THE CARLO CREEK SITE: GEOLOGY AND ARCHEOLOGY OF AN EARLY HOLOCENE SITE IN THE CENTRAL ALASKA RANGE

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PREFACE

This monograph is virtually identical to my unpublished Master's thesis of the same title, which was written during the winter of 1978-79, and defended at Washington State University in 1980. Fieldwork for this study, which focuses on a locality adjacent to Mount Mckinley (Denali) National Park, was conducted in 1976 and 1977.

I wish to add a note of appreciation to Zorro Bradley, Cooperative Park Studies Unit, University of Alaska, who has provided funding for publication of this study. He is to be commended for providing in this Occasional Papers series a forum for the rapid dissemination of information pertaining to Anthropology in Alaska. Additional thanks are also due to Jim Dixon, University of Alaska Museum, who in 1975 encouraged me to undertake this project.

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The Carlo Creek project was funded by the Geist Fund, University of Alaska Museum, Sigma Xi, and the Washington State University Graduate Student Association. Radiocarbon dates were provided by the Cooperative Park Studies Unit, University of Alaska, and the Washington Archeological Research Center.

This study was made possible through the combined efforts of many people. I am particularly grateful for the services of the principal members of the field crew during the 1976 and 1977 field seasons: David Hoch, Mary Whelan, and Edward Wick. Other persons who donated their time and efforts during parts of those field seasons include Jane Bryant, E. James Dixon, Jr., Virgeen Hanna, Mike Schuster, Susan Todd, and Tom Waite. The fieldwork benefitted greatly by the logistic support and/or equipment loans provided by Doug Bowers, Zorro Bradley, John Cook, David Plaskett, Anne Shinkwin, Bill Schneider, Kris Hoy-Thorson, and Bill and Karen Workman.

I am also indebted to a number of individuals for their help during the laboratory and report preparation phases of this project. Thoughtful critiques of portions of a February 1979 draft of this manuscript were provided by Thomas Ager, J. Jeffrey Flenniken, E. James Dixon, Jr., and Robert Thorson. Thomas Hamilton contributed numerous insights concerning the Quaternary geology of the upper Nenana River Valley throughout the course of this project. This thesis has benefitted considerably by the reviews of committee members Robert Ackerman, William Lipe, and Fekri Hassan. My father, William Bowers, generously assisted with the preparation of the photographs; typing was done by Terri Jordan, Debbie Huyler, Kathy Cox, Cindy Bosley, and Marcia Gross. Eric Blinman, Ricky Hoff, Howard Smith, Bob Wilkinson, and Susan Will provided invaluable support during the final preparation of this manuscript. Numerous graduate school-related details were attended to in my absence from Pullman (1978-1979) by Eric Blinman and Marcia Kelley. To all of these people, as well as the others who have assisted in one way or another, I express my sincere gratitude. I alone accept responsibilities for possible inaccuracies in the interpretation of the data presented here. Last, but not least, my hat is off to Mount Saint Helens, which made my return to eastern Washington in May 1980 a most memorable experience.

This thesis is dedicated to the individual who first sparked my interest in arctic archeology, through her scholarship, teaching, and stories about the Alaska and Greenland of yore: Frederica de Laguna, Bryn Mawr College.

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ABSTRACT

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Washington State University, 1980

Chairman: Robert E. Ackerman

During the 1976 and 1977 field seasons, excavations were undertaken at the deeply buried and frozen Carlo Creek site, located in the upper Nenana River Valley, Central Alaska Range. The lowest of two cultural components (Component I) contained well preserved faunal remains, indicating human exploitation of caribou (Rangifer sp.), sheep (Ovis sp.), and ground squirrels (Citellus sp.). The lithic assemblage from four workshop loci within Component I includes percussion-flaked elongate bifaces, a large prismatic blade-like flake, biface fragments, several possible bone tools, retouched flakes, and more than 8000 waste flakes. There is no evidence for an on-site core and blade industry in the Component I cultural horizon. Several lines of evidence suggest that some of the locally-derived argillite/hornfels used during the Component I occupation was thermally treated at the site, presumably to improve the flaking characteristics of the lithic raw material. Charcoal from two hearth areas in the lower cultural level has been radiocarbon dated at circa 8500 years B.P. Although the lithic remains are largely undiagnostic in terms of cultural affiliation, dating and limited

typological comparisons suggest a possible affinity with an early Holocene phase of the Denali complex.

On the basis of modern day observations of faunal distributions, seasonal hibernation patterns of arctic ground squirrels, and ethnographically-documented aboriginal subsistence patterns, a late summer or fall human occupation is inferred for Component I. Interpretation of the faunal data suggests that the site functioned as a secondary kill site/butchering station, where at least one sheep, one caribou, and nine ground squirrels were brought to the site and butchered for transport to a larger regional "base" camp--perhaps a site such as Dry Creek. The presence of bones, representing carcass portions of relatively low dietary yield, suggest that a selective "culling" strategy was employed by the site's inhabitants. The fragmentary nature of the faunal remains and presence of an anvilstone (?) implies that the bones were smashed for marrow extraction and/or bone grease preparation.

An upper cultural level (Component II) consisted of an undiagnostic assemblage of 637 rhyolite biface reduction flakes, and occurred stratigraphically about one meter above Component I. Based on relative stratigraphy and bracketing C-14 dates, Component II is inferred to be between about 6000 and 7500 years old.

Aboriginal selection of the site during both the Component I and Component II cultural occupations was probably influenced by its strategic mid-valley location within a major mountain pass, availability of lithic and food resources, and presence of a freshwater spring.

The locality's geology suggests that the Carlo Creek site may have formed as a result of alluvial deposition from the Nenana River, or from a tributary thereof. This deposition sequence probably took place at least

1500 to 2000 years after the valley had been deglaciated, and occurred after more than 75 % of post-glacial valley incision had taken place. Limited paleoecological data suggest that spruce forests may have been present in the upper Nanana Valley by this time.

On the basis of interpretaion of the four major geologic units identified at the site, the Component I cultural occupation probably occurred on a stabilized sandbar of the Nenana River; the brief Component II habitation most likely took place within an active floodplain. Beginning approximately 3800 to 4000 years ago, the alluvial deposits which enclose both cultural levels were capped by an eolian unit. Contained within this unit is a discontinuous tephra horizon, which has been correlated with the Cantwell Ash Bed.

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CHAPTER 1

THE CARLO CREEK SITE

Introduction

The Carlo Creek site is an early Holocene-age archeological site located in the upper Nenana River Valley, central Alaska. The site contains two deeply buried cultural components, both representing brief occupations by small groups of prehistoric hunters. Although the artifactual assemblage from the site is small, the site is significant in its deep stratification, good organic preservation, and alpine-floodplain geologic setting. The site provides new data which are brought to bear on the problem of early Holocene subsistence/settlement patterns and technological strategies employed among hunter-gatherers in central Alaska. It represents one of less than a dozen known late Pleistocene/early Holocene sites in Alaska which contain in situ cultural material, and which have been systematically excavated. Among pre-Hypsithermal age sites in interior Alaska/Yukon, only the Carlo Creek and Dry Creek sites (Powers and Hamilton 1978) contain well-preserved faunal remains in unambiguous association with lithic artifacts. On the basis of detailed study of the Carlo Creek assemblage, no firm cultural or technological affinities can be established with other early interior sites; however, several lines of evidence suggest possible affinities with Component II of the Dry Creek Site, and possibly with part of an early Holocene phase of the Denali Complex (cf. West 1967, 1975).

The purpose of this thesis will be to provide a data base for interpreting the site's setting and human occupations. The majority of these data are derived from studies of the site's geology, lithic assemblage, and faunal remains. Additional interpretation about the site is drawn from available paleoecological data and limited comparisons with other sites in interior Alaska.

Location

The Carlo Creek site is located in the central Alaska Range, within a narrow constriction in the upper Nenana River Valley (see Figs. 1, 2, and 3). The Nenana River is fed in part by meltwaters of the Nenana glacier, which heads some 75 km upstream from Carlo Creek. The site's valley-floor setting lies at an elevation of 620 m above sea level. The mountains adjacent to the site rise to elevations of 1480 to 2000 m a.s.l., while some of the highest elevations in North America, notably Mt. McKinley (6194 m a.s.l.) and Mt. Deborah (3700 m a.s.l.) are found within 80 km of the site.

The Carlo Creek site is situated within fluvial sediments which were exposed by highway construction activities in the early 1970s. It is located at mile 223.5 on the George Parks (Anchorage to Fairbanks) Highway; NW 1/4 NE 1/4 Sec. 1, T16S, R7W, Healy quadrangle. The site occurs at a latitude of 63° 33' 28" and longitude of 148° 49' 03". It lies roughly 150 air-kilometers SW of Fairbanks, and about 220 km NE of Anchorage.

History of Research/Field Methods

The Carlo Creek site was discovered during the summer of 1975 by the geologists Robert M. Thorson and Thomas D. Hamilton, who were then investigating recently-exposed roadcuts along the new highway from Cantwell to Healy. At that time, non-diagnostic lithics and bone fragments were

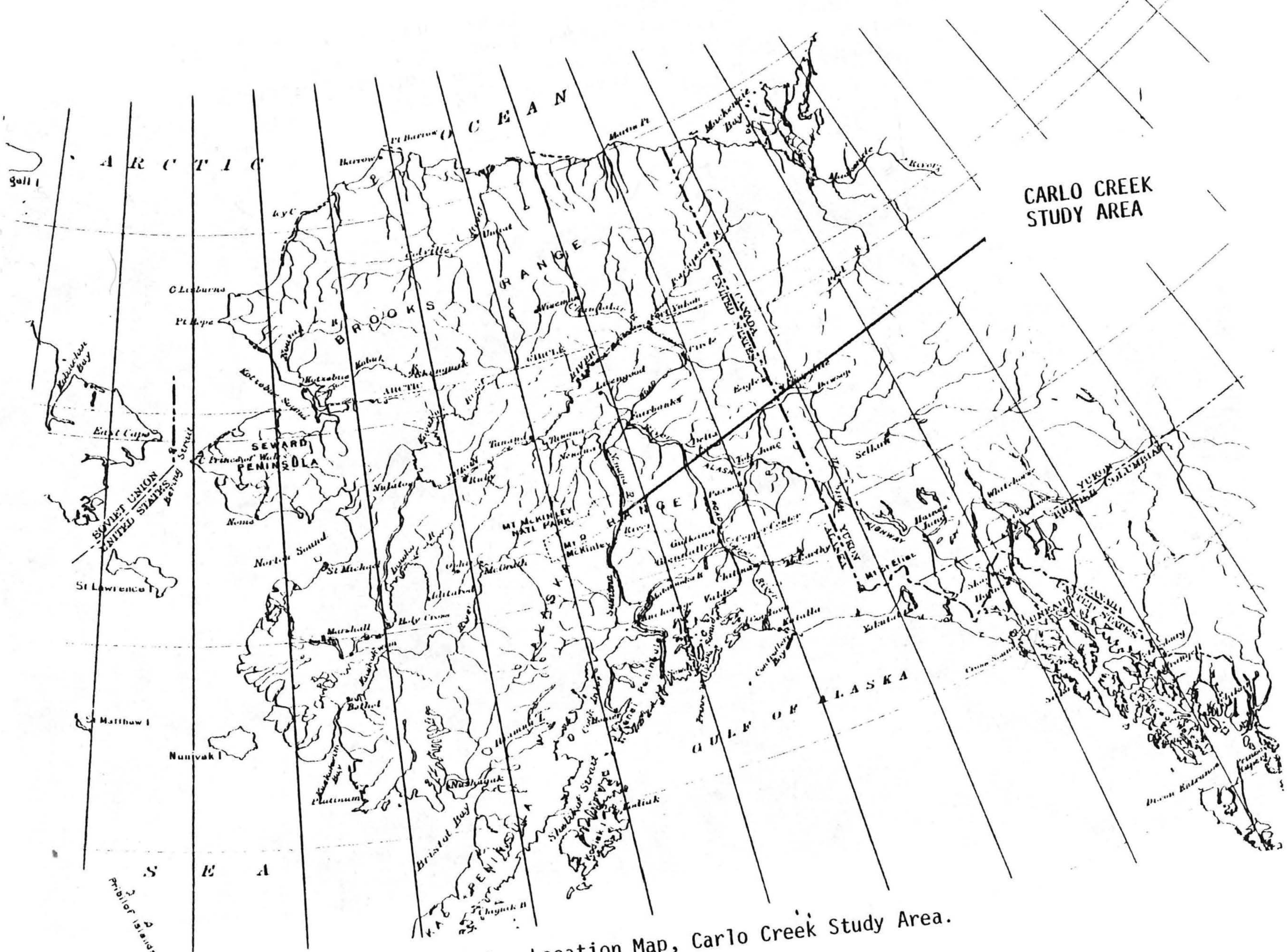


Fig. 1.--Location Map, Carlo Creek Study Area.

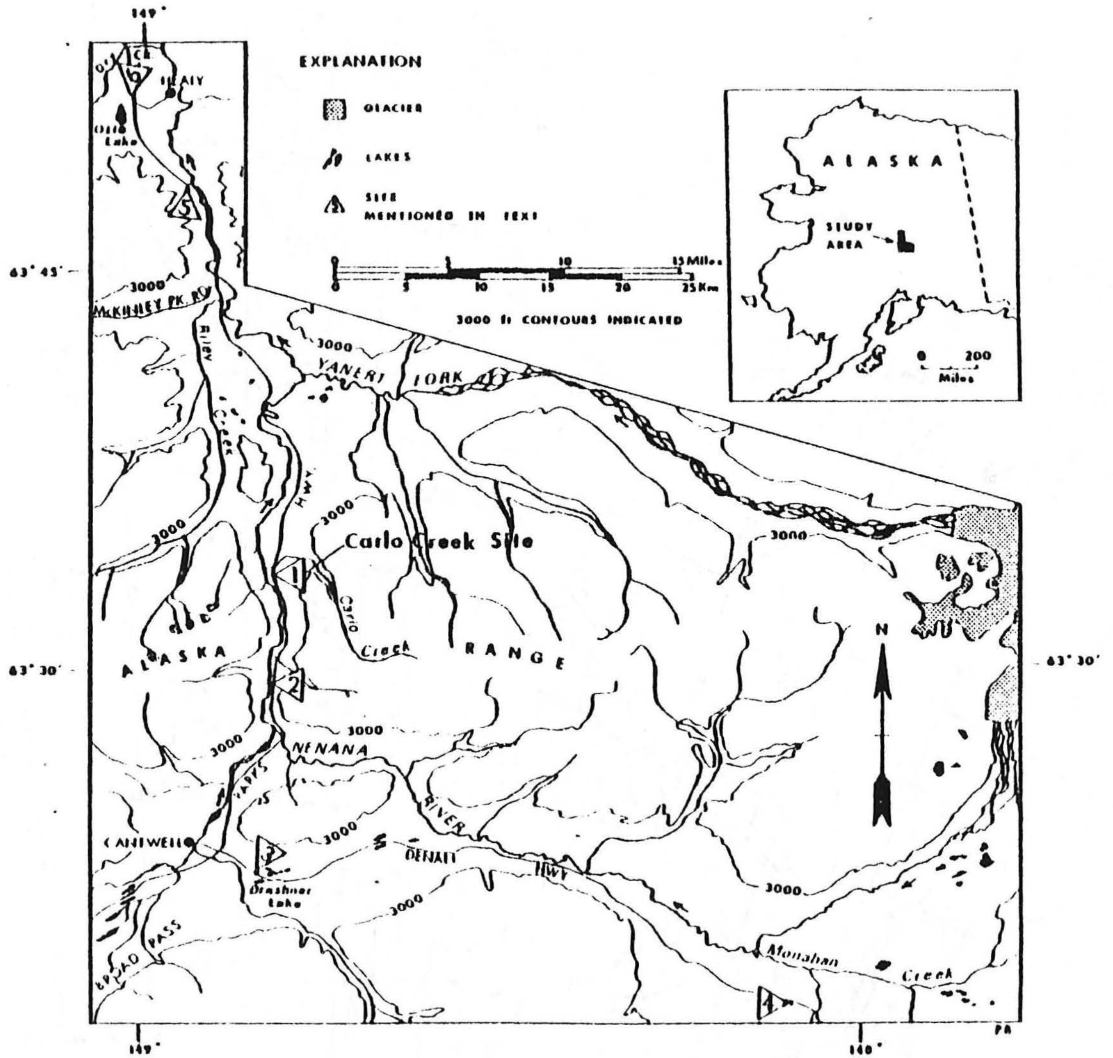


Fig. 2.--Map of the Upper Nenana River Valley, Central Alaska Range. 1--Carlo Creek Site; 2--Cantwell Ash type site (see Fig. 16, locality 2); 3--tephra sampling locality; 4--tephra sampling locality; 5--Nenana River Gorge Site; 6--Dry Creek Site.

Fig. 3.--Nenana River Valley (view to south). Carlo Creek site is indicated by the arrow.

noted eroding out of what appeared to be post-glacial fluvial deposits. Preliminary assessment of the site's geomorphic setting suggested an age for the cultural layer of between 6000 and 10,000 B.P.

The existence of the site was called to the attention of archeologists David Plaskett and E. James Dixon, Jr. Because well preserved condition of organic remains were present, it was felt that the site might yield important data bearing on the aboriginal use of organic tools during the early Holocene. Artifactual materials collected from the site by Thorson and Hamilton were turned over to the University of Alaska Museum. A later inspection of the site was made that fall by Alaska State Archeologist Douglas R. Reger, as well as Thomas Hamilton, Jim Dixon, and a representative of the Alaska State Division of Highways.

In September of 1975, R. Thorson re-investigated the area, and collected additional data concerning the glacial history of the upper Nenana Valley. Thorson was concerned with the regional geomorphology and early post glacial incision and alluviation within the upper Nenana River Valley. On the basis of his fieldwork, a more conservative geologic age assessment of between 3000 and 10,000 B.P. was suggested (Thorson, personal communication, December, 1975).

The site was visited by archeologists Charles E. Holmes and D. Plaskett during the late summer 1975, and briefly mentioned in a manuscript report submitted to the Alaska Division of Parks in December of that year (Holmes 1975). On the basis of the apparent association of faunal remains and cultural lithics at Carlo Creek, it was recommended that further investigations be undertaken. In the fall of 1975, the Carlo Creek site was assigned the designation of HEA-031 by the State of Alaska Heritage Resource Survey.

In November 1975, the author visited the site with David Plaskett. At that time, the initial strategies were formulated for preliminary testing to assess the site's significance. However, due to a temperature of -30.5°C (-23°F) and an accompanying 40 kph wind, little fieldwork was undertaken at that time.

Test excavations at the site were first undertaken by the writer during July and August of 1976. This research was made possible by small grants from the Geist Fund, University of Alaska Museum, Sigma Xi, and limited personal funds. The 1976 fieldwork was conducted under a State of Alaska Field Archeology Permit issued to the University of Alaska Museum. The primary objectives of the 1976 testing program were to: (1) locate and determine the extent of the archeological components, (2) map the site, and (3) collect data necessary to make preliminary interpretations about the site's archeology, age, and paleoenvironments.

During the first season of fieldwork, a total area of approximately 30 m^2 was excavated. The 1976 field crew consisted of the author and two volunteer assistants. Total research time in the Nenana Valley amounted to about 45 days.

Mapping of the site was completed by the end of the first week. Coordinates used in generating the map presented in Fig. 4 were obtained by use of an engineering transit and stadia rod. Datum was established at an existing concrete highway right-of-way marker, located 48 m southeast of the main site area. A subdatum was established on-site at a point 340° (true north) north-northwest of the main datum. All horizontal and vertical control measurements during excavation were determined from this point. An approximation of absolute elevation was determined from the USGS Healy (C-4) 1:63,360 series map, 2000 ft. elevation contour line. Subsequent to the

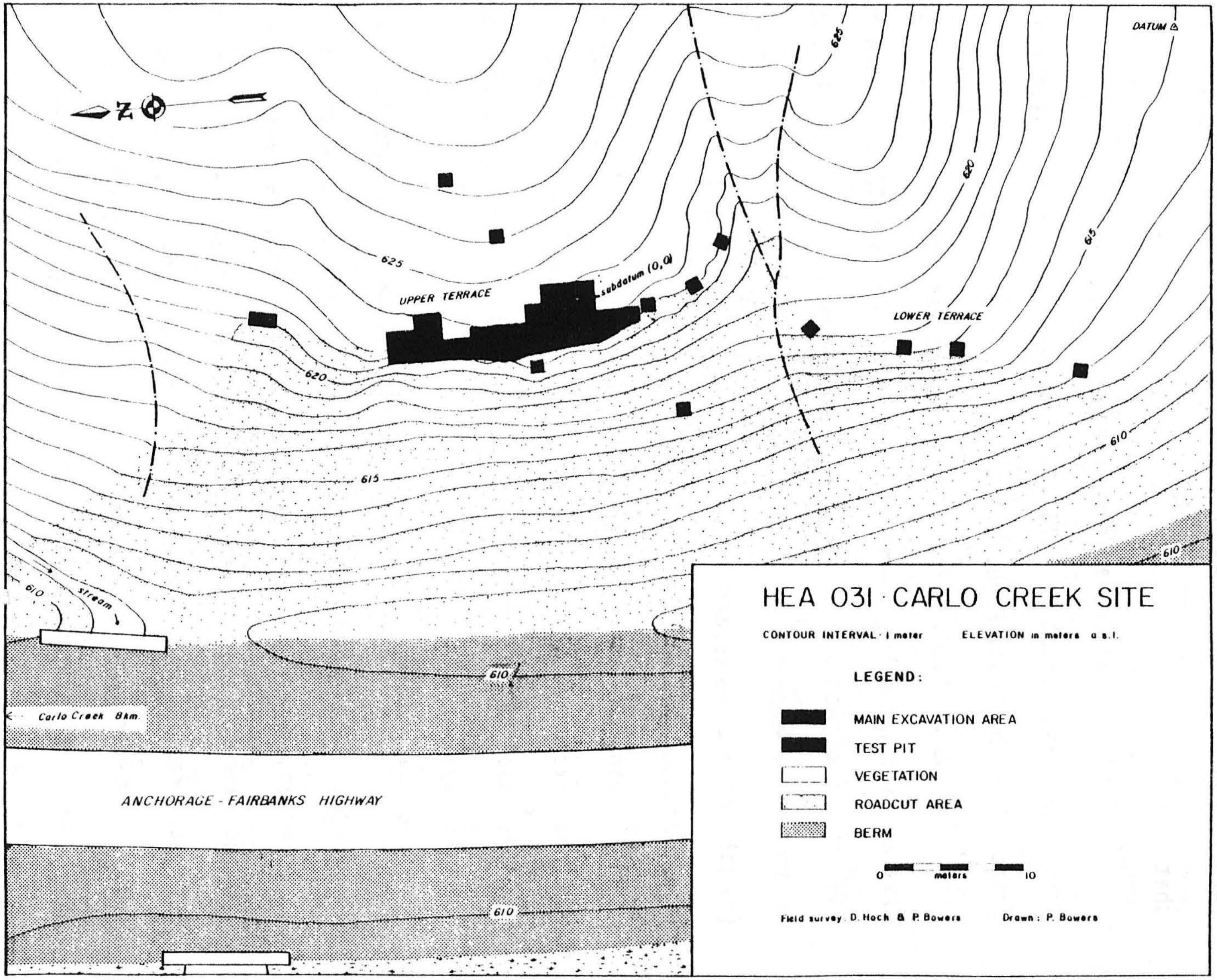


Fig. 4.--Topographic Map of the Carlo Creek Site

establishment of the subdatum, (point ON-OW), a grid of one-meter squares was laid out over the main site area. The north-south axis was extended to 20 m north, while the east-west axis was extended downslope to 24 m west, and upslope to 4 m east. The point 0 north/24 west, located within the berm of the highway, was used as an elevation-control point (610 m a.s.l.).

Following the surficial mapping, test excavations were begun. The major initial problem of the fieldwork was to determine the probable source location of cultural materials. Observations were hampered somewhat by the fact that, in places, as much as 30 cm of colluvium had mantled the exposure face, and in other places, several slump-blocks had displaced part of the upper strata. No additional artifacts were located during these salvage operations.

The original excavation strategy was to excavate a trench perpendicular to the exposure face, in order to reveal the site microstratigraphy. This plan was soon abandoned because of frozen ground and relatively non-cohesive sediments. Frozen ground was encountered about 1 m below the surface, and about 2.5 m back from the exposure face. Thaw rate varied from approximately 5 cm per day to about 20 cm per day when squares east of the 1W line were excavated. At a depth of about 1.5 m, there were a number of difficulties with cave-ins, slumpage, and general deformation of the excavation walls, despite numerous attempts to shore the walls. It was soon realized that a different strategy would be necessary, considering the limitations of funding, manpower, field season, and frozen ground.

As a result, excavation strategy was altered to permit excavating on a parallel to the roadcut face (parallel to the highway). This was found to be quite productive-- as a testing device, it made the best use of available time, avoided frozen ground (at this time of year, the relatively high sun angle permitted thawing back to about 2.5 m from the exposure surface), and permitted us to obtain a continuous north-south transect sample of the site. Excavation was comparatively easier in these areas of non-frozen, loosely-consolidated sands and silts.

All vertical measurements were recorded with respect to site subdatum (point ON/OW). Artifacts, faunal remains, and lithic debitage were mapped three-dimensionally, to the nearest centimeter.

Because one objective of this research was to collect a sample of terrestrial mollusks, considerable care was taken while digging in the zone in which land snails were abundant, or approximately from a level about 50 cm above the Unit 2-3 contact, down to the lower cultural level (see Fig. 11, Chapter 3). To maximize recovery of mollusks, hand-sieves were used; this aspect of the fieldwork was extremely time-consuming. Although we had planned to use these snails for dating, we later found they had little value for radiocarbon dating (J. Sheppard, personal communication, 1976).

In addition to excavations of the "main area" (refer to Fig. 4), a number of peripheral test-pits and stratigraphic-control trenches were dug. None yielded cultural or faunal remains, however.

Excavations in the main site were relatively productive, in that precise stratigraphic location of the cultural materials was determined, and an unexpected second component was uncovered. Although the recovered artifacts were not clearly diagnostic of time period or cultural affiliation, a larger than expected number (more than 2800) waste flakes were recovered during the 1976 season.

In addition to intrasite archeological and stratigraphic excavations, a number of extra-site studies were made. These included examining roadcuts in the valley, correlating terraces, and tracing out a number of suspected volcanic ash horizons which occur at the site and to the south of the site as far as Cantwell (cf. Bowers 1979a).

Unfortunately, the 1976 excavations did not hit the primary archeological activity loci until late in the season. Consequently, the first priority of the following field season was to expand the sample from the southern sector of the excavations, particularly in the vicinity of Hearth 1 (see Chapter 4).

Following a winter of data analysis and tentative interpretation of the previous summer's research (Bowers 1977a), excavations at the site were continued from July to September of 1977, for a total of 60 working days. This research was again assisted by grants from the Geist Fund, University of Alaska Museum, and Sigma Xi. Additional support was obtained from the National Park Service. The size of the 1977 field crew was highly variable, as might be expected in a volunteer situation, and ranged from as few as two to as many as nine persons at one time.

Fieldwork during the second season included expansion of site excavations, regional geomorphological investigations, and limited archeological survey in the upper Nenana River Valley (Bowers 1979b). Work at the site was again hampered by the presence of a considerable volume of overburden, estimated at about 45 cubic meters. Depending on depth of the lowermost cultural level, the excavation depths ranged from 1.5 to 3.5 m below surface. In all areas of the 1977 investigations, the lower cultural component occurred in frozen strata. A total area of 15 m^2 of the lower cultural level was exposed during the 1977 fieldwork (see Figs. 5 and 6).

During most of the 1977 season, all artifacts and faunal remains were mapped in to the nearest centimeter. During the waning days of the

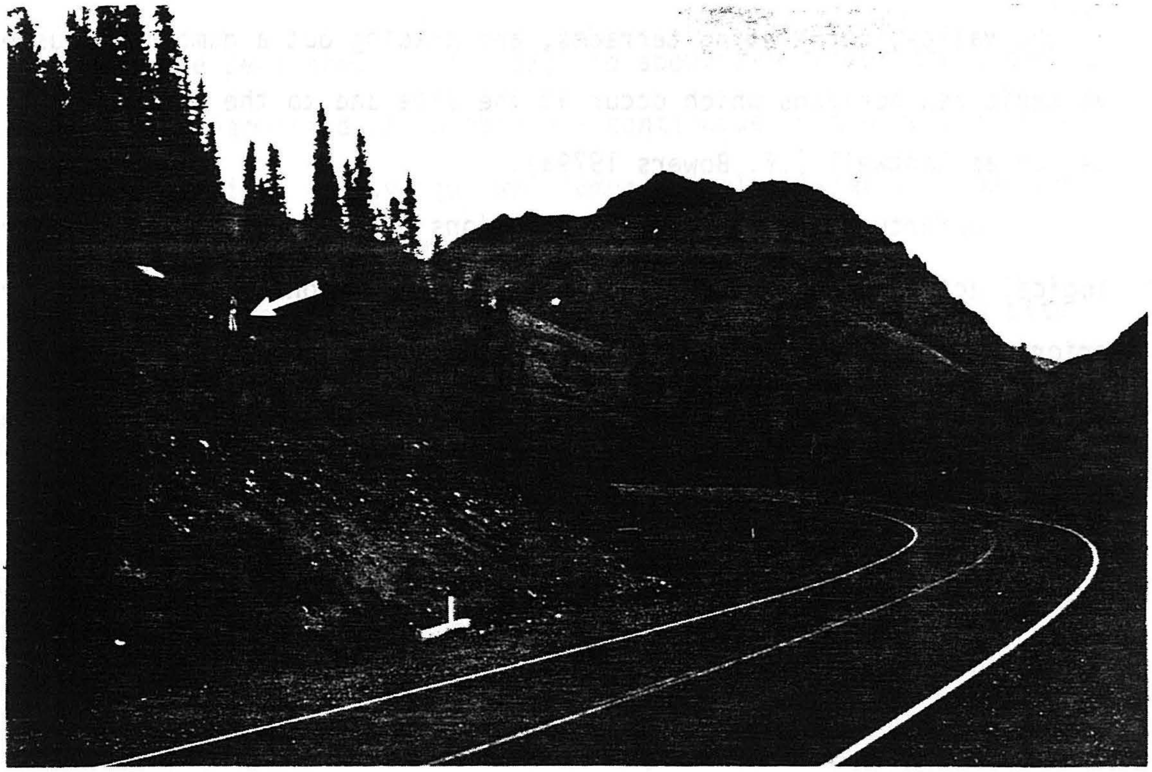


Fig. 5.--Carlo Creek Site (view to south). The location of the site is indicated by the arrow.

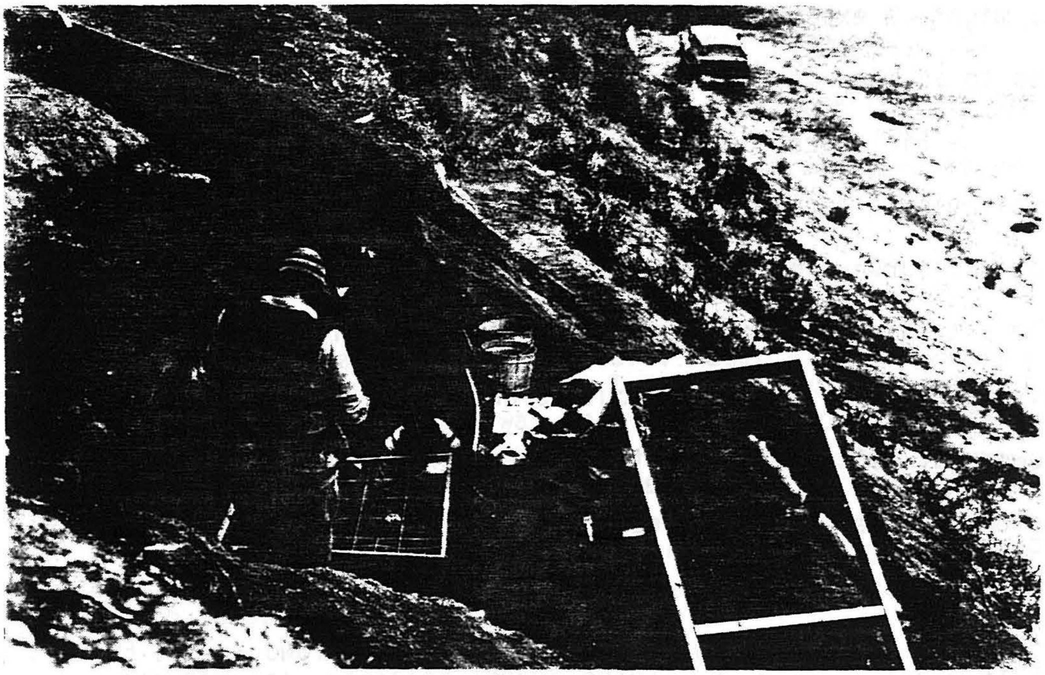


Fig. 6.--Excavations at the Carlo Creek Site, 1977 (view to south).

field season, this strategy was shifted to one of recording and collecting debitage by decimeter units. 1977 excavations were tied into the previously established grid of one meter squares. During both field seasons, cultural materials from the lower excavation levels was screened through a 1/4 in. mesh screen. The site was dug entirely in natural stratigraphic units.

Five specific objectives were realized during the second field season: (1) expansion of the main excavation area, and recovery of additional cultural and faunal materials, (2) collection and dating of additional radiocarbon samples, (3) collection and analysis of additional sediment samples, (4) terrace profiling and related geomorphological investigations, and (5) limited regional site surveys (cf. Bowers 1978b).

At the end of the 1977 field season, the site was backfilled, with plastic sheeting placed at the base and eastern wall of the excavation areas. The remaining unexcavated portions of the site are now protected by a minimum of two meters of fill. Arrangements were made with the Alaska Division of Highways to have the site area and roadcut revegetated.

Laboratory analysis of the artifacts and faunal remains were undertaken primarily at the Laboratory of Anthropology, Washington State University, and completed at the NPR-A Project Archeology Lab of the Bureau of Land Management, Fairbanks. Sediment analysis was completed at the Geoarcheology Laboratory, WSU Department of Anthropology. Tephra analysis was undertaken at the Tephrochronology Laboratory of the WSU Department of Soils and Agronomy. Electron microprobe analysis of one volcanic ash sample was performed at the Idaho Bureau of Mines and Geology, University of Idaho. Radiocarbon dating of six samples was completed by the Radiocarbon Laboratory, Department of Chemical and Nuclear Engineering, WSU, and Geochron laboratories of Cambridge, Massachusetts. One lithic sample was identified by the X-ray diffraction technique at the WSU Department of Geology.

Research Design

As in most multi-year archeological studies, the research design and methodology for the Carlo Creek project evolved through several phases and focused on a number of different aspects of problem orientation. As new data became available from the site and from ancillary studies, research strategies changed. The basic research framework, however, remained unaltered throughout this study: it was designed simply to test, evaluate, and interpret the site's archeology, age, and paleoecology, in an attempt to add new data to the poorly-understood cultural-historical framework of interior Alaskan prehistory.

Before detailing the rationale behind this study, it is necessary to briefly familiarize the uninitiated reader with the present status of interior Alaska's prehistory. "Interior" Alaska, as used here, includes the south slope of the Brooks Range, southward to and including the south slope of the Alaska Range, westward to and including the Koyukuk River and upper reaches of the Kuskokwim River, and eastward to the Canadian border. This area roughly encompasses the ethnographic range of the Athapaskan-speaking Indians, as defined by McKennan (1969) and Krauss (1973, 1974). At the outset, it should be emphasized that only within the past two decades has there been much intensive archeological investigations carried out in interior Alaska. Consequently, work in this area (interior Alaska-Yukon) is still in its infancy, and is at a stage of research which may be considered as "classificatory-historical" (Willey and Sabloff 1974:88). Similar sentiments have recently been expressed by Cook in his introduction to Pipeline

Archeology (1977:1): "Although "new" archeological methods and concepts are eminently suitable, the culture history of interior Alaska is still in the historiography stage of archeological development."

Clearly, there is still an overriding concern with developing chronologies and filling sequence gaps, despite attempts of workers to keep current with, and contribute to, the mainstream of archeological theory.

Due to great distances involved, difficulty of access, and the relatively sparse nature of the resources themselves (reflecting the very nature of subarctic/interior subsistence and settlement patterns), workers in the subarctic have only recently begun to establish a basic cultural-historical framework within which to place archeological data. The more complex tasks of explaining changes in subsistence, settlement, or technology as by-products of environmental and cultural process have thus scarcely begun. A point made by one veteran of subarctic research is well taken:

> The western subarctic is one area whose pioneer archeologists are still among us; they are not even safely retired...Today archeology in the western subarctic is quantitatively different but not different in kind. Success has been qualified. So many sites are so small that often an assemblage of 20 implements is a significant highlight, and sometimes I wonder if not our southern colleagues view us as the 'northwest microcephalic tradition'. I think I can fairly epitomize the current status and future prospects as 'dogged does it.' Dogged is doing it and dogged will do it. We still have our bits and patches, but they are bigger and more exiting. They are still patches because they do not fit together or perhaps they do, and we have not seen the obvious (D. Clark 1975:76-77).

As recently as 1975, a current statement about interior Alaskan prehistory was summarized as follows:

> The known sites in interior Alaska may be placed into three broad categories of culture history: 1) historic or late prehistoric occupations, rather definately Athapaskan in nature, 2) an older cultural stratum which may, or may not be early or ancestral Athapaskan, and 3) a vaguely defined early period (Cook 1975:125).

Because of the limited knowledge of interior prehistory, the information potential of test excavations at the Carlo Creek site was considerable. While some of my colleagues regarded as imprudent (foolhardy?) this shoestring-budgeted excavation of a site which had yielded only a few flakes, one biface fragment, and bone fragments (all buried under some 3 m of frozen overburden), I nevertheless felt the site held promise of much important data. It was, in a large part, the uniqueness of HEA 031 which provided impetus (and funding rationale) for more than one field season's efforts. The research design also focused on the site's unique characteristics:

1. The Carlo Creek site was known to contain well preserved organics, and it was originally thought to be between 3000 and 10,000 years old. The fact that only two other known dated and in situ early Holocene archeological sites in interior Alaska (Dry Creek and Healy Lake) contained any preserved organics suggested that the Carlo Creek data would be able to provide a much-needed comparative data set. Specifically, HEA 031 was regarded as a prime candidate for providing data bearing on the organic fraction of early man's toolkit. We know virtually nothing about the use of bone, wood, or antler by early man in the arctic and subarctic. If one examines some of the available ethnographic literature for interior Alaska (e.g., Allen 1887; McKennan 1959, 1965; Michael 1967; Osgood 1936a, 1936b, 1937, 1970; Schwatka 1885; Van Stone 1974; Whymper 1869), it becomes readily apparent that only a small proportion of the total available aboriginal material culture--perhaps as small as 5 to 10%--consisted of lithics. Yet lithic remains provide the vast majority of the data base from which we formulate our interpretation of ancient lifestyles, subsistence-settlement patterns (cf. Streuver 1968:136), cultural-adaptive systems, etc. Among all known late

Pleistocene or early Holocene in situ, dated, and excavated arctic or subarctic sites (including non-interior sites) only the Trail Creek Caves (Larsen 1968:52-56) and the Canyon site (Workman 1974, 1978) contain preserved organic artifacts. Several other northern early man sites have yielded sparing quantities of bone implements, however, these have all been subjected to major post-depositional disturbance in one form or another (cf. Bonnichsen 1978, 1979; Irving and Harington 1973; Porter 1978; Rainey 1939). In contrast, the Carlo Creek Site appeared to be a locality where well-preserved artifacts of bone, wood, or antler might be recovered in situ.

2. Because of its well-preserved faunal remains, it was felt that HEA 031 might be able to contribute new paleoecological data bearing on early Holocene subsistence-settlement strategies and mammalian ecology.

3. The geologic/physiographic setting of the site was regarded as unique among early Alaska sites (interior and non-interior alike), in that it suggested a floodplain occupation (not redeposited alluvium) within a restricted high-alpine valley. Only one other early man site/complex--the Kobuk complex assemblage from Onion Portage, band 8 (levels 1 and 3)--suggested a similar floodplain setting (cf. Anderson 1970:2-4), and no other known early sites indicated an equivalent mountain pass physiographic setting. Thus, <u>any</u> new data from HEA 031 would add substantially to existing knowledge of Holocene settlement patterns. One question that begged resolution was: is it reasonable or prudent to apply analogies of resource exploitation, types of settlements, and seasonal rounds (Binford 1978b; Campbell 1968; Chang 1962) from the ethnographic present back to the early Holocene?

4. During analysis of the results of the first season's excavations, the data suggested that the original occupants of the site may have been intentionally altering the texture, lustre, and molecular structure of

certain lithic raw materials through thermal pretreatment (I am indebted to Jeff Flenniken for first calling this possibility to my attention). Subsequent field research and replicative laboratory analysis has tended to strengthen this argument. If this supposition is correct, the Carlo Creek site may represent the earliest documented case for intentional thermal pretreatment of lithics in North America.

5. The original broad estimate of the site's date suggested it might fall within the period from 6000 to 8000 B.P.--a time from which we have virtually no dated archeological sites in interior Alaska or Yukon (see list of pre-7000 B.P. radiocarbon dated sites in Table 1). Among interior sites, only the Tuktu site (Campbell 1962), mesa site (Kunz, personal communication, 1980), and the Canyon site (Workman 1978) have been radiocarbon dated to this crucial 2000 year span. At each of the three major non-coastal stratified sites--Onion Portage, Dry Creek, and Healy Lake--there appears a major occupation hiatus between at least 8000 and 6000 B.P. (cf. Anderson 1968a; Cook 1969; Cook, unpublished data; Powers and Hamilton 1978). It is significant that, at each site, the hiatus appears to mask a change from a "paleo" techno-cultural tradition (e.g., American Paleo Arctic: Denali, Chindaden, Kobuk, Akmak) to an apparent boreal forest adaptation, with concomittant changes in toolkits (e.g., Northern Archaic: Palisades, Portage and Tuktu). Whether or not such changes reflect adaptive responses to major post-glacial reforestation of Alaska, as suggested by Anderson (1968b), Dumond (1969), and Bacon (1970), is uncertain. We clearly need data from this time period to demonstrate a change in technologies (if any) and (if possible) to explain such a transition. It was hoped that data from the Carlo Creek site might help resolve these problems.

TABLE 1

PRE 7000 B.P. RADIOCARBON DATED ARCHEOLOGICAL SITES IN ALASKA AND YUKON

Site	Date (B.P.)[a]	Lab. #	Material Dated	Comments	Reference
				Yukon	
Old Crow Loc. 14N	29,100 + 3000 - 2000	GX 1567	mammoth bone	secondary deposits; flakes removed (?)	Irving & Harington 1973:336
	25,750 + 1800 - 1500	GX 1568	mammoth bone	secondary deposits; flakes removed	Bonnichsen 1978, 1979
	27,000 + 3000	GX 1640	caribou tibia	serrated edge (flesher)	Bonnichsen 1978, 1979
Bluefish Cave I	12,900 ± 100	GSC 2881	horse femur	Unit VII; may date occupation	Cinq-Mars 1979:24
Canyon Site	7295 ± 100	SI 117	charcoal	Little Arm phase	Workman 1974b:94, 1977:54
				Central Alaska	
Moose Creek Bluff	11,730 ± 250	GX 6281	charcoal	bifaces, lanceolate points	Hoffecker 1979
Dry Creek	11,120 ± 85	SI 2880	charcoal	Component I; Chindadn (?)	Thorson & Hamilton 1977:166
	10,690 ± 250	SI 1561	charcoal	Component II; Denali	Powers & Hamilton 1978
Carlo Creek	8400 ± 200	WSU 1700	charcoal	Component I; Denali-related (?)	Bowers 1978b; This report
	8690 ± 330	GX 5132	charcoal		
	10,040 ± 435	GX 5131[b]	charcoal		
Healy Lake (Village Site)	8960 ± 50	GX 1340	bone	Level 4 "Quartzite" Horizon	Cook 1969
	10,250 ± 380	GX 2173	charcoal	Level 6 "Early" Horizon	Péwé 1975a:26; Cook unpublished data
	8680 ± 240	GX 2170	charcoal	Level 7 "Early" Horizon	
	8655 ± 280	GX 2171	charcoal	Level 7 "Early" Horizon	
split sample	9895 ± 210	GX 2174	charcoal	Level 7 "Early" Horizon	
	10,150 ± 210	SI 737	charcoal	Level 7 "Early" Horizon	
	11,090 ± 170	GX 1391[b]	bone	Level 8 "Early" Horizon	
split sample	6645 ± 280	GX 2159	charcoal	Level 10 "Early" Horizon	
	8210 ± 155	SI (?)	charcoal	Level 10 "Early" Horizon	
split sample	8465 ± 360	GX 2175	charcoal	Level 10 "Early" Horizon	
	10,040 ± 210	SI 739	charcoal	Level 10 "Early" Horizon	
	10,500 ± 280	GX 1944	charcoal	Level 10 "Early" Horizon	
Tangle Lakes MH 111	10,150 ± 280	UGA 572	soil (?)	Denali Complex	West 1975:78
Tangle Lakes	9720 ± 320	(W-975)	wood	Limiting dates for Denali Complex Sites; relate to "...a high beach strand with which Denali Complex Sites are consistently associated."	<u>Current Research; American Antiquity</u> <u>Vol. 36(4):490</u>
	8810 ± 200	(I-4567)	wood		
Chicken Mining Deposits East-Central Interior	27,000-33,000 (?)		bone	bone apparently altered by man; collected from secondary deposits	Porter 1978

TABLE 1--(Continued)

Site	Date (B.P.)[a]	Lab. #	Material Dated	Comments	Reference
			Northwest Alaska		
Onion Portage	8137 ± 103	P 1076	bone	Band 8, level 1 (Kobuk Complex)	Anderson 1970:4
	8070 ± 82	P 984	bone	Band 8, level 1 (Kobuk Complex)	
	8210 ± 84	P 985	bone	Band 8, level 1 (Kobuk Complex)	
	8440 ± 188	GX 1508	bone	Band 8, level 3 (Kobuk Complex)	
	9857 ± 155	K 1583	bone	Below band 8 (Akmak Complex)	Anderson 1970:4
			Seward Peninsula		
Trail Creek Caves	9070 ± 150	K 980	bone	Layer III, section 2 dates bone points and associated microblades	Larsen 1968:54
	13,070 ± 280	K 1327	bone	fractured bison calcaneous outside cave 9	Larsen 1968:62
	15,750 ± 350	K 1210	bone	fractured horse scapula outside cave 9	Larsen 1968:63
			North Slope		
Gallager Flint Station	10,540 ± 150	SI 974	charcoal	Locality 1; cores & blades	Dixon 1975:69
Putu Site	6090 ± 150	GAK 4940	charcoal	From soil in uncertain association with fluted points	Alexander 1974:25
	8454 ± 130	WSU 1318	charcoal		Morlan 1977:99
	11,470 ± 500	SI 2382[b]	charcoal		
Mesa Site	7260 ± 95	DIC 1589	charcoal	Directly associated with lanceolate, concave-based projectile points	Kunz, unpublished data
			Aleutian Islands		
Anangula	Average of 33 dates: 7785 ± 230 Range: 6992-8480		mostly on charcoal (?)	Anangula core & blade industry	Laughlin 1975:510 (compare interpretation of dating with Aigner 1976:51-62)
			Alaska Peninsula		
Ugashik Narrows	7675 ± 260	SI 1998	?	Paleoarctic tradition; Dumond's stage 1	Dumond et al. 1976:19
	8425 ± 115	SI 2641	?	Ugashik Narrows phase	Henn 1978:12
	8995 ± 295	SI 2492	?		
Naknek Region	7765 ± 95	SI 1955	?	Paleoarctic tradition;	Dumond et al. 1976:19
	7890 ± 90	SI 1956	?	Koggiung complex	Henn 1978:12

TABLE 1--(Continued)

Site	Date (B.P.)[a]	Lab. #	Material Dated	Comments	Reference
				Southeast Alaska	
Groundhog Bay	8880 ± 125	I 7057	charcoal	microblade & core industry; Component II ranges to 4180 B.P.	Ackerman, Hamilton, and Stuckenrath 1979:200
	7545 ± 185	I 7058	charcoal		
	8230 ± 130	I 6395	charcoal		
	10,180 ± 800	WSU 412[b]	charcoal	Component III; flakes, 1 scraper, 2 biface fragments	Ackerman, Hamilton, and Stuckenrath 1979:200
	9220 ± 80	SI 2112	charcoal		
	9130 ± 130	I 6304	charcoal		
Hidden Falls	9860 ± 75	?	wood	Component I; core & blade industry	Davis 1979, 1980
	9410 ± 80	?	wood		
	7175 ± 155	?	wood		

[a]Dates not adjusted for differences between Libby and Penn half lives.

[b]Date questionable.

In short, the Carlo Creek site research strategies were formulated with the primary aim of helping to fill a major lacunae in the extant body of archeological and paleoecological data for interior Alaska; test excavations were not expected to resolve fully the above questions. It was felt that the site probably was a small campsite, reflecting one aspect of an "extinct" seasonal round (Binford 1962:217). Subsequent research has indicated that it does represent a unique phenomenon among known early Holocene Alaskan sites: a high altitude, riverine floodplain killsite/ campsite, which combines excellent organic preservation, good stratification, relatively minor post-depositional changes, and readily datable materials.

CHAPTER 2

ENVIRONMENTAL SETTING

Physiography and Topography

The Carlo Creek area (Figs. 1, 2, and 7) is located in the central portion of the Alaska Range, which is part of the Pacific Mountain system. The Alaska Range forms a mountainous arc some 960 km long and 80 to 170 km wide, stretching from the Canadian border in the east, southwesterly to the Alaska Peninsula and Aleutian Islands. The mountain system ranges in elevation from relatively low passes such as the 600 m elevation Nenana River Valley to massifs as high as Mt. McKinley (6194 m elevation), located 120 km southwest of Carlo Creek. Mountains within the Alaska Range are generally less than 3000 m in elevation (Wahrhaftig 1965).

To the south of the Alaska Range lies the Broad Pass depression, which is a flat-floored trench between the Alaska Range and Talkeetna Mountains. Summit Lake, which marks the drainage divide between the Pacific and Bering Sea drainages, is located within Broad Pass, at an elevation of 690 m above sea level. The pass drains to the north via the Jack and Nenana Rivers to the Tanana-Yukon drainages, and to the south via the Chulitna and Susitna Rivers to Cook Inlet. Although Broad Pass is generally characterized as a north-south trending pass through the Alaska Range, it has been described by Moffit (1915) as an east-west trending depression which connects the heads of the Chulitna and Susitna Rivers.

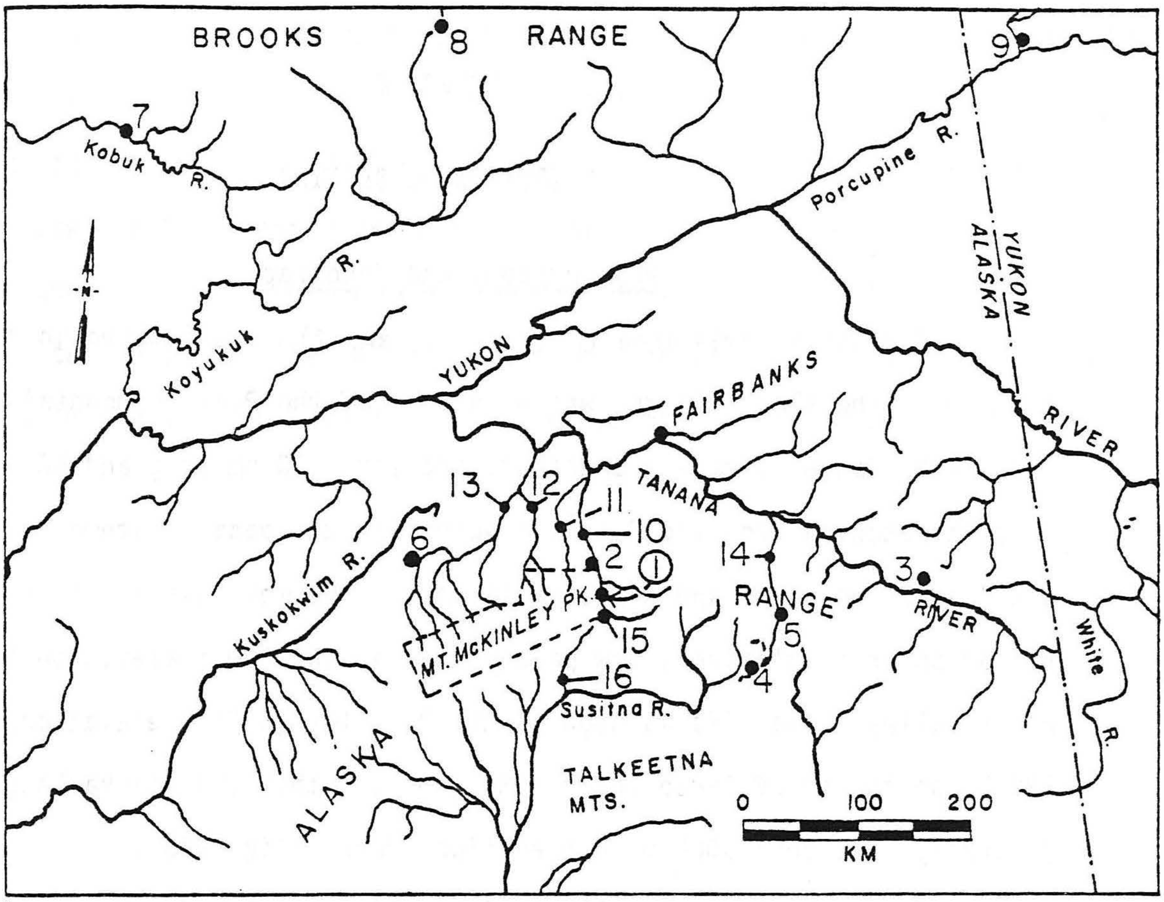


Fig. 7.--Central Alaska, Showing Selected Localities Mentioned in Text. Also included are key localities in Northwest Alaska (7), Brooks Range (8), and Yukon (9). 1: Carlo Creek site, 2: Dry Creek site, 3: Healy Lake site, 4: Tangle Lakes district, 5: Yardang Flint station, 6: Lake Minchumina, 7: Onion Portage, 8: Anaktuvuk Pass, 9: Old Crow, 10: Nenana River, 11: Teklanika River, 12: Toklat River, 13: Kantishna River, 14: Delta River, 15: Broad Pass, 16: Chulitna River.

North of the Alaska Range lies the northern foothills province, which comprises a series of roughly parallel east-west trending ridges, approximately 600 to 1350 m in altitude. The foothills are generally between 4.8 and 11.2 km in width (USDI 1976). North of the foothills are the Tanana-Kuskokwim lowlands of the Intermontane Plateau. This area of low mountains and generally rolling topography drains the Nenana, Delta, Tanana, Koyukuk, Yukon, and Kuskokwim Rivers. Elevations in this region are generally between about 180 and 480 m above sea level (Wahrhaftig 1965). It should be noted that the northern foothills province has been the focus of considerable archeological and geo-archeological research since the mid-1970s (e.g., Thorson and Hamilton 1977).

The Alaska Range in the Carlo Creek Study area is snow-clad at elevations above 2100 m on north facing slopes and 1800 m on the south side of the range (USDI 1976). Canyons and gorges above these elevations are filled by hundreds of cirque and alpine glaciers (USDI 1976).

One of the major glacier complexes in the Central Alaska Range forms on the flanks of the 3700 m high Mt. Deborah/Mt. Hess massif. Glaciers originating in this area include the Susitna and West Fork glaciers, which drain into the Susitna River, the Yanert glacier, which drains into the river of the same name, and the Nenana Glacier, whose meltwaters form in part, the Nenana River.

In the vicinity of the Carlo Creek study area, the most obvious physiographic feature is the Nenana River Valley (Figs. 2 and 3). The Nenana River begins some 75 km upstream from Carlo Creek. This braided river then flows south and west through a wide valley between the Alaska and Talkeetna Mountains. In the vicinity of the Broad Pass depression, after its confluence with the Jack River, the Nenana turns abruptly northward, and cuts a deep U-shaped valley through 15-20 km of the core of the Alaska Range. Within this valley, the Nenana is joined by major tributary streams, including Carlo Creek, Yanert Fork, and Riley Creek (Wahrhaftig 1958). The mean annual high water discharge of the river, recorded 5.6 km downstream from the Moody Bridge, is 7.0 cubic m per second (USDI 1976:22).

After joining with its major tributary, Yanert Fork, the Nenana River then flows for some 13 km through the narrow Nenana River Gorge (Plaskett 1977). Once through the gorge, and into the northern foothills province, the river's gradient is decreased gradually until its eventual confluence with the Tanana River, located some 120 km north of Carlo Creek. In the northern foothills region, the Nenana is fed by tributaries such as Healy Creek, Dry Creek, and Lignite Creek.

Carlo Creek, which flows 16 km northwesterly into the Nenana River, drains from the northern flanks of the rugged Panorama Mountain. This clearwater stream empties into the Nenana at right angles at a point roughly 1.0 km northwest of the Carlo Creek archeological site. The site itself is situated within terrace alluvial sediments formed along the eastern wall of a relatively narrow constriction in the glacially-scoured valley. At this point, the Nenana Valley is about 2.0 km in width. Immediately across from the site is a prominent hanging valley, whose rim is approximately 200 m above the valley floor. Major topographic features in the area include Mt. Carlo (1482 m a.s.l.), Panorama Mountain (1933 m a.s.l.), and an unnamed, 1777 m high peak directly across the valley from Carlo Creek.

The locality "Carlo" was first reported by the Alaska Railroad on a 1923 manuscript map, and was later the name given to the section house at Milepost 334.4 on the Alaska Railroad (Orth 1967). The Alaska Railroad follows a sinuous route along the western bank of the Nenana River. The more recently completed Anchorage to Fairbanks highway (George Parks Highway) is located on the eastern side of the valley.

Climate

The Alaska Range in the Nenana Valley study area forms a transition between the two major climatic zones in interior Alaska. To the north of the range, a Continental climate predominates (hotter summer, colder winters). To the south is found the more temporate transitional zone (USDI 1976).

Climatological data have been only sporadically collected in the study area. There are detailed records for only the past few decades at Nenana, Summit, and McKinley Park Stations. Of these three recording stations, the latter is environmentally most analogous to the Carlo Creek area.

Weather data collected at the Park for the past 40 years indicate an extreme range of 32°C to -46°C (89.6 to -50.8°F). The coldest month, January, has mean temperature extremes of -10°C (14°F) and -46°C(-50.8°F), while the warmest month, July, has mean maximum and minimum temperatures of 20°C (68 °F) and 7°C (44.6°F) (USDI 1976).

Precipitation at the McKinley Park recording station averages approximately 38 cm per year. In general, winters are drier than summers. November has the lowest average precipitation (0.78 cm), while July has the highest average with 9.6 cm. Average snowfall is 192.2 cm per year, with drifts of greater than 6.10 m commonly occurring at higher elevations. For forested areas, snow accumulation may typically average about 90 cm (USDI 1976).

The prevailing wind in the Carlo Creek study area is largely determined by the valley's orientation. Prevailing winds and the strongest winds are from the south, especially during the summer months. North winds may occur during the winter, but are less severe than their southern counterparts. The constriction in the valley between Cantwell and Carlo Creek causes a natural "funneling" effect, resulting in extremely high-velocity winds. (The locality "Windy", 11 km south of Carlo Creek, was aptly named by Alaska Railroad personnel in 1922). Although wind velocity records have not been kept in this locality, average windspeeds of 32-40 kph would not be an unreasonable estimate, with velocities as great as 160 kph at Windy Pass. The locally strong winds in the Carlo Creek study area are important factors in our consideration of: (1) eolian sedimentation in the valley and (2) creation of wind-swept fall and winter pasture for grazers such as sheep and caribou.

Flora

Floral communities in the region may be divided into two major biomes, and subdivided into four local ecosystems (Viereck and Little 1972; USDI 1976). Biomes include taiga and tundra, while the ecosystems include: (1) bottomland spruce-poplar, (2) upland spruce-hardwood, (3) high brush and (4) alpine tundra (USDI 1976).

Characterization of a specific area's vegetation is dependent on a variety of complex and interrelated factors. In general, the net annual productivity of the subarctic environment is low. Factors such as short growing season, low temperatures, precipitation, availability of nutrients, and permafrost all affect plant growth. Slope direction and drainage are critical factors. In addition, forest or tundra fires may be a major contributor to the type and stage of succession of a given plant community.

In the Central Alaska Range, the boreal forest biome occurs in areas of lower elevation, generally below the 700 m level. Included within this biome are the two dominant sub-systems, bottomland spruce-poplar and upland spruce-hardwood forest, and one transitional/early successional sub-system, high brush (USDI 1976; Viereck and Little 1972).

Bottomland spruce-poplar forest contains dense to open stands of white spruce (Picea glauca) and balsam poplar (Populus balsamifera). This system is common along floodplains, where Populus sp. is a major constituent of the early-successional forest. Climax stands of white spruce (Picea glauca) may later develop as floodplain areas become more stable. On north facing slopes with developed permafrost, black spruce (Picea mariana) may become the predominant tree. Dominant shrubs in this ecosystem include: American green alder (Alnus crispa), thin leaf alder (Alnus tennifolia), little tree willow (Salix arbusculoides), feltleaf willow (Salix alaxensis) and high bush cranberry (Viburnum edule) (USDI 1976; Viereck and Little 1972).

Upland spruce-hardwood forest occurs in dense to open stands, and consists of paper birch (Betula papyrifera), and quaking aspen (Populus tremuloides). Depending on drainage, aspect, and underlying soils and permafrost, balsam poplar (Populus balsamifera) and black spruce (Picea mariana) may also occur. Upland forest generally occupies areas of higher elevation, with good drainage and no permafrost. White spruce (Picea glauca) is the dominant species in the climax stage. Principal shrubs in this system include the following: crowberry (Empetrum nigrum), narrow-leaf labrador tea (Ledum decumbens), prickly rose (Rosa acicularis), bebb willow (Salix bebbiana), mountain cranberry (Vaccinium vitis-idaea), feltleaf willow (Salix alaxensis), littletree willow (Salix arbusculoides), and high bush cranberry (Viburnum edule) (USDI 1976; Viereck and Little 1972).

The high brush ecosystem occurs as a transitional zone between the forest and tundra zones, or as an earlier successional stage in the river floodplain areas. Vegetative cover may vary considerably, ranging from dense shrub thickets to comparatively sparse patches of shrubs. The following species are found within this system, depending on moisture, slope, aspect, and permafrost: alpine bearberry (Arctostaphylos alpina), resin birch (Betula glandulosa), bush cinquefoil (Potentilla fruticosa), Barclay willow (Salix barclayi), Alaskan bog willow (Salix fuscescens), diamond leaf willow (Salix planifolia), Richardson willow (Salix lanata), Beauverd spirea (Spiraea beauverdiana), American green alder (Alnus crispa), cranberry (Viburnum sp.), narrowleaf laborador tea (Ledum decumbens), bog blueberry (Vaccinium uliginosum), and mountain cranberry (Vaccinium vitis-idae). Also occurring in this vegetation zone, particularly in areas of poor drainage are: labrador tea (Ledum groenlandicum), sweetgale (Myrica gale), low blueberry willow (Salix myrtillifolia), bog cranberry (Vaccinium oxycoscos), resin birch (Betula glandulosa), narrow leaf labrador tea (Ledum decumbens), Barclay willow (Salix barclayi), Alaskan bog willow (Salix fuscesens), diamond leaf willow (Salix planifolia pulchra), bog blueberry (Vaccinium uliginosum), and mountain cranberry (Vaccinium vitis-idae). In addition to the above species, numerous varieties of grasses (Arctagrostis sp.), sedges (Carex sp.) and mosses (Sphagnum sp.) are common to both phases of high brush ecosystems (USDI 1976; Viereck and Little 1972).

Alpine tundra occurs at elevations greater than 700 m in the Central Alaska Range, and is characterized by low mat plants (both herbaceous and shrubby) and areas devoid of vegetation. Large continuous areas may be covered by White mountain-avens (Dryas octopetala), along with grasses (Arctagrostis sp.), sedges (Carex sp.), and lichens (Cladonia sp.). Common shrubs and herbs in alpine tundra include: arctic willow (Salix arctica), alpine bearberry (Arctostaphylos alpina), resin birch (Betula glandulosa), mountain-avens (Eryas octopetala), crowberry (Empetrum nigrum), narrow-leaf labrador tea (Ledum decumbens), moss-campion (Silene acaulis), black Oxytrope (Oxytropis nigrascens), arctic sandwort (Minvartia arctica) (USDI 1976; Viereck and Little 1972).

The immediate vicinity of the Carlo Creek archeological site is classified as a bottomland spruce-poplar ecosystem. It occurs on a west-facing slope, with moderate to poor drainage, and is underlain by discontinuous permafrost. During August of 1976, the following species were identified in the site area by S. Todd, then of the Institute of Northern Forest, Fairbanks: Black spruce (Picea mariana) (dominant), narrow-leaf labrador tea (Ledum decumbens), willow (Salix sp.), alder (Alnus sp.), mountain cranberry (Vaccinium vitis-idaea), bog blueberry (Vaccinium uliginosum), crowberry (Empetrum nigrum), horsetail (Equisetum sp.), cottongrass (Eriophorum vaginatum), paper birch (Betula papyrifera), prickly rose (Rosa acicularis), grasses (Arctagrostis sp.), blue joint grass (Calamagrostis canadensis), dwarf fireweed (Epilobium latifolium), rhubarb (Polygonum alaskanan), sedges (Carex sp.), mosses (Sphagnum sp.), and lichens (Cladonia sp.). In disturbed areas along the highway and river floodplain, the following were observed: wild rhubarb (Polygonum alaskanum), horsetail (Equisetum sp.), willow (Salix sp.), grasses (Arctagrostis sp.), and dwarf fireweed (Epilobium latifolium).

Fauna

A diverse mammalian fauna is present in the study area today, and has probably been extant in the area for a considerable length of time. It should be emphasized that most of the large mammal species in the Nenana Valley are transient, following seasonal patterns of movement through a diversity of topographic and vegetative zones. It has been postulated (Whitten 1975; restated by Guthrie and Powers 1977) that such movements are directly related to the seasonal nutritional "peaks" in the maturation of key plant species, which enable the animals to optimize available nutrients.

In the Carlo Creek study area, three major ungulates are present today: moose (Alces alces), barrenground caribou (Rangifer arcticus), and Dall sheep (Ovis dalli). The following discussion will examine in detail only those species directly relevant to the Carlo Creek archeological assemblage: caribou, Dall sheep, and ground squirrels (Citellus sp.).

Caribou, a gregarious and grazing mammal, occur seasonally over a wide range in the Central Alaska Range (see Figs. 1, 2, and 7). The McKinley herd, although presently quite small, was estimated at ca. 30,000 animals as recently as 1941 (Hemming 1971). At present, the herd ranges over 9600 km^2 (5965 square miles), extending from the Nenana Valley westward to the north fork of the Kuskokwim River. According to Hemming (1971:45), one of the major wintering grounds for the herd in recent history has been the Broad Pass region, and the hills between the Nenana and Kantishna Rivers. Calving generally takes place during June in the rolling tundra regions between the upper Savage and Teklanika Rivers (Hemming 1971; Murie 1944; Skoog 1960). After calving, the herd then moves over the Alaska Range to the area between Cantwell and the west fork of the Chulitna River, which "...has a long history of early summer use" (Hemming 1971:45). An additional major summer range is the area north of Carlo Creek - Panorama Mountain, where abundant lichens and sedges provide ample food resources (USDI 1976). During the summer, a general western movement occurs, with the herd again crossing the main range. In late August and September, herds begin to drift back toward winter ranges, dispersing enroute (Hemming 1971:4). On the basis of available data, the Carlo Creek region is a primary caribou habitat from mid-summer to spring, and could have been so in the early Holocene.

Dall sheep occur on steep tundra slopes and rocky areas on both sides of the Nenana River Valley, and are restricted primarily to alpine tundra ecosystems. They are gregarious animals, occupying higher elevations during the summer, and lower elevations during the winter. Winter distributions are largely controlled by snow conditions. Although sheep rarely range far from the safety of precipitous terrain, they do occasionally cross valleys to get from one mountain slope to another (Whitten 1975). Major lambing and breeding grounds are found on the eastern side of the Nenana Canyon between Sugar Loaf and Panorama Mountains (USDI 1976). Guthrie and Powers (1977:20) have observed that:

> ...Sheep require windblown pastures for winter range, and travel great distances to mountain pass areas which are more consistently exposed to winter winds. The upper Nenana Valley is a major sheep winter range today because of this phenomenon and undoubtedly was in the past for sheep and a number of other large mammal grazers.

The Carlo Creek vicinity, particularly elevations above 700 m, thus may have provided good sheep habitat during virtually any season of the year.

Moose, which are also common in this area, are browsers, and are generally associated with the forest or high brush ecosystems. Willows and various kinds of lacustrine aquatic vegetation are major food sources for these animals. They are found throughout the study area and throughout most of the interior Alaskan taiga.

Other large mammalian species found in the area are wolf (Canis lupus), Toklat grizzlies (Ursus arctos), Black bears (Ursus americanus), coyotes (Canis latrans), red fox (Vulpes fulva), and lynx (Lynx canadensis). Lesser mammals in the region include the following: arctic gound squirrel (Citellus parryi), marmot (Marmota sp.), porcupine (Erthyzon canadensis), wolverine (Gulo loscus), flying squirrel (Glaucomys sabrinus), red squirrel (Tamiasciurus hudsonicus), various mice and shrews (Sorex sp.), mink (Mustela vison), otters (Lutra canadensis), and red-backed vole (Clethrionomys rutilus) (USDI 1974).

Of the above-mentioned minor species, only one, the arctic ground squirrel, will be discussed in any greater detail. Its presence in the faunal remains at the Carlo Creek site make it of special significance for paleoecological and archeological interpretations.

The arctic ground squirrel is generally regarded as a highland form (either latitude or elevation) (Tikhomirov 1959:33). They are found in colonies, frequently along river banks or abandoned river terraces. Melchior (1964:41) states that the topographic/edaphic features of burrow site location include: (1) well drained soils, (2) topographic prominence and (3) high proportions of phosphorus and potassium in the burrow area. Carl (1962:46) suggested that grasses and willows are the most frequently-observed plant associated with squirrel mounds, and later stated (1971:400) that "...all of these [burrow] locations have a comparatively deep permafrost level."

The ground squirrel goes into hibernation in burrows in late September to early November, depending on temperature. Bee and Hall (1956:55) suggest that the "disappearance of ground squirrels in autumn and their reappearance in spring, after hibernation, was thought to be governed by altitude and surface exposure." Tikhomirov (1959:33) observed that temperatures of approximately -10 to -20°C are required to induce hibernation. Similar observations were made by Carl (1962:51) who observed no squirrels above ground at temperatures less than -15°C.

A ground squirrel colony was observed by the author on the west bank of the Nenana River, near the Carlo section house, in August of 1977. Burrows at this location were dug into well drained sandy sediments overlying a bedrock outcrop, at an elevation of about 605 m a.s.l. Vegetation in the surrounding area was open canopy black spruce-poplar forest, with an open grass and willow association in the immediate vicinity of the burrow.

In addition to mammals, numerous species of birds are found in the Carlo Creek area. Most of these are migratory, and are found in the area only in summer. The Nenana River Valley is one of the most important migration routes through the Alaska Range.

Several species of fish are also found in the study area, although these are not of significant economic or subsistence importance. The Alaska Department of Fish and Game regards the Nenana River as an anadromous fish stream, but this applies only to the river's lower reaches, near its confluence with the Tanana River (USDI 1976). Arctic grayling (_Thymallus articus_) are probably the most abundant species in the area; these are found in the Nenana and nearly all tributary streams. Carlo Creek provides a good grayling habitat during the warmer months. Lake trout (Salvelinus nomaycush) are found in some lakes in the area.

Permafrost and Soils

The Carlo Creek area presently lies with a zone of discontinuous permafrost. Local conditions such as slope angle and direction, drainage, permeability, and vegetation to a large degree determine the presence/absence of permafrost. At the Carlo Creek archeological site, permanently frozen ground was consistently encountered at a depth of 1.0 m below surface. In areas of denser vegetation, or of drainage poorer than at the site locality, frozen ground was encountered at depths as shallow as 0.25 m in mid-August.

Soils in the study area can be divided into three orders: histosols, inceptisols, and spodosols; and may be subdivided into five suborders: fibrists, cryaquepts, aquepts, ochrepts and orthods (terminology based on USDA 1975). There has been no detailed soil association mapping done in the Carlo Creek area.

Fibrists (histosols) are fibrous or woody peats, largely undecomposed, and develop in areas of poor drainage and high permafrost table. They are formed primarily from organic matter and are associated with wet tundra.

Cryaquepts (low humic gley inceptisols) develop in areas of poor drainage, and are associated with black spruce (muskeg vegetation). Permafrost is at or near the surface, and drainage is poor.

Aquepts (inceptisols) may frequently be encountered on alluvial floodplains and recent alluvial terraces. They are seasonally saturated and poorly developed soils with little vegetative covering.

Ochrepts (inceptisols) may develop in association with early stages of forest soil formation, or may be associated with tundra vegetation. Ochrepts characteristically have thin or light colored surface horizons with little organic matter accumulation. Drainage is relatively good, with little or no permafrost.

Orthods (Spodosols or subarctic brown forest soils) form in fairly well drained areas, and represent developed forest soils. These soils generally contain a thin elluvial (E) horizon, and a developed B illuvial horizon, with subsurface accumulations of iron, aluminum, and organic matter. Soils in the immediate vicinity of the Carlo Creek archeological site have been classified by the author as Orthods.

Cultural Environment

Present day population centers in the region include Healy (pop. 79) located off mile 252.5, Parks Highway, and Cantwell (pop. 62), located about 22 km (14 miles) south of Carlo Creek. Healy was established as a coal mining camp in 1905, and later became a railroad supply station when the Alaska Railroad was built in the 1920's. Healy is still an active coal mining town. Cantwell, established during construction of the Alaska Railroad, is inhabited primarily by Athapaskan Indians who moved to the area from the Ahtna/Copper Center area (USDI 1976:40). The Carlo Creek locality has a permanent population of six (USDI 1976:42).

Mount McKinley National Park, the entrance and headquarters of which lie roughly 20 km north of Carlo Creek, has a year around population of 15, with a seasonal population of about 250 (USDI 1976:43). The park was established in 1917 as an area for public recreation and wildlife preservation. The eastern boundary of the Park lies directly across the Nenana River from the Carlo Creek site, a distance of about 0.4 km.

Prior to white exploration and settlement in the early twentieth century, the Carlo Creek/upper Nenana Valley was only sporadically occupied, and only on a seasonal basis. The area was probably used by several different native groups for late summer to winter hunting of caribou, sheep, and moose. The area was within the probable seasonal round of activities for the Ahtna (de Laguna, personal communication, 1975; Osgood 1936a), Tanaina (Osgood 1937), and Tanana (McKennan 1959). All of these groups are of northern Athapaskan linguistic stock (Krauss 1973, 1974) and can be characterized aboriginally as opportunistic hunters and gathers whose lifestyle and relationship to the environment shifted throughout the year.

The following is a highly generalized description of historic period Athapaskan subsistence strategies and seasonal round. Summertime was preoccupied with fishing, particularly along the major salmon-spawning rivers. Fishing camps were established and traditionally re-used year after year. Summer also involved moose hunting. During the fall and earlier winter, the emphasis shifted to hunting sheep and caribou in the upland areas, especially during the seasonal migrations of the caribou herds. Depending on extent and availability of cached reserves, the winter and spring was quite likely a time of scarcity and possibly starvation. Groups may have split into family or extended family units and scattered into the highland areas in search of game. Springtime might have been involved with the taking of waterfowl, and, in early summer, the pattern may have again emphasized fishing and the taking of caribou (abstracted from descriptions in de Laguana, personal communication [1975], McKennan [1959], Osgood [1971], and VanStone [1974]).

The Nenana River Valley mountain pass, which runs through the core of the Alaska range, could have played a key role in virtually any part of the above pattern. The most likely use of the valley, however, would probably have been in the late summer to early winter. It should be noted that recent settlement patterns may be biased somewhat in favor of riverine seasonal settlements, particularly along anadromous fish streams (cf. Andrews 1977; Bowers and Hoch 1978; Morlan 1973). The introduction of the fish wheel and white trade undoubtedly resulted in more intensive and semi-permanent settlements along the rivers.

Although the area is today claimed by the Ahtna group, it is by no means certain that this group was in control of the area prior to White contact. The natives of Cantwell moved to that location during construction of the Alaska railroad, probably from the Copper River, Susitna River, and Valdez Creek mining areas. Historically, they maintained cultural and kinship ties with the Tanana of interior Alaska as well as with the Ahtna groups to the southeast (Ahtna, Inc. 1973).

The early historic literature for the area is noticeably lacking in detail concerning the region's inhabitants. The few early accounts which describe the upper Nenana Valley underscore the region's importance as an aboriginal seasonal hunting ground and as a major transportation corridor through the Alaska Range. William Yanert, in his report entitled "A Trip to the Tanana River" (1900:736) observed that

> The divide between the west fork of the Sushitna and the river flowing northward [Nenana] is low, 2600 feet, and has the appearance of a valley from 7 to 9 miles in width. A belt of spruce extends across from north to south. A well-worn footpath leads over the divide, which the guide assured me was made and used by indians going to and from the Tanana. He also pointed out the frames of two indian houses north of the divide, stating that these were used by the Tanana Indians during the hunting season. Moose and caribou signs were plentiful in this locality and it appeared to be the wintering place of game and other animals.

Yanert's Indian guide, who declined to continue northward beyond this point indicated to him that the Tanana River could be reached in three and a half days journey from the Cantwell area: "As concerns the Indian's refusal to remain in service as a guide, I feel certain that his unwillingness to do so was prompted by fear of the Tanana Indians, who, he frequently assured me, were very numerous and bad" (Yanert 1900:736).

Van Schoonhoven (1900:736) reported a similar aboriginal utilization of the high country in the upper Nenana Valley: "...The Jack River country is a good one for game, and the Sushitna [Tanaina] Indians make this their hunting ground for caribou and sheep." He later continued northward, through the Nenana Valley Pass, and proceeded toward the Tanana (1900: 737).

It is thus quite likely that the region has been used extensively in the prehistoric past. Cultural boundaries in this transitional area doubtlessly shifted back and forth, permitting an influx of traits and material goods from the south central coastal area, as well as the deep interior. Beyond the past several hundred years in the area, however, cultural and linguistic identification of the region's inhabitants is difficult (cf. McKennan 1969; Krauss 1973, 1974). Plaskett's (1977) detailed research at the Nenana Gorge site, located 30.0 km north of Carlo Creek, provides probably the best view of the late prehistoric use of the area. He notes many material similarities with other Athapaskan sites from both sides of the Alaska Range, and points out the importance of the area for hunting and as a trade route (1977:216). Plaskett also provides an excellent summary of the ethnohistoric period in the Nenana River Valley.

Thus, the available ethnographic literature, though limited, indicates the possibility that the Carlo Creek area was used seasonally by groups from either the south or north of the Alaska Range. Of importance to our consideration of early Holocene use of the area are: (1) the extent of deglaciation in the upper valley, (2) the availability of faunal resources and (3) faunal resource procurement systems. All three of these factors either have been, or will be, discussed in greater detail elsewhere in this thesis.

CHAPTER 3

GEOLOGY

Bedrock Geology

The bedrock in the study area consists of east-west trending rocks which range in age from pre-Cambrian to Tertiary. The older group of rocks, pre-Cambrian to Cretaceous, consists of schist, phylite, gneiss, chert, argillite, hornfels, limestone, conglomerate, slate, shale, and coal. These are generally metamorphosed and well consolidated. A younger group consists of low-grade metamorphic rocks which were formed by intrusion and alteration of basic lava flows. These two groups are separated by a major unconformity, and form two contrasting groups, with respect to age, consolidation, and tectonism (Wahrhaftig 1958).

The structure of the Alaska Range is a broad synclinal complex, with indications for early Cenozoic orogeny (W. Gilbert 1976:5). This synclinorium contains Cretaceous rocks in the center and Paleozoic rocks on the flanks (Wahrhaftig 1965). Paralleling the major east-west axis of the range are a number of faults, including the major Denali Fault. Rocks located north of the Denali Fault are primarily Paleozoic and older metamorphosed sediments, while rocks south of the fault are "...characterized by a monotonous sequence of predominantely dark gray argillite, slate, graywacke, and a few intervals of limestone of late Paleozoic(?) and Mesozoic age" (USDI 1974:67).

The Paleocene age Cantwell Formation, the major formation underlying the study area, was deposited in a large continental basin and consists of metamorphosed conglomerate, sandstone, siltstone, shale, coaly shale, coal, and argillite (Wahrhaftig 1958; Wolfe and Wahrhaftig 1970). Approximately 60% of the Cantwell Formation is comprised of sandstone and conglomerates (Wahrhaftig 1958:9). The upper portion of this formation contains a number of volcanic flows and tuffs (USDI 1974). The Cantwell formation extends over an area of some 3500 km^2; within the Nenana River Valley, from Clear Creek to the McKinley Park Station.

Quaternary Geology

Methodology

The recent geologic history of the Carlo Creek region was studied through field, laboratory, and library research. The glacial geology and selected aspects of the regional geomorphology have been summarized from previous published work (Wahrhaftig 1958; Thorson and Hamilton 1977) and through informative communications with the geologists T. D. Hamilton, R. D. Reger, N. Ten-Brink, and R. M. Thorson. Although additional work has been done in the area since 1978 as part of the North Alaska Range Early Man Project, these data have not been made available to the writer and have not yet been published.

Reconnaissance mapping of the Carlo Creek study area was made possible through the use of USGS and Alaska Department of Highways aerial photos, as well as USGS 1:63,360 topographic maps. A total of eleven Brunton compass traverses were made of the post-glacial terraces which are found on both sides of the river.

Most of the geologic data for this report were obtained from the detailed examination of the Carlo Creek site. Seventeen sediment samples from the three main areas tested in 1976-77 were analyzed. Samples were collected in approximately 5 cm increments, within each of the coarse and fine textured laminae at the site. The samples which were later selected for analysis represent increments of approximately 20 cm and are fully representative of the inter-site variability and range of grain-size, sorting, and bed morphology. The results of the laboratory data are presented in Figures 12, 13, 14, 15, and Tables 2 and 3.

Laboratory analysis of the samples first involved drying at 45°C, weighing out of 85-100 gm split samples, then pretreating to remove carbonates and organic matter. A 10% dilute Hcl solution was used to remove carbonates; this was followed by treatment with a 30% H_2O_2 solution to remove organic matter. After each step, the sample was dried at 45°C, then weighed to record weight loss. Proportions of carbonate and organic matter in the sample are expressed in terms of the original dry sample weight.

Following pretreatment, each sample was wet-sieved through a 4 phi (Ø) screen (0.0625 mm), to reduce the total volume of silt-clay fraction in the dry sieve procedure, as well as to separate the fine fraction for later hydrometer analysis. The amount of silt-clay fraction was determined by drying and weighing the sand fraction remaining in the 4 Ø screen, then subtracting from the total after pretreatment.

Each sample was then disaggregated with a calgon solution, dried at 45°C, and weighed. The fraction < 4 phi (obtained from the earlier wet sieving), plus the pan fraction, were then combined for hydrometer analysis of the silt-clay portion of each sample. Samples were analyzed in 1000 ml cylinders with sample sizes restricted to the 20-30 gm range. The silt-clay boundary, as employed here, is 8 phi (0.002 mm). Percentages of silt, clay, sand, and gravel represent the total weight after removal of carbonates and organics.

The analytical methods used here are based on those in use at the Geoarcheology Laboratory, Washington State University (Hassan n.d.). Calculations for mean, sorting, skewness, and kurtosis are based on Folk and Ward (1957).

Glacial Geology

The surficial geology in the Carlo Creek region is the result of a complex history of repeated glacial advances, followed by post-glacial downcutting and aggradation. Interpreting the Quaternary glacial geology is further complicated by the considerable amount of uplift that has occurred in the tectonically-active Alaska Range (Wahrhaftig 1958).

Wahrhaftig (1958) first outlined the glacial sequence in the valley, and recognized four major glacial advances: the Browne, Dry Creek, Healy, and Riley Creek events. These deposits extended well to the north of the present day limits of the northern foothills province of the Alaska Range. The earliest of these is thought to be late Pliocene or early Pleistocene (Thorson and Hamilton 1977).

The subsequent Dry Creek glaciation, regarded as broadly middle Pleistocene in age (Thorson and Hamilton 1977), was less extensive than its predecessor. An uplift of some 150 m probably occurred in the vicinity of Healy during and slightly after this episode (Wahrhaftig 1958).

The following Healy glaciation, regarded as broadly Illinioan to early Wisconsinan in age (Péwé et al. 1965; Thorson and Hamilton 1977), resulted in the formation of a large proglacial lake in the Nenana Canyon

(Wahrhaftig 1958), approximately 30 km downstream from Carlo Creek. Lacustrine and alluvial fan deposits eventually filled this lake, and caused an eastward displacement of the Nenana River. Coupled with this displacement also was extensive downcutting into schist bedrock and formation of the present-day Nenana Canyon. The Healy glacier terminated approximately 1.0 km south of the Dry Creek archeological site (38 km north of Carlo Creek); the outwash from the Healy moraine forms the base on which that site's eolian deposits later accumulated (Thorson and Hamilton 1977:152-153).

The most recent major expansion of glacial ice in the Nenana Valley was the Riley Creek event, first defined by Wahrhaftig (1958). On the basis of outwash terrace profiles and drift limits, three advances of the Riley Creek glaciation have been suggested (Wahrhaftig 1958; Thorson and Hamilton 1977).

The Riley Creek I advance (see Fig. 8) probably extended into the Nenana River canyon, and terminated approximately 2 km north of the McKinley Park Headquarters, about 20 km north of Carlo Creek (Thorson and Hamilton 1977:168). The Riley Creek I glaciation also resulted in the deposition of a kame terrace in a low pass 746 m a.s.l. (2450') in an area about 4.8 km northwest of Carlo Creek. These deposits lie at an elevation about 152 m above the present level of the Nenana River. Outwash gravel at this point is greater than 76 m thick. A "high terrace," traced by Wahrhaftig upstream to the Carlo vicinity, is composed of till and gravel. The elevation of this feature suggests that Riley Creek glacial ice was at least 1036 m a.s.l. near the Carlo Creek area, and at least 416 m thick (Wahrhaftig 1958).

It is probable that the Riley Creek I glacial retreat resulted in the deposition of large amounts of meltwater deposits. There is some

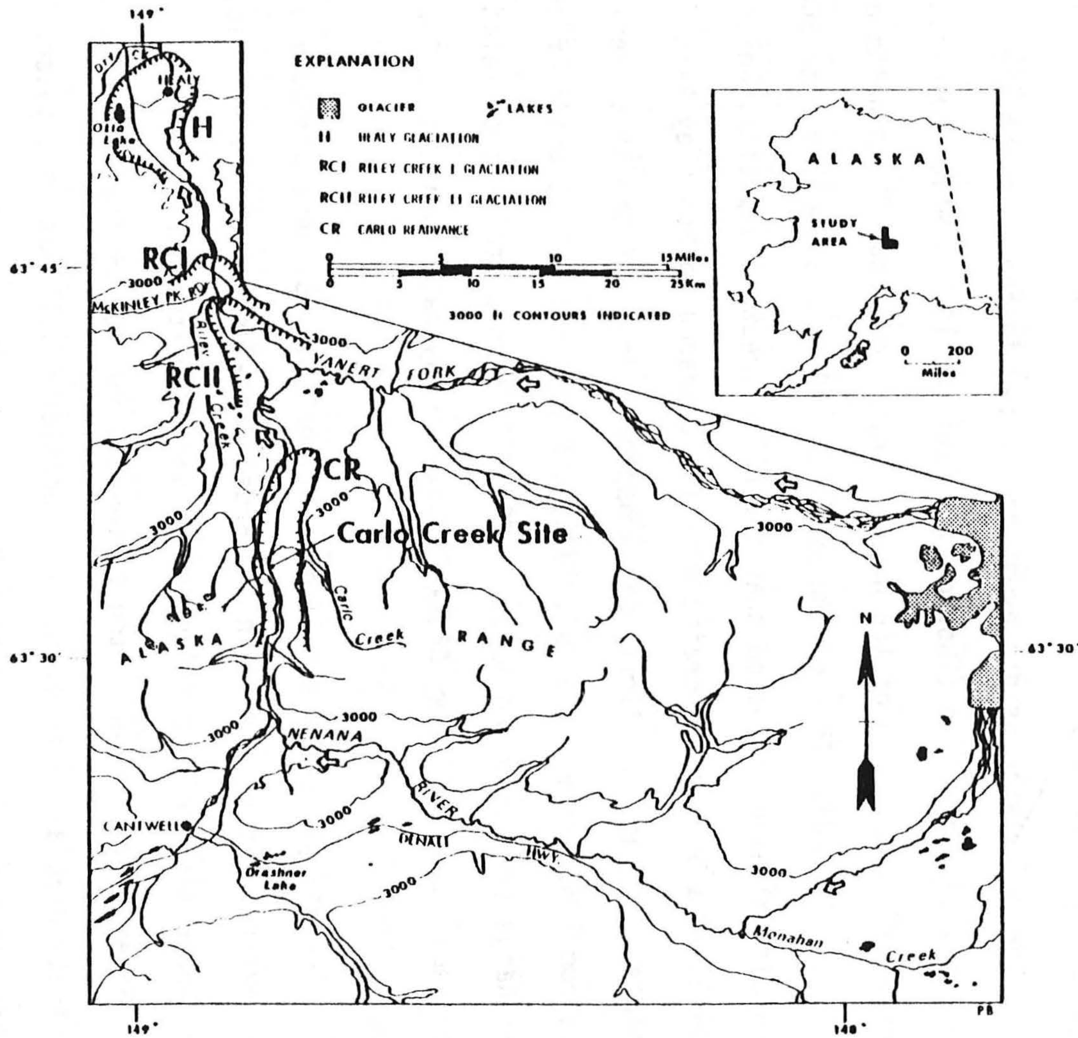


Fig. 8.--Upper Nenana River Valley, Showing Probable Terminal Positions of Late Pleistocene Glaciers. ADAPTED FROM: Thorson and Hamilton (1977) and Wahrhaftig (1958).

evidence for the formation of a large proglacial lake in the vicinity of the Nenana River's confluence with the Yanert Fork (Wahrhaftig 1958). The Riley Creek I event probably represents the maximum advance of late Wisconsinan glaciation in the Nenana River Valley, suggesting a date of approximately 18,000 B.P.

The major Wisconsinan event recognized in the research area is the Riley Creek II glaciation (Thorson and Hamilton 1977), which terminated approximately 2 km south of the Nenana Canyon, or about 20 km north of Carlo Creek (Fig. 8). Thorson and Hamilton (1977) and Thorson (personal communication) have suggested that the Riley Creek II deposits, which terminate in a 50 m-high moraine near the entrance to McKinley Park, may correlate with the more firmly dated Naptowne drift of the Kenai Peninsula (Karlstrom 1965; Schmoll et al. 1972) and the Itkillik II drift of the Brooks Range (Hamilton and Porter 1975). If such postulated correlations are correct, then the Riley Creek II maximum may date to about 13,000 to 14,000 B.P.

The Riley Creek I and II glaciations (Fig. 8) were probably both fed by extensive firn fields in the Broad Pass-Susitna drainage areas, which forced massive quantities of ice and meltwater northward, down the Nenana River Valley. Due to the tremendous amounts of ice in the accumulation zone, these glacial advances may have persisted well past the generally-accepted dates of glacial retreat elsewhere in Alaska. Thorson (personal communication) has suggested that Riley Creek II drift in the Nenana Valley may actually be related to a glacial advance which is controlled more by dynamic, rather than climatic causes.

This factor is important in interpreting the Carlo Creek regional geomorphology. It may well be that stagnant ice and meltwater channels continued to exist in the valley long after Holocene amelioration of climate. Thorson and Hamilton (1977:168) suggest that the Riley Creek II glacier stagnated across a "...broad zone, that includes the lower 4-6 km of Yanert Fork and adjacent parts of the Nenana Valley". In these regions today, fresh kame and kettle topography is common; such a landscape may have been present for early Holocene hunters and their big-game food resources.

In order to determine the earliest possible date for human use of the upper Nenana River Valley, it will be necessary to discuss the known radiocarbon assays relative to deglaciation from the area. First of all, it should be stated that precise dating of deglaciation in the valley is equivocal at this time. Two radiocarbon dates for deglaciation are represented by assays of 10,560 ± 200 years: 8610 B.C. (W-49), and 9060 ± 160 years: 7110 B.C. (AU-94), (Wahrhaftig 1958; Thorson and Hamilton 1977). Hamilton, who collected the latter date, cautions that this type of limiting date (kettle fill) may actually be thousands of years younger than actual date of deglaciation, (Hamilton, personal communication, 1976). AU-94 is thought to represent a minimum age for "Carlo" outwash (Thorson and Hamilton 1977:169). The older of the two dates indicates a period of ice wastage after Riley Creek II advance but before Carlo time (Wahrhaftig 1958; Thorson and Hamilton 1977). However, it should be cautioned that the 10,560 year old sample was analyzed during the early years of the C-14 process, and hence is based on the solid carbon method of dating. As a result, the date may be somewhat suspect.

Further minimum limiting dates for deglaciation in the upper Nenana River Valley are indicated by the author's C-14 dates from the Carlo Creek site, located approximately 20 km up valley from the Riley Creek II terminal moraine. The dates obtained from the Carlo Creek component I occupation suggest that by at least 8500 B.P., more than 75% of post-glacial valley incision had already taken place. Since it is quite likely that initial post glacial downcutting was fairly rapid, these dates may offer a good estimation for the age of late glacial outwash in the upper valley. They do offer nearly incontrovertible evidence that Riley II glacial advances were completed by at least 8500 years ago, and probably 1500 to 2000 years earlier. Hamilton (personal communication, 1977) has cautioned that "...in areas of unusual thick drift and massive stagnant ice, such as probably the upper Nenana Valley, inactive buried ice probably would have persisted for one to several thousand years longer, under probably mild climatic conditions."

Further supporting data bearing on the age of the Riley Creek II retreat may be suggested by a C-14 date of 12,500 ± 150 years: 10,550 B.C. (W-161), obtained from a basal kettle deposit in the adjacent Teklanika Valley, located approximately 40 km west of Carlo Creek (Hamilton, personal communication, 1977). This date appears to be somewhat more compatible, in general, with the more firmly dated deglaciation record in other parts of the Alaska and Brooks Ranges. If this date does in fact correlate with the late glacial record in the Nenana Valley, then an age of between 12,000 to 14,000 B.P. may be ascribed to the Riley Creek II glacial maximum.

A third, minor, late Pleistocene-early Holocene event will be discussed here in an effort to describe the regional geology in the Carlo Creek area. The so-called "Carlo re-advance," however, remains somewhat enigmatic. (For the purposes of this report, the Pleistocene-Holocene boundary is set at 10,000 B.P., as suggested by Hopkins [1975:10]). This event was originally postulated by Wahrhaftig (1958) to account for a belt of ice-marginal topography located between 0.5 and 5.0 km north of Carlo Creek. According to his interpretation, the waning Riley Creek glacier had retreated to its present position --nearly 75 km upstream from Carlo Creek-- before it again advanced. It then readvanced to a position just north of Carlo Creek, forming what he called the Carlo "moraine". This position would have been 14.5 km south of the Riley Creek II moraine. As it again retreated, meltwaters from the Nenana glacier excavated an 80 km long canyon through Riley Creek morainal deposits and outwash, and then refilled the canyon with gravel to the elevation of the original Carlo outwash plain -- a thickness of ca. 76 m in an area about 4.8 km north of Carlo (Wahrhaftig 1958:54). Thorson and Hamilton (1977:168) state that Carlo drift is morphologically similar to Riley Creek II drift, and observe that it forms a wide terminal zone about 3 km north of Carlo Creek.

As recession of the "Carlo" glacier continued, it was hypothesized (Wahrhaftig 1958) that a moraine-dammed lake formed, which extended southward for a distance of some 20 km (see Fig. 8). Also formed at this time was a prominent outwash terrace, which lies at an approximate elevation of 750 m a.s.l., about 100 m above the level of the Nenana River. This terrace is composed entirely of gravel and interstitial sand (Wahrhaftig 1958) and is capped with approximately 1.5 m of massive sand and silt of probable eolian origin (Fig. 9; terrace 4).

Wahrhaftig (1958:54) suggested that the hypothesized proglacial lake in the Carlo area could be explained by: (1) the flat valley floor in the Nenana Valley between Clear Creek and Carlo Creek, (2) the steep valley walls, (3) the "low gradient and gentle meandering flow of the river in this stretch," and (4) (lacustrine) sand deposits. However, on the basis of the Carlo Creek geoarcheological research, further supporting evidence for this postulated lake has not materialized. The sand deposits reported by Wahrhaftig (1958:53-55) as lacustrine appear to this investigator to be fluvial in

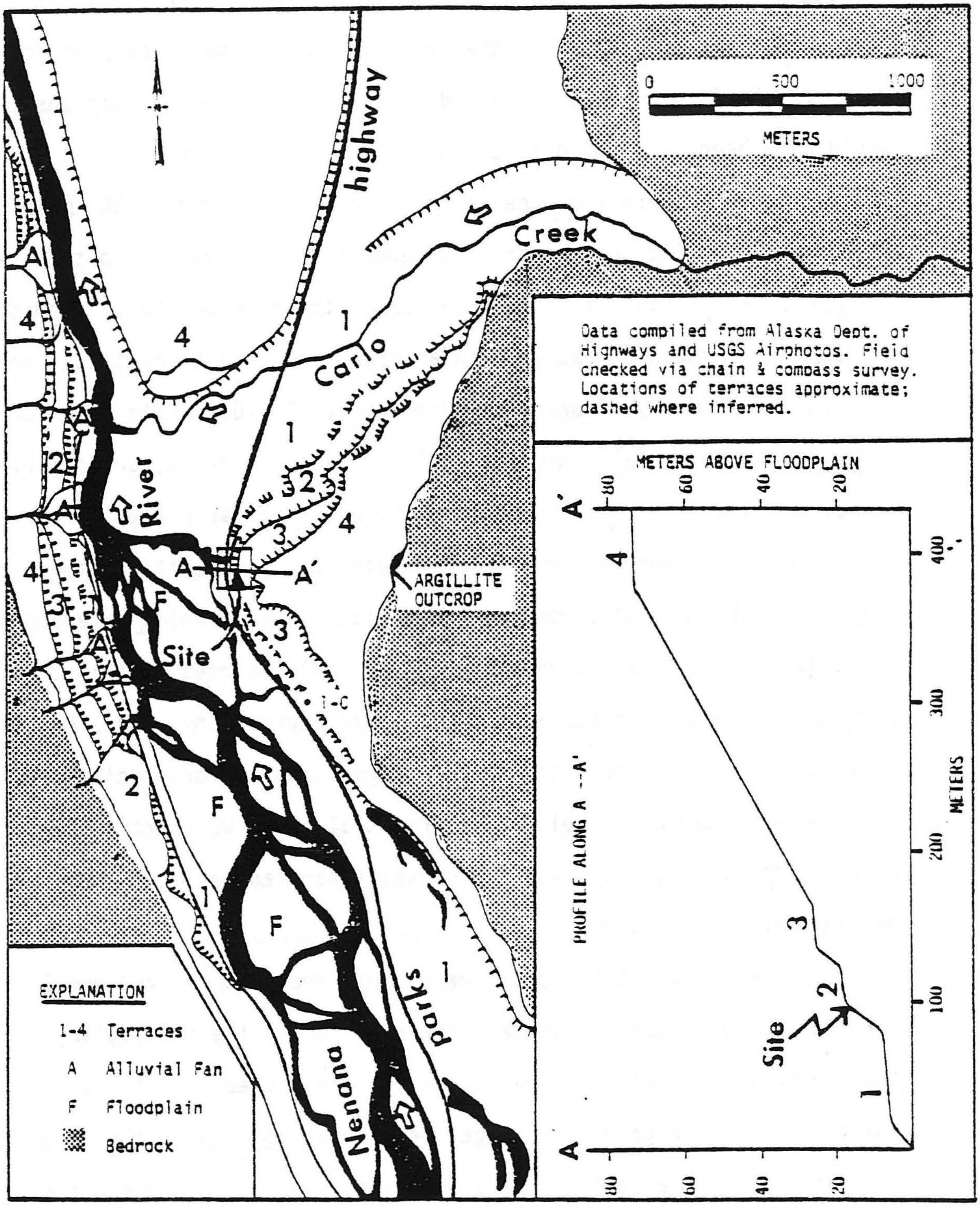


Fig. 9.--Sketch Map of Terraces in the Nenana River Valley in the Vicinity of Carlo Creek and Profile Along Line A-A'. Area enclosed by rectangle shown in Fig. 4; locality "1-C" refers to C-14 sampling site referred to in text, Fig. 16, and Table 5.

origin, as they show considerable cross bedding, ripple laminations, scour and fill features, and have generally coarse textures. As an alternative explanation, the features originally described by Wahrhaftig (1958) are interpreted here as evidence for an early post-glacial period of fluvial aggradation, occurring during minor stillstands in valley incision. The basal Unit of the Carlo Creek site (Fig. 10; Unit 1) may have been deposited as glacio-fluvial sediments during or soon after the "Carlo" event.

At the time of Wahrhaftig's pioneering research in the Alaska Range, no similar "Carlo" features could be found in any of the other major valleys in the Central Alaska Range (1958:52-55). Subsequent research by Thorson and Hamilton (1977:168) has also indicated that deposits correlative with the "Carlo" event probably do not exist elsewhere in the Alaska Range. Hamilton (1973:37) suggested one possible correlation between Carlo age drift and deposits of the Donnelly III glaciation in the Delta drainage. If such a correlation is valid, then an approximate age of 10,000 ± 500 B.P. may be posited for the "Carlo" event (Thorson and Hamilton 1977:167-168).

Investigations carried out north of the Carlo Creek area by Thorson (personal communication, 1976) have raised several questions concerning the significance of the "Carlo" deposits. Possible differences with Wahrhaftig's interpretation are suggested by several tentative observations: (1) similarities in morphology between "Carlo" and Riley II deposits, (2) the absence of a clearly-defined terminal moraine associated with "Carlo" deposits, and (3) the apparent continuity between Riley Creek II and "Carlo" features (Thorson personal communication, 1976). To these points I would add the previous observation concerning the lack of definite evidence for lacustrine-proglacial deposits.

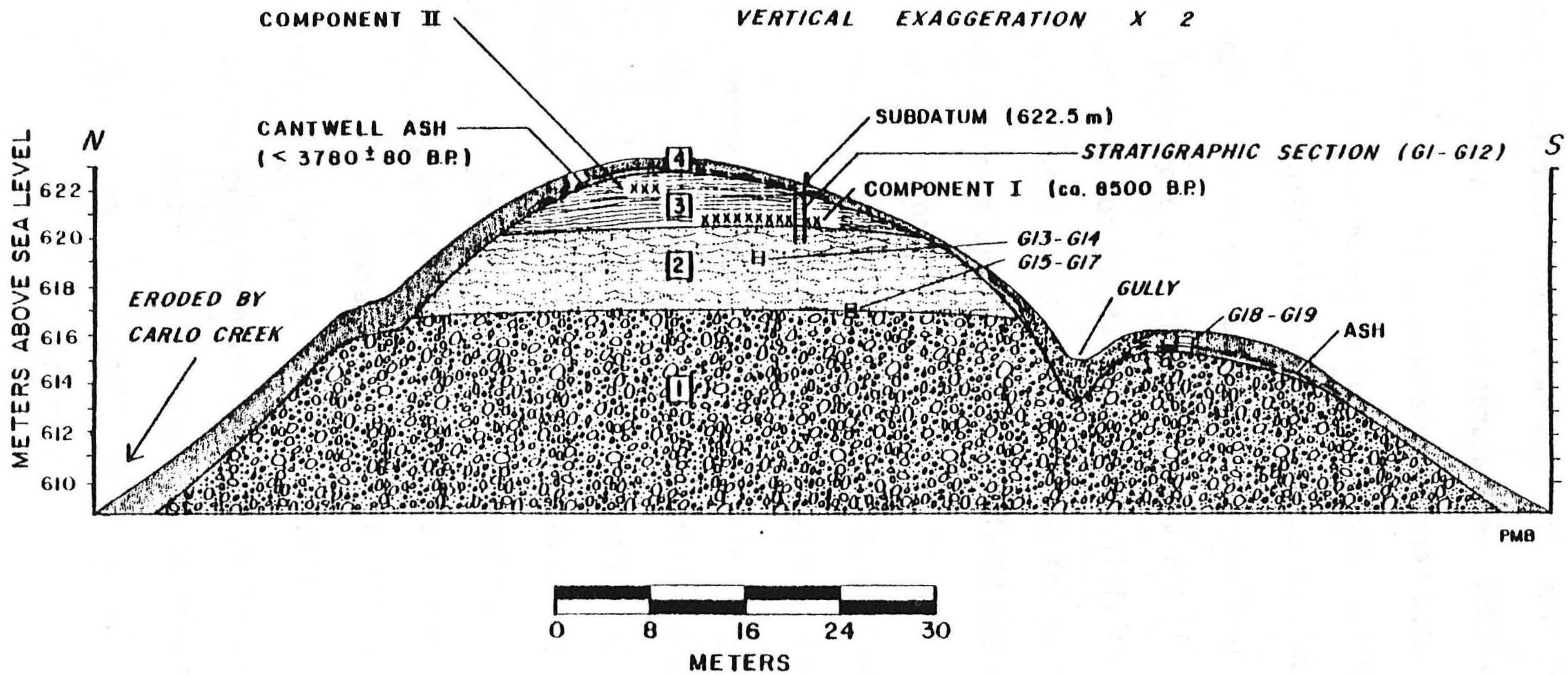


Fig. 10.--Generalized Stratigraphy, Carlo Creek Site. Major stratigraphic units indicated by numbers 1-4; granulometric samples indicated by "G-1" through "G-19". View to east from road level.

However, some mechanism must be set forth to account for the gravel outwash terraces that can be traced downstream from the Riley II moraine to as far as 23 km down valley from Dry Creek (Thorson and Hamilton 1977:168; Wahrhaftig 1958:52-55). Thorson and Hamilton (1977:168) report that "...near the mouth of Dry Creek, the [Carlo] terraces stand about 7 m above the modern floodplain of the Nenana River and are about 6 m lower than the Riley Creek II terrace."

Alternative explanations for formation of the various "Carlo" deposits may be: (1) the Carlo "moraine" may represent valley floor Riley Creek II ablation drift (Thorson, personal communication, 1978), (2) these mid-valley deposits may represent a minor stillstand in waning Riley II glaciation, and (3) "Carlo" drift may have been the result of minor late-glacial surges of glacial activity, limited to the upper portions of cirque-headed valleys feeding the Nenana system (Hamilton, personal communication, 1978). In addition, Hamilton (personal communication, 1978) has suggested that a slight readvance in the Yanert Fork glacial system could have caused aggradation of that stream, resulting in a rise in the local base level of the Upper Nenana River. One final possibility could be a landslide, which could have temporarily blocked the canyon, raised base level, and caused a lake to form (Thorson, personal communication, 1978).

Regardless of whether or not the "Carlo readvance" was a real event, it appears that the major glacial retreat in the upper valley must have been completed by at least 10,000 B.P. This does not preclude the possibility for remnant quantities of massive stagnant ice which could have prevented human use of the valley. The series of C-14 dates from the Carlo Creek area sediments does indicate that the Nenana glacier had retreated sufficiently to enable access to the valley floor by herbivores and human hunting bands by at least 8500 B.P. By the time of the Carlo Creek I occupation, it is probable that the Nenana Valley was sufficiently clear of ice and multi-braided outwash channels to permit north-south movement through the Alaska Range, by way of the Nenana Valley, Broad Pass, and Susitna drainages (see Figs. 7, 8, and 9).

Holocene Geology and Stratigraphy of the Carlo Creek Site

Following the final retreat of late Wisconsinan glaciers in the Yanert Fork and Nenana Valleys, the valleys were subjected to episodes of extensive downcutting, marked by minor stillstands and periods of aggradation. One of the best records of these events is preserved as a set of four depositional terraces directly across (to the west of) the Carlo Creek site (see Fig. 9). These terraces form a series of discontinuous benches that can be traced for several kilometers on both sides of the valley.

The highest surface (not indicated in Fig. 9) represents an erosional terrace which was probably scoured by Riley Creek II ice; this surface is about 1000 m a.s.l. Below this surface is a prominent outwash terrace (Fig. 9; terrace 4), which is approximately 700 m a.s.l., and about 80 m above the level of the Carlo Creek site. On this "Carlo" age surface (cf. Wahrhaftig 1958:53-54), the author has observed collapse structures, kettles, and erratics as large as 5 m in diameter. These observations would suggest a late Riley Creek II or "Carlo" age for the 700 m surface, or about 10,000 ± 500 B.P. The presence of glacier-margin features such as kettles or erratics would indicate that stagnant ice may have been present during the early stages of postglacial downcutting.

Downcutting probably would have initially taken place fairly rapidly; however, the cause of the temporary halt in downcutting at ca. 8500 B.P.--

the age of the Carlo Creek site Unit 2 and 3 sediments--is not clear. Hamilton (personal communication, 1973) has suggested two possible causes for such a temporary halt in valley incision: (1) a minor readvance of cirque glaciers, perhaps those at the head of Carlo Creek, Clear Creek, or Slime Creek, could have supplied extensive meltwater sediments to the Nenana River system, thus increasing the sediment yield and floodplain deposition in the Carlo Creek region. (2) A minor readvance of the Yanert Fork glacier could have caused significant aggradation of Yanert Fork, thereby raising the local base level for the Nenana River.

Such postulated causes for the 8500 B.P. halt in downcutting may be supported by evidence from the Copper River Valley, where a date of 8800 B.P. was obtained in association with cirque glacier marginal moraines (Sirkin et al. 1971:708), and from the North Slope, where Detterman (1964:130-131) has reported similar evidence for an early Holocene episode of alluviation.

The Carlo Creek archeological site (HEA 031) occurs within sediments comprising the third of the four post-glacial depositional terrace remnants (Fig. 9; terrace 2). HEA 031 is about 623 m a.s.l., and is located 20 m above the level of the Nenana River. The terrace surface below which the Carlo Creek site occurs (terrace 2) can be traced upstream for nearly 3 km. On both sides of the river this terrace, as well as one 6 m below it (terrace 1), are preserved as a series of benches. In some places, these surfaces have been dissected laterally by small tributary streams, and have in places been mantled by alluvial fan sediments. The terrace surface at the Carlo Creek site <u>may</u> correlate with a terrace "about 60 feet high", located upstream from Carlo, as reported by Wahrhaftig (1958:54).

The stratigraphy of the Carlo Creek site (Fig. 10) is made up of four major sedimentary units: Unit 1, the bottom of the profile, contains a minimum of 8 m of sandy gravel; Unit 2 consists of m of bedded fluvial sand; Unit 3 consists of about 3-4 m of floodplain silt and fine sand; and Unit 4 contains ca. 30 cm of sand/silt--probably due to primary loess deposition, reworked alluvium, and volcanic ash (see Figs. 10, 11, and Table 2).

A brief discussion of the grain size parameters for each of these four major sedimentary units will be necessary to more completely interpret the site's past geologic history of the site. Granulometric analysis is an invaluable tool in determining relative percentages of gravel, sand, silt, and clay, and can ultimately provide important data bearing on the depositional environment of a site. Data relevant to these analyses are presented in Tables 2 and 3, and Figures 12, 13, 14 and 15. Interpretation of granulometric data are based on previous studies (Allen 1965, 1970; Folk 1966; Hassan, n.d.; Kukal 1971; Reineck and Singh 1965; Visher 1965, 1969).

The lowermost unit in the site, Unit 1, is extremely poorly sorted, very negatively skewed, and mesokurtic, and has a median grain size of 0.7 phi (Ø). The poor sorting, and the presence of large clasts (up to .75 m diameter) suggests that it was deposited as part of the traction load within a major channel of the Nenana river or a tributary stream. The histogram (Fig. 13; Number 17) representing this unit tends toward bimodality, a characteristic of channel bed deposits.

Unit 2, comprised of laminated silt and sand, shows some cross bedding in places. Median grain sizes of the coarse and fine lamianae samples range from 3.4 phi to 1.2 phi. Samples Number 11 to 16, collected from a depth of 185 to 592 cm, are generally poorly to moderately sorted,

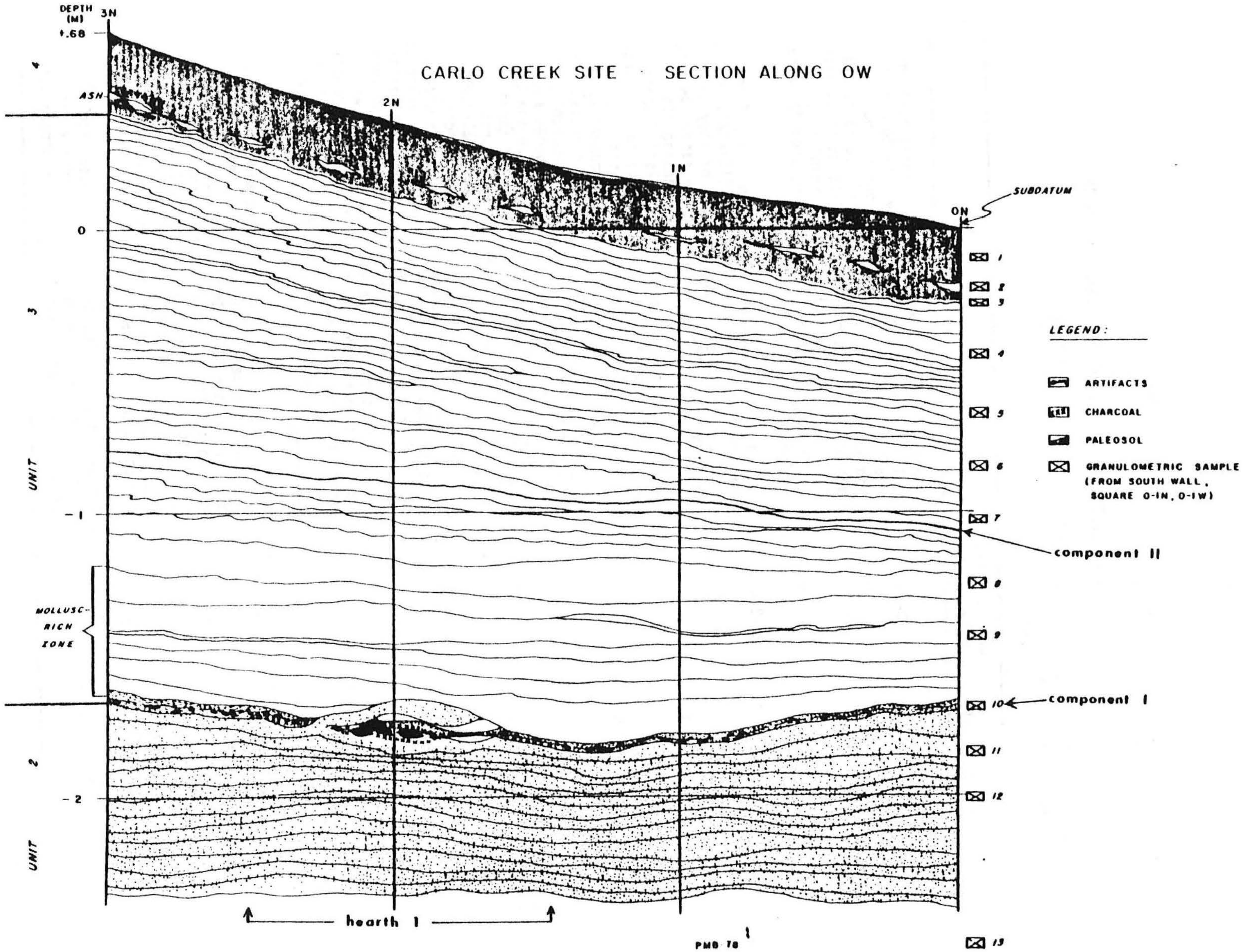


Fig. 11.--Stratigraphic Section Along Line 0 West.

TABLE 2

GENERALIZED DESCRIPTION OF STRATIGRAPHIC UNITS

CARLO CREEK SITE

Unit	Approx. depth below surface	Description
4 a b c	0-30 cm	Modern organic mat and active pedogenic horizons. Silt to fine sand with many very fine to medium rootlets; contains charcoal and burned roots in and above A2 horizon. Several diffuse paleosols evident. Unit 4b represents a 5-15 mm thick discontinuous lens of volcanic ash, found about 20 cm below surface. Abrupt, wavy, uncomfortable boundary.
3	30-200 cm	Laminated fine sand and silty fine sand. Fine laminae consist of very dark gray (10YR3/1, moist) silt/clay. Coarse laminae consist of very dark grayish brown (10YR3/2, moist) fine sand. Bedding is nearly horizontal, with an increasing dip (max. of 25°) toward the exposure face (west). Laminations vary between 2-5 cm and tend to thin upwards. Two archeological components occur within this unit: The upper cultural level, Component II (lithics) occurs 100 to 110 cm below surface, and about 100 cm above lower contact. Component I (lower) cultural materials (lithics, bones and charcoal) are found between 0-5 cm above the lower boundary. Fairly uniform scattering of terrestrial mollusca occur in lower 50 cm of unit 3. Organic stains and/or weakly developed paleosol (?) occur between 0-5 cm above lower boundary. Minor carbonate accumulation occurs on the underside of Component I artifacts. "Paleosol" exhibits weak, fine crumb structure, with moderate cementation; and soft, very friable, very sticky and very plastic consistence. Paleosol appears as 3 wavy bands not more than 5 cm thick (total), and ranges from dark reddish brown (2.5YR3/4, moist) to dark brown (10YR3/3, moist). Boundary: abrupt, wavy, uncomfortable.
2	200-600 cm	Bedded sand with occasional fine gravel near base. Fluvial cross-bedding evident in places. Laminae are nearly parallel. Grains are subrounded to rounded and are very dark grayish brown (2.5YR3/2, moist) to dark grayish brown (10YR5/2, moist). Thickness of laminations range from 5-10 cm near base of unit, to 2-5 cm near top. Boundary: abrupt, smooth, uncomfortable.
1	600 + cm	Gravel and sand. Rounded to subrounded cobbles to small boulders, in sandy matrix, poorly sorted. Lenses of sand and gravelly sand occur throughout.

TABLE 3

CARLO CREEK SITE GRANULOMETRIC ANALYSIS

Unit	Depth (cm)	Comments	Lab #	% Gravel	% Sand	% Silt	% Clay	% Organic Matter	% $CaCO_3$	Median Ø	Sorting	Skewness	Kurtosis
4c	9-12	Al horizon	1	0	26.43	74.15	0	28.81	0	4.4	0.59	0.16	1.07
4b	19-20	Ash lens	2	0	24.48	72.37	3.71	19.50	0	4.5	1.27	0.29	1.46
4a	22-25	Bs horizon	3	0	40.52	59.22	0.28	6.79	0	4.1	0.82	-.16	1.27
3	42-26	C horizon	4	0	73.88	22.79	2.65	1.19	0	3.4	1.12	0.21	1.79
	62-65		5	0	53.70	44.76	1.35	0.22	0	4.0	0.80	-.21	1.00
	81-85		6	0	42.72	55.49	0.99	2.08	0	4.1	0.80	-.14	1.15
	100-104	Comp. II	7	0	44.69	55.12	0.28	0.16	0	4.0	0.72	0.02	1.14
	121-124		8	0	62.00	35.21	3.20	0.24	0	3.8	1.06	0.22	2.14
	141-144		9	0.06	34.39	64.58	1.20	3.53	0.04	4.2	1.05	0.13	1.19
	168-171	Comp. I	10	0	57.42	41.77	0.80	4.06	3.64	2.6	1.28	0.73	1.52
2	181-185		11	0.17	70.04	24.29	4.87	0.38	0.42	3.1	2.05	0.23	1.19
	197-200		12	0.17	75.00	21.37	2.52	0.68	0	2.8	1.73	0.17	1.20
	248-252		13	0.14	80.67	19.70	0.09	0.01	0	2.2	1.79	0.26	1.10
	273-277		14	1.25	92.96	5.81	0.05	0.14	0	1.2	1.34	0.26	1.25
	533-537		15	0	97.53	2.47	0	0.03	0	2.3	0.66	0.04	1.23
	588-592		16	0.05	71.09	27.74	1.12	0.27	0	3.4	1.44	0.14	1.72
1	618-622		17	27.39	66.94	5.43	0	0	0	0.7	2.78	0.20	1.09

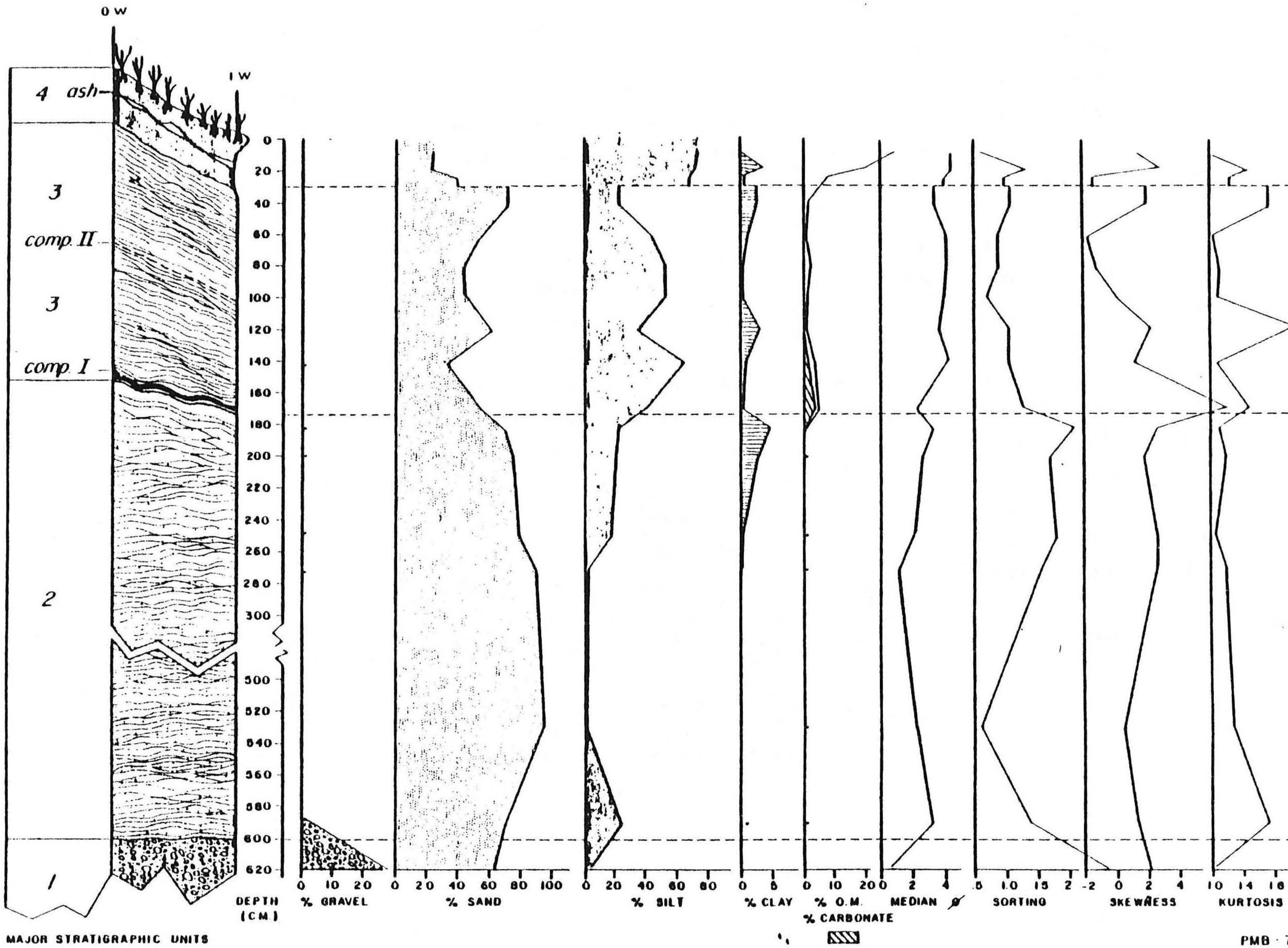


Fig. 12.--Carlo Creek Site Granulometric Analysis.

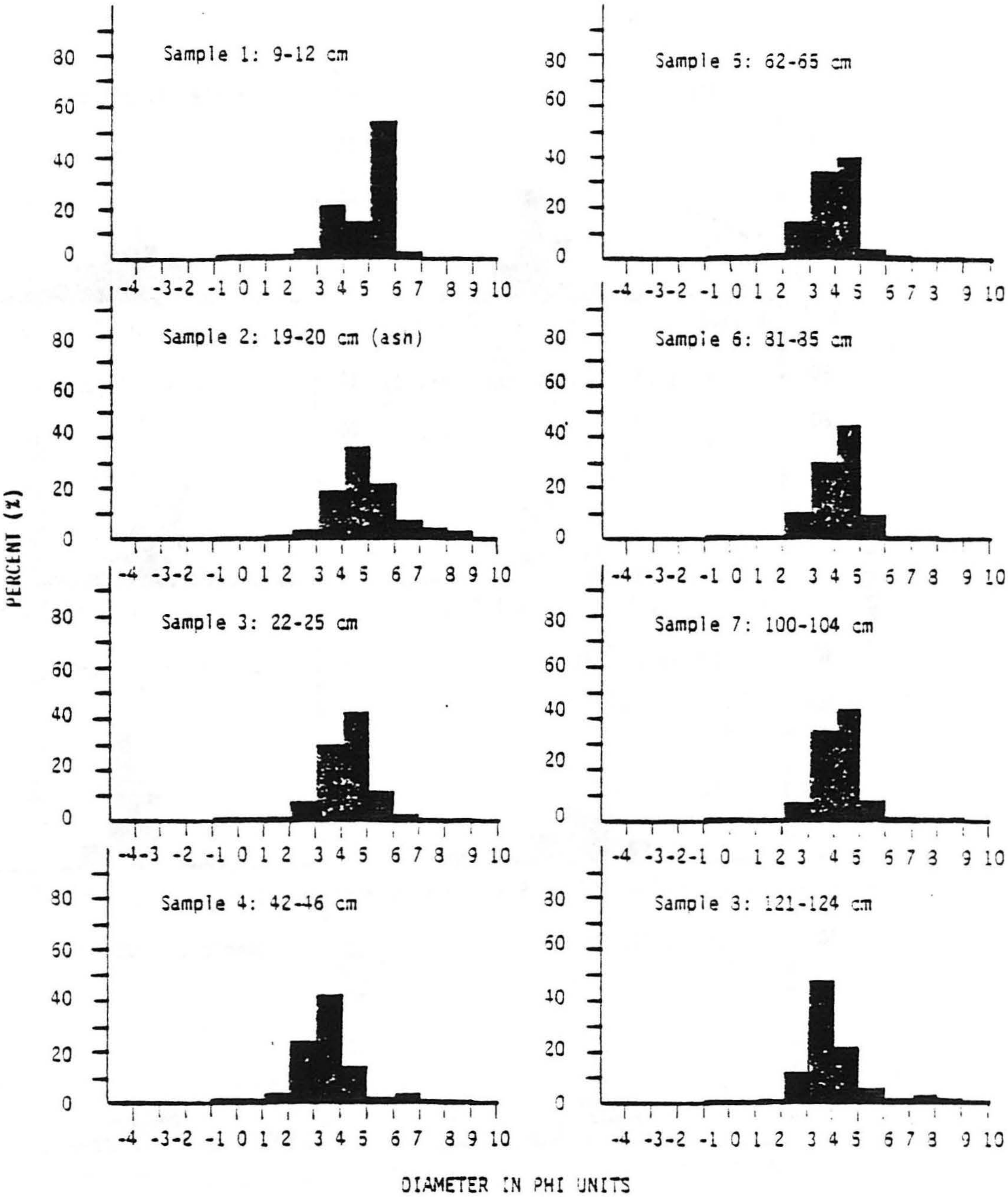


Fig. 13.--Grain Size Distributions, Carlo Creek Site. Histograms represent diameters in phi units vs. percent of total sample after removal of carbonates and organic matter. Refer to sample locations in Figs. 10, 11, and 12. Sample depths are in reference to subdatum.

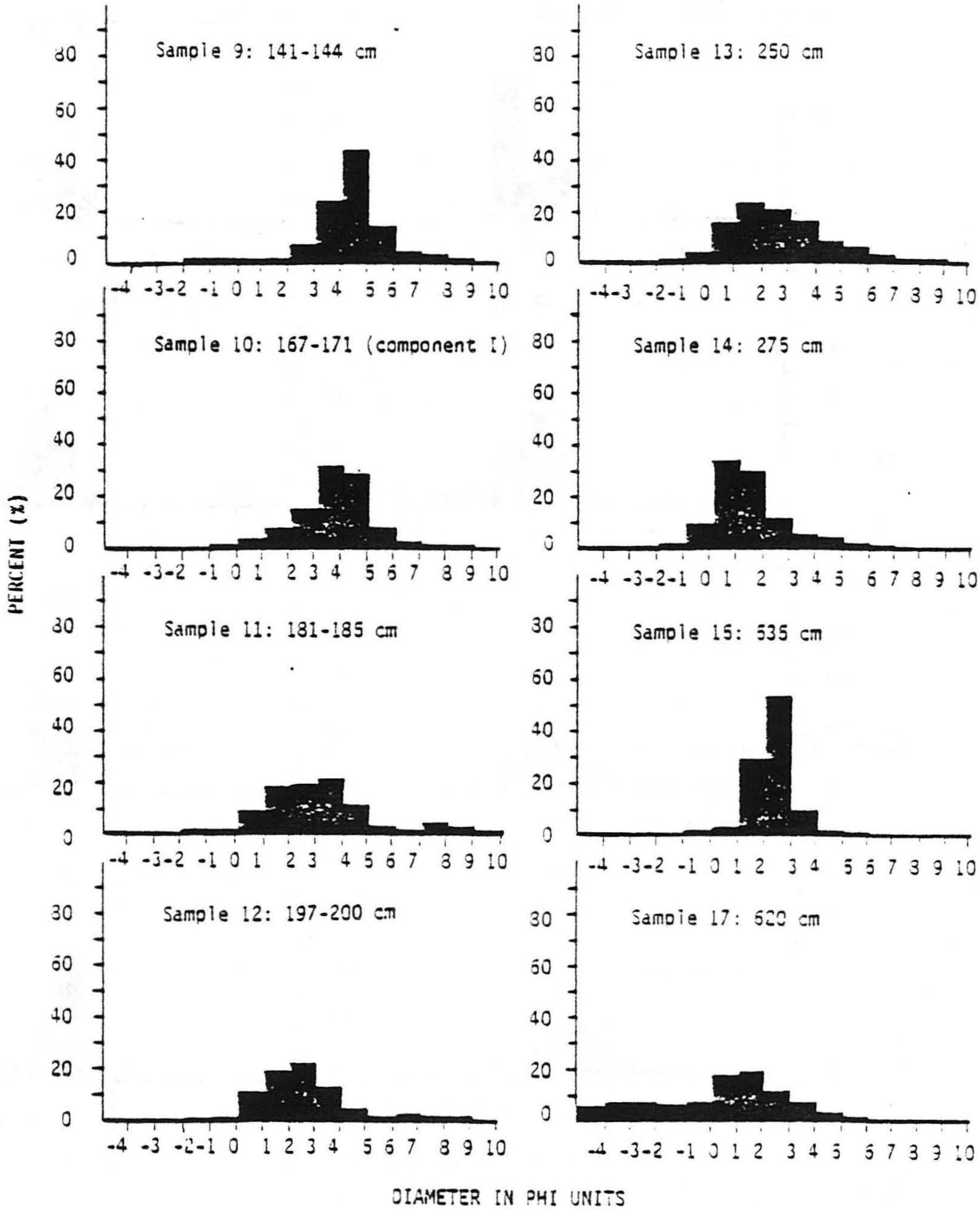


Fig. 13.--Continued.

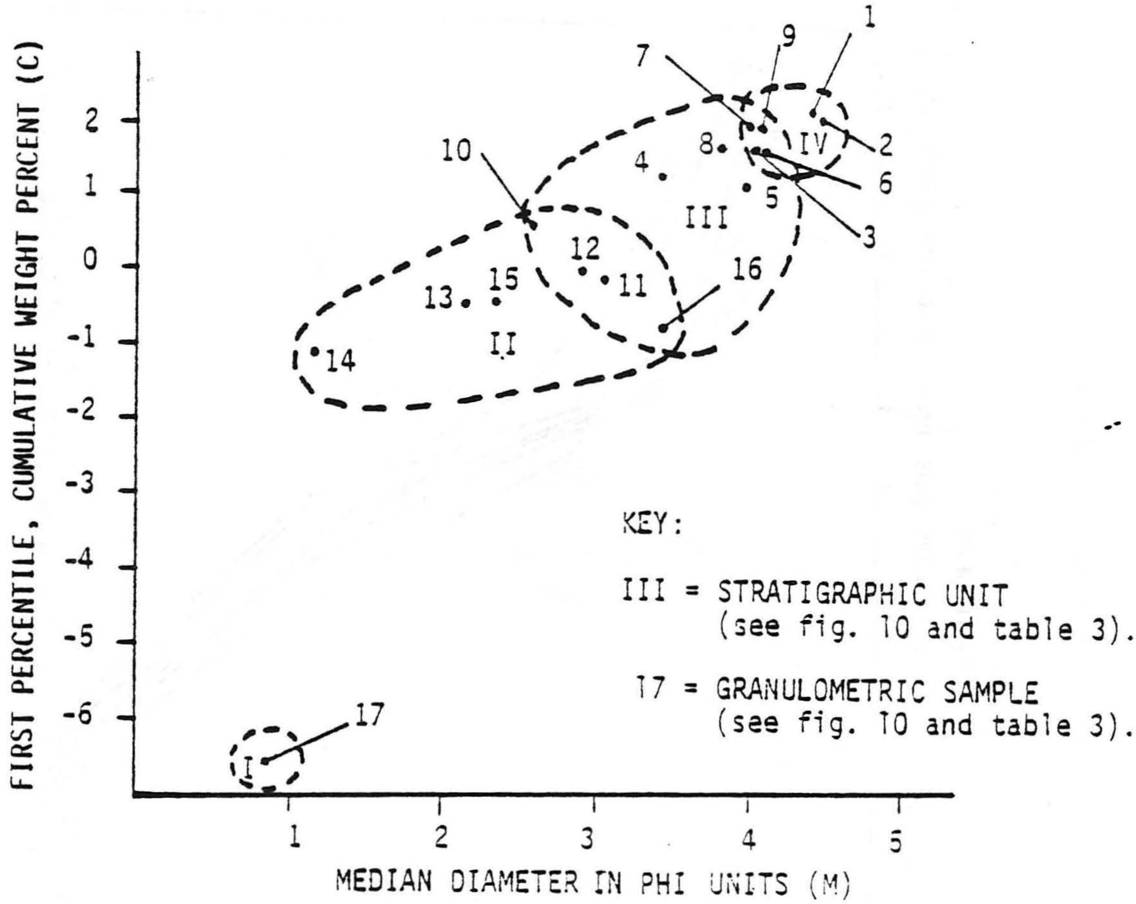


Fig. 14.--C/M Diagram, Carlo Creek Site Sediment Analysis. Refer to cumulative grain size curves, Fig. 15.

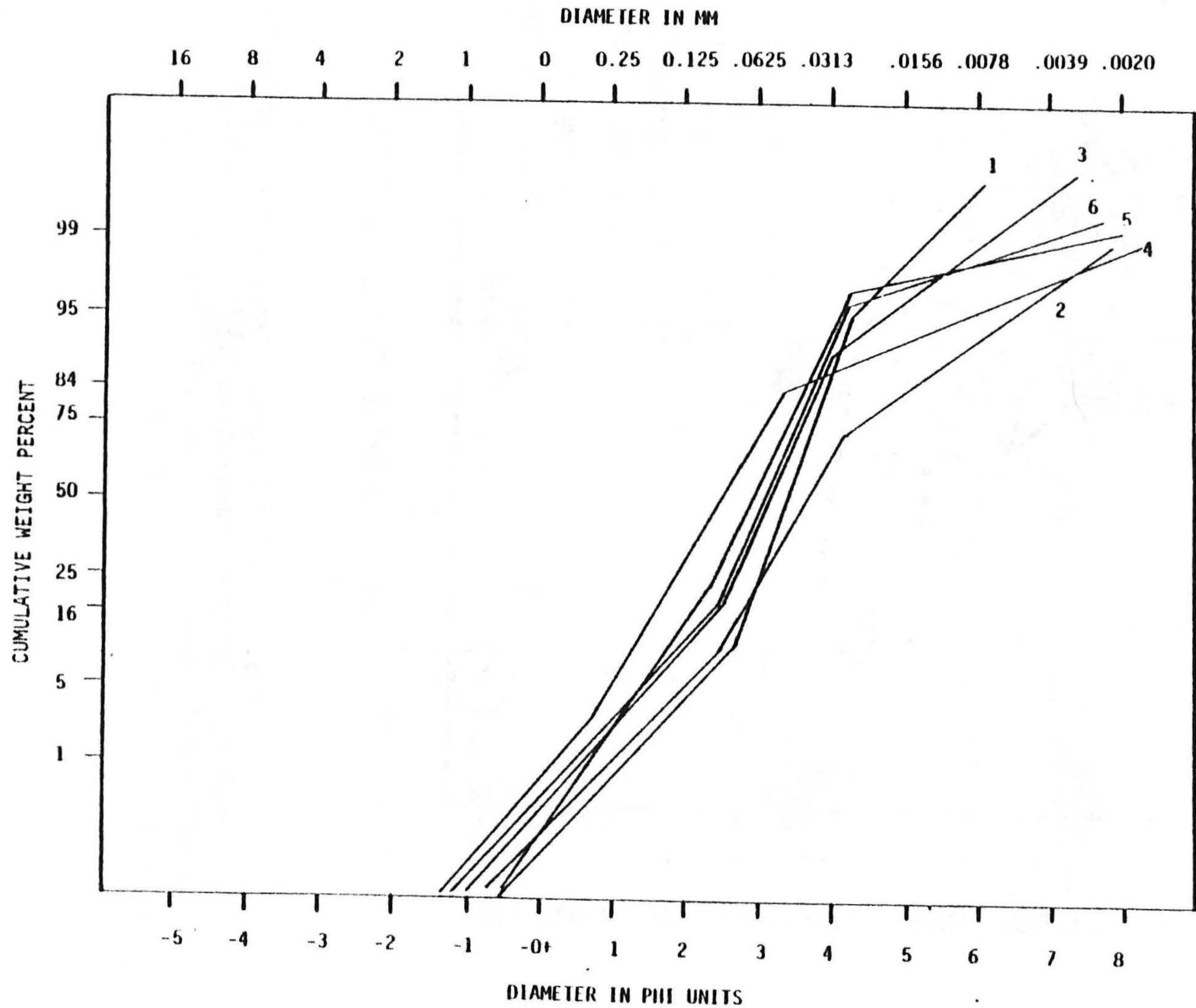


Fig. 15.--Cumulative Grain Size Curves, Carlo Creek Site. Samples 1-6.

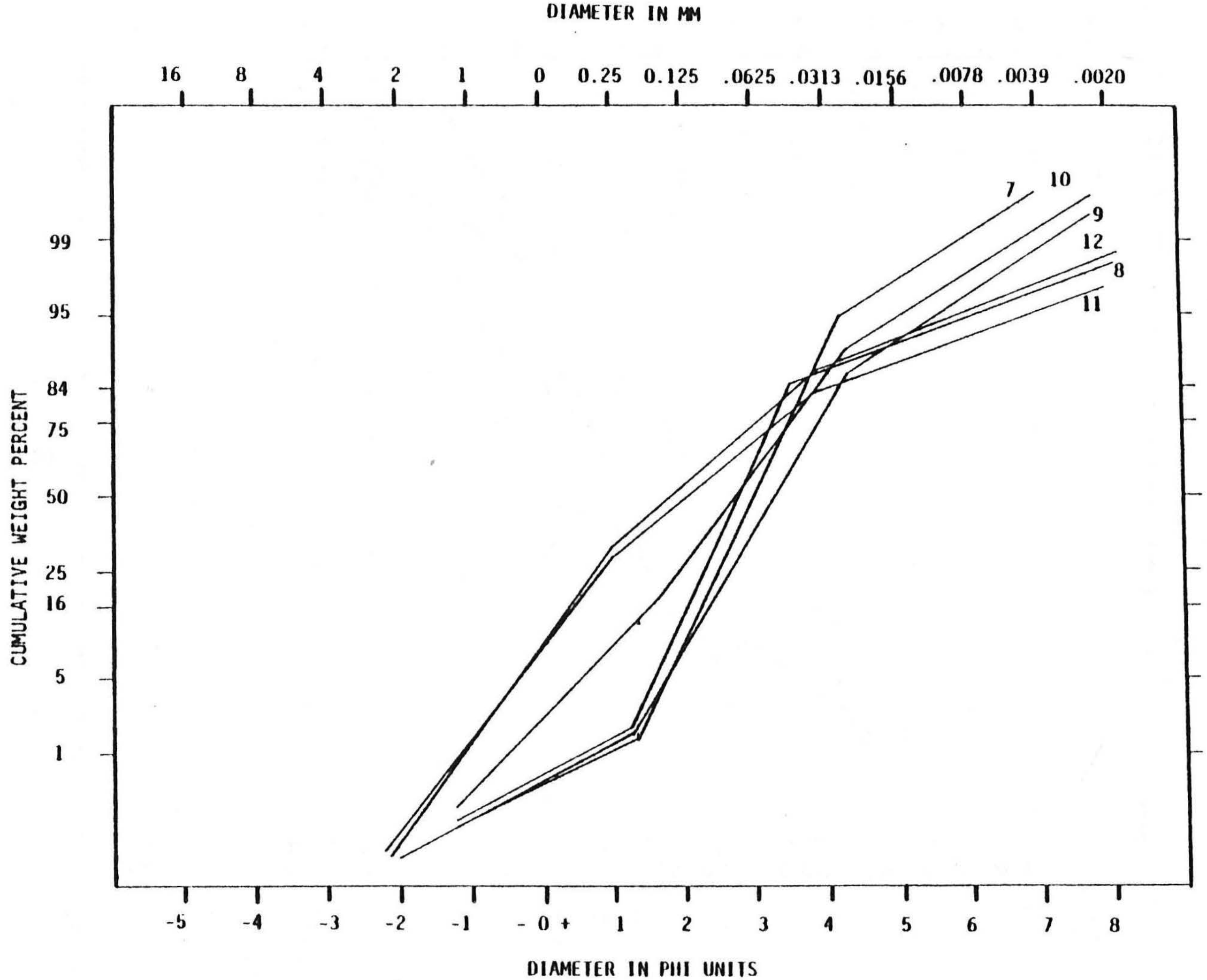


Fig. 15.--Continued. Samples 7-11.

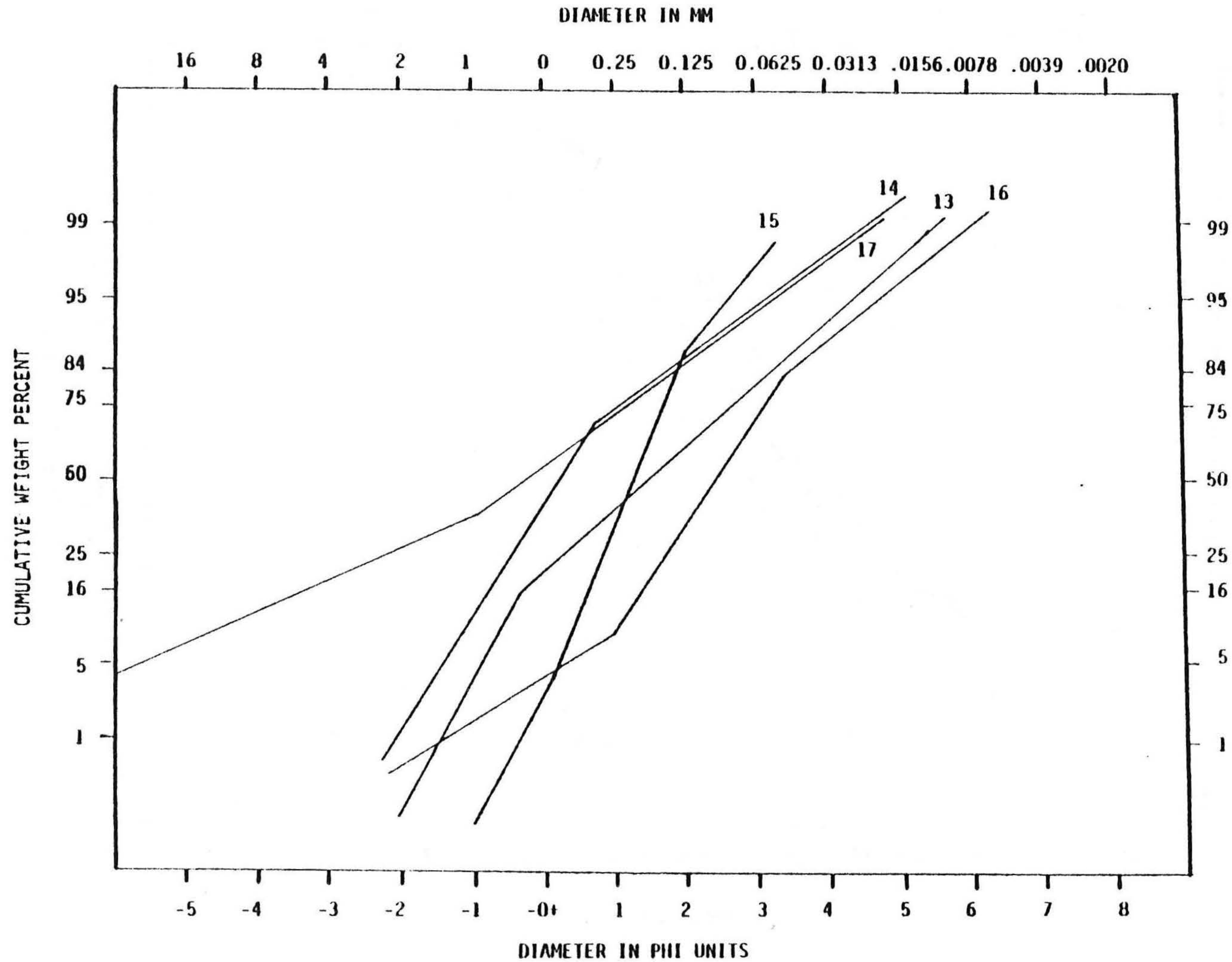


Fig. 15.--Continued. Samples 13-17.

are nearly symetrically skewed, and are mesokurtic to platykurtic. On the basis of field observations and the granulometric data, it can be inferred that these bedded sediments were probably laid down as channel bar deposits. The field data do not indicate the three dimensional geometry characteristic of levee deposits (Allen 1965:146). They do, however, show some interbedded and alternating coarse and fine laminae, another characteristic of levee deposits (Allen 1965). The probably-rapid transition from channel (Unit 1) and bar deposits (Unit 2) in the Carlo Creek may be attributable to westward migration and/or minor downcutting of the channel, away from the site area.

Unit 3 consists of laminated silts and fine sands, which indicates a rather complex micro-stratigraphic sequence of considerable variability. (Cultural Component I occurs at the base of Unit 3; Component II was found within the upper 50 cm of this unit). Median grain size of samples 4 through 10 ranges from 2.6 phi to 4.2 phi (Fig. 12). All samples were either moderately sorted or moderately well sorted. Measures of skewness indicate positively skewed samples (3), negatively skewed samples (2), and nearly symmetrical samples (2). The samples are generally leptokurtic to very leptokurtic. These data, together with the field observations, would tend to indicate an actively aggrading floodplain as the Unit 3 depositional environment. The variability of the samples is attributed to: (1) variation in stream flow velocity during high water stages and (2) eolian reworking of exposed alluvium. A number of authors (Allen 1965, 1970; Leopold et al. 1964) have discussed the complex nature of floodplain environments, where readily available, seasonally replenished overbank sediments are reworked through the action of wind and water.

Also evident in Unit 3 are zones of gleying, mottling and organic accumulations (see Fig. 12 and Table 3). These postdepositional alterations within Unit 3 offer further evidence for a floodplain depositional environment. These features indicate that the early stages of Unit 3 development were marked by long seasonal periods of standing water (ponding) and anaerobic conditions. As indicated on Table 3 and Figure 12, the lower 30 cm of Unit 3 also contains a small percentage of $CaCO_3$, which is probably derived from fossil snail shells occurring in the lower 50 cm of Unit 3.

The uppermost unit at the site, Unit 4, is primarily eolian in origin, although it has also been affected slightly by downslope movement. Unit 4 sediments, with the exception of the tephra unit (Unit 4b), have a median range of 4.1 to 4.5 phi, are moderately to moderately well sorted, are symmetrical to positvely skewed, and are mesokurtic to leptukurtic. The pronounced increase in silt, combined with the good sorting, indicates quite clearly that these deposits are of eolian origin. The cumulative-frequency grain size curve agrees well with curves for Alaskan loess summarized by Péwé (1975b:39).

In interpreting the site stratigraphy, it appears the sedimentary record can be best interpreted in terms of a proglacial braided river sequence, which reflects a change from a channel bed, to a channel bar, to overbank flood deposits. A thin-eolian cap derived from a local source was later deposited on top of the fluvial sequence. Median grain size shows a fining trend upward, with a concommitant improvement in sorting. Based on field observations, granulometric analysis, and C-14 dating, the following explanation is offered for the depositional history of the site. It is recognized, however, that alternate explanations may be equally valid, especially as new data are collected and interpreted.

By approximately 8500 radiocarbon years ago, the Nenana River had incised its valley floor, from a level of approximately 700 m to 620 m.

This incision must have required about 2000 ± 500 years to complete. At least one intermediate terrace (Fig. 9; terrace 3) was formed between the Carlo Creek terrace (terrace 2) and the Riley II (700 m) level surface (terrace 4). By 8500 B.P., an active channel of the Nenana River was depositing channel bed material (Unit 1) at the site locality. These large clasts -- some as large as 0.75 m in diameter -- were deposited while the active channel was at least 18 m above its present level, and while it was at least 0.8 km to the east of its present position.

As the river continued to downcut and migrate westward, the deposition of coarse gravels and sand was replaced by Unit 2 cross-bedded sands. Observations of bed morphology, texture, structure, and statistical parameters of this unit suggest it was laid down as a channel deposit (braided stream), within the proglacial Nenana River system, or possibly as part of a tributary stream flowing from the east.

Eventually, the downcutting and lateral shift of the river reached a point where major bar deposition ceased at the site. A period of relative stability followed -- perhaps as long as 500 years -- which saw incipient soil development (inceptisols) on this exposed surface. At some point during this probably-brief hiatus in downcutting and deposition, the first cultural occupation of the site took place, as represented by Component I (Figs. 10 and 11). Remains of this lower occupation -- lithics, bone and charcoal -- are consistently found to occur within a 5 cm zone above the abrupt unconformity which separates the Unit 2 sands from the overlying Unit 3. This unconformity has been traced for 1.5 km up the valley in roadcut sections morphologically similar to HEA 031 (see Fig. 16). The alteration of the old surface at this level probably represents a paleosol, but may alternatively be explained as drifted-in detrital organics, deposited

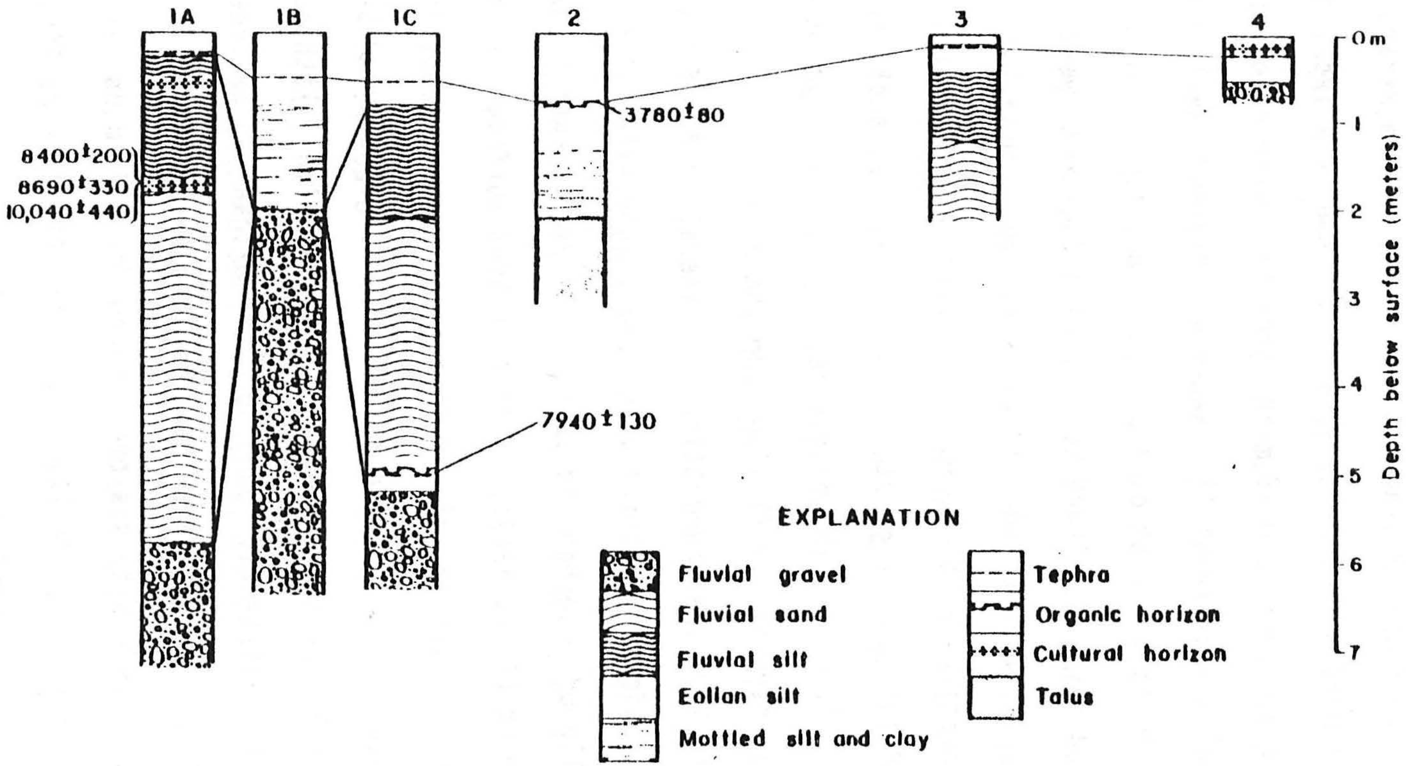


Fig. 16.-- Correlation of Dated Stratigraphic Sections, Upper Nenana River Valley. Refer to locations in Figs. 2 and 9. ADAPTED FROM: Bowers (1979a).

during the early phases of floodplain sedimentation. On the basis of radiocarbon dates and stratigraphic similarities between the Carlo Creek site and Section 1-C (see Fig. 16), located 0.8 km south of the site, it is inferred that the river's halt in downcutting lasted at least 500 years. During much of that time, the main channels of the river were probably in the eastern half of the valley (refer also to discussion in Chapter 5).

After initial human occupation and abandonment of the site, deposition of Unit 3 sand/silt occurred. Unit 3 is a complex micro-stratigraphic sequence, consisting of 3 to 4 m of finely laminated silt, fine sand, and clay. These bedded laminae appear to represent deposition primarily by fluvial processes (aggrading overbank sediments, derived from either the Nenana River or a tributary). To a lesser extent, wind-reworked alluvium is found.

Within the lower 50 cm of Unit 3 is a fairly high concentration of two species of terrestrial molluscs: Succinea sp. and Discus cronkhitei; which are the most likely explanation for the presence of carbonates in the lower 30 cm of Unit 3 (see Table 3 and Fig. 12). Also contained within Unit 3 sediments is evidence of a second, albeit brief, human occupation. Component II of the Carlo Creek site is located about 1 m below surface, 1 m above the Component I level, and 80 cm below the top of Unit 3. This horizon consists of a small amount of lithic debris, and suggests a short period of human occupation. At the time of Component II occupation, the site was probably within an actively-aggrading floodplain.

Between Units 3 and 4 is a distinct unconformity. Unit 4 represents the uppermost 30 cm of the profile, and was most likely formed by eolian actively, through the reworking of locally available alluvium. The eolian origin of this unit is suggested by its relatively massive structure (as opposed to the laminated silt/sand of the underlying Unit 3), by its relatively better sorting, and by a noticeable increase in the percentage of silt in the sediments. Unit 4 includes the zone of modern soil development at the site, as well as several diffuse paleosols. Modern soils at the site are Subarctic Brown Forest Soils (orthods) which are common in the boreal forests of interior Alaska.

Unit 4 has been subdivided into three subunits (a, b, and c), to include a discontinuous lens of volcanic ash (Unit 4b) which is found about 20 cm below surface. Unit 4b, which has been correlated (Fig. 16) with the recently reported "Cantwell Ash Bed", (Bowers 1979a) is radiocarbon dated to slightly less than 3780 ± 80 years: 1830 B.C. (WSU 1747). The Cantwell Ash has been previously described in terms of distribution, age, morphology, petrology, mineralogical composition, and refractive index of glass shards (Bowers 1979a).

The date of 3780 B.P. for the deposition of Unit 4b provides an approximate age for the beginning of Unit 4a deposition. Such a date accords well with similar basal dates on loess sections and peat caps in central Alaska (Hamilton and Robinson 1977; Hamilton 1973). Extensive loess accumulation and peat formation may be due to the effects of late Holocene Neoglaciation and cooling, which has been widely recognized in alpine regions of Alaska. Hamilton and Robinson (1977:1003) suggest that the interval of about 4500 to 3500 B.P., climaxing at about 3000-2500 B.P., was "...marked by alluviation of glacier-fed streams, widespread accumulation of peat, intensified ice-wedge growth, and solifluction...." Hamilton (personal communication, 1978) has suggested that, in the Carlo Creek area, large amounts of coarse-grained gravel fed into the Nenana River system would tend to decrease or stop the river's downcutting. This in turn could cause a cessation of slope steepening and of erosion, as well as renew deposition on the site through the accretion of readily-available sand and silt from the exposed floodplain. This period of slow cliff-head loess deposition has continued up to the present time.

In addition, the fact that the tephra increases in abundance as one digs into the hillside (away from the bluff exposure) indicates that the hillslope morphology at the site was established in more or less its present configuration by at least 3700 radiocarbon years ago. The thickening of the ash into the hillside suggests that ash deposited nearer the bluff edge was subsequently translocated by eolian activity, whereas the ash farther in the hill was somewhat better protected from wind.

The ensuing 3000-4000 years at the Carlo Creek site have probably been marked by minor deposition of airborne particles derived from the Nenana River floodplain, lateral incision of the bluff to the north by Carlo Creek and to the south by gulleying (see Fig. 10), and erosion of the western part of the site by the Nenana River. Podzolization, humus accumulation, and other soil processes have undoubtedly been active.

The major postdepositional alteration which has affected the site appears to have been a westward dipping of the deposits due to mass movement. In places, (e.g., closest to the bluff edge) this dip is as great as 20 to 25 degrees. A likely explanation for this deformation is that the northward-flowing Nenana River truncated the hillside at Carlo Creek, which initiated a gradual downslope movement of the sediments. An important observation to be made in this regard concerns the three dimensional geometry of the site stratigraphy: as one digs eastward into the hillside, away from the river, the dip angle of the laminae decreases. This, coupled with the fact that microfaulting increases in a westward direction toward the bluff edge, suggests that the 20 to 25 degree dip can be best explained as a secondary deformation, rather than as a primary deposit such as an alluvial fan. There is no evidence to suggest that these deformations have significantly altered the relative intrasite spatial relationships of cultural and faunal remains. There were no other major observable deformations due to frost activity, such as cyroturbation features, ice wedges, or solifluction lobes, nor did it appear that forest activity (e.g., tree fall) significantly altered the deposits.

The final major alteration which affected these strata was the construction work of the early 1970s which first exposed these sections. It is not known how much of the site's sedimentary and cultural record was destroyed as a result of these activities.

CHAPTER 4

CULTURAL COMPONENTS

Component I

As I have discussed in the preceding chapter, two distinct cultural components were discovered during the excavations of the Carlo Creek site. Of these two, the lowermost (Component I) has produced the most significant cultural data.

On the basis of the known distribution of cultural materials, the Carlo Creek Component I occupation appears to have been that of a small group. The entire known horizontal area covered by Component I human debris is 10 m x 5 m. This does not necessarily represent the boundary of the Component I level, because the western part of the site was destroyed during highway construction, and excavation into the eastern portion of the hill was restricted by manpower limitations, frozen ground, difficulty in disposing of backdirt, and problems of shoring unconsolidated sediments.

The vertical range from which materials were recovered in the lower component was less than 5.0 cm. Materials were found to occur either directly on the surface of Unit 2 sands, or within the paleosol which makes up the basal 5 cm of Unit 3 floodplain silts and fine sands (see Fig. 11). It is evident that the cultural materials were deposited directly on the surface of Unit 2 sands and later incorporated into the organic layer which formed on this stabilized surface. The horizontal distribution of cultural materials--bone, charcoal, and lithics -- indicates they are clearly associated with two hearth areas (see Figs. 17 and 18). Based on stratigraphic and radiocarbon dating evidence, it is believed that these two features are closely contemporaneous, most likely related to the same occupation.

The first hearth encountered during the 1976 excavation season is designated as Hearth 1 (Fig. 18). Lithic debitage, ground squirrel bones, caribou and sheep bones are scattered in and around this feature, covering an area of about 4 x 5 m, and centered at a point about 2 N, 0.5 W. The exact limits of the hearth were difficult to define; charcoal was concentrated in an oval configuration measuring approximately 1.5 m x 0.75 m. Most of the charcoal appeared as small pieces, with a few well preserved twig-sized pieces (willows?) measuring as large as 4 x 1 cm. Most of the Hearth 1 was apparently built directly on the ground surface, with little evidence of intrusive pits. However, there is one part of the hearth, designated Feature 1 (see stratigraphic section, Fig. 11), which was unquestionably dug into the underlying sediments, causing local disturbance of the sedimentary contact between Units 2 and 3. This feature will be dealt with in Chapter 6, in the discussion of possible thermal alteration of lithics. Whether or not the observed scattering of charcoal in the Hearth 1 area reflects aboriginal activities is equivocal; it is possible that post-occupation seasonal flooding or even wind could have caused a minor scattering of charcoal. Judging by the northwest to southeast trend in the axis of the charcoal, the expected direction of a paleo-flood current, this is a definite possibility. The amount of charcoal displacement, however, was probably less than 0.5 m. Two charcoal samples have been dated from Hearth one: 8400 ± 200 radiocarbon years: 6450 B.C. (WSU - 1700), and 10,040 ± 440 radiocarbon years: 8090 B.C. (GX-5131).

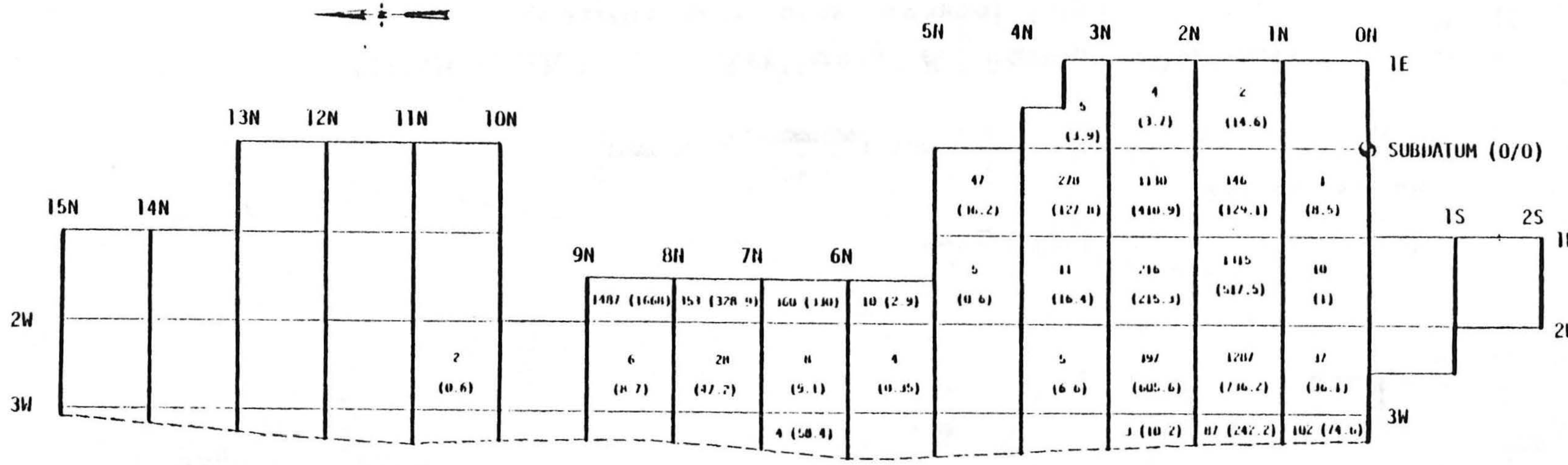
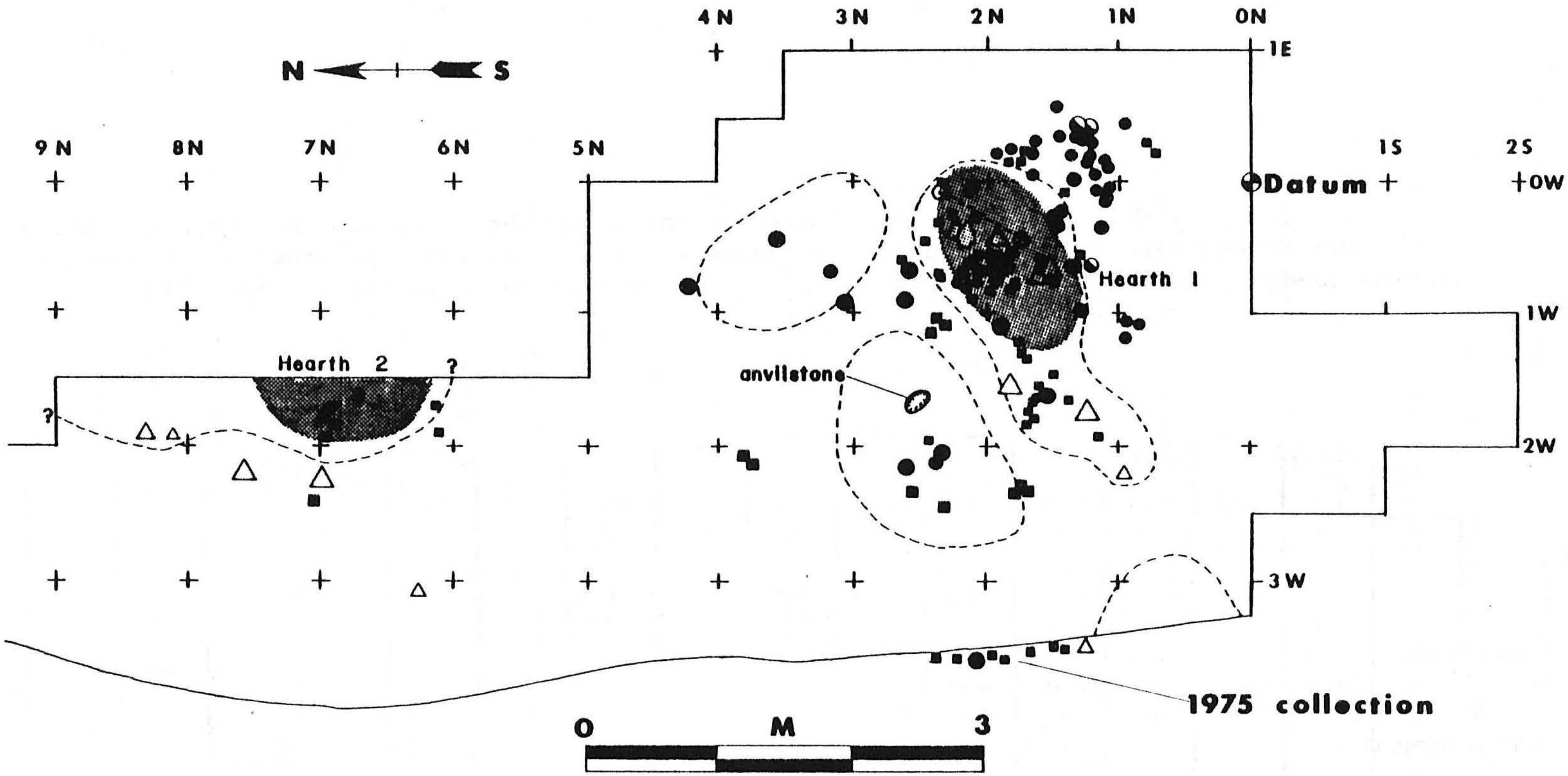


Fig. 17.--Limits of Excavation and Flake Distributions for Component I. Upper numbers within squares indicate total count per one meter square; numbers in parentheses indicate weight in grams per one meter square. Refer to site topographic map, Fig. 4.



COMPONENT 1 · Artifacts & Faunal Remains

LEGEND:
- · Large mammal bone
- · Citellus bone
- · Biface
- · Blade fragment
- · Cranial frags.
- · Possible bone tool
- · Flake concentration

Fig. 18.--Component I: Distribution of Artifacts, Faunal Remains, and Hearths. Refer to site topographic map, Fig. 4.

The scattering of faunal and lithic remains about Hearth 1 can be interpreted as indicating an activity-specific locus, representing two major activities: bone processing/butchering, and biface reduction. As illustrated in Figures 17 and 18, lithic debitage and associated biface fragments appear to cluster into at least four groups. Judging by the quantities of flake debris and broken, unutilized bifaces scattered in this area, these remains probably represent several separate biface - reduction "events", closely spaced in time, as opposed to a single flintknapping activity. As discussed in Chapter 6, these prehistoric actions were probably aimed at producing "tools of the moment", which could be quickly manufactured from local materials, and which could have quickly been put to use in butchering/bone processing. Several biface fragments, as well as 3 fragments of a large prismatic blade, were found within the limits of Hearth 1, suggesting they may have been "tossed" in, perhaps in a manner similar to that described by Binford (1978b). Also located in the activity area surrounding Hearth 1 are two possible bone points (see Fig. 22), which may have been brought into the site within the carcass of a caribou or sheep that had been killed nearby.

There are two major concentrations of fragmentary and splintered bone remains (see Fig. 18) in the Hearth 1 area, one located in squares 1-2 N, 0-1 W and 2-3 N, 0-1 W, and the other in 1-2 N, 0-1 E. It is suggested that these represent butchering, marrow extraction, and/or bone grease preparation areas (see discussion in Chapter 7).

A cobble manuport (Fig. 20) located in square 2-3 N, 1-2 W, is interpreted as having served as an anvilstone on which some of these bones were broken. (The reader is referred to excellent discussions of bone alterations by human agencies in Bonnichsen 1973, 1978, 1979;

Binford 1978a; and Sadek-Koors 1972). This specimen does not exhibit any battering on the margins, which would alternatively suggest its use as a hammerstone; this had been the original interpretation (Bowers 1977a:12). It does not lie in direct association with the nearest splintered faunal remains. It is thus quite probable that this manuport was discarded into the "toss zone" of site use in a manner described ethnographically by Binford (1978b).

A second hearth area (Fig. 18) was partially excavated near the end of the 1977 field season. This feature, located primarily in the western half of square 6-7 N, 1-2 W, appears to be of roughly the same size as Hearth 1. The eastern portion of the feature was not excavated. There are no indications that Hearth 2 was excavated into Unit 2 sediments; conversely, it was probably built directly on the surface of Unit 2 sand surface. There are no major bone-processing areas associated with this feature, except for a few scattered ground squirrel teeth and mandible fragments. The heaviest concentration of lithic debris in the site, 1487 flakes per m^2, occurs within 1 m to the north of Hearth 2 (Fig. 17). The distance from Hearth 2 to Hearth 1 is 4.5 m. The one radiocarbon date from this feature indicates that it is closely contemporaneous with Hearth 1: 8690 ± 330 radiocarbon years: 6740 B.C. (GX-5132).

There is no evidence in Component I for structural features, burials, or cache pits. Except for the suspected heat-treatment pit in Hearth 1, there is little evidence for surface (i.e., top of Unit 2) disturbance by the site's prior occupants.

Component I: Lithic Artifacts

The lithic artifacts from the lowermost cultural level at Carlo Creek are described individually in the following section, and are summarized in Table 4. Observations concerning possible cultural affiliations with these specimens are reserved for Chapter 9.

UA 76 212 1 (Fig. 19, H), is a biface fragment of very dark grey (Munsell value = 3) argillite. The specimen is broken by a transverse fracture, possibly due to endshock. Considerable stepping and hinging is evident on both faces. There is no discernible use-wear or intentional platform preparation on the lateral margins. Flaking technology was most likely by direct freehand percussion, as indicated by the non-patterned flake scars. The artifact is bi-convex in cross-section, with fairly symmetrical lateral margins. Length: 912 cm (broken); width: 6.0 cm; thickness: 1.9 cm; weight: 119.2 gm; provenience: 6.98 N, 2.22 W; 230 cm below subdatum (B.D.).

UA 75 11 9 (Fig. 19, G) is a biface fragment of very dark grey (Munsell value = 3) hornfels. It was broken transversely, by a perverse (helical) fracture. The blow which caused breakage was probably delivered to the right-hand margin. Stepping and hinging is evident, but not pronounced. Only minor flaking is evident on the ventral surface, giving the specimen a nearly-unifacial appearance. Technology was probably direct freehand percussion. There is no indication of intentional platform preparation, and no indications of use wear. Morphologically, this artifact is asymmetrically bi-convex in cross-section, with an asymmetrical outline. Length: 8.5 cm (broken); width: 6.7 cm; thickness: 2.1 cm; weight: 121.1 gm; provenience: found in roadcut at level of unconformity (unit 2/3 contact); approximate coordinates: 1-4 N, 3-4 W.

TABLE 4

COMPONENT I ARTIFACTS

Catalog #	Description	Inferred Function	Material	Figure Reference
UA-76-212-1	biface fragment	preform	argillite	19-H
UA-75-11-9	biface fragment	preform	hornfels	19-G
UA-76-121-2	cobble manuport	anvilstone	gabbro	20
UA-77-61+62+63	prismatic blade-like-flake	knife (?)	hornfels	19-A
UA-77-64-125	biface fragment	biface trimming flake	argillite	19-F
UA-77-3+4	biface	knife (?)	argillite	19-B
UA-77-64-2	biface	preform	hornfels	19-D
UA-77-64-1+317	biface	handaxe/ chopper (?)	argillite	19-I
UA-76-212-105	biface fragment	preform	argillite	19-E
UA-76-212-400	biface fragment	preform	argillite	not illustrated
UA-77-64-79	biface fragment	scraper (?)	argillite	19-C
UA-76-212-385	retouched flake	scraper (?)	argillite	not illustrated
UA-76-212-172	retouched flake	scraper (?)	argillite	not illustrated
UA-77-64-5	tabular flake	flake core (?)	argillite	21
UA-77-64-7	caribou vestigial metacarpal	awl (?)	bone	22-C
UA-77-64-33-A	bone point	projectile point tip (?)	bone	22-A
UA-77-64-33-B	bone point	projectile point tip (?)	bone	22-B

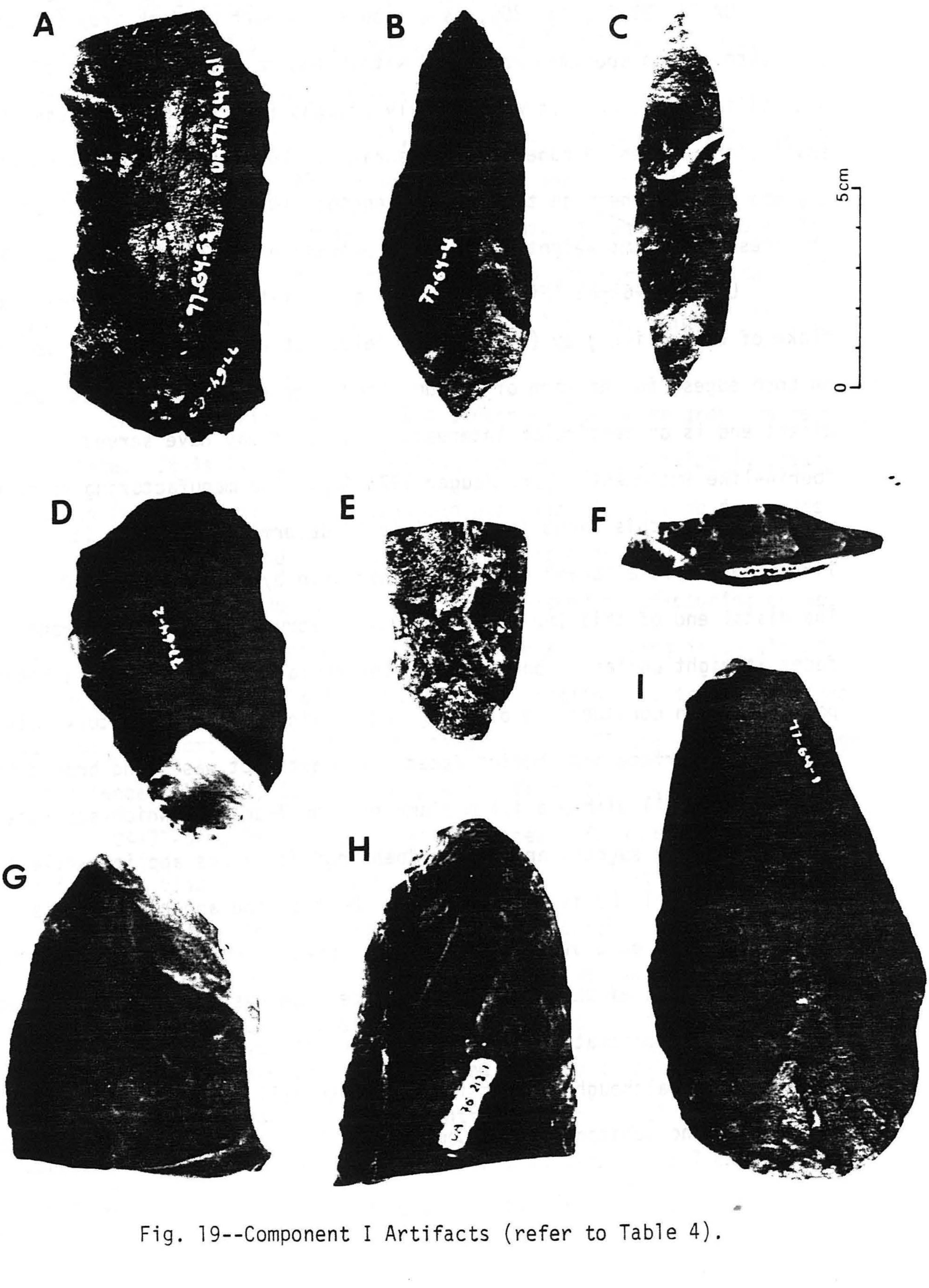


Fig. 19--Component I Artifacts (refer to Table 4).

UA 76 121 2 (Fig. 20), is a cobble manuport of dark grey (value = 3) gabbro. This specimen was found within the main concentration of Locus A argillite debitage. It was probably brought into the site for use as an anvil stone, on which bone could be smashed. There is little indication of any use wear anywhere on this rock. Length: 10.2 cm; width: 9.1 cm; thickness: 4.2 cm; weight: 630.7 gm; provenience: 254 N, 1.64 W; 223 B.D.

UA 77 61+62+63 (Fig. 19, A), is a prismatic blade or blade-like flake of dark olive grey (5YR3/2) hornfels. It exhibits possible use wear on both edges, in the form of medium sized step and feather fractures. The distal end is of particular interest, in that it may have served as a "burin-like implement" (cf. Mauger 1970:46). The manufacturing technique which produced this facet is impossible to determine, although it was most likely formed as a "snap" fracture rather than by a deliberate burin blow. The distal end of this implement terminates abruptly, forming a transverse facet at right angles to both faces. The surface of this facet is heavily polished, with considerable blunting and polishing of the juncture between the ventral surface and "burin" facet. The artifact was found broken in three pieces, all within a 1.5 m diameter; the fractures which separated the three pieces suggest an extreme "bending" force was applied while the implement was held by its proximal end. Most of the apparent wear is on the ventral side edge of the "burin like" facet. The length of this facet is 3.5 cm, with a width of 0.8 cm. The specimen has nearly parallel lateral margins, and is prismatic in cross section. It may have been struck off a prepared core, although this is impossible to tell from the piece itself, and there is no debitage in the Component I level which would indicate a macrocore and blade industry. Length: 10.75 cm; width: 4.9 cm; thickness: 1.5 cm; weight: 87.0 gm; provenience: 1.75 N, 0.45 W, 193 B.D.; 1.95 N, 0.68 W, 187 B.D.; 2.35 N, 0.8 W, 186 B.D.

UA-77-64-125 (Fig. 19, F), is a biface fragment of very dark grey (value = 3) argillite. It was not utilized, and represents a large biface trimming flake. The specimen has a fresh-looking ventral surface, and possesses considerable stack-step fracture on the margin (due to manufacture). Length: 7.5 cm; width: 4.6 cm; thickness: 1.55 cm; weight: 51.5 gm; provenience: 8.35 N, 1.97 W, 192 B.D.

UA-77-3+4 (Fig. 19, B), is a biface of very dark grey (value = 3) argillite. It is bi-convex in outline and nearly lenticular in cross section (asymmetrical). This specimen exhibits minute step fractures along one lateral margin, and could have been utilized briefly as a knife. There is possible edge-damage on the tip, due to either manufacturing or use. It is only slightly modified on the ventral surface, giving it an almost unifacial appearance. It is broken in mid section by a transverse fracture. Length: 11.0 cm; width: 3.85 cm; thickness: 1.25 cm; weight: 50.5 gm; provenience: 1.67 N, 0.81 W, 192 B.D.; 1.55 N, 0.72 W, 192 B.D.

UA-77-64-2 (Fig. 19, D), is a biface/preform of hornfels. Color varies from black (value = 0) to greyish brown (2.5 YR 5/2). It is ovate in outline, with a thick asymmetrical cross section. This particular material type is the finest grained, hardest, and densest material found in the Component I level of the site. It was found in Feature 1, within Hearth 1, and may have been heat treated. It is crudely flaked by direct percussion, and possesses some remnants of the original river-cobble cortex surface. Length: 8.7 cm; width: 5.2 cm; thickness: 2.7 cm; weight: 122.5 cm; provenience: 1.92 N, 0.45 W, 184 B.D.

UA-77-64-1 + 317 (Fig. 19, I), is a large biface of very dark grey (value = 3) argillite. It has a hand-axe like appearance, although that does not necessarily imply function. It is bi-convex in form, with a thick diamond shaped cross-section. Large, wide percussion flakes have been removed from both faces. The distal end has considerable minute stack-step fracturing; however, no striations can be seen at 70X magnification. This implement could have been utilized briefly, perhaps in bone processing activities. Length: 13.15 cm; width: 6.8 cm; thickness: 4.3 cm; weight: 384.8 gm; provenience: 2.15 N, 0.38 W, 184 B.D.; 2.35 N, 0.15 W, 186 B.D.

UA-76-212-105 (Fig. 19, E), is a biface fragment of very dark grey (value = 3) argillite. It was broken along cleavage planes on all but one side. It does not show indications of edge-damage, intentional or otherwise. One small segment of reddened cortex is present. Length: 55.0 cm (broken); width: 37.1 cm; thickness: 1.6 cm; weight: 39.9 gm; provenience: 1.47 N, 1.63 W, 22 B.D.

UA-76-212-400 (not illustrated), is a small biface fragment of very dark grey (value = 3) argillite. It was broken via a helical (perverse) fracture. Length: 6.55 cm (broken); width: 2.1 cm; thickness: 1.3 cm; weight: 28 gm; provenience: 7.60 N, 2.22 W, 237 B.D.

UA-77-64-79 (Fig. 19, C), is a biface fragment of very dark grey (value = 3) argillite. It is bi-convex in outline, with a thick triangular cross section (broken) The specimen exhibits miniature step fractures along a 2.8 cm portion of one margin, beginning at a point 1.0 cm down from the tip. Although it was broken longitudinally when it was detached from the parent piece, it does show some edge damage on the dorsal side margin (right hand side in Fig. 19, C), which would have had to be created after the fragment had been detached. It may have been utilized briefly as a scraping implement; this is further suggested by minor rounding and polishing of edges. At a 70X magnification, no polish or striations are observable. Length: 9.79 cm; width: 2.62 cm; thickness: 1.35; provenience: 8.12 N, 1.95 W, 200 B.D.

UA-76-212-385 (not illustrated), is a possibly-retouched flake of very dark grey (value = 3) argillite. It is roughly ovate in outline with an asymmetrical cross section. Edge damage occurs along 3.1 cm of the distal end, which may indicate use as an end scraper. At 70X magnification, no polish or striations are visible; however, there is a slight rounding of the point of juncture between adjoining flake scars. Length: 6.7 cm; width: 5.4 cm; thickness: 1.1 cm; weight: 39.0 gm; provenience: 6.27 N, 3.10 W, 216 B.D.

UA-76-212-172 (not illustrated), is a possibly retouched flake of very dark grey (value = 3) argillite. It is roughly ovate in form, nearly prismatic in cross section, and possess one dorsal ridge. There is some minor edge damage on a 1.7 cm segment of the distal end of this specimen, suggesting possible function as an end scraper. Microscopic examination revealed no striations or polish, and only minor rounding of the edge. Length: 4.2 cm; width 3.1 cm; thichness: 0.5 cm; weight: 7.8 gm; provenience: 2.05 N, 1.50 W, 226 B.D.

UA-77-64-5 (Fig. 21), is a large, unmodified tabular flake. It is composed of very dark grey (value = 3) argillite or hornfels. It is illustrated primarily to describe the nature of some of the quarried raw material brought into the site from the probably quarry source located approximately 1.0 km away from the site. It has not been shaped into any preform or quarry blank form. It was found within Feature 1, the suspected

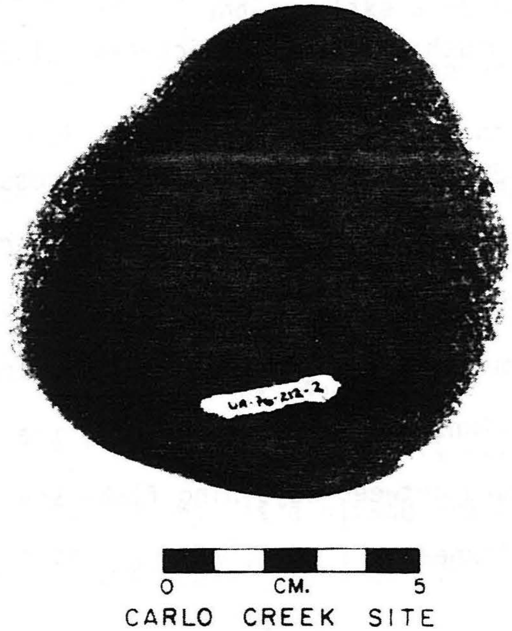


Fig. 20.--Cobble Manuport, Component I.

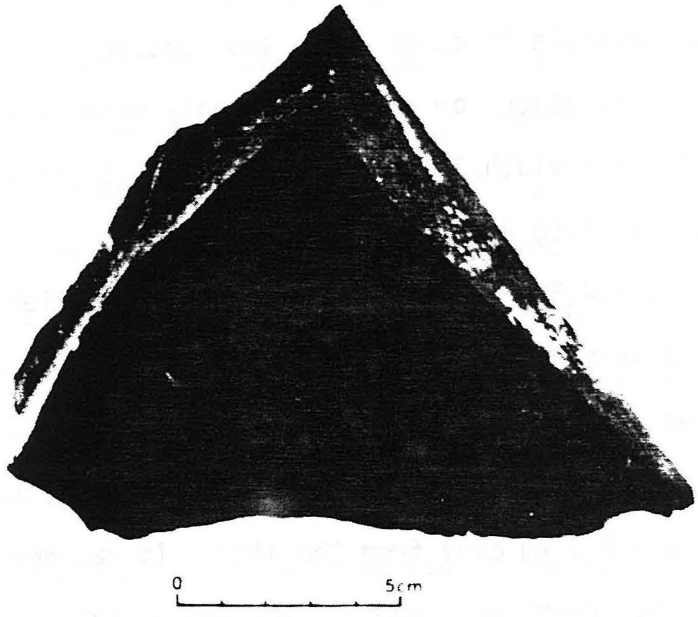


Fig. 21.--Large Tabular Flake, Component I.

heat-treatment pit, and was directly associated with UA-77-64-2. Length: 15.1 cm, 12.4 cm, 5.4 cm; weight: 586.7 gm; provenience: 2.18 N, 0.35 W, 182 B.D.

Component I: Possible Bone Tools

It is not possible to state with certainty that any of the specimens listed below actually functioned as organic artifacts. There is little that is diagnostic about any of these specimens to suggest they were used by man, except for form and possible indications of intentional shaping. However, each of them exhibits one or more morphological characteristics which suggests they could have served as bone artifacts during the Component I human occupations of the Carlo Creek site.

UA-77-64-7 (Fig. 22, C), is a caribou vestigial (second) metacarpal. It is slightly damaged on the distal end, a feature which could be due to either post-depositional damage or utilization as an awl. Length: 7.81; width: 0.93 cm, 0.64 cm; weight: 2.4 gm; provenience: 1.32 N, 0.65 W, 195 B.D.

UA-77-64-33-A (Fig. 22, A), is a small bone point (species unknown), probably derived from a long bone. It exhibits a slight polishing on the pointed end, which may be due to intentional modification. Length: 3.42 cm; width: 0.86 cm; thickness: 3.6 cm; weight: 0.5 gm; provenience: 1.34 N, 0.37 E, 176 B.D.

UA-77-33-B (Fig. 22, B), is a small bone point, virtually identical to the one described above. It was found within 1 cm of the pointed bone object described above. Length: 4.2 cm; width: 0.71 cm; thickness: 0.43 cm; weight: 0.6 gm.

UA-76-212-358 (not illustrated) is a small pointed fragment of wood (species unknown). It exhibits no evidence of modification, and may be

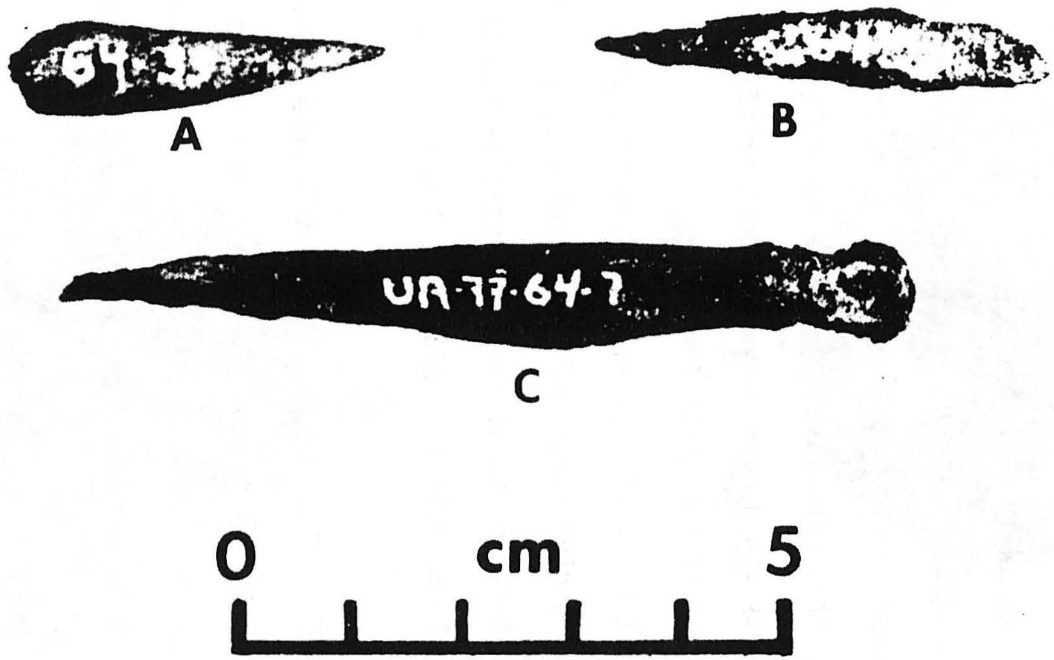


Fig. 22.--Component I: Possible Bone Tools (refer to Table 4).

intrusive into the Component I level. It was found during the screening of Component I backdirt, hence its occurrence within the Component I level is suspect. Length: 3.0 cm; width: 0.41 cm; thickness: 0.41 cm; weight: 0.3 gm; provenience: backdirt from square 3-4 N, 0-1 W.

Component II

As previously discussed, a small lithic component (Component II) was located in the upper part of Unit 3 (see Figs. 10 and 11). An oval-shaped distribution of rhyolite waste flakes approximately 1.5 m by 1 m in size constitutes this cultural level. The total assemblage from the upper component consists of 637 lithic waste flakes. Based on the small size of this concentration, these appear to have been the result of the activities of a single flintknapper for one brief point in time (see Fig. 23).

There is little doubt that Component I and Component II are the result of distinct occupations. Component II occurs stratigraphically approximately 1 m above the Component I level and it is separated horizontally from the nearest cluster of Component I materials by about 3 m. No organic materials of any kind were recovered from Component II, nor are there any indications of any features. Lithic materials from Component II are of white rhyolite, as opposed to the dark grey argillite/hornfels of Component I. As illustrated in Fig. 23, these flakes are tightly clustered, and occur in only one small locus within the upper cultural level.

The physical setting at the time of the second Carlo Creek occupation was probably similar to that of the Component I occupation, except that the Component II flintknapper was probably situated further back on the flood-plain (relative to the river) than were the hunters of the Component I occupation. The Component II assemblage occurs stratigraphically entirely within Unit 3 laminated silts and fine sands.

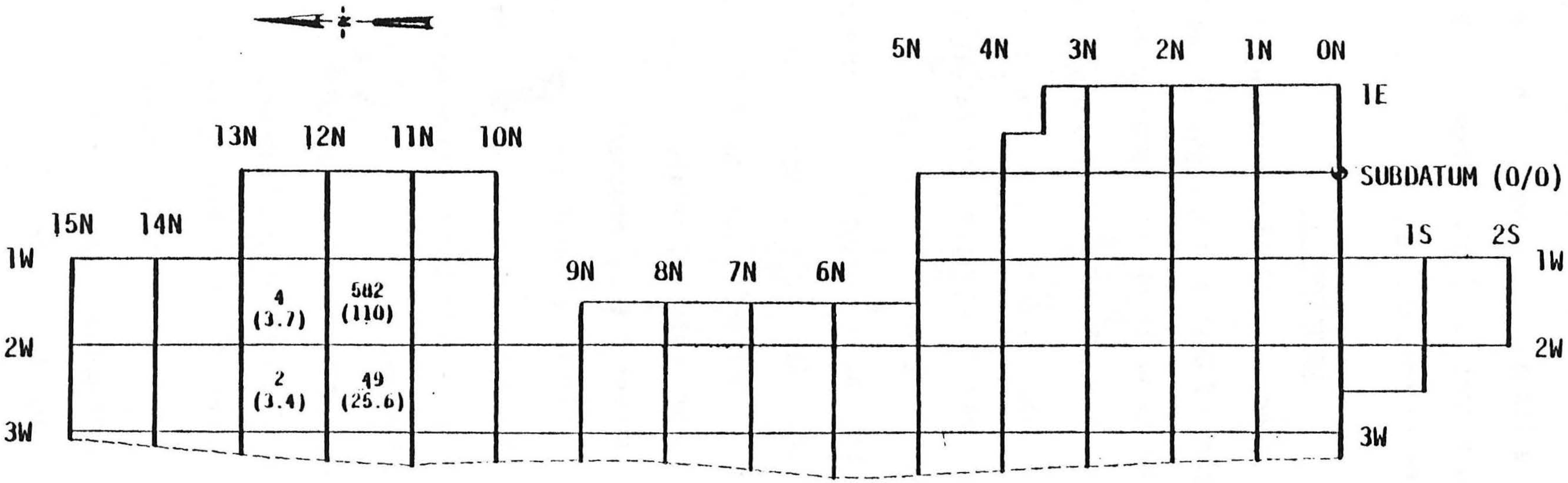


Fig. 23.--Component II: Distribution of Lithic Debitage. Upper numbers within squares refer to total count per one meter square; numbers in parentheses refer to total weight in grams per one meter square. Refer to site topographic map, Fig. 4.

CHAPTER 5

DATING

Radiocarbon Dates Relative to Cultural Occupation

Pursuant to the research of the Carlo Creek site, a total of six radiocarbon samples were dated. Two apply to geological contexts away from the site proper. The four dates that pertain to the cultural occupation will be discussed first. A summary of radiocarbon dates from the Carlo Creek Site and Carlo Creek region is presented in Table 5; the stratigraphic relationships of these samples are illustrated in Figure 16.

All four of the culturally-related samples were collected from the Component I level. All of these are from within 5 cm (at or above) the contact between natural stratigraphic Units 2 and 3. Two of these four dates, obtained from two different radiocarbon laboratories, match within one standard deviation, and offer good evidence for an approximate date of 8500 B.P. for the age of the Component I level. Except for WSU 1727, the four Component I radiocarbon samples are all derived from culturally-deposited charcoal.

Two of these four samples appear to be anomalous. Sample WSU 1727, which is approximately 3380 years younger than the inferred 8500 year age of Component I, was obtained through the combination of eight separate soil humic acid samples from the Component I level. The sample was run primarily as a "back up" and cross-check on the charcoal samples from the same level. The young date is not too surprising in light of the 2-3 m of floodplain

TABLE 5

SUMMARY OF RADIOCARBON DATES FROM THE CARLO CREEK AREA

Location	Date (B.P.)[a]	Lab. No.	Material	Significance
Carlo Creek Site, Component I level, lower paleosol at base of Unit 3.	8400 ± 200	WSU 1700	Charcoal	Hearth #1. Dates Component I occupation
	8690 ± 330	GX 5132	Charcoal	Hearth #2. Dates Component I occupation
	10,040 ± 435	GX 5131	Charcoal	Hearth #1. Date appears too old -- see discussion in text
	5120 ± 265	WSU 1727	Soil humic acid	Average of many soil samples. Date is anomalously young -- probably contaminated by groundwater humic acids.
Roadcut, loc. 0.5 mile south of Carlo Creek site	7940 ± 130	WSU 2148	Wood and peat	Sampling locality 1-C (see Fig. 16). Stratigraphy identical to HEA 031. Sample dates transition from Unit 1 channel gravels to Unit 2 braidbar sands. Sample collected 45 cm above Unit 1-2 contact.
Cantwell Ash Bed type locality, mile 218.3 Parks Highway	3780 ± 80	WSU 1747	Wood	Sample collected 0.5 cm below tephra layer, at a depth of 73.5 cm below surface (Bowers 1979a).

[a]All dates expressed in terms of Libby half life (5570 ± 30 years).

sediments which overlie the level. The possibility is quite good that the organic (humic acid) fraction of these samples was contaminated by more recent additions of humic acids transported by groundwater. Numerous studies have documented these types of problems associated with soil dating (Campbell et al. 1967; Davies 1971; Goh and Malloy 1972; and Goh et al. 1977:177-196).

The 10,040 year date derived from sample GX 5131 is somewhat more puzzling to interpret. According to H. Krueger of Geochron Laboratories (personal communication, 1977) this sample was quite small, amounting to less than 0.5 gm after combustion. It was necessary to dilute it and was subsequently counted in Geochron's smallest counter. The sample size, in and of itself, should not have thrown the age off by the apparent 1540 years indicated. The sample was charcoal, and from the same hearth that yielded the site's "best" date: WSU 1700. One factor which should be considered is the possible contamination of the sample by detrital fragments of coal or lignite, both of which are present in small amounts in the Cantwell Formation (Wahrhaftig 1958). A similar problem was apparently encountered with the dating of the Dry Creek Site, located 35 km down valley from Carlo Creek (Thorson and Hamilton 1977; Powers and Hamilton 1978).

As pointed out by both Stuckenrath (Adovasio et al. 1978:153) and Sheppard (1975, 1977:5) it would require a significant volume of contaminant in a sample to significantly alter its true age. However, the fact that this was a small sample, with resultant high counting error, would make the sample more susceptible to contamination.

Another, but less likely explanation in these apparent inconsistencies may be differences in laboratory analytical techniques. An example of this problem occurred when a series of three paired samples (see Table 1) from the Healy Lake site, east-central Alaska, yielded paired dates that differed by 1575, 255, and 1565 years between determinations made by Geochron Laboratories and the Smithsonian, with the Geochron dates consistently younger (Péwé 1975a, Table 4; Cook, personal communication, 1979).

Taken together, however, these four samples indicate an approximate age of 8500 B.P. for the Component I occupation level. In an earlier report (Bowers 1978a:7) I attempted a weighed average of all samples, following a technique developed in Long and Rippeteau (1974:208). The result of this average was 8487 ± 260 B.P. However, I now feel that it would be most prudent to reject altogether samples WSU 1727 and GX 5131, the youngest and oldest dates. The fact that samples WSU 1700 and GX 5132 fall within 290 years of each other is probably the best single line of evidence in support of our inferred dating of the site. The contemporaneity of WSU 1700 and GX 5132 is readily apparent; an average of these two samples yields the following date:

N= 8545 ± 265 B.P.

1 sigma range: 8280 to 8810 B.P.

2 sigma range: 8015 to 9075 B.P.

Carlo Creek Region: Geologic Dates

Sample number WSU 2148, dated at 7940 ± 130 years:5990 B.C., was obtained from 45 cm above the Unit 1 and Unit 2 contact at a roadcut located at mile 223.0, Parks Highway (see Fig. 16; Section 1-C). The exposed section at this point appears identical to the stratigraphy of the Carlo Creek site in overall morphology elevation, sediment structure, unit thickness, and apparent sorting and texture. It is quite probable that the deposition of these sediments was roughly coeval with the deposition of the

Carlo Creek site sediments. The date obtained from this sample is from a large wood and peat specimen (species unknown) embedded within a bar deposit similar to Unit 2 at HEA 031. This date, when viewed in light of the inferred depositional regime, and physical differences between Units 1 and 2 at the Carlo Creek site, suggests that the aggradational period which marked a temporary halt in the river's post glacial downcutting lasted for at least 500 years. Although sample WSU 2148 appears to occur stratigraphically at the same level as Component I at Carlo Creek, it is not too surprising that this sample is younger than Carlo Creek Component I: in this case, the rock stratigraphic boundary is not necessarily a time-transgressive boundary. Section 1-C probably represents an identical fluviatile sedimentary cycle as the one exposed at the Carlo Creek site. It indicates a similar channel sequence at approximately the same elevation, which occurred a few hundred years later. As the braided river cut numerous channels, and meandered within its floodplain, there were undoubtedly numerous composite sedimentary deposits which are similar to the Carlo Creek sequence. As pointed out by Allen (1970:136)

> The floodplain of a well-developed braided stream is not a continuous region, for it consists of the many alluvial islands or braid bars which divide up the flow. Moreover, the elements of the floodplain have little permanency for the sediment bars experience a continual and rapid modification by the flow passing round them.

The final date reported in this study is sample WSU 1747, dated at 3780 ± 80 radiocarbon years:1830 B.C., which provides a maximum age for the Cantwell Ash Bed (Bowers 1979a). Collected from the Cantwell Ash type locality at mile 218.3 Parks Highway, this sample dates the Cantwell area tephra to between 3800 and 3600 B.P. (Bowers 1979a). It should be noted that the Cantwell Ash Bed is present within the upper Unit 4 sediments at the Carlo Creek site, and thus provides a minimum age for the Component II occupation. The utility of this tephra unit as a stratigraphic marker horizon is illustrated in Figure 16.

Carlo Creek Component II

During excavation of the Component II occupation level, no radiocarbon dateable materials were recovered. In an effort to estimate the age of this occupation, I have attempted to interpolate the strata's age on the basis of maximum and minimum limiting dates for the Component I level and the Cantwell Ash Bed.

Age estimation for Component II was determined by two different methods. First, I assumed that the materials occur in the strata roughly half way between the Component I level and the ash level. On the basis of this assumption, the following age was determined:

$$8500-3780 = 4720$$

$$\frac{4720}{2} = 2360$$

$$2360 + 3780 = 6140$$

$$\text{Age} = 6140 \text{ B.P.}$$

This date represents a midpoint between the early and later dated strata from the site.

The second method, which is considered to be the more accurate means of interpolation, has assumed a logarithmic relationship between rate of Unit 3 deposition and time. Various studies of floodplain sedimentation (e.g., Allen 1965; Leopold et al. 1964) have indicated that deposition rate decreases as distance from channel increases. The fact that Unit 3 sediments generally tend to fine upward would lend support to this notion: as the

Nenana River shifted laterally and/or downcut, it carried less and less sediment with it and deposited gradually smaller amounts of overbank deposit. It is thus felt that this rate of deposition will more closely approach a logarithmic relationship than it would a linear one. Figure 24 illustrates this relationship.

From Figure 24 an age of 7250 B.P. is obtained. Estimating conservatively, I have thus inferred that the date of Component II occupation falls somewhere between 7500 to 6000 B.P. This suggests that the second brief occupation of the Carlo Creek Site occurred between 1000 and 2500 years after the initial utilization of the site, or at about 6700 ± 750 years B.P.

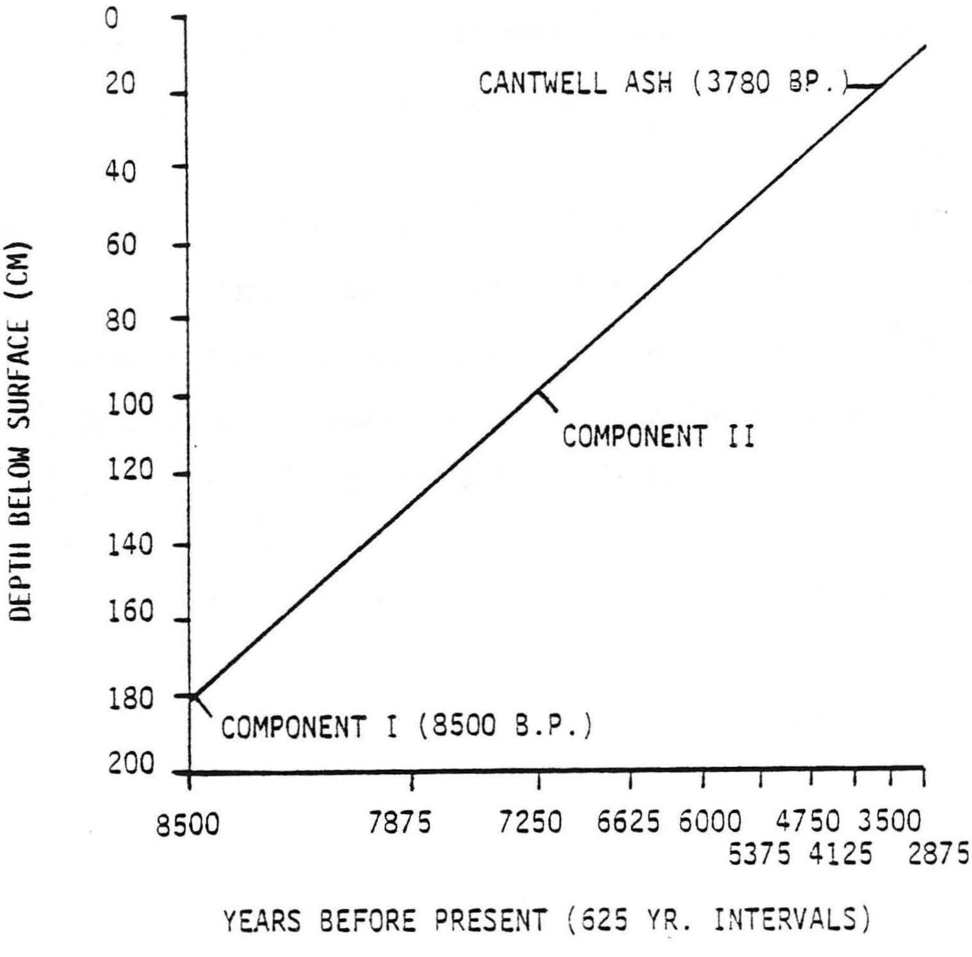


Fig. 24.--Determination of Component II Inferred Age. Note semi-logarithmic relationship between rate of sedimentation (depth) and intervals between bracketing radiocarbon dates (years before present). Sediment deposition probably was rapid at first, then tapered off gradually as Nenana River channel moved away from site. See discussion in text, Chapters 3 and 4.

CHAPTER 6

LITHIC ANALYSIS

Introduction

Analysis of the Carlo Creek lithic assemblage proceeded along three lines of inquiry: (1) morphological attributes, (2) technological stages, and (3) function. Morphology is defined as the physical traits which enable distinctions to be made among a number of specimens. This includes such phenomena as length, width, size class, weight, shape, edge angle, or form of hafting element. (Morphological attributes of tools from the site have been discussed previously in Chapter 4). Technology is the technique employed in the manufacture of lithic implements, including techniques of obtaining raw materials, pretreatment of raw materials prior to flintknapping, sequential stages of tool manufacture, selection and modification of fabricators, and reworking of tools. Function refers to the use, intended or accidental, to which a stone tool is put after its manufacture and prior to its disposal into the archaeological "record" (cf. Schiffer 1976).

This research was directed by two fundamental questions, which invariably face any archeologist involved with lithic studies (Gummerman 1975:7);

1. What types of information are potentially available in lithic debris and tools?

2. How can this information be retrieved from archeological specimens?

The purpose of this analysis is primarily to place the lithic remains from the Carlo Creek Site within an anthropological framework. As products of past human activity, it is important to understand how these materials came to be part of the archeological record, what relationship they have to the past human inhabitants of the site, and, finally, what significance they hold in an attempt to "reconstructing" or interpreting a record of human activity. I do not hold the opinion that the study of lithic technology is an end in itself; it is, however, an extremely valuable analytical tool which can be applied to archeological interpretation. It is especially significant in understanding the early prehistory in central Alaska, where it is evident that a major proportion of the preserved items of material culture are lithics.

In reviewing available literature on the methodology of lithic analysis, it is readily apparent that a wide variety of techniques have been employed. The procedure utilized here has attempted to extract the maximum amount of interpretive data from this particular lithic assemblage. It has been influenced by a number of diverse techniques and ideas from a number of sources, including: Brink (1978); Brose (1975); Crabtree (1964, 1966, 1972, 1976); Flenniken (1975, 1977, 1978); Frison (1968); Hassan (1976); Mauger (1970); Muto (1971); Semonov (1964); Sheets (1973); Solberger and Hester (1972); Tringham et al. (1974); Weymouth and Mandeville (1974); Wilmsen (1970); and Womack (1977).

A basic premise underlying this approach is that a lithic assemblage represents part of a larger system of resource procurement, alterations, useage, and disposal (cf. Schiffer 1976). A lithic "system", as defined by Flenniken (n.d.:4) is

> the entire life of a stone tool from its inception to its deposition in archeological context. In other words, a lithic system involves the selection of raw material, reduction of the raw material into preconceived tools, hafting of the selected stone tools, and functions of these stone tools--every aspect of a stone tool while it is in systemic context or until it is rejected by its original owner.

The theoretical approach of this analysis was somewhat more deductive in nature than were the other analyses of the Carlo Creek data. During and after excavation of the site, but prior to the lithic analysis, several hypotheses were developed concerning the systemic context of the lithic remains:

Hypothesis 1. The Carlo Creek Component I occupants used locally available raw materials.

Hypothesis 2. Component I materials were heat treated prior to reduction.

Hypothesis 3. Technology employed at the site was biface reduction, using direct freehand percussion.

The flow charts in Figures 25 and 26 show the lithic systems thought to be operative at HEA-031. These diagrams will form the basis for later discussion of the Carlo Creek lithic systems.

Methodology

Study of the Carlo Creek lithics followed a reduction stage concept, as developed variously in Flenniken (1975, 1977, 1978), Holmes (1919), Muto (1971), Sharrock (1966), and Womack (1977). As a first step in sequence determination, debitage was examined, with data recorded for the following categories: (1) provenience, (2) size class, (3) stage of manufacture, (4) platform, (5) cortex, (6) lipping, (7) termination, (8) use, (9) material, (10) weight, and (11) blade-like-flakes. Each of these categories will be briefly discussed below, and are summarized in Table 6.

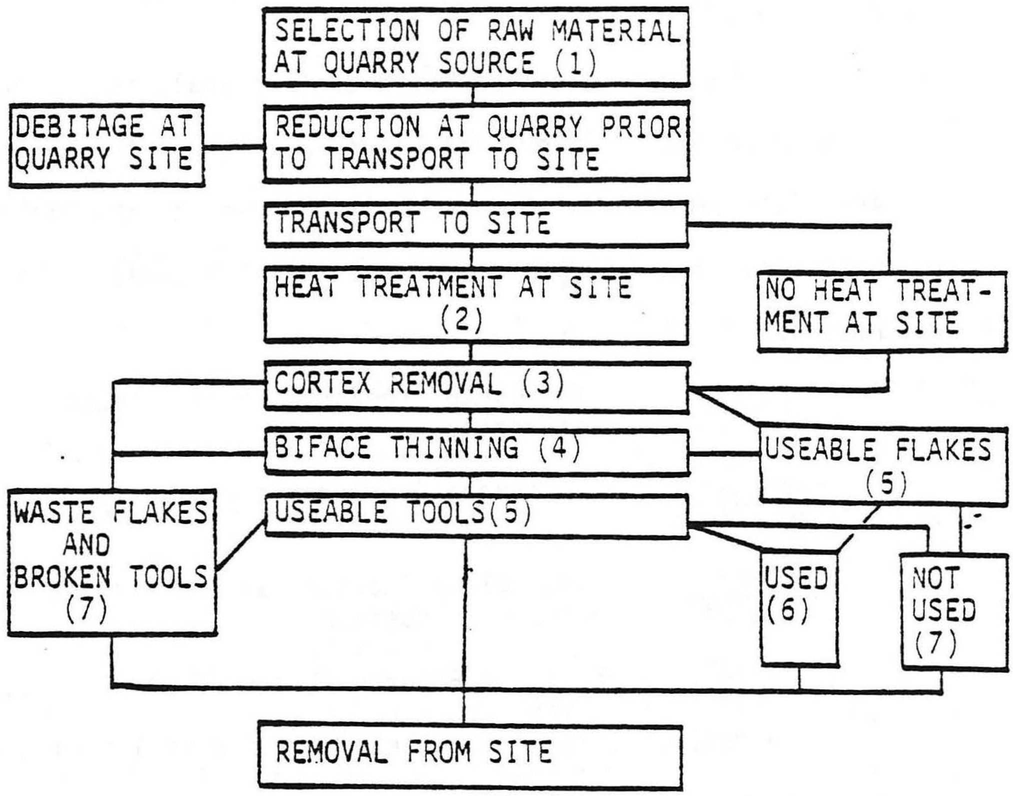


Fig. 25.--Component I Lithic Reduction System. Numbers in parentheses refer to technological stage represented at the Carlo Creek Site. Stage 7, disposal, occurs at most points in the sequence. Refer to discussion in text.

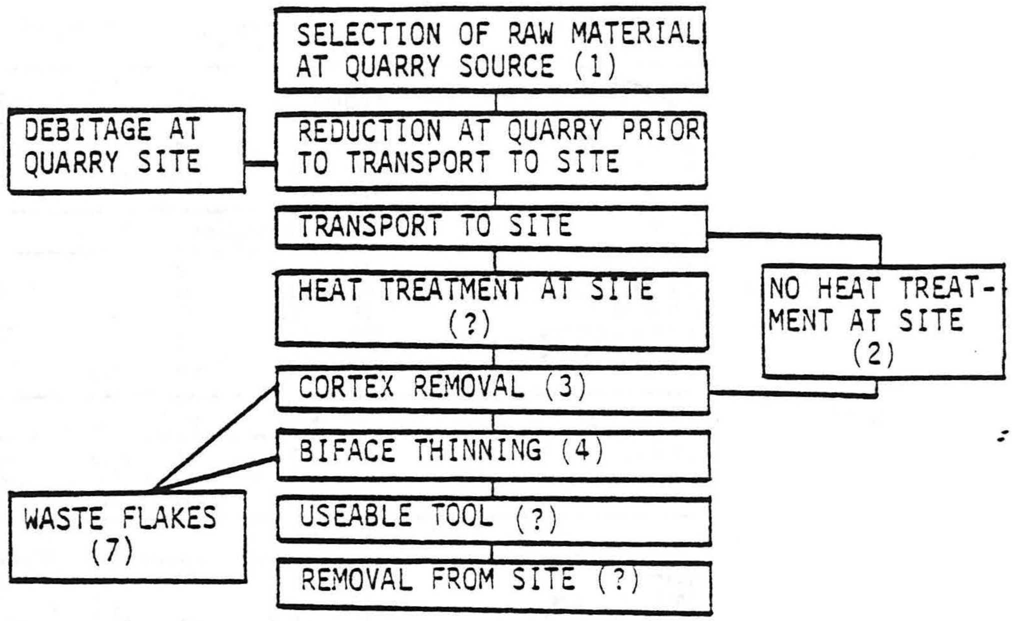


Fig. 26.--Component II Lithic Reduction System. Numbers in parentheses refer to technological stage represented at the Carlo Creek Site. Stage 7, disposal, occurs at most points in the sequence. Refer to discussion in text.

TABLE 6

CARLO CREEK DEBITAGE ANALYSIS

Category	Component I				Component II[c]	
	Locus A[a]		Locus B[b]			
	No.	%	No.	%	No.	%
Size Class[d]						
1 (Largest)	28	2.1	12	2.4	0	0
2	56	4.2	30	6.2	6	4.2
3	100	7.5	90	18.6	12	8.3
4	186	14.0	108	22.3	24	16.6
5	260	19.5	96	19.8	46	32.0
6 (Smallest)	698	52.5	148	30.6	54	37.5
Stage of Manufacture						
Primary decortication	10	0.8	10	2.1	2	1.4
Secondary decortication	74	5.5	24	5.0	16	11.1
Thinning	34	2.5	18	3.7	8	5.5
Biface thinning	206	15.5	74	15.4	36	25.5
Multiple removal	68	5.1	10	2.1	10	7.0
Shatter	946	71.2	348	71.9	72	50.0
Platform						
Chipped platform	226	17.0	116	23.9	12	8.3
Abraded platform	0	0	0	0	48	33.3
Indeterminate	1102	83.0	368	76.0	84	58.3
Cortex						
Quarry	150	11.3	28	5.8	2	1.4
Incipient cone	42	3.1	2	0.4	0	0
No cortex	1136	85.5	454	93.8	142	98.6
Miscellaneous Attributes						
Blade-like	21	1.6	4	0.8	4	2.7
Lipped	138	10.4	50	10.3	16	11.1
Termination						
Hinge	180	13.5	68	14.0	47	32.6
Step	78	5.8	70	14.4	4	2.7
Feather	414	31.2	128	26.4	46	31.9
Indeterminate	656	49.4	218	45.0	50	34.7
Outrepasse	0	0	0	0	0	0
Utilization						
Used	2	0.2	0	0	0	0
Maybe	3	0.2	1	0.2	0	0
Non-used	1323	99.6	483	99.8	144	100
Material Type						
Rhyolite	0	0	0	0	144	100
Hornfels	18	1.4	0	0	0	0
Chert	1	0.1	0	0	0	0
Argillite	1308	98.5	484	100	0	0

[a]There were 5460 flakes (weight: 3236.2 gm) in Locus A; 1328 of the flakes (24.3 %) were analyzed.

[b]There were 2262 flakes (weight: 2453.54 gm) in Locus B; 484 of the flakes (21.4 %) were analyzed.

[c]There were 637 flakes (weight: 142.7 gm) in Component 2; 144 of the flakes (22.6 %) were analyzed.

[d]Refer to Fig. 28.

An attempt at acheiving a random sample for this analysis was made by selecting flakes in "grab" fashion from level bags. (Each flake or flake cluster is in a separate coin envelope within a level bag; selecting an envelope instead of an actual flake reduces the potential bias due to touching or "feel" of a certain size or shape of flake.) Flakes were selected in this manner until a 20 to 25% sample had been analyzed from each 1 x 1 meter square. The total number of flakes thus analyzed was 1956, or 23.4% of the total collection. For purposes of analysis, proveniences were grouped into three spatially-discrete units within the site: (1) Component I, locus A, (2) Component I, locus B, and (3) Component II.

During excavation of HEA 031, flake provenience was recorded by square and by intra-square coordinates, for each of the 8359 flakes. Although not done in this study, it should be possible for a future researcher to use these data for distributional analysis, according to flake "type". This could theoretically enable a nearly complete reconstruction of the lithic reduction activities at the site.

Each of the 1956 flakes analyzed was categorized according to its size class rather than by traditional length-width-thickness measurements. The problems in standard measurements of flake morphology have been previously pointed out by Brauner (1968:12), and are illustrated in Figure 27.

For the purposes of presenting flake-size date, it was felt that a graphic representation of size is more useful than standard numerical length, width, and thickness measurements. I believe that it is too hard for most people to visualize sizes of flakes if only metric attributes or weight are presented. In this study, 60° ellipses were used as templates on which flakes were "sized" (see Fig. 28). A 60° ellipse is regarded as a

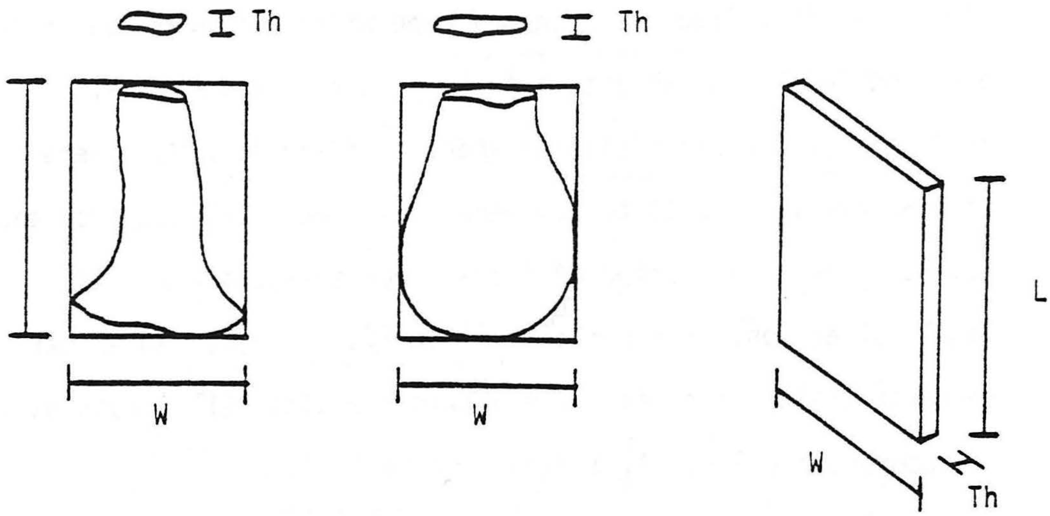


Fig. 27.--The Fallacy Generated by Using Length x Width x Thickness = Volume. ADAPTED FROM: Brauner (1968:12).

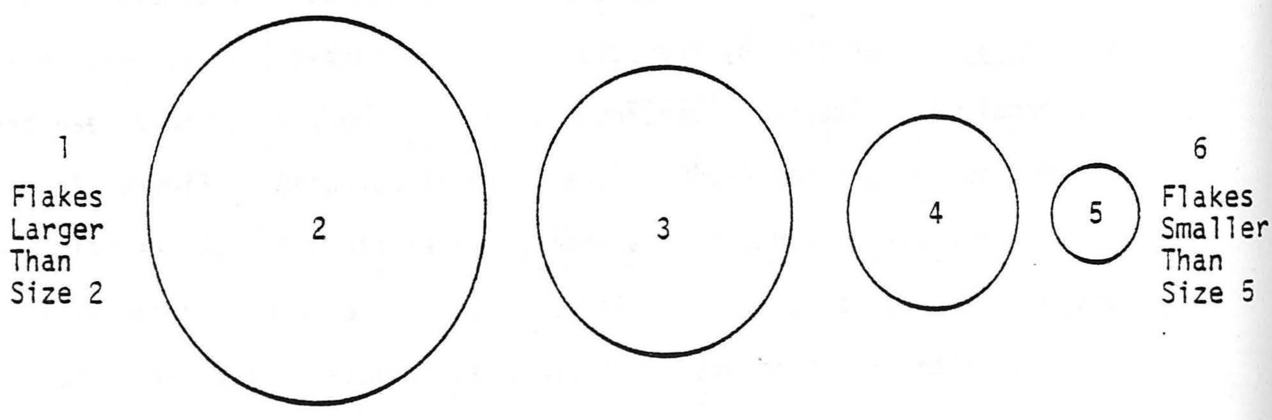


Fig. 28.--Templates Used in Determining Flake Size Categories. Refer to debitage analysis data in Table 6 and discussion in text.

good approximation for the average morphology of a flake, even though it does not completely avoid the pitfalls discussed by Brauner (1968:12).

Stage of manufacture (unless otherwise stated, lithic technology-related definitions follow Crabtree [1972]) was subdivided into classes of: (1) primary decortication (White 1963:5), (2) secondary decortication (White 1963:5), (3) thinning (Womack 1977:65), (4) biface thinning (Womack 1977:65; Flenniken 1977:76), (5) multiple removal (Womack 1977:70), and (6) shatter (Binford and Quimby 1972:347).

Determination of platform preparation was made through visual inspection with a 4x hand lens, and was restricted to categories of chipped vs. chipped and abraded. Abraded platforms are those which show substantial bevelling of the striking platform through grinding or polishing. No attempt was made to record data for platform angles.

Flakes from both cultural components were divided into three categories with respect to cortex: (1) quarry, (2) incipient cone, and (3) no cortex. Quarry cortex, as used here, is a weathered surface on tabular stone, that is broken along natural cleavage planes. The color of Component I argillite quarry cortex, red or reddish brown, formed a sharp contrast with the grey unweathered rock. Component II cortex was a reddish hue, which was distinct from the light colored unweathered rhyolite. Incipient cone (cobble) cortex is that which occurs as a result of rounding and battering in a riverine environment. Cobble cortex was found only in the Component I assemblage.

Presence or absence of a pronounced "lip" on the vertical surface of a flake, immediately below the striking platform, was considered at the time of this analysis to be another potentially useful observation.

It was suggested by Crabtree (1972) that such criteria may indicate the type of fabricator employed; i.e., hard hammer, soft hammer, or antler baton. However, Flenniken (personal communication, 1979) no longer regards this relationship as valid, and does not believe that one can determine fabricator on the basis of lipping.

Nature of terminations (i.e., hinge, step, feather, outrepasse [Tixier 1974]) were other criteria utilized in this analysis. Relative proportions of these termination types may be useful as indicators of the relative ease or difficulty with which a raw material was worked.

Flakes judged to have been utilized were set aside during analysis and later restudied along with edge-damage analysis of major artifacts. These were first given cursory examination under a 4x hand lens, then examined under a binocular microscope at various magnifications ranging from 20x to 70x.

Material types from HEA 031 are restricted to argillite/hornfels (Component I), rhyolite (only in Component II), and chert (1 flake only). Lithic raw materials utilized in the lower level of occupation were all argillite/hornfels, with two exceptions: (1) a single black chert flake, and (2) a single large prismatic blade composed of a different color-grade-texture of stone than any of the other materials. This has not been unequivocally identified, although it probably represents a different grade and composition of contact-metamorphosed argillite.

Although not detailed in Table 6, weight was recorded separately for each flake in the 23.4% sample, down to 0.1 gm. The majority of the smallest-sized flakes (size class 6) were 0.1 gm or less in weight. Total flake weights per meter square are presented in Figs. 17 and 23.

Finally, observations were made on flakes which appeared, morphologically to be blade-like. Following Tixier (1974:7), a specimen that is called a blade must be at least 1.2 cm wide and 5 cm long, and its width must be at least twice its width. Microblades are less than 1.2 cm wide, and at least twice as long (See Table 6).

All of the above data were recorded on IBM Fortran coding forms. The technique employed here was judged to be fairly time-efficient, with a maximum amount of data recorded in a fairly short time. Analytical units were grouped within the site according to each of the three clusters of flaking debris: Component I, locus A; Component I, locus B; and Component II. Finally, total counts and weights were recorded for 100% of the sampling universe. These data have been presented in Figures 17 and 23.

After completing the analysis of debitage, all biface fragments, blade-like flakes, manuports, and possibly edge-modified flakes were examined, with observations recorded for morphology, technology, and inferred function. The results of these observations and measurements have been presented in Chapter 4.

In addition to all of the above, two additional analytical techniques were employed in the analysis of the Carlo Creek lithic collection. These are both considered "replicative experimentation", defined by Flenniken (1978:3; and further modified from Crabtree 1976:106). I would caution, however, that any given replication sequence only suggests <u>one</u> possible means of achieving a desired goal, and does not necessarily exhaust the <u>range</u> of possible techniques for producing a certain stone tool.

> ...Replication, in its strictest sense, is reproducing stone tools, using the aboriginal artifacts as controls, by aboriginal stone working fabricators, employing the same raw materials, and following...similar reduction technology. Therefore, the end products as well as the debitage, sequential stages of manufacture and rejuvenated tools are the same as the aboriginal controls in terms of technical category percentages, morphologies, and technologies (Flenniken 1978:3).

As employed in the Carlo Creek analysis, this methodology was applied in less than its "strictest sense" and was largely subjective in approach. I did not attempt rigorously-controlled experiments which could control for the myriad of mechanical or physical variables in replicative studies (e.g., Bonnichsen 1977; Speth 1972; Tringham et al. 1974). The major purpose of this part of the Carlo Creek lithic analysis was to (1) produce replicas of the lithic artifacts, in an effort to gain personal insights into the technology employed aboriginally, (2) utilize these replicated tools in a variety of bone processing functions, to provide edge-wear controls which could be directly compared to the aboriginal specimens, and (3) determine the extent, if any, of intentional thermal pretreatment of the Carlo Creek Component I sample. The major goal was to replicate a specific artifact <u>type</u>, rather than a specific attribute.

Altogether, ten lithic replications were produced by myself and J. Jeffrey Flenniken. Raw materials used included: (1) unmodified Carlo Creek argillite/hornfels (non-aboriginal), (2) basalt obtained from the Stockhoff quarry, LaGrande, Oregon (Womack 1977), and (3) experimentally heat-treated Carlo Creek argillite/hornfels (non-aboriginal). Stockhoff basalt was used because it was available in large quantities and because it is very similar to Carlo Creek argillite/hornfels in terms of texture, lustre, hardness and "flakeability" (flakeability, as used here, follows the definition in Flenniken and Garrison 1975).

The controlled heat-treatment experiment was designed to determine whether or not lithic raw materials from the site were heat-treated aboriginally. Ever since Crabtree's (1964) observations concerning the possibility of intentional thermal alteration of lithics by prehistoric flintknappers, a growing body of data has been collected which suggests that such procedure is archaeologically widespread (Crabtree 1964; Flenniken and Garrison 1975; Mandeville 1971; Mandeville and Flenniken 1974; Purdy 1971; Shippie 1963; Solberger and Hester 1972; Weymouth and Mandeville 1974). It has been demonstrated rather convincingly that numerous changes occur during heat alteration, including fracture strength, lustre, color, tensile strength, and flakeability (Flenniken and Garrison 1975) of raw material.

To test this possibility in the Carlo Creek lithic sample, a series of rhyolite and argillite specimens from the site and from nearby outcrops were heated in a temperature-controlled furnace at 100°C increments, ranging from 100° to 600°C. Each sample was heated in a sand bath for 10 hours, allowed to gradually cool, then removed. The samples were then examined for color and texture change, after which they were flaked to notice any changes in workability. On the basis of these experiments, it is evident that the argillite/hornfels from Component I was heat-treated. These observations will be discussed in greater detail later in this chapter under the heading of "Stage 2: Heat Treatment".

As a final step in the analysis of lithics from the Carlo Creek site, microscopic edge wear studies were conducted on all "utilized flakes" or tools. A variety of magnifications were used, ranging from a 4x hand lens, up to 70x with a binocular microscope. Edge damage criteria previously established by Semenov (1964), Sheets (1978), and Tringham et al. (1974) were used to identify possible edge damage. As a control, four flakes from the aboriginal collection and three replicated specimens of argillite and Stockhoff Basalt were subjected to bone cutting, smashing, and scraping tasks to experimentally determine edge damage criteria for these raw materials. These were then compared side-by-side with suspected aboriginally -utilized specimens to attempt to determine function. The replications were conducted on fresh articulated cow bones obtained from a local supermarket. Two flakes were used in a scraping motion for 20 and 50 strokes, and two flakes were used in a cutting motion for 20 and 50 strokes. One biface was used as a chopping implement (20 strokes), one was used as a knife (20 strokes) and one was used as a scraper (20 strokes). The major purpose of this experiment was not to rigorously control all variables in stone manipulation, as in Tringham et al. (1974), but rather to gain personal insights as to the functions which may have been operative at the Carlo Creek Site. The results of these observations are presented in the section entitled "Stage 6: Tool Use".

Before turning to the interpretation of the Carlo Creek lithic reduction sequence, it will be useful to examine briefly the results of the lithic debitage analysis presented in Table 6. The major purpose of analyzing the 23.4% sample was to attempt to "fingerprint" the debitage assemblage, to enable the making of quantifiable comparisons, both among intra-site activity areas, and with other Alaskan site assemblages.

The two major loci in the Component I level are remarkedly similar in overall characterization of debitage attributes. Both show similar distributions of flake sizes, manufacturing "stages", percent of platform preparation, percent of "lipped" flakes, distribution of termination attributes, and relative percentage of blade-like flakes (See Table 6).

The only noticeable difference was in the relative amounts of quarry cortex and incipient cone cortex: 11.3% quarry cortex and 3.1% cone cortex in locus A as compared to 5.8% quarry cortex and 0.4 cone cortex in locus B. There also was a lower percentage of step terminations in locus B than in A. This suggests that the sequence of activities in locus A involved the reduction of material having more quarry cortex on it than did the material in locus B. Evidence from both loci indicates the same technique of reduction was used after cortex had been removed.

By way of contrast, the "fingerprint" of the Component II debitage (See Table 6), is strikingly different from Component I. In Component II, there are higher percentages of small (Size 5 and 6) flakes, more evidence of bifacial thinning, more abraded platforms, and more hinge fractures. This probably reflects differences in material types, (argillite vs. rhyolite), and in flaking techniques (percussion in Component I vs. pressure in Component II).

The Carlo Creek Lithic Reduction System: Component I

On the basis of the procedures outlined above, the following system of procurement, pretreatment, reduction, and usage appears to have been operative at HEA 031 during its occupation of circa 8500 B.P. As an aid to the organization of the discussion, I will follow the flow chart in Figure 25, discussing each stage in light of field observations and laboratory analyses. Discussion of the Component II lithic system will be reserved for the last part of this chapter (See Fig. 26).

Stage 1: Raw Material Selection

The major raw material present in Component I at HEA 031 has been characterized, on the basis of X-ray diffraction analysis of one sample, as an argillite/hornfels (Foit, personal communication,1978). It is composed of fine-grained opaque mineral bands, with relict bedding, and contains 20-30% of anhedral quartz grains, 65-75% mica and other layer silicates, and about 5% opaque oxides. According to Dr. F.F. Foit of the W.S.U. Geology Department, this rock is "definitely metamorphic". It could be "either an argillite or hornfels", but because of its density, may be more like the latter, It very closely resembles basalt in texture, lustre, and color (Foit, personal communication, 1978).

Didier (1975) has discussed this problem previously:

> The argillite problem is extremely complex, and difficult, both archaeologically and geologically. Argillite is an aphanitic mudstone, a sedimentary deposit that was deeply buried, compacted, and hardened at relatively low temperatures and low grade metamorphism. It occurs in ranges of colors and textures, and is really not a single unique composition but a continuous gradation of related, yet distinguishable materials...Fresh hornfels (altered argillite) is black, with a crystalline sheen, dense, strong, and flakes with a good conchoidal fracture. Hornfels is a high temperature recrystallized rock; normal argillite is a non-high temperature and pressure "metamorphosed" rock.

The material utilized in Component I activities appears to have been derived from two sources: (1) a minor amount, represented by 3.16% of the analyzed debitage, was derived from [a] stream-rolled cobble[s]. This is posited on the basis of incipient cone cortex (Flenniken, personal communication, 1978), and smooth polished surface. The total amount of this material in the site is estimated at about 112 gm, an amount which could easily represent a single fluvial cobble. (2) Most of the stone in this level was probably derived from a large and quite prominent argillite outcrop located about 0.8 km east of the site. Several large chunks of tabular argillite (e.g., Fig. 21) found in the vicinity of Hearth 1 appear to be similar to material from this source, in cortex texture, size of naturally-occurring spalls, and morphology.

The suspected quarry source was investigated during both the 1976 and 1977 field seasons. However, no definite indications of aboriginal utilization were discovered. The base of the outcrop/cliff was heavily vegetated, with extensive recent frost-cracked rock fragments and large boulders covering the surface (see location in Fig. 9).

The fact that a fairly small proportion of flakes from both Locus A (0.75%) and Locus B (2.06%) were primary decortication flakes suggests that part of the decortication processing was performed at or near the quarry source. The raw materials were probably brought into the site as partially decortified tabular spalls. Based on the total known weight and distribution of materials in Component I, these probably weighed about 500-1000 gm per piece.

Stage 2: Heat Treatment

On the basis of available data, a good argument can be made for intentional thermal alteration of lithics at Carlo Creek. Solberger and Hester (1972:18) have stated that:

> A major advantage in thermal treatment is that it allows an improved conductivity of force in flake removal, i. e., a cleavage which terminates with a thin, feathered edge. This eliminates many of the snapped-off flakes and hinge fractures that frequently ruin bifaces during manufacture. This improved conductivity often allows the developing split or flake cleavage to pass through flaws or inclusions within the mass being flaked. Thermal treatment also permits the removal of much larger flakes by pressure methods than is possible on the same material which is not heat-treated.

Although fully conclusive evidence of thermal treatment at HEA 031 must await the results of X-ray diffraction analysis (cf. Weymouth and Mandeville 1974), the following observations can be marshalled in support of the claim that this technique was used at Carlo Creek:

1. The cortex on the Carlo Creek debitage is identical in hue (reddish-brown) to that from experimentally heated non-aboriginal samples

from the argillite outcrop located near the site. It was found that the closest color match occurred between the aboriginal control and the non-aboriginal samples heated to between 400°C and 500°C. In contrast, unheated non-aboriginal samples show a yellowish-brown cortex.

2. According to the opinion of an expert flintknapper, the unheated raw material from the outcrop is virtually unworkable (Flenniken, personal communication, 1978). When struck by soft hammer, using direct, freehand percussion, the margin crumbles and a series of stack-step fractures result. It is nearly impossible to achieve a controlled conchoidal fracture with the unaltered stone. However, when the same stone has been heated in a furnace to at least 400°C, then gradually cooled, it can be flaked quite easily, with greatly reduced stepping and hinging. The aboriginal collection indicates a step and hinge rate of between about 5 and 15%. Flenniken (personal communication, 1978) has suggested that the Carlo Creek Component I material would have had to have been heat treated in order to be knapped successfully into the bifaces found in Component I.

3. An aboriginally-excavated pit (Feature 1; Fig. 11), located in the northeast end of Hearth 1, may represent an aboriginal oven which could have been used to alter rock. Sand was evidently excavated from the underlying stratum (Unit 2), then piled on top of several quarry blanks and a large tabular chunk of argillite. The contact between the undisturbed sediments and those lying above the blanks exhibited a redder hue than did other sediments in the Component I level. This pit-like feature showed up clearly on the side-wall profile (Fig. 11). Other similar heat-treatment units have been observed archeologically (Shipee 1963; Solberger and Hester 1972).

In addition to the excavated pit and possible "blanks" for thermal treatment, the underlying sediments were significantly redder in hue than were other sediments in the vicinity of the hearth. An excellent comparative replicative study by Mandeville and Flenniken (1974:146-148) describes a heat-treatment pit which was utilized in January with ambient air temperatures of -27°C (-16°F). In that experiment, it was necessary to dig a pit of only 60 cm depth. It was found that a temperature of greater than 200°C could be maintained for up to 14 hours during a single firing, resulting in altered stone which was significantly easier to flintknap (Mandeville and Flenniken 1974). In addition, Harner (1956:40) reports that "...an ordinary wood-burning campfire is easily capable of heating stones (flint)..." to a temperature of 1000° fahrenheit (537.8° celcius) if they are on the ground beneath the fire."

It cannot yet be stated unequivocally that the Carlo Creek Component I materials were thermally treated. However, the available evidence from the lithic analysis and an archeological feature strongly supports such an argument.

Stage 3: Cortex Removal

As previously stated, the majority of cortex removal probably took place at or near the original quarry site. This is based on the observation that secondary cortex is more prevalent than primary cortex in both Locus A and Locus B. (In this study, data for shatter with cortex has been recorded as percentage of cortex on all analyzed flakes.) A total of 14.4% of flakes from Locus A and only 6.2% from Locus B contained cortex, which is regarded as a low percentage. In contrast, Flenniken (1977:75) reports a figure of 52.0% of decortication flakes from a riverine/quarry setting at the Miller Site in Central Washington, while Womack (1977:59) reports a total of 14%

decortication flakes from the Stockhoff Basalt quarry in eastern Oregon. Such correlations are difficult to quantify, however, because of the unknown variables of original cobble size and percentage of cortex on the original rock.

Stage 4: Biface Thinning

After removal of most of the cortex, the Carlo Creek artisans apparently worked tabular pieces of argillite/hornfels down bifacially, utilizing direct freehand percussion. Biface thinning flakes exhibit flake scars on their dorsal surface; only the original detachment flake scar is evident on the ventral surface. As used here, this broadly-defined term can encompass several different biface-reduction techniques. Approximately 15% of the analyzed sample from Carlo Creek level 1 represent biface thinning flakes.

Platform preparation was evidently accomplished through chipping, as there is little apparent evidence for heavy grinding on prepared-platform flakes. Included in this stage of manufacture are multiple removal flakes, defined by Womack (1977:70) as flakes which "...exhibit a positive bulb of force on the ventral surface on the flake, and a negative bulb of force superimposed on the dorsal surface of the flake."

Throughout this stage, as well as those previous, a large amount of shatter resulted: 71.2% and 71.9% for the two Component 1 loci. Shatter has been defined (Binford and Quimby 1972:346) as "cubical and irregularly shaped chunks that frequently lack any well defined bulbs of percussion or systematic alignment of cleavage scars on the various faces." The high frequency of shatter at HEA 031 reflects: (1) the coarseness of the raw material, and (2) the relatively early stages of reduction via direct freehand percussion.

Stage 5: Finished Tools

Finished tools from the Carlo Creek Component 1 level are represented by only four complete or broken specimens. An additional six biface fragments were recovered in addition to these specimens, all of which were apparently broken in manufacture. The finished tools, along with larger biface fragments, have been described individually in Chapter 4; finished tools represent 9.02% of the total lithic assemblage from Component I.

One specimen, a prismatic blade (UA-77-64-61+62+63), is of a noticeably different material type than other materials from Component I; it is also apparently the product of a different technological sequence than that described above. However, this material is not represented in large enough quantities in the debitage (1.3% from locus A, 0% from locus B) to suggest that it was reduced at the site. This specimen apparently was brought into the site as a finished tool, was used on site, and was subsequently broken during usage or resharpening activities.

In addition to the bifaces and one "prismatic blade", two moderately sized flakes were judged to have been utilized. These are discussed in the following section under function.

It should be noted that, in the process of flake analysis, a total of 25 (1.5%) "blade-like" or "linear" flakes were culled out of the debitage. In the early stages of analysis, I was uncertain as to whether or not there was a definite core and blade technology present at the site. In view of the artifactual data, coarse-grained raw material, and technological sequence as revealed through debitage analysis, I am of the firm opinion these "blades" are fortuitous, and are not the result of an intentional core and blade manufacturing technique.

Stage 6: Tool Use (Function)

As discussed in the lithics methodology section, determination of function was established through direct comparison with replicated "controls". I do not claim that these observations offer conclusive "proof" that a particular specimen was utilized for a given function; I only suggest possible uses to which it may have been put.

Semenov (1964:14), in his excellent pioneering study of use wear, determined three basic kinds of observed wear patterns: (1) polishing (fine abrasion), (2) coarse abrasion (grinding and striations), and (3) rasping (minute chipping of the edge). The utility of these three distinctions have been supported variously by Tringham et al. (1974) and Keller (1966). These three basic criteria were applied to microscopic observations of the Carlo Creek specimens.

On the basis of microscopic analysis of the edge-wear of replicated specimens, it was not possible to identify striations on the margin or face of any piece. This is believed to be a function of the extremely durable edges of the hard argillite/hornfels, and control basalt samples. Lack of visible striations on worked pieces have been observed previously in use-wear studies, as in, for example, Tringham et al. (1974:175):

> It was found that, even with the addition of earth and other abrasives, striations form very slowly, sometimes not at all, and that their use as a criterion of variation in wear patterns is possible only with the aid of high magnifications (frequently higher than those possible with a binocular 100x microscope).

Discernable modifications occurred on experimentally modified aboriginal flakes only after considerable scraping or cutting directed to a fresh bone surface. It was experimentally observed that after 20 strokes, a number of minute "rasping" flakes were removed. Only at 50 strokes of these flakes was it possible to see even incipient polishing. Two of the experimental bifaces, when subjected to these actions, were affected in a similar way, except that observable modifications were even less pronounced. Striations, even after 50 strokes on fresh bone, were not visible. On the biface subjected to chopping actions, considerable blunting of the margin was noted, with a high degree of stack-step fractures observed after 50 strokes.

In order to compare these observations to the Carlo Creek Site data, it was necessary to consider three factors, which further complicate interpretation. The first factor is in attempting to distinguish edge abrasion during manufacture from use-wear (Sheets 1973). During normal biface reduction, it is necessary to "strengthen" the edge by decreasing the edge-angle; this can be achieved by abrading the edge by either grinding or fine chipping (cf. Crabtree 1972; Muto 1971). These minute flake scars have, in the past, been misinterpreted as indications of use-wear (cf. Nance 1971). Sheets (1973:218) has suggested that the best means of differentiating between manufacturing abrasion and use abrasion is through microscopic examination:

> A clean, crisp juncture between an abraded area and a flake scar indicates an edge that was strengthened and then flaked, but not used. Use tends to nick the sharp boundaries and blur the crisp, fresh edges. In other words, abrasion occurring during manufacture is cross-cut by flaking, whereas abrasion from use crosscut or blurs the edges of the flake scars.

He further emphasizes the importance of debitage analysis in distinguishing use-wear from manufacturing abrasion (1973:218): "If the platforms of biface trimming flakes exhibit the same abrasions as found on portions of the bifacially flaked tool, then abrasion as a manufacturing procedure is indicated."

A second major limiting factor in the production of use-wear damage on a butchering tool is in the accumulation of animal fat on the edge, as suggested by Brose (1975). His analyses suggest that "... a major factor inhibiting the creation of striations during butchering is the accumulation of fat along the working edge" (Brose 1975:93). In the case of a durable material such as Carlo Creek argillite/hornfels, this might have been an especially significant factor, which would substantially reduce the apparent edge damage caused by usage. Brose (1975:93) further observes that significant patterned wear may not be noticed on flakes unless they are used for longer than about 3-4 minutes, or up to several hundred strokes. Since he was using flints and cherts, which may have been of a lower hardness value than the Carlo Creek material, it is quite possible that argillite/hornfels could have been utilized briefly for butchering activities with virtually no identifiable butchering damage observable.

In the case of the experimentally-replicated bifaces used in this analysis, it was not possible to distinguish manufacturing abrasion on one edge from use-wear abrasion on the opposite edge of the same specimen. At a magnification of 70x, there were no use-induced striations or similar edge-damage. Similar results were obtained in replicative studies by Faulkner (1977). It was only after a tool had been subjected to heavy usage on bare (non-fleshy) bone that it was possible to detect changes. Thus, material used aboriginally at HEA 031 for only a few strokes may go completely unnoticed.

A third factor which must be considered here is the effect of post-depositional alterations such as trampling by the site's occupants, mishandling during shipment (this factor may be ruled out in this case, due to individual wrapping of specimens during shipping and in the lab) or trowel/screen retouch. Several investigators (e.g., Tringham et al. 1964) have pointed out various types of "retouch" which can occur to flakes either during detachment or during occupations of a refuse floor.

Taking into consideration all of the above, several tentative inferences can be made about use of lithics during the Component I occupation of HEA 031. I do not make any certain claims as to utilization; I only suggest possible uses for selected specimens (refer to Table 4 and Fig. 19), based on limited experimental and observed data:

1. Two specimens, UA-77-64-3+4, and UA-77-64-79, may have been utilized as cutting tools. They both exhibit a series of minute step fractures along segments at least 3.0 cm long along one or both lateral margins. Under 70x magnification, these segments have rounded edges, and appear slightly polished. There are no visible striations.

2. The single hornfels "prismatic blade" (UA-77-64-61+62+63) exhibits possible wear patterns on both lateral edges, in the form of medium sized step and feather fractures, and on the distal end. The latter is of particular interest, in that it may have served as a "burin-like implement" (terminology based on Mauger 1970:46). The distal end of this implement terminates abruptly, forming a transverse facet at right angles to both faces. The manufacturing technique which produced this facet is impossible to determine, although it was most likely formed as a "snap" fracture rather than by a deliberate burin blow. The surface of the facet is heavily polished, with considerable blunting and polishing of the juncture between the ventral surface and "burin" facet. When found, the artifact was in three pieces, all within a 1.5 m of one another (See Fig. 18); the fractures which had separated the three pieces suggest an extreme "bending" force while the implement was being held by its proximal end.

3. A large biface, UA-77-64-1, could have been used in a hand-axe fashion, as inferred from the slight edge damage on its distal end. The nature of this damage is similar to stack-step fractures observed on an

experimental specimen used in a battering motion for 20 strokes. If it was in fact utilized aboriginally, this specimen was used for only a short period of time before being discarded.

4. Two "retouched" flakes, UA-76-212-385, and UA-76-212-172, both have systematic minute step fractures on their distal ends. Modified margins are 3.1 cm long on one, and 1.7 cm long on the other. Both appear similar to flakes that were experimentally-modified by being used in a cutting mode for less than 20 strokes.

It is thus suggested that several of the Carlo Creek lithics may have been utilized briefly, probably in connection with animal dismemberment. Due to the durable nature of the hornfels and argillite, it was not possible, even on experimental controls, to develop "fail-safe" criteria for determining sources of edge-damage. Even where controls were used for 50 strokes, it was difficult to observe changes. The additional complicating factors such as animal fats (Brose 1975), "spontaneous" retouch (Brink 1978), edge abrasion during manufacture (Sheets, 1973), and secondary alteration after discarding make any statements concerning utilization somewhat equivocal.

The fact that primary butchering remains are associated with these lithics suggests that these lithic materials were brought into the site for the express purpose of dismembering the carcass of at least one caribou, one sheep, and possibly nine ground squirrels (see Chapter 7). The relationship of the lithic debitage and regional geology further suggests that these materials were brought into the site from close by, and were modified and used on-site. I regard these as "tools of the moment", which achieved a potentially-functional stage quite early in the reduction process.

Stage 7: Disposal Mode: Introduction into the Archeological Record

The final "stage" of the Component I lithics sequence is disposal, i.e. the output of archeological remains from their systemic context into the archeological context (cf. Schiffer 1976). For the sake of discussion, this will be viewed as a "stage", although in reality, discarding occurs at all stages including quarrying, heat treatment, cortex removal, biface reduction, and breaking of finished tools during resharpening or use. (See also the discussion of spatial relationships in Chapter 4, as this relates to disposal of lithics). Included in this final "stage" is some debitage from all prior stages. The disposal mode is the only "stage" readily observed during excavation of a site, and is in effect, the archeological "record". In the Carlo Creek Component 1 assemblage, discarded tools, broken tools, and products of tool production mainly occurred as primary disposal. The only apparent exception to this is the single "prismatic blade", which was probably manufactured at another location, and discarded on site.

The Carlo Creek Lithic Reduction System: Component II

The small flake cluster found in the site's upper level (see Fig. 23) is clearly different from the flake scatters found in the lower level. Aside from an obvious difference in material type, the lithic reduction technology was noticeably different. In particular, differences can be noted in flake size, percent of decortication flakes, and overall proportion of biface thinning and shatter flakes. Especially significant is the presence in Component II of platform abrasion, which may be taken as supporting evidence for pressure flaking (not the only criterion). The following briefly summarizes the Component II reduction sequence, as indicated at Carlo Creek. It is not a complete sequence, for the complete sequence is not represented at the site. As previously mentioned, the total number of Component II waste flakes is 637.

Stage 1: Raw Material Selection

The only rock type found in the Carlo Creek Component II assemblage is white rhyolite. This lithic material was probably obtained locally, from one of the numerous outcrops of rhyolite in the Cantwell Formation and in the Central Alaska Range in general. Wahrhaftig (1958:14): reports that a: "...layer of white rhyolite 100 ft. wide crops out on the crest of the ridge between Riley Creek and the Nenana River about 1 3/4 miles due west of the lagoon section house and 3 miles due south of McKinley Park Station." (The latter is 14 km north of Carlo Creek). In addition, one of his rock sampling localities for soda rhyolite is described as a "...hill (altitude 2200 ft.) about 2 miles N 20° E of the mouth of Carlo Creek" (1958:15). However, no aboriginal rhyolite quarries have yet been recognized in the Alaska Range.

It should be noted that this material type is found widely, both temporally and spatially, in archeological collections from interior Alaska. Among collections I have personally observed this material type in are the Campus site, Dry Creek Component II, Teklanika east and west, Dragonfly Creek site, and the Nenana Gorge Site.

Stage 2: Heat Treatment

It is not known whether or not the Component II rhyolite was thermally heated. Although I did experimentally heat Carlo Creek aboriginal rhyolite to 600° C, I did not have the benefit of non-aboriginal control samples as in the case of the Component I argillite/hornfels. Until such controls can also be heated, it will not be possible to determine the presence of heat treating in the Component II assemblage. I did, however, observe a slight color change (increase in purple hue) and change in lustre (glassier).

Stage 3: Cortex Removal

After a quarried piece of unknown size was brought to the site, the remaining cortex was removed by direct percussion. The amount (12.5%) of cortex flakes present indicates that probably most cortex was removed at a local quarry source.

Stage 4: Biface Thinning

Analysis of a 22.6% sample of the 637 flakes in the Component II cluster indicates that a direct freehand percussion technique was probably employed by the aboriginal artisans during at least part of the Component II reduction sequence. Platforms were prepared primarily by light abrasion (33%), after which biface thinning flakes were detached. A number of small flakes in the Component II collection suggest removal by pressure (multiple removal flakes; 17% of total). These generally have pronounced lips, are ovate to linear in form, and have a prominent bulb of force.

Stage 5: Finished Tools

No finished tools were recovered during the Component II excavations. It thus can only be inferred what end products are represented in the Component II assemblage. Observations of the rhyolite debitage from Component II suggest that the tools being worked on that this locus were bifaces; there is no evidence of core and blade production.

Stage 6: Tool Use

On the basis of the extremely limited data from the Component II level (i.e., no artifacts), it is not possible to make any statement concerning tool use. Also, because no faunal remains were recovered from this upper level, we cannot infer lithic tool use as reflected by butchering practices.

Stage 7: Disposal

As in the case of Component I, discarding of detached flakes may have occurred at any stage of biface reduction. Since this entire system is not represented in the Component II debitage, most Component II disposal probably occurred during Stages 3 and 4. The disposal of debitage in the Component II level appears to have occurred at the same locus as its locus of manufacture; it is thus considered primary disposal.

Summary

The primary purpose of this chapter has been to attempt to transcend the static record of the lithic remains, and to place thm in their systemic context of resource procurement, modification, and discard. While it can never be stated with 100% certainty precisely what activities took place at the site, we have at least attempted to explore the range of possibilities as borne out by the data.

In essence, the Component I lithic system entailed the procurement of argillite/hornfels from a local quarry source and perhaps a cobble or two from the Nenana River gravel, probable heat-treatment on-site to improve flaking characteristics of the raw material, biface reduction, and possible use of several implements and flakes in the dismembering of several animals.

The Component II system was limited to secondary biface (?) reduction, probably utilizing both direct percussion and pressure flaking. The limited data from Component II do not permit a more precise statement than this, however. As in the case of Component I, the Component II lithic raw materials were probably obtained locally, within the Nenana Valley.

CHAPTER 7

FAUNAL ANALYSIS

Introduction

Faunal analysis, as defined here, is minimally the identification, analysis and interpretation of bone remains from an archeological site. Through faunal analysis, much important site interpretative data may be realized, including aboriginal subsistence strategies, settlement patterns, butchering practices, seasonality, and relative dietary importance of animal species. The Carlo Creek research strategy included faunal data as an integral part of the interpretation, from the perspective of both the systemic and archeological contexts.

During the excavation of HEA 031, bone or shell remains representing five different taxa were recovered. These can be placed into two general categories: (1) artifactual and (2) non-artifactual. Artifactual faunal remains are those associated with, or a result of, past human activity at the site. Such remains occur non-randomly due to actions of human behavior. They are purposely brought to a locus, and are discarded and/or modified for one purpose or another. At the Carlo Creek Site, (Component I), artifactual faunal remains (N=306) represent three mammalian species: caribou (*Rangifer* sp.), mountain sheep (*Ovis dalli*), and arctic ground squirrel (*Citellus* sp.), (see Fig. 29, and Tables 7 and 8).

Non-artifactual faunal remains found at Carlo Creek include two species of pulmunate snails: *Succinea* sp. and *Discus cronkhitei*. Both of

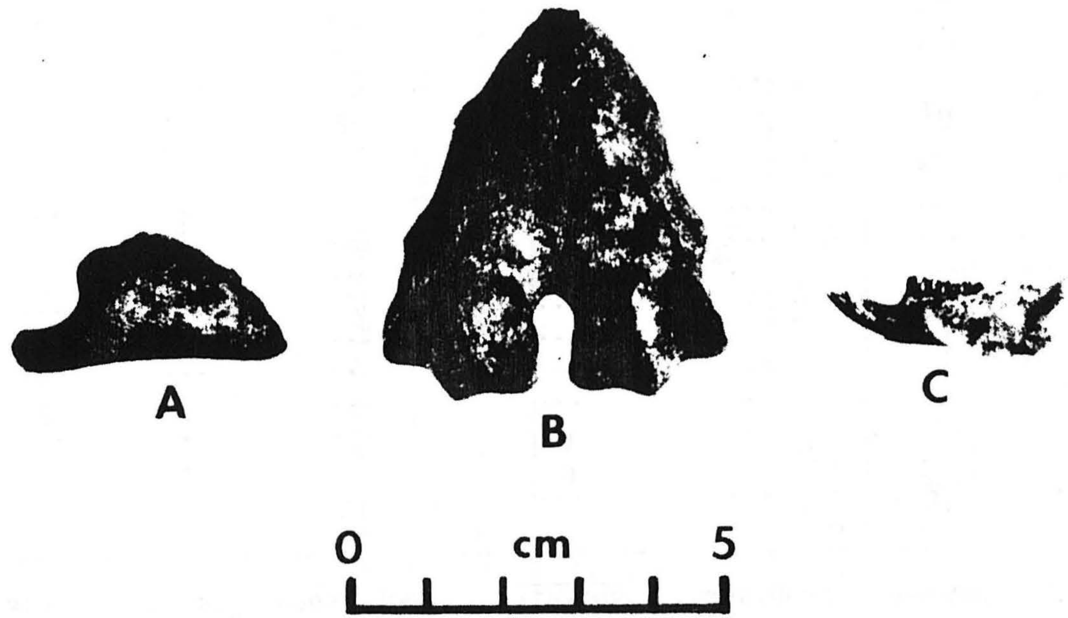


Fig. 29.--Representative Examples of 3 Mammalian Species Found in Component I. A = Ovis; B = Rangifer; C = Citellus.

TABLE 7

COMPONENT I FAUNAL DATA

Anatomical Element	Large Mammal			Small Mammal		All Remains			
	Caribou[a]	Sheep[a]	Unassigned	Citellus[a]	Unassigned	Burned	Cut	Spiral Fracture	Total Elements
Skull	...	...	31	...	...	31	...	...	31
Mandible	...	...	...	9	...	...	...	...	9
Maxilla	...	...	...	4	...	...	...	...	4
Metacarpal	2	...	...	...	...	...	...	1	2
Talus	...	...	...	...	...	...	...	...	0
Carpal	1	...	...	...	...	1	...	...	1
Metapodial	...	...	7	...	...	1	1	4	7
Phalange 1	2	...	...	...	...	...	...	...	2
Phalange 2	1	...	...	...	...	...	...	1	1
Phalange 3	...	1	...	...	...	...	...	...	1
Metacarpal (vestigial)	1	...	...	...	...	...	...	...	1
Carpal/tarsal	...	...	20	...	...	10	...	...	20
Long bone	...	...	16	...	23	...	1	4	39
Indeterminate	...	...	55	...	5	...	...	1	60
Incisor, upper	...	...	...	7	...	...	...	...	7
Incisor, lower	...	...	...	14	...	1	...	...	14
Incisor, indeterminate	...	...	...	32	...	...	...	...	32
Premolar	...	...	...	7	...	1	...	...	7
Molar	...	...	...	68	...	7	...	...	68
TOTAL	7	1	129	141	28	51	2	10	306

[a]M.N.I. for caribou and sheep is 1; M.N.I. for Citellus is 9.

TABLE 8

FREQUENCIES OF SELECTED CHARACTERISTICS OF THE FAUNAL ASSEMBLAGE FROM THE CARLO CREEK SITE

Characters	Proportion of Large Mammal Bones[a]	Proportion of Small Mammal Bones[b]	Proportion of Total Bones
Burned	31.38%	5.33%	17.00%
Spiral fracture	7.29%	0	3.28%
Dentition	0	75.74%	41.83%
Unidentifiable[c]	94.16%	16.57%	51.30%

[a]Large mammal bones comprise 44.77% of the total number of bones.

[b]Small mammal bones comprise 55.22% of the total number of bones.

[c]The frequency of unidentified bone is a relative index of fragmentation.

these snail species occur from 5 cm to 50 cm above the cultural level, within the basal portion of Unit 3 (refer to Fig. 11). They are fairly evenly distributed throughout this zone, and show no apparent relationship with the main cultural areas of artifact and bone clusters. Snail samples were collected from unit 3 sediment samples; no attempt was made to recover all snails from that level. Discussion of snails at the Carlo Creek site is reserved for a later section on paleoecology (Chapter 7).

Bone remains excavated from the site occurred only in the Component I level. There were no indications of food storage pits, nor were there any observable non-human features such as animal burrows. It is posited that the animals represented by these bone remains were brought into the site, where they were discarded, modified, or utilized in one form or another by the site's prehistoric inhabitants. Faunal remains at HEA 031 are scattered in and around the main area of lithic modification activities, and appear to be most closely associated with Hearth 1 (see Fig. 18) in the Component I level.

In discussing faunal analysis, Bonnichsen (1973:9) has aptly stated that, "Faunal remains are a primary source material for interpreting aboriginal subsistence patterns as well as identifying man's presence. It is more important than ever to be able to distinguish cultural from natural systems of bone alteration." He further states that "...before bone data can be understood, the kinds of cultural and natural filters (cf. Reed 1963) through which they have passed must first be understood " (1973:13).

The following discussion will deal with these various "filters" through which they passed in the transformation from living animal, to prey species, to butchering, and finally, to the transformation from cultural-ecological systemic context to the archeological record. Among other considerations, it will be necessary to examine the ecology of mammals, possible or potential aboriginal hunting strategies, decision-making necessary to harvest these resources, the "schlepping" (cf. Daley 1969:149) of animal butchering units from kill site to campsite, further "culling" (cf. Binford 1978a:460) of butchering units out of the site context, on-site processing (cf. Binford 1978a:460) and utilization, recognizable effects of human alteration of bone, disposal, and finally, post-depositional alterations, preservation, and archeological recovery.

For a number of reasons, there is little doubt that the Component I level bones are artifactual; this includes the ground squirrel remains as well as the caribou and sheep. This argument is supported by the following points:

1. The bones, together with lithic remains and charcoal, occur in a stratigraphic/geomorphic setting which would make it virtually impossible for them to have been transported and deposited in this area by natural processes. The predominately sandy matrix in which they occur indicates they were deposited by human agency. In addition, there is no sorting of the bones according to weight or size, as one might expect if they had been transported by water. There is no apparent sorting of lighter bone and charcoal fragments relative to massive lithic specimens.

2. Mammalian faunal remains at HEA 031 are spatially related to other aspects of human occupation - hearths and lithic concentrations (see Fig. 18). This association is clearly not a random one.

3. As previously stated, there is no evidence anywhere in the site for krotovinas or active animal burrows. This fact is especially important in the consideration of the Citellus sp. remains. There is little doubt

that they occur at the site as a result of human action, and probably represent a food resource for early Holocene hunters. Small mammal remains were found in close proximity to the hearths, and at least nine bones were charred.

4. Some of the bones have been altered in such a way as to indicate human manipulation. Such alterations include charring (17.0% of total), cut marks (0.65% of total), and "spiral fractures" (3.28% of total) directed to the medial segments of long bones (cf. Sadek-Kooros 1972; Bonnichsen 1973, 1977, 1978, 1979).

5. There are no suggestions for carnivore-derived bone alterations, such as tooth perforation marks, gnawing, spiral fractures directed from the epiphyseal ends, or partial digestion (Bonnichsen 1973:24). Many of the bones at HEA 031 are splintered and fragmentary, which is taken as a further indication of human actions. Such actions may have included bone smashing to extract marrow, preparation of bone "grease" (Binford 1978a) of various segments of the carcass.

Faunal Analysis: Methodology and Interpretation

In an attempt to establish tight spatial controls, faunal remains excavated from HEA 031 were mapped in to the nearest centimeter. All in situ mammalian faunal material was collected from the site, while non-artifactual gastropods were collected randomly, as part of Unit 3 sediment samples. Bone remains were stabilized, where necessary, with vinylite resin and/or polyethylene glycol. The majority of the bones, onced thawed from the frozen Component I level, needed little or no stabilization, and were bagged without further treatment.

Preservation of faunal remains at the Carlo Creek site is regarded as relatively good, despite the small sample recovered from the site. A large proportion of the recovered pieces were fragmentary; the size of these fragments is interpreted as having resulted from human activity, rather than from post-depositional changes at the site. The fact that small and comparatively delicate bones such as ground squirrel mandibles (N=9) were preserved attests to the site's quality of organic preservation. In addition to the presence of frozen ground, preservation in the site may also be attributable to the base-rich sediments in the vicinity of Unit 2 and Unit 3 contact.

In discussing the excavation of bone at Carlo Creek, mention should be made of a probable recovery bias in favor of large-mammal and large fragment remains. Guthrie (1968:224) has previously addressed this question:

> Small mammal remains are more subject to long distance transport by either physical or biotic forces...because of their small size, the bones of small mammals would be less resistant to destruction by exposure and crushing than large mammal bones, but might be more easily covered by sediment and preserved.

Similar observations have been made by Plaskett (1977), Repenning et al. (1964), and by Ziegler (1965). The first study (1977:114) suggests that a significant recovery bias may result from screening backdirt through 1/4 in. mesh screens. (Although a number of bulk soil samples were collected from Component I, most of the excavations employed the use of a 1/4 in. mesh screen.) Thus, for these reasons, any MNI figures (minimum number of individuals) developed for the Carlo Creek small mammal data must be regarded as conservate estimates.

Laboratory analysis of the faunal collection proceeded as follows: Individual bones or bone fragements were first cleaned, cataloged, and if necessary, further stabilized with vinylite resin. Individual fragements or bones were then classified with data recorded for: (1) catalog number,

(2) provenience, (3) anatomical element, (4) side, (5) species, (6) age, and (7) presence or absence of modifications (charring, cut marks, or spiral fracture). The systematic variable list utilized for this project was modified and simplified from Bonnichsen and Sanger (1977:115), with influences from Binford (1978a), Chaplin (1971), and Grayson (1973).

Identification relied upon comparative specimens from the faunal laboratory of the Washington State University Anthropology Department, Conner Museum, Washington State University, and the vertebrate paleontology collection of the University of Alaska Museum. Although all identifications were made by the author, several specimens were examined for confirmation by faunal experts Carl Gustafson, Chris Brown, S. Kent Harkins (all of WSU), and R. Dale Guthrie (University of Alaska). In addition, several published and unpublished keys were used (Glass 1951; Gustafson n.d.; Hall and Kelson 1959; Lawrence 1951; MacDonald 1978; and Schmid 1972).

For the purposes of classification, the analytical concept of size working group was evoked. Bones were divided up first into two major and largely subjective categories based on relative size. After each fragment or complete bone was classified according to the above procedures, the data were entered in Table 7.

As indicated in Tables 7 and 8, most of the 306 bones from the site are small fragments, which precluded positive identification of more than 51% of the assemblage. The most commonly-represented elements in the collection are tooth fragments (n = 128; 42 % of total), all of which are of <u>Citellus</u> species. Dentition was the best-preserved portion of the faunal assemblage. Molars and premolars were, for the most part, intact. In several cases, they were still articulated within a maxilla or mandible fragment.

A number of cranial fragments (31) were excavated from within the limits of Hearth 1 (see Fig. 18). These were all in a fragmentary and charred condition, and were identifiable as cranial fragments on the basis of unfused sutures, and presence of trabeculated bone between two compact bone layers. On the basis of relative size, they appear to be large mammal remains, probably caribou. I cannot, however, rule out the possibility that they are human. The largest fragment measured 25 x 19 mm. None of these specimens were identifiable according to species, although their proximity to other caribou bones leads me to suspect they are of that taxon. The position of the cranial fragments within the hearth, their fragmentary condition, and the fact that they were found in an "inverted" position (inside of skull facing upwards) suggests the cranium was purposely smashed, perhaps to extract brains. The non-closed sutures suggest a young adult or immature animal.

Identifiable large mammal remains, with the exception of the cranial fragments, are restricted to either fore or hind limb bones: metacarpals (2), carpal (1), unassigned metapodials (7), and phalanges (4). Seven of the above bones appear to be from a single caribou limb. The presence of sheep is indicated only by a single 3rd phalange.

The one sheep bone is worthy of special note. It was found out of context, during the initial 1975 investigation of the site. Found protruding from the Component I level, it was associated with argillite flakes and one biface fragment. I have estimated its position within the excavation grid as square 1-2 N, 3-4 W. There is little doubt, however, that this representative of the taxon Ovis was associated with the Component I occupation. The identification of this specimen was cross-checked a number of times, using a minimum of six comparative specimens. The fact that sheep is represented by only one phalange is probably due to the highway construction activities which first exposed the site. It is quite likely that there are fragmentary remains of at least one early Holocene-age mountain sheep scattered somewhere in the fill of the George Parks Highway.

Because of the fragmentary nature of the Carlo Creek large mammal remains, it was not possible to determine the sex of those specimens. Determining age of individuals represented by the bones likewise was not possible. In several instances, it was possible to make general statements regarding the apparent degree of epiphyseal fusion or suture closure; these observations were not sufficient, however, for making definitive statements on the age of the animal. No attempt was made to determine sex or age of the small mammal remains.

Intentional human-induced (?) modifications of bone were identified by several criteria (see Table 7). Charring or calcification of bone was determined simply by color observations (charred black or calcified white, as opposed to unaltered brownish color) and/or hardness (e.g., denseness and good preservation of bone resulting from thermal alteration). Cut marks were indicated unambiguously on only two samples; these both show tiny grooves transverse to the main axis of the bone. Neither of these specimens, a metapodial and long bone, were identifiable as to species. Presence or absence of spiral fractures was determined through application of previously-established comparative critera (Sadek-Kooros 1972; Bonnichsen 1973, 1978, and personal communication, 1977). A total of 10 specimens possessed spiral fractures: 1 caribou metapodial, 4 unassigned metapodial fragments, 4 unassigned long bone fragments, and one completely undiagnostic bone fragment. It should be noted that presence or absence of <u>any</u> of these traits does not in and of itself imply human alteration. However, when viewed in terms of the total assemblage and intrasite spatial relationships, the presence of certain traits may be of interpretative importance.

Following classification of bone fragments and human modifications, the faunal data were manipulated to derive estimates of minimum number of individuals (MNI). MNI is here defined as the lowest number of individual animals present from an archeological locus, which are necessary to account for all the elements (or fragments thereof) of a particular species (modified from Shotwell 1955). Although a variety of formulas have been proposed for MNI calculation (e.g., Chaplin 1971; Grayson 1973) the simplified expression of the concepts, as used here, appear to me to most accurately estimate true MNI.

One problem encountered in interpreting these data has resulted from the fragmentary condition of the bones, which necessitated a slight revision of the above formulations. For example, if ten metacarpal fragments were identified, we cannot assume automatically that ten metacarpals, and accordingly, five individuals are represented. The faunal analyst must do some anatomical reconstruction of the fragments of each identified bone to obtain the smallest number of complete elements represented by the fragments. If we were to assume that our hypothetical ten fragments were all from the same metacarpal, then we would have identified only one individual from the site. One can readily see the potential for error in this mis-application of these formulae. Similar problems in MNI determination are discussed in greater detail by Binford (1978a) and by Grayson (1973).

Given the above parameters, calculation for MNI in the Carlo Creek Component I assemblage indicates 1 caribou, represented by 7 elements, 1 sheep, represented by 1 element, and at least 9 ground squirrels, represented by 141 elements. The figures for the caribou and sheep are regarded as fairly accurate assessments of the data. The estimate of Citellus sp. MNI is quite definitely a minimum one, due to the previously discussed sampling bias in favor of large mammal remains.

One final level of abstraction from the data will be mentioned here. For a number of reasons, however, its utility in interpretation of the Carlo Creek data is questionable.

A number of authors have attempted to calculate the weight of meat which may have been available for human use at a given site (e.g., Hall 1971; Lyman 1979; Plaskett 1977; Thomas 1969; White 1953a). In an earlier preliminary presentation of the Carlo Creek faunal data, I attempted a similar calculation (Bowers 1977a:13). The major aims of these kinds of analyses have been to try to determine potential diet, carrying capacity, and, ultimately, population sizes for a given site.

Using standard formulas (Lyman (1979; Thomas 1969; White 1953a) it can be estimated that the large mammal bones found in Component I represent 8.49 lbs. (3.82 kg.) of meat (Table 9). While other studies have attempted to extract dietary and population inferences from such a figure, it is felt that this kind of projection would be inappropriate for the Carlo Creek site data.

The first problem encountered is the fact that the sites boundaries (i.e., sampling universe) are ill defined, due to destruction of part of the site, and/or the lack of definition of the eastern boundaries due to excessive overburden and manpower limitations. These factors preclude any exact statements concerning diet and nutritional "reconstruction" for the site as a whole based on faunal remains.

TABLE 9

CALCULATION OF POTENTIAL AVAILABLE MEAT WEIGHTS

Portion	Caribou (lbs)	Dall Sheep (lbs)
Live weight	240	180
Carcass weight[a]	168	131
Butchering unit[b]	8.4	6.5
Meat weight/butchering unit[c]	4.8	3.7

ADAPTED FROM: White 1953a; Lyman 1979.

[a]Carcass weight is 70% of live weight for caribou, 73% of live weight for sheep.

[b]In this case, a butchering unit is assumed to be either a hindshank or foreshank; weight is about 5% of carcass weight.

[c]Meat weight is about 57% of butchering unit weight.

A second problem in determining dietary potential from faunal remains is the assumption that only fresh meat was used at a site. In addition to this potential use, meat obtained from the lower limb of a caribou or sheep may also have been used for dried meat, sinew, marrow, bone "grease" (cf. Binford 1978a:32-39; White 1953b), dog food, or trap bait. Additionally, such bone remains may represent raw materials for artifact manufacture. One of the key questions, given these possible uses, is how much meat was actually left on the bone and thus available for human use?

Furthermore, the assumption that the meat was used on site is perhaps the major source of error in faunal interpretation. It is not a reasonable a priori assumption that an entire carcass was used at a given site. Modern ethnographic observations (cf. Binford 1978a) suggest that, more often than not, an animal is butchered into units for the purposes of transport and/or further modification. If such ethnographically-observed "culling" (Binford 1978a:460) of selected anatomical units is correct, we should be able to predict the anatomical portions represented at functionally-specific types of sites.

The Carlo Creek data suggest that most of the meat obtained from the caribou and sheep was probably used elsewhere, and that HEA 031 was a killsite and/or primary butchering site. The fact that bones were cracked and splintered tends to compound this interpretation, suggesting utilization of marginal-value bones for marrow or bone great extraction. Only lower limb bones (phalanges up to metapodials) are represented at the site, in addition to the few cranial fragments. Such an assemblage is highly suggestive of a kill station or "field" butchering site, where a dispatched animal was processed, and the low value meat units (e.g., lower legs, skull) were selectively culled from the dismembered carcass. Presumably, the high-yield portions (higher caloric potential) were transported to a "central base" camp (terminology based on Chang 1962 and Campbell 1968).

A number of ethnographic sources demonstrate analogous selectivity in faunal assemblages. For example, White (1953b:162-163) discussed bison bone remains from two archeological sites near Pierre, South Dakota:

> If the kill was some distance from the village, the lower legs were removed by chopping through the wrist and ankle... Since the lower limb does not carry any usable meat, it is conceivable that it was chopped off, either through the distal end of the radius or through the carpus, and left at the place of kill in order to reduce the load.

Bonnichsen (1973:11) has described a similar situation in his observations of butchering practices among the Calling Lake Cree in Alberta: "The rather nonproductive carpals, tarsals, and phlanges are not broken for marrow. In fact, they are not represented in the Calling Lake assemblage, a fact which suggests that they were left in the field with the animal's intestines."

One of the best interpretative sources for the Carlo Creek faunal data is Binford's recently published Nuniamuit Ethnoarcheology, which describes in detail the economic anatomy of sheep and caribou, butchering practices, types of sites, subsistence/procurement strategies, and subsistence/seasonal patterns of a Brooks Range (Alaska) inland Eskimo group. His study, based on observations of 277 caribou dissections at 411 separate kill-butchering locations, provides comparative data which one can apply cautiously to interpret the archeological record:

> The faunal remains in hunting camps have a characteristic signature in that some culling strategy is invariable practiced... the relative success and the attendant variations in transport problems may condition the particular forms of culling strategies employed (1978a:342).

The "culling" strategy as applied to kill locations is the frequently-observed discarding of the lower limb bones, by smashing through the metapodials, leaving behind distal metapodial and phalanges. The skull is likewise discarded at the killsite, to enable easier transport of the high-yield meat-bearing anatomical elements back to the habitation site. Binford noted significantly higher percentages of distal leg and skull portions of caribou remaining in dispersed kill/butchering locations (1978a:76-77).

The fact that all of the Carlo Creek large mammal remains have been cracked and/or splintered may be interpreted as indicating extraction of marrow or bone grease (Binford 1978a:32) preparation. As suggested by several of the above-cited ethnographic sources (Binford 1978a; Bonnichsen 1973; White 1953a), it was common practice to make use of lower yield bones at the killsite, rather than squander high-yield meat or carry low value portions back to camp: "...thus the bones were left behind. The marrow and sometimes the brain were eaten as the butchering went on " (Wissler 1910:41-42).

In discussing the calorific-maximizing strategy employed by the Nunamiut, Binford makes the following observations, suggesting that intensive use of low-value bone sets could indicate hardship conditions. These observations offer a possible glimpse into the bone processing that took place some 8500 years ago at Carlo Creek:

> If food is in short supply, or if marrow bones from the legs are not available at the meal, consumers may break the phalanges for marrow. Today this is accomplished by placing the articulated first and second phalanges on an anvil stone and striking them a transverse blow with the back of a knife blade in the middle of each shaft. This results in breaks in the middle of each phalange. These are picked up and separated midshaft. The units recovered are (a) proximal first phalange, (b) articulated distal first phalange and proximal second phalange, and (c) distal second phalange. These are

> sucked and the marrow licked out of the small cavities. Once finished they are tossed in the bone dish for subsequent dumping by the woman of the house. Articulations remaining from such a meal are (a) vestigial metapodials and vestigial phalanges and (b) distal first phalange and proximal second phalange. Since this is a--"maximizing" meal -- that is, only prepared when stores are low the remains from such meals are rarely mixed with other anatomical parts. The resulting dump is almost always discrete resulting in a pile of almost nothing but phalanges (Binford 1978a:148-149).

On the basis of such ethnographic analogies, the Carlo Creek faunal data may best be interpreted as the remnants of a kill site or primary butchering site. One may speculate that the sheep and caribou represented at the site were killed fairly close by, then brought into the site for processing. Concomitant with carcass dismemberment and preparation of high-value portions for further transport might have been the on-site use of low value anatomical elements (e.g. lower leg and skull) for marrow extraction, bone grease preparation, and brain extraction.

As pointed out earlier in this chapter, it is difficult, if not impossible, to make projections concerning occupancy or population size; particularly as based on MNI or MT. WT. calculations:

> At kill sites and processing locations, the number of animals present in the faunal assemblages bears little if any relationship to the number of consumer days of occupation. In all these logistical locations, the relationship is systematically in favor of the presence of many more animals than are needed to sustain the occupants during the use of the location (Binford 1978a:448).

Thus, on the basis of the Component I faunal data and ethnographic comparisons with contemporary hunters in northern Alaska, we have been able to posit a number of statements concerning site function and activities. Although the large-mammal faunal assemblage from Carlo Creek is small, it is distinctive, and clearly suggests the nature and extent of human activites which occurred at the site some 8500 years ago.

Seasonality and Aboriginal Procurement Strategies

The faunal data from HEA 031, in addition to offering insights into site utilization and duration of occupancy, may also be useful in inferring seasonality. The fact that no antler, horn or other season-specific epiphysial elements were present in the large mammal remains from the site precludes the use of actual bone for determination of seasonality. However, a number of inferences can be made, based on the present-day ecology of the three mammalian species present at the site: ground squirrels, sheep, and caribou.

On the basis of available data, a late summer or fall utilization is suggested. The following observations may be marshalled in support of this interpretation:

1. The presence of numerous ground squirrel bones at the site, in association with other occupational debris, point towards use of the site during the warmer months, before winter freeze-up. Ethnographically, it is reported that Citellus parryi was taken by a variety of methods, almost exclusively during the late spring, summer, and early fall (e.g., Bee and Hall 1956; Campbell, 1968; Gubser 1965; Ingstad 1954; McKennan 1959, 1965; Nelson 1973; Spencer 1959). There is little evidence in the literature that these animals were harvested during hibernation periods in the late fall and winter, nor would it seem feasible. Indeed, such cold weather procurement of ground squirrels would present difficulties for the hunter, in that extracting the sleeping animals from snow-covered and frozen burrows might have required expending more net energy than could be realized in return.

2. Based on the observations of Bee and Hall (1956:55), Carl (1962: 51), and Tikhomirov (1959:33), daily average temperature of about -15°C

to -20°C are necessary before ground squirrels hibernate. If it is possible to project such patterns back to the early Holocene, we might surmise that the use of local ground squirrels--and hence occupation of HEA 031--took place while temperatures were higher than this. Given present climatological data for the Nenana Valley, this would suggest that the site was occupied after early April, and before early November. However, this assumes that (1) the ground squirrel bones at the site were deposited as freshly-killed animals, not as dried meat, and (2) ground squirrels were not dug out of their burrows during hibernation.

3. Such a seasonal pattern may be further supported by ethnographic data. Campbell, in a study of the North Alaska Brooks Range Eskimo, provides the following excellent observation:

> With the exception of two ungulates, the arctic ground squirrel was the most important food mammal. Adult arctic ground squirrels typically weigh only two or three pounds, but they are usually fat, are easily captured, and are abundant north of the forest. They hibernate in winter, and are then very difficult to obtain, but in summer, which is traditionally a time of hunger...a few trappers may take a dozen or more day after day for several weeks in an area of only a few square miles. For this reason, during the summers the Tuluaqmuit depended heavily on them. Arctic ground squirrels are so common and so widely distributed north of the tree line, that they had little to do with the precise locations of summer settlements within the tundra zone. However, the fact that this species is an open lands mammal very probably had much to do with the Tuluaqmuit dwelling on the tundra rather than in the forest during the warm season (Campbell 1968:13).

Carl (1962:83) reports that Arctic Ground squirrels were frequently caught by Eskimos of northwestern Alaska, by use of traps, sticks, hands, rifle, and were frequently taken by children with stones. He states that "...most of the squirrels are caught near the village or near seasonal camps."

McKennan (1959:60-62; 1965:32), Nelson (1973:144), and Osgood (1970:111) all report the use of ground squirrels by inhabitants of the taiga zone. They were harvested in the past by snares and deadfalls. It should be noted that, during the historic period, ground squirrels were frequently looked upon as "famine" food, taken primarily when large game was not plentiful. In addition, squirrels are today, and probably were in the past, regarded as sources of high quality pelts. The Inupiat word for these animals is Siksrik, translated roughly as "parka squirrel" (Webster and Zibell 1970:76).

4. As stated in Chapter 2 of this thesis, the occurrence of caribou and sheep in the Nenana Valley area is presently most frequent during late summer to early winter (Alaska Department of Fish and Game 1973; Guthrie and Powers 1977; Hemming 1971; USDI 1976; Van Schoonhoven 1900; Yanert 1900). Whitten (1975:71) states that the main Alaska Range supports many sheep in the summer, but that winter habitats are generally restricted to the outer ranges. A similar seasonal pattern may have been operative during the early Holocene. Sheep reportedly are taken most frequently in the Brooks Range during the period July through October, and begin coming down into the lower elevation mountain valleys in late summer and fall (Binford 1978a; Bee and Hall 1956). Binford (1978a) observes that distal leg remains of caribou (of the sort found at HEA 031), tend to occur in greatest proportions in archeological sites in the fall.

Taken together, the above observations suggest that the Carlo Creek site was most likely occupied during the late summer or early fall. The presence of a sizeable number of ground squirrels at one locus argues that they were not harvested during the colder months. Present patterns of seasonal movements of caribou and sheep suggest these animals were in the Carlo Creek area in greatest densities during the late summer to early winter. Ethnographic patterns of seasonality and subsistence strategies indicate the most intensive aboriginal use of the area occurred in the fall and early winter.

In terms of aboriginal procurement techniques, it is probable that the caribou represented in the fossil record at Carlo Creek was obtained through any one of four ethnographically-documented hunting strategies: intercept, pursuit, lure, and drive (Burch 1972:339-368; Plaskett 1977:179). Sheep may have been obtained by all of the above methods except for lure (Plaskett 1977:179). Ground squirrels may have been collected by snaring, deadfall, trapping, lure, or pursuit.

To summarize, the mid-valley location of the Carlo Creek site was probably a strategic one for hunting. The probable aboriginal use of the site was in late summer or fall. During Component I occupation, at least nine ground squirrels were taken locally, in addition to one sheep and one caribou. The large mammals were butchered at the site; the carcass portions of relatively high dietary value were removed from the site, perhaps to some "regional base" type of camp. The left-over large mammal faunal remains at the site were utilized for marrow, and possibly in bone grease preparation. The bones found at the site are all representative of relatively lower dietary value butchering segments. On the basis of available data, aboriginal group size cannot be determined; however, several hunters, a small hunting band, or an extended family would be a reasonable estimate for the nature of the social unit exploiting the site.

CHAPTER 8

PALEOCOLOGY

Regional Paleocology

Precise determination of early Holocene vegetation in the upper Nenana Valley is not possible at this juncture. One of two pollen cores collected from Otto Lake in connection with the Dry Creek Early Man Project has yielded a maximum age of 5620 ± 250 years: 3670 B.C. (W-3888) (Ager, personal communication, 1979). The cores from Otto Lake indicate that spruce was established in the northern foothills of the Alaska Range by at least the mid-Holocene. However, they tell us little about regional pre-Hypsithermal vegetational changes.

The vegetation sequence for interior (unglaciated) central Alaska is somewhat better understood. Based primarily on the work of Ager (1975 and personal communication, 1969), the following sequence is indicated for the Tanana Valley lowlands.

From at least as early as 16,000 B.P. to 14,000 B.P. a late glacial "tundra steppe" environment zone is indicated, consisting of

> ...grasses, Artemisia, some sedges, and a number of opportunistic herbs such as Plantago, Taraxacum, and various Compositae and Cruciferae. Climate during that full-glacial interval was extremely continental with very severe winters and dry, warm summers of short duration. Mean annual temperature was perhaps in the range of -7°C to -12°C, whereas at present it is about -4°C in the lowland. Pollen of spruce and alder are nearly absent in sediments of late Wisconsin age from the region... (Ager 1975:87). (Note: Ager [personal communication, 1979] suggests that his earlier figures for full glacial temperatures should be viewed extremely conservatively).

At approximately 14,000 B.P., a sudden climatic change evidently occurred, resulting in a change from xeric steppe tundra to more mesic shrub tundra. Evidence from this pollen zone (2) indicates that shrub birch, willows, sedges, grasses, and heaths were common in the area (Ager 1975:87).

The first indications of spruce migration into the lowlands occurred as early as 11,000 B.P. and most likely, at about 9500 B.P. (Ager, personal communication, 1979). By 8000 B.P., spruce-birch forests had more or less dominated the shrub tundra (Ager 1975:87).

The past 9400 years, as represented by Ager's subzone 3B, indicates increasingly high percentages of alder, with a noticeable decline in spruce in the interval from 8400 to 7000 B.P. (1975:88). Ager has suggested that this decline could be explained either by an increase in frequency of forest fires, brought about by warm dry conditions, or alternately, by forest pathogens (Ager 1975:88).

The final 6500 years of the Tanana Valley pollen record shows little change. However, it is unlikely that tree-line fluctuations would have been recorded in these lower elevation sampling locations (Ager 1975:88).

Of significance to the Carlo Creek study is the question of the time of spruce appearance in the Tanana Valley, and more importantly, its appearance in the higher elevation mountain passes of the Alaska Range. Ager's sampling localities are at elevations of approximately 400 m above sea level (1975:3); in contrast, the Carlo Creek area lies at an elevation of 600-700 m a.s.l.

Supporting evidence for the presence of spruce in the Tanana Valley is indicated in the work of Matthews (1970, 1974). He reports that spruce forest was probably established in the vicinity of Tofty, central Alaska, by ca. 7300 B.P., while a fairly contemporaneous forest presence is documented for the Fairbanks area by at least 8080 B.P. (Matthews 1970:249).

A more precise dating of the beginning of the taiga forest in the interior is indicated by Matthew's (1974) pollen percentages for Picea and Betula in the Isabella basin near Fairbanks. There, his zone B-C boundary indicates the occurrence of a major vegetation change between about 7800 to 9200 years B.P. (Matthews 1974:838). Matthews (1974:838) has followed Péwé's suggestion that the "grassland" to forest change had occurred by at least 8500 B.P.

West (1972:15) reports that the pollen work of Schweger in the Tangle Lakes vicinity indicates that spruce was present at that relatively high altitude (ca. 879 m a.s.l.) by about 9100 B.P. The present day ecosystem in the Tangle Lakes region has been described as "shrub tundra, low sedge, and grass tundra, and low matted tundra with occasional open stands of black and white spruce" (West 1974:217).

The work of Denton and Karlén (1977) may offer perhaps the best data for inferring the elevation of the upper Nenana Valley early Holocene treeline. They report (1977:103) a date of 8020 ± 120 years: 6070 B.C. (Y-2302) on a buried spruce stump which occurs at an elevation of 1067 m a.s.l. (183 m below present treeline) in the White River Valley, northern St. Elias Mountains. They interpret this date as a minimum age for early Holocene forestation in the valley. This age also appears to correlate fairly well with Rampton's (1971) date of about 8700 B.P. for spruce migration into the northern St. Elias Mountains.

Taken together, the above data would indicate that spruce could have been established in the upper Nenana Valley by the time of Carlo

Creek I occupation. Obviously, the details of this interpretation are obscured by the lack of good pollen data from the site itself. It is probable that the constant shifts in the course of the braided Nenana River would have resulted in a series of early successional stages of vegetational communities, as is described below. Whether the vegetation in the area was a sparse scattering of spruce in a shrub tundra or herbaceous tundra association, or a denser closed spruce forest is conjectional at present. However, dating from other parts of the interior Alaska do suggest that the treeline may have risen to at least 600 m in the Central Alaska Range by at least 8500 B.P. Ager (personal communication, 1979), has stated that "...it is very difficult to confidently differentiate between closed spruce forest and open spruce-shrubby tundra on the basis of pollen data alone. It is also difficult to differentiate treeless shrub tundra from open spruce forest, if the shrub site is within 20-30 km or so of spruce-alder sources".

Local Paleocological Setting

As discussed in the geology chapter, an actively aggradating floodplain has been inferred for the time at which the Component I human occupation took place. On the basis of mammalian faunal analysis, a late summer-fall utilization of the site has been suggested. It may be postulated that the site was fairly dry, at least during the brief periods of human occupation. Without detailed modern studies of the Nenana River floodplain for comparison, it is not possible to reconstruct the exact setting of the camp in relation to the river. One might surmise, however, that the hearths were utilized within a few tens of meters from the river, on a dry portion of an abandoned river braid bar.

It is possible, too, that a spring which is present at the site (presently used extensively by the local inhabitants), was flowing in roughly its present pattern. Based on the site's present position in the post-glacial terrace sequence, it is fairly certain that the locality would have commanded a fairly good view of the floodplain, for approximately 3.0 km to the south, 1.0 km to the west, and 2.0 km to the north. The position of the site at an inflection point in the river's course (see Fig. 9) may indicate a fairly wide sandy braid-bar deposit on which occupation occurred. It is thus probable that a trek of only a few kilometers would enable the inhabitants of the site to obtain necessary water, lithic resources, and probably, willow or alder for firewood and shelter. Within 0.5 km to the east, a higher terrace would have provided an excellent vantage point, with a good view of the entire valley.

It has not been possible to determine the vegetation at the site during the time of occupation. Pollen is not well enough preserved at the site to permit detailed palynological studies. It is quite possible that, despite the frozen strata overlying the early cultural deposit, episodes of oxidation/reduction during the early phases of Unit 3 deposition would have been sufficient to destroy much of the fossil pollen.

During recovery of sedimentological samples at the site a number of pollen samples were systematically collected. A single sample from the Unit 2/3 contact "paleosol" was submitted for analysis to Thomas Ager, USGS palynologist. His report on the sample indicated that pollen preservation was poor: "The sample from the site itself is nearly barren of pollen and spores. There are a few grains of resistant spores like Lycopodium, monolete fern spores, and occasional pollen grains of spruce, and alder" (Ager, written communication, March 1978).

On the basis of the local pollen data it is thus not possible to reconstruct early Holocene vegetation. It is probably that spruce may have been present in the valley at ca. 8500 B.P., along with alder and willow. This assumption is by no means unreasonable, based on the limited pollen preservation at the site, and given the supporting data from other parts of the interior Alaska, especially Denton and Karlen's 8020 year old dated spruce from the White River Valley (1977:103), and Schweger's 9100 B.P. evidence for spruce migration into the Tangle Lakes area (West 1972:15).

Data on terrestrial invertebrates collected from the site may offer additional evidence relating to the site's paleo-environment. Two species of gastropods occur stratigraphically from 5 cm to approximately 50 cm above the Component I occupational level, within Unit 3 floodplain silts. The occurrence of two species of terrestrial mollusca, Succinia sp., and Discus cronkhitei, are generally associated with moist habitat, as in a river floodplain (Dall 1905; Henderson 1931; Pilsbry 1939-48; Péwé 1975a; and Taylor (1965). Kalas (Matthews 1974:835) has suggested an open woodland type of habitat for Discus cronkhitei, while McCulloch et al. (1965) have posited that these snails also inhabited "hypoarctic" tundra sites. Matthews (1974:835) uses the association of Discus cronkhitei macrofossils, Picea, and Rubus idaeus, in zone Aa of the Isabella Basin near Fairbanks to argue for a probable "...open, sedge-dominated environment with scattered spruces and practically no alders". This, he suggests, may be roughly analogous to the contemporary forest-tundra ecotone (1974:336). In addition, Repenning et al. (1964: 183-185) report an apparent association of Succinea sp. in sediments bearing plant macro-fossil remains tentatively identified as Labrador tea (Ledum sp.) and cranberry (Vaccinium vitis-idaea).

I must add a note of caution, however, in the use of such species as index fossils or in suggesting their possible utility as sensitive climatic indicators. Péwé (1975a:88) summarizes Succinea occurrences in central Alaska, and notes that they occur in loess less than 1000 years old as well as in strata of Wisconsin age. J. Mead (personal communication, 1976) has indicated to the writer that Succinea sp. in particular, may be a rather unreliable indicator of microenvironment as they are known from throughout North America and have a wide ecologic amplitude.

On the basis of available data, however, we may posit a locally moist environment for the period following Carlo Creek I occupation predictable in an actively aggrading floodplain and may tentatively speculate that a riparian open-canopy forest may have been in the valley. Obviously, detailed pollen studies from the upper valley will be needed to firmly establish early Holocene movements of spruce into areas of successively higher elevations.

Viereck (1966) has summarized the modern day vegetational succession on gravel outwash from the Muldrow Glacier, Central Alaska Range, located at elevations of 730 m to 760 m a.s.l. His observations may provide a useful analogy in interpreting the paleoenvironments of the Carlo Creek site cultural occupations. His five stages (vegetation stands) of succession are thought to span the intervals 25 to 30 years, 30 to 100 years, 150 to 200 years, 200 to 300 years, and 5000 to 9000 years, after initial subaerial exposure of glacial outwash sediments (Viereck 1966:198):

> The vegetation development progresses from that of scattered mat plants with isolated willow and Shepherdia shrubs to a closed grassy meadow interspersed with small but dense clumps of willow shrubs and eventually replaces them. The low shrub birch forms a continuous and even stratum underlain by a thick moss layer of Hylocomium splendens and Pleurozinium schreberi. The final stage, the climax tundra, consists of low shrub birch and ericaceous shrubs interspersed with Eriophorum vaginatum tussocks growing through Sphagnum and other mosses.

On the basis of these observations (Viereck 1966), the Carlo Creek Component I data may be comparable with Viereck's stage I and/or stage II vegetation stands. Relatively minor proportions of organic matter in the paleosol at the contact between Units 2 and 3 at Carlo Creek suggest that the development of the soil (inceptisol) was in its early stages of development; hence vegetation was probably restricted to early successional stages. The Stage I vegetation described by Viereck (1966:186-187) is composed primarily of "...mat and clump species which attain a height of only a few centimeters above the surface... visually estimated cover is 50%". He indicates that Dryas sp. and legumes are a major constituent of these communities, even though their total cover is less than 20%.

In addition, a few shrubs in "Stage I" as tall as 1.5 m represent approximately 1% of the total cover; these include Salix spp. and Populus spp. (Viereck 1966: 187). His suggested age of 25-30 years for development of Stand I would probably be a fairly good estimate for the amount of time it took the Component I soil to develop. Floodplain alluviation would in all likelihood have occurred fairly rapidly after this region's human occupation, truncating the soil development processes.

Stand II from the Muldrow Glacier area, as described by Viereck, was found to consist of large groups of Elymus innovatus, Festuca altaica, and Poa sp. (Viereck 1966:187). These species virtually covered the abandoned braid bar, he observed, and included a number of herbs, other grasses, willows, and low shrub birch (1966:187).

Using a model for vegetation development such as Viereck's (1966) study, it is postulated that as many as four of his five stands may have been represented in the early Holocene Nenana valley's various floodplains and terraces. These communities were probably dominated by early successional phases of plant growth, which would have provided attractive grazing areas for large mammal herbivores. A similar idea was previously suggested by Ager (1975:85) who pointed out that well-drained outwash and eolian deposits may have provided good habitat for large grazing mammals, and may have been predominately "...vegetated by pioneer plant types such as grasses and herbs" (1975:85).

This hypothesis also has been stated by Péwé (1975a:102), who pointed out that floodplains of braided rivers such as this were probably major refugia for late Pleistocene herbivores due to the "disclimax" vegetation which favored grasslands. He observed (1975a:102) that such areas have a low permafrost table, are well drained, and have little muskeg. Particularly in the winter, such environments would have provided ideal habitat for herbivores, particularly in the wind-swept, snow-free floodplain areas. Thus, it might be inferred that a variety of local plant communities were available on the Nenana River floodplain for grazing herbivores and concominant human exploitation. Early successional plants such as grasses, sedges, <u>Salix</u> sp., <u>Alnus</u> sp. are common today on abandoned floodplain and braid bars in the Nenana Valley; these observations might provide a useful analogy with the early Holocene situation. This mountain pass is today an environmentally-attractive zone for many game animals, both in terms of vegetation, and as a natural "artery" for funneling animals through the Alaska Range. A site such as Carlo Creek would thus have been ideally located to intercept animals exploiting the area's rich and diverse vegetation.

CHAPTER 9

PREHISTORIC CULTURAL RELATIONSHIPS

Data from the Carlo Creek Site indicate that initial human utilization of the upper Nenana River Valley occurred not later than circa 8500 B.P. It is presumed that by this time, the valley would have been sufficiently free of ice and outwash to permit human and animal movements in a north-south direction through the Alaska Range. HEA 031 represents a high mountain pass floodplain site, which was probably utilized briefly (one to several days) by a small hunting group, perhaps by several males or family sized unit. The faunal remains preserved at the site are consistent of species extant in the valley today. Comparisons with ethnographic data suggest aboriginal use of the area occurred in late summer to early winter for hunting of sheep and caribou, with additional exploitation of ground squirrels. The nature of the faunal remains, combined with ethnographic data and the strategic mid-valley location of the site, suggest its use as a kill site, where the major portions of the large mammal carcasses were probably dismembered, then carried off to a regional "central base" camp.

Campbell's (1968) model of Nuniamuit settlement types may offer a useful modern day analogy for the probable pattern of subsistence and settlement for the early Holocene. His type III settlements are (1968:15) hunting or fishing camps. These are occupied most intensively during the leanest parts of the year (in the case of the Nunamuit, February through

March and June through July) by one to five males "...for periods of two to five days for the purpose of securing food." (1968:15). He Observed that:

> Caribou and Dall sheep were the game most sought after, but some Type III settlements were placed specifically for purposes of securing other vertebrates... [such as ground squirrels?] ...The importance of caribou and Dall sheep explains why so many settlements of this type were situated well up toward the heads of creeks or elsewhere high in the mountains, where the sheep dwell the year around and where caribou live in the summer.

Campbell suggests that a Type III settlement would have probably contained a makeshift shelter, most likely consisting of "...a few caribou hides stretched over boulders or supported by willow sticks " (1968:17). He states (1968:9) that the location of such settlements was largely dependent on available wood supplies (willow, in the case of the Nunamuit)-- and that they frequently were situated on "...well-drained, gravelly ground, usually on old stream bars" (1968:9).

What we can thus infer from the Carlo Creek data is a season-specific, task-specific site, which is representative of just one portion of an overall seasonal-settlement pattern (cf. Binford 1962). The limited variety of artifacts from the site supports this interpretation. The Carlo Creek data thus offer an excellent glimpse of one specific aspect of the early Holocene subsistence settlement pattern in interior Alaska.

Campbell (1968:18) has eloquently stated the importance of such factors as seasonality, ecologic setting, and limitations of site function:

> ...[If] we can assume that wandering hunters of the more distant past were obliged, like the Tuluaqmiut, to adopt to their habitats to secure the necessities of life, then we must recognize that the archeological record is likely to be selective not only in respect to the kinds of artifacts that survive, but also in respect to the kinds of sites that can be recognized. Tuluaqmiut settlements of Types II, III, IV and VI are fundamental components of the way of life, and information derived from Types I and V alone gives a biased picture. However, only the latter types normally possess sufficient

> cultural debris to permit discovery by archeologists centuries or millenia after their abandonment. This fact is not always fully recognized by specialists in Paleo-Indian or Paleolithic cultures; on the contrary, known sites are likely to be taken as representative of settlement patterns of these early hunting groups.

To this statement, a more general comment by Binford (1978a:342) may be added: "...hunting camps are accumulation points for foods in an extended logistical system. Animals introduced and culled at such locations are being accumulated not directly in terms of the consumer needs of the occupants but instead in terms of the consumer needs of a much larger group of consumers in the residential locations". It is apparent that prehistorians must look more closely at the details of seasonality, function, and setting in interpreting the portion of the total available tool kit which may or may not be represented.

The objective of these observations has been to place the Carlo Creek site within a larger framework of seasonality, function, and environmental setting, in order to make some cultural inferences about the site. To place the site in diachronic perspective, however, it will be necessary to go beyond the site itself, and compare the artifactual data with relevant data from other early Holocene age sites in central Alaska.

First of all, the lithic artifacts represented at Carlo Creek are primarily bifaces or biface fragments, with the single exception of a large "prismatic blade" or blade-like flake. These large percussion-flaked bifaces, manufactured from locally-available raw materials, represent what I would term "tools of the moment". As such, they would have achieved a functional level in the manufacturing process long before other implement types would, such as finely prepared microblade cores or projectile points. Many of the large, coarse-grained bifaces from interior Alaskan sites may represent quarry blanks carried to a site for further reduction as the need arose. It is thus extremely difficult to make definitive comparisons until it is known from what stage in the manufacturing process a set of specimens is derived and what function they ultimately served. Even with this knowledge of morphology, technology, and function, comparisons may have little cultural-historical value.

With the above cautionary remarks in mind, the following observations are made concerning the techno-cultural placement of HEA 031. These are not intended as an exhaustive review of the available data; such a review would be of marginal utility in light of the largely undiagnostic materials from Carlo Creek.

Artifacts from the Component II level at the Dry Creek Site (Holmes 1974; Powers and Hamilton 1978), located 35 km downvalley from Carlo Creek, suggest perhaps the closest similarities with those from HEA 031. Based on similar morphologies and some edge-wear comparisons, affinities are suggested between the biface industries at the two sites. Guthrie and Powers (1977:11-13) report that the 1977 excavations at Dry Creek revealed a number of spatially discrete biface reduction loci within the Component II level at the site; these suggest areas analogous to Loci A and B at Carlo Creek. It is significant to note that these biface "workshops" appear to occupy spatially separate locations in the site, apart from the core and blade activity loci (Powers, personal communication, 1978). One might speculate about what the interpretation of that site might have been if only the biface reduction areas has been tested. Assuming contemporaneity between these loci and the core and blade production areas, it would appear that the biface loci represent just one portion of a much more complex lithic technology. A number of specimens from the Dry Creek collection show strong morphological similarity with Carlo Creek bifaces, and particularly with the forms represented in Figure 18; B and I of this report.

In addition to bifaces, the occurrence of large retouched prismatic blades or blade-like flakes (e.g., Fig. 18; A) may suggest a toolkit affinity between the two sites. My examination of the Dry Creek collection indicates that there is a limited macroblade and core technology at Dry Creek II (loess 3). These large blades and blade-like flakes characteristically were struck from large blocky cores by direct percussion. The cores have poly-directional platforms, with little intentional platform preparation. There does not appear to have been any specific selection for blades per se, as both flakes and blades are represented. Many of the large flakes and blade-like flakes from Dry Creek II were further reduced as bifaces, or were at least edge modified in a bifacial fashion.

In both sites, there was a tendency for coarse-grained rocks to be selected as raw materials for both biface and macroblades. In the case of the Carlo Creek I materials, hornfels and argillite were used, whereas at Dry Creek, rhyolites, rhyodacites, and dacites were selected (Guthrie and Powers 1977). In terms of texture, lustre, and overall "look", the latter are difficult to distinguish from the argillite/hornfels from Carlo Creek. These raw materials represent a logical choice with respect to their durability and strong cutting edge; but to what extent they represent a culturally-patterned choice from among available options we will never know.

Probable use of manuports as anvil stones for bone breaking is a trait apparently common to both assemblages (Guthrie and Powers 1977).

However, no further significance can be attached to a largely time-transgressive trait such as this.

Finally, the temporal placement of the two occupations must be considered. Dry Creek II is radiocarbon dated at 10,690 ± 250 years: 8740 B.C. (SI-1561) (Thorson and Hamilton 1977:166), and Carlo Creek I is about 8500 years old. If these dates are correct, it would indicate that Dry Creek II pre-dates Carlo Creek I by approximately 2190 years. On the basis of the suggested dating for the interior Alaska Denali Complex, as originally defined by West (1967, 1975), both of these occupations could be culturally-related.

The toolkit represented at Dry Creek II appears to contain all the defined categories of the Denali complex, as previously observed by Holmes (1974), and Powers and Hamilton (1978). The Carlo Creek I materials, conversely, would appear to meet these criteria only for(1) bifacial convex knives (West 1967:365, 372) and(2) large "blades" and blade-like flakes (West 1967:366, 372). However, these largely undiagnostic implements could be just as easily included in later cultural traditions, as I will detail below.

Given the activity specific nature and probably short duration of occupation at HEA 031, the lack of other such "diagnostic" tools such as microblades, cores, endscrapers, and burins, is not surprising. It seems unlikely that a group of hunters would have carried their entire lithic tool inventory with them, and even less likely that they would have left it behind, at every site they utilized. The ethnoarcheological work of Binford among present day hunters at Anaktuvuk Pass has suggested that archeologists should not assume a patterned and static model of disposal into the archeological record (cf. Binford 1978a, 1978b). We must begin to become more cognizant of the factors which affect the transformation of material culture from its systemic context into the archeological record (cf. Bowers and Bonnichsen 1980; Schiffer 1976).

The differences in material remains at the two sites clearly reflect a different range of activities. While the Carlo Creek Site was probably used solely for limited butchering, (using "tools of the moment"), as inferred from a small assemblage of bone mashing and cutting tools, the activities at Dry Creek II component additionally included use of bone incising tools (burins), composite tool production (microblades, cores, core tablets), and skin working (scrapers of various sorts). In short, the Carlo Creek I occupation was limited in duration and activity, while Dry Creek II was probably used much more extensively, perhaps over several seasons, with a wider variety of activities represented. In a sense, we might view Carlo Creek I as a type of satellite site of a Dry Creek-like "regional base" camp.

Returning to the temporal placement of the Carlo Creek I occupation, I should also briefly mention its possible affiliation with later cultural manifestations such as the Northern Archaic tradition (Anderson 1968b). At each of the three major non-coastal stratified sites--Onion Portage, Dry Creek, and Healy Lake--there appears a major occupational hiatus between about 8000 and 6000 B.P. (cf. Anderson 1968a; Powers and Hamilton 1978; Cook unpublished data). At each site, this apparent hiatus appears to mask a change from a "paleo" tradition (American Paleo-Arctic: Denali, Akmak, Kobuk, Chindadn), to an apparent boreal forest-adapted culture (Northern Archaic: Palisades Tuktu, Portage). We have very little data which can be brought to bear on the problem of understanding this apparent hiatus and adaptive change. The tools represented at Carlo Creek, especially coarse-grained bifaces, are well documented in Northern Archaic assemblages (e.g., Anderson 1968a and b; Skarland and Keim 1958), and thus could have been the result of a Northern Archaic tradition occupation. Due to our lack of knowledge about this crucial time period, we cannot state with certainty when these postulated forest adapted cultures first appeared in Alaska; they may well predate the currently-accepted date of about 6200 B.P. (Anderson 1968a and 1968b).

Going somewhat farther afield from Carlo Creek and the Nenana Valley, limited similarities in artifact morphology, technology, and apparent age may also be indicated with the Teklanika East and West sites (West 1965, 1967). These two undated sites, located about 40-45 km northwest of Carlo Creek, were included by West (1967) in his original definition of the late Pleistocene/early Holocene interior Alaskan Denali Complex. The sites, both which lie at an elevation of about 790 m a.s.l, were originally interpreted (West 1965) as game lookout and flaking stations (see Fig. 7).

A number of other widely scattered surface sites within McKinley Park reported by Morgan (1965) and Treganza (1964) may also indicate possible affinity with the occupation at Carlo Creek I. However, these are all small, undated, and all lack faunal remains. These sites differ from the Carlo Creek site in that they represent chipping and game lookout/ intercept stations, located on relatively high ridges of elevations between 760 m and 915 m a.s.l.

Several more recent surveys along the north flank of the Alaska Range and within the Nenana Valley have located sites which may have affinities in site function or artifact technology with Carlo Creek

(Holmes 1975; Guthrie and Powers 1977; Plaskett 1976). Again, however, all of these sites are poorly preserved, undated, and most were surfacial in nature.

Attempting to make any but the most general statements concerning artifact or site affinities between Carlo Creek and these undated and largely "undiagnostic" assemblages is of little utility. The specific tasks represented by the Carlo Creek data, together with the relative "crudeness" of tool form, makes any detailed trait-by-trait interpretive statements difficult. Suffice it to say at this point that there has undoubtedly been intensive utilization of the upper Nenana Valley by semi-nomadic hunting groups ever since the valley was free of ice and extensive outwash channels at the end of the Pleistocene. Based largely on the age of the Carlo Creek site, it is speculated that the site may be part of an early Holocene phase of the Denali Complex toolkit, as originally defined (West 1967).

CHAPTER 10

SUMMARY AND CONCLUSIONS

Geological, ecological, radiometric and archeological data from the surrounding area have enabled a fairly clear picture to be drawn of the Carlo Creek Site's function and setting. There are, obviously, a myriad of unsolved questions concerning occupational group size, techno-cultural affiliations, etc. In general, it is felt that the task-specific nature of this site effectively limited the diversity of materials left behind by the site's occupants.

In summary, the site's geological and archeological history may be stated as follows:

1. The site's geomorphology appears to be the result of a fluvial sequence attributable to downcutting and lateral shift of the glacial Nenana River. The earliest evidence of human use of the site occurred as soon as 1500-2000 years after deglaciation of the valley, and may have occurred at a time while minor amounts of stagnant ice were still wasting in the upper valley. At the time of Component I occupation (circa 8500 B.P.), a temporary cessation of downcutting had taken place; by this time, at least 75% of all Holocene downcutting had already occurred.

2. Stabilization of this surface was probably a short lived phenomenon lasting perhaps no longer than 500 years. Limited soil development (inceptisols) from this surface did begin, but was halted by later overbank alluviation. Component I utilization of the site took place

directly on the surface of a stabilized braid bar on the eastern banks of the Nenana River; this early occupation of the site is radiocarbon dated to approximately 8500 B.P.

3. Based on faunal data, a late-summer/fall seasonal use is inferred for Component I. Functionally, the site appears to represent a secondary kill site and brief (perhaps overnight?) encampment, where one sheep and one caribou were brought into the site and dismembered for transport to a larger regional "base camp"-- perhaps a site such as Dry Creek. The fact that only low-value bone remains are present supports a notion of "culling" of the carcass portions with greater dietary importance. The fragmentary remains of the bone and the presence of a possible anvil stone suggests that it was smashed and processed for marrow and/or bone grease. On the basis of comparisons with recent Nuniamuit Eskimo hunting practices, the Carlo Creek Site could be interpreted as a season and task-specific upland hunting site, located within modern ranges of both sheep and caribou. Additional locally-procured resources included ground squirrels, argillite for lithic raw materials, and probably, alder or willow (for fire and shelter?). The site location was probably determined, in part, by its strategic intercept position in this valley, and possibly by the presence of a freshwater spring which flows near the site today. Ethnographic data for the area support these interpretations of seasonality and site function.

4. The activities in the lower component appear to be spatially separated into at least three activity areas, centered around two hearths. Activities indicated include biface production, possible thermal heat treatment(?) of lithics, carcass dismemberment, and bone smashing for marrow/bone grease extraction.

5. Lithic technology at the Carlo Creek I occupation was almost exclusively devoted to biface reduction. Data suggest that lithic raw materials were locally procured from a quarry source within the valley, and a lesser proportion of rock was obtained from the stream bed of the Nenana River. There is fairly good evidence that at least part of the raw argillite brought into the site was intentionally heat-treated in a crude sand "furnace", presumably to improve the workability of the rock for flaking and edge durability. In addition to argillite, a single large "prismatic blade" or blade-like flake of hornfels is present at the site. The lack of chipping debris associated with this specimen suggests it was manufactured elsewhere, then brought into the site and discarded following breakage.

6. Due to a small and largely undiagnostic lithic sample, it has not been possible to make definitive technocultural comparisons between Carlo Creek and other known late Pleistocene-early Holocene sites in Alaska-Yukon. On the basis of temporal similarities, general tool morphology, inferred site function, and raw material selection, similarities are noted primarily with the biface-reduction workshop loci in Component II of the nearby Dry Creek site. On a more speculative level, the Carlo Creek Component I level can be assigned to an undesignated early Holocene phase that may or may not be analogous to the Denali Complex, as originally defined by West (1967, 1975). However, any such provisional assignment must take into account the site's inferred function and restricted tool inventory.

7. The Carlo Creek Site, Yardang Flint Station (Reger et al. 1964), and the Canyon Site (Workman 1974, 1978), all represent relatively rare occurrences in the subarctic: firmly dated sites within clear

stratigraphic contexts. Unfortunately, all three of these sites appear to contain relatively few artifactual remains. Perhaps this fact in and of itself has much to tell us about the nature of the relatively meager subarctic archeological record, or perhaps it is entirely a site sampling problem. It is increasingly evident that human subsistence in the subarctic was possible through the use of rudimentary material culture inventories. One major drawback to this interpretation is, however, our lack of knowledge concerning the organic portion of the toolkit of aboriginal occupants in Interior Alaska. This question, unanswered during the Carlo Creek research program, will be a necessary next step in the understanding of Alaska's prehistory.

8. Environment at the time of Component I occupation is inferred as being not too different from that of today, although the extent of spruce forest colonization into the alpine areas is not known. By 8500 B.P. a number of distinct early successional plant associations were probably established in the Nenana Valley's floodplains, terraces, and valley slopes. These most likely reflect a pattern of succession similar to those found today in subarctic alpine regions. Probably included in these communities were grasses, alder(?), willow, open spruce/shrubby tundra and closed spruce(?) forest. The site utilization most likely occurred within an early successional phase of grasses, alders(?) and/or willows.

9. Following abandonment of the site after the brief Component I occupation at 8500 B.P., the locality was subjected to repeated episodes of overbank flooding, which resulted in a net accumulation of 3-4 m of floodplain laminated silts and fine sands. Within the lower 50 cm of this overbank unit are two species of terrestrial mollusca, which offer further evidence for locally-moist conditions and possibly an open spruce

ecosystem. Throughout this overbank unit are the poorly preserved remains of detrital organics, which were probably drifted in during high water stages. The overbank unit (3) shows alternate periods of wetting and drying, as evidenced by oxidation/reduction sequences.

10. After approximately one meter of overbank sediments had been deposited, a second extremely brief human occupation occurred. This later use of the site appears to represent the activity of only a single (?) individual, and reflects only stone working activities. The lithic raw material used at the Component II occupation was different from that of the lower occupation (rhyolite vs. argillite) and appears to reflect different stoneworking technique (pressure vs. percussion). It is not known whether or not the Component II rhyolite was heat treated. The presence of a spring, as well as strategic mid-valley location, may have again influenced selection of this site as a chipping/lookout station. On the basis of inferred rates of sediment deposition, and bracketing C-14 dates, this occupation is estimated to have occurred sometime between 6000 and 7500 B.P.

11. Cessation of overbank deposition at the site was probably the result of a gradual resumption in the Nenana River downcutting and/or lateral shift to the west, away from the site area. Floodplain sedimentation was replaced at approximately 3000 to 4000 B.P. by eolian deposition. The cause of this depositional change is unknown, although it is thought to relate to neoglaciation in the central Alaska Range.

12. These eolian deposits, which cap the site and mantle the hillside, are thought to be of local origin, probably derived from locally available floodplain alluvium. Contained within this uppermost unit, at an average depth of about 20 cm below surface, is a discontinuous lens of

volcanic ash, which has been correlated by comparison of refractive index, shard morphologies, and phenocrysts with at least four other tephra horizons in the upper Nenana Valley. This ash has been assigned a maximum C-14 age of 3780 ± 80 years: 1830 B.C. (WSU - 1747), on the basis of a dated wood sample collected from 5 cm below the ash at a locality approximately 8 km up valley from the Carlo Creek site. It has not been possible to correlate this ash bed with others reported in central Alaska, although its vent source may be one of three sources in the southwest Alaska Range dated to about 3600-3800 B.P. (cf. Bowers 1979a).

13. The geologic setting of the Carlo Creek site may provide northern Quaternary specialists with a useful model for predicting site locations and directing future "early man" surveys. Although the maximum possible age for the Carlo Creek site is itself limited by former glacial activity in the Nenena Valley, the site's stratigraphy and strategic mid-valley location may be applicable to a variety of models of late Pleistocene or early Holocene settlement patterns and site locations. The fact that well defined terraces occur on both sides of the Nenana River in this part of the valley means that one could closely formulate a future sampling strategy directed towards the location of a functionally-specific or temporally-specific type of site. Also, the fact that we are in reality sampling space, rather than area demands that we concentrate our limited funding and manpower resources in areas that combine the geologic conditions for site preservation (e.g., alluvial sediments) with a means of observing the third dimension (e.g., roadcut, exposed riverbank, etc.).

14. In sum, the Carlo Creek Site represents an early Holocene floodplain occupation (Component I) within a high subarctic alpine valley. Activities at the site appear to reflect a number of specialized activities

dictated by seasonality, available resources, and function. The site is noted particularly for its good organic preservation and possible indications of thermal pre-treatment of lithics. It served first as a secondary kill/butchering site, with marrow extraction, lithic pre-treatment and biface reduction, and later (Component II) functioned briefly as a lookout/chipping site.

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POSTSCRIPT

Since the completion of this research, much additional work has been undertaken in the upper Nenana Valley, primarily by the geologist Norman Ten-Brink and colleagues associated with the North Alaska Range Project. Ten-Brink's research included a re-examination of the geology of the Carlo Creek site; his preliminary interpretation of the site's sediments suggested to him an alluvial fan origin, as opposed to the fluvial model proposed herein. Although I still regard as valid the fluvial interpretation, I do not feel that an alternative geologic explanation would alter my interpretations of the site's stratigraphy, technological or faunal analysis, or cultural-historical placement of the artifacts recovered at this small early holocene butchering station. I remain open to any new data which may favor other explanations, and hope that eventual publication of the North Alaska Range Project's research will serve to clarify the various interpretations. My major interest at this point is to see that the available data are disseminated in a timely fashion.

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