind	0.59	0.43	1.32	5 1 3 3 1 2 1 1
	S 13.00	W 31 75	II	67	Ind	0.99	Ind	1.38	0.62	0.28	0.50	2 1 3 3 5 2 1 1
	S 5.74	W 29.54	II	69	Ind	Ind	Ind	Ind	0.62	0.31	0.37	2 1 4 6 1 2 1 5
	S 5.74	W 29.52	II	70	Ind	Ind	Ind	Ind	Ind	0.28	0.20	0 3 4 6 5 2 3 5 4 7
	S 5.74	W 29.52	II	71	1.51	0.54	Ind	1.38	0.47	0.30	0.41	2 1 3 3 1 2 1 1
	S 13.00	W 31.75	II	72	Ind	0.64	1.12	1.32	0.63	0.38	0.81	2 1 1 1 1 2 1 1
	S 13.00	W 31.75	II	73	Ind	1.01	1.15	Ind	0.64	2.99	0.70	2 1 3 6 1 2 1 1
	S 5.74	W 29.52	II	74	2.06	0.92	0.99	Ind	0.72	0.39	0.76	2 1 3 3 1 2 1 1
	S 13.00	W 31.75	II	75	Ind	0.76	Ind	1.10	Ind	0.30	0.29	2 3 3 3 5 2 1 1
	S 12.00	W 30.75	II	78	2.05	0.91	1.16	1.53	0.78	1.39	1.01	2 1 3 3 2 2 1 1
	S 13.00	W 31.75	II	88	Ind	Ind	0.82	Ind	0.59	0.33	0.42	2 1 4 6 1 2 1 1
	S 5.74	W 29.52	II	93	Ind	N/A	1.10	N/A	N/A	0.32	0.40	1 1 3 3 5 2 1 1
	S 1.96	W 0.90	V	120	1.22	0.40	Ind	0.64	0.54	0.40	0.49	3 1 3 2 3 2 1 1
	S 1.96	W 1.90	III	126	Ind	Ind	Ind	Ind	Ind	0.34	0.80	5 1 4 6 1 2 1 5
	S 1.96	W 1.90	V	127	Ind	Ind	Ind	Ind	Ind	0.26	0.15	6 3 4 6 5 2 3 5
	S 1.96	W 2.90	V	128	Ind	0.65	Ind	1.30	0.50	0.28	0.29	2 1 3 3 5 2 3 1
	S 14.95	W 23.37	III	139	2.00	1.00	0.86	0.70	N/A	0.36	0.42	3 2 2 1 1 1 1 1
	S 15.95	W 24.37	III	142	1.21	0.60	1.00	1.20	0.70	0.32	0.28	2 1 3 3 1 2 1 1
	S 15.95	W 25.37	II	143	2.60	0.93	Ind	Ind	0.70	0.38	0.94	2 1 3 3 2 2 1 1
	S 15.95	W 25.37	III	144	Ind	N/A	Ind	N/A	N/A	0.41	0.80	1 1 0 3 1 1 1 1
	S 4.96	W 0.90	VII	145	Ind	Ind	Ind	Ind	Ind	0.81	4.45	6 2 4 6 5 1 3 5
	S 0.40	W 53.90	VII	150	Ind	0.40	1.99	Ind	0.72	0.40	0.88	5 1 3 1 1 1 1 1
	S 14.95	W 24.37	IV	152	Ind	N/A	Ind	N/A	N/A	0.38	0.69	3 1 4 6 3 1 1 1

Table G-1. 3 of 4

Site	Grid N/S	Grid E/W	Field level Strat	Cat. Number	Max. Length	Stem Length	Blade Width	Stem Width	Neck Width	Max. Thick.	Weight (g)	Descriptive Dimensions 1 2 3 4 5 6 7 8 9 10
45-OK-197	S 1.96	W 0.90	VIII	161	Ind	Ind	Ind	Ind	Ind	0.21	0.15	6 3 4 5 5 2 3 5
	S 1.96	W 0.90	VII	163	1.95	0.43	1.03	0.78	0.60	0.23	0.30	3 1 3 1 1 2 1 1
	S 2.96	W 0.90	XII	173	Ind	0.43	0.76	0.48	0.30	0.21	0.50	3 1 3 2 5 2 3 5
	S 2.40	W 1.90	VIID	174	Ind	0.53	1.89	0.82	1.12	0.73	3.36	3 1 2 1 1 2 1 1
	S 2.40	W 1.90	VIID	180	2.64	0.40	1.60	0.84	0.70	0.38	1.17	5 1 3 1 2 1 1 1
	S 2.40	W 51.90	VIID	181	Ind	Ind	Ind	Ind	0.49	0.38	0.62	5 1 4 6 1 2 1 1
	S 2.96	W 0.90	VIII	185	Ind	0.33	Ind	0.61	0.48	Ind	0.20	5 1 3 2 1 2 1 1
	S 1.40	W 56.90	VIIZ	190	Ind	Ind	2.27	Ind	2.06	0.72	6.86	1 2 4 6 2 2 1 1
	S 1.40	W 52.90	VI, VII	195	Ind	Ind	Ind	Ind	Ind	0.21	0.05	6 3 4 6 5 5 1 5
	S 2.40	W 55.90	VII	202	Ind	0.31	1.11	0.65	0.60	0.31	0.44	5 1 3 1 3 2 1 1
	S 1.96	W 1.90	VIII	208	Ind	Ind	Ind	Ind	Ind	Ind	0.21	6 3 4 6 5 5 3 5
	S 1.96	W 1.90	VIII	209	Ind	Ind	Ind	Ind	Ind	Ind	0.05	6 3 4 6 5 5 3 5
	S 1.96	W 1.90	VIII	211	1.92	0.39	1.17	0.97	0.51	0.30	0.39	2 1 1 1 2 2 1 1
	S 2.40	W 51.90	VIID	219	Ind	Ind	Ind	Ind	Ind	0.40	0.40	3 1 3 3 1 2 1 1
	S 14.95	W 24.37	IV	226	1.89	N/A	1.28	N/A	N/A	0.26	0.24	1 1 0 3 1 1 1 1
	S 2.96	W 2.90	VIII	235	Ind	0.67	Ind	1.01	1.01	0.81	4.80	3 2 2 2 5 1 3 3
	S 5.96	W 0.90	VIII	244	Ind	0.48	1.11	Ind	0.63	0.40	1.30	2 1 1 1 1 2 1 1
	S 2.96	W 0.90	VIII	247	2.47	0.30	1.30	1.05	0.94	0.27	0.70	5 1 3 1 2 1 1 1
	S 2.40	W 56.90	VIID	254	1.60	0.46	Ind	0.59	0.51	0.26	0.30	5 1 1 2 3 2 1 1
	S 1.40	W 56.90	VIID	255	3.45	0.89	1.93	1.79	1.67	0.59	3.65	2 1 3 2 2 1 1 1
	S 2.40	W 55.90	VIID	262	Ind	Ind	Ind	Ind	Ind	Ind	0.10	6 3 4 6 5 1 3 5
	S 2.40	W 56.90	VIID	264	2.48	0.33	Ind	Ind	0.45	0.31	0.53	5 1 1 2 3 2 1 1
	S 1.40	W 56.90	VIID	265	Ind	0.50	Ind	0.86	0.61	0.30	0.51	5 1 3 2 3 2 1 1

Table G-1. 4 of 4

Site	Grid N/S	Grid E/W	Field level Strat	Cat. Number	Max. Length	Stem Length	Blade Width	Stem Width	Neck Width	Max. Thick.	Weight (g)	Descriptive Dimensions 1 2 3 4 5 6 7 8 9 10
45-OK-197	S 2.40	W 56.90	VIID	267	Ind	Ind	Ind	1.61	Ind	0.21	0.36	5 1 4 6 2 2 1 5
	S 5.54	W 0.90	XII	271	6.11	0.82	2.32	1.44	1.44	0.91	12.80	1 2 2 2 2 2 1 1
	S 1.96	W 0.90	VIII	280	Ind	0.40	1.41	0.89	0.70	0.34	0.29	3 1 3 1 5 2 3 1
	S 1.96	W 0.90	VIII	231	2.58	0.31	1.74	0.51	0.51	0.21	0.29	3 2 2 4 2 1 1 1
	S 1.96	W 0.90	VIII	283	1.64	0.41	0.99	1.10	0.62	0.13	0.10	2 1 1 2 2 1 1 1
45-OK-136	Test Pit #1		3	6	3.30	0.52	2.02	1.12	1.09	1.73	3.60	3 1 3 3 4 2 1 1
	Test Pit #3		5	7	Ind	0.82	3.88	1.82	1.29	0.55	5.14	5 1 3 2 3 2 1 1
	N 104.0	E 263.0	13	14	2.32	0.42	1.51	0.88	0.88	0.34	1.28	5 1 2 2 1 2 1 1
	N 105.0	E 263.0	9	18	2.59	Ind	1.41	Ind	1.01	0.68	2.76	6 1 4 6 2 2 1 2
	N 105.0	E 263.0	15	19	Ind	1.07	1.63	0.51	1.19	0.78	2.38	5 1 2 1 5 2 1 1
	N 104.0	E 258.0	14	23	Ind	Ind	1.83	Ind	1.00	0.68	3.97	6 1 4 6 1 2 1 1
	N 104.0	E 258.0	15	34	Ind	0.79	Ind	1.69	1.21	0.43	0.92	6 3 3 1 5 2 1 1
	N 104.0	E 258.0	15	36	Ind	0.86	Ind	1.18	Ind	0.58	0.50	6 3 1 1 5 2 1 1

APPENDIX H

FLORAL ANALYSIS RESULTS

Compiled by
David Rhode

Table H-1. Carbonized plant remains, 45-OK-197.

Occ.	Field Strat	Provenience	Description
II	II	15.95S/22.37W	2 seeds, *Crataegus*; 2 charred unknown seeds
III	III	15.95S/24.39W	1 charred seed, *Prunus virginiana*
IV	IV, L4	13.95S/25.37W	1 seed, *Purshia tridentata*
II	II	14.95S/25.37W	4 charred seeds of three unknown types
III	III, L3	14.95S/22.37W	3 charred seeds, unknown spheroidal type
III	III, L1	14.95S/22.37W	4 charred seeds, unknown
II	II	14.95S/24.37W	4 charred seeds, unknown spheroidal type
UA	VI, L1	14.95S/24.37W	1 seed, *Cornus*?
IV	IV, L5	14.95S/24.37W	1 seed, *Cornus sp.*
IV	IV, L3	14.95S/25.37W	1 charred seed, unknown spheroidal type
II	II	14.95S/22.37W	2 seeds, *Cornus sp.*
II	II	13.95S/23.37W	1 charred seed, unknown spheroidal type
	III	100N/137E	1 charred seed, *Cornus sp.*
IV	IV, L2	15.95S/23.37W	1 unknown charred seed, too fragmented
V	V	13.95S/24.37W	1 unknown charred seed, too fragmented
IV	IV, L5	13.95S/24.37W	1 unknown charred seed, too fragmented
IV	IV, L2	14.95S/25.37W	1 unknown charred seed, too fragmented
IV	IV	15.95S/22.37W	1 charred seed fragment, unknown
IX	VIII	1.96S/4.9W	1 charred root fragment
I	II, Fea 11	2.4S/52.9W	9 charred seeds, *Crataegus*; 10 charred seeds, *Cornus sp.*
I	Fea 9 fill	2.4S/59.9W	8 darkened uncharred seeds, *Crataegus sp.*
UA	IV	0.4S/53.9W	1 seed, *Prunus virginiana*
I	II	2.4S/55.9W	8 seeds, *Cornus sp.*
I	III & IV, Fea 11	1.4S/51.9W	1 seed, *Cornus sp.*; 1 seed, *Prunus virginiana*
UA	VIII	2.4S/52.9W	1 charred seed, *Cornus sp.*; 1 charred seed, unknown
I	II	2.4S/56.9W	3 seeds, *Cornus sp.*; 3 seed fragments, *Prunus virginiana*; 1 charred seed, unknown
UA	III? IV?	2.4S/55.9W	1 charred seed, *Cornus sp.*; 2 unknown seeds; 1 charred berry, *Crataegus*

Note: Unknown spheroidal type seeds are probably fragments of *Cornus sp.* which are too fragmented to make positive identification.

APPENDIX I

PROVENIENCE OF ARTIFACTS ILLUSTRATED IN THE TEXT

3. current characteristics, which may yield selective sorting of certain sizes. Currents with constant strength (either low or high) will give better sorting, as will currents intermediate in strength;

4. amount of sediment from the source. If the stream has reached capacitance, its ability to sort during deposition will necessarily be lower.

Sorting of samples from 45OK197 remains constant at or about 2ϕ, the cut-off between poorly sorted and very poorly sorted. In light of the proximity to the Columbia River, it seems likely that the sediments were dumped intermittently by currents of varying strengths and durations. Most fluvial sediments, especially floodplain, exhibit sorting at or greater than 2ϕ. Texas floodplain deposits, for example, range from 2.0 - 3.5ϕ. However, loess deposits also exhibit poor sorting, so in this instance sorting is not as diagnostic as it might be.

III. SKEWNESS

Skewness is a graphic measure of the distribution symmetry. It is geometrically independent of the sample sorting; since most samples taken for analysis include <u>many</u> depositional episodes, the analysis reflects bulk sorting rather than depositional or transport sorting. The skewness of a deposit sampled in bulk is *sensitive* to the type of depositional environment. Some river sands show positive skewness due to enrichment in fine silt-sized particles deposited as the river drops after floodstage. The sediments from 45OK197 are unfailingly strongly fine-skewed (positive), indicating a fine-grained tail in the grain-size distribution. Fine-grained tails are extremely common in both floodplain and loess deposits (due to low efficiency of wind in moving coarse particles); the skewness for these samples may narrow the choices but, like the sorting, is not diagnostic of the environment.

IV. KURTOSIS

The kurtosis, or peakedness, of the curve is a graphic measure of the ratio of sorting in the tails to sorting in the central portion. The samples from 45OK197 range from very leptokurtic to extremely leptokurtic (peaked) which means the central portion is better sorted than the tails. *In fact, Trasks sorting coefficient (So), which measures sorting only in* the middle of the curve, indicates that every sample is well-sorted.

Skewness and kurtosis are more pronounced in sediments from multiple sources. The extreme fine-skewing and peakedness of samples from strata 2-23 argue strongly for a multiple-source origin.

Plots of skewness versus kurtosis often yield environmental differentiation. Sediments from fluvial environments are commonly positive (fine) skewed and leptokurtic; unfortunately, those from aeolian flats are also.

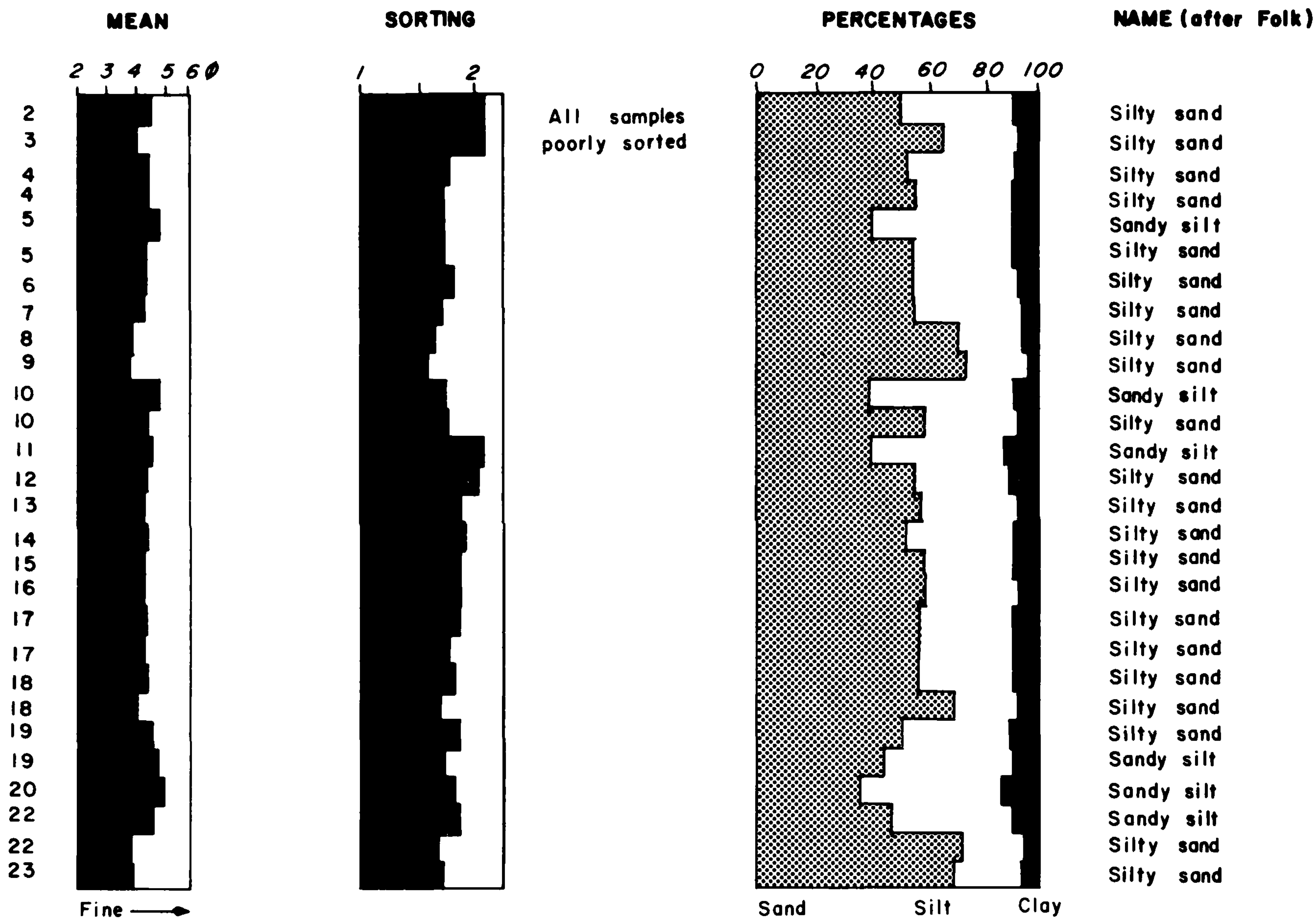


Figure J-2. Summary of textural analysis, East Block 450K197

INTERPRETATION OF DATA

I. MEAN

The mean is defined as the sum of measurements divided by the number of measurements, and, as such, is a superior estimator of the whole distribution of sizes. There is very little variation in the mean for this series of sample, remaining constant at or about 4ϕ, which corresponds to the very fine sand class and also serves as the cut-off point between sand and silt.

The mean has an obvious although not well understood correlation with the environment of deposition. The mean depends on:

1. current strength (including turbulence) of the local environment;
2. size of material available at the source.

The fine grain size indicates that the sediments were probably deposited by rather weak, low competence currents, either fluvial or aeolian. If fluvial, it is more than likely that deposition occurred somewhere outside the main channel, such as on a floodplain, throughout the entire interval sampled.

The actual mean exhibited by the samples is also heavily dependent on the second factor. Natural sediments can be broken down into three broad categories:

1. Pebble population - massive rocks with blocky breakage.
2. Sand-coarse silt population - stable residual products liberated from weathering of granular rocks such as granite, schist and phyllite.
3. Clay population - products of chemical weathering.

The proximity of 450K197 to granitic-metamorphic source rocks argues for the dominance within the samples of the second population type. The mean tends to confirm this.

II. STANDARD DEVIATION

The standard deviation of grain sizes in a sample, also known as sorting, is usually broadly diagnostic for particular environments. Sorting depends on:

1. size range of available material;
2. type of deposition occurring, whether the sediment is spread as deposited or just dumped, for example;

Textural Analysis of Sediments
East Block, 450K197, Strata 2-23

by

Karin A. Hoover

SAMPLE PREPARATION AND ANALYSIS

1. Sample split to 30-40 grams.

2. Sample placed in centrifuge bottle and distilled water added in 1:1 - 1:2 ratio to create a slurry-like mixture.

3. Calcium carbonate removal: Approximately 10 ml hydrochloric acid (10% solution) added to remove $CaCO_3$ - as soon as the fizzing ceased the samples were centrifuged for 15 minutes and the HCl - H_2O siphoned off.

4. Removal of organics: Distilled water was added to the centrifuged sample in a 1:1 ratio followed by 5 ml of 30% hydrogen peroxide (H_2O_2) and the sample stirred - allowed to sit for 10 minutes - 5 ml more 30% H_2O_2 added followed by successive 1 ml additions until frothing ceased. The samples were then heated at 50°C for one hour and left to sit overnight, after which they were centrifuged and the liquid siphoned off.

5. The samples were wet sieved through a 4ϕ screen into a 1000 ml cylinder with peptizing agent composed of 1.5 gms sodium hexametaphosphate per liter of distilled water.

6. The coarse fraction was washed into a 250 ml beaker with distilled water and dried overnight at 100°C.

7. The coarse fraction was mechanically sieved (Ro-Tap) for 20 minutes at 1/2ϕ intervals to 4ϕ and the pan added to the pipette cylinder. The other sizes were weighed to the nearest 0.0001 gm.

8. The fine fraction was pipetted following Folk (1974a, pg. 40). 20 ml liquid drawn from 1000 ml cylinder of sediment and peptizing agent at timed intervals for whole phi sizes 4-8 (silt) and, in some cases, 9 (coarse clay) and placed in 50 ml beakers.

9. Beakers dried overnight at 100°C and weighed to nearest 0.0001 gm after cooling to room temperature.

10. Size fraction weights entered into computer program "Sed Lab" and moment measures computed.

1400) encompasses the little ice age, during much of which the climate of western North America was cool and dry (Chatters 1982b). During the intervening warm period, there were short peiods of alternating dry and moist conditions. Although the relationship of flooding to climatic conditions is complex and not amenable to simple, univariate explanation, we will not attempt here to offer any hypotheses to account for the correspondence between climates and changes in flood tempos. Hypothesis formulation will be an interesting direction for later research into the meanings of data presented here.

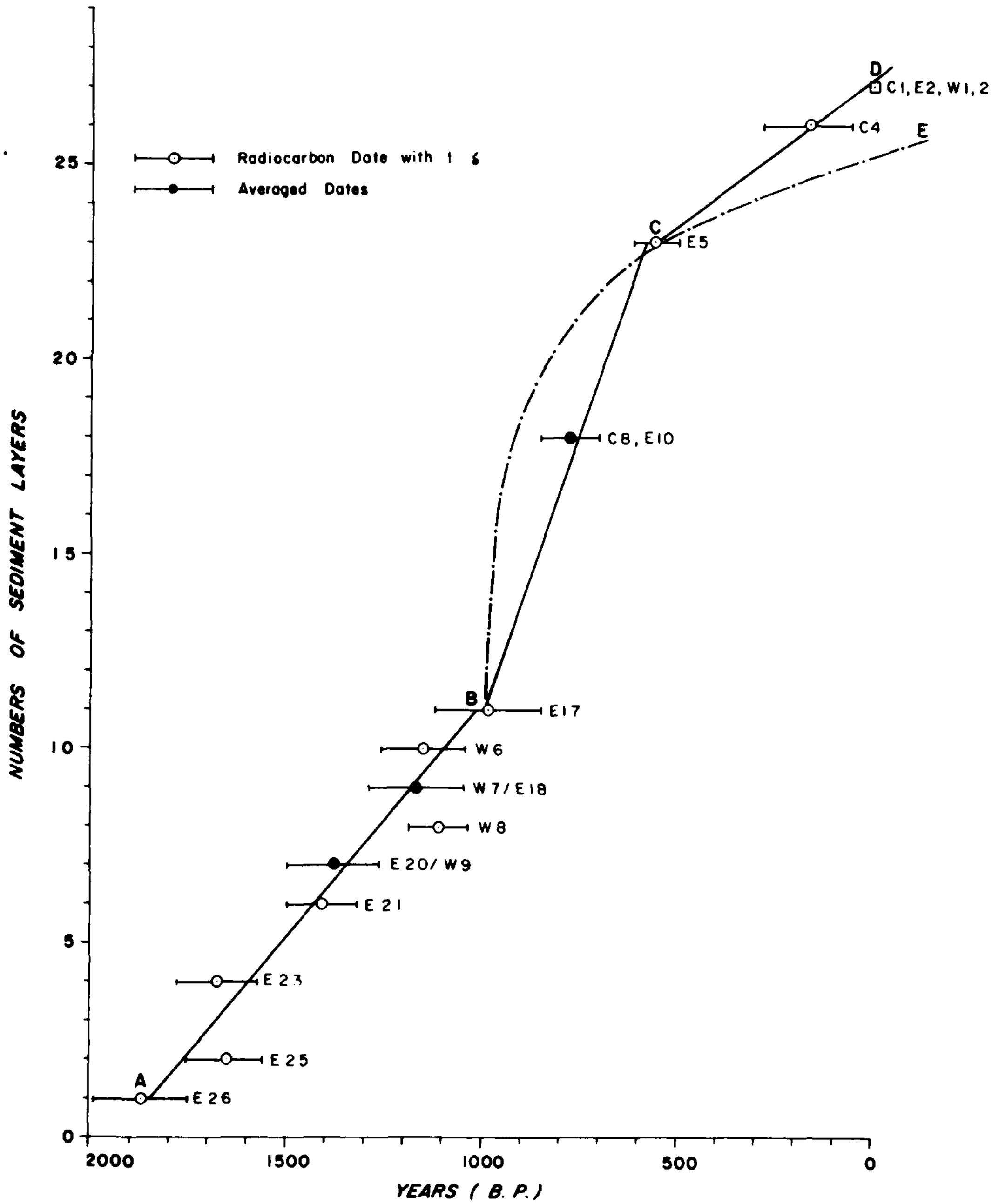


Figure J-1. Tempo of sedimentation episodes at 450K197. Line segments BA, BC and CD are described by equations of the form $y = ax + b$; Line BE represents an asymptotic function of the type $y = a\log x + b$. Note the extreme variations in flood frequency expressed by the straight line segments. Numbers above radiocarbon dates refer to strata from which the dates were derived (see text Chapter V, Tables 3 and 6).

Actual Flood Tempos

The sedimentation curve from 450K197 (Figure 10) is based on the ages of sediment layers at 450K197 as cross dated in Chapter V. It does not conform to the asymptotic model, but shows evidence of at least two and probably three intervals of time among which flood frequencies varied. Line segment AB describes the interval between 1870 BP (AD 80) and 980 BP (AD 970). Sedimentation frequencies (represented by the function $y = 83.65x - .25$, $r = .965$, $r2 = .931$) were one per 83.65 years. The linear function indicates that the impact of elevation gain (ca. 1.0m) was insufficient to have a significant impact on sediment deposition.

Sediments from the period from 980 BP (AD 970) to 2 BP (AD 1948) appear at first to conform to the asymptotic model of uniform flood tempo. However, when the correlation coefficient (r) and variance (r2) for curvilinear function BE ($y = .1677\log x +. 60$, $r = .910$, $r2 = .83$) are compared with coefficients and variances for linear functions BC ($y = 34.45x + .25$, $r = .986$, $r2 = .968$) and CD ($y = 137.30x$, $r = .998$, $r2 = .996$) it seems more probable that the frequency of floods has varied considerably during the past 1000 years. Again, the elevation factor does not seem to have been influential.

From 980 BP (AD 970) to 560 BP (AD 1390) floods exceeding 293.5m a.s.l. occurred approximately once every 34 years, whereas since AD 1390 they have been occurring only once every 137 years.

Here we must interject a caveat. Linear function AB represents 11 data points (including 4 dates from which averages shown in Figure 10 were calculated) and it is probably an accurate representation of actual flood frequencies. However, linear function BC is calculated from only four data points (including two averaged dates) and function CD describes only three points. Correlations are therefore high and the lines describe nearly 100% of data variance, but confidence limits are low. More dates will be required for sediment layers deposited during the time intervals represented by lines BC and CD before we can have full confidence in our results.

Despite the data's shortcomings, it remains clear that flood tempo has not been constant during the past 19 centuries, but has changed once (ca. 1000 BP; AD 950) and probably twice (also at ca. AD 1400). Only during the past 600 years have flood frequencies (1/137 yr) approximated the U.S. Army Corps of Engineers (USACE) concept of "100 year" floods. Since severe floods have been more frequent for most of the last 1900 years, perhaps the USACE should rethink its ideas about flooding tempos on the Columbia River.

Points at which flood frequencies change correspond roughly to the temporal boundaries between major climatic periods. Point B (Figure 10) corresponds with the end of a cool interval that lasted from approximately 1550 to 1000 BP (ca. AD 400-900; Denton and Karlen 1973).[1] The final period (CD) beginning around 560 BP (ca. AD

[1] References in the text bibliography.

alluvial fan formed by Corral Creek is also a factor, today causing waters of Rufus Woods Lake to eddy behind it. In a flood situation, this could lead to erosion (such as the re-entrant in the central area) or deposition of sediment.

We attempted to solve the problem of following sediment layers upslope using a geophysical instrument called a gamma scanner. The gamma radiation emitted from sediment layers varies with their mineralogy and is regularly used to map subsurface stratigraphy on a large scale. This was the first attempt made to apply the technique on recent (<12,000 years) sediments. Results had begun to look promising at the time of Dr. Crosby's death and we were unable to complete the study. Thus we can only consider the tempo of floods severe enough to deposit sediment above 293.5 m.a.s.l. (lowest site elevation).

Tempo

To examine variation in the frequency of flood episodes during the nearly 1900 years represented by 450K197 sediments, we have compared the actual curve of sediment deposition frequency against two hypothetical models representing the results of a uniform tempo of flooding: asymptotic and linear.

The asymptotic model assumes that the river's normal bed and surface elevations remain constant, the range of flood magnitude, the mean flood magnitude and the factors affecting sediment deposition remain constant. That is, each flood of sufficient magnitude to exceed the 293.5m level deposited observable sediment. In using an asymptotic model we are taking into consideration the fact that each time sediment is deposited on a surface, the elevation of that surface increases. As elevation rises, it will take increasingly severe floods for more sediment to be added to the surface. Thus, a mathematical description of the long-term frequency of sediment deposition on a site should take the form $y = a\log x + b$ where y = sediment deposition events and x = time.

If elevation gain is insufficient to affect the occurrence of sedimentation on a surface, but all other assumptions of the asymptotic model hold, then sedimentation rates should be constant and describable by a linear function of the type $y = ax + b$. We would expect this type of sedimentation over a short period when elevation gain from each sedimentation event is slight. Over the long term, or with greater elevation gains from each event, the asymptotic model should hold.

If flood tempos have not varied in the past 1900 years, the sedimentation curve should conform to one of the models described above and be represented by a binomial function of either the $y = ax + b$ or $y = a\log x + b$.

Flood Periodicity

by

James C. Chatters

In considering the periodicity of overbank flooding by the Columbia River during the time interval represented by sediments at 45OK197, we are concerned with two principal flood dimensions: magnitude or the duration and depth of flood waters, and the tempo or frequency with which floods of varying severity occur. We have approached tempo and severity of flooding at 45OK197 from the point of view that thickness, elevation and ages of single beds of sediment should provide information on how often flood levels exceeded 293.5m (954') a.s.l. (the base of site deposits) and how severe those floods were.

As described in text Chapter V, sediments consist of graded fluvial beds overlain by a long series of massive (i.e., ungraded) beds. Because of only moderate sorting and consistent particle sizes among massive strata (part 2), we have concluded that all these beds were deposited by the same process, probably fluvial (see J, part 2).

We are assuming that each recognizable bed sediment was deposited during a single flood episode. This is certainly the case for graded beds, but it is possible that massive sediments might contain particles from more than one event. However, soil A horizons form rapidly at this site due to the leaf mold produced on the woodland floor. If any of the massive beds contain sediment from more than one flood, the floods must certainly have occurred so close together that not a single year's leaf fall could be deposited on site. We believe the single flood, single bed assumption is appropriate here.

Magnitude

We considered the elevation reached by sediment and the thickness of sediment, corrected for elevation, to be possible indicators of magnitude. Two facts worked against us here: 1) there is no definite correlation between water depth and sedimentation amounts and 2) individual layers could not be followed visually upslope. The amount of silt and sand deposited would depend not only on water depth, but also on how much sediment the water carried per unit volume (load), and how rapidly the water flowed over the deposition site. Sediment load would vary in floods of the same depth and speed, dependent on the ground cover and erosibility of soils from which the water originated and over which it flowed. Water speed over a site can vary from time to time dependent on blockages upstream, downstream and on site. Certainly if there was dense vegetation on a surface, as at 45OK197 today, water would be slowed suddenly and sediment deposition would occur rapidly even in floods carrying light loads. The small

APPENDIX J

STRATIGRAPHIC ANALYSIS, 450K197

COLUMBIA RIVER FLOOD PERIODICITY

Prepared by

James C. Chatters

ANALYSIS OF SEDIMENTS FROM EAST BLOCK, 450K197

Compiled by

Karin A. Hoover

Figure I-1. (4 of 4)

Figure	Item	Occupation	Provenience	Catalog #
16	a	IX	S2.96/W0.90	185
16	b	IX	S2.96/W0.90	247
16	c	IX	S5.96/W0.90	244
16	d	IX	S1.96/W1.90	211
16	e	IX	S1.96/W0.90	288
16	f	IX	S1.96/W0.90	280
16	g	IX	S1.96/W0.90	287
16	h	IX	S2.96/W2.90	234
16	i	IX	S1.96/W2.90	215
16	j	IX	S2.96/W0.90	263
16	k	IX	S1.96/W2.90	214
16	l	IX	S4.96/W1.90	19
16	m	IX	S2.96/W2.90	237
16	n	IX	S4.96/W3.90	242
16	o	IX	S4.96/W0.90	241

Table I-1. (3 of 4)

Figure	Item	Occupation	Provenience	Catalog #
15	a	XI	S0.4/W53.9	150
15	b	XI	S2.4/W51.9	174
15	c	XI	S1.4/W56.9	255
15	d	XI	S2.4/W51.9	180
15	e	XI	S2.4/W56.9	264
15	f	XI	S6.4/W53.9	25
15	g	XI	S2.4/W53.9	112
15	h	XI	S3.4/W53.9	12
15	i	XI	S2.4/W53.9	111
15	j	XI	S2.4/W55.9	259
15	k	XI	S1.4/W56.9	260
15	l	XI	S2.4/W55.9	248
15	m	XI	S3.4/W54.9	11
15	n	XI	S1.4/W56.9	261
15	o	XI	S2.4/W55.9	250
15	p	XI	S2.4/W55.9	252
15	q	XI	S2.4/W52.9	177
15	r	XV	S1.96/W0.90	279
15	s	XV	S1.96/W0.90	272
15	t	XV	S1.96/W1.90	266
15	u	XV	S1.96/W2.90	176
15	v	XV	S2.96/W0.90	273
15	w	XV	S1.96/W2.90	172
15	x	XV	S1.96/W0.90	277
15	y	XV	S1.96/W1.90	245
15	z	XV	S1.96/W0.90	278

Table I-1. (2 of 4)

Figure	Item	Occupation	Provenience	Catalog #
14	a	II	S13/W31.75	73
14	b	II	S13/W31.75	72
14	c	II	S13/W31.75	88
14	d	II	S5.74/W29.52	71
14	e	II	S5.74/W29.52	74
14	f	II	S15.95/W29.37	143
14	g	II	S12/W31.75	82
14	h	II	S13/W31.75	67
14	i	II	S12/W29.75	90
14	j	II	S12/W31.75	80
14	k	II	S13/W31.75	87
14	l	II	S12/W29.75	94
14	m	VI	S2.96/W2.90	217
14	n	VI	S1.96/W0.90	120
14	o	VI	S1.96/W2.90	128
14	p	VI	S5.96/W0.90	136
14	q	VI	S5.9/W3.9	2
14	r	VI	S1.96/W0.9	296
14	s	VI	S4.96/W2.90	45
14	t	VI	S2.96/W0.90	155
14	u	VI	S1.96/W0.90	119
14	v	VI	S1.96/W4.90	131
14	w	VI	S3.96/W0.90	134

Table I-1. Provenience data on illustrated artifacts.

Figure	Item	Occupation	Provenience	Catalog #
5	a	II	S13/W31.75	73
5	b	II	S5.74/W29.52	71
5	c	VII	S5.96/W2.90	52B
5	d	II	S15.95/W25.37	143
5	e	II	S13/W31.75	72
5	f	IX	S5.96/W0.90	244
5	g	IX	S1.96/W0.90	288
5	h	IX	S1.96/W1.90	211
5	i	IX	S2.96/W0.90	247
5	j	XI	S2.4/W51.9	180
5	k	XII	S5.96/W3.9	10C
5	l	XI	S1.4/W56.9	265
5	m	VI	S1.96/W0.90	120
5	n	X	S0.4/W53.9	150
5	o	XI	S2.4/W56.9	264
5	p	XI	S2.4/W56.9	254
5	q	III	S15.95/W25.37	144
5	r	XI	S3.4/W53.9	12
5	s	IV	N104/E258	34
5	t	94.24	S5.96/W36	271
5	u	Strat V 100-140cm	N99/E137	207
5	v	IV	N104/E263	14
5	w	IV	N104/E258	23
5	x	XI	S2.4/W51.9	174
5	Y	VIII	S1.96/W0.90	163
5	z	XII	S2.96/W0.90	173
5	a^1	IX	S2.96/W0.90	185
5	b^1	XII	S2.45/W53.9	28

V. PARTICLE MORPHOLOGY

Particle morphology (form, sphericity and roundness) and especially surface texture of the individual grains (whether frosted or dull) may be of some use in resolving the problem of aeolian versus fluvial origins, resp. Fluvial sediments in general have higher sphercity and little or no rounding, but this depends on the structure of the mineral and time available for work.

SUMMARY

Given the mean, sorting, skewness and kurtosis rendered by textural analysis for the samples from 45OK197, the most reasonable working hypothesis is that the sediments were originally floodplain deposits which were perhaps reworked by the wind (although not enough to change their original character) prior to stabilization by vegetation. Had they been originally wind-deposited, I would expect the silt content to be somewhat higher, close to 70%. More importantly, what the analysis has demonstrated is that the mechanisms acting upon the sediments, either during or subsequent to deposition, have remained constant throughout the interval sampled.

Table J-1. 1 of 29
Textural analysis of East Block sediments 450K197.
Stratum 2

PHI SIZE	FRACTION WEIGHT	FRACTION PERCENT	ACCUMULATED PERCENT
-2.25	0.000	0.00	0.00
-2.00	0.000	0.00	0.00
-1.50	0.000	0.00	0.00
-1.00	0.000	0.00	0.00
-0.50	0.139	0.48	0.48
0.00	0.014	0.05	0.53
0.50	0.024	0.08	0.61
1.00	0.032	0.11	0.72
1.50	0.065	0.23	0.95
2.00	0.309	1.07	2.02
2.50	1.332	4.61	6.63
3.00	3.825	13.25	19.88
3.50	4.334	15.01	34.89
4.00	4.450	15.41	50.30
5.00	6.835	23.67	73.97
6.00	2.270	7.86	81.83
7.00	1.430	4.95	86.79
8.00	0.815	2.82	89.61
9.00	0.585	2.03	91.64
10.00	2.415	8.36	100.00

POST ANALYTICAL WEIGHT = 28.875 ; MODE = 5.00 PHI

PERCENTAGES OF				SAND/MUD	SHEPARD
GRAVEL	SAND	SILT	CLAY	RATIO	CLASS
0.00	50.30	39.31	10.39	1.01	2

PHI SIZES AT PERCENT LEVELS OF

1.	5.	16.	25.	35.	50.	65.	75.	84.
1.57A	2.40A	2.88A	3.18A	3.50A	3.99A	4.44A	5.10A	6.37A

TRASK VALUES

Q1	Q2	Q3	SO	LOG SO	SKG
0.111	0.063	0.029	1.950	0.290	0.902

INMAN VALUES (2ND SKEWNESS AND KURTOSIS COULD NOT BE COMPUTED)

MEDIAN	MEAN	DEV.	SKEW.
3.99	4.62	1.74	0.36

FOLK AND WARD VALUES (ONLY THE MEAN COULD BE COMPUTED)

MEAN
4.41

MOMENT MEASURES (WITHOUT SHEPPARD CORRECTIONS)

MEAN	ST. DEV.	SKEW.	KURT.
4.55	2.05	1.12	3.81

NO SHEPPARD CORRECTION. PHI VALUES ARE NOT EQUALLY SPACED.

Table J-1. 2 of 29
Textural analysis of East Block sediments 450K197.
Stratum 3

PHI SIZE	FRACTION WEIGHT	FRACTION PERCENT	ACCUMULATED PERCENT
-2.25	0.000	0.00	0.00
-2.00	0.000	0.00	0.00
-1.50	0.000	0.00	0.00
-1.00	0.000	0.00	0.00
-0.50	0.445	1.73	1.73
0.00	0.019	0.08	1.81
0.50	0.015	0.06	1.87
1.00	0.020	0.08	1.95
1.50	0.056	0.22	2.17
2.00	0.411	1.60	3.77
2.50	1.823	7.10	10.86
3.00	4.742	18.47	29.33
3.50	4.767	18.56	47.89
4.00	4.401	17.14	65.03
5.00	4.690	18.26	83.29
6.00	1.125	4.38	87.67
7.00	0.565	2.20	89.87
8.00	0.410	1.60	91.47
9.00	0.155	0.60	92.08
10.00	2.035	7.92	100.00

POST ANALYTICAL WEIGHT = 25.680 ; MODE = 3.50 PHI

	PERCENTAGES OF			SAND/MUD	SHEPARD
GRAVEL	SAND	SILT	CLAY	RATIO	CLASS
0.00	65.03	26.44	8.53	1.86	2

PHI SIZES AT PERCENT LEVELS OF (LAST VALUE IS EXTRAPOLATED)

1.	5.	16.	25.	35.	50.	65.	75.	84.	95.
-0.54L	2.18A	2.67A	2.90A	3.15A	3.55A	4.00A	4.50L	5.11A	14 90L

TRASK VALUES

Q1	Q2	Q3	SO	LOG SO	SKG
0.134	0.085	0.044	1.741	0.241	0.905

INMAN VALUES

MEDIAN	MEAN	DEV.	SKEW.	2ND SK.	KURT.
3.55	3.89	1.22	0.27	4.10	4.22

FOLK AND WARD VALUES

MEAN	DEV.	TYPE	SKEW.	TYPE	KURT.	TYPE
3.78	2.54	5	0.53	5	3.26	6

MOMENT MEASURES (WITHOUT SHEPPARD CORRECTIONS)

MEAN	ST. DEV.	SKEW.	KURT.
4.06	2.03	1.33	5.07

NO SHEPPARD CORRECTION. PHI VALUES ARE NOT EQUALLY SPACED.

Table J-1. 3 of 29
Textural analysis of East Block sediments 450K197.
Stratum 4-upper

PHI SIZE	FRACTION WEIGHT	FRACTION PERCENT	ACCUMULATED PERCENT
-2.25	0.000	0.00	0.00
-2.00	0.000	0.00	0.00
-1.50	0.000	0.00	0.00
-1.00	0.000	0.00	0.00
-0.50	0.136	0.42	0.42
0.00	0.067	0.21	0.63
0.50	0.030	0.09	0.72
1.00	0.044	0.14	0.86
1.50	0.089	0.27	1.13
2.00	0.254	0.79	1.91
2.50	0.864	2.67	4.58
3.00	3.432	10.61	15.19
3.50	5.217	16.12	31.31
4.00	7.069	21.84	53.16
5.00	8.025	24.80	77.95
6.00	2.130	6.58	84.53
7.00	1.250	3.86	88.40
8.00	0.815	2.52	90.92
9.00	2.940	9.08	100.00

POST ANALYTICAL WEIGHT = 32.362 ; MODE = 5.00 PHI

GRAVEL	PERCENTAGES OF SAND	SILT	CLAY	SAND/MUD RATIO	SHEPARD CLASS
0.00	53.16	37.76	9.08	1.13	2

PHI SIZES AT PERCENT LEVELS OF

1.	5.	16.	25.	35.	50.	65.	75.	84.
1.32A	2.54A	3.03A	3.32A	3.58A	3.92A	4.44L	4.73A	5.89A

TRASK VALUES

Q1	Q2	Q3	SO	LOG SO	SKG
0.100	0.066	0.038	1.629	0.212	0.928

INMAN VALUES (2ND SKEWNESS AND KURTOSIS COULD NOT BE COMPUTED)

MEDIAN	MEAN	DEV.	SKEW.
3.92	4.46	1.43	0.38

FOLK AND WARD VALUES (ONLY THE MEAN COULD BE COMPUTED)

MEAN
4.28

MOMENT MEASURES (WITHOUT SHEPPARD CORRECTIONS)

MEAN	ST. DEV.	SKEW.	KURT.
4.40	1.74	1.01	3.93

NO SHEPPARD CORRECTION. PHI VALUES ARE NOT EQUALLY SPACED.

Figure J-1. 1 of 27
Textural analysis of East Block sediments 450K197.
Stratum 4-upper

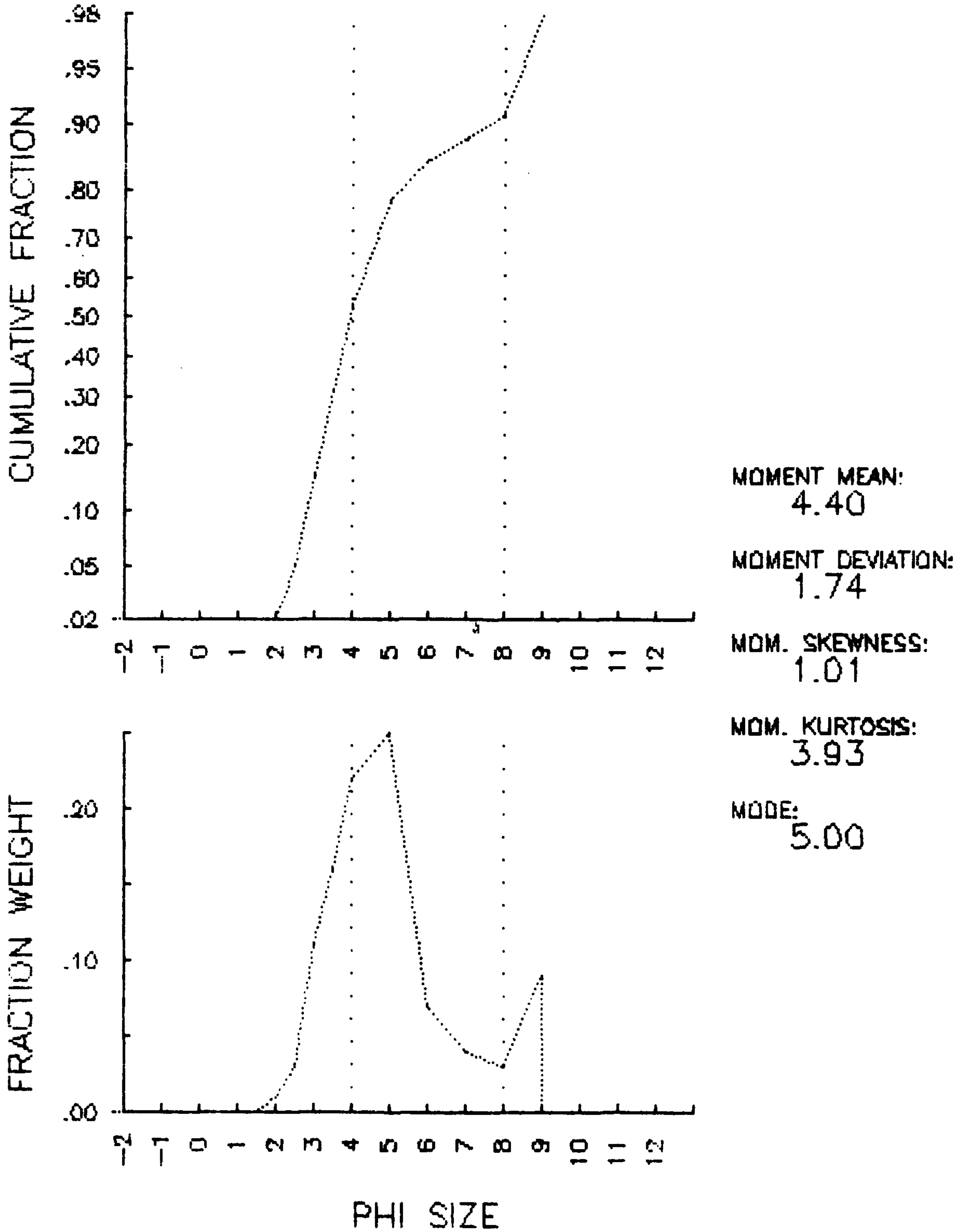


Table J-1. 4 of 29
Textural analysis of East Block sediments 450K197.
Stratum 4-lower

PHI SIZE	FRACTION WEIGHT	FRACTION PERCENT	ACCUMULATED PERCENT
-2.25	0.000	0.00	0.00
-2.00	0.000	0.00	0.00
-1.50	0.000	0.00	0.00
-1.00	0.000	0.00	0.00
-0.50	0.000	0.00	0.00
0.00	0.003	0.01	0.01
0.50	0.007	0.03	0.04
1.00	0.010	0.04	0.09
1.50	0.016	0.07	0.16
2.00	0.062	0.28	0.43
2.50	0.347	1.54	1.97
3.00	2.338	10.40	12.37
3.50	4.311	19.16	31.54
4.00	5.381	23.92	55.46
5.00	5.610	24.94	80.39
6.00	1.045	4.65	85.04
7.00	0.675	3.00	88.04
8.00	0.500	2.22	90.26
9.00	2.190	9.74	100.00

POST ANALYTICAL WEIGHT = 22.494 ; MODE = 5.00 PHI

GRAVEL	PERCENTAGES OF SAND	SILT	CLAY	SAND/MUD RATIO	SHEPARD CLASS
0.00	55.45	34.81	9.74	1.24	2

PHI SIZES AT PERCENT LEVELS OF

1.	5.	16.	25.	35.	50.	65.	75.	84.
2.31A	2.74A	3.11A	3.35A	3.57A	3.87A	4.35L	4.75L	5.73A

TRASK VALUES

Q1	Q2	Q3	SO	LOG SO	SKG
0.098	0.068	0.037	1.623	0.210	0.884

INMAN VALUES (2ND SKEWNESS AND KURTOSIS COULD NOT BE COMPUTED)

MEDIAN	MEAN	DEV.	SKEW.
3.87	4.42	1.31	0.42

FOLK AND WARD VALUES (ONLY THE MEAN COULD BE COMPUTED)

MEAN
4.24

MOMENT MEASURES (WITHOUT SHEPPARD CORRECTIONS)

MEAN	ST. DEV.	SKEW.	KURT
4.41	1.67	1.39	4.08

NO SHEPPARD CORRECTION. PHI VALUES ARE NOT EQUALLY SPACED.

Figure J-1. 2 of 27
Textural analysis of East Block sediments 450K197.
Stratum 4-lower

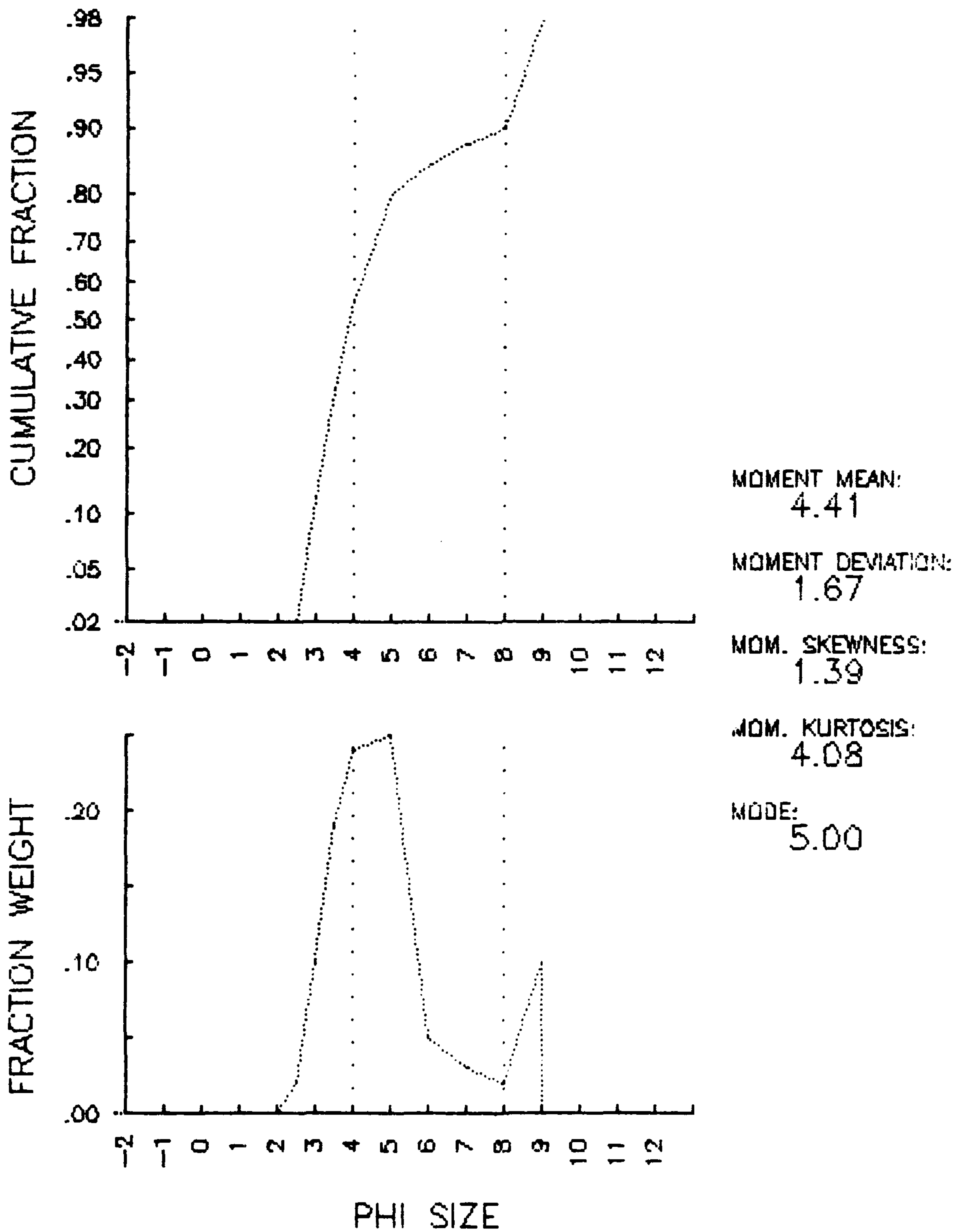


Table J-1. 5 of 29
Textural analysis of East Block sediments 450K197.
Stratum 5-upper

PHI SIZE	FRACTION WEIGHT	FRACTION PERCENT	ACCUMULATED PERCENT
-2.25	0.000	0.00	0.00
-2.00	0.000	0.00	0.00
-1.50	0.000	0.00	0.00
-1.00	0.000	0.00	0.00
-0.50	0.000	0.00	0.00
0.00	0.000	0.00	0.00
0.50	0.017	0.05	0.05
1.00	0.029	0.09	0.14
1.50	0.041	0.12	0.26
2.00	0.103	0.31	0.57
2.50	0.330	0.99	1.57
3.00	1.855	5.59	7.15
3.50	4.004	12.06	19.21
4.00	6.981	21.02	40.23
5.00	9.605	28.92	69.15
6.00	3.255	9.80	78.95
7.00	2.170	6.53	85.49
8.00	1.330	4.00	89.49
9.00	3.490	10.51	100.00

POST ANALYTICAL WEIGHT = 33.211 ; MODE = 5.00 PHI

GRAVEL	PERCENTAGES OF SAND	SILT	CLAY	SAND/MUD RATIO	SHEPARD CLASS
0.00	40.23	49.26	10.51	0.67	3

PHI SIZES AT PERCENT LEVELS OF

1.	5.	16.	25.	35.	50.	65.	75.	84.
2.30A	2.89A	3.39A	3.65A	3.88A	4.19A	4.74A	5.54A	6.73A

TRASK VALUES

Q1	Q2	Q3	SO	LOG SO	SKG
0.080	0.055	0.021	1.929	0.285	0.756

INMAN VALUES (2ND SKEWNESS AND KURTOSIS COULD NOT BE COMPUTED)

MEDIAN	MEAN	DEV.	SKEW.
4.19	5.06	1.67	0.52

FOLK AND WARD VALUES (ONLY THE MEAN COULD BE COMPUTED)

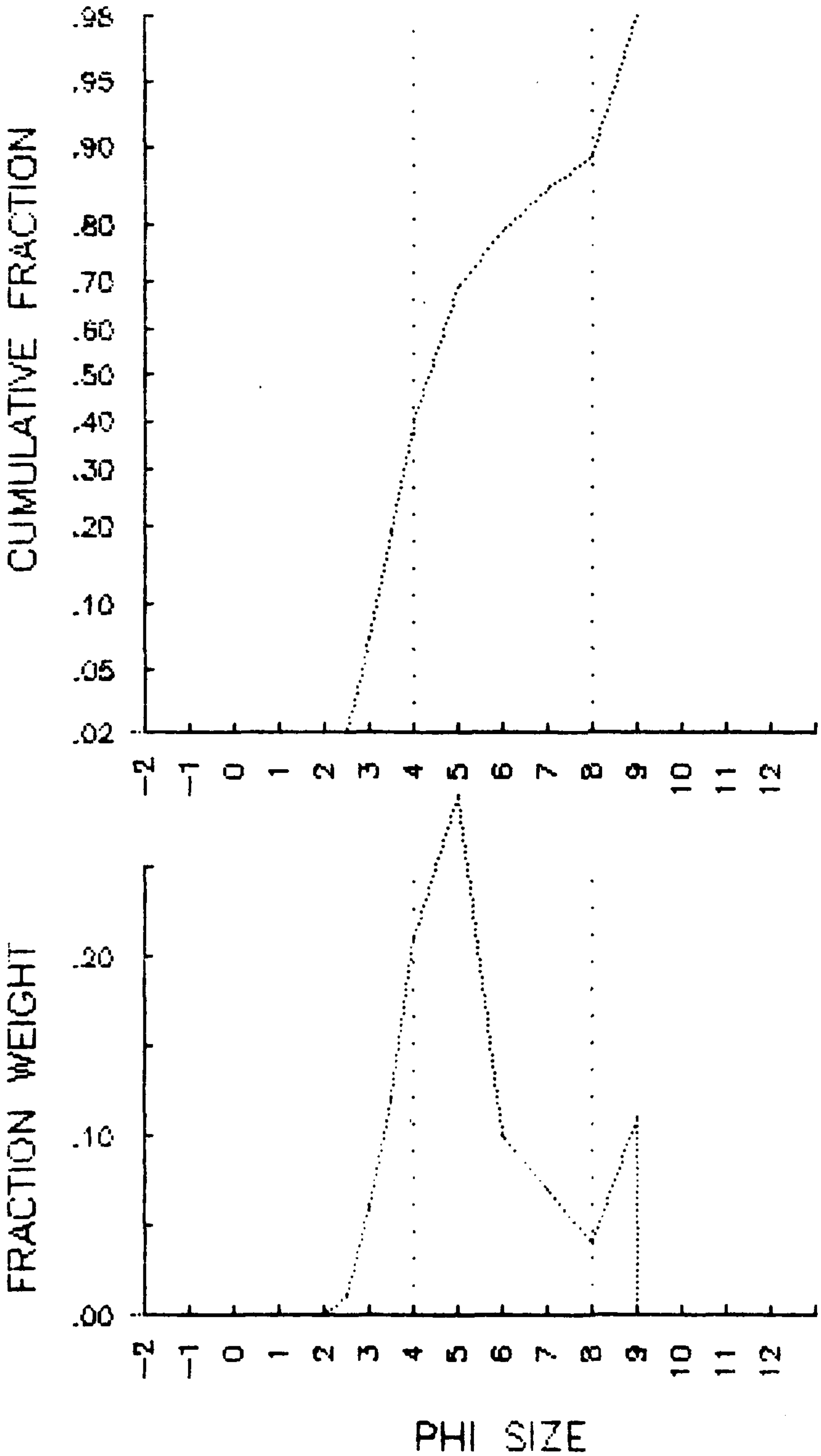
MEAN
4.77

MOMENT MEASURES (WITHOUT SHEPPARD CORRECTIONS)

MEAN	ST. DEV.	SKEW.	KURT.
4.82	1.70	0.95	3.04

NO SHEPPARD CORRECTION. PHI VALUES ARE NOT EQUALLY SPACED.

Figure J-1. 3 of 27
Textural analysis of East Block sediments 450K197.
Stratum 5-upper



MOMENT MEAN:
4.82

MOMENT DEVIATION:
1.70

MOM. SKEWNESS:
0.95

MOM. KURTOSIS:
3.04

MODE:
5.00

Table J-1. 6 of 29
Textural analysis of East Block sediments 450K197.
Stratum 5-lower

PHI SIZE	FRACTION WEIGHT	FRACTION PERCENT	ACCUMULATED PERCENT
-2.25	0.000	0.00	0.00
-2.00	0.000	0.00	0.00
-1.50	0.000	0.00	0.00
-1.00	0.000	0.00	0.00
-0.50	0.000	0.00	0.00
0.00	0.012	0.03	0.03
0.50	0.009	0.03	0.06
1.00	0.014	0.04	0.10
1.50	0.024	0.07	0.17
2.00	0.079	0.23	0.40
2.50	0.477	1.37	1.77
3.00	3.679	10.57	12.34
3.50	6.609	18.99	31.33
4.00	8.108	23.30	54.63
5.00	8.435	24.24	78.86
6.00	1.945	5.59	84.45
7.00	1.225	3.52	87.97
8.00	0.785	2.26	90.23
9.00	3.401	9.77	100.00

POST ANALYTICAL WEIGHT = 34.802 ; MODE = 5.00 PHI

GRAVEL	PERCENTAGES OF SAND	SILT	CLAY	SAND/MUD RATIO	SHEPARD CLASS
0.00	54.63	35.60	9.77	1.20	2

PHI SIZES AT PERCENT LEVELS OF

1.	5.	16.	25.	35.	50.	65.	75.	84.
2.36A	2.76A	3.11A	3.35A	3.57A	3.89A	4.39L	4.81L	5.90A

TRASK VALUES

Q1	Q2	Q3	SO	LOG SO	SKG
0.098	0.068	0.036	1.660	0.220	0.872

INMAN VALUES (2ND SKEWNESS AND KURTOSIS COULD NOT BE COMPUTED)

MEDIAN	MEAN	DEV.	SKEW.
3.89	4.51	1.39	0.45

FOLK AND WARD VALUES (ONLY THE MEAN COULD BE COMPUTED)

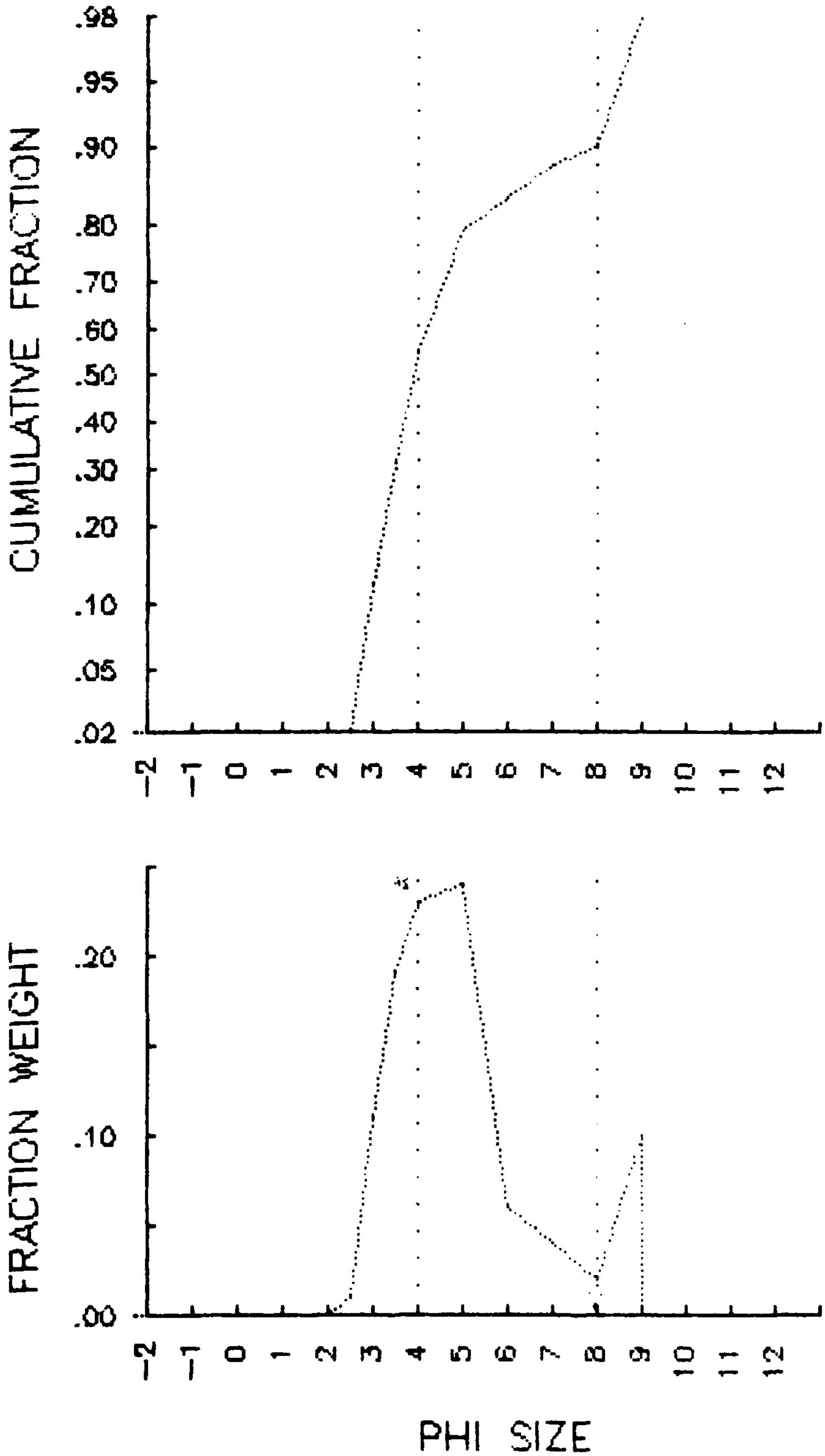
MEAN
4.30

MOMENT MEASURES (WITHOUT SHEPPARD CORRECTIONS)

MEAN	ST. DEV.	SKEW.	KURT.
4.44	1.68	1.33	3.92

NO SHEPPARD CORRECTION. PHI VALUES ARE NOT EQUALLY SPACED.

Figure J-1. 4 of 27
Textural analysis of East Block sediments 450K197.
Stratum 5-lower



MOMENT MEAN:
4.44

MOMENT DEVIATION:
1.68

MOM. SKEWNESS:
1.33

MOM. KURTOSIS:
3.92

MODE:
5.00

Table J-1. 7 of 29
Textural analysis of East Block sediments 450K197.
Stratum 6

PHI SIZE	FRACTION WEIGHT	FRACTION PERCENT	ACCUMULATED PERCENT
-2.25	0.000	0.00	0.00
-2.00	0.000	0.00	0.00
-1.50	0.000	0.00	0.00
-1.00	0.000	0.00	0.00
-0.50	0.000	0.00	0.00
0.00	0.030	0.07	0.07
0.50	0.023	0.05	0.13
1.00	0.034	0.08	0.21
1.50	0.041	0.10	0.30
2.00	0.085	0.20	0.50
2.50	0.570	1.35	1.86
3.00	5.943	14.09	15.95
3.50	7.523	17.84	33.79
4.00	8.678	20.58	54.37
5.00	9.590	22.74	77.11
6.00	3.290	7.80	84.92
7.00	1.900	4.51	89.42
8.00	1.030	2.44	91.87
9.00	0.765	1.81	93.68
10.00	2.665	6.32	100.00

POST ANALYTICAL WEIGHT = 42.166 ; MODE = 5.00 PHI

GRAVEL	PERCENTAGES OF SAND	SILT	CLAY	SAND/MUD RATIO	SHEPARD CLASS
0.00	54.37	37.49	8.13	1.19	2

PHI SIZES AT PERCENT LEVELS OF (LAST VALUE IS EXTRAPOLATED)

1.	5.	16.	25.	35.	50.	65.	75.	84.	95.
2.39A	2.73A	3.00A	3.27A	3.53A	3.88A	4.30A	4.83A	5.85A	9.88L

TRASK VALUES

Q1	Q2	Q3	SO	LOG SO	SKG
0.104	0.068	0.035	1.718	0.235	0.890

INMAN VALUES

MEDIAN	MEAN	DEV.	SKEW.	2ND SK.	KURT.
3.88	4.42	1.42	0.38	1.70	1.51

FOLK AND WARD VALUES

MEAN	DEV.	TYPE	SKEW.	TYPE	KURT.	TYPE
4.24	1.79	4	0.53	5	1.88	5

MOMENT MEASURES (WITHOUT SHEPPARD CORRECTIONS)

MEAN	ST. DEV.	SKEW.	KURT.
4.46	1.82	1.50	4.72

NO SHEPPARD CORRECTION. PHI VALUES ARE NOT EQUALLY SPACED.

Figure J-1. 5 of 27
Textural analysis of East Block sediments 450K197.
Stratum 6

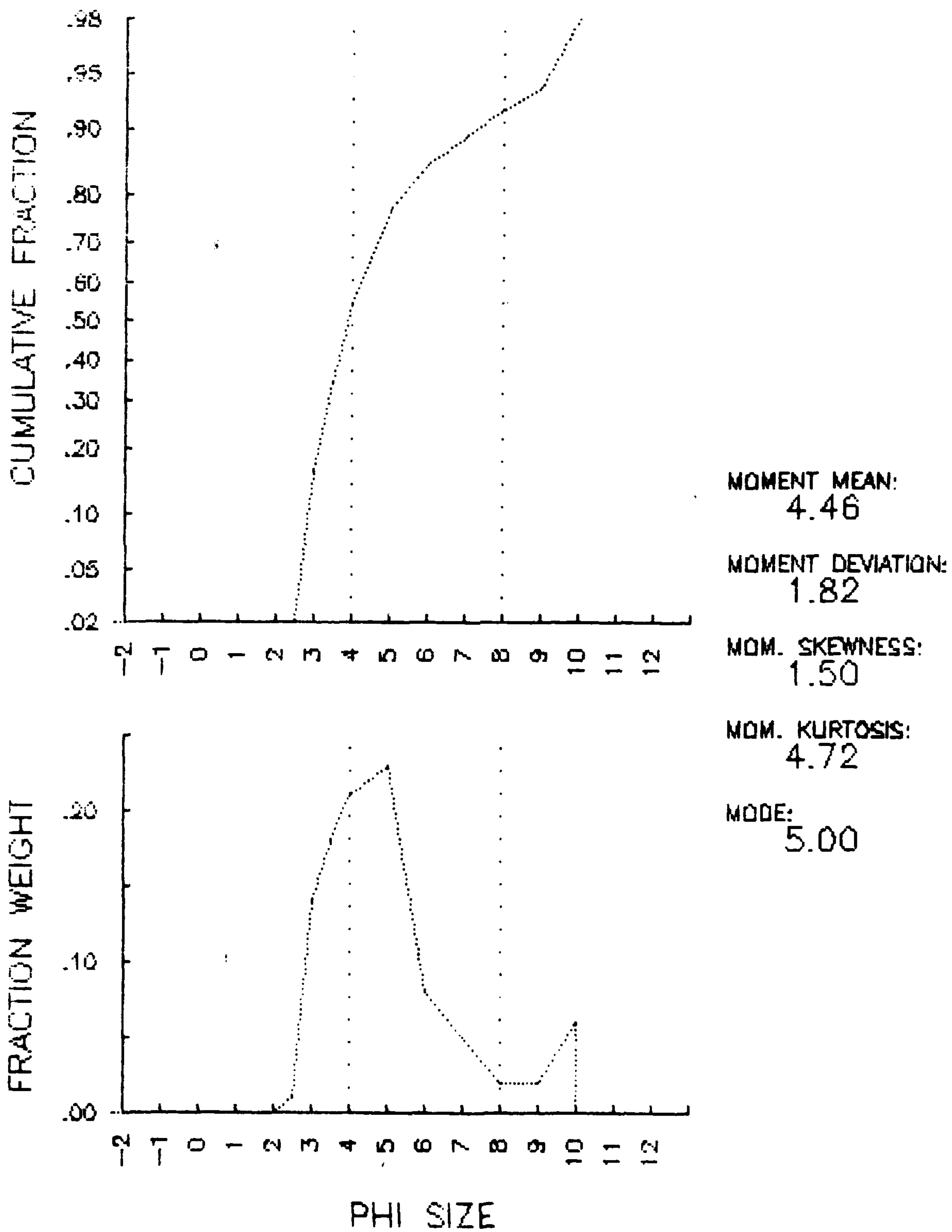


Table J-1. 8 of 29
Textural analysis of East Block sediments 450K197.
Stratum 7

PHI SIZE	FRACTION WEIGHT	FRACTION PERCENT	ACCUMULATED PERCENT
-2.25	0.000	0.00	0.00
-2.00	0.000	0.00	0.00
-1.50	0.000	0.00	0.00
-1.00	0.000	0.00	0.00
-0.50	0.000	0.00	0.00
0.00	0.046	0.11	0.11
0.50	0.000	0.00	0.11
1.00	0.030	0.07	0.18
1.50	0.091	0.22	0.40
2.00	0.355	0.85	1.26
2.50	1.523	3.66	4.92
3.00	5.859	14.09	19.02
3.50	7.218	17.36	36.38
4.00	7.977	19.19	55.57
5.00	8.870	21.34	76.91
6.00	3.320	7.99	84.89
7.00	2.085	5.02	89.91
8.00	1.005	2.42	92.33
9.00	3.190	7.67	100.00

POST ANALYTICAL WEIGHT = 41.570 ; MODE = 5.00 PHI

GRAVEL	PERCENTAGES OF SAND	SILT	CLAY	SAND/MUD RATIO	SHEPARD CLASS
0.00	55.57	36.76	7.67	1.25	2

PHI SIZES AT PERCENT LEVELS OF (LAST VALUE IS EXTRAPOLATED)

1.	5.	16.	25.	35.	50.	65.	75.	84.	95.
1.92A	2.51A	2.92A	3.18A	3.46A	3.84A	4.30A	4.85A	5.86A	9.44L

TRASK VALUES

Q1	Q2	Q3	SO	LOG SO	SKG
0.110	0.070	0.035	1.780	0.250	0.886

INMAN VALUES

MEDIAN	MEAN	DEV.	SKEW.	2ND SK.	KURT.
3.84	4.39	1.47	0.37	1.45	1.36

FOLK AND WARD VALUES

MEAN	DEV.	TYPE	SKEW.	TYPE	KURT.	TYPE
4.21	1.79	4	0.49	5	1.71	5

MOMENT MEASURES (WITHOUT SHEPPARD CORRECTIONS)

MEAN	ST. DEV.	SKEW.	KURT.
4.33	1.68	1.16	3.77

NO SHEPPARD CORRECTION. PHI VALUES ARE NOT EQUALLY SPACED.

AD-A159 823 DIMENSIONS OF SITE STRUCTURE; THE ARCHAEOLOGICAL RECORD FROM TWO SITES IN (U) CENTRAL WASHINGTON ARCHAEOLOGICAL SURVEY ELLENSBURG J C CHATTERS ET AL SEP 84 4/4

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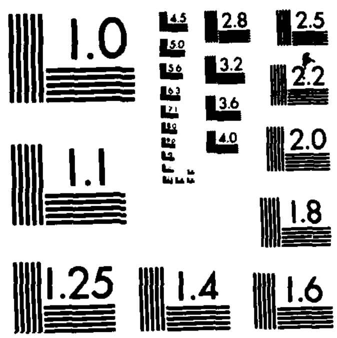


MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

Figure J-1. 6 of 27
Textural analysis of East Block sediments 450K197.
Stratum 7

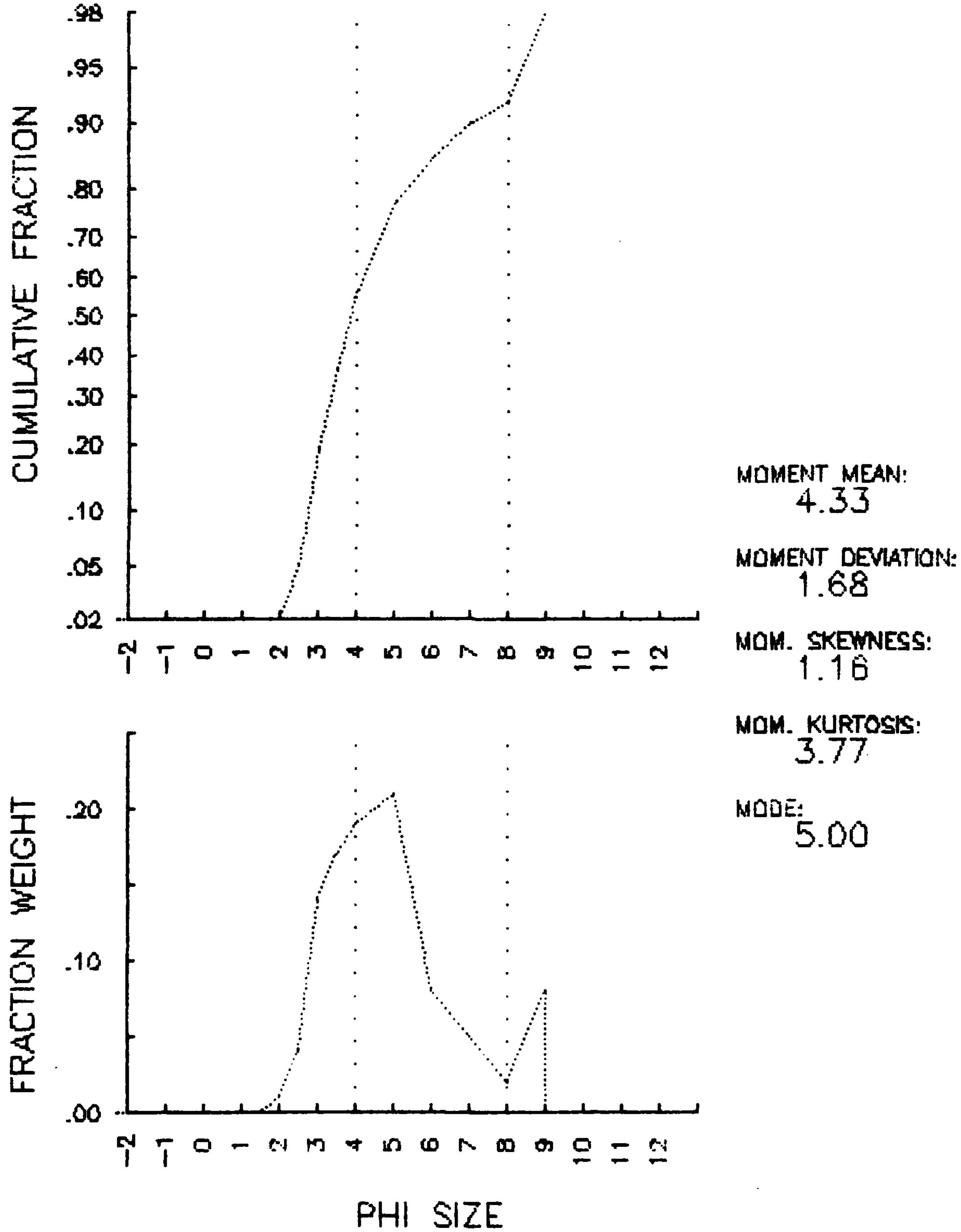


Table J-1. 9 of 29
Textural analysis of East Block sediments 450K197.
Stratum 8

PHI SIZE	FRACTION WEIGHT	FRACTION PERCENT	ACCUMULATED PERCENT
-2.25	0.000	0.00	0.00
-2.00	0.000	0.00	0.00
-1.50	0.000	0.00	0.00
-1.00	0.000	0.00	0.00
-0.50	0.000	0.00	0.00
0.00	0.016	0.05	0.05
0.50	0.011	0.04	0.09
1.00	0.013	0.04	0.14
1.50	0.034	0.12	0.25
2.00	0.217	0.74	0.99
2.50	1.585	5.41	6.40
3.00	7.247	24.73	31.13
3.50	6.773	23.12	54.25
4.00	5.020	17.13	71.38
5.00	4.260	14.54	85.92
6.00	0.940	3.21	89.13
7.00	0.655	2.24	91.36
8.00	0.395	1.35	92.71
9.00	2.135	7.29	100.00

POST ANALYTICAL WEIGHT = 29.300 ; MODE = 3.00 PHI

GRAVEL	PERCENTAGES OF SAND	SILT	CLAY	SAND/MUD RATIO	SHEPARD CLASS
0.00	71.38	21.33	7.29	2.49	2

PHI SIZES AT PERCENT LEVELS OF (LAST VALUE IS EXTRAPOLATED)

1.	5.	16.	25.	35.	50.	65.	75.	84.	95.
2.00A	2.44A	2.73A	2.89A	3.08A	3.40A	3.77A	4.05A	4.65A	10.08L

TRASK VALUES

Q1	Q2	Q3	SO	LOG SO	SKG
0.135	0.095	0.060	1.492	0.174	0.952

INMAN VALUES

MEDIAN	MEAN	DEV.	SKEW.	2ND SK.	KURT.
3.40	3.69	0.96	0.31	2.99	2.99

FOLK AND WARD VALUES

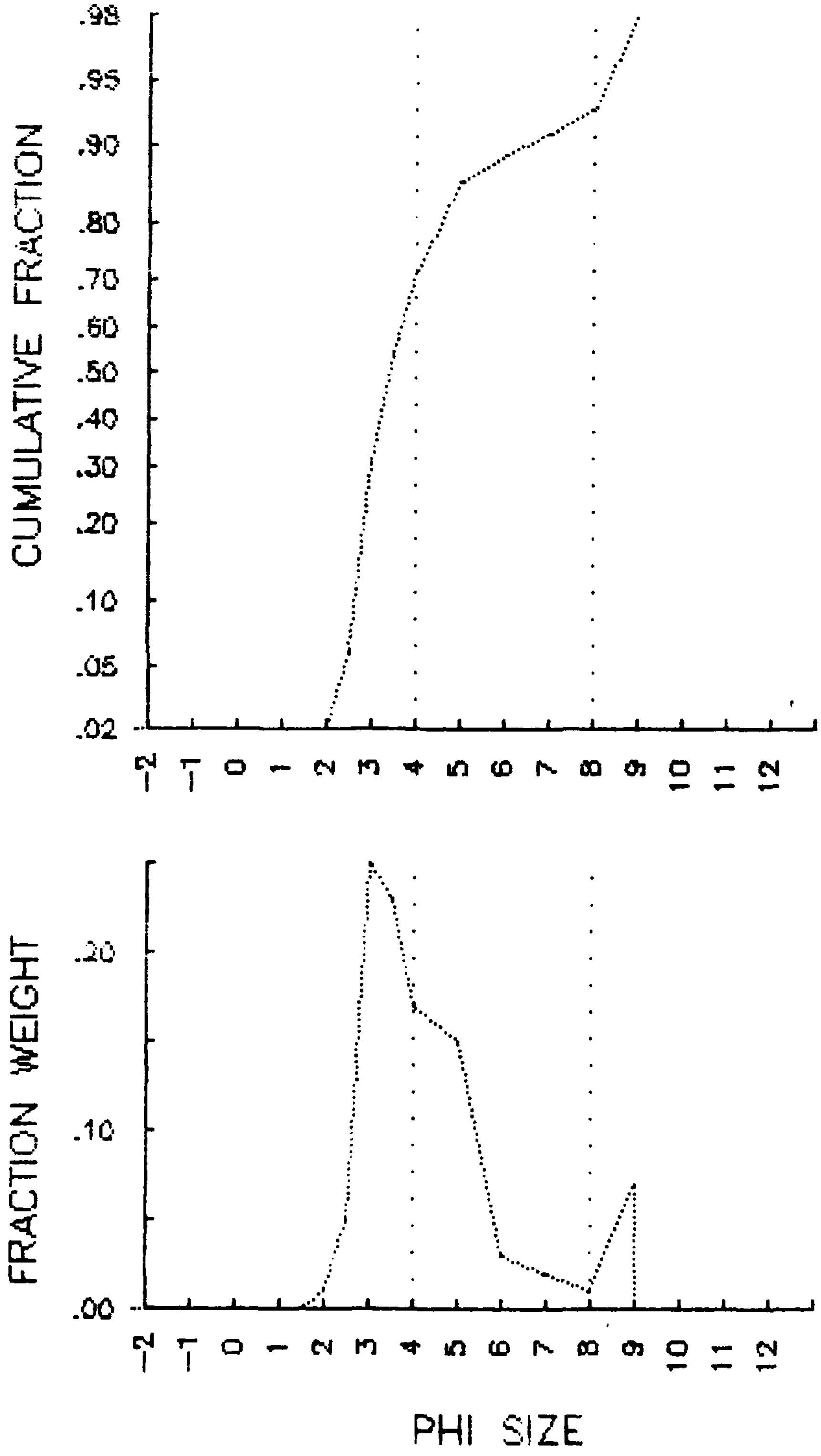
MEAN	DEV.	TYPE	SKEW.	TYPE	KURT.	TYPE
3.59	1.64	4	0.53	5	2.71	5

MOMENT MEASURES (WITHOUT SHEPPARD CORRECTIONS)

MEAN	ST. DEV.	SKEW.	KURT.
3.91	1.62	1.72	5.36

NO SHEPPARD CORRECTION. PHI VALUES ARE NOT EQUALLY SPACED.

Figure J-1. 7 of 27
Textural analysis of East Block sediments 450K197.
Stratum 8



MOMENT MEAN:
3.91

MOMENT DEVIATION:
1.62

MOM. SKEWNESS:
1.72

MOM. KURTOSIS:
5.36

MODE:
3.00

Table J-1. 10 of 29
Textural analysis of East Block sediments 450K197.
Stratum 9

PHI SIZE	FRACTION WEIGHT	FRACTION PERCENT	ACCUMULATED PERCENT
-2.25	0.000	0.00	0.00
-2.00	0.000	0.00	0.00
-1.50	0.000	0.00	0.00
-1.00	0.000	0.00	0.00
-0.50	0.000	0.00	0.00
0.00	0.009	0.02	0.02
0.50	0.013	0.03	0.05
1.00	0.030	0.07	0.12
1.50	0.126	0.28	0.39
2.00	0.736	1.63	2.02
2.50	3.790	8.38	10.40
3.00	11.111	24.57	34.97
3.50	9.600	21.23	56.20
4.00	7.720	17.07	73.27
5.00	6.460	14.28	87.55
6.00	1.495	3.31	90.86
7.00	0.930	2.06	92.91
8.00	0.615	1.36	94.27
9.00	2.590	5.73	100.00

POST ANALYTICAL WEIGHT = 45.225 ; MODE = 3.00 PHI

GRAVEL	PERCENTAGES OF SAND	SILT	CLAY	SAND/MUD RATIO	SHEPARD CLASS
0.00	73.27	21.01	5.73	2.74	2

PHI SIZES AT PERCENT LEVELS OF (LAST VALUE IS EXTRAPOLATED)

1.	5.	16.	25.	35.	50.	65.	75.	84.	95.
1.80A	2.27A	2.64A	2.81A	3.00A	3.35A	3.72A	4.03A	4.70L	8.61L

TRASK VALUES

Q1	Q2	Q3	SO	LOG SO	SKG
0.142	0.098	0.061	1.526	0.184	0.949

INMAN VALUES

MEDIAN	MEAN	DEV.	SKEW.	2ND SK.	KURT.
3.35	3.67	1.03	0.31	2.03	2.07

FOLK AND WARD VALUES

MEAN	DEV.	TYPE	SKEW.	TYPE	KURT.	TYPE
3.56	1.48	4	0.49	5	2.13	5

MOMENT MEASURES (WITHOUT SHEPPARD CORRECTIONS)

MEAN	ST. DEV.	SKEW.	KURT.
3.77	1.55	1.77	5.88

NO SHEPPARD CORRECTION. PHI VALUES ARE NOT EQUALLY SPACED.

Figure J-1. 8 of 27
Textural analysis of East Block sediments 450K197.
Stratum 9

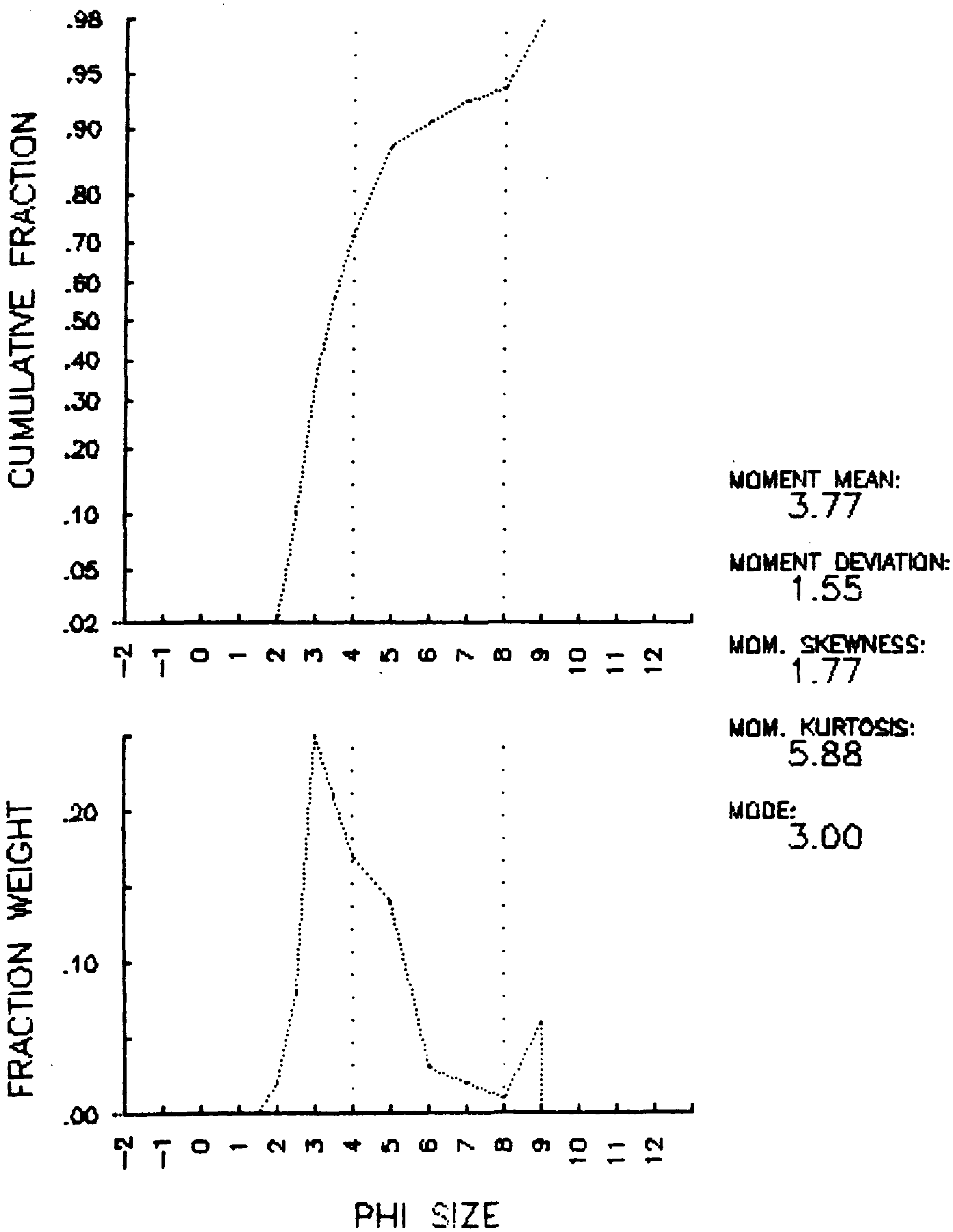


Table J-1. 11 of 29
Textural analysis of East Block sediments 450K197.
Stratum 10-upper

PHI SIZE	FRACTION WEIGHT	FRACTION PERCENT	ACCUMULATED PERCENT
-2.25	0.000	0.00	0.00
-2.00	0.000	0.00	0.00
-1.50	0.000	0.00	0.00
-1.00	0.000	0.00	0.00
-0.50	0.000	0.00	0.00
0.00	0.000	0.00	0.00
0.50	0.009	0.02	0.02
1.00	0.019	0.05	0.07
1.50	0.055	0.15	0.22
2.00	0.225	0.61	0.83
2.50	0.909	2.46	3.29
3.00	3.096	8.38	11.67
3.50	4.236	11.46	23.12
4.00	5.918	16.01	39.13
5.00	10.110	27.34	66.47
6.00	4.760	12.87	79.35
7.00	2.620	7.09	86.44
8.00	1.360	3.68	90.11
9.00	3.655	9.89	100.00

POST ANALYTICAL WEIGHT = 36.972 ; MODE = 5.00 PHI

	PERCENTAGES OF			SAND/MUD	SHEPARD
GRAVEL	SAND	SILT	CLAY	RATIO	CLASS
0.00	39.13	50.98	9.89	0.64	3

PHI SIZES AT PERCENT LEVELS OF

1.	5.	16.	25.	35.	50.	65.	75.	84.
2.07A	2.64A	3.21A	3.56A	3.88A	4.32A	4.92A	5.59A	6.57A

TRASK VALUES

Q1	Q2	Q3	SO	LOG SO	SKG
0.085	0.050	0.021	2.015	0.304	0.838

INMAN VALUES (2ND SKEWNESS AND KURTOSIS COULD NOT BE COMPUTED)

MEDIAN	MEAN	DEV.	SKEW.
4.32	4.89	1.68	0.34

FOLK AND WARD VALUES (ONLY THE MEAN COULD BE COMPUTED)

MEAN
4.70

MOMENT MEASURES (WITHOUT SHEPPARD CORRECTIONS)

MEAN	ST.DEV.	SKEW.	KURT.
4.79	1.72	0.82	2.92

NO SHEPPARD CORRECTION. PHI VALUES ARE NOT EQUALLY SPACED.

Figure J-1. 9 of 27
Textural analysis of East Block sediments 450K197.
Stratum 10-upper

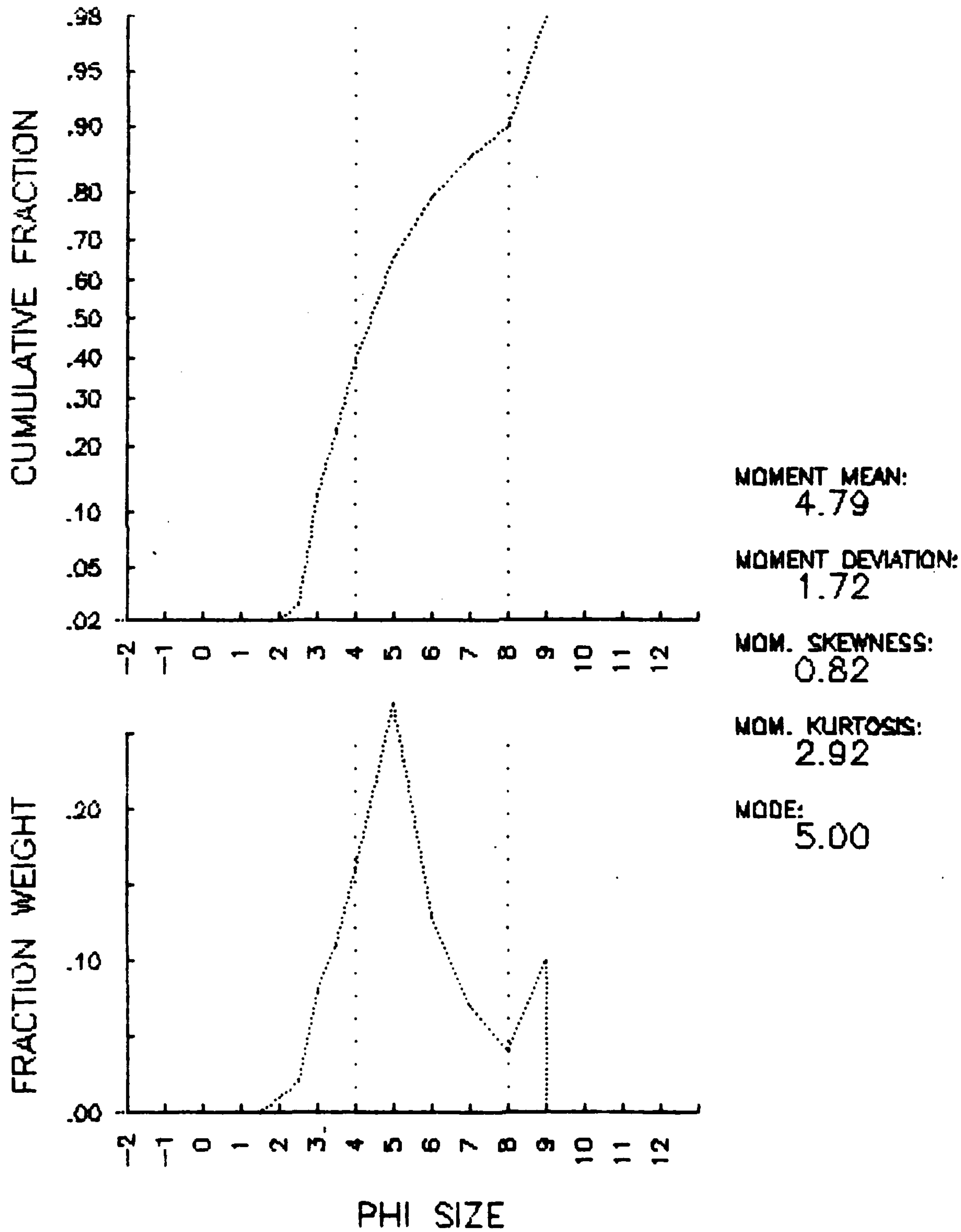


Table J-1. 12 of 29
Textural analysis of East Block sediments 450K197.
Stratum 10-lower

PHI SIZE	FRACTION WEIGHT	FRACTION PERCENT	ACCUMULATED PERCENT
-2.25	0.000	0.00	0.00
-2.00	0.000	0.00	0.00
-1.50	0.000	0.00	0.00
-1.00	0.000	0.00	0.00
-0.50	0.000	0.00	0.00
0.00	0.000	0.00	0.00
0.50	0.251	0.69	0.69
1.00	0.058	0.16	0.86
1.50	0.083	0.23	1.09
2.00	0.307	0.85	1.94
2.50	1.454	4.03	5.97
3.00	5.298	14.68	20.65
3.50	6.925	19.19	39.84
4.00	7.031	19.49	59.33
5.00	7.235	20.05	79.38
6.00	2.105	5.83	85.21
7.00	1.510	4.18	89.40
8.00	0.835	2.31	91.71
9.00	2.990	8.29	100.00

POST ANALYTICAL WEIGHT = 36.083 ; MODE = 5.00 PHI

GRAVEL	PERCENTAGES OF SAND	SILT	CLAY	SAND/MUD RATIO	SHEPARD CLASS
0.00	59.33	32.38	8.29	1.46	2

PHI SIZES AT PERCENT LEVELS OF

1.	5.	16.	25.	35.	50.	65.	75.	84.
1.34A	2.45A	2.88A	3.12A	3.38A	3.74A	4.13A	4.59A	5.76A

TRASK VALUES

Q1	Q2	Q3	SO	LOG SO	SKG
0.115	0.075	0.042	1.663	0.221	0.923

INMAN VALUES (2ND SKEWNESS AND KURTOSIS COULD NOT BE COMPUTED)

MEDIAN	MEAN	DEV.	SKEW.
3.74	4.32	1.44	0.40

FOLK AND WARD VALUES (ONLY THE MEAN COULD BE COMPUTED)

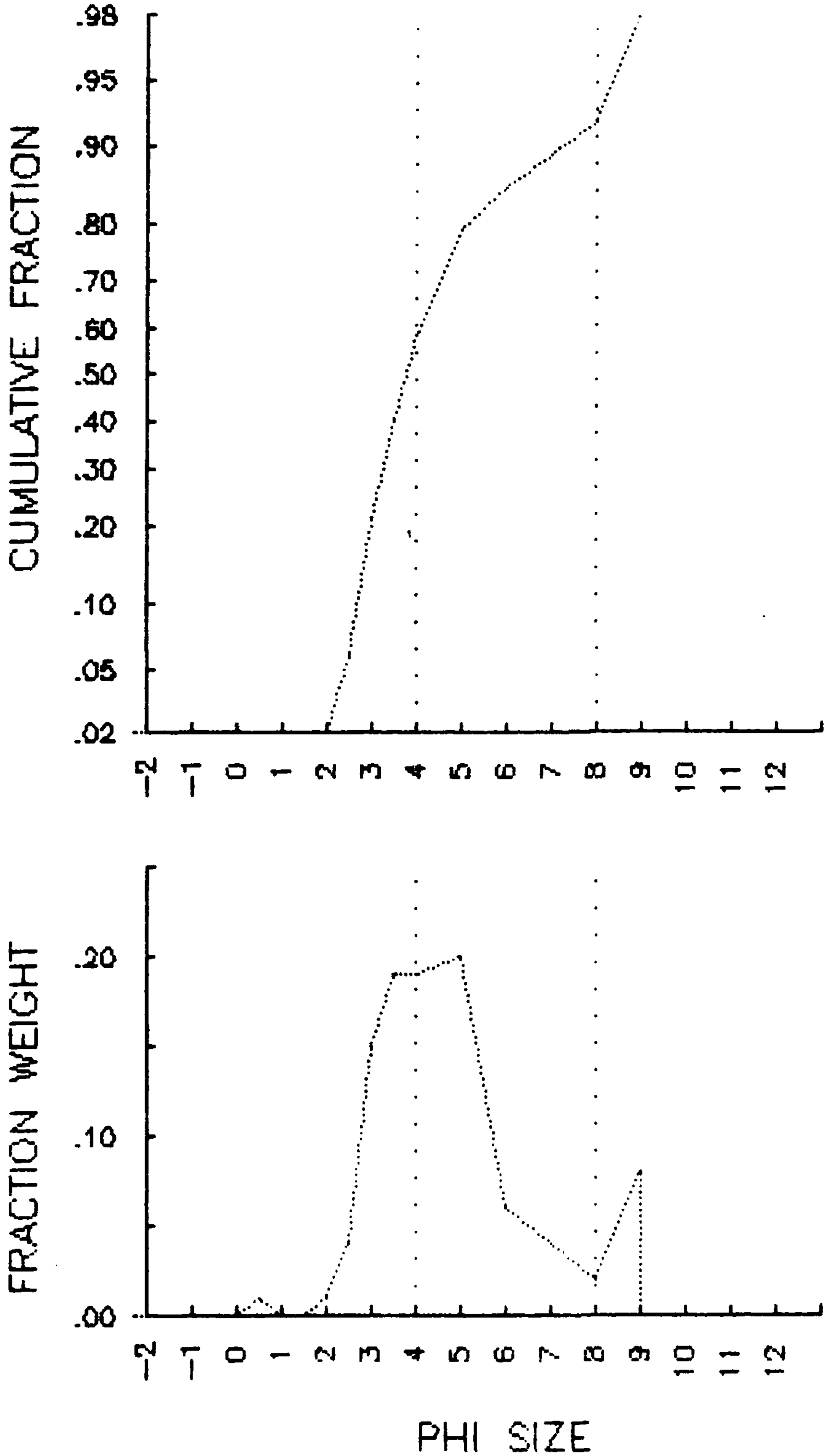
MEAN
4.13

MOMENT MEASURES (WITHOUT SHEPPARD CORRECTIONS)

MEAN	ST. DEV.	SKEW.	KURT.
4.24	1.73	1.17	3.92

NO SHEPPARD CORRECTION. PHI VALUES ARE NOT EQUALLY SPACED.

Figure J-1. 10 of 27
Textural analysis of East Block sediments 450K197.
Stratum 10-lower



MOMENT MEAN:
4.24

MOMENT DEVIATION:
1.73

MOM. SKEWNESS:
1.17

MOM. KURTOSIS:
3.92

MODE:
5.00

Table J-1. 13 of 29
Textural analysis of East Block sediments 450K197.
Stratum 11

PHI SIZE	FRACTION WEIGHT	FRACTION PERCENT	ACCUMULATED PERCENT
-2.25	0.000	0.00	0.00
-2.00	0.000	0.00	0.00
-1.50	0.000	0.00	0.00
-1.00	0.000	0.00	0.00
-0.50	0.000	0.00	0.00
0.00	0.000	0.00	0.00
0.50	0.105	0.28	0.28
1.00	0.072	0.20	0.48
1.50	0.123	0.33	0.81
2.00	0.589	1.59	2.41
2.50	2.397	6.49	8.90
3.00	5.741	15.54	24.44
3.50	5.906	15.99	40.43
4.50	5.550	15.03	55.46
5.00	6.125	16.58	72.04
6.00	2.665	7.22	79.26
7.00	0.395	1.07	80.33
8.00	2.470	6.69	87.02
9.00	4.796	12.98	100.00

POST ANALYTICAL WEIGHT = 36.935 ; MODE = 5.00 PHI

GRAVEL	PERCENTAGES OF SAND	SILT	CLAY	SAND/MUD RATIO	SHEPARD CLASS
0.00	40.43	46.58	12.98	0.68	3

PHI SIZES AT PERCENT LEVELS OF

1.	5.	16.	25.	35.	50.	65.	75.	84.
1.64A	2.28A	2.75A	3.01A	3.28A	4.14A	4.68A	5.39L	7.52L

TRASK VALUES

Q1	Q2	Q3	SO	LOG SO	SKG
0.124	0.057	0.024	2.281	0.358	0.961

INMAN VALUES (2ND SKEWNESS AND KURTOSIS COULD NOT BE COMPUTED)

MEDIAN	MEAN	DEV.	SKEW.
4.14	5.13	2.38	0.42

FOLK AND WARD VALUES (ONLY THE MEAN COULD BE COMPUTED)

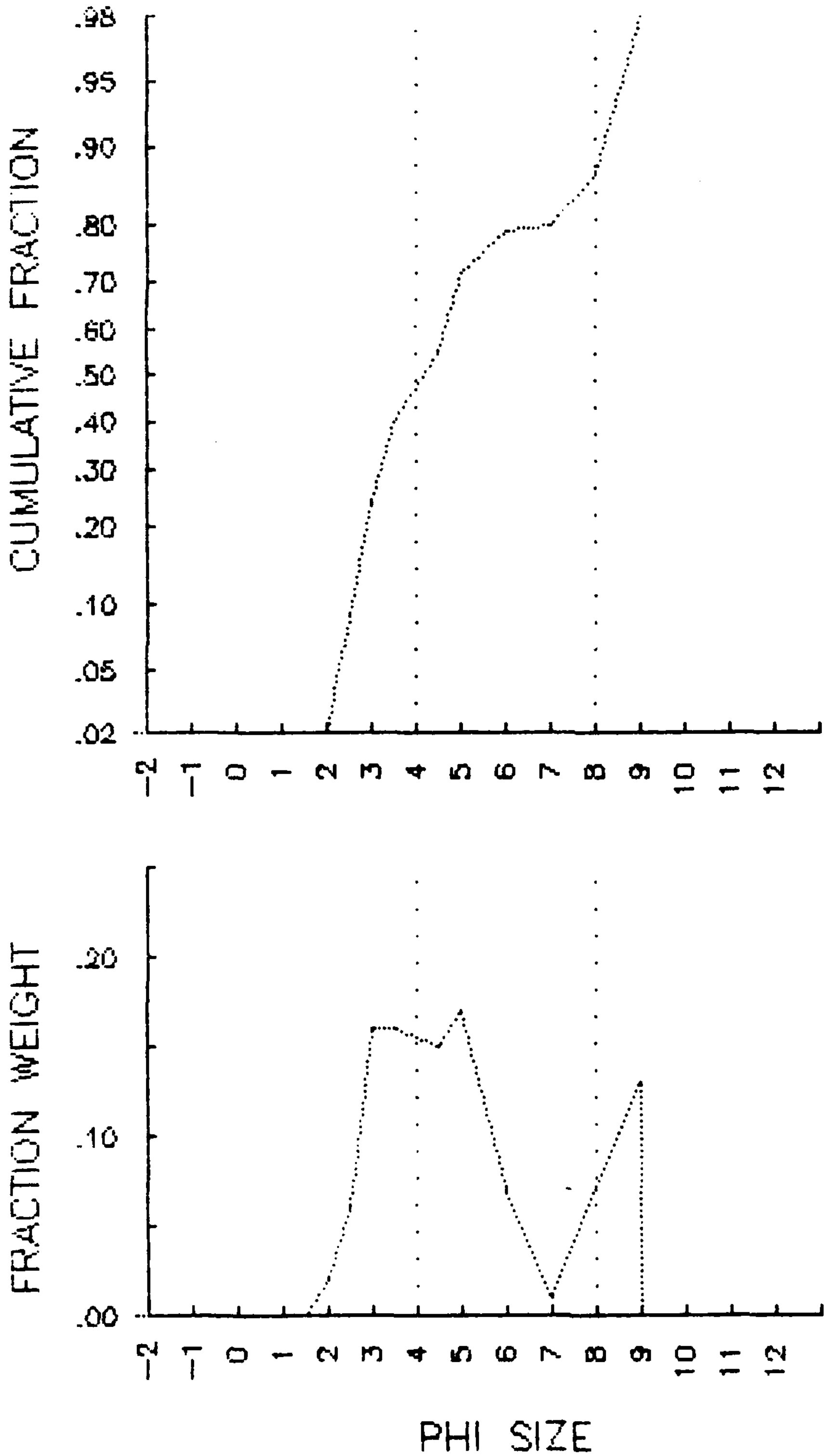
MEAN
4.80

MOMENT MEASURES (WITHOUT SHEPPARD CORRECTIONS)

MEAN	ST. DEV.	SKEW.	KURT.
4.59	2.03	0.78	2.50

NO SHEPPARD CORRECTION. PHI VALUES ARE NOT EQUALLY SPACED.

Figure J-1. 11 of 27
Textural analysis of East Block sediments 450K197.
Stratum 11



MOMENT MEAN:
4.59

MOMENT DEVIATION:
2.03

MOM. SKEWNESS:
0.78

MOM. KURTOSIS:
2.50

MODE:
5.00

Table J-1. 14 of 29
Textural analysis of East Block sediments 450K197.
Stratum 12

PHI SIZE	FRACTION WEIGHT	FRACTION PERCENT	ACCUMULATED PERCENT
-2.25	0.000	0.00	0.00
-2.00	0.000	0.00	0.00
-1.50	0.000	0.00	0.00
-1.00	0.000	0.00	0.00
-0.50	0.000	0.00	0.00
0.00	0.000	0.00	0.00
0.50	0.193	0.50	0.50
1.00	0.158	0.41	0.91
1.50	0.304	0.78	1.69
2.00	1.258	3.24	4.93
2.50	3.563	9.17	14.10
3.00	5.986	15.41	29.51
3.50	5.004	12.88	42.39
4.00	4.972	12.80	55.19
5.00	6.800	17.51	72.70
6.00	2.945	7.58	80.28
7.00	1.920	4.94	85.22
8.00	1.115	2.87	88.09
9.00	4.626	11.91	100.00

POST ANALYTICAL WEIGHT = 38.846 ; MODE = 5.00 PHI

	PERCENTAGES OF			SAND/MUD	SHEPARD
GRAVEL	SAND	SILT	CLAY	RATIO	CLASS
0.00	55.19	32.90	11.91	1.23	2

PHI SIZES AT PERCENT LEVELS OF

1.	5.	16.	25.	35.	50.	65.	75.	84.
1.08A	2.01A	2.56A	2.85A	3.21A	3.79A	4.44A	5.25A	6.69A

TRASK VALUES

Q1	Q2	Q3	SO	LOG SO	SKG
0.139	0.072	0.026	2.299	0.362	0.832

INMAN VALUES (2ND SKEWNESS AND KURTOSIS COULD NOT BE COMPUTED)

MEDIAN	MEAN	DEV.	SKEW.
3.79	4.63	2.06	0.41

FOLK AND WARD VALUES (ONLY THE MEAN COULD BE COMPUTED)

MEAN
4.35

MOMENT MEASURES (WITHOUT SHEPPARD CORRECTIONS)

MEAN	ST. DEV.	SKEW.	KURT.
4.35	2.02	0.84	2.77

NO SHEPPARD CORRECTION. PHI VALUES ARE NOT EQUALLY SPACED.

Table J-1. 21 of 29
Textural analysis of East Block sediments 450K197.
Stratum 19-lower

PHI SIZE	FRACTION WEIGHT	FRACTION PERCENT	ACCUMULATED PERCENT
-2.25	0.000	0.00	0.00
-2.00	0.000	0.00	0.00
-1.50	0.000	0.00	0.00
-1.00	0.000	0.00	0.00
-0.50	0.000	0.00	0.00
0.00	0.000	0.00	0.00
0.50	0.004	0.01	0.01
1.00	0.005	0.01	0.03
1.50	0.012	0.03	0.06
2.00	0.080	0.22	0.28
2.50	0.476	1.31	1.59
3.00	2.811	7.74	9.33
3.50	5.326	14.67	24.01
4.00	7.157	19.72	43.73
5.00	9.830	27.08	70.81
6.00	3.610	9.95	80.75
7.00	2.115	5.83	86.58
8.00	1.300	3.58	90.16
9.00	3.571	9.84	100.00

POST ANALYTICAL WEIGHT = 36.297 ; MODE = 5.00 PHI

GRAVEL	PERCENTAGES OF SAND	SILT	CLAY	SAND/MUD RATIO	SHEPARD CLASS
0.00	43.73	46.44	9.84	0.78	3

PHI SIZES AT PERCENT LEVELS OF

1.	5.	16.	25.	35.	50.	65.	75.	84.
2.37A	2.80A	3.25A	3.53A	3.77A	4.14A	4.66A	5.35A	6.49A

TRASK VALUES

Q1	Q2	Q3	SO	LOG SO	SKG
0.087	0.057	0.025	1.881	0.274	0.814

INMAN VALUES (2ND SKEWNESS AND KURTOSIS COULD NOT BE COMPUTED)

MEDIAN	MEAN	DEV.	SKEW.
4.14	4.87	1.62	0.45

FOLK AND WARD VALUES (ONLY THE MEAN COULD BE COMPUTED)

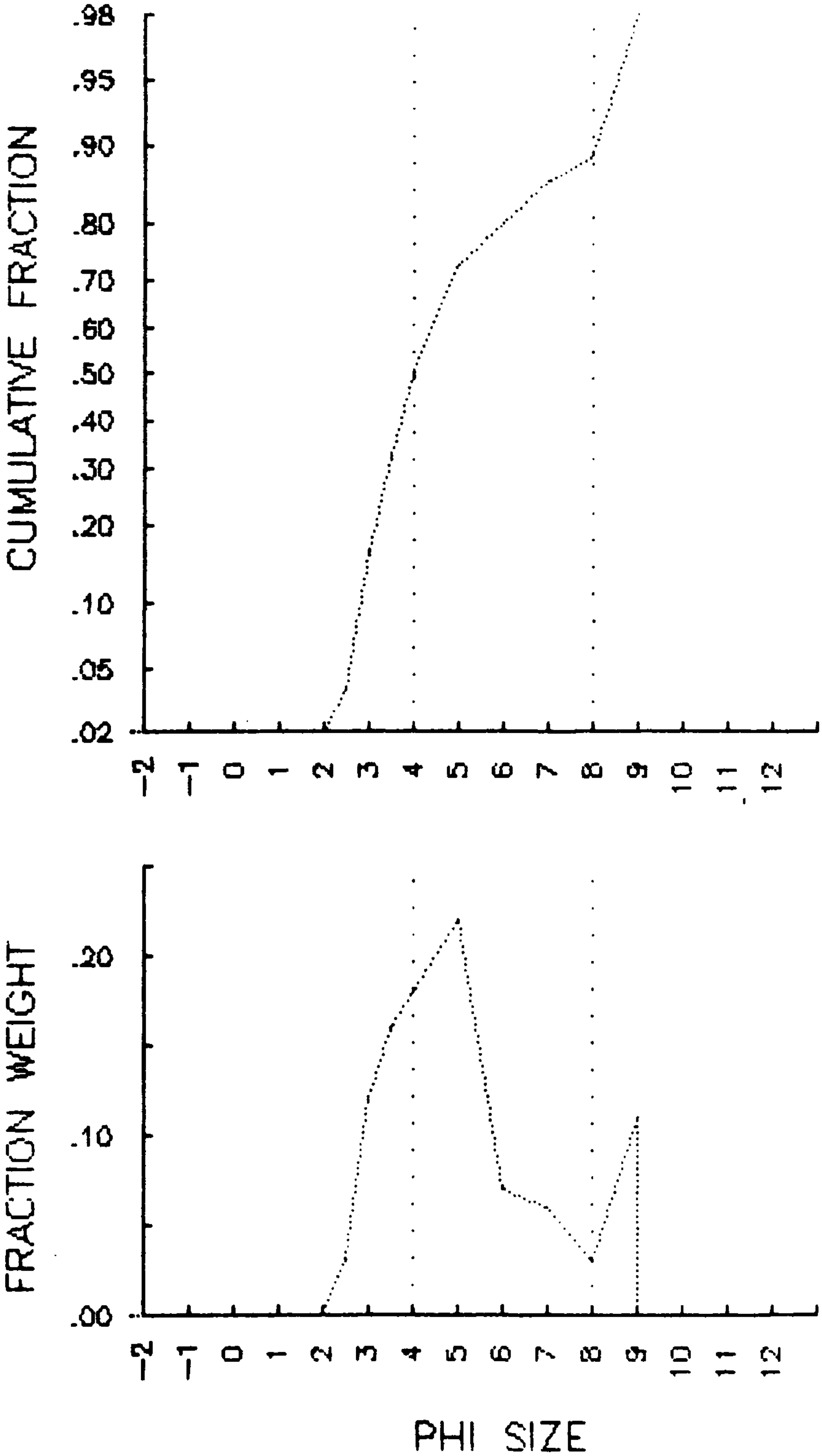
MEAN
4.63

MOMENT MEASURES (WITHOUT SHEPPARD CORRECTIONS)

MEAN	ST. DEV.	SKEW.	KURT.
4.71	1.69	1.04	3.17

NO SHEPPARD CORRECTION. PHI VALUES ARE NOT EQUALLY SPACED.

Figure J-1. 18 of 27
Textural analysis of East Block sediments 450K197.
Stratum 19-upper



MOMENT MEAN:
4.59

MOMENT DEVIATION:
1.84

MOM. SKEWNESS:
0.96

MOM. KURTOSIS:
3.02

MODE:
5.00

Table J-1. 20 of 29
Textural analysis of East Block sediments 450K197.
Stratum 19-upper

PHI SIZE	FRACTION WEIGHT	FRACTION PERCENT	ACCUMULATED PERCENT
-2.25	0.000	0.00	0.00
-2.00	0.000	0.00	0.00
-1.50	0.000	0.00	0.00
-1.00	0.000	0.00	0.00
-0.50	0.000	0.00	0.00
0.00	0.000	0.00	0.00
0.50	0.139	0.40	0.40
1.00	0.021	0.06	0.46
1.50	0.037	0.11	0.57
2.00	0.160	0.46	1.03
2.50	0.966	2.80	3.84
3.00	4.060	11.78	15.61
3.50	5.643	16.37	31.99
4.00	6.347	18.42	50.40
5.00	7.630	22.14	72.54
6.00	2.530	7.34	79.88
7.00	1.975	5.73	85.61
8.00	1.025	2.97	88.58
9.00	3.936	11.42	100.00

POST ANALYTICAL WEIGHT = 34.468 ; MODE = 5.00 PHI

	PERCENTAGES OF			SAND/MUD	SHEPARD
GRAVEL	SAND	SILT	CLAY	RATIO	CLASS
0.00	50.40	38.18	11.42	1.02	2

PHI SIZES AT PERCENT LEVELS OF

1.	5.	16.	25.	35.	50.	65.	75.	84.
2.00A	2.59A	3.01A	3.30A	3.58A	3.99A	4.46A	5.30A	6.64A

TRASK VALUES

Q1	Q2	Q3	SO	LOG SO	SKG
0.102	0.063	0.025	2.000	0.301	0.806

INMAN VALUES (2ND SKEWNESS AND KURTOSIS COULD NOT BE COMPUTED)

MEDIAN	MEAN	DEV.	SKEW.
3.99	4.83	1.82	0.46

FOLK AND WARD VALUES (ONLY THE MEAN COULD BE COMPUTED)

MEAN
4.55

MOMENT MEASURES (WITHOUT SHEPPARD CORRECTIONS)

MEAN	ST. DEV.	SKEW.	KURT.
4.59	1.84	0.96	3.02

NO SHEPPARD CORRECTION. PHI VALUES ARE NOT EQUALLY SPACED.

<u>Figure J-1.</u> 17 of 27
Textural analysis of East Block sediments 450K197.
Stratum 18-lower

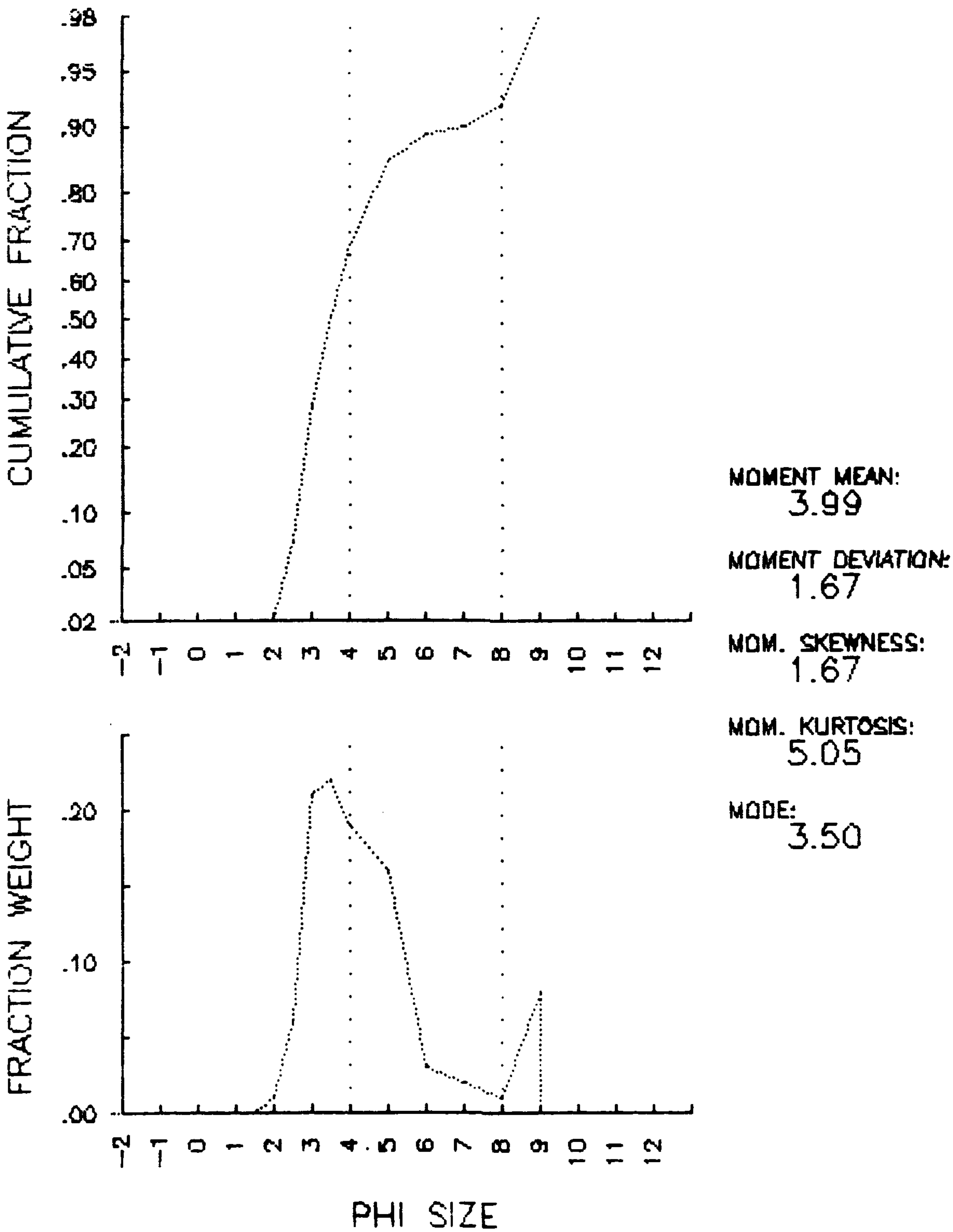


Table J-1. 19 of 29
Textural analysis of East Block sediments 450K197.
Stratum 18-lower

PHI SIZE	FRACTION WEIGHT	FRACTION PERCENT	ACCUMULATED PERCENT
-2.25	0.000	0.00	0.00
-2.00	0.000	0.00	0.00
-1.50	0.000	0.00	0.00
-1.00	0.000	0.00	0.00
-0.50	0.000	0.00	0.00
0.00	0.000	0.00	0.00
0.50	0.001	0.00	0.00
1.00	0.009	0.03	0.03
1.50	0.017	0.05	0.08
2.00	0.278	0.80	0.88
2.50	2.007	5.80	6.69
3.00	7.358	21.28	27.97
3.50	7.598	21.98	49.95
4.00	6.668	19.29	69.24
5.00	5.575	16.13	85.36
6.00	1.105	3.20	88.56
7.00	0.625	1.81	90.37
8.00	0.420	1.21	91.58
9.00	2.911	8.42	100.00

POST ANALYTICAL WEIGHT = 34.572 ; MODE = 3.50 PHI

GRAVEL	PERCENTAGES OF SAND	SILT	CLAY	SAND/MUD RATIO	SHEPARD CLASS
0.00	69.24	22.34	8.42	2.25	2

PHI SIZES AT PERCENT LEVELS OF

1.	5.	16.	25.	35.	50.	65.	75.	84.
2.03A	2.42A	2.75A	2.94A	3.16A	3.50A	3.86A	4.31L	4.73A

TRASK VALUES

Q1	Q2	Q3	SO	LOG SO	SKG
0.130	0.088	0.050	1.610	0.207	0.917

INMAN VALUES (2ND SKEWNESS AND KURTOSIS COULD NOT BE COMPUTED)

MEDIAN	MEAN	DEV.	SKEW.
3.50	3.74	0.99	0.24

FOLK AND WARD VALUES (ONLY THE MEAN COULD BE COMPUTED)

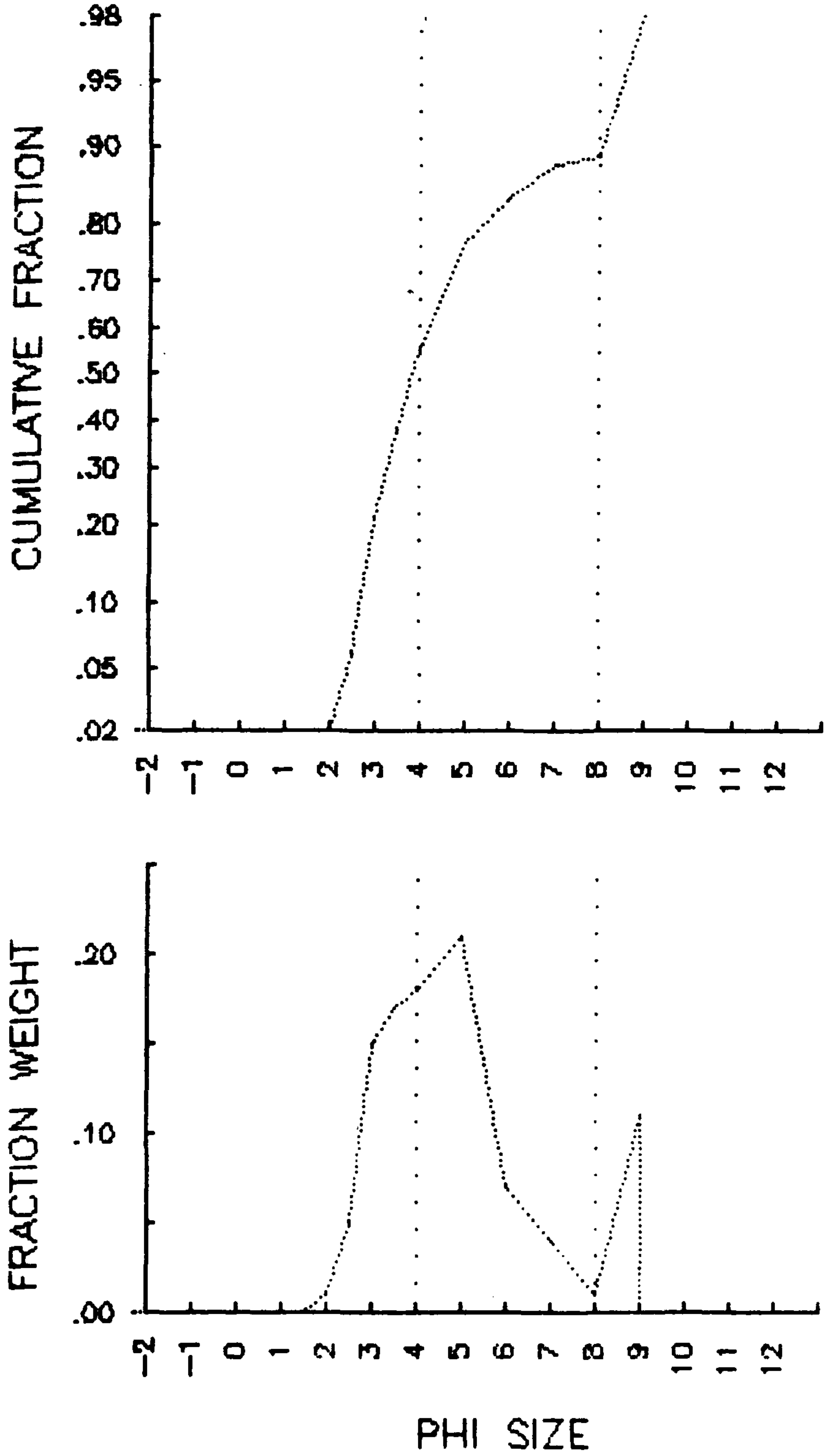
MEAN
3.66

MOMENT MEASURES (WITHOUT SHEPPARD CORRECTIONS)

MEAN	ST. DEV.	SKEW.	KURT.
3.99	1.67	1.67	5.05

NO SHEPPARD CORRECTION. PHI VALUES ARE NOT EQUALLY SPACED.

Figure J-1. 16 of 27
Textural analysis of East Block sediments 450K197.
Stratum 18-upper



MOMENT MEAN:
4.37

MOMENT DEVIATION:
1.79

MOM. SKEWNESS:
1.19

MOM. KURTOSIS:
3.55

MODE:
5.00

Table J-1. 18 of 29
Textural analysis of East Block sediments 450K197.
Stratum 18-upper

PHI SIZE	FRACTION WEIGHT	FRACTION PERCENT	ACCUMULATED PERCENT
-2.25	0.000	0.00	0.00
-2.00	0.000	0.00	0.00
-1.50	0.000	0.00	0.00
-1.00	0.000	0.00	0.00
-0.50	0.000	0.00	0.00
0.00	0.000	0.00	0.00
0.50	0.007	0.02	0.02
1.00	0.011	0.03	0.06
1.50	0.031	0.10	0.15
2.00	0.303	0.94	1.10
2.50	1.592	4.96	6.06
3.00	4.714	14.68	20.74
3.50	5.478	17.06	37.80
4.00	5.782	18.01	55.81
5.00	6.890	21.46	77.27
6.00	2.130	6.63	83.91
7.00	1.310	4.08	87.99
8.00	0.455	1.42	89.41
9.00	3.401	10.59	100.00

POST ANALYTICAL WEIGHT = 32.104 ; MODE = 5.00 PHI

GRAVEL	PERCENTAGES OF SAND	SILT	CLAY	SAND/MUD RATIO	SHEPARD CLASS
0.00	55.81	33.59	10.59	1.26	2

PHI SIZES AT PERCENT LEVELS OF

1.	5.	16.	25.	35.	50.	65.	75.	84.
1.98A	2.44A	2.86A	3.13A	3.42A	3.83A	4.24A	4.79A	6.01A

TRASK VALUES

Q1	Q2	Q3	SO	LOG SO	SKG
0.114	0.071	0.036	1.776	0.249	0.911

INMAN VALUES (2ND SKEWNESS AND KURTOSIS COULD NOT BE COMPUTED)

MEDIAN	MEAN	DEV.	SKEW.
3.83	4.44	1.57	0.39

FOLK AND WARD VALUES (ONLY THE MEAN COULD BE COMPUTED)

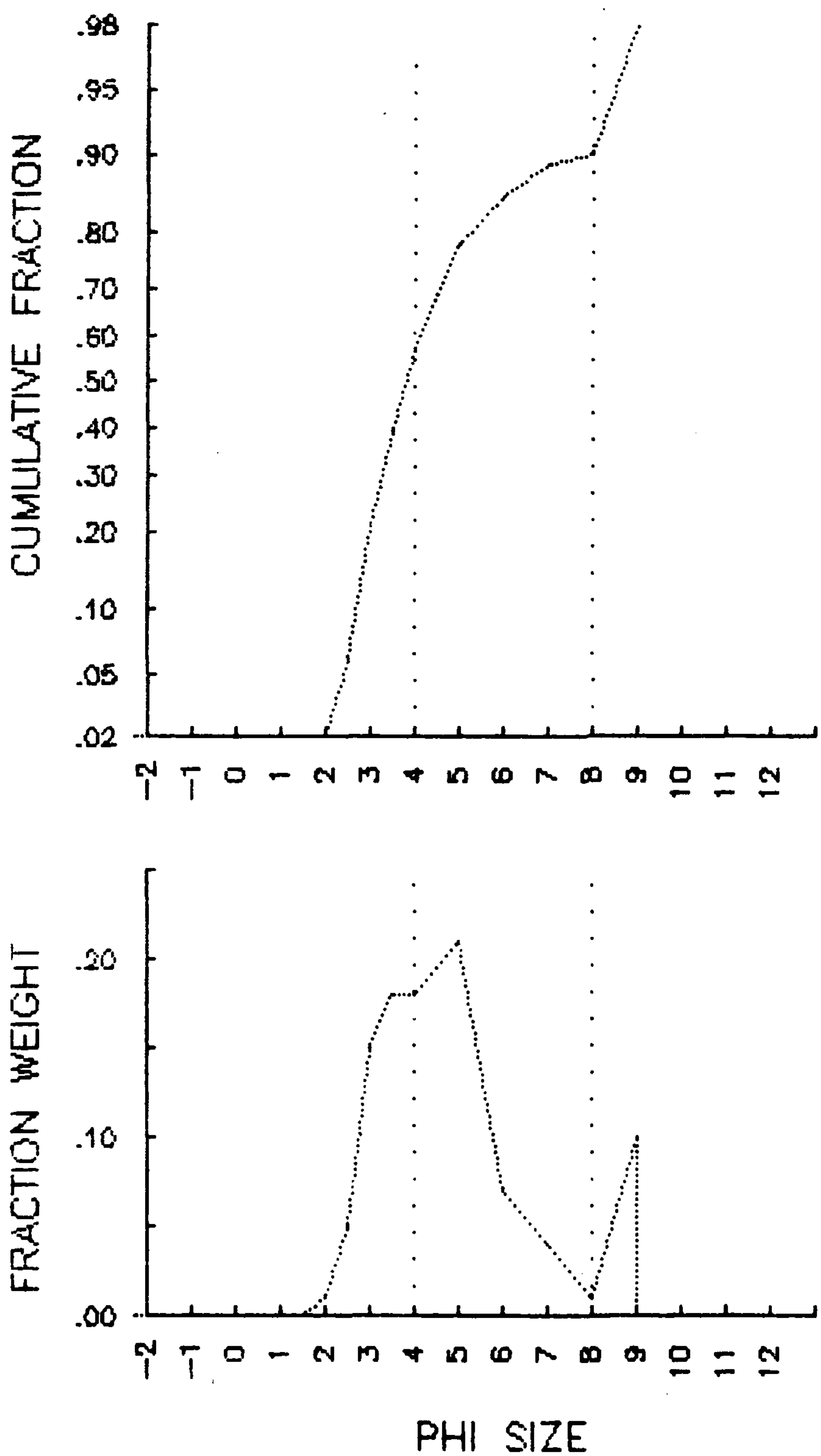
MEAN
4.23

MOMENT MEASURES (WITHOUT SHEPPARD CORRECTIONS)

MEAN	ST. DEV.	SKEW.	KURT.
4.37	1.79	1.19	3.55

NO SHEPPARD CORRECTION. PHI VALUES ARE NOT EQUALLY SPACED.

Figure J-1. 15 of 27
Textural analysis of East Block sediments 450K197.
Stratum 17-lower



WATER DEPTH:
FT

MOMENT MEAN:
4.33

MOMENT DEVIATION:
1.76

MOM. SKEWNESS:
1.23

MOM. KURTOSIS:
3.70

MODE:
5.00

Table J-1. 17 of 29
Textural analysis of East Block sediments 450K197.
Stratum 17-lower

PHI SIZE	FRACTION WEIGHT	FRACTION PERCENT	ACCUMULATED PERCENT
-2.25	0.000	0.00	0.00
-2.00	0.000	0.00	0.00
-1.50	0.000	0.00	0.00
-1.00	0.000	0.00	0.00
-0.50	0.000	0.00	0.00
0.00	0.000	0.00	0.00
0.50	0.011	0.03	0.03
1.00	0.015	0.04	0.07
1.50	0.043	0.11	0.18
2.00	0.359	0.95	1.13
2.50	1.782	4.70	5.83
3.00	5.735	15.13	20.96
3.50	6.728	17.75	38.71
4.00	6.829	18.02	56.73
5.00	8.000	21.11	77.84
6.00	2.590	6.83	84.67
7.00	1.495	3.94	88.61
8.00	0.555	1.46	90.08
9.00	3.761	9.92	100.00

POST ANALYTICAL WEIGHT = 37.903 ; MODE = 5.00 PHI

	PERCENTAGES OF			SAND/MUD	SHEPARD
GRAVEL	SAND	SILT	CLAY	RATIO	CLASS
0.00	56.73	33.35	9.92	1.31	2

PHI SIZES AT PERCENT LEVELS OF

1.	5.	16.	25.	35.	50.	65.	75.	84.
1.98A	2.45A	2.86A	3.12A	3.40A	3.80A	4.23A	4.75A	5.87A

TRASK VALUES

Q1	Q2	Q3	SO	LOG SO	SKG
0.115	0.072	0.037	1.760	0.245	0.910

INMAN VALUES (2ND SKEWNESS AND KURTOSIS COULD NOT BE COMPUTED)

MEDIAN	MEAN	DEV.	SKEW.
3.80	4.37	1.50	0.38

FOLK AND WARD VALUES (ONLY THE MEAN COULD BE COMPUTED)

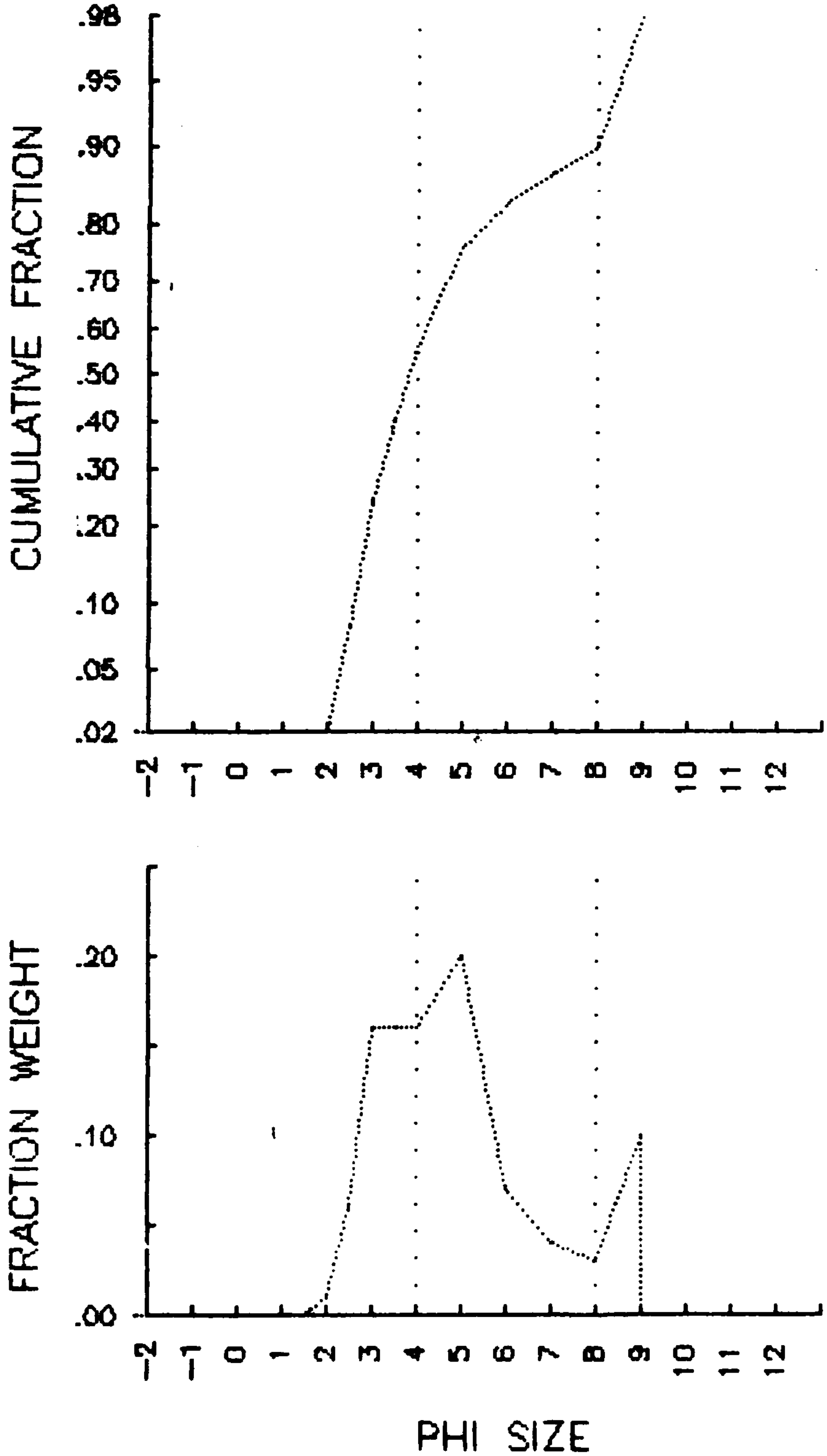
MEAN
4.18

MOMENT MEASURES (WITHOUT SHEPPARD CORRECTIONS)

MEAN	ST. DEV.	SKEW.	KURT.
4.33	1.76	1.23	3.70

NO SHEPPARD CORRECTION. PHI VALUES ARE NOT EQUALLY SPACED.

Figure J-1. 14 of 27
Textural analysis of East Block sediments 450K197.
Stratum 17-upper



MOMENT MEAN:
4.35

MOMENT DEVIATION:
1.86

MOM. SKEWNESS:
1.05

MOM. KURTOSIS:
3.25

MODE:
5.00

Table J-1. 16 of 29
Textural analysis of East Block sediments 450K197.
Stratum 17-upper

PHI SIZE	FRACTION WEIGHT	FRACTION PERCENT	ACCUMULATED PERCENT
-2.25	0.000	0.00	0.00
-2.00	0.000	0.00	0.00
-1.50	0.000	0.00	0.00
-1.00	0.000	0.00	0.00
-0.50	0.000	0.00	0.00
0.00	0.000	0.00	0.00
0.50	0.110	0.28	0.28
1.00	0.045	0.12	0.40
1.50	0.100	0.26	0.66
2.00	0.570	1.47	2.13
2.50	2.368	6.10	8.23
3.00	6.129	15.79	24.01
3.50	6.305	16.24	40.26
4.00	6.226	16.04	56.29
5.00	7.580	19.53	75.82
6.00	2.695	6.94	82.76
7.00	1.595	4.11	86.87
8.00	1.090	2.81	89.68
9.00	4.006	10.32	100.00

POST ANALYTICAL WEIGHT = 38.819 ; MODE = 5.00 PHI

GRAVEL	PERCENTAGES OF SAND	SILT	CLAY	SAND/MUD RATIO	SHEPARD CLASS
0.00	56.29	33.39	10.32	1.29	2

PHI SIZES AT PERCENT LEVELS OF

1.	5.	16.	25.	35.	50.	65.	75.	84.
1.77A	2.32A	2.77A	3.03A	3.34A	3.79A	4.29A	4.92A	6.26A

TRASK VALUES

Q1	Q2	Q3	SO	LOG SO	SKG
0.122	0.072	0.033	1.925	0.284	0.879

INMAN VALUES (2ND SKEWNESS AND KURTOSIS COULD NOT BE COMPUTED)

MEDIAN	MEAN	DEV.	SKEW.
3.79	4.51	1.74	0.42

FOLK AND WARD VALUES (ONLY THE MEAN COULD BE COMPUTED)

MEAN
4.27

MOMENT MEASURES (WITHOUT SHEPPARD CORRECTIONS)

MEAN	ST. DEV.	SKEW.	KURT.
4.35	1.86	1.05	3.25

NO SHEPPARD CORRECTION. PHI VALUES ARE NOT EQUALLY SPACED.

Figure J-1. 13 of 27
Textural analysis of East Block sediments 450K197.
Stratum 15

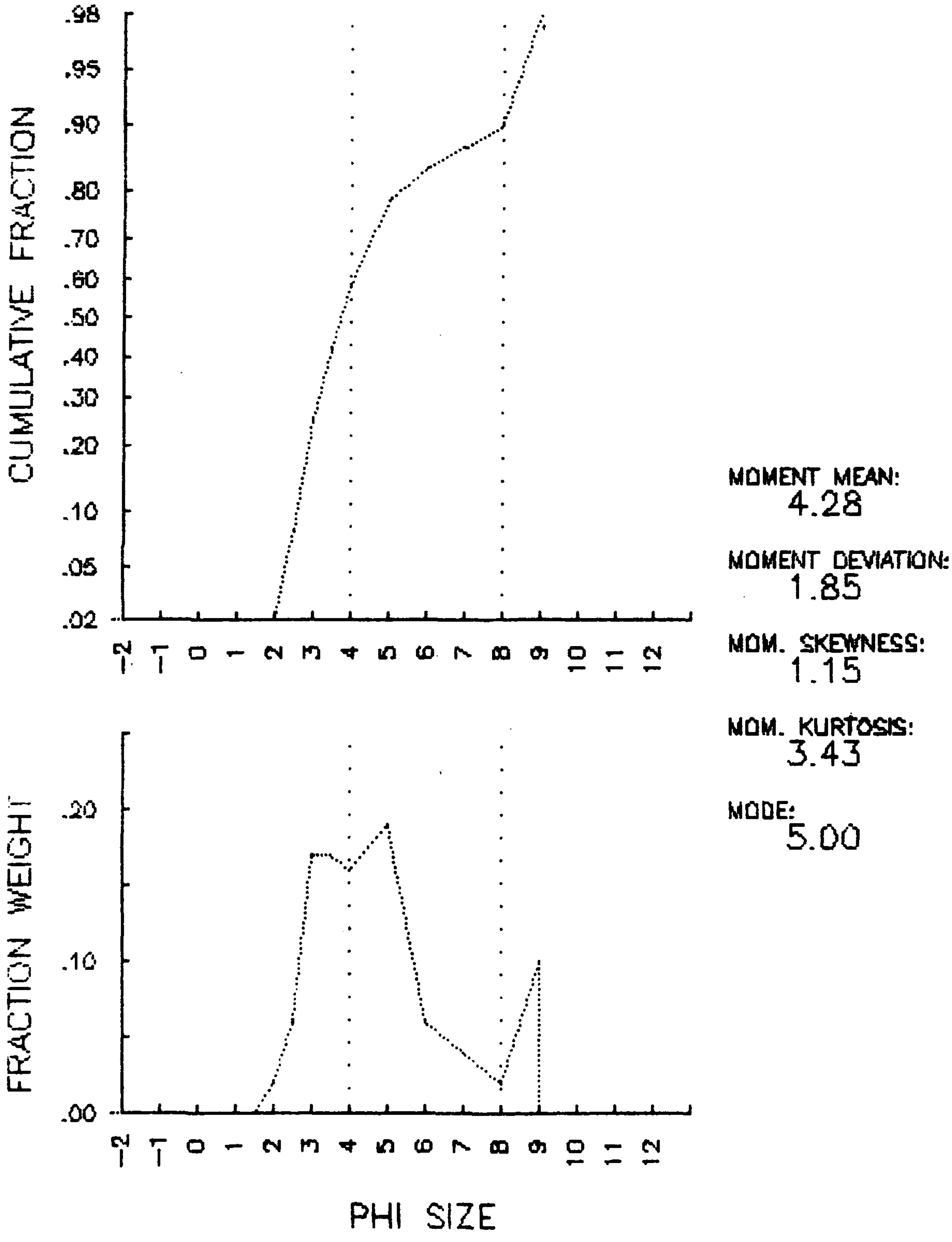


Table J-1. 15 of 29
Textural analysis of East Block sediments 450K197.
Stratum 15

PHI SIZE	FRACTION WEIGHT	FRACTION PERCENT	ACCUMULATED PERCENT
-2.25	0.000	0.00	0.00
-2.00	0.000	0.00	0.00
-1.50	0.000	0.00	0.00
-1.00	0.000	0.00	0.00
-0.50	0.000	0.00	0.00
0.00	0.000	0.00	0.00
0.50	0.039	0.11	0.11
1.00	0.042	0.12	0.23
1.50	0.099	0.28	0.51
2.00	0.575	1.64	2.16
2.50	2.175	6.21	8.37
3.00	5.915	16.89	25.26
3.50	6.013	17.17	42.44
4.00	5.735	16.38	58.81
5.00	6.550	18.71	77.52
6.00	2.100	6.00	83.52
7.00	1.385	3.96	87.47
8.00	0.725	2.07	89.54
9.00	3.661	10.46	100.00

POST ANALYTICAL WEIGHT = 35.015 ; MODE = 5.00 PHI

	PERCENTAGES OF			SAND/MUD	SHEPARD
GRAVEL	SAND	SILT	CLAY	RATIO	CLASS
0.00	58.81	30.73	10.46	1.43	2

PHI SIZES AT PERCENT LEVELS OF

1.	5.	16.	25.	35.	50.	65.	75.	84.
1.78A	2.30A	2.75A	2.99A	3.28A	3.71A	4.18A	4.74A	6.09A

TRASK VALUES

Q1	Q2	Q3	SO	LOG SO	SKG
0.126	0.076	0.037	1.833	0.263	0.898

INMAN VALUES (2ND SKEWNESS AND KURTOSIS COULD NOT BE COMPUTED)

MEDIAN	MEAN	DEV.	SKEW.
3.71	4.42	1.67	0.42

FOLK AND WARD VALUES (ONLY THE MEAN COULD BE COMPUTED)

MEAN
4.18

MOMENT MEASURES (WITHOUT SHEPPARD CORRECTIONS)

MEAN	ST. DEV.	SKEW.	KURT.
4.28	1.85	1.15	3.43

NO SHEPPARD CORRECTION. PHI VALUES ARE NOT EQUALLY SPACED.

Figure J-1. 12 of 27
Textural analysis of East Block sediments 450K197.
Stratum 12

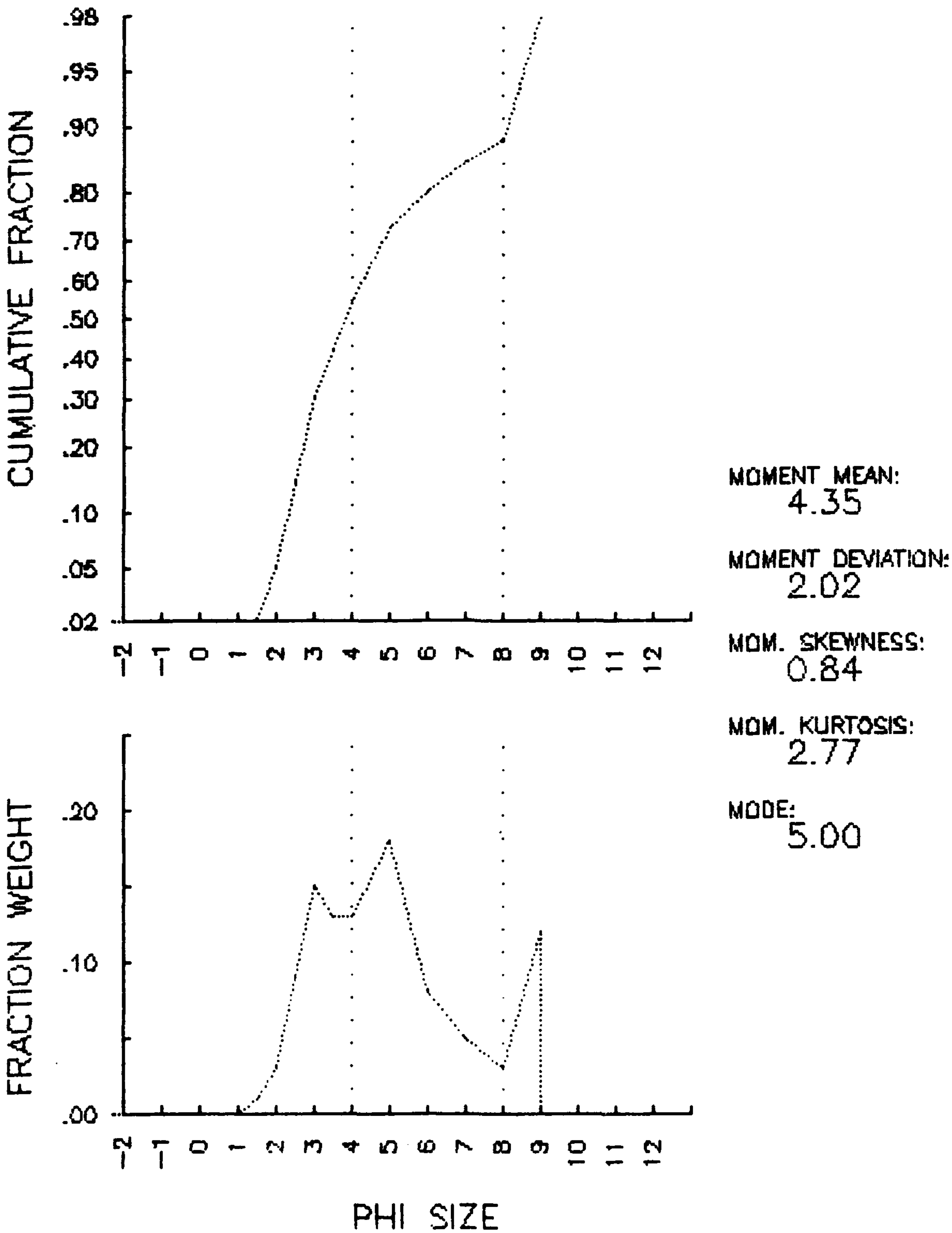
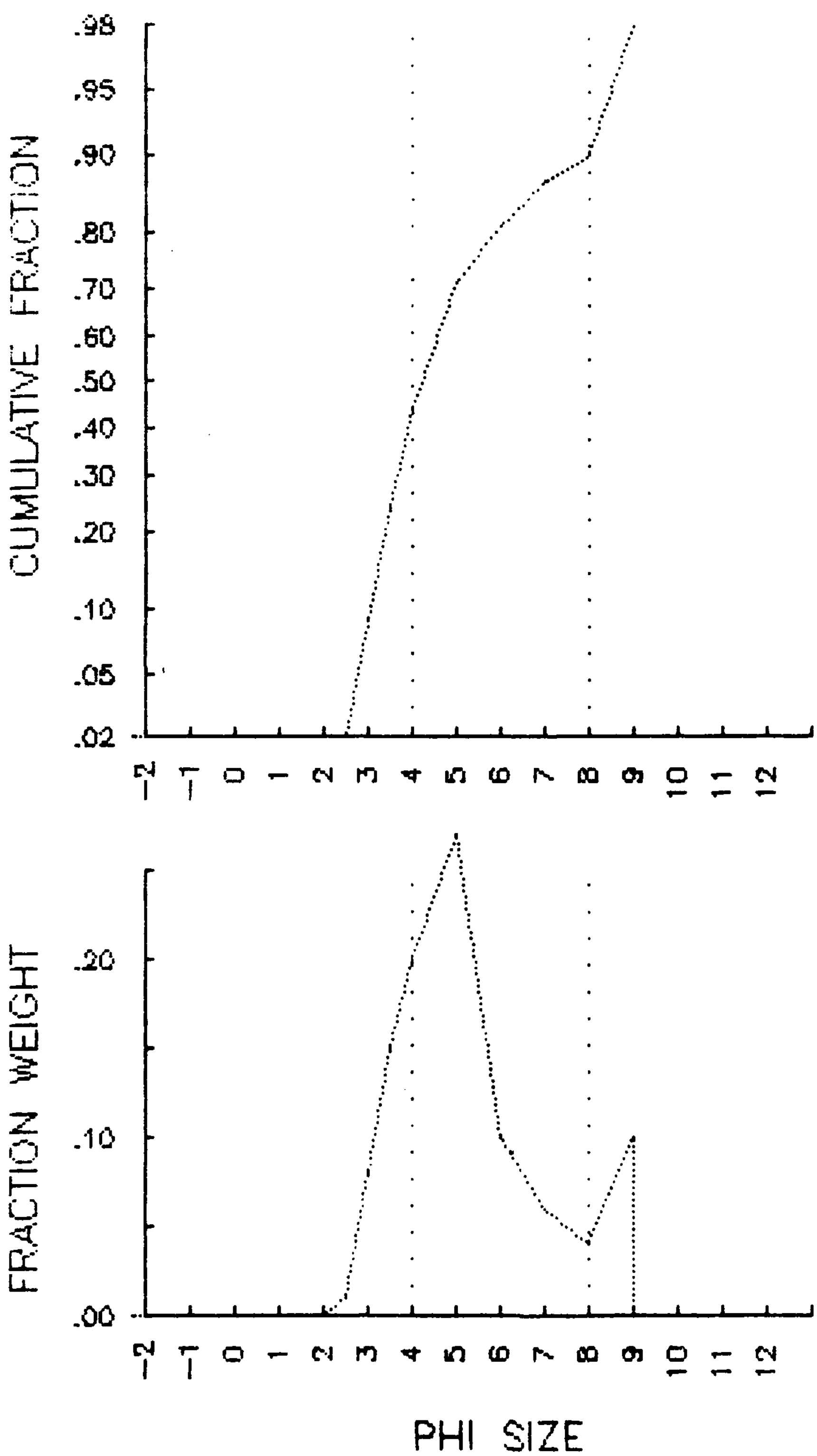


Figure J-1. 19 of 27
Textural analysis of East Block sediments 450K197.
Stratum 19-lower



MOMENT MEAN:
4.71

MOMENT DEVIATION:
1.69

MOM. SKEWNESS:
1.04

MOM. KURTOSIS:
3.17

MODE:
5.00

Table J-1. 22 of 29
Textural analysis of East Block sediments 450K197.
Stratum 20

PHI SIZE	FRACTION WEIGHT	FRACTION PERCENT	ACCUMULATED PERCENT
-2.25	0.000	0.00	0.00
-2.00	0.000	0.00	0.00
-1.50	0.000	0.00	0.00
-1.00	0.000	0.00	0.00
-0.50	0.000	0.00	0.00
0.00	0.000	0.00	0.00
0.50	0.042	0.15	0.15
1.00	0.004	0.02	0.16
1.50	0.012	0.04	0.21
2.00	0.062	0.22	0.42
2.50	0.341	1.20	1.63
3.00	1.610	5.66	7.29
3.50	3.256	11.46	18.75
4.00	4.655	16.38	35.13
5.00	8.245	29.02	64.15
6.00	3.150	11.09	75.24
7.00	1.955	6.88	82.12
8.00	1.230	4.33	86.45
9.00	3.851	13.55	100.00

POST ANALYTICAL WEIGHT = 28.413 ; MODE = 5.00 PHI

GRAVEL	SAND	SILT	CLAY	SAND/MUD RATIO	SHEPARD CLASS
	PERCENTAGES OF				
0.00	35.13	51.31	13.55	0.54	3

PHI SIZES AT PERCENT LEVELS OF

1.	5.	16.	25.	35.	50.	65.	75.	84.
2.37A	2.86A	3.40A	3.70A	4.00A	4.36A	5.06A	5.97A	7.38A

TRASK VALUES

Q1	Q2	Q3	SO	LOG SO	SKG
0.077	0.049	0.016	2.198	0.342	0.722

INMAN VALUES (2ND SKEWNESS AND KURTOSIS COULD NOT BE COMPUTED)

MEDIAN	MEAN	DEV.	SKEW.
4.36	5.39	1.99	0.52

FOLK AND WARD VALUES (ONLY THE MEAN COULD BE COMPUTED)

MEAN
5.05

MOMENT MEASURES (WITHOUT SHEPPARD CORRECTIONS)

MEAN	ST. DEV.	SKEW.	KURT.
5.01	1.80	0.77	2.57

NO SHEPPARD CORRECTION. PHI VALUES ARE NOT EQUALLY SPACED.

Figure J-1. 20 of 27
Textural analysis of East Block sediments 450K197.
Stratum 20

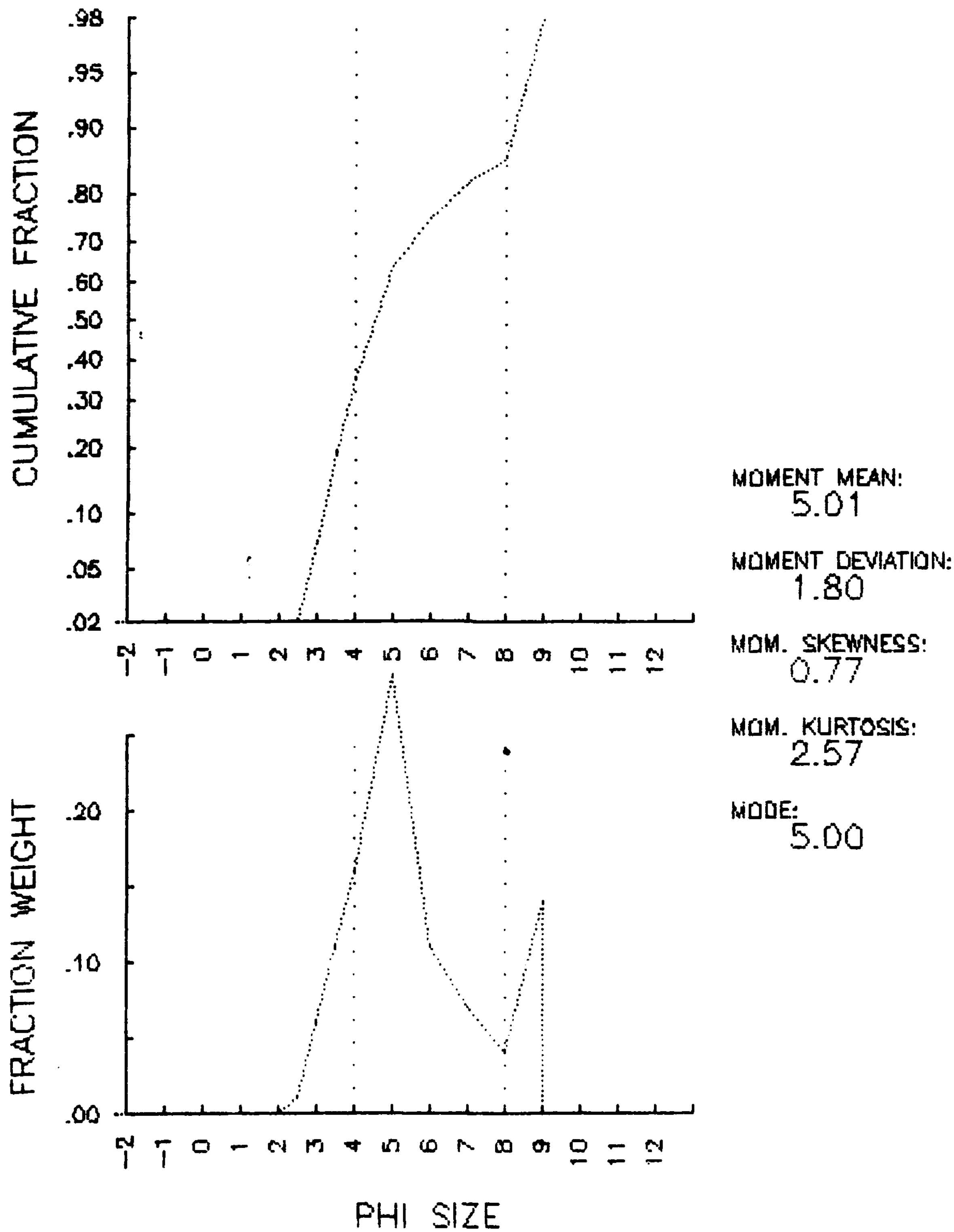


Table J-1. 23 of 29
Textural analysis of East Block sediments 450K197.
Stratum 22-upper

PHI SIZE	FRACTION WEIGHT	FRACTION PERCENT	ACCUMULATED PERCENT
-2.25	0.000	0.00	0.00
-2.00	0.000	0.00	0.00
-1.50	0.000	0.00	0.00
-1.00	0.000	0.00	0.00
-0.50	0.000	0.00	0.00
0.00	0.000	0.00	0.00
0.50	0.120	0.29	0.29
1.00	0.051	0.12	0.41
1.50	0.093	0.22	0.63
2.00	0.568	1.35	1.98
2.50	2.390	5.67	7.65
3.00	5.448	12.93	20.58
3.50	5.068	12.03	32.62
4.00	6.123	14.54	47.15
5.00	10.060	23.88	71.03
6.00	3.730	8.86	79.89
7.00	2.615	6.21	86.10
8.00	1.625	3.86	89.96
9.00	4.231	10.04	100.00

POST ANALYTICAL WEIGHT = 42.122 ; MODE = 5.00 PHI

GRAVEL	PERCENTAGES OF SAND	SILT	CLAY	SAND/MUD RATIO	SHEPARD CLASS
0.00	47.15	42.80	10.04	0.89	2

PHI SIZES AT PERCENT LEVELS OF

1.	5.	16.	25.	35.	50.	65.	75.	84.
1.82A	2.34A	2.83A	3.19A	3.58A	4.08A	4.62A	5.40A	6.61A

TRASK VALUES

Q1	Q2	Q3	SO	LOG SO	SKG
0.110	0.059	0.024	2.148	0.332	0.861

INMAN VALUES (2ND SKEWNESS AND KURTOSIS COULD NOT BE COMPUTED)

MEDIAN	MEAN	DEV.	SKEW.
4.08	4.72	1.89	0.34

FOLK AND WARD VALUES (ONLY THE MEAN COULD BE COMPUTED)

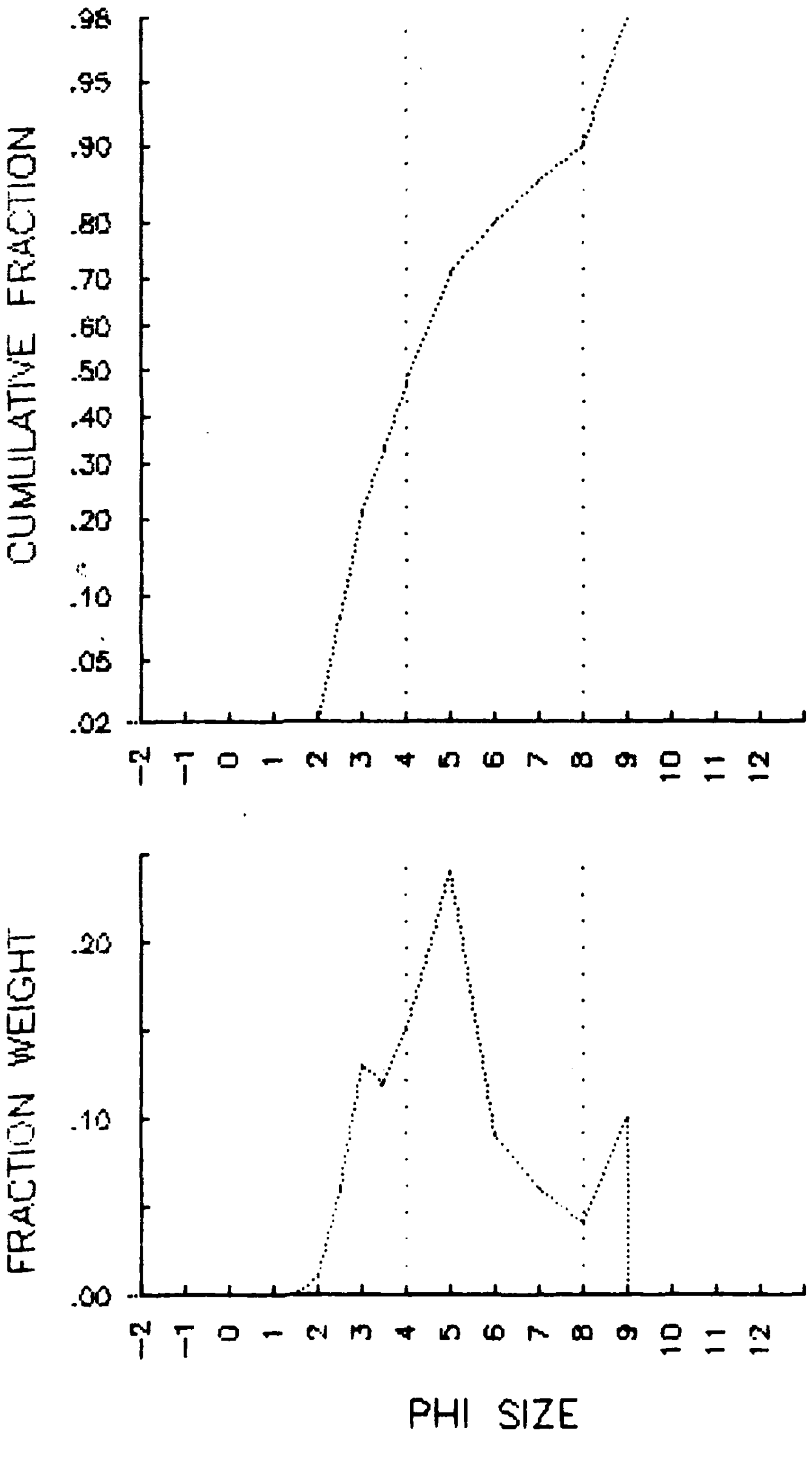
MEAN
4.51

MOMENT MEASURES (WITHOUT SHEPPARD CORRECTIONS)

MEAN	ST. DEV.	SKEW.	KURT.
4.56	1.85	0.82	2.87

NO SHEPPARD CORRECTION. PHI VALUES ARE NOT EQUALLY SPACED.

Figure J-1. 21 of 27
Textural analysis of East Block sediments 450K197.
Stratum 22-upper



MOMENT MEAN:
4.56

MOMENT DEVIATION:
1.85

MOM. SKEWNESS:
0.82

MOM. KURTOSIS:
2.87

MODE:
5.00

Table J-1. 24 of 29
Textural analysis of East Block sediments 450K197
Stratum 22-lower

PHI SIZE	FRACTION WEIGHT	FRACTION PERCENT	ACCUMULATED PERCENT
-2.25	0.000	0.00	0.00
-2.00	0.000	0.00	0.00
-1.50	0.000	0.00	0.00
-1.00	0.000	0.00	0.00
-0.50	0.000	0.00	0.00
0.00	0.000	0.00	0.00
0.50	0.194	0.58	0.58
1.00	0.036	0.11	0.68
1.50	0.046	0.14	0.82
2.00	0.696	2.07	2.89
2.50	3.470	10.31	13.20
3.00	7.936	23.58	36.77
3.50	6.722	19.97	56.74
4.00	5.145	15.28	72.03
5.00	4.700	13.96	85.99
6.00	1.350	4.01	90.00
7.00	0.750	2.23	92.23
8.00	0.515	1.53	93.76
9.00	2.101	6.24	100.00

POST ANALYTICAL WEIGHT = 33.660 ; MODE = 3.00 PHI

	PERCENTAGES OF			SAND/MUD	SHEPARD
GRAVEL	SAND	SILT	CLAY	RATIO	CLASS
0.00	72.03	21.73	6.24	2.57	2

PHI SIZES AT PERCENT LEVELS OF (LAST VALUE IS EXTRAPOLATED)

1.	5.	16.	25.	35.	50.	65.	75.	84.	95.
1.57L	2.19A	2.57A	2.76A	2.96A	3.32A	3.74A	4.09A	4.71A	8.96L

TRASK VALUES

Q1	Q2	Q3	SO	LOG SO	SKG
0.148	0.100	0.059	1.588	0.201	0.927

INMAN VALUES

MEDIAN	MEAN	DEV.	SKEW.	2ND SK.	KURT.
3.32	3.64	1.07	0.30	2.11	2.17

FOLK AND WARD VALUES

MEAN	DEV.	TYPE	SKEW.	TYPE	KURT.	TYPE
3.53	1.56	4	0.48	5	2.08	5

MOMENT MEASURES (WITHOUT SHEPPARD CORRECTIONS)

MEAN	ST. DEV.	SKEW.	KURT.
3.78	1.64	1.57	5.24

NO SHEPPARD CORRECTION. PHI VALUES ARE NOT EQUALLY SPACED.

Figure J-1. 22 of 27
Textural analysis of East Block sediments 450K197.
Stratum 22-lower

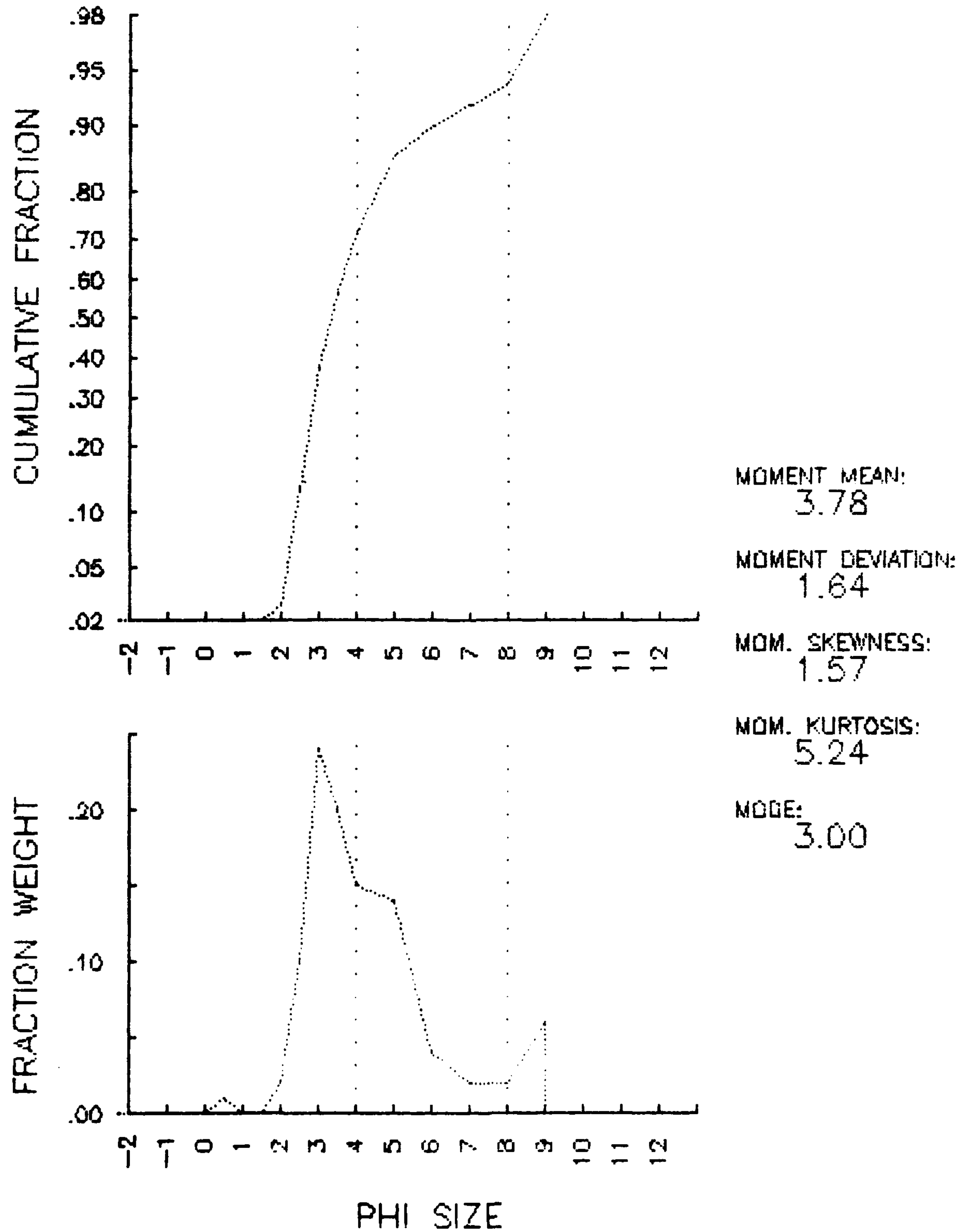


Table J-1. 25 of 29
Textural analysis of East Block sediments 450K197.
Stratum 23

PHI SIZE	FRACTION WEIGHT	FRACTION PERCENT	ACCUMULATED PERCENT
-2.25	0.000	0.00	0.00
-2.00	0.000	0.00	0.00
-1.50	0.000	0.00	0.00
-1.00	0.000	0.00	0.00
-0.50	0.000	0.00	0.00
0.00	0.000	0.00	0.00
0.50	0.176	0.52	0.52
1.00	0.040	0.12	0.64
1.50	0.089	0.26	0.90
2.00	0.688	2.04	2.94
2.50	3.296	9.75	12.69
3.00	7.795	23.06	35.75
3.50	6.157	18.21	53.96
4.00	4.973	14.71	68.67
5.00	4.870	14.41	83.07
6.00	1.720	5.09	88.16
7.00	1.040	3.08	91.24
8.00	0.635	1.88	93.12
9.00	2.327	6.88	100.00

POST ANALYTICAL WEIGHT = 33.807 ; MODE = 3.00 PHI

	PERCENTAGES OF			SAND/MUD	SHEPARD
GRAVEL	SAND	SILT	CLAY	RATIO	CLASS
0.00	68.67	24.45	6.88	2.19	2

PHI SIZES AT PERCENT LEVELS OF (LAST VALUE IS EXTRAPOLATED)

1.	5.	16.	25.	35.	50.	65.	75.	84.	95.
1.61A	2.19A	2.58A	2.77A	2.98A	3.38A	3.85A	4.28A	5.14A	9.24L

TRASK VALUES

Q1	Q2	Q3	SO	LOG SO	SKG
0.147	0.096	0.051	1.688	0.227	0.905

INMAN VALUES

MEDIAN	MEAN	DEV.	SKEW.	2ND SK.	KURT.
3.38	3.86	1.28	0.37	1.82	1.75

FOLK AND WARD VALUES

MEAN	DEV.	TYPE	SKEW.	TYPE	KURT.	TYPE
3.70	1.71	4	0.52	5	1.91	5

MOMENT MEASURES (WITHOUT SHEPPARD CORRECTIONS)

MEAN	ST DEV	SKEW.	KURT.
3.89	1.71	1.40	4.50

NO SHEPPARD CORRECTION. PHI VALUES ARE NOT EQUALLY SPACED.

Figure J-1. 23 of 27
Textural analysis of East Block sediments 450K197.
Stratum 23

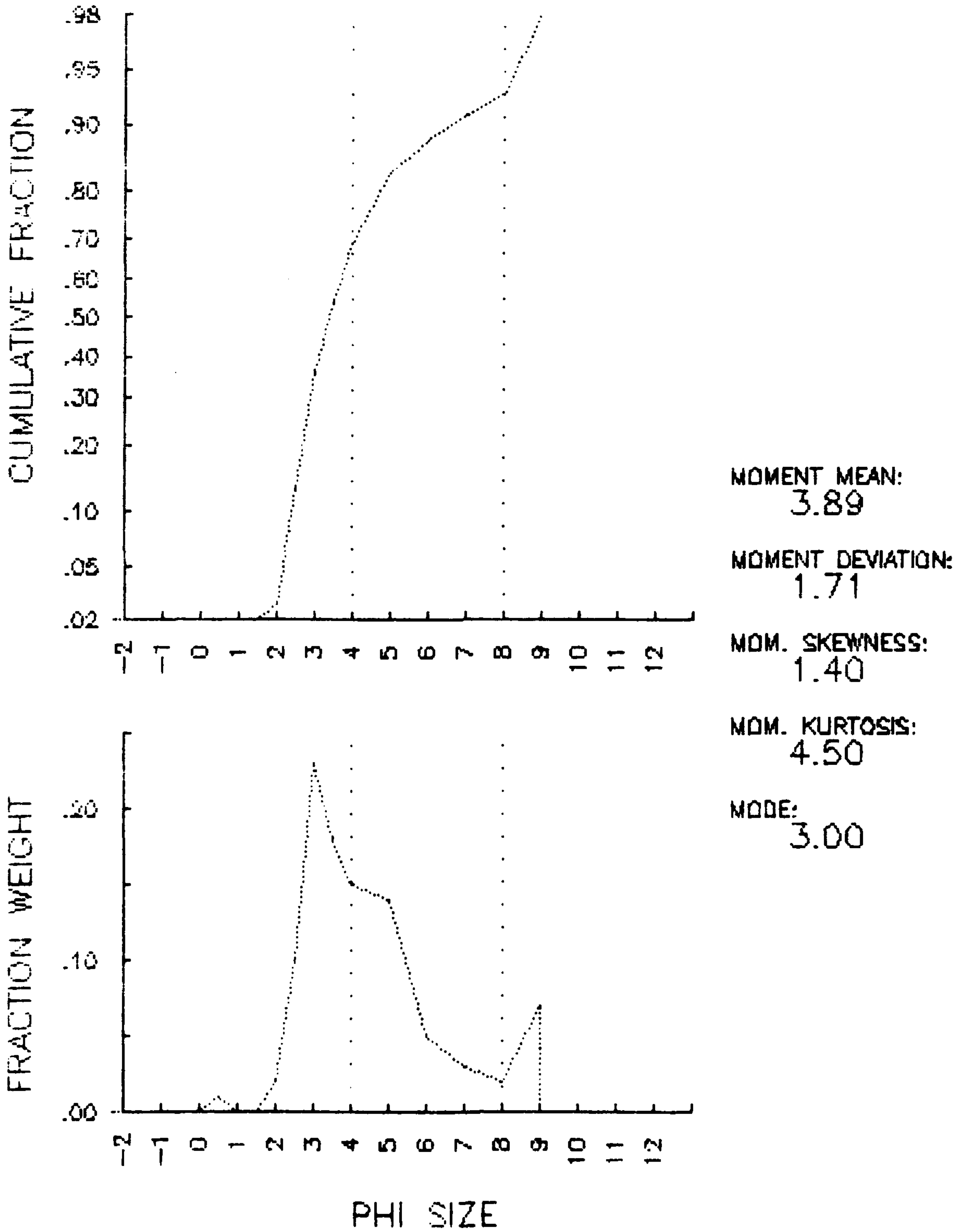


Table J-1. 26 of 29
Textural analysis of East Block sediments 450K197.
Stratum 26

PHI SIZE	FRACTION WEIGHT	FRACTION PERCENT	ACCUMULATED PERCENT
-2.25	0.000	0.00	0.00
-2.00	0.000	0.00	0.00
-1.50	0.000	0.00	0.00
-1.00	0.000	0.00	0.00
-0.50	0.000	0.00	0.00
0.00	0.000	0.00	0.00
0.50	0.065	0.20	0.20
1.00	0.049	0.15	0.34
1.50	0.108	0.33	0.67
2.00	0.552	1.66	2.33
2.50	2.369	7.14	9.47
3.00	5.805	17.49	26.97
3.50	5.588	16.84	43.81
4.00	5.099	15.37	59.18
5.00	5.905	17.79	76.97
6.00	2.120	6.39	83.36
7.00	1.530	4.61	87.97
8.00	0.810	2.44	90.41
9.00	3.182	9.59	100.00

POST ANALYTICAL WEIGHT = 33.184 ; MODE = 5.00 PHI

	PERCENTAGES OF			SAND/MUD	SHEPARD
GRAVEL	SAND	SILT	CLAY	RATIO	CLASS
0.00	59.18	31.23	9.59	1.45	2

PHI SIZES AT PERCENT LEVELS OF

1.	5.	16.	25.	35.	50.	65.	75.	84.
1.71A	2.27A	2.71A	2.95A	3.24A	3.68A	4.20A	4.80A	6.11A

TRASK VALUES

Q1	Q2	Q3	SO	LOG SO	SKG
0.130	0.078	0.036	1.902	0.279	0.876

INMAN VALUES (2ND SKEWNESS AND KURTOSIS COULD NOT BE COMPUTED)

MEDIAN	MEAN	DEV.	SKEW.
3.68	4.41	1.70	0.43

FOLK AND WARD VALUES (ONLY THE MEAN COULD BE COMPUTED)

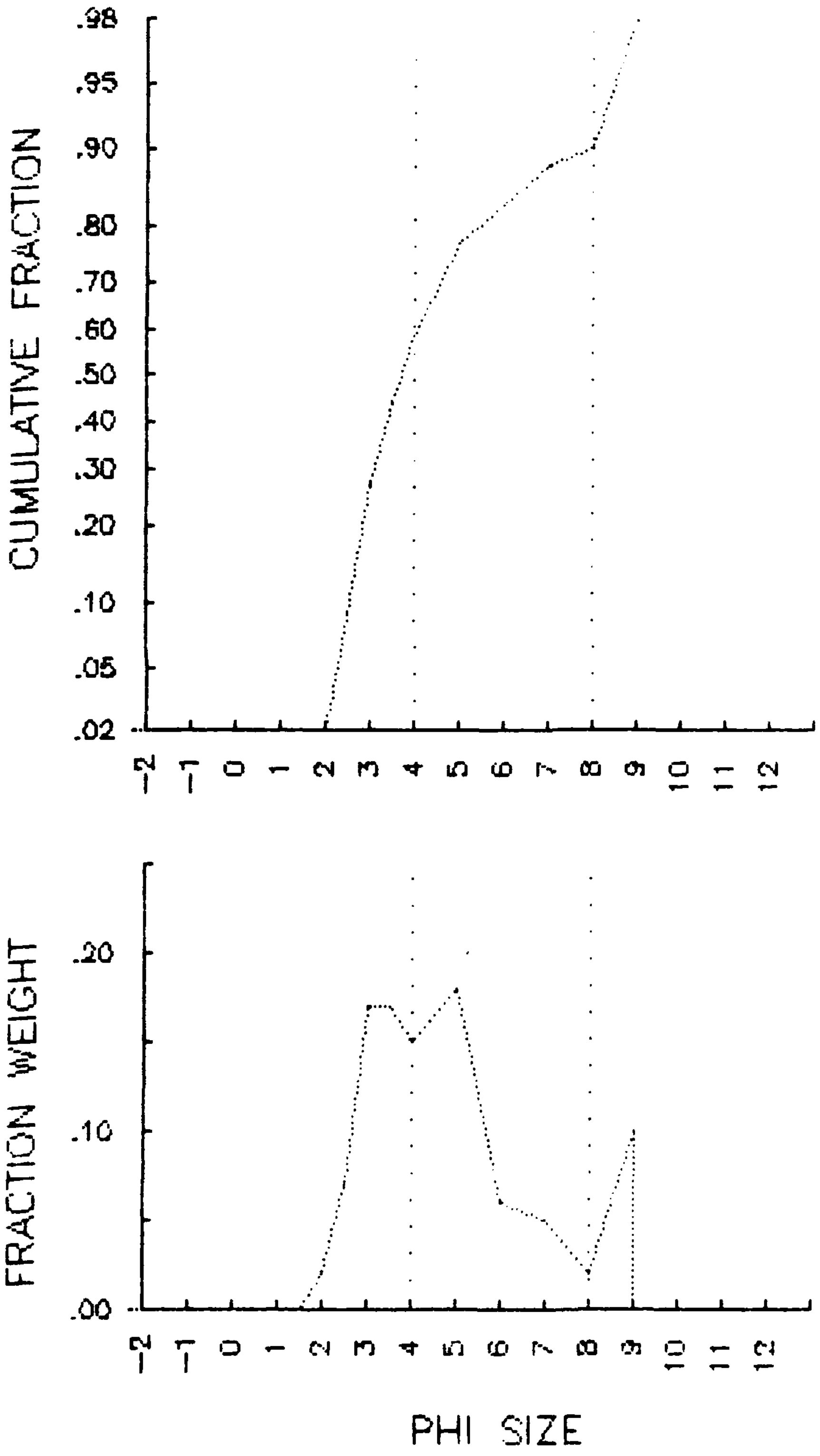
MEAN
4.17

MOMENT MEASURES (WITHOUT SHEPPARD CORRECTIONS)

MEAN	ST. DEV.	SKEW.	KURT.
4.25	1.84	1.11	3.38

NO SHEPPARD CORRECTION. PHI VALUES ARE NOT EQUALLY SPACED.

Figure J-1. 24 of 27
Textural analysis of East Block sediments 450K197.
Stratum 26



MOMENT MEAN:
4.25

MOMENT DEVIATION:
1.84

MOM. SKEWNESS:
1.11

MOM. KURTOSIS:
3.38

MODE:
5.00

Table J-1. 27 of 29
Textural analysis of East Block sediments 450K197.
Stratum 9 (Sample 2)

PHI SIZE	FRACTION WEIGHT	FRACTION PERCENT	ACCUMULATED PERCENT
-2.25	0.000	0.00	0.00
-2.00	0.000	0.00	0.00
-1.50	0.000	0.00	0.00
-1.00	0.000	0.00	0.00
-0.50	0.000	0.00	0.00
0.00	0.000	0.00	0.00
0.50	0.059	0.15	0.15
1.00	0.026	0.07	0.22
1.50	0.044	0.11	0.33
2.00	0.232	0.59	0.92
2.50	1.144	2.91	3.83
3.00	4.131	10.51	14.34
3.50	5.680	14.45	28.80
4.00	6.743	17.16	45.96
5.00	9.960	25.35	71.30
6.00	3.845	9.78	81.09
7.00	2.490	6.34	87.42
8.00	1.375	3.50	90.92
9.00	3.567	9.08	100.00

POST ANALYTICAL WEIGHT = 39.297 ; MODE = 5.00 PHI

PERCENTAGES OF GRAVEL	SAND	SILT	CLAY	SAND/MUD RATIO	SHEPARD CLASS
0.00	45.96	44.97	9.08	0.85	2

PHI SIZES AT PERCENT LEVELS OF

1.	5.	16.	25.	35.	50.	65.	75.	84.
2.04A	2.59A	3.06A	3.38A	3.68A	4.10A	4.63A	5.32A	6.39A

TRASK VALUES

Q1	Q2	Q3	SO	LOG SO	SKG
0.096	0.058	0.025	1.961	0.292	0.842

INMAN VALUES (2ND SKEWNESS AND KURTOSIS COULD NOT BE COMPUTED)

MEDIAN	MEAN	DEV.	SKEW.
4.10	4.73	1.66	0.37

FOLK AND WARD VALUES (ONLY THE MEAN COULD BE COMPUTED)

MEAN
4.52

MOMENT MEASURES (WITHOUT SHEPPARD CORRECTIONS)

MEAN	ST. DEV.	SKEW.	KURT.
4.61	1.73	0.94	3.15

NO SHEPPARD CORRECTION. PHI VALUES ARE NOT EQUALLY SPACED.

Figure J-1. 25 of 27
Textural analysis of East Block sediments 450K197.
Stratum 9 (Sample 2)

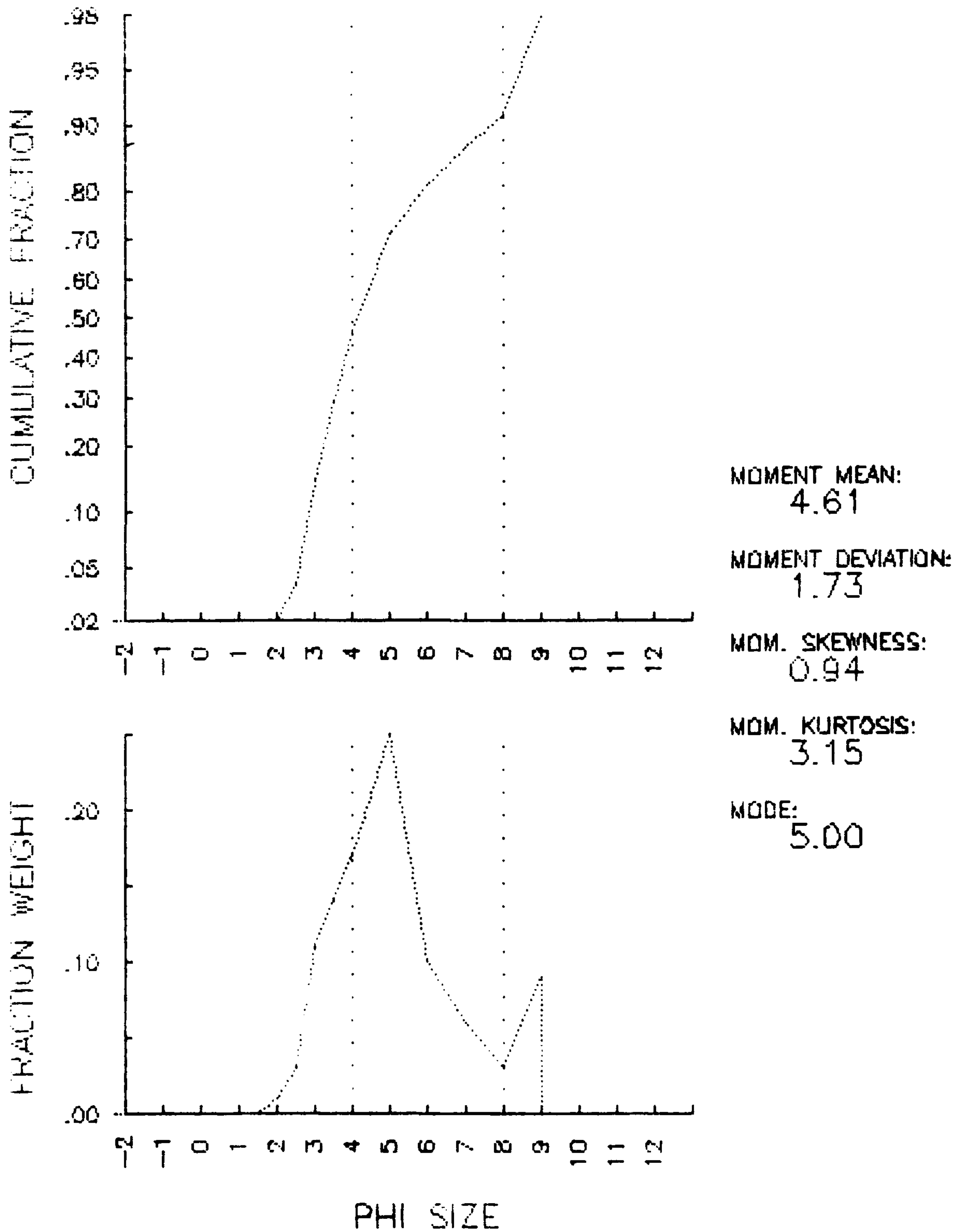


Table J-1. 28 of 29
Textural analysis of East Block sediments 450K197.
Stratum 13 (Sample 2)

PHI SIZE	FRACTION WEIGHT	FRACTION PERCENT	ACCUMULATED PERCENT
-2.25	0.000	0.00	0.00
-2.00	0.000	0.00	0.00
-1.50	0.000	0.00	0.00
-1.00	0.000	0.00	0.00
-0.50	0.000	0.00	0.00
0.00	0.000	0.00	0.00
0.50	0.161	0.48	0.48
1.00	0.053	0.16	0.64
1.50	0.125	0.37	1.01
2.00	0.571	1.70	2.71
2.50	2.346	6.98	9.69
3.00	5.592	16.63	26.31
3.50	5.431	16.15	42.46
4.00	5.079	15.10	57.56
5.00	6.085	18.09	75.66
6.00	2.630	7.82	83.48
7.00	1.570	4.67	88.14
8.00	1.015	3.02	91.16
9.00	2.972	8.84	100.00

POST ANALYTICAL WEIGHT = 33.632 ; MODE = 5.00 PHI

GRAVEL	PERCENTAGES OF SAND	SILT	CLAY	SAND/MUD RATIO	SHEPARD CLASS
0.00	57.56	33.60	8.84	1.36	2

PHI SIZES AT PERCENT LEVELS OF

1.	5.	16.	25.	35.	50.	65.	75.	84.
1.49A	2.25A	2.71A	2.96A	3.27A	3.73A	4.30A	4.94A	6.09A

TRASK VALUES

Q1	Q2	Q3	SO	LOG SO	SKG
0.128	0.075	0.033	1.985	0.298	0.858

INMAN VALUES (2ND SKEWNESS AND KURTOSIS COULD NOT BE COMPUTED)

MEDIAN	MEAN	DEV.	SKEW.
3.73	4.40	1.69	0.40

FOLK AND WARD VALUES (ONLY THE MEAN COULD BE COMPUTED)

MEAN
4.18

MOMENT MEASURES (WITHOUT SHEPPARD CORRECTIONS)

MEAN	ST. DEV.	SKEW.	KURT.
4.27	1.84	1.02	3.31

NO SHEPPARD CORRECTION. PHI VALUES ARE NOT EQUALLY SPACED.

Figure J-1. 26 of 27
Textural analysis of East Block sediments 450K197.
Stratum 13 (Sample 2)

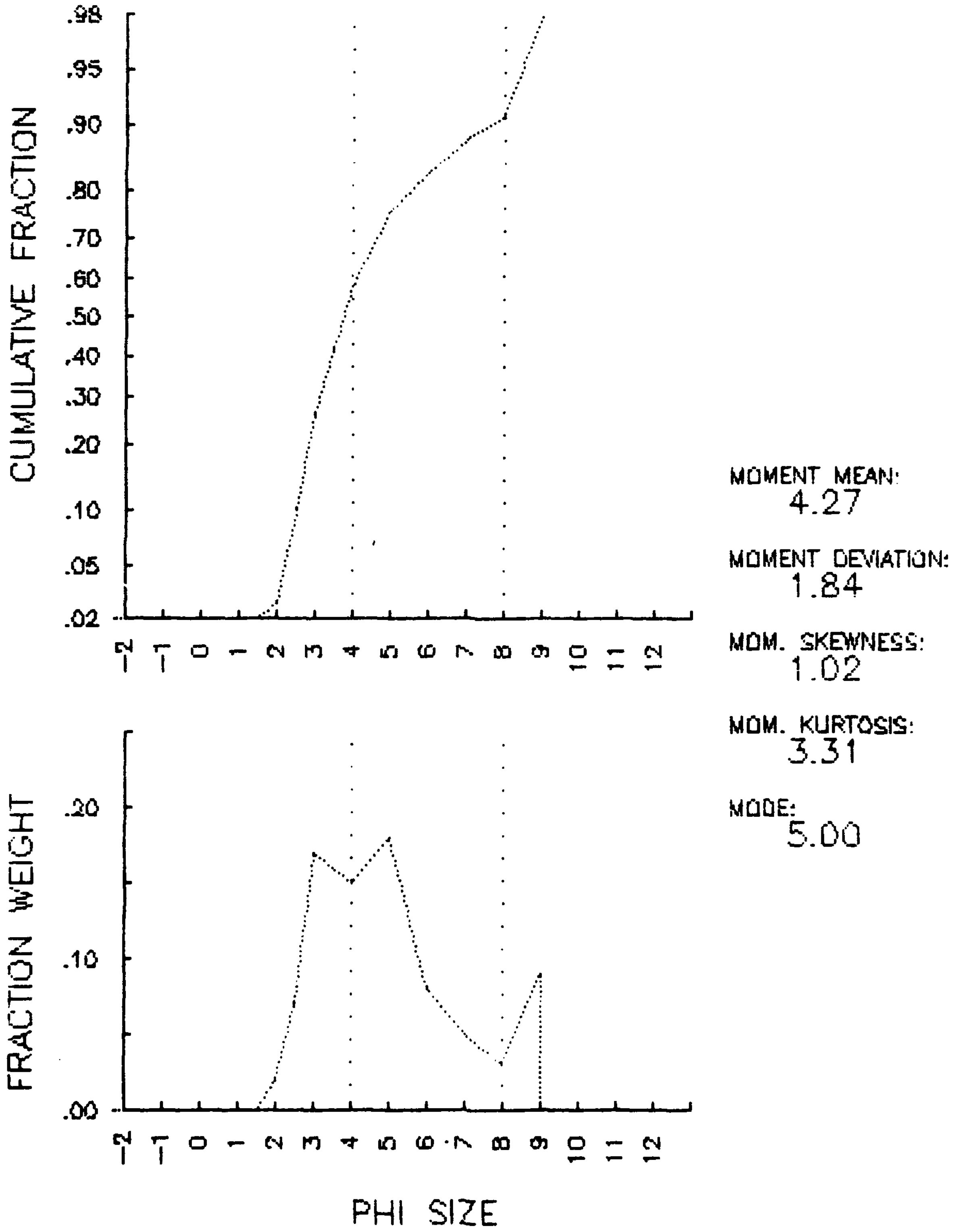


Table J-1. 29 of 29
Textural analysis of East Block sediments 450K197.
Stratum 14 (Sample 2)

PHI SIZE	FRACTION WEIGHT	FRACTION PERCENT	ACCUMULATED PERCENT
-2.25	0.000	0.00	0.00
-2.00	0.000	0.00	0.00
-1.50	0.000	0.00	0.00
-1.00	0.000	0.00	0.00
-0.50	0.000	0.00	0.00
0.00	0.000	0.00	0.00
0.50	0.232	0.87	0.87
1.00	0.055	0.21	1.08
1.50	0.088	0.33	1.41
2.00	0.400	1.51	2.92
2.50	1.636	6.16	9.08
3.00	4.101	15.46	24.54
3.50	3.880	14.62	39.16
4.00	3.654	13.77	52.92
5.00	5.675	21.39	74.31
6.00	1.935	7.29	81.60
7.00	1.310	4.94	86.54
8.00	0.820	3.09	89.63
9.00	2.752	10.37	100.00

POST ANALYTICAL WEIGHT = 26.536 ; MODE = 5.00 PHI

GRAVEL	PERCENTAGES OF SAND	SILT	CLAY	SAND/MUD RATIO	SHEPARD CLASS
0.00	52.92	36.70	10.37	1.12	2

PHI SIZES AT PERCENT LEVELS OF

1.	5.	16.	25.	35.	50.	65.	75.	84.
0.83A	2.27A	2.74A	3.02A	3.36A	3.89A	4.40A	5.08A	6.43A

TRASK VALUES

Q1	Q2	Q3	SO	LOG SO	SKG
0.124	0.068	0.030	2.042	0.310	0.897

INMAN VALUES (2ND SKEWNESS AND KURTOSIS COULD NOT BE COMPUTED)

MEDIAN	MEAN	DEV.	SKEW.
3.89	4.59	1.84	0.38

FOLK AND WARD VALUES (ONLY THE MEAN COULD BE COMPUTED)

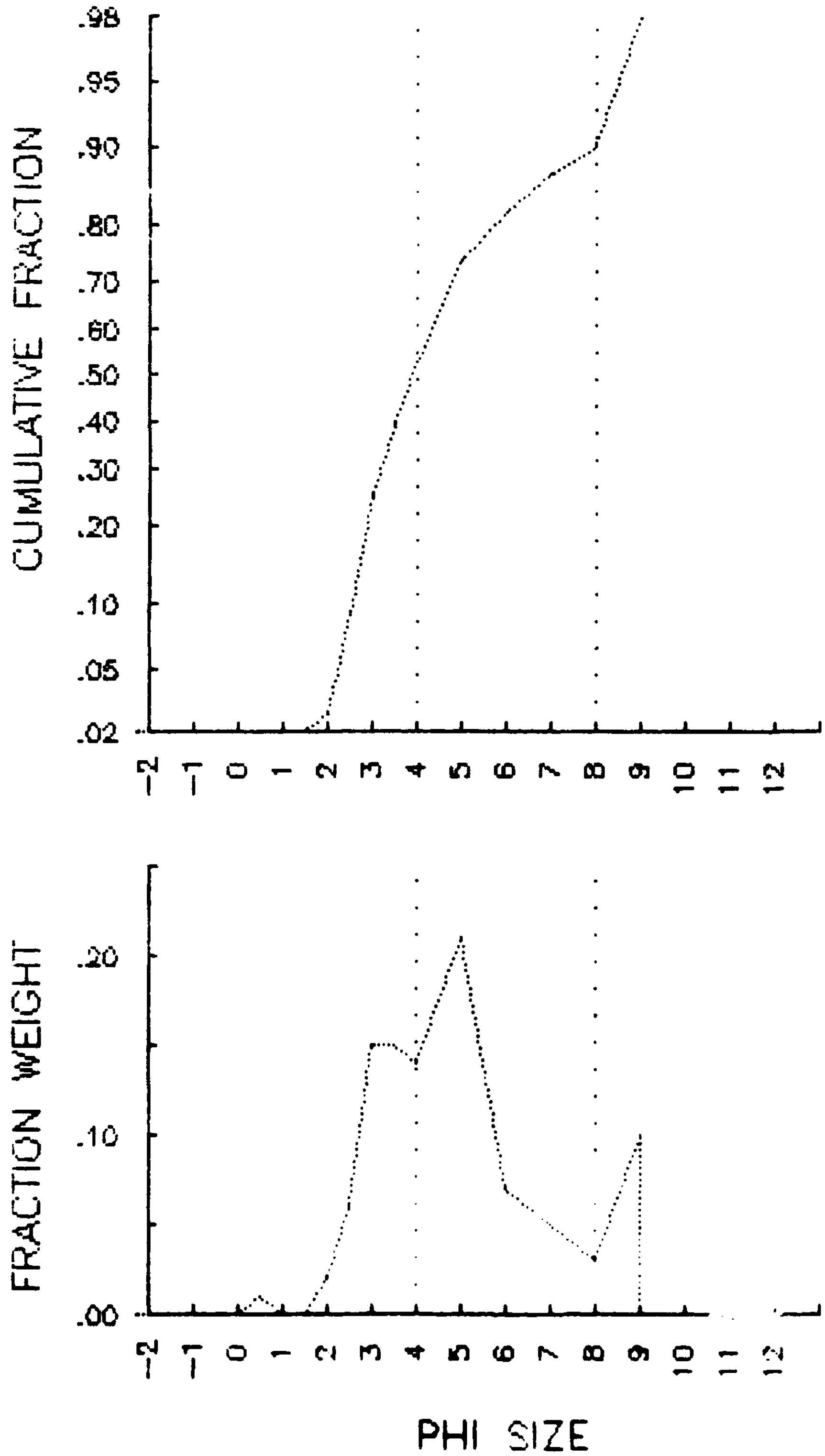
MEAN
4.35

MOMENT MEASURES (WITHOUT SHEPPARD CORRECTIONS)

MEAN	ST. DEV.	SKEW.	KURT.
4.39	1.90	0.88	3.07

NO SHEPPARD CORRECTION. PHI VALUES ARE NOT EQUALLY SPACED.

Figure J-1. 27 of 27
Textural analysis of East Block sediments 450K197.
Stratum 14 (Sample 2)



MOMENT MEAN:
4.39

MOMENT DEVIATION:
1.90

MOM. SKEWNESS:
0.88

MOM. KURTOSIS:
3.07

MODE:
5.00

APPENDIX K

STRATIGRAPHIC PROFILES

Prepared by
Carol Ellick

Figure K-3. Profile from West Block, 45-OK-197.

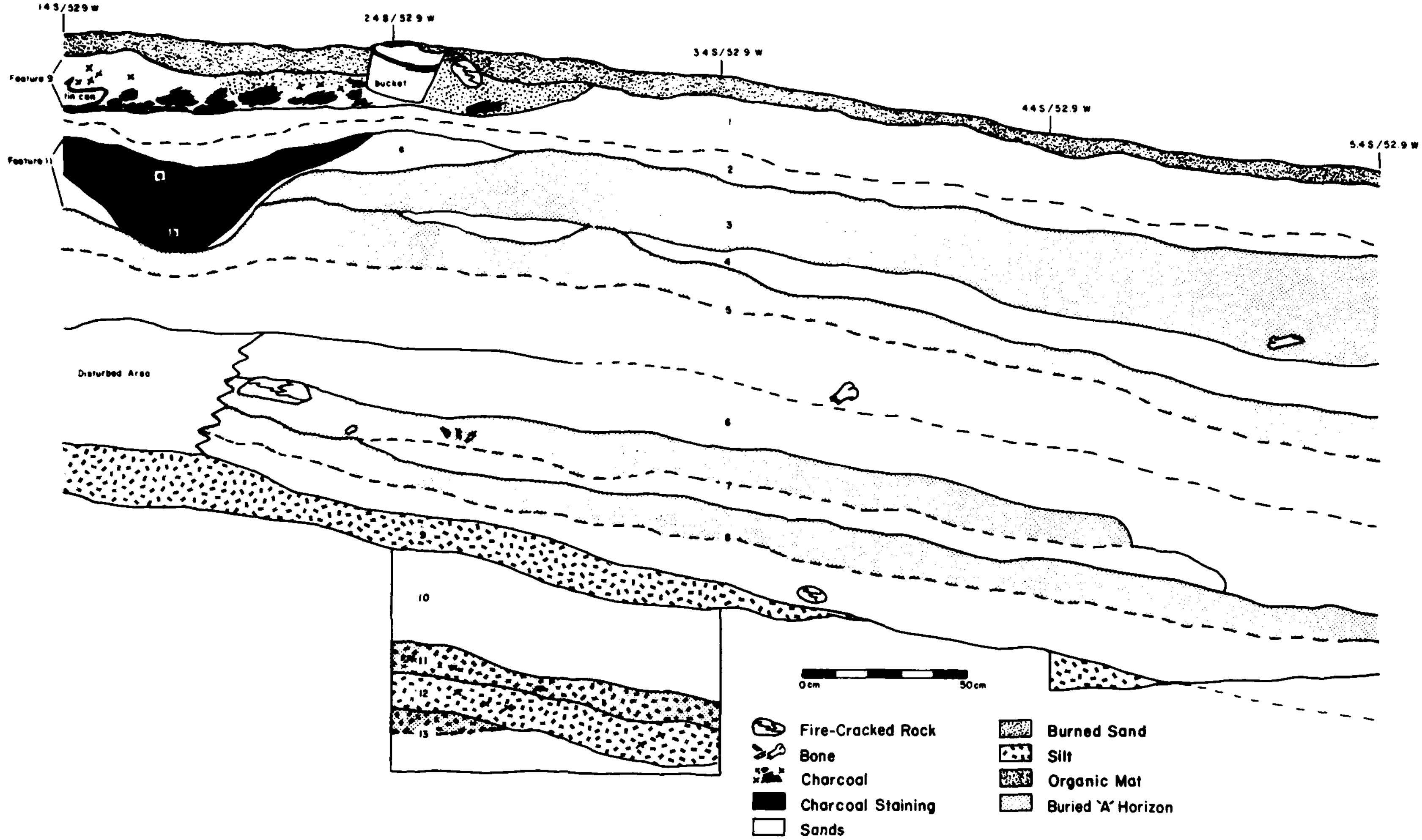


Table K-3. Description of profile from West Block, 1.4S/52.9W to 5.4S/52.9W, 45-OK-197.

Geologic Stratum	Description
0	Litter mat of loose organic material and silty, very fine-medium sand. Color: 10YR3/2, very dark grayish brown.
Fea. 9	Pit containing large chunks of charcoal and oxidized sand in a matrix of well sorted, silty, very fine-medium sand, predominantly fine sand; indistinct boundary. Color: variable.
1	Soft-loose, very well sorted, very fine-medium sand, predominantly fine sand containing mica and mussel shell fragments; boundary abrupt. Color: 2.5Y5/2, grayish brown.
2	Slightly hard, very well sorted, silty, very fine-fine sand, predominantly very fine sand; boundary gradual. Color: 2.5Y5/2-6/2, grayish-light grayish brown. Appears to be part of same episode as No. 1 (with inverse grading).
Fea. 11a	Slightly soft, very well sorted, slightly silty, very fine-fine sand, predominantly very fine sand mixed with charcoal, bone fragments; clear, abrupt boundary. Color: 10YR4/2, dark grayish brown. This is pit fill.
Fea. 11b	Same as 11a only darker. Color: 10YR3/2-2/2, very dary grayish brown-black, boundary gradual.
Fea. 11c	Slightly soft, poorly sorted, very fine-medium sand; boundary gradual. Color: 2.5Y5/2, grayish brown.
3	Soft-slightly hard, very well sorted, silty, very fine-medium sand, predominantly fine sand, containing some shell particles, bone fragments; abrupt boundary. Color: 10YR4/2, dark grayish brown. Buried A horizon.
4	Soft-slightly hard, very well sorted, very fine-fine sand, predominantly very fine; discontinuous; clear boundary, numerous roots. Color: 2.5Y5/2, grayish brown.
5	Slightly hard-hard, very well sorted, slightly silty-silty, very fine-fine sand, predominantly very fine sand, clear, gradual boundary. Color: 2.5Y5/2, grayish brown. Weak buried A horizon at surface of stratum.
6	Slightly hard-hard, very wiel sorted, silty, very fine-medium sand, predominantly fine sand with a few coarse particles and bone fragments; boundary clear, gradual. Color: 2.5Y5/2, grayish brown. Buried A horizon occurs at surface of stratum in some areas. Color: 2.5Y4/2, dark grayish brown.
7	Graded bed: slightly hard-soft, very well sorted-well sorted, slightly silty, fine-medium sand, grading upward to silty, very fine-medium sand, predominantly fine sand. Color: 2.5Y5/2, grayish brown. Buried A horizon at upper surface, contains FCR and bone fragments. Color: 10YR4/2, dark grayish brown. Stratum is truncated at downslope end.
8	Slightly hard, very well sorted, silty, very fine-medium sand, predominantly very fine lower, fine upper part of stratum; clear boundary. Color: 2.5Y5/2-6/2, grayish-light grayish brown. Buried A horizon at surface is slightly coarser, with a few coarse sand particles. Color: 10YR4/2, dark grayish brown. Grading is inverse, as in Stratum 1, 2.
9	Hard, well sorted, very silty, very fine-medium sand, predominantly very fine sand; clear boundary. Color: 2.5Y6/2, brownish gray.
10	Slightly hard, very well sorted, fine-coarse sand, predominantly medium sand. Boundary gradual-graded. Color: 2.5Y6/2, brownish gray slightly lighter than 9. Probably Strata 9 and 10 form a graded bed.
11	Slightly hard, very well sorted, slightly sandy silt with some charcoal flecks; boundary clear. Color: 2.5Y6/2-5/2, light brownish gray-grayish brown. Buried incipient A horizon.
12	Very hard, very well sorted, silty clay loam; boundary clear. Color: 2.5Y6/2, light brownish gray.
13	Hard, very well sorted, graded bed. Sandy silt, boundary clear-gradual. Color: 2.5Y6/2, light brownish gray. Buried incipient A horizon at surface, containing less sand with darker color. Color: 2.5Y5/2, grayish brown.

Figure K-2. Profile from Central Block, 45-OK-197.

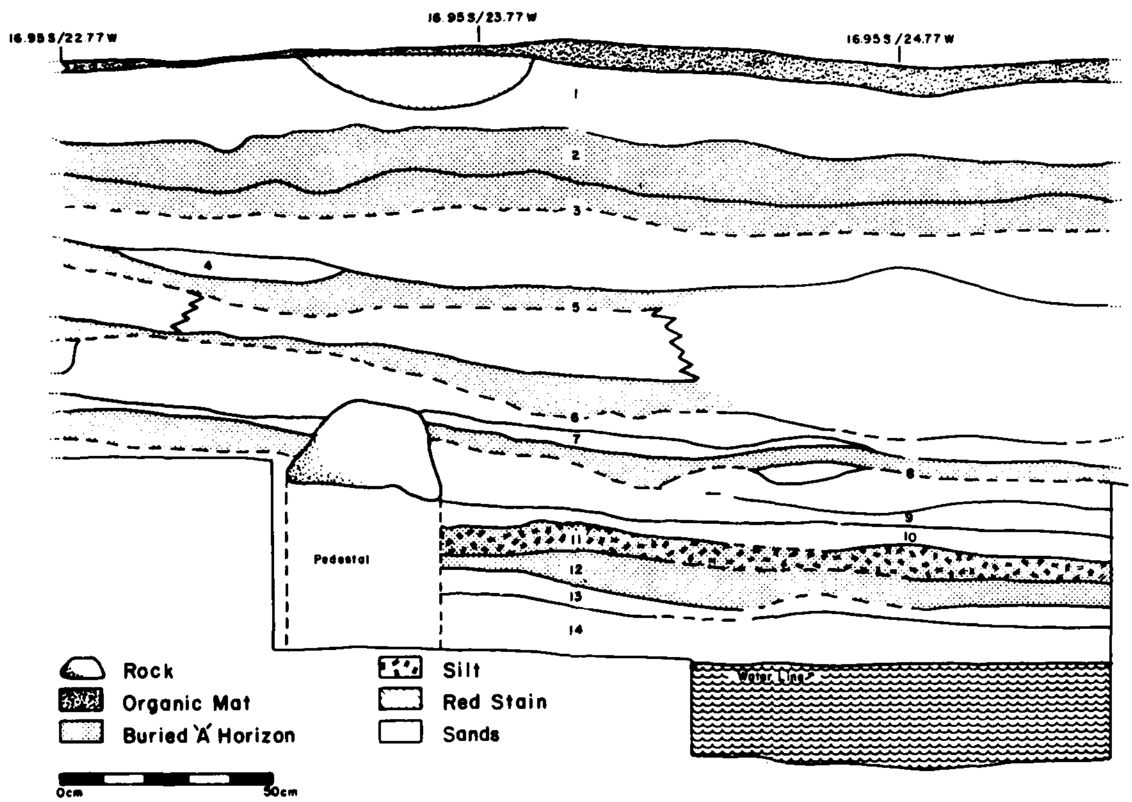


Table K-2. Description of profile from Central Block, 16.95S/22.77W to 16.95S/24.77W, 45-OK-197.

Geologic Stratum	Description
0	Duff, a loose mix of organics and silty fine, very fine sand.
1	Loose, well sorted, slightly silty, very fine-medium sand, predominantly very fine and fine sand; boundary abrupt. Color: 5Y5/3, olive.
2	Slightly hard, well sorted, very fine-fine sandy silt with numerous rootlets, extensive rodent disturbance; abrupt boundary. Color: 5Y2.5/2, black. Buried A horizon.
3	Soft-slightly hard, well- moderately well sorted silty, very fine-medium sand, predominantly fine sand with many roots and krotavian; abrupt, wavy boundary. Color: 2.5Y3.5/2, very dark-dark gray brown. Buried A horizon at surface.
4	Slightly hard, well sorted, very silty, very fine-fine sand, predominantly very fine sand and silt; boundary abrupt. Color: 2.5Y4/2, dark gray brown.
5	Graded bed: soft-slightly hard, slightly silty, very fine-medium sand, predominantly fine-medium sand grading upward to fine-very fine sand, extensive bioturbation in some areas; boundary abrupt. Color: 5Y4/4, olive. Buried A horizon at surface. Color: 10YR3/2, very dark grayish brown.
6	Graded bed, soft, very well sorted, very fine-medium sand, predominantly fine-medium sand, some grading upward to slightly hard, well sorted, silty, very fine-medium sand, predominantly very fine-fine sand; abrupt mottled boundary. Color: 2.5Y3/2, very dark gray brown. Bioturbation is extensive.
7	Slightly hard, well sorted, silty, very fine-medium sand, predominantly very fine, fine sand, abrupt, mottled boundary.
8	Graded bed?: soft, well sorted, very fine-medium sand, predominantly fine sand, Color: 5Y4/3, olive, grading upward to slightly hard, well sorted, mottled, silty, very fine-fine sand, predominantly very fine sand. Color: 2.5Y3/2. Boundary abrupt, mottled, upper surface is buried A horizon with charcoal fragments, mussel shell.
9	Slightly hard, well sorted, mottled, silty, very fine-medium sand, predominantly fine-very fine sand, abrupt boundary with many krotavina. Color: 5Y4/3, olive.
10	Slightly hard, well sorted, mottled, silty, very fine-fine sand, predominantly very fine sand; abrupt boundary. Color: 5Y3/2, dark olive gray.
11	Slightly hard, well sorted, mottled, silty, very fine-fine sand; abrupt boundary. Color: 2.5Y4/2, dark grayish brown. Buried incipient A horizon.
12	Slightly hard-hard, well sorted, mottled, very silty, very fine-fine sand, predominantly very fine sand and silt; boundary abrupt. Color: 5Y3/2, dark olive gray.
13	Slightly hard, well sorted, mottled, silty, very fine-fine sand, predominantly very fine sand; abrupt boundary. Color: 5Y4/3, olive. This may be part of a graded fluvial bed including Stratum 12.
14	Graded bed, slightly hard, well sorted, slightly silty, very fine-medium sand, predominantly fine sand, grading upward to silty, very fine-fine sand, predominantly very fine sand and silt; boundary abrupt. Color: 5Y3.5/2, olive gray.

Figure K-1. Profile from East Block, 45-OK-197.

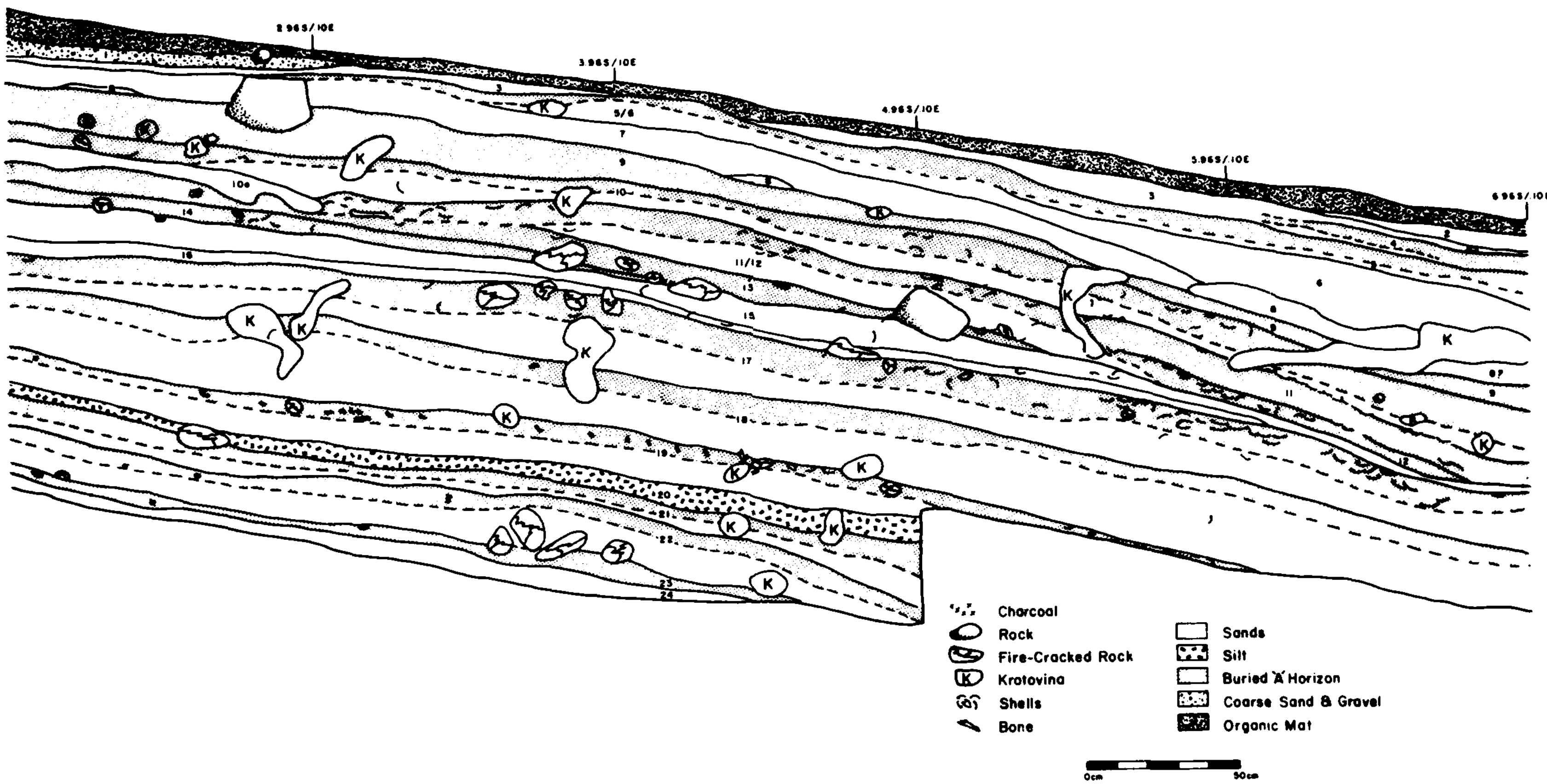


Table K-1. Description of profile from East Block, 2.96S/.10E to 6.96S/.10E, 45-OK-197.

Geologic Stratum	Description
0	Loose, very fine sand with silty, very fine to coarse sand pockets intermingled with rootlets and organic debris. Color 5Y2.5/2.
1	Loose, very poorly sorted, slightly silty, very fine to very coarse sand with granules and small pebbles. Grains are predominantly angular-subangular; upper boundary abrupt. Color: none taken - too variable colluvium.
2	Loose, well sorted, silty, very fine-medium sand. Predominantly fine sand with few medium sand grains; upper boundary abrupt. Color: 10YR4/4 dark yellowish brown. Soil appears burnt, with a few flecks of charcoal.
3	Loose, very well sorted, slightly silty, very fine-medium sand, predominantly fine and medium sand; upper boundary abrupt. Color: 5Y4.5/3, olive.
4	Loose, well-sorted, silty, very fine-fine sand, predominantly fine sand; upper boundary abrupt. Color: 5Y4/3, olive. Buried A horizon in surface of stratum is Color: 2.5Y4/2, dark grayish brown.
5	Loose, well sorted, silty, very fine-fine sand, predominantly very fine sand; upper boundary abrupt. Color: 5Y4/3, olive. Buried A horizon in surface of stratum - very silty with Color 2.5Y3/2 very dark grayish brown. This may be a graded bed.
6.	Loose, well sorted, silty, very fine-fine sand, predominantly very fine sand; upper boundary abrupt. Color: 2.5Y4/2, dark grayish brown.
7.	Moderately loose, well-sorted, silty, very fine-fine sand, predominantly very fine sand; upper boundary abrupt to very abrupt, shows some disturbance by bioturbation.
8.	Loose, very well sorted, very slightly silty, very fine-medium sand, predominantly fine and very fine sand; not laterally persistent, upper boundary abrupt. Color 5Y4.5/3, olive.
9.	Soft, silty, very fine-fine sand, predominantly very fine sand; upper boundary abrupt, heavily disturbed by bioturbation (mostly roots). Color: 2.5Y3/2. Buried A horizon.
10.	Soft, well sorted, silty, very fine-fine sand, predominantly very fine and fine sand; upper boundary abrupt, some bioturbation. Color: 2.5Y4/2 dark grayish brown, mottled. Buried A horizon in upper surface, contains some medium sand grains, mussel shell. Color: 2.5Y3/2, very dark grayish brown.
10a.	Loose, well sorted, very fine-fine sand, predominantly very fine sand; occurs as lenses and is not laterally persistent; upper boundary abrupt. Color: 5Y4/3, olive.
11.	Soft-slightly hard, well sorted, silty, very fine-fine sand, predominantly very fine sand, contains numerous mussel shells; upper boundary abrupt. Color: 2.5Y3/2, very dark grayish brown. This is a buried A horizon.
12.	Soft-slightly hard, well sorted, silty, very fine-fine sand, predominantly very fine sand with mussel shell fragments. Upper boundary abrupt. Color: 2.5Y4/2. Buried A horizon atop layer in some areas, contains some medium sand with abundant mussel shells. Color: 2.5Y3/2, very dark grayish brown.
13.	Soft-slightly hard, well sorted, silty, very fine to medium sand, predominantly fine and very fine sand, contains a few FCR and shell fragments; upper boundary abrupt. Color: 10YR3/2. Buried A horizon.
14.	Slightly hard, well sorted, silty, very fine-medium sand, predominantly fine sand, contains FCR, some mussel shell; upper boundary abrupt. Color: 2.5Y3/2, very dark grayish brown. Buried A horizon.
15.	Slightly hard, well sorted, very fine-fine sand, predominantly very fine sand with some FCR, shell near contact with 14; upper boundary abrupt. Color: 2.5Y4/2, dark grayish brown.
16.	Slightly hard, silty, very fine-medium sand, predominantly fine sand; upper boundary abrupt. Color: 2.5Y4/2, dark grayish brown. Mottled.
17.	Slightly hard, well sorted, silty, very fine-fine sand, predominantly fine-very fine; upper boundary abrupt. Color: 10YR4/2, dark grayish brown. Buried A horizon at surface, containing numerous FCR and mussel shell, some bioturbation. Color: 2.5Y3/2, very dark grayish brown.
18.	Loose, very well sorted, very slightly silty, very fine-medium sand, predominantly fine sand; contains moderate bioturbation; upper boundary abrupt. Color: 5YR4/3, olive. Buried A horizon at upper surface, silty, very fine-medium sand, predominantly very fine-fine sand with few white (calcium carbonate) specks in upper 1cm. Color: 10YR3/2, very dark grayish brown. This may be a graded bed.
19.	Soft-slightly hard, graded bed. Grades from well sorted, silty, very fine-fine sand (predominantly fine sand) to more silty, very fine-fine sand (predominantly very fine sand. 6-10cm from surface is a band containing <5% specks of calcium carbonate. Upper boundary abrupt. Color: 5Y4/3, olive. Buried A horizon at surface containing many bone fragments, FCR and mussel shells. Color: 2.5Y4/2.
20.	Hard, well sorted, very silty, very fine-fine sand, predominantly very fine sand and silt. Approximately 5% of matrix is white specks (< 2mm diameter) of calcium carbonate. Upper boundary abrupt. Color: 2.5Y4/2, dark grayish brown. Buried A horizon.
21.	Soft-slightly hard, graded bed, slightly silty, very fine-fine sand, predominantly fine sand; grading upward to predominantly very fine sand. Upper boundary, abrupt. Color: 2.5Y4/2, dark grayish brown. Buried A horizon at surface - including extensive worm burrow-type bioturbation. Color: 5Y2.5/2, black.
22.	Soft-slightly hard, graded bed. Grades from very well sorted, slightly silty, very fine-medium sand with predominantly fine-very fine sand to well sorted, very silty, very fine-medium sand with very fine sand and silt predominating. Upper boundary is abrupt. Color: 5Y4/3, olive. Buried A horizon at surface, including charcoal flecks, bone fragments and abundant worm burrow. Bioturbation.
23.	Soft, well sorted, silty, very fine-medium sand, siltier than over- or underlying units (predominantly very fine sand); contains an abundance of bone; upper boundary worm burrowed but abrupt. Color: 5Y3.5/2, dark olive. Incipient A horizon.
24.	Soft, very well sorted, very slightly silty, very fine-medium sand, predominantly fine sand; upper boundary abrupt. Color: 5Y4/4, olive.

END

FILMED

11-85

DTIC

END

FILMED

11-85

DTIC