United States
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2360
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EXPLAINING LITHIC ASSEMBLAGE DIFFERENCES IN THE MEDICINE LAKE HIGHLANDS, SISKIYOU COUNTY, CALIFORNIA

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Spring 1992

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This manuscript is a Masters Thesis presented to the faculty of California State Universtiy, Chico in the Spring of 1992. It was approved by committee chair Dr. Kowta and committee member Dr. Bayham in partial fulfillment for a degree in Master of Arts in Anthropology. Pages i through iii were omitted for this printing.

ACKNOWLEDGEMENTS

I would like to acknowledge the following people for their invaluable help and support. First, I would like to acknowledge my committee, Dr. Kowta and Dr. Bayham, who critically reviewed my progress and changed the shape of this study substantially. In addition to my committee, I owe to Dr. Winfield Henn, Forest Archaeologist, thanks for the idea and continued encouragement. Also, to Dr. Eric Ritter, Bureau of Land Management Archaeologist, thanks for help with the gray literature. Second, I am deeply indebted to three well-known lithic analysts--Peter Ainsworth, Betsy Skinner, and John Fagan--who trained me in lithic analysis and shared their knowledge with me throughout the preparation of this report. I also want to thank Robert Jackson for his consultations on obsidian hydration sampling.

This study was funded in part by the Shasta-Trinity National Forest, and I gratefully acknowledge their interest in supporting archaeological research in northern California. The McCloud District made available funds for obsidian hydration and blood residue analysis and also provided time for the writing and analysis. Other Forest Service contributions included the artifact drawing from Doe Peak by Ellen Jellison and invaluable computer support by the following Forest Service employees: Kim Weston, Charles Miller, Mike Bunten, and Carl Skinner.

Finally I would like to thank my husband, Michael Cassidy, for his support and understanding throughout this study.

PREFACE

The impetus for this study was sparked by personal observations at obsidian sources and archaeological sites located in the Medicine Lake Highlands, Siskiyou County, California. My interest in lithic source localities and adjacent areas began with my participation in excavations and analysis of sites near these lithic sources in the Medicine Lake Highlands. My interest was heightened by the training I received in flint knapping and debitage analysis.

When I searched for a focus for this study, many avenues of research were quickly ruled out because of the absence of regional chronological data for the Highlands. Studies involving exchange or shifting patterns of source utilization through time, for instance, would require regional-level syntheses. Hughes' (1983) geochemical characterizations of the obsidian sources in the Medicine Lake Highlands led him to such a regional level approach. He examined the distributions of projectile points at sites outside of the Highlands and by sourcing these points from dated contexts he was able to describe the utilization of different sources through time. However, the majority of sites within the Highlands have not been dated. The genesis of a research approach presented itself when discussions with Winfield Henn (personal communication, 1989) and my own observations of the lithic assemblages from test excavations suggested that sites in the Highlands displayed considerable variability in artifact form and technology. Given this observed variability, my overall focus crystallized--to attempt to explain assemblage variability at sites in the Highlands.

It is hoped that the base-line data generated from this study of site variability would provide the U.S. Forest Service with a research orientation that could be used for determining the significance of the multitude of prehistoric sites recorded in the Medicine Lake Highlands.

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IN THE MEDICINE LAKE HIGHLANDS,
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by

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Master of Arts in Anthropology

California State University, Chico

Spring 1992

This study examines the factors responsible for variation displayed between lithic assemblages at two sites located in the Medicine Lake Highlands in northern California. Because the sites were located close to one another and similarly close to an obsidian source, many ecological factors which may have explained their differences were held constant. The factors which were investigated were differences in manufacturing technology, site function, ethnic affiliation, and mobility strategies. The results indicate that the reasons for variation were multidimensional. With the exception of ethnic affiliation, which could not be determined from the existing data, all of the factors--manufacturing technology, site function, and mobility strategies--were found to be responsible for the

variation. Mobility strategies offered more explanatory value than the other explanations because it explained differences in terms of complex dynamics of hunter-gatherer organization.

CHAPTER I

INTRODUCTION

A well-established tradition in archaeology is to explain patterning and variability in archaeological assemblages. This tradition became popular in the 1960s when a number of American archaeologists investigated variability in the archaeological record. L. Binford (1968:26) suggested that:

> The elaboration of theory and method which characterizes much of the recent work in archaeology consist minimally of two elements: First, the active search for understanding variability in the archaeological record--all of the variability and not just that judged a priori to be significant; second an attempt to explain variability scientifically, rather than by conjecture or by "hunch."

This established tradition of explaining variability provides an explicit theoretical perspective for this study. Results of test excavations conducted by the U.S. Forest Service on two prehistoric archaeological sites in the Medicine Lake Highlands, Siskiyou County, California (Henn 1990; Krieger and Goheen 1984) revealed that there was considerable variability in their lithic assemblages. At the Giant Crater site (CA-SIS-1072) discarded bifaces and biface thinning flakes were recovered, while at the Doe Peak site (CA-SIS-615) many discarded blades and conical blade cores were found. These sites offered a unique opportunity to explore variability not only because they were disparate but because their apparent differences were in direct contrast with environmental phenomena that seemingly made them similar. These phenomena include their proximity to the same obsidian source in the Medicine Lake Highlands, their physical proximity to one another, and their setting in relatively similar microhabitats.

The existing literature is replete with studies that attempt to explain variability in lithic assemblages. Explanations offered include differences that are attributable to environmental phenomena and differences attributable to cultural explanations. Environmental explanations include differences in quality of different types of raw material (Gould and Saggers 1985), access to and distance from raw material sources (Kelly 1983), availability of water (Gould 1980), seasons of use (Thomas 1983), and a myriad of other explanations. Cultural explanations include differences in site function (Binford 1979; Wilmsen 1968), manufacturing processes (Crabtree 1972), ethnicity (Close 1978), and mobility strategies (Bayham et al. 1986; Kelly 1988). The diversity of explanations reflects the fact that lithic assemblages can be influenced by virtually every aspect of life among hunter-gatherers. Explaining the causes for the differences observable in the flaked stone assemblages between Giant Crater and Doe Peak is the main objective of this study.

The location of Giant Crater and Doe Peak near Grasshopper Flat, one of the major obsidian sources in northern California, adds another important dimension to this study. This dimension concerns obsidian exploitation processes in the immediate vicinity of the quarry itself. Ericson (1982, 1984) proposes that the importance of quarries, workshops, and other sites of production lies in their value as the only nodes in a lithic production system which are ultimately connected to every other component of a system. He advocates that these site types should, therefore, be the initial focus of research of lithic production and exchange in regional studies. Yet quarry research in the vicinity of Grasshopper Flat is lacking, despite the fact that the importance of this prehistoric quarry has been demonstrated by the extensive spatial and temporal distribution of its obsidian which cross-cuts ethnolinguistic boundaries. Large proportions of obsidian traced to Grasshopper Flat have been recovered in recent large-scale excavations in the Sacramento Canyon (Basgall and Hildebrandt 1989) and in the Pit River drainage (Kelly et al. 1987). The proportions are often as high as 90%.

Further afield, obsidian from Grasshopper Flat has been found as far west as the Kings Range in Humboldt County (Levulett 1986); as far north as the Elk Creek drainage in southern Oregon (Nilsson and Kelly 1991); and as far south as the Black Butte Reservoir in Tehama County (Johnson et al. 1984). To the east of the Highlands, obsidian from

Grasshopper Flat diminishes because of the presence of high quality obsidian in the Warner Mountains. Temporal correlates indicate that Grasshopper Flat was exploited as early as 8,000 B.P. (Hughes 1982:180; Sundahl 1985) and continued to be procured into the late prehistoric period (Nilsson et al. 1988).

There are many questions that can be be generated from a regional study of sites near the obsidian quarries in the Medicine Lake Highlands (MLH). These include:

1. Was obsidian mined and shaped in the MLH into forms that were easy for transport or was raw material taken in bulk to sites outside the Highlands where it was reduced?

2. Can artifacts found in the MLH be identified as specialized, utilitarian or ceremonial forms?

3. Was obsidian procurement embedded in subsistence processes such as hunting or food gathering?

4. Do patterns of exploitation change through time?

5. Is there a systemic relationship between sites located in the MLH and sites located outside the MLH where there is a prevalence of MLH obsidian?

No pretense is made that the information generated from this study can fully contribute to these regional-level research questions. It is anticipated, however, that the analyses used in this study to determine causes of inter-site variability will at the same time provide base-line data needed for larger regional-level studies.

This study is presented in eight chapters. Chapter II describes the physical, biological, and cultural environment of the Giant Crater and Doe Peak sites. It also summarizes the archaeological data for the vicinity and provides a summary of the test excavations that were conducted at Giant Crater and Doe Peak. The temporal placement of the Giant Crater and Doe Peak sites is discussed at the end of this chapter. Chapter III examines the observed archaeological patterning from the environmental, cultural, and archaeological contexts described in Chapter II. These observations are then linked to existing theories of variability offered in the literature. Four alternative hypothesis are then presented separately in Chapters IV, V, VI, and VII. In each chapter a hypothesis is presented, a number of relevant previous studies are reviewed, methods used to analyze the data are described, sample size or representation is noted, and the results of the analyses are described. Each chapter is concluded with a summary of the data and an assessment of the validity of the hypothesis. Chapter VIII summarizes the results of the entire study and evaluates the contributions it has made. Regional implications of this study and directions for future research are also discussed.

CHAPTER II

STUDY AREA OVERVIEW

Introduction

The development of alternative explanations for site differences between Giant Crater and Doe Peak will be based on observable assemblage characteristics in combination with environmental and cultural phenomena. The intent of this chapter is to provide background information necessary for hypothesis formulation. First, an environmental overview which includes a description of the physical and biological environment surrounding the sites is provided. Second, a cultural overview is provided which includes a summary of the ethnographic record and a summary of the findings of previous archaeological investigations in the Medicine Lake Highlands. Finally, an overview of the site assemblages from Giant Crater and Doe Peak is provided which includes a summary of the test excavations and materials recovered and an analysis of the temporal placement of the sites relative to one another.

Environmental Overview

Physical Environment

The archaeological sites Giant Crater and Doe Peak are located in the southern Medicine Lake Highlands on public lands administered by the Shasta-Trinity National Forest, McCloud Ranger District. The Medicine Lake Highlands is located 35 miles to the east of Mount Shasta in northern California (see Figure 1). It is a volcanic upland 20 miles in diameter that is surrounded to the north, south, and east by an undulating plateau of small fault blocks. To the west the Medicine Lake Highlands merges with the volcanic cones of the Cascade Range (Anderson 1941:349).

The Giant Crater site was recorded in 1983 and assigned the Forest Service Number F.S. 05-14-61-324. Henceforth in this study the site will simply be referred to as "Giant Crater." It is located at an elevation of 5,380 feet on a gently sloping forested older lava flow and covers four acres. The site is located in a largely undisturbed old growth forest (see Figure 2a). The Doe Peak site was recorded in 1977 and assigned the Forest Service Number F.S. 05-14-61-62. Henceforth in this study the site will simply be referred to as "Doe Peak." It is located at an elevation of 5,640 feet on the south-facing lower slopes of a mountain called "Doe Peak" and covers approximately one acre. The site surface has been disturbed by tree planting operations to a depth of approximately 6". The plantation failed, and the site is now open meadow/grasslands (see Figure 2b).

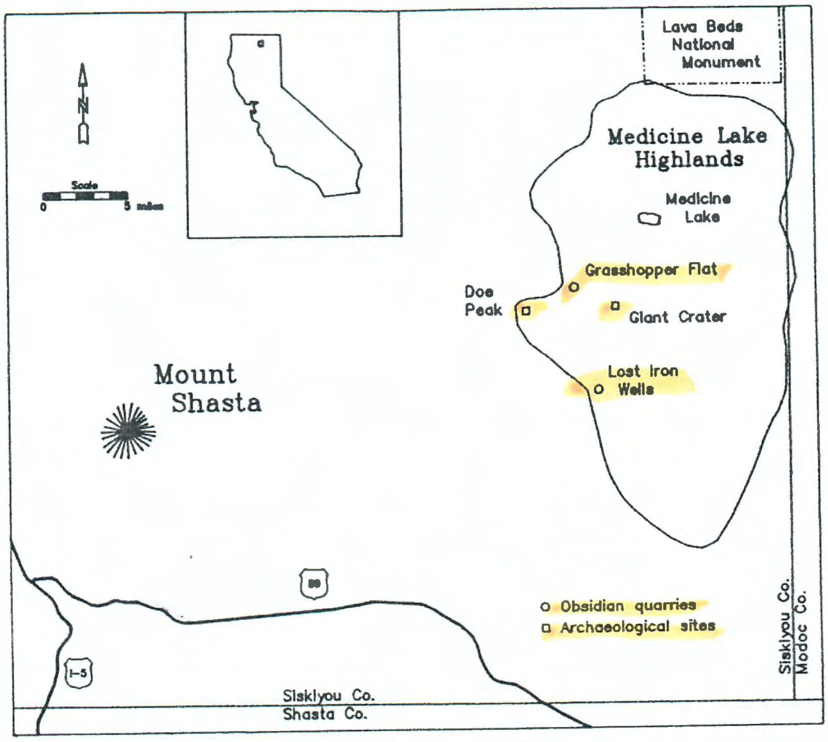

Figure 1. Study area vicinity.

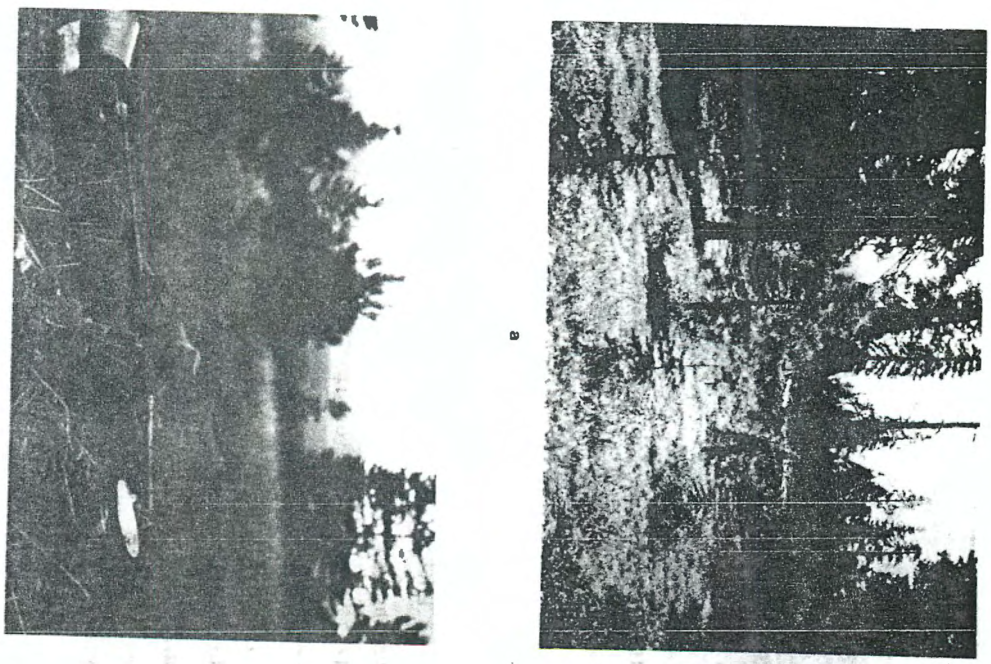

Figure 2. Site setting of Giant Crater (a) and Doe Peak (b).

Both sites lie adjacent to dramatic geologic features. Giant Crater borders a stark and relatively young lava flow called the Giant Crater Lava Flow. The site also lies at the junction of two other lava flows: the Medicine Lake Andesite Flow and the Porcupine Flow (Baer 1973). Doe Peak is in a volcanic upland on the sloping mountainside of Doe Peak and adjacent to a large and deep double crater known as Twin Crater.

Giant Crater and Doe Peak are located near two obsidian source localities in the southern Medicine Lake Highlands--Grasshopper Flat and Lost Iron Wells. Grasshopper Flat is approximately 1-3/4 miles northwest of Giant Crater and approximately 2-1/8 mile northeast of Doe Peak, and Lost Iron Wells is located approximately 3 miles south of both sites (see Figure 3). The obsidian exposures at Grasshopper Flat and Lost Iron Wells actually represent a single large mountain of glass that has been covered by numerous volcanic events including andesite flows, basalt flows, and the later pumice eruptions from Paint Pot Crater and Little Glass Mountain (Donnelly-Nolan 1986). Donnelly-Nolan notes that the obsidian nodules in the meadow at Grasshopper Flat come from the top of the glass mountain which is today level with the ground surface.

The obsidian at both Grasshopper Flat and Lost Iron Wells is considered high in quality. Large, medium, and small angular obsidian cobbles occur at Grasshopper Flat in several shallow pits that are surrounded by considerable

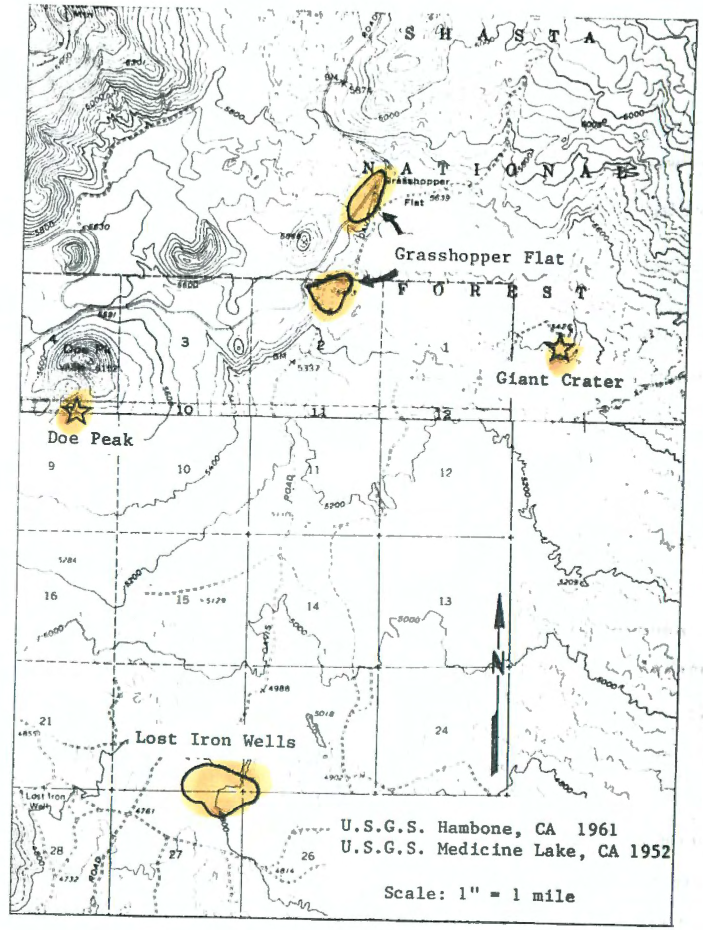

Figure 3. Location of Giant Crater and Doe Peak in relationship to the obsidian quarries of Grasshopper Flat and Lost Iron Wells.

flaking debris (cf. Fox and Hardesty 1972). The cortex on the cobbles is either a discolored and rough-textured banded surface or a slightly discolored smooth surface. Color ranges from opaque black with a yellow tinge and black-and-grey banded to mottled grey with a sheen. Red banding sometimes occurs as well.

Both Giant Crater and Doe Peak lack obvious surface water. This is not unusual in the Highlands where surface water is scarce despite the high annual precipitation ranges between 25 and 45 inches. Medicine Lake, Bullseye Lake, Blanche Lake, and Porcupine Lake represent the only standing water in the MLH. Van Susteren (personal communication, 1990) suggests that flowing rivers, creeks, and intermittent drainages may have originally occurred in the MLH but are now absent because they were filled in and buried during Pleistocene times by massive glacial outwashes. MacDonald (1966:83) notes that the general scarcity of surface drainages is also a result of the high permeability of the surface basalts. Jasso and Haskins (1983) suspect that this water is trapped underground by a layer of either older nonporous basalt rocks or impermeable sediments and that it moves through spaces between lava flows to either the downhill slope (the graben areas) or to cavernous areas such as ice caves or deep areas in collapsed lava tubes. The relevance of Jasso and Haskins' hydrologic research to Giant Crater and Doe Peak is that undiscovered water might be available in the lava features close to both sites.

The soils at Giant Crater and Doe Peak are heavily influenced by volcanic events and the frigid temperature regime in the Highlands. They are in general comprised of weathered basalt and wind-laid volcanic ash. Pumice that is 1" to 2" deep covers the surface of both sites. The pumice is traced to Little Glass Mountain which erupted approximately 900 +/- 90 years before the present (MacDonald 1966:86). The soil at Giant Crater is part of the Sheld family (Lanspa 1982:292). Surface soils are dark brown, gravely, coarse sandy loam. The subsoils are dark yellowish-brown and extremely cobbly, fine sandy loam. The substratum is consolidated glacial till. The soil at Doe Peak is part of the Yellani family (Lanspa 1982:425). Surface soils of this family are brown and very pale brown and very cindery, coarse sandy loam. The subsoils are very cobbly with a medium, subangular, blocky structure. The substratum is broken basalt.

The climate of Giant Crater and Doe Peak is characterized by moderate summer temperatures and near arctic-like winter temperatures with heavy snowfall. The mean annual temperature is 9° C. These conditions dictate the annual migrations of deer herds and probably conditioned the mobility of human groups as well (Krieger and Goheen 1984:5).

Biological Environment

The environment surrounding Giant Crater and Doe Peak consists of three habitat types: conifer forests, chaparral, and barren. The coniferous forests include species such as ponderosa pine, sugar pine, Douglas fir, white fir, red fir, and incense cedar. Aspens and willows occur sporadically. The chaparral is comprised of snowbrush, green-leaf manzanita, chokecherry, bittercherry, rabbitbrush, bitterbrush, and service berry. The term "barren habitat" refers to the area of recent lava flows where the vegetation is sparse and widely dispersed, such as the Giant Crater flow.

Wildlife in the vicinity of Giant Crater and Doe Peak is varied. Mule deer, snowshoe hare, grey squirrels, and golden mantle ground squirrels are abundant. Black bear, bobcat, mountain lion, pine marten, and wolverine have been sighted but are scarce. Bird species include blue grouse, pileated woodpecker, golden eagles, goshawks, red-tailed hawk, black capped and mountain chickadee, and a number of other varieties. Today, mule deer migrate into the Highlands near Medicine Lake in the summer and travel north to the lowlands in the Lava Beds National Monument in the winter (Smith 1979).

Cultural Overview

Ethnographic Background

There are no direct references in ethnographic and historic sources concerning the sites at Giant Crater and Doe Peak. The references refer instead to features of the landscape such as Glass Mountain and Medicine Lake. Tribal

boundaries, hunting, power quests, and obsidian procurement rights in the Highlands are also documented. Tribal boundaries were in dispute in the Highlands with two tribes claiming actual ownership--the Modoc and the Achomawi (Kroeber 1925:318; Merriam 1926:21, 24). The Modoc maintained a summer village at Medicine Lake which was used as a base for hunting game and mining obsidian at Glass Mountain (Ray 1963:208). The Achomawi hunted the area, collected obsidian, and used Medicine Lake as a medicine/power place (Dixon 1908:208; Kniffen 1928:301; Kroeber 1925:305; Roybal-Evans 1982:25). The ethnographic literature also notes, however, that other tribes such as the Wintu and the Shasta, whose primary bases were outside the Highlands itself, actively visited the region, coveting it for its abundant supply of obsidian (Merriam 1926:21). Like the Achomawi, the Wintu considered Medicine Lake and Glass Mountain as power-spots (La Pena 1978:33).

A reconstruction of the cultural activities in the Medicine Lake Highlands suggests that while hunting and power quests were reasons for visiting the Highlands, the major focus lay in the obsidian, its procurement and exchange, and the conflicts it generated. With regard to procurement, it appears that the Modoc, Achomawi, Atsuge, Wintu, and possibly Shasta and Northern Paiute obtained obsidian directly from the sources in the Highlands. The Achomawi approached the area regularly (Kniffen 1928:301), the Atsuge passed through Ilmawi territory to reach the area

(Kniffen 1928:316), the Modoc maintained a summer village from which they mined obsidian (Ray 1963:208), the Wintu came on individual or small peaceful expeditions (DuBois 1935:25), and the area was simply "well known" to the Shasta and to the Northern Paiute (Merriam 1926:21). Glass Mountain is the only obsidian source cited in the literature. It is not known if this term refers to today's Glass Mountain or is a generic term for any of the obsidian sources in the Medicine Lake Highlands. The latter seems plausible since source studies have documented that other obsidian sources in the Highlands such as Grasshopper Flat and Cougar Butte were used ethnographically (Nilsson et al. 1988).

Active trading or exchange of obsidian from the Medicine Lake Highlands is also documented in the literature. The Achomawi traded arrowheads to the Surprise Valley Paiute (Kelly 1932:151) and to the Yana (Sample 1958:9). The Achomawi also traded obsidian in its raw material form to the Yana. The Modoc may have traded immense blades to the tribes of the lower Klamath (Kroeber 1925:320). The Achomawi or Modoc may have traded obsidian to the Shasta (Martin 1971:40) who in turn made the large blades used by the tribes of the lower Klamath (Voegelin 1942:201).

It also appears that the pursuit of obsidian was not altogether amicable. There are a number of references which mention battles in the Highlands. The Achomawi engaged in battles with the Modoc at Glass Mountain (Merriam 1926:24).

A fight would ensue with the Atsuge and the Paiute or Oregon Indians at Glass Mountain whenever the latter crossed the boundary line (Ethnographic files, Lassen National Forest). Constant battles were fought between the Shasta, Modoc, and Wintu over Glass Mountain obsidian (Merriam 1926:24; Redding 1879:670).

Archaeological Background

Fox and Hardesty (1972) provided the first documented archaeological survey in the southern Medicine Lake Highlands in the vicinity of Giant Crater and Doe Peak. The importance of their survey is that they identified an extensive prehistoric quarry at Grasshopper Flat. They also noted that another potential quarry source at Little Glass Mountain was not used as a quarry (Fox and Hardesty 1972:38). These investigations were followed by other cultural resource management surveys which were conducted by the Shasta-Trinity, Klamath, and Modoc National Forests. Numerous prehistoric sites were recorded as a result of these surveys. But it was not until 1984 when the first excavations were conducted at Giant Crater that archaeology in the Highlands moved from simply recording sites to actual research. Four sites have been tested in the Highlands thus far and are described individually below.

Test excavations were initiated at Spattercones site (F.S. 05-14-61-308) in 1985 (Sundahl 1985). Spattercones is located two miles northeast of the Giant Crater site along the borders of the Giant Crater lava flow. It lies adjacent to a row of spattercones. The site exhibited a subsurface deposit to a maximum depth of 60 cm where bedrock was reached. Based on diagnostic projectile points and obsidian hydration reading on 15 specimens, it was tentatively concluded that the site dated between 3,000 to 2,000 years before the present. Besides the projectile points the cultural materials at Spattercones consisted of obsidian debitage and a cache of eight obsidian macro-flakes. Sundahl (1985:31) tentatively hypothesized that the cultural materials at Spattercones "were left behind by ancestors of the Achumawi people who ventured northward to collect Grasshopper Flat obsidian to make a much wider range of artifacts and blanks." In contrast, she hypothesized that the large bifaces that were reported at the Giant Crater site were made by people ancestral to the Modoc who lived to the north.

Test excavations were conducted at Hopper Hill #1 (F.S. 05-14-61-156) in 1987 (Krieger 1990). The site is located two-thirds of a mile west of Grasshopper Flat at the base of Hopper Hill. Subsurface deposit in one unit extended to a maximum depth of 50 cm where bedrock was reached. Despite the subsurface deposit, it was concluded that the site post-dates the surface pumice, which came from Little Glass Mountain circa 900 years before present. This conclusion was based on the observation that the site is subject to deep frost-heaving and that the pumice soils of the site are highly permeable. Both phenomena cause

obsidian to move downward into the subsoil matrix. The cultural materials yielded only obsidian debitage. Krieger (1990) describes the debitage as a mixed technology with some biface thinning and some primary reduction of large core parent pieces. The lack of formal tools and the presence of many decortication elements suggested to Krieger that the site was primarily an obsidian processing area where the reduction of unspecialized cores took place.

In 1990, test excavations were conducted at two sites (F.S. 05-14-61-343 and F.S. 05-14-61-377) located roughly one mile southwest of Giant Crater along the Giant Crater Lava Flow (Sundahl 1990). Both sites exhibited a subsurface deposit ranging in depths from 30 to 60 cm. Based on a debitage analysis, Sundahl determined that the technology was very similar to that of the Giant Crater site. Both sites feature biface manufacturing technologies which appear to be either "the major or perhaps the only activity taking place at the sites" (Sundahl 1990:23).

Assemblage Overviews

Giant Crater

In 1983, test excavations were initiated at Giant Crater because of an impending timber harvest project planned for the site area. Results were subsequently documented in a report by Krieger and Goheen (1984). Investigations focused on three areas where materials were collected from the surface and excavations of three 1 by 1 meter excavation units. Units 1, 2, and 3 were excavated to depths of 70 cm, 90 cm, and 30 cm, respectively, where cultural materials diminished in an extremely cobbly subsoil. The units revealed no obvious stratigraphy despite the rather deep deposits displayed by Units 1 and 2. The estimated volume of the site sampled was less than 1% of the site. The sample recovered consisted entirely of flaked stone made from a single raw material type--obsidian. A total of 3,147 pieces of debitage and tools were recovered through surface collections and excavations. Debitage comprised 99% of the recovered sample. The collection is accessioned at Shasta College Archaeology Laboratory, Redding, under accession number 261-324. All references to artifacts from Giant Crater will contain only the number 324 and the specimen number.

Previous analysis of the recovered materials resulted in descriptions with very little interpretation. Krieger and Goheen (1984:21) classified 20 artifacts as biface fragments. Sixty percent were found on the surface, and 40% were recovered during excavations of Units 1 and 2. The analysis conducted on these bifaces included a description of their shape, flake scars, and edges. Length, width, and thickness measurements were provided. The bifaces were regarded as preforms and believed "to represent an intermediate stage of manufacture between quarry blanks and finished products" (Krieger and Goheen 1984:21).

The entire sample of debitage was classified into debitage types which were very general in nature. Debitage was separated into three large categories: initial modification, subsequent modification, and undetermined. Within these categories seven flake types were established. Biface thinning flakes were recognized in the large and small secondary flake categories. The frequencies of flake types were then calculated and summarized. Because of the small numbers of flakes with cortex and only one primary flake, it was concluded that there was little evidence of primary reduction at the site. The overwhelming number of flake types were from subsequent modification stages, and biface thinning flakes represented approximately 10% of the debitage. Undetermined flakes comprised a little over half of all debitage.

In sum, the earlier analysis of the Giant Crater debitage was conducted without a full understanding of technological processes and in the absence of sensitivity to site function, ethnicity, and other cultural evolutionary phenomena.

Doe Peak

In 1987, test excavations were initiated at Doe Peak by W. Henn who recognized the unusual nature of the assemblage found on its surface. This consisted of a large number of blades and blade-cores. One of the main purposes of the excavation was to ascertain whether a sub-surface deposit existed. Excavations consisted of three 1 by 1 meter units. Units 1, 2, and 3 all reached a depth of 50 cm when large subangular blocky rocks were encountered. The estimated volume of the site sampled through excavation was less than 1% of the site. The sample recovered consisted of only flaked stone debitage and artifacts, dominated by obsidian. Only four basalt flakes were recovered in the excavation units, and of these none was recovered from the surface. The total sample recovered from surface collection and excavations was 2,045 pieces of debitage and tools. Ninety-eight percent of the sample was debitage. The collection is accessioned at Shasta College Archaeology Laboratory under accession number 261-62. All references to artifacts from Doe Peak will contain only the number 62 and the specimen number.

The analysis of the artifacts from Doe Peak concentrated on deriving morphological descriptions of blade tools and unmodified blades. Henn (1990) classified the surface materials and the subsurface materials into nine distinct categories. These include blade-cores, blade-core fragments, unmodified blades, unmodified blade fragments, modified blades, modified blade fragments, flakes, and debitage. Eighty-one percent (n = 31) of the specimens recognized as formal artifacts (i.e., cores and modified blades) were found on the surface, while only 9% (n = 3) of these were found in subsurface deposits. The cores were described as "cores from which blades have been struck" (Henn, 1990:6). Henn classified the modified blades into

three types of modification: unifacial, bifacial, and partly bifacial. He suggested that size was the principal determinate of degree of modification; if the approximate size desired was achieved through unifacial reduction, the tool form was not subject to further modification.

Debitage was not formally analyzed by Henn, although he describes the complete unmodified blades collected from the surface as flakes with parallel edges, a ridged dorsal surface, and a length/width ratio of just over two. They range in length from 1 cm to 10 cm and in width from about 1 cm to 5 cm. Henn suggests that these unmodified blades of varying dimensions were used as blanks for tool production.

In sum, the previous analysis of Doe Peak identified a blade-core industry and briefly explained some of the technological processes of blade-core reduction. But the analysis did not include a debitage analysis and an interpretation of site function based on tool function, ethnicity, or other cultural phenomena.

Temporal Placement of the Sites

At both Giant Crater and Doe Peak there was a lack of obvious stratigraphy, absence of temporally diagnostic artifacts, and lack of materials suitable for radiometric dating. Obsidian hydration was thus the only means of dating available. All specimens were determined to be from the Grasshopper Flat obsidian source through visual inspection.

There were two main goals for the use of obsidian hydration in this study:

1. To test for the presence of more than one component at each site.

2. To compare hydration values obtained in order to determine the temporal placement of the two sites relative to one another.

The sampling strategy devised to meet these objectives was as follows. A total of 40 specimens from the top and bottom excavated level at each site was selected in order to monitor stratigraphic integrity and to determine if hydration values increased with depth. Twenty specimens were selected per excavated level as the sample size. This number was recommended by R. Jackson (personal communication, 1991) who suggested that the hydration threshold obtained from this number of specimens hydrated would yield an accurate mean hydration for a single level.

The hydration results from this study are combined with previous hydration analyses conducted on specimens from these sites. The micron value obtained for each specimen is listed in Appendix A. A mean hydration reading per level was derived to test for intersite temporal variability (see Table 1). Other univariate statistics such as the standard error of the mean and the standard deviation of the mean were also derived from the data to evaluate the strength of the mean. The results obtained from the top and bottom levels at each site are discussed below.

Table 1. Hydration Averages per Level at Giant Crater and Doe Peak

Site	Level (cm)	Mean Micron	Range	Standard Deviation	Standard Error	No. of Samples
GC	Surface	1.28	1.7	.55	.21	7
GC	0-10	1.33	3.3	.76	.16	21
GC	10-20	2.41	2.6	.87	.35	3
GC	20-30	2.13	.6	.30	.17	3
GC	30-40	2.13	.4	.23	.13	3
GC	40-50	3.47	1.6	.68	.34	4
GC	50-60	3.64	2.5	1.03	.46	5
GC	60-70	3.76	2.1	.72	.29	4
GC	70-80	3.23	2.1	.59	.12	23
GC	80-90	3.80	1.8	.78	.39	4
DP	Surface	2.48	2.7	.85	.25	11
DP	10-20	2.75	4.5	1.32	.30	19
DP	40-50	2.85	4.1	1.24	.28	19

The first objective of the analysis was to evaluate the strength of the mean obtained from the top and bottom levels at each site. At Giant Crater the mean obtained for the 0-10 cm level is 1.33 microns. The standard error of the mean is 0.16 and the standard deviation is 0.75. Both the standard error and the standard deviation are low which suggests that the sample mean is fairly representative of the true population mean and that the majority of micron values for the 0-10 cm level clusters around the mean. The mean obtained for the 70-80 cm level at Giant Crater is 3.23. The standard error is 0.12 and the standard deviation is 0.59. Once again, the low standard error and standard deviation suggest that the mean is representative. At Doe Peak the mean obtained for the 10-20 cm level is 2.75 microns. The 40-50 cm level yielded a similar mean of 2.85 microns. The standard error of the mean is 0.30 for the 10-20 cm level and 0.28 for the 40-50 cm level. The low standard error suggests that the sample mean is fairly representative of the true population mean. The standard deviation is 1.32 for the 10-20 cm level and 1.24 for the 40-50 cm level. The larger standard deviations obtained from Doe Peak suggest that there were micron values that deviated considerably from the mean. This suggests that the mean is not a precise indicator of the time of site occupation.

The next objective was to compare the two means obtained from each site to test for the presence of more than one component. A comparison of the two means obtained at Giant Crater suggests that there were two discrete temporal periods of site occupation (see Figure 4a). In sum, these data suggest that the top and bottom levels at Giant Crater are temporally discrete. This does not necessarily suggest that the site was culturally discrete (i.e., contained two separate cultural components). A preliminary analysis of the obsidian reduction strategies suggests that there is no discernible intra-assemblage variability. Furthermore, hydration data from the intervening levels show an incremental increase in micron value

with depth. This suggests that Giant Crater may have been visited over a period of time which is measurable in terms of hydration. For analytical purposes the uppermost and deepest levels at Giant Crater are regarded as representing two different time periods. On the other hand, the similarity in the two means obtained at Doe Peak suggests that there was only a single component (see Figure 4b). But considering that there was a micron range of over 4 microns for both levels, it was concluded that the levels were stratigraphically mixed. This large range suggests that the site might have been originally stratified but had been compressed though natural erosion or site planting activities. Despite indications of a mixed deposit, both levels at Doe Peak are regarded for analytical purposes as representing the same time period.

The third objective of this analysis was to compare the relative age of the two sites since different ages could be one explanation for the differences between them. Since Giant Crater and Doe Peak yielded obsidian that is believed to have come from the same source and have similar elevations, the mean micron values for each site could theoretically be compared. Since the micron values for Doe Peak suggest that the site was stratigraphically mixed, this comparison should be regarded with caution. The mean hydration value per level for each site is plotted on Figure 5. At Giant Crater a mean was obtained for all levels,

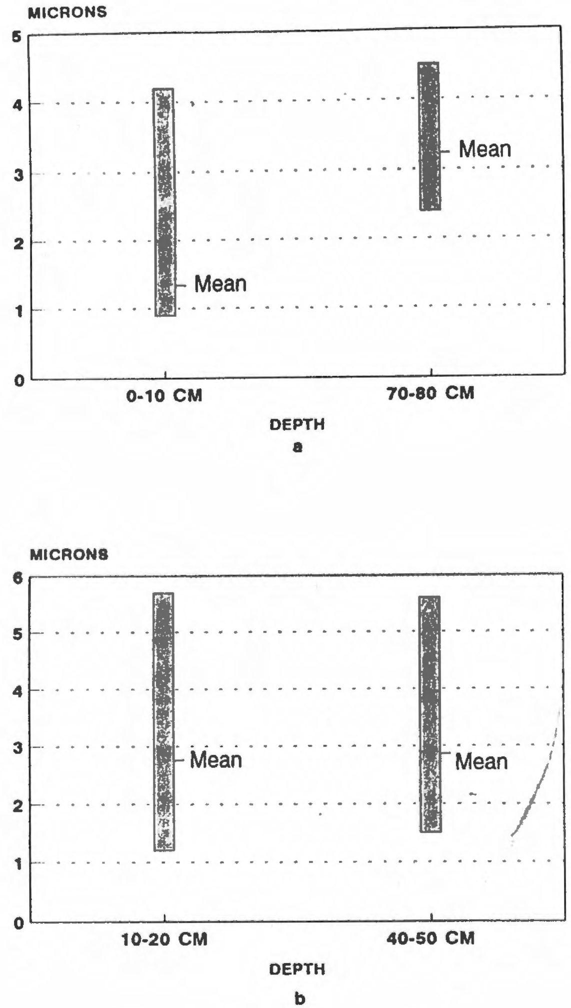

Figure 4. Obsidian hydration ranges and means from Giant Crater (a) and Doe Peak (b).

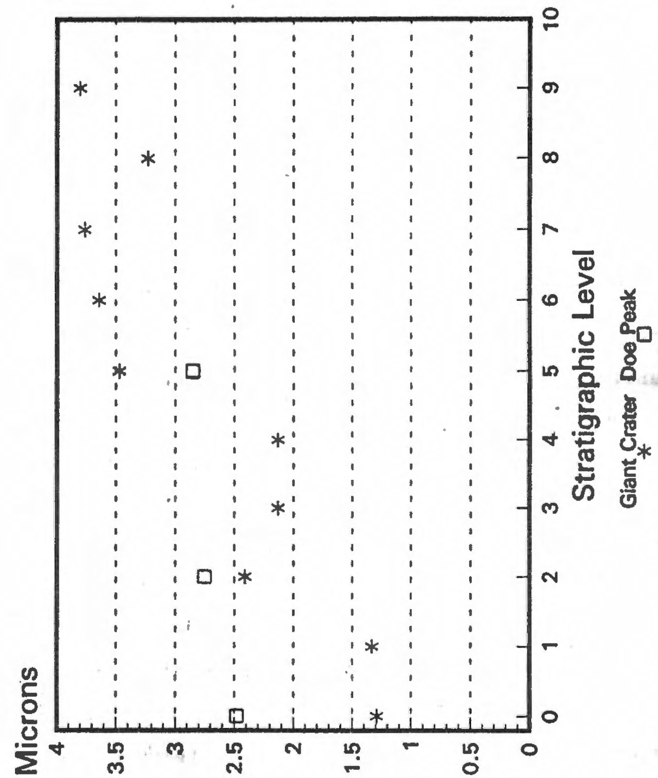

Figure 5. Obsidian hydration means per level at Giant Crater and Doe Peak.

while at Doe Peak a mean was obtained for only the surface, level 10-20, and level 40-50. In Figure 5, the means compared at the two sites seem to suggest that Doe Peak is "sandwiched" in time between the two occupational episodes of Giant Crater. However, when the ranges are evaluated, the two sites appear to overlap. The results are not fine-grained enough to determine if the sites are contemporaneous or separated in time.

The final analysis attempted to assign chronometric dates to Giant Crater and Doe Peak on the basis of their hydration results. This was done by using a formula developed by Basgall and Hildebrandt (1989:198) at sites in the Sacramento River Canyon where radiocarbon dates were used to derive a rate of hydration for Grasshopper Flat obsidian. The formula to derive an adjusted hydration rate for other localities in which the same obsidian is present is to decrease or increase micron values by 7% for every 1° C difference in temperature. The mean annual temperature in the Sacramento Canyon is 14.9° C. The mean annual temperature in the Medicine Lake Highlands is lower at 8.72° C. The temperature difference between the two localities is thus 6.18° C. Seven is multiplied by 6.18 to derive the percentage which each micron value in the Sacramento Canyon must be lowered to yield hydration values in the Medicine Lake Highlands. This rate is 43.26%, which is subtracted (because of the decrease in temperature in the Medicine Lake Highlands) from the micron values obtained in the Sacramento

River Canyon to yield an adjusted rate (see Table 2 and Figure 6).

Table 2. Micron Conversion Table from the Sacramento River Canyon to the Medicine Lake Highlands

Years (B.P.)	Sacramento River Canyon Microns	Rate Adjustment (%)	Medicine Lake Highlands Micron Equivalent
295	1.098	0.47	0.62
565	1.647	0.71	0.93
895	2.196	0.95	1.25
1,280	2.745	1.19	1.56
1,710	3.294	1.42	1.87
2,190	3.843	1.66	2.18
2,710	4.392	1.90	2.49
3,275	4.941	2.14	2.80
3,875	5.490	2.37	3.12
4,515	6.039	2.61	3.43
5,190	6.588	2.85	3.74
5,900	7.137	3.09	4.05
6,640	7.686	3.32	4.36

The final step in this series of calculations was to derive chronometric date(s) for the sites. Chronometric dates for Giant Crater and Doe Peak are based on the mean micron values obtained for each level (see Table 3). Since there is not a one-to-one correspondence between the mean micron values from the sites and the adjusted micron values noted in Table 2 above, chronometric equivalences for the sites were estimated. The results are displayed graphically on Figure 7. Two temporal episodes were derived for Giant

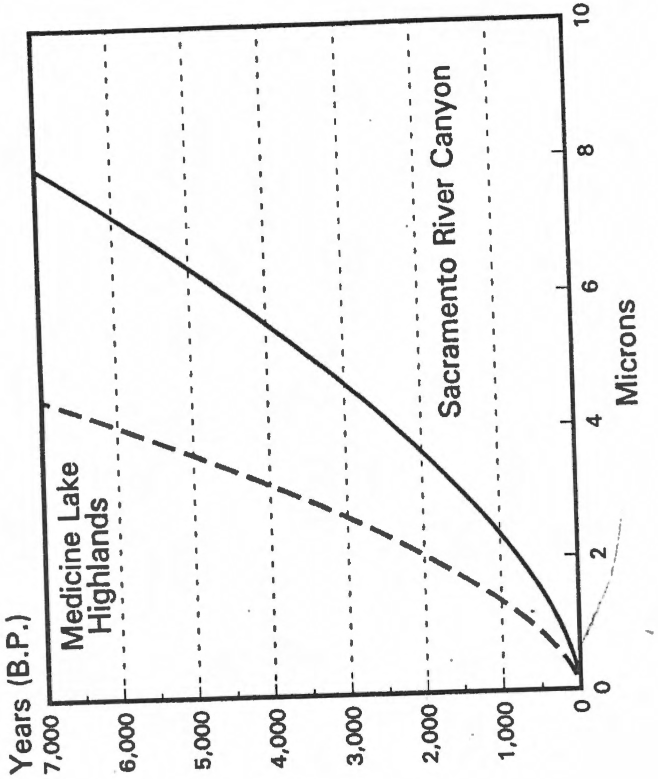

Figure 6. Adjusted rate of hydration for the Medicine Lake Highlands.

Crater. The first ranged from 932 to 2,575 years before the present. The second ranged from 4,040 to 5,281 years before the present. Doe Peak ranged from 2,693 to 3,275 years before the present.

Table 3. Estimated Chronometric Dates per Level from Giant Crater and Doe Peak

Site	Level	Mean Micron	Estimated Years B.P.
GC	Surface	1.28	932
GC	0-10	1.33	995
GC	10-20	2.41	2,575
GC	20-30	2.13	2,112
GC	30-40	2.13	2,112
GC	40-50	3.47	4,602
GC	50-60	3.64	4,972
GC	60-70	3.76	5,236
GC	70-80	3.23	4,040
GC	80-90	3.80	5,282
DP	Surface	2.48	2,693
DP	10-20	2.75	3,275
DP	40-50	2.85	3,275

The final objective of this analysis--to compare the relative age of Giant Crater and Doe Peak--was not met. Time overlap was indicated by micron ranges, while temporal discreteness was indicated by micron means. The inconclusive results, however, do not affect later interpretations in this study because age is regarded as a relative value and not an explanation of variation.

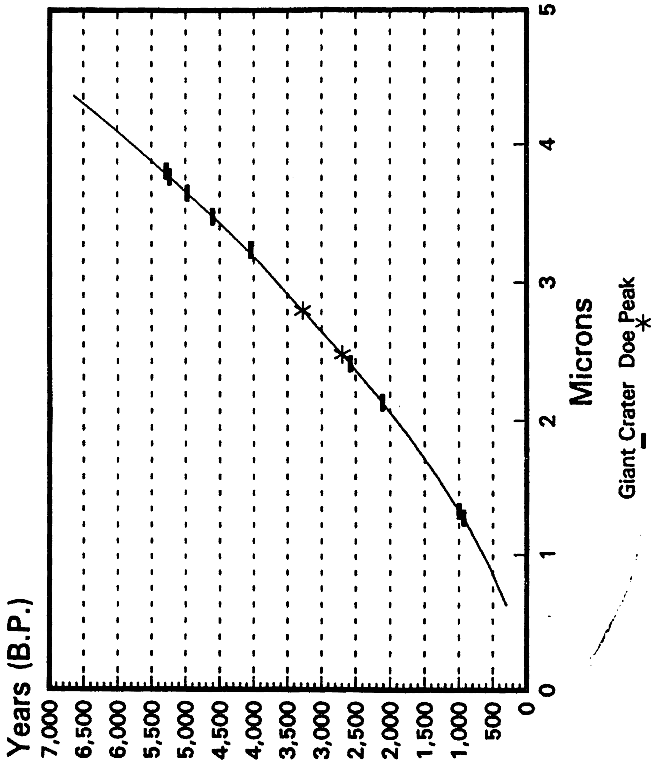

Figure 7. Chronological estimates for Giant Crater and Doe Peak based on adjusted hydration rates.

CHAPTER III

HYPOTHESIS FORMULATION

Introduction

The background information presented in Chapter II provides an empirical base from which observations can be made on the archaeological patterning and variability. These observations are discussed in this chapter in relationship to existing theories of variability offered in the archaeological literature. The theories that are appropriate to the differences displayed between Giant Crater and Doe Peak are discussed and then recast into specific hypotheses in the remaining chapters.

Study Parameters

Intersite differences are expressed between Giant Crater and Doe Peak principally by lithic assemblage differences. A comparison of the respective site reports reveals that the two sites differ specifically in their debitage and tool types. To review, biface thinning flakes were noted at Giant Crater but not at Doe Peak while blades were noted at Doe Peak but not at Giant Crater. Similarly, biface tool blanks were noted only at Giant Crater and blade-cores and blade tools were noted only at Doe Peak.

CHAPTER VIII

CONCLUSIONS

Introduction

The primary goal of this study was to explain the differences observable in the flaked stone assemblages from Giant Crater and Doe Peak, two prehistoric sites located in the Medicine Lake Highlands near obsidian sources. The observed variation between the sites concerned differences in both their debitage and tool compositions. These artifactual differences were a marked contrast to the similarity of their environment, their use of the same obsidian source for their raw material reduction, and their similar distances to the source of obsidian at Grasshopper Flat.

Discussion of Hypotheses

In order to develop hypotheses for the observed differences between Giant Crater and Doe Peak, the existing archaeological literature was examined for explanations of variability at other sites. Four explanations that were prominent in the existing literature were formulated into hypotheses for this study. The hypotheses were as follows:

1. Variation exists because the two sites possess different manufacturing technologies.

2. Variation exists because the two sites served different functional purposes.

3. Variation exists because the two sites represent two distinct ethnic groups.

4. Variation exists because the two sites reflect different mobility strategies.

Other hypotheses offered in the literature for intersite and intrasite variability included differences in seasons of use, differences in the distance of sites to obsidian sources, and differences in types of obsidian used. These hypotheses were examined briefly but were not explored further in this study because of either lack of data or the fact that these phenomena were observed to be the same at both sites. Seasonality was not explored because of the absence of floral and faunal data. The distance of each site to the obsidian sources and differences in the fracturing properties of obsidian were considered to be insignificant as explanatory variables in this study because the sites were both located approximately two miles southeast and southwest of Grasshopper Flat, and it was determined by visual inspection that the same source of obsidian was used at both sites.

Chronological differences were also not explored as a hypothesis in this study. This variable was not examined further because there were no means of determining whether differences in age could have been a source of variation in the assemblages. In addition, the longevity of the biface production technology at Giant Crater argues against the proposition that the sites were different because they represented a change in technology over time.

Final Conclusions

Based on the analyses presented in this study, it is concluded that the combination of three hypotheses explained the observed differences between Giant Crater and Doe Peak. These included differences in technology, site function, and mobility strategies. Differences in ethnic affiliation was the only hypothesis that could not be validated from the existing data. The integrated explanations are described here. It is inferred that bifaces were selected at Giant Crater for functional reasons--they were adaptable to multi-purpose needs for future use. But the design of the bifaces and the technology selected at the same time satisfied demands of movement. The mobility strategy hypothesis suggested that these demands included a task-specific foray which was limited in duration. To address these conditions, an expedient technology for producing biface blanks was selected (i.e., the reduction of flake blanks to biface blanks). The bifaces were also portable and could be carried in large number. The formerly thick flake blank was thinned so that much of the bulk was removed yet the bifaces retained enough mass so they were not easily broken during transport.

It is inferred that the blade form was selected at Doe Peak also for functional reasons, but these reasons were very different from Giant Crater. The blade-core technology produced a form that once retouched and hafted fit particular specifications of a specialized hunting strategy. The specialization of the hunting was inferred from both blood residue analysis where it was discovered that two non-consumptive species--bear and wolf--were hunted, and from the specialized and complex nature of the technology selected. But the design of the blade tools and the technology selected also satisfied demands of movement. The mobility strategy hypothesis suggested these demands included an embedded and extended resource acquisition foray. To address these conditions a technology was selected which offered a production mode where numerous blanks could be produced. The blades, once produced, were portable and adaptable to the production of an array of tool types. This array could be used to maintain the group while in transit. In addition, the blade-core technology which was time-consuming and complex met the conditions of an extended foray in which time stress was not as much of a factor. The results derived from each separate hypothesis are presented here in the order they were presented in the study.

The first hypothesis explored site differences relating to use of different manufacturing technologies. The results indicated that there were two different industries represented at Giant Crater and Doe Peak and that each technology involved different techniques of stone reduction and produced a different array of debitage and tool types. The technique used at Giant Crater was determined to be a biface thinning technology in which a flake blank was thinned on both faces to produce bifaces. The technique used at Doe Peak was determined to be a blade reduction technology in which a core was specially prepared to produce blades. The blank blades were then modified by pressure flaking on one or both faces to produce various blade tools. These conclusions were based on the types of cores, debitage, and tools present and their differential distribution.

Indicators of a biface thinning technology included the presence of fragmentary bifaces, biface thinning flakes, overshot biface terminations, and the dominance of multi-faceted platforms and ventral surface remnants. These tool and flake types did not occur at Doe Peak, although multi-faceted platforms and ventral surface remnants were present at Doe Peak in very low frequencies. Indicators of blade technology included the presence of blade-cores, tools fashioned on blades, unmodified blades in the debitage, overshot blade terminations, and the dominance of single-faceted and cortical platforms. These tool and flake types did not occur at Giant Crater, although single-faceted and cortical platforms were present at Giant Crater in very low frequencies. It was concluded that identification of

different manufacturing technologies did not, however, explain why different technologies were necessary in the first place and therefore it was only a proximate explanation for assemblage differences between Giant Crater and Doe Peak.

The second hypothesis explored site differences relating to different site functions. Site function was determined by a number of indicators. These included tool type, tool function, species hunted, manufacturing behavior, and discard patterns. The results indicated that the two sites were different because they served different functional purposes. Giant Crater functioned primarily as a manufacturing site where biface blanks were produced to be used elsewhere. Doe Peak functioned primarily as a locale that served as a base for specialized hunting activities and as a manufacturing locale for blade tool replenishment.

The inference that Giant Crater served primarily as a manufacturing site was based on the pattern of discarding unfinished bifaces, the domination of primary and secondary bifacial thinning stages, and the absence of maintenance on the bifaces indicating reuse. The inference that biface blanks were the intended product was based on the generalized morphology of the bifaces produced and the absence of other bifacial tool forms. A secondary site function was identified by residues of blood from elk and rabbit left on two bifaces. The obtuse edge angles on both of these utilized bifaces suggested that they were probably used for heavy bone or hide scraping, rather than for cutting. The absence of tools appropriate for hunting, such as projectile points, suggested that hunting activities did not occur and that hide processing was likely incidental to the main task of manufacturing bifaces.

The inference that Doe Peak served as a base for specialized hunting was based on the presence of blood residues of bear and Canidae which were both not commonly used as a dietary staple and the use of a specialized blade manufacturing technology. Hunting was inferred by the occurrence of projectile points and blood residue analysis, and their actual use was indicted by the fact that they were resharpened in their hafts. Meat and hide processing activities were inferred by the presence of knives and a wide variety of other types of blade tools with edge-angles that varied from acute to obtuse. The inference that Doe Peak also served as a manufacturing locale for blade tool replenishment was based on the presence of curated tools that were discarded, and the occurrence of a complete manufacturing trajectory of blade making which included blade-cores, unretouched blades, and blade tools that were broken during manufacturing stages.

The third hypothesis explored site differences relating to the presence of two distinct cultures. Ethnic affiliation was difficult to assess, however, from the existing data base. The temporal periods defined for Giant Crater and Doe Peak indicated that they were occupied during

prehistoric times. This precluded a determination of ethnic affiliation based on historic ethnographic boundaries. The absence of an overlapping artifact type between the two sites also precluded a determination of ethnic affiliation based on like artifact types. A corollary hypothesis was therefore offered in order to establish ethnic affiliation by other means. This hypothesis suggested that there be a mutually exclusive distribution of technologies similar to either Giant Crater or Doe Peak across a given landscape. A literature search was conducted to identify the technologies at numerous sites within approximately 100 mile radius of the Medicine Lake Highlands. The results obtained were inconclusive primarily because there was a paucity of sites that were similar to Doe Peak and its associated blade-core technology. Sites similar to Giant Crater formed a patterned distribution which largely clustered in the Medicine Lake Highlands but were also northward-trending.

The final hypothesis explored site differences relating to differences in mobility strategies. Mobility strategy theory suggests that from a behavioral perspective, hunter-gatherer movement would greatly influence technology. Variables mediating mobility, such as transportation weight and bulk, distance that had to be traveled, subsistence needs while in transit were among the considerations that would affect technological choices. Hence, variable mobility strategies would translate into variable assemblages.

Mobility strategies were reconstructed by exposing the underlying foundation of technological organization at each site in relationship to variables of movement. Three aspects of technological organization were first identified--obsidian acquisition strategies at the quarry, tool design strategies, and tool maintenance strategies. These strategies were then ranked according to various relative measures of energy investment. Obsidian acquisition strategies were ranked according to time-efficiency and complexity of nodule reduction at the quarry. Tool design strategies were ranked according to the adaptability of both current and presumed future tool use, and the durability and portability of the assumed transported product. Tool maintenance strategies were ranked according to whether they indicated that the tools had been reused and maintained through a number of uses (curated) or were used once and discarded (expedient).

The results of the mobility strategy analysis indicated that different mobility strategies were practiced by the travelers to Giant Crater and Doe Peak. The mobility at Giant Crater was defined as a task-specific foray organized by a group for purposes of producing bifaces for their own use. Their travel was within their home base logistic radius (not more than 20 miles). The mobility at Doe Peak was defined as an embedded and extended foray organized by a group for purposes of hunting and tool replenishment. Their

travel was beyond their logistic radius (i.e., greater than 30 miles).

The inference that the foray to Giant Crater was task-specific was supported by the determination that only one artifact type was produced and there was little evidence for tasks other than biface production. The short-distance travel was inferred from the absence of tools suitable for hunting which would have limited subsistence activities while traveling. The distance was estimated to be within a home base logistic radius which was probably not more than 20 miles. The geographic distribution of the biface technology in the ethnic analysis suggested that the travelers to Giant Crater came from the north, perhaps from villages located in the Lava Beds National Monument or even from summer villages at Medicine Lake. Direct acquisition of the bifaces for personal use is inferred because there is no intrasite variability despite indications of two distinct temporal occupations. The time efficiency and simplicity of the quarry reduction techniques and the portability and durability of the bifaces were thought to be partially an outcome of the time-stress associated with a limited travel distance.

The inference that the foray to Doe Peak was embedded as a multiple resource acquisition trip was supported by the following data. First, it was determined based on the occurrence of projectile points, the use of a specialized blade-core technology, and the capture of nonconsumptive species that a specialized hunting strategy occurred both during travel and at Doe Peak. Second, the pattern of discarding completed blade tools at Doe Peak, the curation of projectile points, and the occurrence of a complete blade-core manufacturing trajectory suggested that the trip was embedded in raw material acquisition for purposes of tool replenishment. The inference that the distance traveled was extended was based on the presence of projectile points that were curated prior to their arrival at Doe Peak and the presence of an adaptable array of tools that were capable of sustaining a group on an extended trip.

Mobility strategy was perhaps the most explanatory of the hypotheses because it explained the differences between the sites not only from the perspective of technology and function, but also from a middle range theoretical perspective of hunter-gatherer organization.

Study Evaluation

Three out of four hypotheses examined in this study were confirmed. The study objective of explaining factors responsible for site variation between Giant Crater and Doe Peak was thus met. An evaluation of certain facets of this study are presented here. In general, the amount of information generated about cultural systems was unexpected in light of the fact that the archaeological remains were limited to flaked-stone industries. Undoubtedly, the nature of the unmixed technologies near an obsidian source area

provided both an unusual and a rich data base. Some of the results such as patterns of technology, tool production, site function, obsidian acquisition strategies, and mobility strategies including traveling distance, location of home bases, and organization of group travel yielded a good deal more about regional patterns of movement, use of resources, desired tool products, and optimizing behaviors than was expected from the study of only two sites. Another promising result was in the area of obsidian hydration analysis. The fact that Giant Crater and Doe Peak were dated relative to one another by obsidian hydration analysis is promising since many other sites in the Highlands also lack obvious stratigraphy, temporally diagnostic artifacts, and materials suitable for radiometric dating.

This study was unique for two other reasons as well. First, the methods used for inferring mobility in this study were unlike existing studies of mobility in the literature. In this study mobility was inferred not only based on technological and functional factors, but also on an analysis of energy correlates. Measures of efficiency, portability, adaptability, durability, and expediency of various strategies served to characterize decisions and compromises behind a given strategy. Second, the blade technology reported in this study is significant in its own right, because blade technologies are virtually absent at sites in northern California. The tentatively suggested association of Doe Peak with the Hedge Creek site in the Sacramento River

Canyon and the site on the Malheur Wildlife Refuge provides a foundation for future research on the origins of the blade-core technology in northern California.

Despite the fact that the overall goals of this study were met, there were also areas of weakness. One area was the sample used for the ethnic affiliation analysis. Perhaps more positive results would have been obtained if the sample was temporally sensitive. Another weakness of this study was that the functional inferences of tool use were largely based on morphological factors. More sophisticated use-wear studies would have strengthened these interpretations, especially at Giant Crater where it was uncertain the degree to which the bifaces were used in subsistence pursuits.

Regional Implications

This study of assemblage variation between Giant Crater and Doe Peak contributes to the conduct of archaeological research of much of the northern California region because of base-line data it yields on technology, function, and mobility strategies at sites that are located near a dominant obsidian source area. A number of patterns of obsidian exploitation emerged from this study which could be used in regional level syntheses. First, the variable technologies of the sites suggest that patterns of obsidian exploitation in the Highlands were variable. This pattern of technological variation contrasts with the finding of a

major study of late period ethnographic village sites in the regions northeast and northwest of the Medicine Lake Highlands. Nilsson (1985:199) discovered in a study of intersite comparison that these sites possessed relatively homogeneous technologies that cross-cut cultural and spatial boundaries and may have cross-cut temporal boundaries as well. The dominant obsidian at these sites was from the Grasshopper Flat source. Among the similarities in technology were the predominance of lisse and crushed platforms, the predominance of unidirectional platform cores and flakes, and the predominance of tertiary blanks. Two explanations are offered to account for the discrepancy between this study and Nilsson's:

1. Technologies become more similar in ethnographic times perhaps as a result of increased cultural interaction or a response to similar subsistence orientations.

2. Technological industries become less distinct as they move away from the sources of obsidian. This trend towards homogeneity may be due to the fact that distinct industries tend to get mixed as a result of the presumed wider variety of tasks at residential sites away from the source areas.

Another pattern that emerged from this study concerns site locating behavior in the Medicine Lake Highlands. A pattern of workshops surrounding the quarry at Grasshopper Flat was noted. This was based on observations from Giant Crater and Doe Peak that the large nodules of obsidian were initially reduced at Grasshopper Flat into a desired parent form and then this parent piece was transferred to the sites where production of tools was completed. This pattern was not only supported by the evidence from Giant Crater and Doe Peak, but was also noted at the Spattercones site (Sundahl 1985) where large macro-flakes were brought to the site from the quarry. The macro-flakes were the presumed parent form for the production of corner-notched and side-notched projectile points. The pattern was also noted at Grasshopper Flat where there was a notable absence of finished artifacts (Krieger 1986). The absence of water at Grasshopper Flat may have contributed to the occurrence of manufacturing workshops located away from the quarry itself, but additional data are needed to consider these relationships further.

Yet another obsidian exploitation pattern revealed by this study concerned modes of artifact production in the Highlands. A pattern of reducing quarry nodules into an artifact and then transporting that reduced form outside the Highlands was noted at both Giant Crater and Doe Peak. At Giant Crater the presumed transported products were biface blanks and at Doe Peak the presumed transported products were blade tools including projectile points and knives. Blade-cores may also have been transported. This pattern contrasts with the parent forms reported in the literature in the larger region. The Lake Britton sites, for instance, which range from 4,000 to 200 B.P., exhibit obsidian cores

sourced to Grasshopper Flat (Kelly et al. 1987). Krieger (1990) reported the existence of a cache of flake blanks made of Grasshopper Flat obsidian at the Lower Falls site on the McCloud River. Some of the larger flake blanks were similar in size to the presumed flake blank that was reduced to a biface at Giant Crater. Large flake blanks and biface cores were also noted on the Sacramento River at sites that date to the Pollard and Vollmers phases (1,700-5,300 B.P.). These flake blanks ranged in size from 15 to 25 cm and were larger than the flake blanks at Giant Crater. These varying forms of obsidian transported from the Highlands suggest that the systemic relationship between sites located in the Medicine Lake Highlands and sites located outside the Highlands is complex and must be studied within a temporal framework in the future.

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APPENDIX A

OBSIDIAN HYDRATION VALUES FOR GIANT CRATER AND DOE PEAK

Giant Crater Obsidian Hydration Values
(1983, 1988, 1991 Results)

Catalog No.	Artifact Type	Provenience (cm)	Micron Value (mean)
261-324-2	Biface	Surface	0.7
261-324-3	Biface	Surface	1.0
261-324-6	Biface	Surface	1.6
261-324-11	Biface	Surface	1.1
261-324-12	Biface	Surface	1.1
261-324-13	Biface	Surface	2.4
261-324-14	Biface	Surface	1.1
261-324-33	Debitage	Unit 2/0-10	0.9
261-324-33	Debitage	Unit 2/0-10	0.9
261-324-33	Debitage	Unit 2/0-10	1.0
261-324-33	Debitage	Unit 2/0-10	0.9
261-324-33	Debitage	Unit 2/0-10	1.2
261-324-33	Debitage	Unit 2/0-10	1.6
261-324-33	Debitage	Unit 2/0-10	0.9
261-324-33	Debitage	Unit 2/0-10	1.7
261-324-33	Debitage	Unit 2/0-10	1.2
261-324-33	Debitage	Unit 2/0-10	1.1
261-324-33	Debitage	Unit 2/0-10	0.9
261-324-33	Debitage	Unit 2/0-10	1.0
261-324-33	Debitage	Unit 2/0-10	1.4
261-324-33	Debitage	Unit 2/0-10	1.0
261-324-33	Debitage	Unit 2/0-10	0.9
261-324-33	Debitage	Unit 2/0-10	1.0
261-324-33	Debitage	Unit 2/0-10	1.5
261-324-33	Debitage	Unit 2/0-10	1.0
261-324-33a	Debitage	Unit 2/0-10	2.6
261-324-33b	Debitage	Unit 2/0-10	1.2
261-324-33c	Debitage	Unit 2/0-10	4.2
261-324-16	Biface	Unit 2/10-20	2.2
261-324-17	Biface	Unit 2/10-20	2.9
261-324-1	Biface	Unit 2/10-20	2.3
261-324-34a	Debitage	Unit 2/10-20	3.8
261-324-34b	Debitage	Unit 2/10-20	1.2
261-324-34c	Debitage	Unit 2/10-20	2.1
261-324-35a	Debitage	Unit 2/20-30	2.2
261-324-35b	Debitage	Unit 2/20-30	1.8
261-324-35c	Debitage	Unit 2/20-30	2.4

Catalog No.	Artifact Type	Provenience (cm)	Micron Value (mean)
261-324-36a	Debitage	Unit 2/30-40	2.4
261-324-36b	Debitage	Unit 2/30-40	2.0
261-324-36c	Debitage	Unit 2/30-40	2.0
261-324-37a	Debitage	Unit 2/40-50	2.8
261-324-37b	Debitage	Unit 2/40-50	3.2
261-324-37c	Debitage	Unit 2/40-50	3.5
261-324-37d	Debitage	Unit 2/40-50	4.4
261-324-5	Biface	Unit 2/50-60	4.3
261-324-38a	Debitage	Unit 2/50-60	5.0
261-324-38b	Debitage	Unit 2/50-60	2.8
261-324-38c	Debitage	Unit 2/50-60	2.5
261-324-38d	Debitage	Unit 2/50-60	3.6
261-324-10	Biface	Unit 2/60-70	4.1
261-324-7	Biface	Unit 2/60-70	2.4
261-324-39a	Debitage	Unit 2/60-70	4.5
261-324-39b	Debitage	Unit 2/60-70	3.9
261-324-39c	Debitage	Unit 2/60-70	3.7
261-324-39d	Debitage	Unit 2/60-70	4.0
261-324-40	Debitage	Unit 2/70-80	3.3
261-324-40	Debitage	Unit 2/70-80	3.6
261-324-40	Debitage	Unit 2/70-80	2.8
261-324-40	Debitage	Unit 2/70-80	2.4
261-324-40	Debitage	Unit 2/70-80	3.7
261-324-40	Debitage	Unit 2/70-80	3.0
261-324-40	Debitage	Unit 2/70-80	3.6
261-324-40	Debitage	Unit 2/70-80	2.4
261-324-40	Debitage	Unit 2/70-80	3.0
261-324-40	Debitage	Unit 2/70-80	3.8
261-324-40	Debitage	Unit 2/70-80	2.8
261-324-40	Debitage	Unit 2/70-80	3.6
261-324-40	Debitage	Unit 2/70-80	4.5
261-324-40	Debitage	Unit 2/70-80	2.6
261-324-40	Debitage	Unit 2/70-80	2.8
261-324-40	Debitage	Unit 2/70-80	2.6
261-324-40	Debitage	Unit 2/70-80	2.6
261-324-40	Debitage	Unit 2/70-80	3.4
261-324-40	Debitage	Unit 2/70-80	3.5
261-324-40	Debitage	Unit 2/70-80	2.7
261-324-40a	Debitage	Unit 2/70-80	4.2
261-324-40b	Debitage	Unit 2/70-80	3.7
261-324-40c	Debitage	Unit 2/70-80	2.9

Catalog No.	Artifact Type	Provenience (cm)	Micron Value (mean)
261-324-41a	Debitage	Unit 2/80-90	3.8
261-324-41b	Debitage	Unit 2/80-90	4.2
261-324-41c	Debitage	Unit 2/80-90	4.5
261-324-41d	Debitage	Unit 2/80-90	2.7

Doe Peak Obsidian Hydration Values
(1981 and 1991 Results)

Catalog No.	Artifact Type	Provenience (cm)	Micron Value (mean)
261-62-4	Modified Blade	Surface	1.8
261-62-5	Modified Blade	Surface	2.7
261-62-6	Modified Blade	Surface	1.3
261-62-14	Modified Blade	Surface	2.8
261-62-18	Blade	Surface	3.3
261-62-21	Blade	Surface	1.4
261-62-22	Blade	Surface	2.2
261-62-23	Blade Fragment	Surface	1.9
261-62-30	Blade Fragment	Surface	3.3
261-62-39	Modified Blade	Surface	4.0
261-62-40a	Modified Blade	Surface	2.6
261-62-74	Debitage	Unit 1/10-20	2.2
261-62-76	Blade	Unit 1/10-20	5.4
261-62-77d	Blade Fragment	Unit 1/10-20	2.0
261-62-77e	Blade Fragment	Unit 1/10-20	1.8
261-62-77f	Blade Fragment	Unit 1/10-20	2.5
261-62-79	Blade Fragment	Unit 1/10-20	2.1
261-62-79	Blade Fragment	Unit 1/10-20	1.8
261-62-78a	Debitage	Unit 1/10-20	5.1
261-62-78b	Debitage	Unit 1/10-20	1.9
261-62-78c	Debitage	Unit 1/10-20	3.6
261-62-75a	Debitage	Unit 1/10-20	2.5
261-62-78d	Blade	Unit 1/10-20	5.7
261-62-79	Blade	Unit 1/10-20	1.8
261-62-79d	Debitage	Unit 1/10-20	2.4
261-62-79e	Debitage	Unit 1/10-20	1.7
261-62-79f	Debitage	Unit 1/10-20	1.2
261-62-79h	Debitage	Unit 1/10-20	3.6
261-62-79i	Debitage	Unit 1/10-20	3.0
261-62-79j	Debitage	Unit 1/10-20	2.1

Catalog No.	Artifact Type	Provenience (cm)	Micron Value (mean)
261-62-92	Debitage	Unit 1/40-50	1.8
261-62-92	Debitage	Unit 1/40-50	4.2
261-62-92	Debitage	Unit 1/40-50	1.5
261-62-92	Debitage	Unit 1/40-50	2.0
261-62-92	Debitage	Unit 1/40-50	1.9
261-62-92	Debitage	Unit 1/40-50	2.8
261-62-92	Debitage	Unit 1/40-50	1.8
261-62-92	Debitage	Unit 1/40-50	1.8
261-62-92	Debitage	Unit 1/40-50	2.5
261-62-92	Debitage	Unit 1/40-50	2.1
261-62-92	Debitage	Unit 1/40-50	2.0
261-62-93	Debitage	Unit 1/40-50	2.3
261-62-94	Debitage	Unit 1/40-50	2.9
261-62-92	Debitage	Unit 1/40-50	2.3
261-62-92	Debitage	Unit 1/40-50	5.6
261-62-92a	Debitage	Unit 1/40-50	3.8
261-62-93	Blade	Unit 1/40-50	3.8
261-62-93	Debitage	Unit 1/40-50	3.7
261-62-93a	Debitage	Unit 1/40-50	5.5

APPENDIX B