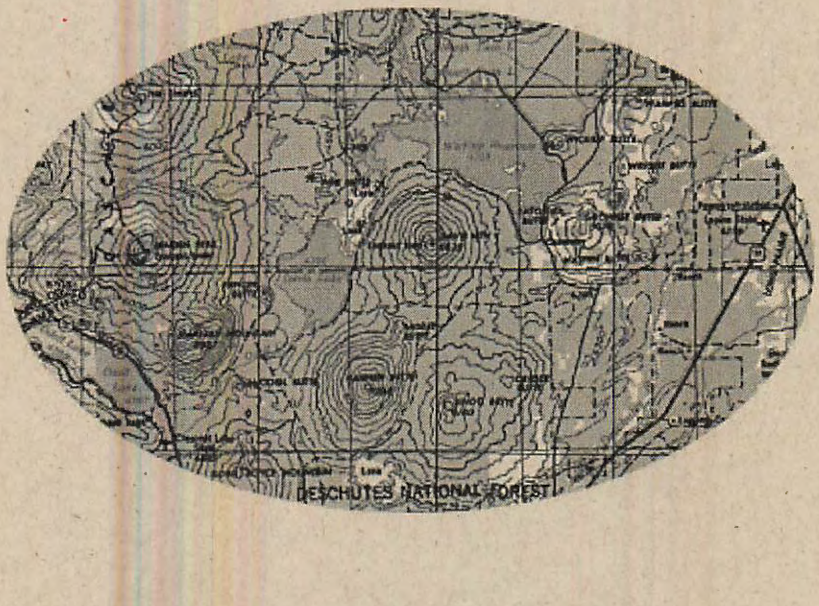
Upper Deschutes River Basin Prehistory:

A Preliminary Examination of Flaked Stone Tools and Debitage



Michael W. Taggart

2002

Craig –

Thanks for your encouragement & support!

Best,

Mike

AN ABSTRACT OF THE THESIS OF

Michael W. Taggart for the degree of Master of Arts in Interdisciplinary Studies in Anthropology, Anthropology, and Geography presented on April 19, 2002.
Title: Upper Deschutes River Basin Prehistory: A Preliminary Examination of Flaked Stone Tools and Debitage.

Abstract approved: ___________________________
Barbara J. Roth

The prehistory of Central Oregon is explored through the examination of six archaeological sites and two isolated finds from the Upper Deschutes River Basin. Inquiry focuses on the land use, mobility, technological organization, and raw material procurement of the aboriginal inhabitants of the area. Archaeological data presented here are augmented with ethnographic accounts to inform interpretations.

Eight stone tool assemblages and three debitage assemblages are analyzed in order to characterize technological organization. Diagnostic projectile points recovered from the study sites indicate the area was seasonally utilized prior to the eruption of ancient Mt. Mazama (>6,845 BP), and continuing until the Historic period (c. 1850). While there is evidence of human occupation at the study sites dating to between >7,000 – 150 B.P., the range of activities and intensity of occupation varied. Source characterization analysis indicates that eight different Central Oregon obsidian sources are represented at the sites. Results of the lithic analysis are presented in light of past environmental and social phenomena including volcanic eruptions, climate change, and human population movements.

Chapter One introduces the key questions that directed the inquiry and defines the theoretical perspective used. Chapter Two describes the modern and ancient environmental context of study area. Topics of discussion include physiography, fauna, vegetation, geology, and climate. Chapter Three introduces the aboriginal inhabitants of the Upper Deschutes River Basin and summarizes past archeological investigations in the area. Hunter-gatherer land use and lithc technology are discussed in Chapter Four. The methods used to collect and analyze the data used in this study are presented in Chapter Five. Chapter Six summarizes the results of the technological lithic analysis and geochemical sourcing. The final chapter, Discussion and Conclusions, interprets the results with respect to cultural chronology, site function and distribution, land use and mobility, lithic technology, and raw material procurement.

Upper Deschutes River Basin Prehistory: A Preliminary Examination of Flaked Stone Tools and Debitage

by
Michael W. Taggart

A THESIS

submitted to

Oregon State University

in partial fulfillment of
the requirements for the
degree of

Master of Arts in Interdisciplinary Studies

Presented April 19, 2002
Commencement June 2002

ACKNOWLEDGEMENTS

Many people have given guidance and support during the design and execution of this project. Some of those I'm indebted to shared their knowledge, others offered inspiration. I am grateful for them all.

First of all I would like to thank the good people at the Deschutes National Forest and the Central Oregon Heritage Group. Crescent District Archaeologist, Leslie Hickerson, gave generously of her time and made available the records and artifact collections that were used here. A big thanks also goes out to Paul Claeyssens, Heritage Program Manager for the Forest, who took an interest in this project early on and helped get it off the ground. Scott Goodman, High Desert Area Archaeologist for the BLM, was kind enough to give me access to the COHG GIS database and provided technical support.

Dr. Barbara Roth, my Graduate Advisor, provided encouragement and a critical eye that helped to smooth out some of the rough spots in this project. Thanks also to Dr. Roberta Hall for her input and helping to keep me gainfully employed during this process.

Craig Skinner and the Northwest Research Obsidian Studies Lab were instrumental in making this happen. The donation of lab services in the form of the 2000 Northwest Research Obsidian Studies Lab Grant was a big help. Thanks.

Finally, special thanks go to my parents, Bill and Jackie Taggart. None of this would be possible without them. I love you guys.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF FIGURES (Continued)

LIST OF TABLES

UPPER DESCHUTES RIVER BASIN PREHISTORY: A PRELIMINARY ANALYSIS OF FLAKED STONE TOOLS AND DEBITAGE

CHAPTER 1: INTRODUCTION

Many aspects of the prehistoric human ecology of the Northern Great Basin remain unclear to researchers. This study examines lithic technology and land use patterns of prehistoric hunter-gatherers of the upper Deschutes River Basin. A central goal is to examine how people used the upper Deschutes at different points in time. Lithic assemblages from eight prehistoric archaeological sites are examined in order to describe the technology, determine the raw material sources, and place artifacts within a time sensitive typology. Analysis indicates that the study area was occupied, with varying degrees of intensity, from the Early Holocene until the Historic period (c. 1850). During this time, tool stone from eight Oregon obsidian sources was brought into the area. The obsidian source data are used to outline the range of variability in behavior of past occupants of the region with respect to group mobility and technological organization. Spatial analysis conducted as part of this study focused on the archaeological distribution of obsidian artifacts relative to their primary source. Insights gleaned from the analysis provide a few more brush strokes to our emerging understanding of prehistoric spheres of interaction in the Far West.

This study is primarily concerned with the southwest portion of the Deschutes National Forest, although the findings are interpreted within the larger context of Northern Great Basin, Plateau and Cascade physiographic and culture areas. The region described here as the Upper Deschutes River Basin covers approximately 4,200 km^2 (1,600 mi^2). The northern boundary extends from Cultus Lake near the crest of the Cascades to Swamp Wells Butte located to the east in the High Lava Plains. Moving south, the eastern boundary roughly coincides with the eastern flank of Newberry Crater down to Hole In The Ground. From there, the area of inquiry extends to the Douglas / Klamath county line at the crest of the Cascade Range (Figure 1.1). Clearly, the delineation of the study area is somewhat arbitrary, given the fluidity of people, their culture, and their spheres of interaction. Yet, such distinctions are useful and necessary for this study, as they provide a basis for comparison between different environmental zones.

This research has grown out of work carried out in the Northern Great Basin and southern Columbia Plateau since the 1930's (Aikens 1978; Ames 1998; Bedwell 1973; Cressman 1940; Jenkins and Connolly 1996; Skinner 1994; Steward 1938; Stewart 1939). Early approaches in cultural history shed light on the linguistic affiliation of groups in the region, and provided descriptions of material culture. Work performed within the last few decades has given more attention to concerns of human ecology (Aikens 1993; Atwell et al. 1994; Connolly 1999; Jenkins 1993). Since regional chronologies and typologies have been comprehensively described elsewhere, this thesis will provide a more site-specific account of behavioral and technological variability of the prehistoric inhabitants of the Upper Deschutes River Basin.

All of the dates used in the text are given in *years before present* (BP) and are derived from uncalibrated radiocarbon ages. The disparity between radiocarbon and calendar years grows with increasing time depth and can be significant. For example, the climactic eruption of Mt. Mazama occurred at 6,845 BP, or approximately 7,700 calendar years ago, a difference of almost a millennium. Radiocarbon ages can be converted into calendar years by an Internet-based conversion programs such as *Calib* (http://depts.washington.edu/qil/), or by downloading a freeware version of *OxCalv* (http://129.219.233.190/archnet/uconn_extras/software/oxc218.zip).

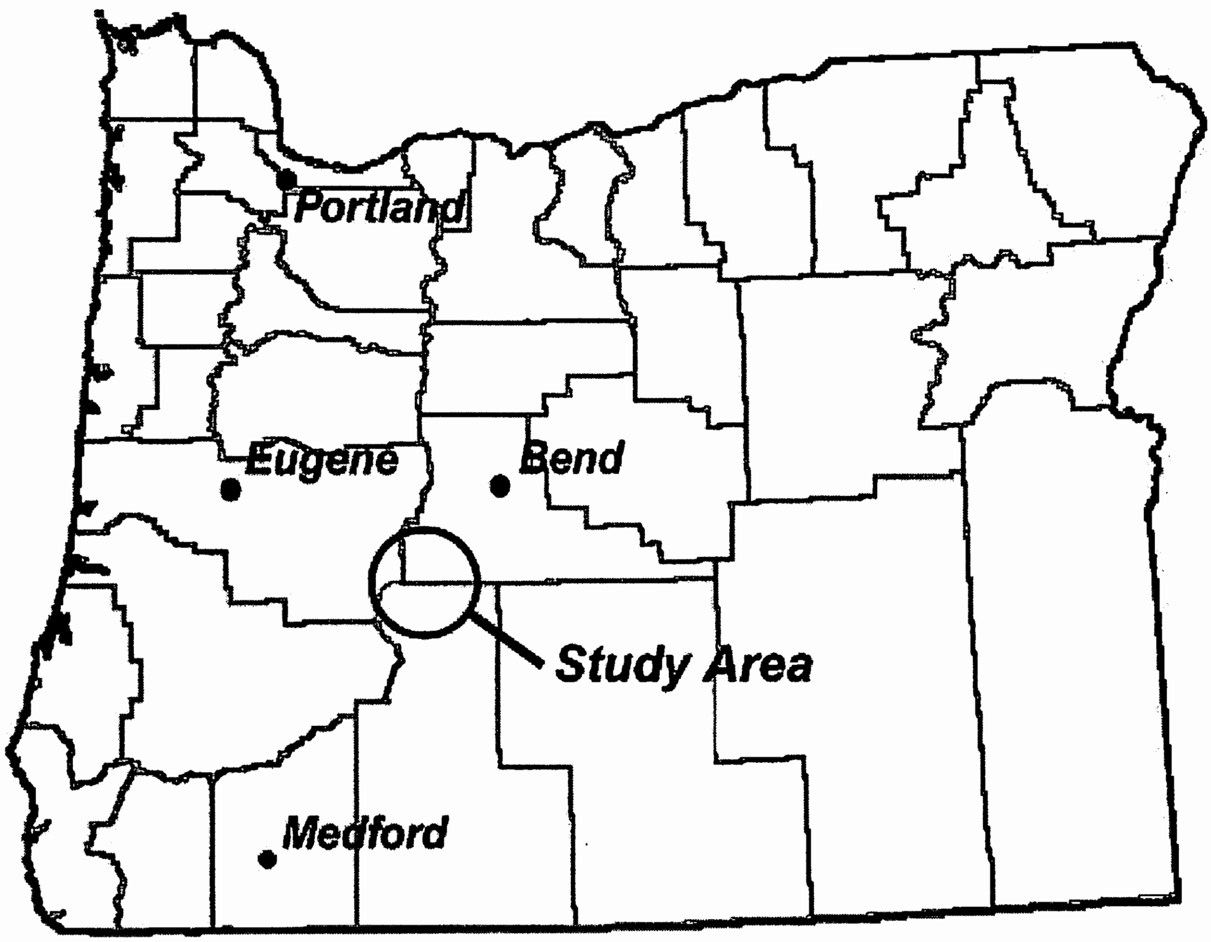


Figure 1.1 Location of study area in relation to Oregon cities.

STATEMENT OF PROBLEM

This research examines the interaction of prehistoric peoples of the upper Deschutes River basin with the land that they were intimately tied to by studying the imperishable objects people used. Two aspects of human behavior are examined and interpreted in light of their spatial and temporal context: *land use* (settlement patterns, mobility) and *lithic technology* (fracture mechanics, material quality, material size, preparation, reduction continuum). Spatial analysis is

used to examine the use of obsidian sources through time across Central Oregon. Inferences drawn from the analyses will address the following questions:
Did occupational intensity of the Upper Deschutes River Basin decline dramatically with the Mazama ashfall (cataclysmic volcanic eruption that created Crater Lake ca. 6,845 BP) in response to locally reduced biotic productivity?

What were the coping mechanisms (settlement/subsistence strategies, technology, etc.) used by the native peoples to respond to a dynamic Holocene environment?

Were post-Mazama occupations of the Upper Deschutes River Basin focused much less on wetland resources and much more on terrestrial game animals such as deer?

What is the range of variation in the degree of mobility as represented in the archaeological record? Where do prehistoric inhabitants of the area fall on the mobility spectrum? Is there a discernible pattern of intermittent abandonment or aggregation, related to periods of environmental change or stability across the region?

In what ways have tool stone procurement strategies changed over time in the region? Are there changes in the distribution of obsidian sources in Upper Deschutes River Basin assemblages related to shifts in procurement ranges?

Since the 1970's, the nature of American archaeology has undergone a significant change. Cultural resource management (CRM) has become, by far, the most common form of archaeology. This fact has radically changed the way archaeology is done, as well as the questions archaeology seeks to answer. In the past few decades, the archaeologist's role has diversified to that of resource manager as well as researcher. One clear effect of this trend has been a monumental surge in the amount of data collected. These data have been used, largely, to help direct land use policies. The shift in focus from a purely research-oriented approach to the study of material remains of culture to that of management orientation has left countless site reports without any meaningful synthesis or contribution to archaeology/anthropology in general. This shortfall is addressed here by culling and synthesizing the data from eight sites reported from the Deschutes National Forest. These data are used to examine the lithic technology and land use patterns of the prehistoric occupants of the area.

Spatial data culled from "gray" literature (unpublished reports and archaeological site records) were transferred to a geographic information system (GIS) in the form of georeferenced maps and a relational database by the Central Oregon Heritage Group (COHG; see Chapter 5, *Methodology*). In GIS format, gray literature is becoming more useful in both resource management and prehistoric research. Digital storage allows for detailed spatial analysis, as well as the ability to perform queries (spatial and tabular) and manipulate raw data. For the purpose of this study, the GIS was used to define the environmental context of each site, plot obsidian source locations, and perform a limited spatial analysis.

THEORETICAL PERSPECTIVE

Analysis of data collected by cultural resource managers can contribute to our emerging understanding of aboriginal technology and land use. As stated above, a goal of this research is to address the question of how land use patterns in the southwest portion of the Deschutes National Forest have changed over time.

As defined by Steward, *Cultural Ecology* "is the study of the processes by which a society adapts to its environment. Its principal problem is to determine whether these adaptations initiate internal social transformations of evolutionary change" (Steward 1968:337). The manner in which a population adapts to its environment was dependent upon four variables: technology, the needs of the population, the structure of society and the nature of the environment (both physical and cultural) (Steward 1977:22). Steward suggests that cross-culturally observed parallels of form and function developed independent of each other. The parallels could be explained by causes that were present in both societies. He termed this *multilineal evolution* (Moore 1996:187).

Steward's conception of cultural ecology was no doubt influenced by his work in the Great Basin (Steward 1939;1969;1977). In a marginal environment where many hours of the day were spent pursuing food and related domestic activities, Great Basin natives were attuned to the ever-changing landscape. Such an arrangement is a natural fit for the application of cultural ecological frameworks. It was in this setting that Steward described an approach for studying cultural ecology.

Cultural Ecology has proven its usefulness over the decades since its inception. This is evidenced by most contemporary accounts of northern Great Basin prehistory (Aikens 1993; Connolly 1999; Jenkins 1993; Wingard 1999) that still use an ecological framework. Yet the nomothetic approach used by Steward in an effort to explain all cultural change through time and space has been abandoned in favor of an iconographic regional approach (Aikens 1993; Atwell et al. 1994; Connolly 1999).

Researchers have come to realize that the so called "Desert Culture" of the Great Basin is somewhat of a misnomer (Heizer and Napton 1970). Once thought to represent an extremely stable adaptation over the whole of the Great Basin through 12,000 years of prehistory, the idea of a Desert Culture has come to be recognized as over-generalized and applicable mainly to parts of the eastern Great Basin (Madsen 1982). Stability of adaptations can be seen most readily in resource procurement. Aikens (1993) has suggested that examination of stone tool technology provides evidence for cultural dynamics. In other words, the range of resources pursued by people in the region has not changed significantly over millennia, though the tools used to exploit them have. It is now recognized that there were, in fact, a variety of different environments that changed radically over time, particularly in the Northern Great Basin (NGB).

Although much has been published regarding the material correlates of past human behavior in the NGB, much remains unknown about the activities and arrangements that produced those materials (Aikens 1996). Some inferences are being drawn currently relate to "social groups, the distribution of their settlements over the landscape, their relative degree of sedentism or mobility, and possible changes in these dimensions over time as environments changed" (Aikens 1993:81). Acknowledging the presence of gaps in our knowledge, Aikens (1993:81) has remarked, "much further research will be needed before anything approaching a full picture of prehistoric human ecology is developed."

Acknowledging the complexity of human interaction with the environment, it is necessary to take a more contemporary approach to the study of human ecology. *Contextual archaeology* seeks to describe "a four dimensional spatial-temporal matrix that comprises both a cultural environment and a non-cultural environment and that can be applied to a single artifact or to a constellation of sites" (Butzer 1982:4). Contextual archaeology addresses the material correlates of human behavior (artifacts, features, sites, etc.) motivated by rational thought in an effort to understand forces both internal and external to the system. While it is not the intention of this study to fully describe the prehistoric human ecology of the region, it will provide another element by identifying the range of variability in mobility and technological organization of the Upper Deschutes.

The contextual approach is made possible through the study of five aspects of human/environmental interaction: space, scale, complexity, interaction, and stability. The patterning of artifacts, features, and sites is the focus of the spatial aspect. The scale or extent of the spatial phenomenon is viewed from the micro to the macro level. At the intrasite level, the distribution of artifacts is considered, while at the regional level, sites are viewed in relation to one another. The interaction of human, biotic and inanimate elements within an ecosystem is the key to understanding the flow and magnitude of energy between all the parts. Contextual archaeology suggests that elements interact at "different scales, from varying degrees of proximity, and at changing or unequal rates" (Butzer 1982:8)._ The stability of ecological interactions is subject to constant change as a result of "internal processes or external inputs" (Butzer 1982:8). This research will focus on one piece of the larger body of evidence required to accurately theorize on the nature of prehistoric human ecology in Central Oregon.

Stone tools from eight prehistoric sites in the Upper Deschutes River Basin are examined as part of this research. The analysis that follows will place the assemblages within a standard time-sensitive typology and identify tool stone sources in order to detect changes in lithic technology and obsidian source use through time. The findings are interpreted within a contextual framework that will allow for identification of ecological and social forces acting on prehistoric inhabitants of the area. Interpretations drawn from the analysis will be used to: 1) gauge the intensity of prehistoric human occupation of the Upper Deschutes, 2) identify adaptive strategies used, 3) describe the degree of mobility practiced by past users of the area, and 4) and describe any changes in lithic procurement ranges.

CHAPTER 2: ENVIRONMENTAL BACKGROUND

The area addressed in this thesis, the Upper Deschutes River Basin, encompasses a considerable amount of land and several different environmental zones (Figure 2.1). The study area is located in the high lakes and steams in the headwaters of the Deschutes River in central Oregon. This discussion is primarily concerned with three distinct physiographic regions that stretch from southeast Oregon north to the Columbia River. The northwestern extreme of the Great Basin occupies the southern part of the study area. To the north, the High Lava Plains form somewhat of a transition zone that eventually merges with the Southern Columbia Plateau. Each physiographic province is unique in terms of its topography, hydrology and, natural resources.

The following brief sketch of the modern and ancient environmental conditions provides a backdrop for the interpretation of the land use patterns represented at the sites in the Upper Deschutes River Basin. This study demonstrates that the Upper Deschutes River Basin presents a complex and dynamic history of geologic unrest and forest succession. The episodic restructuring of the local biota directly affected local populations. Ultimately, the distribution (seasonal, linear, elevation) and abundance of plants and animals had a substantial influence on the land use patterns of past human populations. The following sections explore the environmental diversity of Central Oregon, with an emphasis on the Deschutes River Basin.

PHYSIOGRAPHIC PROVINCES

High Cascades

The Cascade Range, bordering the Great Basin to the east, is a north – south trending chain of volcanic peaks that stretch from Northern California to just south of the Fraser Plateau in British Columbia. In Oregon, the range is divided into two provinces: the Western and High Cascades. The High Cascades, which run from Mt. Lassen to the Columbia River, include large volcanic peaks and the shorter eastern slope. The crest of the High Cascades forms a distinct geographic boundary between eastern and western Oregon.

Formations of the High Cascades are relatively young (having developed primarily during the Pliocene and Pleistocene epochs) compared to the more eroded Tertiary landforms of the Western Cascades (Baldwin 1964). The High Cascade province is essentially a high, undulating plateau, punctuated by intermittent peaks and cinder cones (Figure 2.2). The mean elevation of the plateau is 4,900 – 5,900 ft. Cones generally rise to an elevation of 150 – 5,500 ft. above the surrounding terrain. Prominent peaks such as Mt. Hood (11,240 ft.), Mt. Jefferson (10,495 ft.), Mt. Washington, and the Three Sisters (10,045 – 10,357 ft.), form conspicuous landmarks, visible for miles on the east side. The terrain slopes to the west, where many watercourses follow glacially excavated channels. Evidence of extensive glaciation can be found throughout the High Cascades, most visibly on the flanks of the larger peaks. Most lakes near the crest of the Cascades have formed in glacial cirques, while some in the lower elevations formed behind moraines (Baldwin 1964:74).

The late Pliocene and Pleistocene epochs were a time of widespread lava extrusions from vents in the High Cascades. The resulting materials are grey olivine basalts and olivine-bearing andesites with subordinate amounts of porphyritic pyroxene andesites (Franklin and Dryness 1988). More recent flows, of the Holocene and terminal Pleistocene, are generally composed of andesites and basalts. The bedrock is most often covered with layers of pumice and ash, most notably by materials attributed to Mt. Mazama.

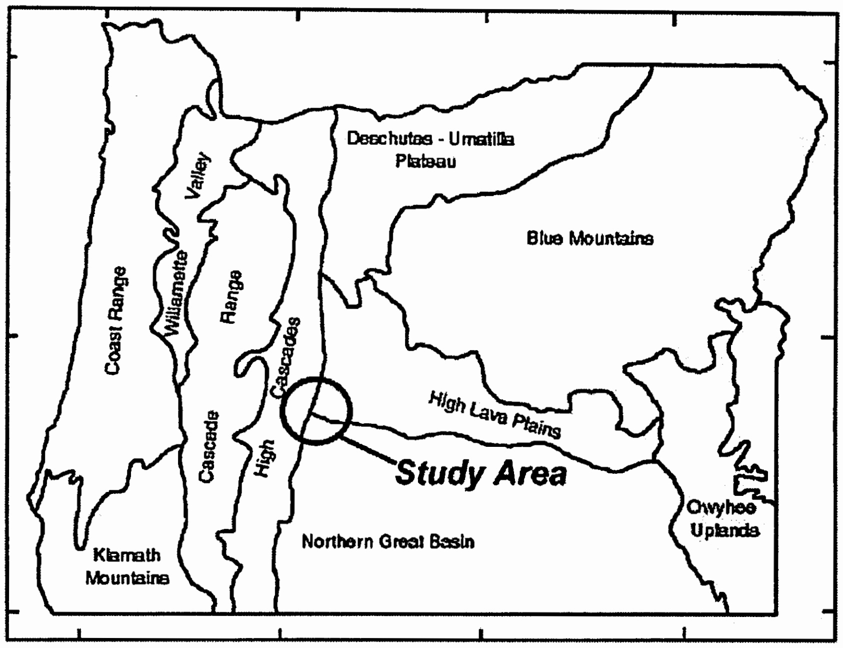


Figure 2.1 Physiographic provinces of Oregon.

At least seven significant eruptions have occurred in the last two millennia within the High Cascades (Table 2.1). These include the South Cinder Peak (~1,000 BP), Blue Lake (1,330 BP), Belknap Crater (1,400 B.P.), Collier Cone (1,600 B.P.), Lost Lake Cones (1,950 B.P.), Devils Hill (1,970 B.P.), and Four-in-One Cone (1,980 B.P.) eruptions. Six other eruptions have occurred during the Holocene, the most extensive and destructive being that of ancient Mt. Mazama, which occurred ca. 6,845 +/-50 BP. The climatic and precursory eruptions ejected a total of 51 to 59 cubic km of magma, resulting in the collapse of the former mountain. It is estimated that ~40 – 52 cubic km of Mt. Mazama had disappeared following the exhaustion of the underlying magma chambers and subsequent formation of the caldera, Crater Lake (Bacon 1983). This eruption had a severe impact on the landscape of central Oregon, which will be discussed later.

Soils in the region are relatively immature. The principal component of local soils is volcanic ejecta. More stratigraphic development can be found in glacially deposited soils. Within the southern and central portions of the High Cascades, soil development is occurring on pumice,

Eruption	Location	Age (rcBP)	Type	Features
South Cinder Peak	South of Mt. Jefferson	1,000*	Basaltic	Cinder Cones, Lava Flows
Big Obsidian Eruptive Episode	Newberry Caldera	1,310	Rhyolitic	Newberry Pumice, Paulina Lake Ashflow, Big Obsidian Flow
Blue Lake Eruption	Belknap Volcanic Field	1,330	Basaltic	Explosion Crater, Spatter Cone Chain, Tephra Deposit
Belknap Crater	Belknap Volcanic Field	1,400	Basaltic	Shield, Cinder Cone, Lava Flows, Secondary Shield & Flow
Collier Cone Eruption	Belknap Volcanic Field	1,600	Basaltic	Cinder Cone, Lava Flows
Lost Lake Cones Eruption	Sand Mountain Volcanic Field	1,950	Basaltic	Cinder Cones
Devils Hill Eruptive Episode	South Sister	1,970	Dacitic	Devils Hill Chain of Vents (15 domes) Newberry Flow, Carver Lake Vents, Devils Hill Tephra
Four in One Cone Eruption	Belknap Volcanic Field	1,980	Basaltic	Cinder Cone, Lava Flows
Rock Mesa Eruptive Episode	South Sister	2,150	Dacitic	Rock Mesa Domes, Flow and Tephra
Sand Mountain Eruptions	Sand Mountain Volcanic Field	2,790**	Basaltic	Cider Cones, Lava Flows
Eastlake Eruptive Episode	Newberry Caldera	3,550*	Rhyolitic	East Lake Obsidian Flows
Black Rock Eruptive Episode	Davis Lake Area	5,540	Basaltic	Davis Lake Flow and Cinder Cone
Climactic Eruption of Mt. Mazama	Crater Lake	6,845	Rhyolitic	Caldera
Llao Rock Eruption of Mt. Mazama	Crater Lake	7,015	Rhyolitic	Dome, Flow and Tephra
Northwest Rift Eruptive Episode	Newberry Volcano	7,050**	Basaltic	Cinder Cones, Flows, Spatter Ramparts, Spatter Cones, Lava Cast Forest Flows
Interlake Eruptive Episode	Newberry Caldera	7,210	Rhyolitic	Interlake Obsidian Flow, Pumice Deposits, Central Pumice Cone, Flows and East Lake Tephra
Forked Butte Eruptions	South of Mt. Jefferson	7,400*	Basaltic	Forked Butte Cinder Cones and Flow
East Rim Eruptive Episode	Newberry Caldera	10,000	Basaltic	Lava Flows

(From Jensen 2000: http://www.fs.fed.us/r6/centraloregon/desnf/resource/physical/geology/holocene.html)
* Calendar Years Before Present.
** Average based on multiple radiocarbon dates.

Table 2.1. Holocene eruptions in Central Oregon.

cinders and ash. Such soils are classed as Vitrandepts (Baldwin 1964). Profile development is minimal.

East of the crest, vegetation takes on characteristics of the arid interior. Higher elevations (4,500+ ft.) of the eastern slope are covered with coniferous forests similar in composition to those of the western slope characterized by the presence of douglas fir, grand fir, and mountain hemlock. These grade down into shrub and shrub-steppe communities common to the High Lava Plains and southern Plateau. Several forest associations have been described for the central High Cascades and High Lava Plains (Franklin and Dryness 1988:160). Figure 2.3 shows the distribution of forest types in the Upper Deschutes River Basin. Forest zones are characterized by the climax species found within each region. There is a great deal of variation in the distribution of forests due to the presence of microenvironments produced by the unique interaction of several factors including elevation, species presence, soil composition, and fire history. As such, forests do not always occur along discrete elevational bands and are often discontinuous.

Franklin and Dryness (1988) have described a typical forest sequence for the eastern slope of the Cascades as follows (from lowest elevation to highest): western juniper, ponderosa pine, douglas fir; grand fir, Pacific silver, and mountain hemlock. A variation of this pattern occurs in the southern Oregon Cascades. Here, the forest zones are: lodgepole pine, ponderosa pine, and white fir.

The western juniper zone in Oregon occupies a niche similar to that of the Pinon – Juniper zone found in many parts of the Basin and Range to the south. Its elevation range is primarily between 2,500 – 4,600 ft. The zone is savanna-like and the most arid of the forested types. Its ecotonal setting is intermediate between the more mesic Ponderosa pine forest and the Basin's more xeric sagebrush shrub-steppe. Precipitation in this zone is low, averaging only 32 cm in Bend, 21.6 cm in Redmond, and 23.8 cm in Prineville (Franklin and Dryness 1988:164).
The ponderosa pine zone has a broad distribution through eastern Oregon. It occurs as a narrow belt, approximately 15 – 30km wide, on the eastern slope of the Cascades. It is also found throughout the High Lava Plains and much of the Blue and Ochoco Mountains. In central Oregon, the ponderosa pine zone is situated between 4,750 – 6,500 ft. In other parts of the state, it can be found as low as 2000 ft. At higher elevations, this zone may grade into forests of douglas fir, grand fir or white fir. At lower elevations, ponderosa pine forests often border juniper and sagebrush zones. Precipitation in this zone ranges from 35.5 – 76 cm. Summers are dry in this zone, with a great deal of diurnal temperature variation. Ponderosa pine forests favor coarse-grained and sandy soils. In central Oregon, they are found covering large portions of immature regosolic soils, known as Vitrandepts. Vitrandepts develop in dacitic and ryolitic pumice that was erupted by Mt. Mazama and Newberry Crater. Weak A horizons contain very little organic material and grade into unweathered pumice sand and gravel (Franklin and Dryness 1988:168 – 184).

Franklin and Dryness (1988:193) cite the grand fir zone as the "most extensive midslope forest zone in the Oregon and southern Washington Cascade Range and Blue Mountains of eastern Oregon." This zone manifests itself in the central Oregon Cascades as a grand fir– White fir complex. It generally has an elevation range of 1,650 – 2,000m in the southern Cascades. Depending on the specific location, the grand fir zone may be bordered by sub-alpine fir, Pacific silver fir, western hemlock, western red cedar or mountain hemlock forests at higher elevations, and douglas fir or ponderosa pine zones at the lower end. Conversely, it may grade into sagebrush dominated lowlands rather abruptly. Although grand fir is the climax species in this zone, other species such as lodgepole pine sometimes dominate seral patches. This zone enjoys one of the mildest environments on the east slope, sustaining neither excessive precipitation nor temperature.

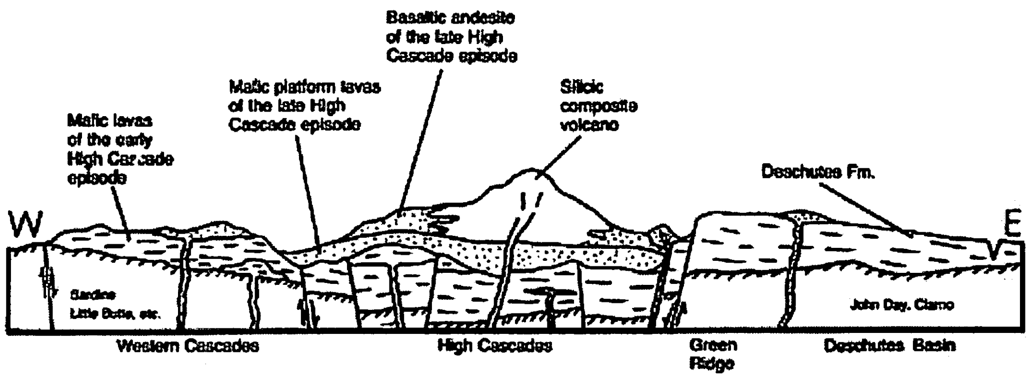


Figure2.2 Cross-section of the Cascade Range in Central Oregon (from Baldwin 1976).

Some lakes in the Cascades, such as Davis Lake, owe their existence to the emplacement of lava dams. Clear lake was formed around 3,000 B.P. after a flow caused the subterranean headwaters of the McKenzie River to back-up (Baldwin1964).

Precipitation in the Cascades is delivered by westerly air masses moving in from the Pacific Ocean. During the summer the westerlies lie to the north, depriving the High Cascades of much rainfall. During the winter, however, Pacific fronts move southeasterly and cross the range. As the air masses gain elevation, they cool and condense, resulting in heavy precipitation, especially on the western slopes. Higher elevations receive the greatest amount of moisture, primarily in the form of snow. A rain shadow effect is produced east of the High Cascades as the eastern slope grades into the High Lava Plains and the Northern Great Basin. The degree to which the regions east are affected by the rain shadow depends on the mass and elevation of the section of range that they are adjacent to (Grayson 1993).

Northern Great Basin

The Great Basin physiographic province reaches its northern extent in southeastern Oregon. This province dominates much of the landscape of the intermontane West, stretching from southeastern California, east across all of Nevada and much of Utah. The Northern Great Basin lies at elevations of 4,000 to just under 10,000 feet within a rain shadow produced by the Cascade Mountains to the west. As a result, much of the landscape is high desert, although it exhibits a fair amount of biotic diversity (Harper 1986). The region as a whole is characterized by north-south trending mountain ranges interspersed with basins. Once home to many large pluvial lakes, low-lying basins tend to be quite arid, although a number of "wet basins" still may be found at the foot of the Cascade, Ochoco, Steens, Warner and Hart Mountains (Aikens and Jenkins 1994:3).

Vegetation within the Basin lowlands is predominately arid adapted species such as sagebrush, greasewood and saltbrush. Wet basins at low elevations may support more plants such as tule, cattail, rushes and various marshland grasses. Moving up from the basin floor, slightly more hydric environmental zones are home to western juniper, sagebrush, and grasses at intermediate elevations. Still higher, the Northern Great Basin uplands may be covered by forests of ponderosa pine, quaking aspen, and mountain mahogany (Aikens and Jenkins 1994:3).

The High Lava Plains lie within the heart of Oregon in an area that has seen a great deal of volcanic activity over the last 2 to 3 million years (Toepel et al. 1980). This region is sometimes lumped into the broader Northern Great Basin physiographic province (Musil 1995), yet will be considered as a distinct region in this study. The province is bounded by the High Cascades to the west, the Blue Mountains to the northeast, the Great Basin to the south and the Columbia Basin to the north. The hydrology of the area is dominated by the Upper Deschutes and John Day watersheds, which eventually empty into the Columbia River. The landscape is dotted with cinder cones and lava buttes atop relatively young lava flows. Elevation does not vary significantly across the region and averages about 4,000 feet above sea level (Toepel et al. 1980:14).

Prominent volcanic features in this region include Newberry Crater, Lava Butte, Lava Cast Forest and numerous subterranean lava tubes. Many geologic formations in the area have a brief past, having been formed during the Holocene.

The dominant vegetation zones found on the High Lava Plains are the ponderosa pine, western juniper, and shrub-steppe zones (Franklin and Dyrness 1973). The Ponderosa pine zone can be found along the foothills of the Cascades and Blue Mountains at elevations between 3,000 to 5,000 feet in the north and generally lower to the south (Toepel et al. 1980:19). Other species that often co-occur in this zone include white oak, lodgepole pine, western juniper, and quaking aspen. Many low-lying shrubs can also be found in sparse ponderosa woodlands including bitterbrush, sagebrush, rabbitbrush, bluebunch wheatgrass, Idaho fescue, Sandberg's bluegrass and cheatgrass brome (Toepel et al. 1980:21). In slightly more xeric areas, the Ponderosa pine zone gives way to juniper-sagebrush woodlands. The Western Juniper zone occupies regions within the High Lava Plains that are intermediate in moisture between forest and shrub-steppe zones at elevations between 2,500 to 4,600 feet (Toepel et al. 1980:21). The understory cover in this zone consists of big sagebrush and bitterbrush interspersed with numerous other shrubs and grasses. Arid, low-lying areas within the High Lava Plains are dominated by a Shrub-Steppe zone that is characterized by the presence of various species of sagebrush and perennial grasses (Toepel et al. 1980: 21).

The Deschutes River Basin drains the eastern slope of the High Cascades from just south of the Three Sisters, to the Columbia River. As it flows north along the eastern flank of the High

Cascades, it drains tributaries to the west and east such as the Metolius River, Squaw Creek, Paulina Creek and the Crooked River. The Deschutes River joins the Columbia River east of The Dalles.

Forest composition in the Upper Deschutes differs markedly from that of the surrounding Cascade forests. The Upper Deschutes is distinguished by the presence of dense stands of lodgepole pine. Lodgepole pines are generally considered to be a pioneer species that are eventually out-competed by taller trees. Yet this species has managed to develop into dense climax forests. Burtchard et al. (1997) suggest that the unique forest composition is maintained by the Mazama-derived soils (Figure 2.4). They convincingly argue that the present forest has been dominant since the eruption of Mt. Mazama. Prior to the eruption of Mt. Mazama, the region's forests were probably unable to develop such dense forests for extended periods of time. Uncontrolled fire, sparked by lightning, would have encouraged the development of large open patches within the forest. These open, prairie-like settings would have provided a relative wealth of resources for human consumption.

The present biotic arrangement leaves the Upper Deschutes resource poor for several months of the year. In winter, the area is blanketed in a deep snow and is not productive. Such an environment would therefore not be a suitable for year-round habitation. The most productive season, and therefore the most opportune, would have been in late summer and early fall. This was a time when deer and elk could have been hunted during their seasonal migrations, and ripening nuts, seeds and berries were relatively plentiful. In addition, the wetland settings of the Upper Deschutes would have provided a draw for local groups, providing yellow water lilies (wokas), fish and fowl. Unlike the Lower Deschutes River, the Upper segment does not receive the bounty provided by anadromous fish runs. Steelhead and salmon are unable to move upstream past Big Falls north of Redmond, thus limiting viable habitat to the lower 132 miles of the 252 mile river (Nehlsen 1995).

Southern Columbia Plateau

The Southern Columbia Plateau is composed of various sedimentary and igneous rock formations that have produced a broad plateau cut by major river drainages. The Lower Deschutes, Umatilla, and John Day Rivers flow north through the Deschutes-Umatilla Plateau to reach their confluence with the Columbia. Situated in north central Oregon, the province is bounded by the Columbia River, the Blue Mountains to the east, the High Cascades to the west and the High Lava Plains to the south. The gently sloping plateau rises from an elevation of 300 feet at the Columbia River to more than 3,000 feet at the southern margin (Aikens 1993:93).

Vegetation on the Southern Columbia Plateau is predominately steppe and shrub-steppe characterized by a number of sagebrush and grass species (Toepel et al. 1980). The Steppe zone dominates most of the basin and includes many grass species, scattered patches of sagebrush, and occasional ponderosa pines and western junipers. Within the Shrub-Steppe zone big sagebrush and low sagebrush occur alongside other shrubs such as rabbitbrush, wax currant, round-leafed snowberry. Grasses found throughout this zone include bluebunch wheatgrass, Idaho fescue, cheatgrass brome and giant wildrye. Western juniper may be found within the shrub-steppe zone, primarily in areas with rocky soils, intermittent drainages and on some northerly slopes (Toepel et al. 1980).

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Central Oregon provides habitat for a diverse array of wildlife. Large mammals common to the High Cascades during the nineteenth century included mule deer, pronghorn antelope, big horned sheep, black bear, and grizzly bear. Canids present in the area today include coyote, red fox and gray fox. Cats present include mountain lion, bobcat, and lynx. Small mammals are abundant in the region. They include weasel, skunk, rabbit, hare, pika, gopher, squirrel, beaver, rat, mice, vole, shrew, and bat (Bailey 1936; Deschutes National Forest 2001).

The rivers and lakes of the High Cascades and High Lava Plains are home to several indigenous species of fish including redband rainbow trout, bull trout, and mountain whitefish (Williams and Jensen 2001). Kokanee (landlocked sockeye salmon) occupied Suttle Lake near the town of Sisters, but have not been reported for the Upper Deschutes. Steelhead and salmon are absent in the upper reaches of the Deschutes River and its tributaries south of Big Falls, near Redmond. Even at times of very high water, the waterfall posed an insurmountable obstruction to anadromous fish (Nehlsen 1995).

The lakes and wetlands of the Upper Deschutes serve as a stop-over point for a number of migratory birds on their annual southern migration. Over a dozen water-fowl species are present seasonally including mallard, teal, Canadian geese, and canvasback (Snyder 1987). Resident bird populations include grouse, quail, chukar, partridge, pheasant, and turkey (Jensen 2001).

In the High Cascades, the highest concentration of economically important animals are found in or near water bodies and wetlands. The waters of the region provide habitat for fish and fowl, while forest openings along streams, meadows, bogs, and lakes provide the most desirable forage for elk and deer. Snyder (1987) suggests that the non-forested portions of the Cascade range in Oregon supports 85% of floral species, many of which were harvested for food (berries, camas, fleshy-rooted plants) and raw material (bear grass). It is probable that such biotic concentrations were also present in ancient times, as indicated by stable mires (dating to the terminal Pleistocene) found in the High Cascades (MacMahon 1979).

HOLOCENE CLIMATE AND VEGETATION

In the Great Basin and Pacific Northwest, considerable attention has been given to reconstruction of postglacial climate patterns (Antevs 1948 and1955; Chatters 1994; Grayson 1977, 1982; Mehringer 1977, 1985; Sea and Whitlock 1995). Paleoecological reconstructions have provided a context for interpreting archaeological remains, as well as for developing and refining cultural chronologies. Rapp and Hill (1998:86) define climate change as the "result of global, regional, and local geologic changes that influence atmospheric and hydrologic circulation patterns." Oscillations in temperature and effective moisture can have a profound effect on the organization and distribution of plant and animal species. The resulting restructuring influences the organization of subsistence and settlement strategies of local human populations, which depend on such resources for their survival.

The Terminal Pleistocene / Early Holocene (10,000 – 6,900 BP) was a time of dramatic change in North America and beyond. In the far West, the end of the Pleistocene was marked by the recession and eventual disappearance of the gigantic pluvial lakes fed by massive ice sheets to the north. As these large pluvial lakes began to dry up, they left in their wake the defining characteristics of the Great Basin landscape as we know it today. Large Pleistocene lakes such as Mohave, Bonneville, and Lahontoan, held only a fraction of what they had during their peak, some 20,000 to 12,500 years ago (Mehringer 1986). Although significantly reduced, some basins retained productive aquatic ecosystems. Many shallow lakes and marshes survived in what are today dry valleys. In the Columbia Basin and High Lava Plains, the vegetation communities lost their glacial steppe character. In the Basin, conifers that once dotted the landscape began to recede to well-watered areas. Still moist and cool relative to modern times, the climate continued to become warmer and drier.

The rapid desiccation of Western environments prompted a radical redistribution of plants and animals. Animals adapted to glacial-steppe environments began a mass migration north, on the flank of the receding ice sheets. Plants and animals that remained south of the ice sheets saw their habitats reorganized both altitudinally and latitudinally.

We know from the archaeological record that during the terminal Pleistocene and early Holocene 35 genera of mammals became extinct (Martin and Klein 1984). This mass extinction took the heaviest toll on large herbivores and the carnivores that preyed upon them. Species such as mammoth, mastodon, camel, horse, bison, sabertooth cat and tapir all went extinct. There were also some, though fewer, small mammal extinctions. These included types of skunk, beaver and rabbit. Although no floral extinctions occurred, there was a radical reorganization of floral habitats. Extinction probably started around 12,000 B.P. and was complete by 10,000 B.P.

Two competing theories seek to explain this phenomena: the Overkill model (Mosimann and Martin; Martin 1984) and the Climate model (Haynes 1987). The Climate model does not recognize over-predation by humans as the primary cause of extinction. Haynes argues that warmer and dryer environments of the Holocene led to a major reorganization of flora. The more specific plant zones that developed led to a reduction in habitat for many species of animals. Whereas the Pleistocene was characterized by intermingled and "disharmonious" animal species living together in mosaic habitats, Holocene habitats became much more specific. The Holocene has also witnessed an increase in seasonality. These findings have led Haynes to argue that terminal Pleistocene extinctions resulted primarily from a radical change in climate which resulted in a drastic reduction of habitat and less time to prepare for more severe winters. Haynes acknowledges that human intervention may have slightly sped the process of extinction, however, it did not cause it. Whether or not the mass extinction at the end of the Ice Age was caused by over-predation by humans or by a restructuring of the resource base, it happened in the context of a rapidly changing climate.

Two case studies from south-central Oregon provide an idea of the effect a changing Early Holocene climatic regime had on the abundance and distribution of plant communities in the

West. Fish and Wildhorse lakes, located in glacial canyons of Steens Mountain in southeastern Oregon, have revealed pollen records spanning the last 13,000 years (Mehringer 1985). Lake sediment cores from both locations suggest that local glaciers were in retreat by 13,000 BP. A sediment core from Wildhorse Lake, located near the crest, suggests local glaciers were completely gone by 9,500 BP (Mehringer 1985). Evidence from both lakes supports observations made elsewhere that moist and cool conditions (relative to modern) prevailed throughout the Early Holocene.

Sometime around 8,000 BP, a period of decreased effective moisture began, which continued, with short-term fluctuations, until 5,500 BP at Fish Lake. At Wildhorse Lake, the period of increased aridity appears to have begun around 7,000 BP, and continued until approximately 4,000 BP. The difference in timing of the warming trend documented at the two lakes has been attributed to differences in elevation (Aikens 1993).

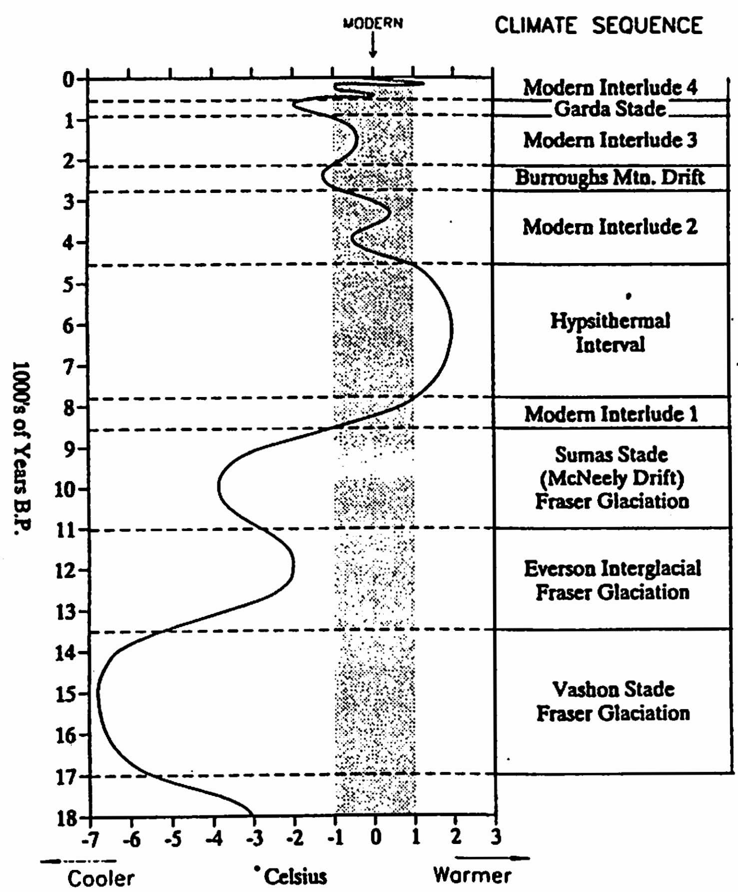


Figure 2.3 Late Pleistocene and Early Holocene climate chart for the southern Washington Cascades (from Burtchard et al. 1997:9).

Burtchard et al. (1997) developed a chart to plot Holocene climate fluctuations based on data gathered for the southern Washington Cascades (Figure 2.5). Although it is expected that the climate of central Oregon was subject to slightly different conditions, the trends that the chart maps out have been documented region-wide.

Burtchard et al. (1997) suggest that the basic geologic character of the Upper Deschutes River Basin was in place by 10,000 BP, although the sediment structure was dramatically altered with the fall of Mazama tephra. There is mounting evidence for the domination of lodgepole pine forests and juniper / sagebrush communities at higher elevations during the terminal Pleistocene, which quickly gave way to others with the onset of Holocene climatic conditions (Chatters 1994; Burtchard 1997). Pre-Mazama surface horizons are primarily silts and silt loams of weathered basalts (Burtchard 1997:6). Such soils are capable of supporting forest

communities of ponderosa pine and mountain hemlock. Franklin and Dryness (1973:185) postulate that between 10,000 - 6,900 BP, dominant ponderosa pine forests held more massive trees than are present today, with a more open character.
Although the examples presented above are in general agreement with schemes proposed throughout the West, it must be recognized that there was substantial regional variation in climate and biotic responses. It is not possible at this time to bring to bear detailed environmental reconstructions of the Upper Deschutes region, because few comprehensive studies have been conducted on the subject in the area.

The beginning of the Middle Holocene (6,900 – 4,500 BP) is marked by cataclysmic eruption of ancient Mt. Mazama. On a regional scale, the Mid-Holocene throughout the West has been characterized as a time of "considerable and rapid climatic fluctuations" (Mehringer 1986:214). The most striking change during this period was the warming and drying of the West as a whole.

In the Upper Deschutes, the depth of Mazama tephra varies locally, according to particular topography and other depositional factors. The coarse-grained, low bulk volcanic sediments generally reach depths of 50+cm, although they also occur in deposits approaching 3 m. On the margin of lakes, streams, and rivers, such sediments may be completely absent, having been washed away through fluvial processes. Where tephra derived soils persisted, the extremely well-drained sediments allow for rapid absorption of surface water. As a result, several small drainages, such as Ranger Creek, dried up. The resulting soils made possible the replacement of ponderosa pine forests by lodgepole pine. This transition was facilitated by the development of nutrient-poor soils that do not allow for good root support required for tall, massive trees (Burtchard et al. 1997).

Evidence gathered from modern analogs suggest that the effects of the Mazama eruption were influenced primarily by the proximity to the blast zone (Workman 1979). Grayson (1979) presents evidence from Fort Rock Basin archaeofaunas that indicate a dramatic redistribution of several avian and mammalian species beginning around 7,000. He suggests that climatic conditions were responsible for the disappearance of migratory water-fowl species in the Connolly Caves faunal assemblage. The local extinction of pika within the Basin was attributed to the climactic eruption of Mt. Mazama superimposed on a desiccated environment (Grayson 1979:447-448).

The amount of time that was required for the local biota to rebound following the eruption of Mt. Mazama is not entirely clear. The eruption of Mt. St. Helens in May of 1980 provides some useful insights into the possible short-term effects of the Mt. Mazama eruption. Gamblin and Griffith's (1986) study of the impact on trout populations in the St. Joe River Drainage (~500km east) revealed that the ash plume dropped over 2cm of tephra over an eighteen hour period. Suprisingly, the ash "did not substantially affect the [trout's] spawning success" (Gamblin and Griffith 1986:297). Overall, they found that trout populations remained stable. Alternatively, anadromous fish populations in the Toutle River Drainage, located within the outer blast zone, were initially heavily impacted by the rapid burial of stream channels by massive mudflows. Five years after the eruption, native steelhead populations were on the rebound, increasing tenfold between 1981 and 1984 (Lucas 1986).

The recovery of riparian vegetation and aquatic habitat over a period of five years was found to be highly variable as a result of proximity to the blow-down zone and the unique fluvial erosion and deposition patterns of each drainage (Kiilsgaard et al. 1986). Annual disturbances to stream-side vegetation are dependent on the intensity and frequency of flooding events that tended to be highly erosive with its high volcanic sediment load. Areas within the blow-down zone have more sediment loading and little to no vegetation to slow water and catch sediments.

Recolonization of the blast zone by large mammals such as elk happened relatively rapidly. Keller (1986) documented immediate and short-term effects of the eruption on the local Roosevelt elk populations. Initially, 1600 were killed in the blast and resulting debris flows. Within five years, elk were recovering in the northwest portion of the blast zone, although with different movement patterns, with the aid of natural and seeded forage. The historic pattern of elk herds migrating to the uplands during the summer was absent, however, following the eruption.

Burtchard et al. (1997) argue that the abundance of plant and animal resources returned to pre-Mazama levels in a relatively short period of time. They suggest that the economically important wokas remained plentiful in the area, seemingly uninterrupted. Open portions of lodgepole pine forests that appeared shortly after the eruption should have provided habitat for the aggregation of large game.

The restructuring of the resource base that occurred at the onset of the Middle Holocene was also influenced by less catastrophic geologic phenomena. Most relevant to this study is the Black Rock Eruptive Episode which produced the Davis Lake Flow and cinder cone. The Davis Lake flow, which occurred at 5,540 BP, dammed Odell Creek and created Davis Lake. This relatively recent geologic event likely made use of the Upper Deschutes more attractive to hunter-gatherers, as it served as habitat and magnet for economically important biota.

The dramatic volcanic activity of the Mid-Holocene occurred alongside a rapidly warming climate. Referred to alternatively as the Altithermal or Hypisthermal, this period brought with it the rapid desiccation of large lakes and wetlands throughout the Great Basin (Mehringer 1985). By 7,000 BP, arid adapted shadscale and sagebrush vegetation communities were well established in the north. In the southern Basin, conifers were incrementally giving way to sagebrush and grass communities.

This period of aridity has been correlated with periods of significantly decreased occupational intensity and intermittent abandonment of certain areas in the Great Basin. Willig (1988) has studied the late Pleistocene / early Holocene history of lake fluctuations and human habitation of the Alkali Lake Basin. She described a number of wet phases in the basin that allowed shallow lakes and marshes to develop between 11,500 – 8,000 BP. She noted a rapid drying of these features between 8,500 – 6,800 BP, resulting in a diminished resource base. Similarly, there is a hiatus in human occupation at Connolly Caves between 7,200 and 4,400 BP (Bedwell 1973). This occupational hiatus is correlated with the drying of Paulina Marsh, which lies one mile to the southwest. Similar scenarios have been documented for the Chewaucan Marsh and the southern Harney Lake Basin.

After 4,500 (Late Holocene: 4,500 BP – present), the climate and vegetation of the Pacific Northwest took on a more contemporary appearance. The modern climate regime brought with it more effective moisture and allowed many low-lying basins to once again hold water (Mehringer 1985). These wet basins provided habitat for many economically important plants and animals and served as a magnet for human exploitation. By 4,000 BP, the xeric plant communities that had reached their zenith in the preceding three thousand years began to wane. At the same time, more mesic adapted species expanded their distribution (Matz 1991).

CHAPTER 3: CULTURAL BACKGROUND

ETHNOGRAPHIC SURVEY

The following discussion describes the ethnographic inhabitants of the study area and their immediate neighbors. It will provide a basis for comparison with the archaeological findings presented in Chapter 6. Topics to be addressed include linguistic affiliation, geographic distribution, antiquity of individual cultural traditions, and ethnographic subsistence and settlement systems of Northern Paiute, Molala, and Klamath groups in Central Oregon.

Northern Paiute (Paviatso)

The Uto Aztekan language stock has wide distribution in the western United States and Mexico. Within the Great Basin, the stock is composed of four language families: Numic, Takic, Tubatulabal and Hopic. The Numic family is composed of three sister pairs of closely related languages: Western Numic speakers (Mono and Paviotso) were spread throughout the western Basin; Central Numic (Panamint and Shoshoni) is distributed through the central Basin and western Plains; and Eastern Numic (Kawaii'su and Ute) is found in the eastern Basin, Colorado Plateau, central Rocky Mountains and the western Plains (Aikens and Witherspoon 1986).

Although Numic languages were distributed over an enormous area, there is a surprisingly high degree of similarity between them. Among the Western Numa, Northern Paiute was spoken, albeit in different yet mutually intelligible dialects, from southeastern Oregon to just south of Mono Lake in California and Nevada. However, there exists a clear distinction between the northern area and Owens Valley, both of which are considered Western Numic (Miller 1986:98). Differences were apparent enough to consider them two separate languages. Lamb (1939) termed them Paviotso (used synonymously with Northern Paiute) and Monachi (used synonymously with Mono), respectively. A similar situation exists for the southern portions of the Eastern and Central Numic regions. Within the Central Numic grouping, Shoshone had a vast distribution, covering large parts of Nevada, Idaho, Wyoming and Utah. Conversely, the closely related language of Panamint was confined to a relatively small portion of southeastern California and southwestern Nevada. Among Southern Numa, Ute was spoken across western Colorado, southern Utah, northern Arizona, and southeastern California. Ute's sister language, Kawaiisu, was spoken only in a small area of southeastern California.

It is interesting that the greatest amount of linguistic diversity is found in a very small, localized portion of the Great Basin. Within the three largest Numic languages in the Basin, Northern Paiute, Shoshone and Ute, there is increasing dialectical diversity as you travel southeast (1986). This fact has some implications for ancient aboriginal distribution, which I will return to shortly.

The basic unit of social organization among the Northern Paiute was the family (Steward 1938). The family, as defined by Fowler and Liljeblad (1986:446) was,

...at base nuclear and independent, but at times variously modified to allow for inclusion of fractional elements. Ideally, it included parents and siblings, but at various points in time a parent might be absent through death or divorce and one
or more siblings might be resident elsewhere. Time depth added additional spouses and children, some temporarily, so that the core expanded and contracted continually.

Generally, camp groups were comprised of two or three related (although not necessarily) families that often traveled, hunted, and gathered together. Although camp group membership was fluid and the associations were not corporate, there was no obligation to share gathered foods, although meat often was shared. Camp groups provided an additional level of risk management with the ability to pool resources when times were tough.

Individual family autonomy was occasionally surrendered to organizers of communal events. Social happenings that required a greater amount of cooperation and leadership , such as dances or communal game drives, were handled by a "big talker", a shaman or a drive boss. Under such circumstances his/her power and influence were limited to the duration of the event. Communal drives were a relatively rare phenomenon. Steward reports that rabbit drives could be undertaken on the order of every three to five years, while larger game populations such as antelope and deer took much longer to recover (5 – 7 years). Perhaps only 10 – 20 percent of people's time was spent in communal activities (Aikens 1999).

Winter encampments often constituted the largest seasonal aggregation of people. The make up of seasonal aggregations changed from year to year. Winter camps often included visitors who were separated from their home districts out of economic need or social obligations. Given that the annual harvest was likely to vary in location from year to year, so too was the location of seasonal gatherings.

Bands were composed of several camp groups that seasonally occupied a common home district, or *tibiwa*. More specifically, a tibiwa refers to "a resume of preferred camping places where maximal congregations seasonally occurred. It included as well the foraging districts associated with these camping places" (Fowler and Liljeblad 1986:436). The term *band* is used quite loosely when referring to the Northern Paiute of Oregon in that they did not recognize any permanent, centralized political control. The existence of chiefs at all among them is thought to be an artifact of the contact period, lasting only about thirty years (Fowler and Liljeblad 1986:437). Aboriginally, it is extremely doubtful that any chiefs existed. The *chiefs* described by Stewart (1939) had only received recognition following the initial displacement of natives by Nineteenth Century settlers. This level of organization was probably not well represented prehistorically.

Group territory did not have any sharp boundaries. As Fowler and Liljeblad (1986:448) state:

A person was familiar with the camping spots and their patrons in his district, but probably equally familiar with places and individuals in immediately adjacent *districts. Some individuals were also known to have traveled widely, sometimes for the purpose of trade, but often also just out of curiosity. These individuals had friends and often relatives (kindred or more extended) even more widely spaced.*

Within the whole of the western Great Basin, Stewart identified 21 Northern Paiute bands. He recognized the difficulties in accurately rendering group boundaries and prefaced the proposed distribution with a warning that borders were not always conceived so precisely" (Stewart 1939:130).

The names of Northern Paiute groups were primarily derived from food-name designations. A group's neighbors would often refer to them according to a common food resource in the area. Alternatively, a group may have been distinguished according to topographic features within their home range. Fowler and Liljeblad (1986:436) note that: "With potentially hundreds of local place-names, groups of varying size, composition, economic pursuit, and degree of permanency could be designated in several ways."

The territory occupied by the Hunipuitoka,:

...enclosing about 7,000 square miles, starting at Pauline Mountain in Des Chutes County to the Wasco County line where Highway 97 crosses; thence east to the John Day River, up the river to North Fork, then up the North Fork to the Blue Mountains; thence south along the Blue Mountains to the head of the Malheur River; thense southwesterly along the divide between the John Day and the Malheur drainages to Pauline Mountain, the place of beginning (Stewart 1939:131).

The Yahuskin or Goyatoka (crawfish eaters) occupied approximately 5,000 miles,

Starting where the Oregon line crosses Goose Lake, the western border runs west to include Dog Lake and Drews Creek, then turns north to pass east of Bly and goes to Gearheart Mountain; thence northwesterly through Sycan Marsh to Yamsay Mountain and on to Pauline Mountain; thence easterly along the along the southern line of the Hunipuitoka almost to Hampton, where it curves southeasterly to Little Juniper Mountain before going south to Goose Lake. This territory touched the Klamath and Modoc on thewest and south, the Hunipuitoka on the north, the Wadatoka and Kidutoka on the east (Stewart 1939:132).

Subsistence for Northern Paiute groups included a broad range of plants, animals, and insects. Deer, antelope, and desert bighorn sheep were the primary large game that was hunted (Fowler and Liljeblad 1986). These larger animals were captured with a variety of implements such as the bow and arrow, traps, and corrals. Small herds of antelope were occasionally taken in large numbers through drives. This practice had the effect of decimating populations of antelope and was not done frequently. Deer and bighorn sheep were taken opportunistically while in the vicinity of other important resources (plant foods, lithic sources, gathering places, etc.) (Steward 1938). Although large game was important for its sustenance and raw material (particularly hides), it was generally a secondary component (at best) of the Northern Paiute diet (Steward 1938:33). Smaller animals such as rabbits, hares, porcupines, ground squirrels and marmots also made up a significant portion of the Northern Paiute meat intake. Small game was hunted individually with traps, noose snares, and bow and arrow. Rabbits and hares were also hunted by means of communal drives (Fowler and Liljeblad 1986; Steward 1938). Local nesting birds such as grouse, and migratory species such as geese were hunted with nets and bow and arrow.

Fishing was important to Northern Paiute living around large lakes (Pyramid Lake, Humboldt Lake) and rivers with anadromous fish runs (John Day , Snake River Basins). In more arid portions of the Basin, fish was not a significant component of the diet (Steward 1938).

Once every few years, great swarms of crickets and grasshoppers appeared in the Great Basin. They were collected in copious quantities and could be stored for several months (Steward 1938). These unexpected windfalls provided an excellent supplement to the diet, but occurred too irregularly to be relied upon.

Seeds, roots, nuts, and berries were the primary component of most Northern Paiute diets. Whereas the pinon nuts were the staple food in the southern Basin, roots such as camas were a staple in Oregon (Fowler and Liljeblad 1986). Seeds such as Indian rice grass and wild rye were collected and ground into a flour with a mano and metate. Depending on the region and food being processed, mortars and pestles were sometimes used instead. Seed meal was sometimes combined with dried berries to make small cakes that could be stored (Fowler and Liljeblad 1986).

Due to the high degree of mobility practiced by most Northern Paiute during the ethnographic period, they traveled light with mostly utilitarian belongings. Their fine weaving ability was put to use producing baskets, mats, footwear, rafts, shelter and clothing. Baskets were used to carry belongings, collect and process food, as well as for hats.

Several types of structures were made by the Northern Paiute for shelter throughout the Great Basin. Although structures varied in composition and design from region to region, two main types were used. Lowland winter dwellings tended to be the most substantial. They were often conical and covered with mats, grass, or tulle. In the warm seasons, Northern Paiute preferred the shelter of lightweight wickiups. These structures were dome-shaped and mat covered (Fowler and Liljeblad 1986).

Problems Defining Northern Paiute Distribution

The exact definition of language boundaries in the northern Great Basin prior to, and during, the ethnographic period is problematic for a several reasons. Early on, the most formidable challenge to tracing linguistic relationships in the Great Basin was a chronic misapplication of cultural and linguistic terms. Referring to this problem Stewart (1939:128) states: "The differences in nomenclature for the Indians here embraced by one rubric are a result of historic accidents. Effects of those accidents are continually reappearing to obscure the real relationships of these bands."

Confusion was caused by the use of a number of different epithets for the Northern Paiute between 1805 and 1907 by explorers, traders, government officials and anthropologists. Early accounts often referred to the Northern Paiute in Oregon as Sosone, Shoshone, Snake, Bannock, Wurrock, Digger or Paviotso. Stewart (1939) reported that Sahaptin informants living near the Columbia River told Lewis and Clark that their southern neighbors near the Deschutes River were Shoshonean. Lewis and Clark thus associated those particular bands with the "Snakes" living in the east side of the Snake River (Stewart 1939:128). Steward (1938:263) commented that "Early writers were liable to several kinds of error. First, the differences between the linguistic divisions are sufficiently slight to have escaped the attention of persons not well versed in these languages."

Some writers assumed all Numic groups were one "tribe." Ross, visiting Oregon in 1819, defined the boundaries of the Snakes as: "the Rocky Mountains of the east, "Spanish waters" on the south, the Cascades on the west, and the Blue and Teton mountains of the north" (Stewart 1939:128). Steward (1938:263) observed that "it was often assumed that well-defined, bounded, and named political units would be found everywhere. It was not known that the only grouping in the greater part of the area was the family or village, so that "tribe" had significance only in synonymy with language." Visitors subsequent to Ross recognized the distinctness among Numic groups. Ogden (1825) was one of the first to distinguish between those in the northeast who used horses to hunt buffalo and those west of the Snake River who were more focused on root and fish resources. He termed the two groups "Banacks" and "Diggers," respectively (Stewart 1939). In 1873 Powell observed differences between the Southern Paiute and the Northern Paiute of southeastern Oregon. Kroeber (1908, 1909) shed much light on the linguistic relationships that existed between Great Basin Numa. His work revealed similarities of Mono, Poviotso, "Shoshoneans of eastern Oregon called both Snake and Paiute, and probably certain of the Bannock or other Indians of Idaho" (cf. Stewart 1939:129).

Yet even after a better understanding of the linguistic relationships that existed between groups had developed, their exact geographic location was not always known. The high degree of mobility practiced by the Northern Paiute doesn't lend itself to firm delineations of territoriality. Seasonal rounds were constantly modified to accommodate several economic and socio-cultural needs. The home range of a given band or family could be altered significantly within a single generation due to factors such as social relations and resource availability. Over several generations, the home range of the same group may have changed even more dramatically. On a similar note, Steward (1938:264) points out that "observers did not always distinguish the temporary from the habitual residents of a region. Although mounted Shoshoni and Ute were sometimes encountered several hundred miles from their homes, the fact was not always recognized or stated." Another problem related to mobility that Steward pointed out was that "it was often assumed that well-defined, bounded, and named political units would be found everywhere. It was not known that the only grouping in the greater part of the area was the family or village, so that "tribe" had significance only in synonymy with language" (Steward 1938:263). To this day, Stewart's 1939 study of Northern Paiute distribution and cultural elements continues to be the best source on the subject.

Numic Origins

Some researchers have suggested that the Paviotso and other Numic speakers are relatively recent arrivals in many parts of the Great Basin (Aikens and Witherspoon 1986; Lamb 1956). This line of reasoning is supported primarily by linguistic evidence. While there is some agreement in terms of the antiquity of the Numic presence in the Basin, there is contention regarding the mechanisms that led to its distribution during the ethnographic period.

A scenario advanced by Lamb suggests that the breakup of a Proto-Uto-Aztekan language, located near the boundary between Arizona and Sonora, began around five thousand years ago (Lamb1956:99). By 4,000 BP, Numic and Tubatulabalic were slowly becoming distinct languages. Numic was, presumably, becoming internally differentiated before it split completely from Tubatulabalic. Lamb argued that the Kawaiisu-Ute dialect was the first to cleave from the greater Numic language sometime around two thousand years ago. This bifrication was followed soon after by the separation of the Monachi-Paviotso and Panamint-Shoshone (Lamb 1956:99). In this scenario, the three Numic languages were occupying a small portion of the southwestern Great Basin until approximately one thousand years ago.

Lamb proposed that the similarity of language documented across all of the Great Basin during the Ethnographic period was due to a recent migration of ancestral proto-Numic groups out of the Death Valley area. The Death Valley region was suggested as the probable point of diffusion because it is where the greatest amount of diversity is found within the Numic family. According to lexicostatistical principles, a center of linguistic diversity is often assumed to be an ancestral homeland (Aikens and Witherspoon 1986). Lamb proposed an exodus out of the ancestral homeland around 1000 BP along three parallel routes heading northeast.

Aikens and others have countered that the linguistic diversity in the Death Valley area is more a function of geography than origin (Aikens 1984). Referring to Lamb's interpretation, Goss (1977:56 cf. Aikens 1984) has noted:

> *I would simply counter that the Mono of Owens Valley and theSouthern Sierra Nevada Mountains are the most isolated of the Monoish (Northern Paiute) groups. The Panamint or Koso are the most isolated from ongoing communication with other Shoshonish [Shoshoni] groups of the Great Basin. The Kawaiisu are located across the Mojave Desert from their nearest Yutish [Ute] sister group, the Chemehuevi. The relative linguistic diversity in the southwestern corner of the Great Basin could just as well, and perhaps better, be explained as a function of isolation from ongoing communication with the fully communicating cluster sister dialects out in the Basin* (Goss 1977:56 cf. Aikens 1984).

Lamb's hypothesis is based on some questionable methods and assumptions. First is the use of lexicostatistics to arrive at a date of divergence. The underlying assumption behind this method is that languages change at a known and steady rate (retention rate). Retention rates used in

North America are based on European analogs that may not be appropriate. Furthermore, it has been shown that the accepted rate of retention does not accurately predict the known rate of divergence for Romance languages (Aikens 1999). As was the convention, Lamb also assumed that, geographically, language diversity equals language origin. Because he observed that the southwestern portion of the Great Basin was home to five related, yet differentiated languages, he assumed that this area was the ancestral homeland of the Numa.

Some valid criticisms of Lamb's hypothesis have been raised over the years. Some have questioned the idea of three separate groups moving in parallel lines out of Death Valley at the same time. Such a scenario seems unlikely given human nature. Second, the archaeological record does not show any swift "replacement" of one people by another. Finally, Lamb did not provide any substantive clues as to who occupied the area prior to the Numic expansion.

An alternative to Lamb's hypothesis has been suggested by Aikens and Witherspoon (1986) that takes issue with the linear march and "replacement" theory while incorporating archaeological evidence. Their position accepts the rough dates for the breakup and diffusion of Numic peoples, but suggests a somewhat different homeland. This hypothesis relates the spread of Numic people to the collapse of the archaeological cultures of the Lovelock, Chewaucan, Fremont, and Anasazi, which were once located peripheral to the central Great Basin. It is suggested that the withdrawal of these cultures, following a climatic shift towards less effective moisture, left many desirable tracts of land open to occupation by others. Aikens and Witherspoon. (1986:15) postulate an early Numic presence in the central Great Basin, dating back to at least the Uto-Aztekan break- up around 5000 BP. They suggest that the Numic homeland extended from north-central Nevada south to the Owens Valley. The Lovelock and Chewaucan cultures were presumably the first to collapse, allowing western expansion and development of a separate language. The Fremont and Anasazi cultures soon followed, resulting in the eastward expansion and differentiation between Central and Eastern Numic languages.

The alternative hypothesis presented above is one of many competing to best explain the Numic expansion. Now that the recent expansion of Numic people has been established (Aikens and Witherspoon 1986; Lamb 1956; Madsen 1975, Madsen and Rhode 1994), continued work should focus on gaining a better archaeological understanding of the central Great Basin. Madsen and Rhode (1994) suggest that the proposed alternative models must now be tested. They also note the possibility of using genetic markers to trace ancient population movements in the region. Although this may provide some additional insight, I suspect such a route would be wrought with ethical and methodological obstacles. A re-examination of lexicostatistics may make the method more trustworthy and thus more useful. Finally, a systematic analysis of the different patterns left by different modes of migration (invasion vs. replacement vs. expansion, etc.) would significantly contribute to the continuing discourse on the Numic expansion.

Molala

Aboriginal occupation of the Cascade Range in Central Oregon has been attributed to the Molala (Berreman 1937; Loy 1976; Rigsby 1965, 1969; Murdock 1938). Very little is known about this group of people, whose last living member died in 1957 (Ruby 1986:139). Although most

Molala resided on the more mild Western Slope of the Cascades during the ethnographic period, it has been suggested that they once also lived east of the Cascade Crest, along the Deschutes River (Berreman 1937; compare Zenk and Rigsby 1998).

Linguistically, the group belongs to the ancient Penutian language phylum, which has widespread distribution in Oregon. Other languages of Penutian origin in Oregon include Chinook, Nez Perce, Klamath, Cayuse, and Alsea. Zenk and Rigsby (1998:439) uncovered ethnographic texts and manuscripts in the Frachtenberg Collection that suggest the existence of northern and southern Molala dialects.

During the ethnographic period, large game such as deer and elk was a major part of the Molala diet (Zenk and Rigsby 1998). Large game was taken primarily with the bow and arrow, but also by means of pitfalls, deadfalls, snares, and drives. Like their neighbors to the south, Molola used dogs to track and drive deer (Drucker 1934 cf. Zenk and Rigsby 1998). A number of other animals were also hunted for both food and raw materials including steelhead and salmon, a variety of migratory and upland game birds, various small mammals, coyotes, and bobcats. Plant foods utilized by the Molala included camas root, tarweed, hazelnuts, various berries, and rhizomes. Meat, seeds, berries, and roots were preserved through drying or smoking, then cached for use during the lean months (Zenk and Rigsby 1998).

Klamath

Historically, the Klamath lived along the eastern slope of the cascades with principal villages in the Klamath Basin. Their territory extended south of the Upper Deschutes River Basin to the California border and encompassed the Sprague, Sycan, Williamson, and Upper Klamath River systems. Large settlements were located along Upper Klamath Lake, Agency Lake, Klamath Marsh and the Lower Sprague and Williamson Rivers (Connolly 1999).

Linguistically, the Klamath are related to the Plateau Penutian language phylum, of which the Molala are also classified. They were closely related to their neighbors to the south, the Modoc, though were often in conflict with them. The Klamath functioned as autonomous groups organized at the extended kin level.

The Klamath Basin provides a veritable oasis in an otherwise parched land. The open waters of the basin attract many species of migratory waterfowl. The upper reaches of the Klamath River once provided salmon and steelhead in great numbers. They were taken by a number of methods including dip nets, harpoons, weirs, hook and line, and by clubbing (Stern 1998). Large game endemic to the area that were hunted include deer, antelope, and to a lesser degree, elk.
The seasonal round followed by the Klamath enabled them to exploit a variety of resources in both upland and lowland settings. Leaving behind their semi-subterranean pit houses in the spring, they would depart for sucker fishing in Upper Klamath Lake. Following the first run of sucker fish, families would spread out to collect the ipos root. While the women dug for roots, the men would venture off to fish or hunt. The spring was also a time to collect waterfowl eggs and the cambium layer of young ponderosa pine. By early summer camas bulbs were being collected and waterfowl and large game were hunted. During the months of July and August, the

ripe seeds (wokas) of the yellow pond lilly were collected (Barrett 1910). Wokas were widely available on Klamath Marsh where many families would congregate to harvest the seed by canoe (Spier 1930). On occasion, deer and antelope were communally driven into corrals with fire, where they were clubbed. In the late summer and early fall the Klamath gathered various berries and fruits, such as black cherries and prunes (Stern 1998). By October, they once again returned to their winter lodges. There they stored surplus roots, flour, and dried meat to be eaten in the cold months. Stored food was supplemented in the winter by fishing and opportunistic hunting. Archaeological evidence suggests that the land use systems practiced by the Klamath date back at least 5,000 – 7,000 years (Cressman 1956; Sampson 1985).

The Klamath made use of three types of structures for shelter. The earth lodge was generally round and excavated to a depth of one to four feet. The diameter of the lodge varied greatly, from 12 to 35 feet. Planks were laid across a rectangular frame, creating the walls and roof. Mats were overlain and then covered with earth. Mat lodges were used in both winter and summer months, though were of much less sturdy design. These were occupied by individuals with meager economic resources who could not afford the labor or materials required for an earth lodge. The floors of mat lodges were excavated to a much shallower depth. They were often erected at favorite fishing grounds (Stern 1998). The wickiup was used in the summer months and periods of high mobility. They were also used when giving birth, for cooking spaces, and places to weave.

ARCHAEOLOGY

Prehistoric cultures of the Great Basin and Columbia Plateau have been the focus of intense study over the past century (Steward1938; Murdock 1938; Jennings 1957; Aikens 1970, Chatters 1994; Ames 1998; Connolly 1999). A significant amount of research has concentrated on clearly defining cultural patterns for these groups observed ethnographically and in the archaeological record. A growing body of work describes adaptive strategies used by the indigenous people since the closing of the Pleistocene in these diverse regions. Archaeological evidence shows that some strategies observed ethnographically have long histories in their respective habitats, while others had faded before they could be preserved as text. Yet, the line defining Plateau and Great Basin cultural, or even physical, boundaries is not a sharp one.

CENTRAL OREGON LAND USE

The eight archaeological sites under consideration here occupy a transition zone between the Klamath Basin to the south and the High Lava Plains to the north and east. Both regions have fostered the development of different land use patterns, each tied to the abundance and distribution of available food resources. Schalk et al. (1994) have proposed a prehistoric "developmental land use trajectory" for central Oregon that seeks to account for the range of variability present in the archaeological assemblages of the area. While relying heavily on middle range theory, Schalk et al. (1994) divide the forager / collector continuum into five distinct strategies: foraging, rest-rotation collecting, semi-sedentary collecting, full sedentism, and equestrian based hunting and gathering. Although the model they present retains unilinear evolutionary overtones, it still provides a useful basis for comparison and is used in this study.

A pure foraging strategy follows the basic scheme set forth by Binford (1978). This strategy involves a very high degree of residential mobility and a relatively large home territory. The rest-rotation strategy is one in which seasonal rounds are continuously modified so that any one resource patch is not exploited to the point of depletion. A foraging approach to resource acquisition relies on the timely dissemination of information regarding which patches are most productive at any given time. Although rest-rotation strategies are practiced within a more confined territory than foraging, the amount of land traversed during seasonal rounds is expected to be larger than for semi-sedentary collecting. In contrast, the semi-sedentary strategy relies on the same resource patches year after year, which are not rotated out of the seasonal round. Fully sedentary strategies are unlikely to have occurred in the Upper Deschutes at any point in prehistory given the spatial and temporal distribution of resources. Such a strategy is not suited to a semi-arid environment, and is more likely to occur in rich coastal and riverine environments. Finally, equestrian based hunting and gathering was a short-lived adaptation that developed after Euroamerican contact and was documented ethnographically (Shalk et al. 1994). In an effort to help frame questions related to land use strategies in the Upper Deschutes River Basin, it is useful to consider those suggested for the Klamath Basin and High Lava Plains by Schalk et al. (1994).

Klamath Basin

Based on ethnographic and archaeological evidence, Schalk et al. (1994) suggest that land use strategies practiced in the Klamath Basin changed markedly over the millennia. They argue that a foraging strategy is suggested by the earliest archaeological remains, followed by a period when a rest-rotation strategy was used, which then gave way to a semi-sedentary collecting strategy, documented ethnographically. As noted by Atwell et al. (1994), there is some disagreement as to the time depth of the ethnographically observed semi-sedentary strategy practiced by the Klamath. It has been variously argued that the pattern has been in place since as early as 6,800 BP (Cressman 1956), 5,000 – 6,000 BP(Aikens and Minor 1978), and 5,000 BP (Sampson 1985).

As envisioned by Cressman (1956), the ethnographic Klamath settlement system had enjoyed long periods of stability made possible through exploitation of lacustrine and marsh environments, and made only limited, seasonal use of upland resources. Prompted by increasing population pressure, a shift occurred in the subsistence economy that led to an intensification in the use of fish and yellow pond lilies (wokas). This economic shift occurred hand in hand with the development of semi-sedentary pit-house villages situated to provide ready access to lakes and rivers (Atwell 1994). Winters were spent at a village with extended kin and band members. As the weather improved in the spring, family groups would head to the uplands to hunt and gather (Spier 1930). Fewer people allowed for the pursuit of more widely distributed upland resources in summer and fall. Resources sought in the uplands included nuts, seeds, berries, and large game.

Upper Deschutes and High Lava Plains

Schalk et al. (1994) argue that the land use strategies used by ethnographic Northern Paiute groups who occupied the High Lava Plains centered on a rest-rotation strategy. Exploitation of the region by Northern Paiute groups relied on a high degree of mobility and encompassed a rather large territory. Resources pursued included a variety of small and large game, insects, fish, berries, nuts and seeds (Fowler and Leljeblad 1986). The fact that Northern Paiute stored food for use in the lean winter months precludes their classification as foragers, in the strict sense of the term. Evidence provided by Aikens and Witherspoon (1986) and Bettinger and Baumhoff (1982) suggests that they arrived in Central Oregon quite recently, perhaps 300 to 1,000 years ago. It has been shown that more ancient traditions made use of the High Lava Plains while practicing similar land use strategies. It is plausible that the High Lava Plains and Upper Deschutes could have supported small semi-sedentary groups during the warm months of the year, when large game, waterfowl, and vegetable foods were plentiful. Such was the case in the low-lying mesic basins to the north (Paquet Gulch), south (Klamath Basin), and east (Newberry Crater and Fort Rock Basin). Given the comparatively low productivity of the High Lava Plains, use of the region was probably supplemented by low-land resources through much of the year (Atwell et al. 1994). Low-lying lake basins to the east would have offered slightly more tolerable weather in the coldest months, and the opportunity to intercept deer wintering in the area. The apparent absence of seasonal pit house villages in the Upper Deschutes may be the result of sample bias. One site, 35KL111, discussed in the following section may represent one of the few upland villages in the area.

PREVIOUS ARCHAEOLOGY

This discussion examines the transition zone that conjoins the Southern Columbia Plateau and Northern Great Basin, to help frame the current investigation of adaptive strategies used in the middle and upper Deschutes River Basin. Each period is distinguished by the particular technology and inferred adaptive strategies used. Each is represented by local and regional patterns, periods, horizons and traditions (Endzwig 1994:38). Figure 3.1 lists archaeological periods currently used in the Pacific Northwest.

Initial Occupation of the West

The earliest occupations of Oregon, Washington, and California are evidenced by the presence of Western Clovis and Western Stemmed assemblages. To date, Clovis assemblages remain poorly dated in the Far West due to the fact that most have been recovered from the surface. On the Plains and the Southwest, the Clovis period is generally accepted to have occurred between 11,500 – 11,000 B.P. Haynes (1991) argues for a shorter duration of the pattern. Based on a reevaluation of radiocarbon dates associated with Clovis finds, he has suggested that the pattern may have only persisted for 300 years between 11,200 – 10,900 B.P. Although its form varies regionally, Clovis has been documented across the lower 48 states, down through Central America, at a few sites in Alaska and possibly in South America. Early sites in the West are most often associated with water sources such as springs, river terraces, lake and pond shores.

Camps have generally been interpreted to be ephemeral with small groups occupying them. North American sites tend to be in open areas, while South American Clovis variants often show up in rock shelters.

The Clovis pattern is characterized by relatively long, bifacially flaked points with longitudinal flutes. The points often exhibit parallel or slightly convex sides and a concave base. Blackwater Draw #1, the Clovis type site, produced an assemblage that included worked bone, small triangular points, large lanceolate points, retouched flakes, hammer stones, and the diagnostic Clovis points. Other sites in the Far West that have produced significant amounts of Clovis material include: China Lake, CA (Davis 1967) ; Tulare Lake, CA (Wallace and Riddell 1988); Borax Lake and Clear Lake area, CA (Fredrickson 1973; Fredrickson and White 1988); Tonopah Lake and Mud Lake area, NV (Tuohy 1988; Campbell and Campbell 1940); and the Richey-Roberts Clovis Cache, WA (Mehringer 1988).There is a great deal of variation in style attributed to Clovis pattern. Variations in the general morphology of Clovis points include fluting on one side only, multiple flutes on one side and flutes extending the length of the point. Size and shape vary in addition to the presence and location of edge grinding. The raw material that most early tools are made of is high quality and fine-grained. Clovis assemblages often exhibit exotic materials, sometimes from hundreds of miles away. This has implications for settlement patterns, suggesting that people practicing highly mobile strategies would have come across an array of quality lithic sources.

The subsistence economy of the Clovis culture has often been interpreted to be specialized in large game, predominately mammoth. Indeed, mammoth is the most common faunal remain found associated with Clovis sites. This fact may be a function of the enormity of mammoth remains. Remains of many smaller animals would be much less likely to survive 11,000 years. Depending on local resource availability, Clovis people may have had a more general subsistence economy, exploiting a variety of plants and animals. The fact that depositional environments rarely allow for preservation of vegetable materials doesn't mean they were not being used. Sites in the Far West, such as Dietz, suggest that Paleoindians may have adopted a more diversified domestic economy earlier than generally presumed (Willig and Aikens 1988).

The Western Stemmed complex was widely distributed and has been documented from British Columbia to northern Mexico. Western Stemmed assemblages are characterized by large shouldered, stemmed, and lanceolate points. These tools are sometimes found in association with crescents and heavy core tools (Willig and Aikens 1988). Western Stemmed assemblages have been given numerous regional monikers such as Lake Mohave (Amsden 1937), Lind Coulee (Daugherty 1956), Windust (Leohardy and Rice 1970), and Cascade (Butler 1961). Remarking on the highly diffuse nature of the tradition, Willig (1988:68) noted:

> *Despite [the] diversity of regional styles, assemblages asdistant as northern Mexico and central Washington share strikingly similar point forms, tool kits and technology, suggesting that all of these stemmed point complexes represent one closely related, widespread Western Stemmed cultural tradition present throughout the Far West from 10,500 to 7,500 BP.*

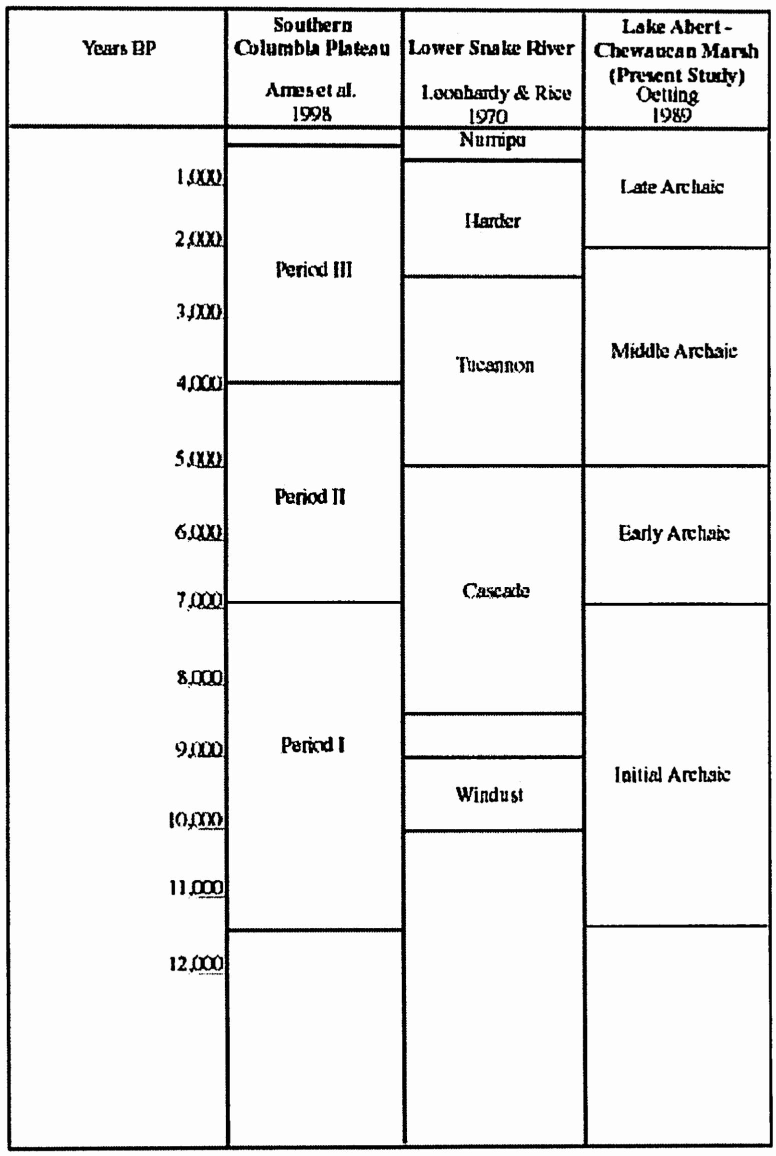


Figure 3.1 Archaeological periods of the Pacific Northwest.

The earliest unequivocally accepted radiocarbon date for a Western Stemmed assemblage comes from Nevada. The Smith Creek Cave site produced a date of 11,140 +/-200 on charcoal taken from an associated hearth. This find, as well as others such as Fort Rock Cave, have been used by some to suggest that the Western Stemmed Tradition was a contemporary of Clovis (Bryan 1979). Early stemmed point sites in Oregon include Fort Rock Cave (10,230 +/-230 BP), Connley Cave (9,540 +/-260 BP), Dirty Shame Rock shelter (9,500 +/-95 BP), and Wildcat Canyon (10,600 +/-200 BP).

The Dietz site in southern Oregon provides a unique example of Clovis and Western Stemmed occupations at the same site (Fagen 1988). The site is located on the margin of an ancient pluvial lake (now dry) in the Alkali Lake Basin of southeastern Oregon. The Dietz site represents one of the largest Clovis assemblages recovered from a site in the Western United States (Fagan 1988). Sixty-one fluted points and fragments have been found in five concentrations (Willig 1988). The Western Stemmed artifacts occur in two concentrations at the base of a ridge, just above a beach. The Clovis lithic scatters overlap with the Western stemmed deposits at the base of the ridge. A portion of the Clovis deposit was found in the playa, indicating higher water during the Western Stemmed occupation.

Fagan's (1988) lithic analysis of the Dietz assemblages revealed several important differences between Clovis and Western Stemmed lithic technology at the site. He found that during both periods of occupation people were manufacturing large bifaces from blanks, although there was a difference in the method of platform preparation. The Western Stemmed assemblages contained a wide variety of artifacts including large stemmed points, blanks, knives, preforms, crescents, spokeshaves, scrapers, gravers, manos and metates. The Clovis assemblages were less diverse and showed a preference for bifacial tools associated with hunting related activities. The lithic material from all occupations was high quality. Western Stemmed artifacts are made of local lithic material and represent few sources. The Clovis tools were made from exotic materials from many different sources. Based on these findings, Fagan (1988) concluded that Clovis and Western Stemmed occupations represent different populations of people. He also inferred a broader subsistence economy for the Western Stemmed occupations

In an effort to clarify the relationship between the Clovis and Western Stemmed traditions, Willig and Aikens (1988) evaluated data from 28 early sites in the West. With regard to the so-called *Clovis – Archaic Interface*, they explore three central issues, including: 1) the role of big game hunting, 2) the role of lake and marsh adaptations, and 3) the antiquity and inception of broad spectrum subsistence economies.

Regarding the first issue, Willig and Aikens (1988) found no acceptable data to indicate specialized big game hunting by Western Clovis or Western Stemmed traditions. They remark that it is doubtful that the Far West ever supported extensive herds of terrestrial grazers. Although bison and other large grazers are known to have occupied the Great Basin, they have never been reported in large numbers and thus provided an unpredictable component of the diet.

Willig and Aikens (1988) argue that large pluvial lakes and marshes represent a "pivot point" of a flexible, wide-range, broad spectrum subsistence strategy “tethered” to mesic habitats. Although the densest Western Stemmed and Clovis occupations are found on or near pluvial lakes and marshes, many are also found at upland springs, mountain passes, rivers, streams and rock shelters.

By re-evaluating radiocarbon, stratigraphic, and obsidian hydration data, Willig and Aikens (1988) found that the overlap of Clovis and Western Stemmed traditions is 190 years, if you ignore the outlier, Smith Creek. This amount of overlap is similar to the Clovis – Folsom interface on the Plains. Stratigraphically, Western Stemmed artifacts have not been documented below Clovis.

Clovis and Western Stemmed traditions differ in three primary ways according to Willig and Aikens (1988): assemblage structure, variability in reduction sequences, and flaking techniques. These data could be interpreted in several different ways. Three migration events could be represented (Clovis, Western Stemmed, later Archaic); or, viewed as evidence of technological evolution within a single culture (Musil 1988); or, possibly, unique adaptations to specific environments.

Bedwell (1973) introduced the notion of a Western Pluvial Lakes Tradition (WPLT) in the Great Basin. The WPLT was proposed to account for the presence of stemmed points, crescents and gravers on now dry pluvial lakes and marshes. Based on geologic associations (most importantly early Holocene shorelines) and correlation with similar artifacts from dated contexts, Bedwell placed the WPLT at 11,000 to 8,000 BP. This concept has had a powerful effect on the theorizing of postglacial occupations since its inception. Willig (1988) has challenged the notion that pluvial lakes and marshes were the primary focus of Paleo – Archaic subsistence strategies. Instead, she argues that such mesic habitats provided a "pivot point" for a flexible, broad spectrum strategy. To support this position she points to the fact that many Western Clovis and Western Stemmed sites have been documented at upland springs, mountain passes, rivers and rock shelters.

The Archaic

Southern Columbia Plateau

The Southern Columbia Plateau pattern, as manifested in Oregon, is explored here with an emphasis on the archaeological remains and the basic cultural sequences proposed for the region. The discussion is organized around a tripartite sequence adopted from Ames et al. (1998).

Period I

The archaeological record on the Southern Columbia Plateau for the period from 11,500 to 7,000 BP has been interpreted as reflecting a broad-spectrum hunter-gatherer economy. While this is true for most of the region, some sites such as the Dalles point to a narrowly focused economy based on fish resources very early (Aikens 1993). Elsewhere, early populations were small and highly mobile, rarely stopping any one place long enough to have much use for substantial structures or storage.

Prior to 9,000 BP, diagnostic artifacts include stemmed points, shouldered points and unstemmed lanceolate points. From 9,000 to 7,800 BP Cascade points dominate. Within this category of projectile points there appears to be a good deal of spatial and temporal variation. After 7,800 B.P., large corner-notched points appear and include the well-known Northern Side-Notched and Bitteroot series.

The Dalles Roadcut Site, also known as Five Mile Rapids, is an ancient Plateau fishery located just above the Long Narrows on the Middle Columbia River. Intense salmon harvesting has been practiced at the site dating back some 10,000 years. The earliest strata from the Roadcut site yielded an assemblage of lithic blades, scrapers and worked bone (Aikens 1993). The Full Early period (9,800 – 7,900 BP) of occupation at the site has produced an enormous faunal assemblage containing an estimated 300,000 salmon vertebra (Ames et al. 1998). This period broadly corresponds to the Windust Phase known from other sites in the region (Aikens 1993). Artifact assemblages from this time often include projectile points, cobble tools, bifaces, utilized flakes, scrapers, gravers, burins, bolas, and cores. Occasional bone points have also been noted from this time period (Ames et. al. 1998).

The stratum dated to 7,900 – 6,100 at the site has produced considerably less evidence of human occupation. Aikens (1993:100) suggests this may be the result of taphonomic processes at the site, rather than a change in occupational intensity. Artifacts recovered and assigned to this period include choppers, scrapers and projectile points.

In younger deposits, cultural material included Cascade points (8,000 – 4,500 BP), Tucannon points (4,500 –2,500 BP) and Harder Phase points (2,500 – 100 BP). Many non-utilitarian artifacts have been recovered from the site and attributed to later occupations, testifying to the development of an elaborate artistic tradition. Aikens (1993:100) suggests that the Roadcut site was most likely occupied continuously over its 10,000 year history, although the intensity of the occupation may have been variable.

The Wildcat Canyon site, located about 30 miles upstream from the Roadcut site, provides additional evidence of exploitation of fish resources on the Middle Columbia River by early inhabitants of the area. Early occupation of the site assigned to the Philippi Phase (~9,000 – 7,500 BP) correlates to the Windust and Full Early Periods elsewhere. Early use of the site appears to be ephemeral. Diagnostic artifacts from this period at the Wildcat site include lanceolate projectile points with basal indentions. Other artifacts include knives, scrapers, gravers, burins and milling stones. The faunal assemblage is dominated by fish and artiodactyle remains. The initial occupation of the site between 9,000 and 7,500 BP was interrupted by an apparent 1,000 year hiatus between 7,500 and 6,500 BP..

Finally, the Umatilla Rapids site has produced some evidence of early occupation in the area. Only three formed artifacts and 27 flakes have been assigned to an Early Period occupation, having been found beneath Mazama ash. Fauna from the site reflects a diverse diet including fish, small mammals, bison, bighorn sheep, and fresh water mussels. Although no radiocarbon dates are available for the earliest occupation levels, they are thought to correlate in time to the Philippi Phase at Wildcat Canyon.

Period II

We know little about this period in Oregon. Less is known about human activity on the Southern Columbia Plateau during Period II (7,000 to 3,900 BP) than during Period I and subsequent Period III. Any attempt to account for settlement and subsistence patterns at this time is severely limited by a dearth of archaeological evidence. On the Southern Columbia Plateau as a whole, Period II is characterized by several distinguishing features. In some areas semi-subterranean houses appear along with an increase in sedentism. Salmon and root crops become more intensively exploited. Ground stone tools increase in frequency and size. Prepared cores and edge-ground cobbles disappear from tool assemblages. Additionally, projectile point styles become much more varied over space after 5,800 BP (Ames et al 1998:108).

After a hiatus of about 1,000 years at the Wildcat Canyon site, occupation resumes with the locally recognized Canyon Phase dated to 6,500 – 5,000 BP. Diagnostic artifacts from this period include Cascade and Northern Side-Notched projectile points. Aikens (1993:103) notes the presence of curious depressions at the site which he conjectures may be wells dug by the ancient inhabitants during a period of Mid-Holocene drying. However, Ames et al. (1998:110) raise some questions regarding the authenticity of a Period II occupation at Wildcat. They cite the possibility of post-depositional mixing of Period I and Late Period strata.

A similar situation exists downstream at the Roadcut site where artifacts assigned to a Period II occupation do not differ from those of the earlier period. Ames et al. (1998:111) argue that there is not enough evidence to support a Period II occupation at the site and suggest that the site experienced a 3,000 year hiatus between 6,000 and 3,000 BP.

Despite the lack of plentiful evidence in Oregon for Period II occupations, Ames et al. (1998) suggest that this period was transitional between the earlier Period I and Period III. They assert that people on the southern Plateau at this time would likely have been practicing settlement and subsistence strategies virtually identical to those of several millennia before.

Period III

Occupation of the Southwestern Columbia Plateau during Period III (3,900 –180 BP) is evidenced by vastly more archaeological data than are available from the preceding period. Cultural developments during this period include a dramatic shift to more sedentary settlement patterns along the Middle Columbia River, followed by a shift to "paired residential sites" during subperiod IIIA (3,000 – 1000 BP) (Chatters 1989 cf. Jenkins and Connolly 1996). The "paired residential" settlement pattern has also been observed ethnographically with large, circular housepits occupied in the winter and later abandoned for less substantial summer camps. Substantial pithouse villages appear in areas of diverse resources. A root processing complex becomes more widespread as is evidenced by earthen ovens often associated with house pits of this period. The increased importance of fish is attested to by an increase in the number of remains recovered, as well as by more fishing tackle such as net weights (Ames et. al. 1998). Storage becomes more prevalent in this region throughout the period. Shifts in hunting technology are evident in this period with the narrowing of projectile point bases around 2,000 BP and the adoption of "pin stemmed" points around 1,500 BP (Ames et. al. 1998). The narrowing of projectile point necks has been interpreted as the introduction of the bow and arrow (Musil 1988).

In the vicinity of the John Day Reservoir, nine sites have been investigated containing about 30 house pits attributable to Period IIIA occupations. Houses tend to be square or rectangular, reaching depths of 30 to 100 cm. At the Umatilla Rapids site, a fire hearth has produced a radiocarbon date of 2,559 BP, which makes it the oldest such structure on the Middle Columbia River (Ames et. al. 1998:115). House pit depressions from the Lower Deschutes River at Mack Canyon are also thought to date to Period IIIA.

At Wildcat canyon, the Wildcat Phase of occupation dates to 2,500 – 1,000 BP and is characterized by the pursuit of a diverse diet, year-round occupation of the site and a diverse tool assemblage. This phase of occupation roughly correlates to the Harder Phase elsewhere (Aikens 1993:104). Large corner-notched projectile points dominate the lithic assemblages early on, but are supplanted by smaller points thought to represent the atlatl / bow transition (Ames et. al. 1998).

Overall, the tool assemblage from Wildcat Canyon indicates that the occupants were pursuing a variety of tasks. Artifacts recovered include groundstone, flaked stone tools, net sinkers and many non-utilitarian artifacts. Faunal remains confirm the presence of a broad-based diet that included many species of fish, fresh water mussels, small mammals and large game.

For the most part, Southwestern Columbia Plateau subsistence and settlement strategies appear to continue unmodified in Period IIIB times.

Northern Great Basin

A discussion of the emerging picture of Fort Rock Basin prehistory is needed here to help frame questions related to settlement and subsistence in the nearby Basin / Plateau Interface. I have chosen to focus exclusively on the Fort Rock Basin because of its proximity to the Upper Deschutes River Basin. The discussion below, derived primarily by Aikens and Jenkins (1994), will serve to highlight the sequence of cultural adaptations in the Fort Rock Basin, as it is currently understood.

Initial Archaic

In the Fort Rock Basin, the period spanning 11,000 to 7,000 BP is characterized by an environment that has already succumbed to the effects of a drier post-Pleistocene climate. Archaeological remains from the Fort Rock Basin during this time reflect the classic Desert Culture adaptation. There appears to be widespread use of lowland basins as well as uplands in the pursuit of a broad diet. Diagnostic artifacts from the area include large Western Stemmed projectile points for the entire period, with side and corner-notched points appearing around 9,000 BP (Aikens and Jenkins 1994). Populations in the region were apparently quite mobile, settling at any one place for a very short time, with one striking exception.

Connolly Caves provides the only evidence in the Fort Rock Basin of intensive occupation early on. Here, people were heavily exploiting marsh resources as well as a variety of large and small terrestrial animals near Paulina Marsh. Paleoenvironmental data gleaned from pine charcoal and pika middens at the site suggest that the region was much cooler and wetter than it is today, providing a bounty of lowland resources.

Elsewhere in the Fort Rock Basin, people were pursuing highly dispersed animal and plant resources during the Early Holocene. Many sites in the area dated to this period are located in the open, often on low strand lines of now dry lakes and marshes. The Dietz site is one such example. Here, Clovis and Western Stemmed projectile points have been found on the surface and have been interpreted as indicators of a large game oriented economy. Large game hunting has also been suggested as the primary pursuit of the people who occupied the Far Butte site during the same period. Here, a number of Great Basin Stemmed points were recovered from the surface. The site's location, topography and artifact typology have led some researchers to postulate a focus on large mammals. Yet, this interpretation may be in need of some amendment in light of another interesting find in the Fort Rock Basin. At site 35LK2076 (radiocarbon dated to 8,870 and 8,780 BP), large Great Basin Stemmed and broad necked points were found in association with a large number of rabbit bones. A similar situation exists at the Buffalo Flat site (radiocarbon dated to 9120, 8950 and 8080 B.P.) where an extensive rabbit bone bed was discovered in association with a large stemmed point basal fragment and lithic debitage. Over 14,000 bones and fragments have been attributed to cottontail and jackrabbits. These interesting associations suggest that the points were likely used in the butchering of the animals, and not necessarily in the hunt.

Early Archaic

The Early Archaic in the Northern Great Basin (7000 – 5000 BP) roughly coincides with the warming and drying trend known as the Altithermal. During this period of less effective moisture, a sharp decrease in basin and marsh biotic productivity, with its concomitant decrease in lowland land use, is inferred from paleoenvironmental data and a dearth of archaeological evidence for human occupation.

At Connolly Caves during this period there is a sharp decline in occupation (Bedwell 1973). Local inhabitants were likely forced to increasingly look outside of the Fort Rock Basin as resources around Paulina Marsh gradually dried up. Elsewhere in the Basin, a general trend of greatly decreased use of lowlands is also apparent. A complete abandonment of the Northern Great Basin, as postulated by Bedwell (1973), seems unlikely in light of a few recently discovered sites dated to the Early Archaic (Aikens and Jenkins 1994). Fagan (1974) delivered the final blow to Bedwell's hypothesis with an accounting of a number of upland spring sites in the Northern Great Basin occupied during the Altithermal. Fagan pointed out that people gravitated towards well-watered upland spring sites during periods of aridity, while still occasionally using lowlands in the Basin for hunting, gathering and fishing (Fagan 1974).

Toward the end of the Early Archaic, there is evidence of a return to wetland conditions in the Fort Rock Basin. Aikens and Jenkins (1994) point to a "dark brown" soil which is prevalent throughout the Silver Lake area. Most interestingly, this soil has been identified in the Silver Lake overflow channel. This soil horizon has been interpreted as indicative of standing water for long periods sometime between 5700 and 5400 BP. Despite the apparent return to a moister climate near the end of the period, there is little evidence of human occupation of the area. It seems possible that the eruption of Mt. Mazama more than one thousand years earlier may have had some residual affects on biotic productivity in the area.

Middle Archaic

The Middle Archaic (5000 – 2000 BP) in the Fort Rock Basin was a time of plenty compared to the previous period. A Neopluvial interval beginning around 5000 BP marked the return of a moister climatic regime to the Northern Great Basin. With wetter conditions prevailing, we see increased use of lowlands in the Fort Rock Basin for the exploitation of marsh resources. Aikens and Jenkins (1994:13) suggest that the dietary focus was on lowland fish and seed resources, supplemented with roots, bulbs, waterfowl and terrestrial animals. Lowland sites with structures and storage pits become visible in the archaeological record and attest to the bountiful harvests and a growing population. These features suggest that people were becoming less mobile and staying at each settlement longer (Aikens and Jenkins 1994). A rise in frequency of radiocarbon dated assemblages and diagnostic projectile points has also been used as evidence of substantial population growth during this period. Upland resources, in particular root crops, continue to be exploited extensively and were probably processed and stored on-site to be retrieved in the winter. Common artifacts dated to this period include net weights, fish hooks, atlatl weights, awls, wedges, projectile points, ground stone and related stone working paraphernalia. Other artifacts point to a growing elaboration of artistic traditions of social significance. A stable subsistence economy and rising populations have been credited with the observed increase in personal ornamentation, processing and cooking utensils, as well as enigmatic artifacts during this period (Aikens and Jenkins 1994).

Sites characteristic of this period include the Big M site, DJ Ranch and the Bowling Dune site. The Big M site, radiocarbon dated to between 4,910 and 3,530 B.P., is located along the overflow channel that connects Silver Lake Valley to the Fort Rock and Christmas Valleys. Here, a rich artifact assemblage was found in association with three wikiup-like structures. Artifacts recovered include clay pipes, bone spoons, bone and shell beads, projectile points, knives, scrapers, pestles, grinding slabs and lithic debitage. Fishing at the site is attested to by net weights, bone gorges and tui chub bones (Aikens and Jenkins 1994).

The DJ Ranch site, located three miles downstream from the Big M, has produced a number of hearths and cache pits. Floral remains from the site include bulrush, spike grass and chenopods. Artifacts found at the site closely resemble those found at the Big M site. The Bowling Dune site, located just one mile downstream from DJ Ranch, produced evidence of substantial occupations in the form of house pits and large storage pits. Tui chub bones make clear the importance of marsh/stream-side resources at the site (Aikens and Jenkins 1994:9).

Beginning around 3000 BP and continuing until ~2000 BP, we see an increase in the use of upland resources, particularly roots. During this period, paleoenvironmental data suggest the climate was unpredictable and unstable. With populations still on the rise, people began to rely more and more on upland root crops for sustenance.

Late Archaic

The Late Archaic (2000 – 150 BP) in the Fort Rock Basin is characterized by a number of short/sharp fluctuations in climate that, along with a still growing population, produced changes in human settlement patterns in very short periods of time. Around 1500 BP there is an abrupt shift to upland residential occupations. The dietary focus had gradually come to emphasize root crops, while lowland seeds and fish likely supplemented this resource. It appears that hunting did not form a substantial segment of the diet. This pattern of settlement and subsistence may be seen in the remains of Boulder Village east of Silver Lake (Aikens and Jenkins 1994).

Located between 5000 and 5300 feet in elevation, Boulder Village produced evidence of 122 stone ringed houses and 48 storage pits. Fourteen C14 dates place occupation of the village between 1510 and 100 BP. One wikiup structure was dated between 1885 and 1863 AD. The floral assemblage from the site contained salt sage, goosefoot, suaeda, chenopods, juniper and yampa root. Non-utilitarian tools make up a very small portion of the artifact assemblage. It has been suggested that the site was definitely occupied during the spring and early summer and possibly through the winter (Aikens and Jenkins 1994). Occupational intensity likely varied with the climatic fluctuations of the following centuries.

Between 900 and 100 BP there appears to be considerable fluctuation in the use of uplands in the Fort Rock Basin. The years spanning 900 to 600 BP show a decrease in the use of upland villages. Over the next 100 years upland residential structures increase dramatically. During this period, small mammals gain importance in the diet and were likely supplemented with fish transported from the lowlands. Between 500 and 200 BP upland village occupations are on the decline once again. This trend is reversed after 200 BP with upland villages increasing once more (Aikens and Jenkins 1994). It remains to be seen whether these perceived short-term trends are real, or if they are a product of depositional and investigative bias. More work is needed to answer this question.

Middle and Upper Deschutes River Basin

Archaeological investigations along the middle and upper Deschutes and John Day River systems have suffered from research bias. The region has been partially dismissed by some as a "hinterland" (Ames et al. 1998), as if to suggest that it was a cultural backwater that was left unexploited. Perhaps the region's lack of a well-defined cultural sequence is due more to the fact that it has been studied disproportionately compared to the Columbia Plateau proper or Great Basin, rather than an absence of human activity in the area. After reviewing the archaeology of the middle and upper Deschutes River system, inferred settlement and subsistence patterns is compared to those of the Southern Columbia Plateau and the Northern Great Basin. Since a well-defined cultural sequence for this area is still in an embryonic state, the sites in this region are organized according to when the initial occupation occurs relative to the very general sequence of Initial, Early, Middle and Late Archaic. This division is somewhat arbitrary, either glossing over or, possibly, over-emphasizing distinctions in cultural adaptations.

Initial Archaic

Paulina Lake, located within Newberry Crater, provides the earliest evidence for a major occupation in the area. Situated some 20 km upstream from the confluence of Paulina Creek and the Deschutes River, the site's initial occupation has been dated +11,000 – 8,500 BP. Diagnostic artifacts such as Windust and Cascade series projectile points have been found in association with an ephemeral structure. A relatively large number of cobble and ground stone tools were also recovered, suggesting that the occupants were pursuing a fairly broad subsistence base (Ames et al. 1998).

The Three Sheep Rockshelter, located near the confluence of Crooked Creek and the Deschutes River, has produced evidence of human occupation dated to 9,047 BP. Projectile points recovered from the site have been compared to others found on the Columbia Plateau and suggest an early date in agreement with the radiocarbon date. The assemblage recovered from the site is suggestive of hunting related activities. All cultural materials were recovered from a stratum underlying a lens of tephra, probably related to the eruption of Mt. Mazama ca. 6,845 BP (Ames et al. 1998).

Early Archaic

Located approximately 30 km north of site 35JE41, near the confluence of Trout and Hay Creeks, the Johnson site provides good evidence for an early pithouse village occupation. The site was apparently occupied with some intensity starting around 8,000 BP, peaking around 6,800 to 5,800 BP as indicated by several stratified living surfaces. Although the faunal assemblage from an excavated house pit remains largely unanalyzed, the occupants appear to have enjoyed a diverse diet as evidenced by the presence of fish bones, knapweed, acorns and grass seed. Corner notched and "foliate points" corroborate the dates ascertained radiometrically. The investigators interpret the site as a winter camp. There appears to be a substantial occupational hiatus between 5,800 and 3,300 BP, although obsidian hydration dates suggest it may have been visited intermittently during this period (Jenkins and Connolly 1996). I found the suggestion of a 2,500 year hiatus quite confusing in light of some comments Pettigrew has made regarding the site. Referring to a Mid Archaic land-use intensification in Central Oregon, Pettigrew states: "The [Johnson site's] location at Willowdale matches the settlement evidence there for an early peak in land use intensity between the Mazama ash fall and about 4,000 BP" (Pettigrew 1996:19). Pettigrew suggests a reduction in land use intensity, if not a hiatus, between 4,500 and 3,900 BP.

The Odell Lake (Cressman 1948) and Wikiup Dam (Cressman 1937) sites, located in Upper Deschutes southwest of the town of Bend, were recorded by Luther Cressman prior to the advent of radiometric dating methods. At both sites, leaf shaped, shouldered and corner-notched points were found under a layer of Mazama ash, indicating the sites are at least 6,900 years old. The Wickiup Dam site also produced a cache of large bifaces (Cressman 1937). These sites suggest that the ethnographic pattern of upland lakeside adaptations practiced by the Molala and Klamath was firmly established by the Mid Holocene (Aikens 1993).

The Heath Cliffs site, located on the Warm Springs Indian Reservation, provides evidence for a fairly sedentary village occupation beginning around 6,650 BP (Jenkins and Connolly 1996). Some obsidian hydration age determinations suggest a much earlier initial occupation, dated to 10,000 BP, but are not supported by any other evidence. Investigation of one of the houses revealed that the living floor had been excavated to a shallow depth, indicating that it may have been occupied for several months at a time. The site was most intensely occupied from about 5,500 BP until approximately 2,250 BP (Jenkins and Connolly 1996:146). The three main periods of occupation identified at the site are the Canyon Phase (7,500 – 5,500 BP), Warm Springs I (5,500 – 3,700 BP) and Warm Springs II (3,700 – 2,250).

The site's occupants appear to have used the surrounding area for intense hunting of large game early on. A substantial faunal assemblage is dominated by artiodactyle bones in the earliest component. The intense processing of vegetal foods is also evident early in the site's history as indicated by the high proportion of milling stones used to process the area's abundant seeds, roots and berries. Macro- and micro-botanical remains suggest that the site was used in the early spring until the fall during the Canyon and Warm Springs I phases. The presence of freshwater mussel shells, most easily harvested at times of low water, also points to a summer and fall occupation during these early periods (Jenkins and Connolly 1996).

A significant shift in land use around the site is interpreted to have occurred during the Warm Springs II phase. The lithic and faunal assemblages from this period suggest that hunting is still an important activity. While in the earlier components groundstone makes up a relatively large portion of the tool assemblage, during the Warmsprings II phase it all but disappears, suggesting that the site's function has changed to that of an ephemeral hunting camp (Jenkins and Connolly 1996:148).

Human occupation of the Lava Butte site, near the town of Bend, is attested to by the presence of many flaked stone tools and ground stone (Davis and Scott 1993). The site, interpreted as a repeatedly occupied hunting camp, was apparently used after the eruption of Lava Butte sometime around 6,200 BP. The processing of vegetal foods is indicated by the presence of several hopper mortar bases and pestles. Diagnostic artifacts include Elko, Rosegate and Desert Side-Notched points, indicating the site was occupied intermittently until late prehistoric times (Ames et al. 1998).

Middle Archaic

The Peninsula 1 rock shelter near Bend attests to the presence of human activity dating back to 4,550 BP. Excavated by amateur archaeologists in 1961, the site's assemblage was later analyzed by Stuemke (1989; Jenkins and Connolly 1996). Four stratigraphic units were defined, and three of them were dated to 4,550, 3,200 and 520 BP. Elko and corner-notched projectile points dominate the tool assemblages in three of the earliest components. Narrow-necked points dominate the latest component thought to represent the last 3,000 years. Stuemke (1989) noted the presence of both Great Basin and Plateau influences in the lithic assemblages and interpreted the evidence as indicating cultural continuity of the occupants until 3,000 BP. After that time, Stuemke perceives more affinities with the Columbia Plateau than the Great Basin (1989).

Stuemke (1989) refutes the hypothesis developed by Ross which attempted to account for the presence high proportions of obsidian on one side of the Deschutes River and cryptocrystal silicates (CCS) on the other. Ross had theorized that the river represented a boundary between Great Basin and Plateau groups. Stuemke came to a much different conclusion. He argued that different lithic materials would have been used by the same people to make different *types* of tools. He noted that projectile points and bifaces in the area tended to be made of obsidian, while drills, cores, scrapers and choppers were commonly made of CCS. Thus, he interpreted the different materials on either side of the river as a reflection of different tasks carried out, not of cultural affiliation (Jenkins and Connolly 1996).

Late Archaic

Lava Island Rockshelter, located near Bend, was the site of a substantial cache of lanceolate shaped bifaces made from local Newberry Crater obsidian. Projectile points recovered from the site included small, notched dart and arrow points (Minor and Toepel 1984, 1989). The presence of a large amounts of lithic debitage points to the site's use as a flaking station used to reduce locally quarried obsidian. Subsistence activities at the site appear to be focused on a general strategy of hunting, fishing and gathering. Radiocarbon age determinations point to an initial occupation around 2,150 BP, which continued intermittently until the historic period. Estimating the site's antiquity has generated some controversy. It has been argued on typological grounds that the lithic assemblages are much older, possibly dating to 10,000 BP (Minor and Toepel 1984). Others (Scott, Davis and Flenniken 1986) have countered that what has been interpreted by some as large Early Archaic tools are nothing more than large blanks and preforms.

The Paquet Gulch site, located along the Middle Deschutes River, is an upland village occupation with evidence of 75 –100 housepits with associated storage features (Jenkins and Connolly 1996). It is located near a large root gathering area used ethnographically by the Molala. Initially occupied sometime around 1,350 BP, the village is thought be a winter settlement in years of good root and/or acorn harvests. Macrobotanical remains indicate the processing of acorns, biscuit root, elderberries, grass seed and buckwheat at the site. Salmon, fresh water mussel and large mammals make up the bulk of the faunal assemblage (Jenkins and Connolly 1996).

The preceding discussion described the archaeological complexes documented in central and north-central Oregon. Each period is distinguished by its particular technological and land use patterns. Next, the study sites are introduced with a focus on each site's constituents and environmental context.

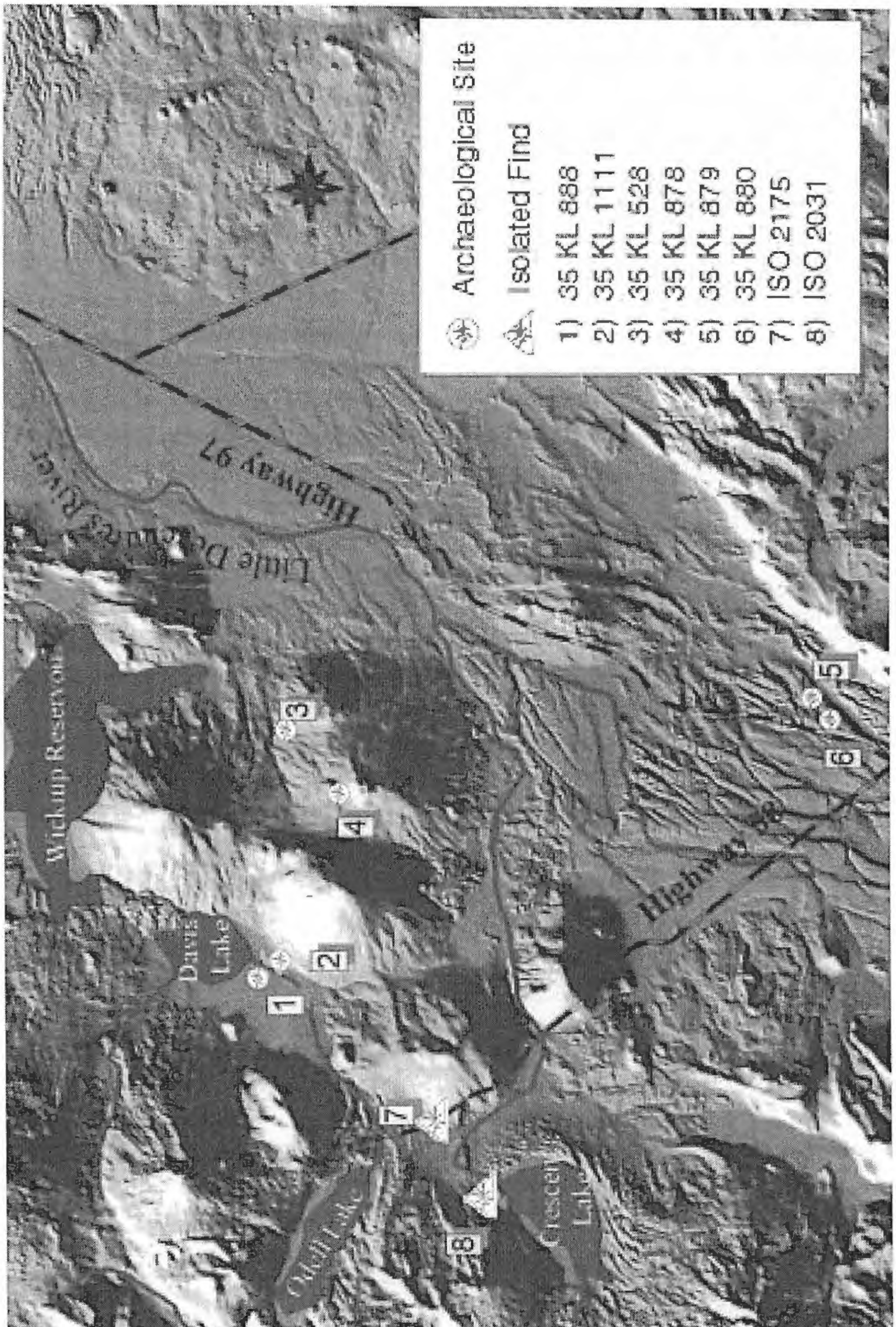


Figure 3.2 Archaeological sites in the study area.

The Study Sites

The following discussion presents a brief description of each site and its artifacts and features as taken from site records, monitoring forms, evaluations, and field notes maintained at the Crescent Ranger District of the Deschutes National Forest. The sites are located within the Upper Deschutes River Basin at elevations ranging from 4,396 to 5,350 ft. Figure 3.2 shows the location of each site in relation to major landscape features.

35-KL-528 (Shibikashe)

35KL528 is an open-air lithic scatter on the northern flank of Cryder Butte. Figure 3.3 is a sketch map of the site. It was originally reported in 1984 and was subsequently monitored in 1993 and 1996 (Steece 1984; Hickerson 1997a). Situated at an elevation of 4,780 feet and covering approximately 35 acres, the site is composed of several concentrations of lithic debitage. The site is associated with two springs (one of which measured ~2 meters in diameter) that held standing water when visited in 1984. Other nearby water bodies include Davis Lake 1.7 miles due east, Wickiup Reservoir (formerly a channel of the Deschutes River) 3.5 miles to the north and the Little Deschutes River 5.5 miles due east. The surface of the site slopes to the north at a 5 – 15 percent gradient. The local overstory vegetation includes white fir, douglas fir, ponderosa pine and lodgepole pine. The understory includes manzanita, bitterbrush and currant. Various grasses, forbes and perennials make up the ground cover.

Thirty-one formed tools (including scrapers and utilized flakes) have been documented at the site, although only fifteen have been collected. Artifacts analyzed for this study include nine complete and fragmentary projectile points, a large biface fragment, a drill, and a utilized flake. Two other artifacts (obsidian scrapers) had been transferred to an educational display and were not available for examination. The remaining sixteen artifacts reported from the site, but not collected, were stolen from the site in 1993. Preliminary documentation indicated that the artifacts consisted of several projectile points (1 stemmed, 1 Elko, and 4 “others”), a large obsidian crescent, one complete biface, two fragments, one base, and one drill.

Sketch maps from 1984 and 1993 indicate the presence of at least four surface concentrations of stone tools and debitage. Several other artifacts were found scattered throughout the site. One concentration of burnt bone was documented and collected from the southeast portion of the site in 1984, but is too fragmentary to allow for identification. Although the artifacts were documented on the surface, many are thought to have been exposed from sub-surface deposits. Most were found in disturbed contexts (e.g. skid trails). This site has been heavily impacted by logging activity, recreational use, and looting.

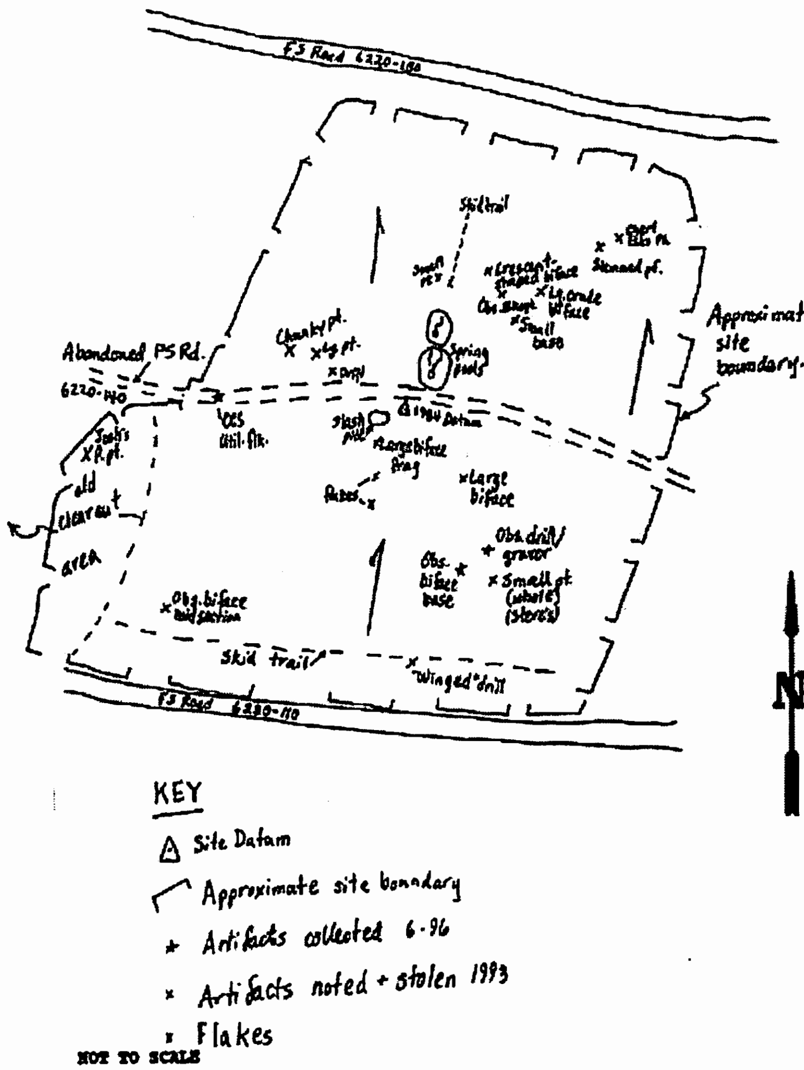


Figure 3.3. Site sketch map from 35KL528 (from Hickerson 1997).

35-KL-878 (Little Butte)

35KL878 is an open-air lithic scatter located on the northern flank of Ringo Butte, adjacent to a smaller, unnamed butte. Figure 3.4 is a sketch map of the site. This site was first documented in 1986 and again in 1993 (Mayer 1989; Hickerson 1993). It lies at an elevation of 5,360 feet and covers approximately 251 square meters. The site is situated upon a slope with a 3 percent gradient, facing northwest. Over- and understory vegetation within the site includes ponderosa and lodgepole pine. Ground cover is composed of bitterbrush and manzanita. Local water sources include an unnamed spring that lies two miles to the east, Davis Lake4.6 miles to the

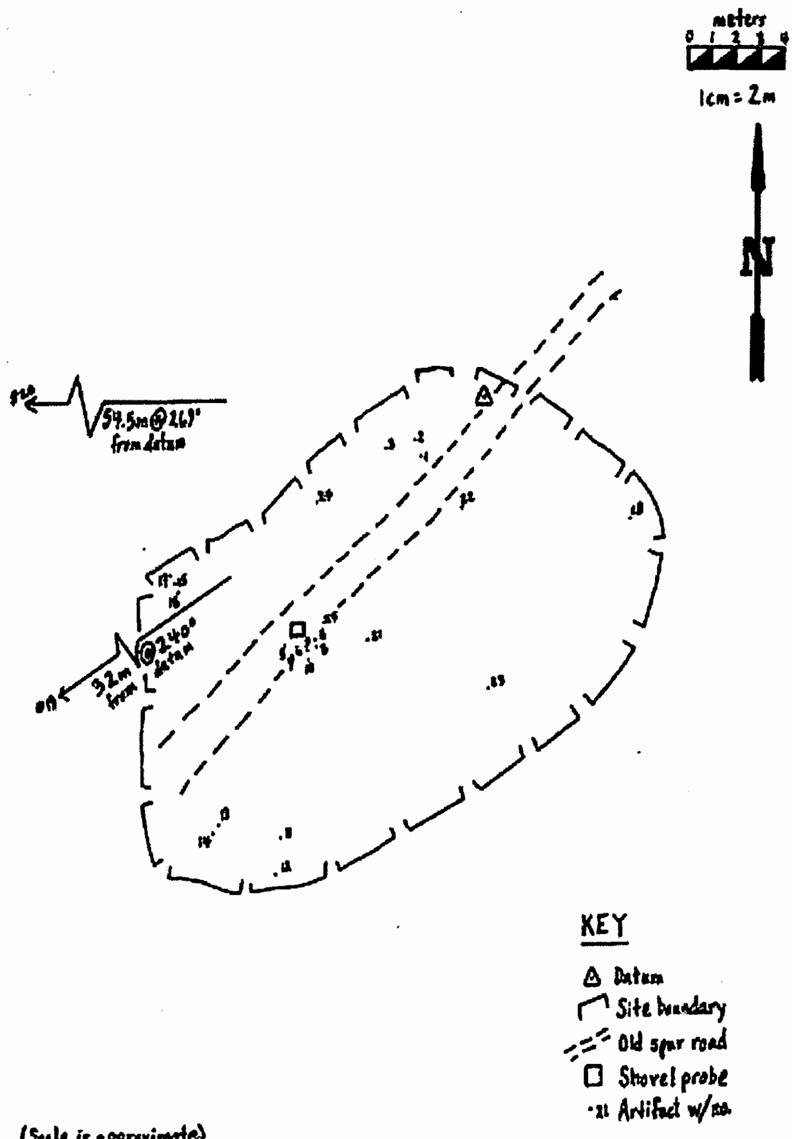


Figure 3.4. Sketch map of site 35KL878 (from Hickerson 1993).

northwest, and Crescent creek four miles to the south. Three intermittent drainages are located within one mile to the north, south, and east.

Ten formed artifacts, collected in 1989 (Mayer 1989), make up the assemblage studied here. Several pieces of lithic debitage were reported in 1989 but were not collected. During a 1993 visit, an additional fourteen bifaces and fragments (6 complete, 5 proximal and 3 distal) were noted, along with 11 flakes. All artifacts are made of obsidian. A single shovel probe (50 square centimeters) was excavated to a depth of 30 cm, in arbitrary 10cm levels, during the 1993 visit. This yielded two biface fragments and two obsidian flakes in level 1, and one biface and one obsidian flake in level 2. Level 3 was sterile. All cultural material was left in the ground.

Mayer (1989) suggests that the site contained a cache of stone tools unearthed through timber harvesting and erosion. Hickerson (1993) agrees and goes on to estimate that the bifaces were originally deposited 30 – 50 cm below the modern surface, as suggested by the depth of the road cut and positive shovel probe.

This site has been negatively impacted by timber harvesting activities and erosion, although is appears to have stabilized.

35-KL-879 (Jim Bob)

The Jim-Bob site is an open-air lithic scatter that covers approximately 14,400m². The site is situated on two sides of an unnamed, ephemeral stream, at an elevation of 4,520 feet. Figure 3.5 is a sketch map of site 35KL879. The site is located in a small valley . Approximately one half-mile to the southwest lies an unnamed spring, and the Little Deschutes River is located five miles to the west. On-site vegetation includes a lodgepole and ponderosa pine forest, with an understory of greenleaf manzanita, dwarf monkeyflower, beargrass, Idaho fescue, antelope bitterbrush, and squaw currant. The site was first documented in 1989 (Halloran 1989), and subsequently monitored in 1997 (Hale and Furlong 1997a). 35KL879 has suffered significant impacts due primarily to timber harvests and road building.

After the initial description of the site in 1989, the site's boundaries were more accurately defined in 1997 (Hale and Furlong 1997) by excavating two shovel probes. Both were taken to a depth of 20cm, and neither contained any cultural material. The surface lithic scatter observed in 1997 was described as "light," and was confined to two loci. By comparing the two site records (1989 and 1997), it is apparent that during the later visit the archaeologists were able to relocate only a
portion of the surface materials reported in 1989. Most likely, this is a result of decreased ground visibility caused by eight years of vegetative growth in the timber harvest unit.

While lithic debitage appears to be dispersed over the site, four large bifaces, one large flake blank, and two pieces of fire-cracked rock were discovered eroding out of the road bed, on the north side of Forest Service road 9760-290, which lies on the northern flank of the site. Given the fact that these artifacts were all located within three meters of one another, they exhibit no use-wear, and they were eroding out of a subsurface deposit, it is likely that they were once cached for later use. With the exception of the fire-cracked rock, all of the above artifacts were collected. Additionally, one projectile point, one scraper, and three large flakes exhibiting use-wear were collected. All of the artifacts collected were made available for this study.

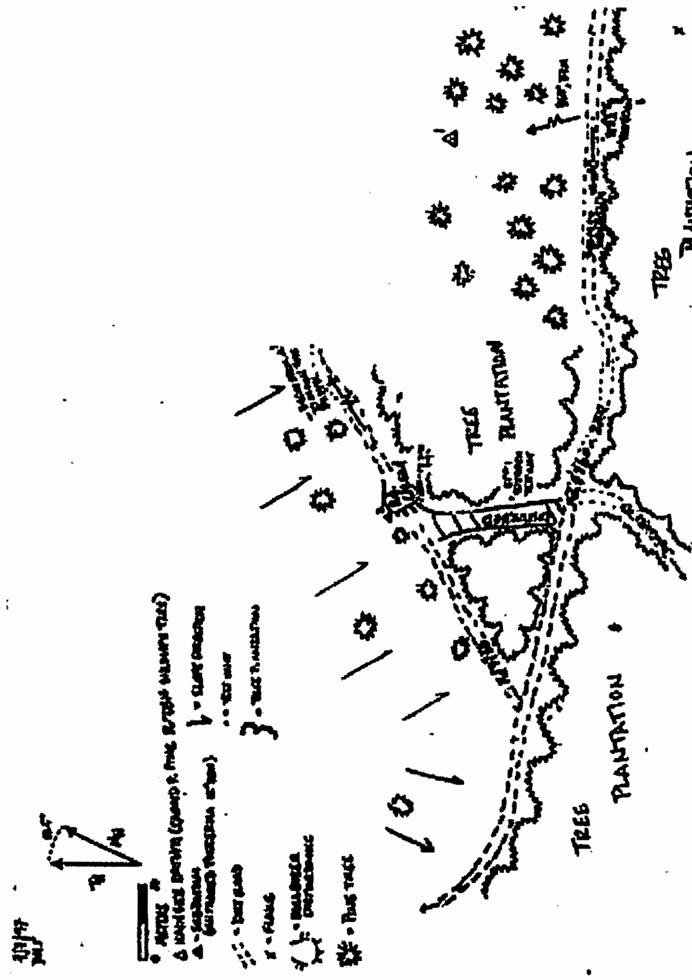


Figure 3.5 Sketch map of site 35KL879 (from Hale & Furlong 1997).

35-KL-880 (June Bug)

35KL880 is an open-air lithic scatter at the base of a small valley floor, surrounded by low ridges. It is situated at the margin of an unnamed spring feeding a small meadow at an elevation of 4,580 ft. The site is located along the same unnamed intermittent stream as 35KL879. A sketch map of the site is provided in Figure 3.6. The deposit lies within a young plantation of ponderosa pines, having been logged
and burned in the recent past. Other vegetation observed on-site includes antelope bitterbrush, western yarrow, Idaho fescue, wooly mullein, western buttercup, woolly groundsel, and squaw currant. The site was initially recorded in 1989 (Tillman 1989) and subsequently updated in

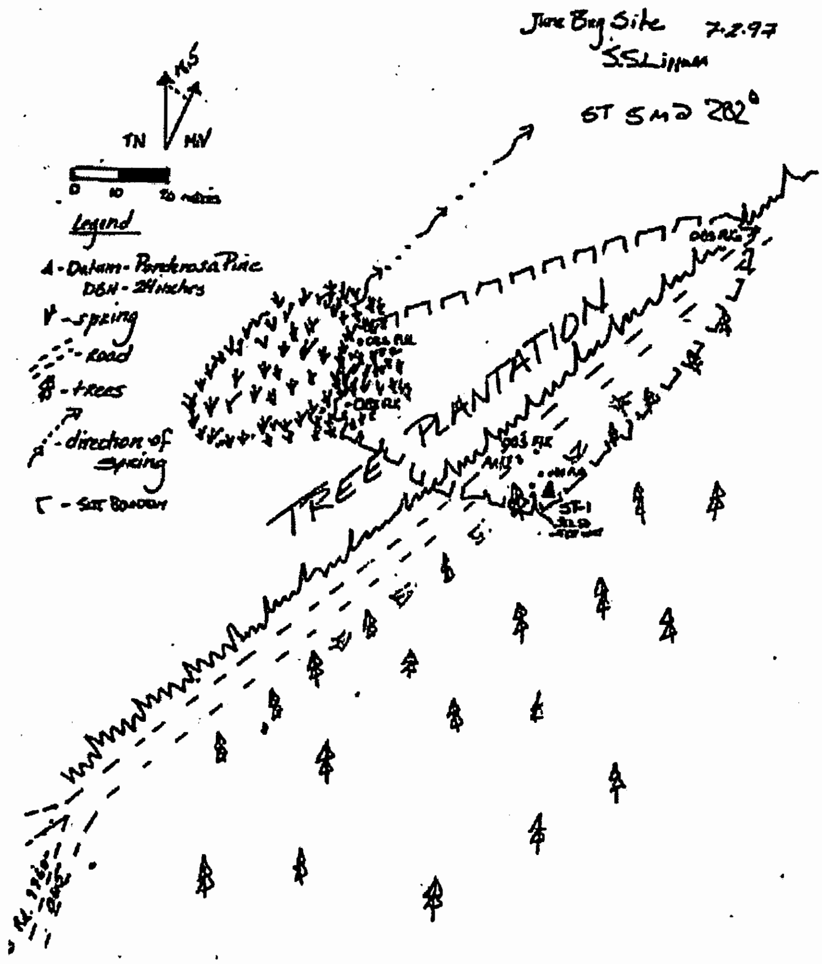


Figure 3.6 Sketch map of site 35KL880 (from Hale & Furlong).

1997 (Hale and Furlong 1997b). During the 1989 recording, upwards of 15 pieces of lithic debitage were observed on the surface, along with two biface fragments and one large, complete biface. All but the debitage was collected. During the 1997 visit, two additional artifacts were collected. One biface midsection was collected from the surface and one shovel probe (excavated to a depth of 20cm) produced one piece of a fragmentary groundstone implement. Artifacts that were available for this study include a core tool, a complete biface and two fragmentary bifaces that were collected in 1989.

<u>35-KL-888 (West Davis Lake Campground)</u>

The West Davis Campground site is a large, open-air lithic scatter located on the west-side of Odell Creek, adjacent to Davis Lake (to the northeast). 35KL888 sits directly across Odell Creek from 35KL1111 on a gently sloping margin of the watercourse. Figure 3.7 is a sketch map of the site. The environmental setting is much the same as that which was described for 35KL1111. Like its neighbor, 35KL888 is located within a modern, developed campground. Surface

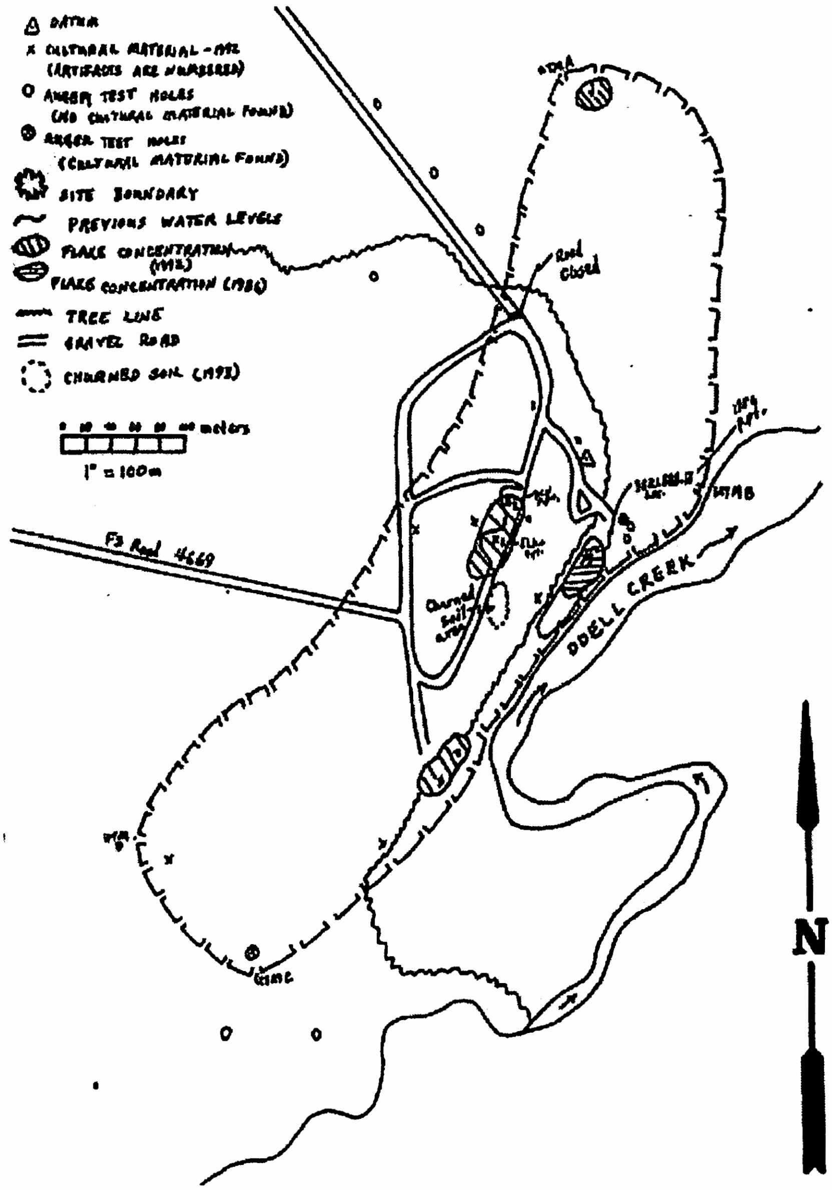


Figure 3.7 Sketch map of site 35KL888 (from Hickerson 1997b).

collections were made in 1982 and 1987 (Gallagher and Gallagher 1986). Subsurface collections were made in 1993 (Ball 1993a; Hickerson 1997b; Jenkins and Churchill 1993a).

Four concentrations of flaked stone tools and debitage have been identified at the site. The southernmost concentration, located adjacent to the creek, exhibited five pieces of debitage on the surface. At another concentration located near the boat ramp at Odell Creek, eight pieces of debitage were noted. The third concentration is located within two modern campsites in the middle of the site and contains eight pieces of debitage on the surface. The northernmost concentration, which is located along the grassy southern shore of Davis Lake, produced four pieces of debitage. Eleven auger test holes were dug in 1993. One probe near the boat ramp yielded one obsidian flake at 42cm. An additional probe dug in the southern portion of the site produced five flakes at 50cm. The remaining nine probes did not yield any artifacts. The artifacts made available for study from 35KL888 include three bifaces, two projectile points, two scrapers, one flake core (with evidence of use-wear, suggesting cutting or scraping), one utilized flake, one graver (rejuvenated projectile point), and one drill or punch.

35-KL-1111 (East Davis Lake Campground)

35KL1111 is a very large, open-air site that covers approximately 502,400m². The site is situated within a modern developed campground on the east-side of Odell Creek, where it meets the southern margin of Davis Lake. A sketch map of the site is provided in Figure 3.8. At 4,394 feet in elevation, the area is cloaked in a lodgepole pine forest, with an understory of bitterbrush, currant, willow, as well as various grasses and forbes. The landform upon which the site is located has a 0 – 3 percent slope with a northern aspect. The East Davis site is located directly across Odell Creek from 35-KL-888. Given their proximity and the apparent differences in tool assemblages, it is very likely that the two locations actually represent different activity or task areas used simultaneously during past occupations. The site was first documented in 1982, with subsequent investigations and collections in 1990, 1992, 1993, and 1995 (Ball 1993b; Hickerson 1997c; Jenkins and Churchill 1993b; Snyder 1982).

The East Davis Lake site is characterized by the presence of a large lithic scatter with five concentrations, two ground stone artifacts, and 29 closely-spaced, circular depressions which appear to be pit houses (Figure 3.9). The extent and size of the lithic concentrations vary, and surface distributions tend to increase, moving south to north. This could be a result of preservation bias. The southern portion of the site has been highly disturbed by the developed campground, whereas the northern loci have been less affected (Hickerson 1997c). The existence of the circular depressions is suggestive of a former pit house village, although none of the suspected features has been tested. The depressions sit atop a slight rise on the eastern creek margin, and occupy an area measuring approximately 70 x 40m². Depressions range in circumference from 2.3 – 7.5m, and average about 3m (Ball 1993b). Depths range from 10 – 27cm. The location of the depressions roughly coincides with the distribution of one of the northern lithic scatters.

Several pieces of debitage were noted in 1993 atop nearby rodent burrow mounds, and within the depressions themselves. A "blade core" was found within depression 27. During the 1992 field season, fifteen auger probes were dug to a depth of 50cm in the southern half of the site to help delineate its boundaries (Figure 3.8). Eight of the probes were positive and produced a total of 11 pieces of lithic debitage. In the summers of 1994 and 1995, four shovel probes (50 x 50cm²) were excavated. The single probe from 1994 was taken to a depth of 30cm and produced one piece of lithic debitage (obsidian). Three shovel probes excavated in 1995 were all positive. Probe A, dug to a depth of 60cm, produced 54 pieces of lithic debitage (53 obsidian, 1ccs), and an obsidian scraper. Probe B was taken to a depth of 90cm and revealed 21 pieces of lithic debitage (19 obsidian, 2 CCS) and one projectile point. No stratigraphic control was used on any of the subsurface probing. The most common type of artifact recorded at the site is debitage, followed by projectile points. Other artifacts observed (although not all collected) include bifaces, a scraper, a mortar fragment, and a mano. The artifact assemblage now curated by the Deschutes National Forest, and made available for study consists of 15 projectile points, 6 biface fragments, 12 pieces of lithic debitage, and one mano.

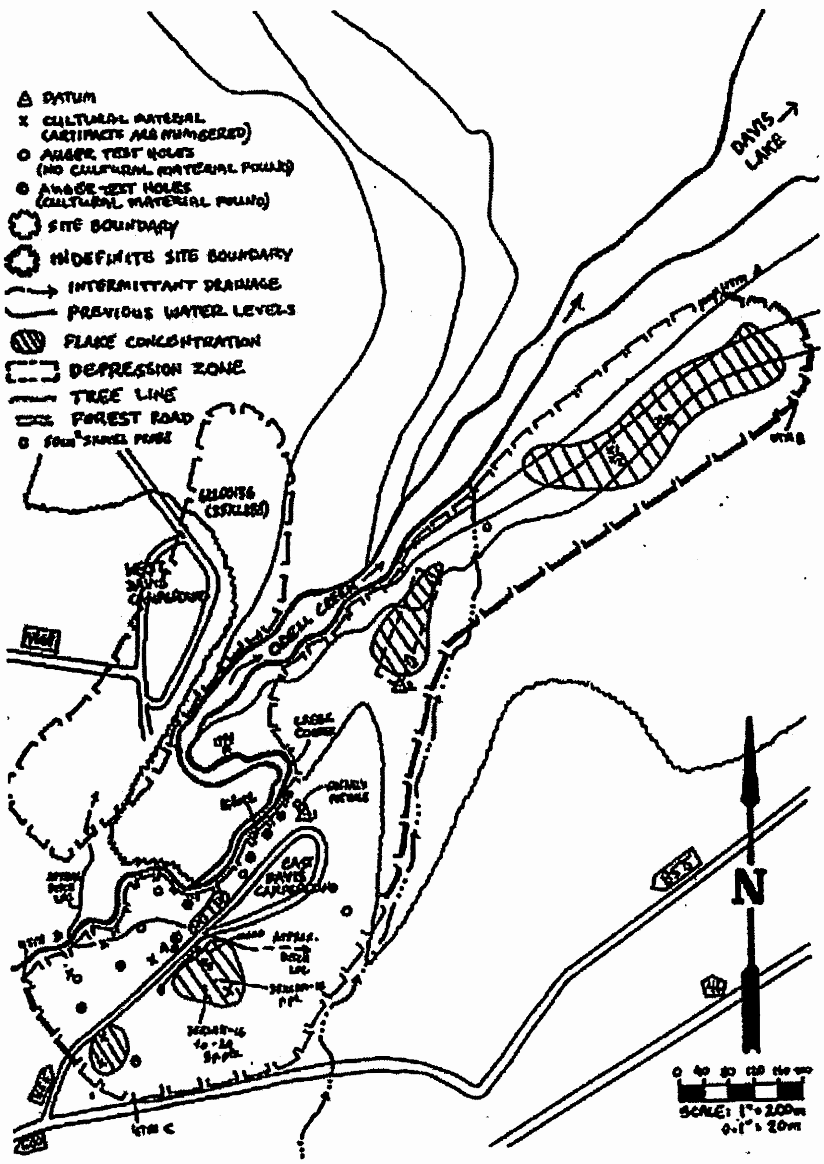


Figure 3.8 Sketch map of site 35KL1111 (from Hickerson 1997c).

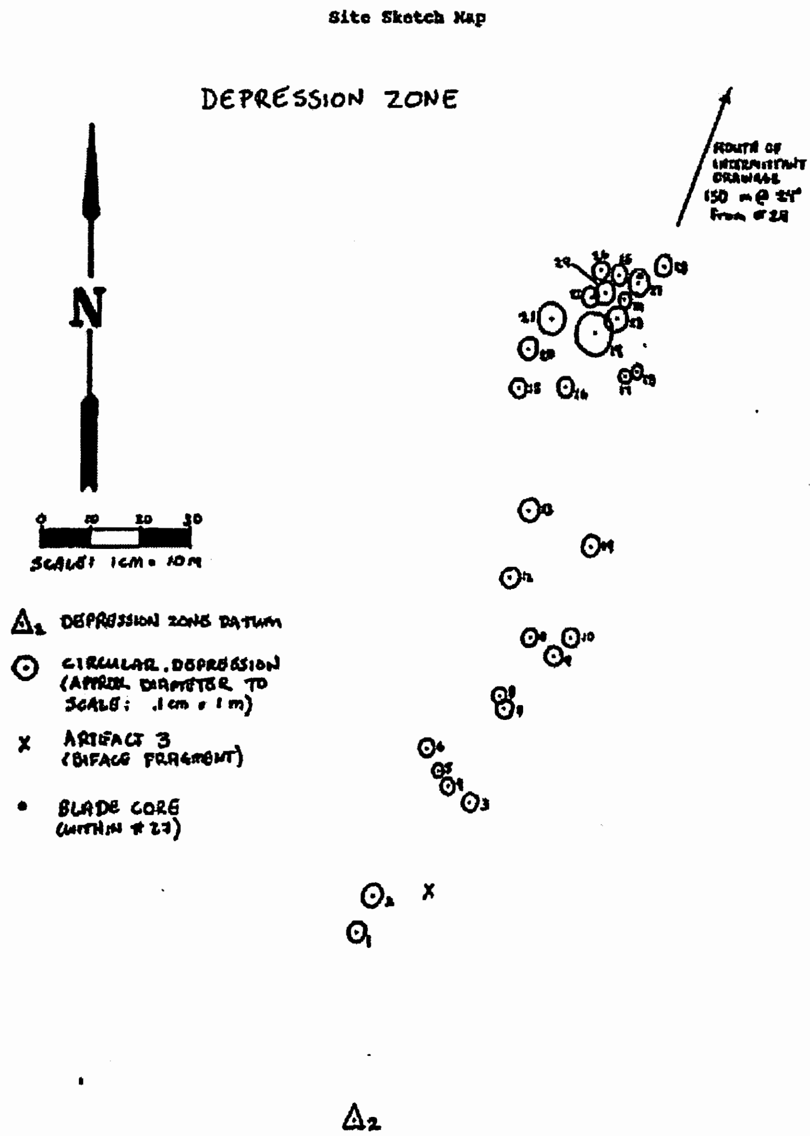


Figure 3.9 Possible housepit features at site 35KL1111 (from Ball 1993).

Isolates

ISO-2031

Site ISO2031 is characterized by the presence of an obsidian projectile point and large utilized flake. The artifacts were found on a 30 percent slope at 4,960 feet. It lies less than one-quarter mile north of Crescent Lake. The surrounding over-story is composed of white fir, mountain hemlock, red fir, ponderosa pine, lodgepole pine, douglas fir, and Shasta fir. The local under-story includes snow brush, chinquapin, sedges, and needle grass (Steece n.d.). ISO2031 is one of many sites documented around Crescent Lake, the closest being one-third of a mile to the east.

At least eighteen other sites lie within one and a half miles of the lake's shore. The environmental context of this isolated find suggests that the artifact was lost in transit or pursuit.

ISO-2175

Isolate ISO2175 consists of three artifacts found in two loci 130 m apart. Two large obsidian biface fragments were found in loci 1, 3.5m apart. Loci 2 produced a single obsidian projectile point. The site sits on the western flank of Royce mountain on a gently sloping rise above a small tributary to Crescent Creek (Hickerson 1999). ISO2175 was first recorded in 1999 and has not been subject to subsurface probes or testing. All of the artifacts were found in a primitive dirt road, suggesting that they were buried below the surface at some point. Nearby lakes include Odell, approximately 1.75 miles to the northwest, and Crescent 2.5 miles to the southwest. On-site vegetation is dominated by lodgepole pine.

CHAPTER 4: HUNTER-GATHERER LAND USE & LITHIC TECHNOLOGY

HUNTER-GATHERER RESEARCH

During the first half of the 20th century, materialist approaches to hunter-gatherer societies, past and present, dominated the literature (Kroeber 1922; Jennings 1957; Steward 1938). Historically, materialist frameworks were closely tied to the concept of cultural evolution in which hunting and gathering subsistence strategies were seen as a "stage" (Bettinger 1991:47). Interpretations derived from such frameworks reinforced the widely held assumption that hunter-gatherer groups were continually teetering on the brink of survival. This legacy can be seen in Steward's (1938) seminal work in the Great Basin. The notion of scarcity, and responses to it, is a central theme running through his monographs.

Intellectual vestiges of Jefferson and Morgan still permeated the archaeological literature until researchers began to actually test such hypotheses. Prior to the mid 20th century, the notion of the hunter-gatherer society as primitive was accepted at face value. Referring to this period, Bettinger (1991:47) has remarked, "most characterizations of hunter-gatherers derived less from ethnographic or archaeological observation than from preconceptions- more charitably hypotheses; their basis was in evolutionary or materialist theory rather than fieldwork."

A significant paradigm shift occurred in the 1960's and 1970's with the publication of new ethnographic and experimental research among modern hunter-gatherers (Binford 1978; Yellen 1977; Lee and DeVore 1968). Lee and DeVore's work among the !Kung San challenged the assumption that hunter-gatherers were in a state of constant struggle. They introduced the idea that a foraging adaptation required less effort and afforded more leisure than any form of agriculture.

Lee and DeVore's work was important because it generated a great deal of debate regarding mobility, foraging strategies, and interpretation of archaeological assemblages. Their efforts inspired many actualistic studies that sought to link hunter-gatherer theory with empirical observations made in the field. Actualistic studies have proven their usefulness over the past three decades. Ethnoarchaeology and experimental archaeology, in particular, have shed light on the behavioral correlates of material remains. Knowledge gained from such approaches form the contemporary basis for the study of prehistoric hunter-gatherer subsistence and technological organization.

THE FORAGER / COLLECTOR MODEL

The Forager / Collector (F/C) model is a useful framework for approaching the way in which hunter-gatherers exploit resources in the context of their particular environment (Binford 1977). The F/C model proposes a relationship between environmental productivity, seasonality and the organization of settlement / subsistence systems. At the most basic level, Binford distinguishes between foragers and collectors by contrasting the "variability in quantity and seasonal distribution of resources at their disposal" (Bettinger 1991:65). It is postulated that local environments where resources are plentiful, evenly distributed (though time and space), and not subject to seasonal shortages will encourage the adoption of subsistence strategies that are "extremely simple and highly redundant across time and space" (Bettinger 1991:65). Conversely, local environments that require more complexity in settlement and subsistence patterns tend to be more marginal in terms of resource productivity, do not have homogeneous distributions through time and space, and present seasonal scarcity of economically important plants and animals. While the F/C model presents two polar options in exploiting resources, such extremes are rare. More often than not, hunter-gatherer societies fall somewhere between these two extremes. Thus, the F/C model is best understood as a continuum (Bettinger 1991).

In theory, people will tend to use a foraging strategy in regions with abundant resources evenly distributed through the seasons (Lee 1981; Gould 1969). True foragers practice an annual round that lacks distinct seasonal phases. The annual round in such circumstances is best understood as a series of similar cycles (Bettinger 1991). Departing from a *residential base camp*, people move out on a daily basis to exploit resources within a two hour walk. Resources are taken from what Binford terms a *site exploitation area (SEA).* In this strategy, people are said to "map" onto local resources (Binford 1983). When resources within the SEA are exhausted (or at least reach a level of diminishing returns), the base camp is moved to a new locale. Base camps and SEA's tend to contain virtually the same resources, yet differ in terms of size, the number of individuals present, and the length of stay (Bettinger 1991:67).

The Collector strategy is pursued in regions where uneven distributions of resources occur through time and space. Storage is essential within this form of organization. As Collectors are faced with seasonal shortages, they must harvest and preserve resources in quantities that exceed their immediate need. The Collector system is considered a more complex settlement / subsistence adaptation (Bettinger 1991:68) because it requires advanced planning and organization at the group level.

Despite its obvious advantages, resource caching has some important disadvantages as well. One disadvantage is that storage anchors a group to an area and prevents them from exploiting resources that are becoming available elsewhere. While solving a temporal incongruity between people and resources, storage causes a spatial one. That is, it makes it more difficult to shift settlements to exploit the changing distributions of plants and animals.

Collector strategies are thought to require more technological sophistication than Forager strategies. Collectors will use a broad array of gear that is highly specialized in function and more difficult to make (Bettinger 1991:69). Procurement activities are organized around the task group that moves out from a base to logistical sites to hunt and gather. Seasonal shortages (temporal incongruities) are dealt with by caching food, while spatial incongruincies are dealt with by the logistical movement of task groups and by "more exhaustive exploitation of resources" (Bettinger 1991:70). Caching food and other supplies enables collectors to set aside provisions for later use when resource acquisition is uncertain.

In order to operationalize the forager-collector model, Binford proposes five site types that reflect the continuum from forager to collector. At one extreme, it is anticipated that foragers will make use of residential bases and locations . A *base* is a location that is inhabited for the majority of the seasons, from which task groups are deployed to gather essential resources from nearby *locations*. At the other extreme, it is suggested that collectors will make use of field camps, stations, and caches. A *field camp* serves as a temporary residence from which necessary resources can be gathered at short distances. A *station* is the location used for acquisition of such resources, while a *cache* is a location where resources are stored in anticipation of future use. Binford suggests that each site type contains a unique distribution of artifact types, thus allowing for discrimination. A collector system may be indicated by greater variability within sites because a range of activities would have been carried out there. Additionally, more variability may exist between different kinds in a collector system (Bettinger 1991:70). Researchers such as Kelly (1983, 1985) and Shackley (1988, 1990) have elaborated on this idea and have developed archaeological expectations for assemblages based on the forager-collector continuum, which are discussed below.

LANDUSE & MOBILITY IN THE GREAT BASIN

As the concept was first applied, mobility simply referred to the frequency and distance traveled by a group of individuals in their economic pursuits. By perusing the literature, it becomes abundantly clear that archaeologists have had difficulty identifying and quantifying the different scales and forms of mobility. More recent studies suggest that mobility is "universal, variable, and multidimensional" (Kelly 1992:43). Mobility is variable because it occurs on different scales within and between groups. For example, a group that occupies the same parcel of land year-round (and thus would be considered to have low residential mobility) will send out task groups to acquire resources at various distances. Contrast this strategy with one in which the entire group moves as resource distributions and weather change through the seasons. Mobility is multi-dimensional because different members of any given group will practice differing levels of mobility depending on the season and the tasks they are charged with carrying out.

The settlement / subsistence patterns proposed by Steward (1938) and, later, Jennings (1957) focused primarily on "fission-fusion" strategies used by natives of the central and eastern Great Basin. The "fission-fusion" strategy is characterized by short-term, periodic aggregation of people in seasonal camps and/or collecting grounds. Once supplies had been exhausted or when other resources were becoming available, family groups would disperse again to exploit widely distributed resources. This was, no doubt, a successful adaptation practiced over a long period of time throughout many parts of the Great Basin (Bettinger 1979). It wasn't the only strategy, however.

As portrayed by Steward (1938), the environment of the Great Basin was marginal, at best. This perspective colored many descriptions of life in the region. He described natives in the central Great Basin as practicing a highly mobile settlement system that did not afford many luxuries or time for relaxation. The notion of a marginal environment helped explain the high degree of residential mobility and overlapping (or nonexistent) territories in the Great Basin. The veritable oasis of the Owens Valley was seen as an exception to the rule. For Steward, *scarcity* was the main impetus for the development of extremely fluid bands with the immediate family as the main socio-political unit.

Although Steward's depiction of life in the Great Basin may have overstated the geographic distribution and time depth of ethnographic settlement and subsistence patterns, he nonetheless described a real pattern. His account is accurate for the Central Great Basin, though it is still unresolved as to how widespread and long-lived this pattern was.

Wetland adaptations in the Great Basin were being reported in the literature prior to either Steward's or Jennings' work. L.L. Loud's (1929) excavations at Lovelock cave in western Nevada provided a wealth of evidence pointing to the exploitation of lacustrine resources. Loud looked to the Klamath people for an interpretive framework since such an adaptation was largely unknown in the Great Basin. Following the publication of Steward's and Jennings' seminal works in the Great Basin, attention did not shift back to wetlands adaptations until Heizer (1970) re-investigated western Nevada and Lovelock cave. It was there that he and his students described a strategy they dubbed *liminosedentism.* By applying this term, Heizer acknowledged the increased dependency on lakeside resources and decrease in mobility.

Barrett (1910, 1917) and Lowie (1939) were among the first to describe ethnographic wetland adaptations in the Great Basin. Barrett's work among the Washoe noted the importance of fishing and hunting waterfowl in several communities at Pyramid Lake, Winnemucca Lake, and Lake Tahoe. Lowie made similar observations at Pyramid Lake, Winnemucca Lake, and on the Humboldt River. Loud's (1929) early theorizing on the materials of Lovelock culture drew heavily upon Klamath ethnography to provide a basis for comparison.

The liminosedentism model has been used to interpret assemblages from wetland contexts in many parts of the Great Basin including Pyramid Lake, Surprise Valley, Lake Abert, Warner Valley, as well as the Malheur, Harney and Fort Rock basins. Recently, there has been more emphasis placed on the variability of precipitation versus relative temperatures (Aikens 1993). Local and regional variations in timing and intensity of climatic regimes are also recognized as key components in studying prehistoric wetland adaptations (Oetting 1989). Additionally, researchers have convincingly demonstrated the prevalence of sharp , short-term changes in effective moisture of northern Great Basin wetlands, which dramatically impacted human settlement and subsistence (Jenkins 1994). Data from Fort Rock and elsewhere show that wetland systems respond rather quickly to changes in available surface water and thus precipitate changes in human settlement and subsistence strategies relatively rapidly.

The Fort Rock Basin provides a good example of how changes in the dominant weather pattern, as inferred from pollen cores (e.g. Diamond Lake), happen quickly, as do their resultant human adaptations (Jenkins 1994). Evidence from the Fort Rock Basin indicates that while the actual harvesting and processing activities carried out in the region do not change through time, the relative importance of the components of the diet do change. A fluctuating climate has produced shifts in hunter-gatherer settlement and subsistence strategies. For example, from ~7,000 to ~5,000 BP, there is an apparent reduction in occupational intensity of lowland settings, as indicated by the sparse deposits at Connolly Caves. Around 5,000 BP, a late Middle Holocene Neopluvial period allowed for more intensive occupation of low-lying wetland sites. Throughout this period, a steady population increase is hypothesized, eventually leading to severe resource stress. By 3,000 BP people were once again forced to look outside of the wetland setting for food. Evidence for resource exploitation is sparse between 2,000 and 1,500

BP but appears to indicate use of both upland root and lowland marsh resources. At 1,500 BP there is a dramatic shift to the exploitation of upland root crops as suggested by the remains from Boulder Village in the Basin (Wingard 1999). Two processes have been suggested to account for this radical change: increasing population density and a late Holocene climate that is beginning to fluctuate widely. After 900 BP there is a continued pattern of climate fluctuation and its concomitant settlement and subsistence change (Jenkins 1994).

Although early depictions of Great Basin settlement and subsistence strategies generalized about the entire Basin based on evidence from the central and eastern regions, it is now clear that wetland settings played an important role in prehistoric Great Basin adaptations. Future work in the northern Great Basin will refine settlement and subsistence patterns already proposed for the region. Directions of inquiry suggested by Jenkins (1994) include more tightly defining when populations in the region shifted from lowland to upland resources. Questions related to this revolve around whether root crop intensification was due to population induced resource stress or advances in root collecting and storage technologies.

Cressman's pioneering (1937, 1943, 1948, 1956) work in the Northern Great Basin and High Cascades established the importance of wetland resources on the northwestern fringe of the Great Basin. Diagnostic artifacts discovered below a layer of Mazama tephra at Odell Lake attest to an Initial Archaic (>6,845 BP) occupation of the Upper Deschutes River Basin. Evidence suggests that the Mazama ashfall essentially extinguished the Upper Deschutes biotic productivity. This sudden and catastrophic event no doubt triggered a response among natives who relied on the plants and animals of the uplands for a portion of their subsistence. Such a contingency was handled by making changes in settlement strategy. For mobile hunter-gatherers, changing the seasonal round was probably much less difficult than for more sedentary groups. This is because a higher degree of flexibility and fluidity in movement and group composition is necessary for mobile groups to get to where resources are becoming available. The length of time before the Upper Deschutes was cycled back into the seasonal round is still debated. After one thousand years, vegetation communities were on the rebound, albeit with different compositions and structures (Matz 1991). Regardless of how much time passed before the upland resources became a significant draw again, occupational intensity probably did not reach pre-Mazama levels until after the Neopluvial (<4,000 BP), as suggested by the dearth of Middle Holocene sites in the area. Furthermore, it is hypothesized that post-Mazama occupations of the Upper Deschutes were more narrowly focused on terrestrial food resources such as deer, as compared to the wetland centered subsistence economies of the pre-Mazama era.

LITHIC TECHNOLOGY & MOBILITY

Technological organization, as the concept is applied here, refers to an array of cognitive processes, behaviors and patterns associated with the acquisition, transportation and use of stone tools. As Kelly (1988:717) puts it:

> *Research on the organization of technology aims to elucidate how technological change reflect large-scale behavioral changes in a prehistoric society. Critical to*

this approach is the development of middle-range theory relating stone tool shape and use to those aspects of cultural behavior affecting them.

The fact that lithic technology is guided by constraints imposed by mobility has been established by a number of archaeologists (Kelly 1988, 1992; Parry and Christenson 1987; Shott 1986; Torrence 1989). Analysis of stone tools (including sourcing, quantitative and qualitative observations, and placement within a reliable typology) and the by-products of their manufacture and use can contribute to our emerging understanding of prehistoric settlement strategies in the Northern Great Basin. This is possible because many studies have established correlates between technological organization and various sets of patterned behaviors (Andrefsky 1986; Bamforth 1988, 1990, 1991; Binford 1978; Crabtree 1970; Flenniken and Raymond 1986; Gould 1980; Hofman 1991; Kelly and Todd 1988; O'Connell 1977; Parry and Kelly 1987; Shott 1986). Such studies have linked lithic technology with group mobility, procurement strategies, and raw material quality and availability. The following discussion explores sources of variability in lithic technology.

Raw Material

Raw material studies have been used successfully in archaeology to characterize prehistoric group mobility (cf. Andrefsky 1998) and delineate spheres of interaction (Shackley 1988; Skinner 1983). These studies have demonstrated that lithic raw materials retain a reflexive role in the development and maintenance of technological organization. It is possible to outline some basic expectations in regard to group mobility and technological organization vis-a-vis the availability and distribution (both primary and cultural) of quality tool stone.

Obsidian source characterization has proven its efficacy as a tool for modeling prehistoric mobility and procurement range (Roth 2000; Shackley 1996, 1992, 1988, 1986). By identifying obsidian sources in the assemblages of a given region and comparing this to the distribution of tool stone across the landscape, it is possible to gauge the amount of ground covered on seasonal forays. This approach can be especially useful if sourced artifacts can be placed within a chronology to detect shifts in procurement ranges over time. Changes can then be viewed in light of cultural and environmental forces in an effort to explain changing source compositions.

Central to understanding the relationship between raw material and the array of human behaviors related to it is the *lithic landscape*. A working knowledge of the lithic landscape must take into account the distribution, character, and availability of tool stone (Skinner 1989) across a broad exploitable range. The distribution, character and availability of obsidian in Central Oregon is discussed in chapter 2, *Environmental Background.* For an exhastive list of Oregon obsidian sources, refer to the Obsidian World Source Catalog maintained by the International Association for Obsidian Studies (http://www.peak.org/obsidian/).

Kelly (1988) draws on ethnographic sources that suggest differences in tool morphology can be the result of raw material quality and availability. He suggests that these attributes are the main force influencing tool kit composition. While stones suitable for expedient and crude tools were widely distributed across the Basin and Plateau, fine-grained igneous (obsidian and basalt) and cryptocrystal silicates (CCS) occur over much more restricted areas and are not as readily available. As such, curated tools tend to be produced from high quality obsidian and CCS, whereas expedient tools tend to be produced with whatever is at hand.

As hunter-gatherers moved through seasonal rounds, tool kits varied in their state of repair and composition depending on tasks and frequency of retooling events. The availability and distribution of tool stone should affect assemblages to the extent that the greatest amount of conservation is expected in areas lacking abundant lithic resources. In cases where the next retooling event is distant or uncertain, raw material use should be most conservative just after retooling while still near the source (Hoffman 1991). When considering availability, the simple linear distance from the source is not always sufficient to account for the distribution of tool stone. Instead, factors such as seasonality, direction of movement, time between retooling, and redundancy of settlement patterns must be taken into consideration (Hoffman 1991). Thus, it is clear that quality, abundance, and accessibility of tool stone plays a major role in the expression of technology.

Given the high degree of residential mobility documented ethnographically and archaeologically for aboriginal hunter-gatherers in Central Oregon and the abundance of high quality obsidian sources, raw material procurement is expected to be direct. That is, tool stone was obtained directly from the quarry, rather than through a secondary distribution network. People venturing into the Upper Deschutes River Basin would have no *need* to trade for tool stone when it was readily accessible. Furthermore, the procurement of raw material in the area is expected to be embedded within the pursuit of other key resources such as game and vegetable foods. Given the spatial incongruencies in resource availability, central Oregon groups moved often to take advantage of the most productive areas. Whether groups moved only a few times a year, or dozens of times, these periods of high mobility allowed for the replenishing of tool stone, while still pursuing other activities. When obsidian was located at short distances from resource patches being exploited, a small group or individual could break off from the larger group and replenish the tool stone reserves. It is likely that users of Newberry Volcano, Quartz Mountain, and other obsidian sources were procuring a surplus of tool stone to be traded or otherwise distributed. Such pieces were reduced to rough blanks for transport.

It is expected that with a high degree of residential mobility, groups would have access to a variety of tool stones. Furthermore, the curated tool assemblages of highly mobile groups should represent a variety of distant sources, whereas the debitage is expected to be of more local material (Atwell 1994). This occurs for two reasons. First, because tools that are maintained for extended use are generally made from high quality material and are time consuming to produce. Therefore, locally available materials will be used when they are appropriate, thus conserving valuable time and resources. Secondly, high quality tool stone that was acquired most recently will be reduced significantly through manufacture and use following a re-tooling event and used less conservatively. This phenomenon is often represented in the archaeological record by the presence of discarded tools from distant sources found in association with debitage from more proximal sources.

The Curation Concept

Central to the topic of lithic technology and prehistoric mobility are the concepts of curation and expediency. Much has been written on the ambiguously defined *curation concept* (Bamforth 1986; Binford 1979; Hofman 1991; Ozbun 1991; Parry and Kelly 1987; Shott 1996 and 1986; Skinner and Ainsworth 1991). As originally postulated by Binford (1978), curation encompassed prefabrication in anticipation of use, technological sophistication, formality, transportability, multifunctionality, maintenance, recycling, and thus, mobility (Bamforth 1986:38). The use of curated technologies has also been associated with caching behavior (Bettinger 1991:69).

As the concept was appropriated by others, its meaning has become clouded. Shott (1996:264) enumerates the multiple meanings it has taken on and argues that many had been attached needlessly or incorrectly. Shott proposes a redefenition of the concept as follows: "Curation is *the degree of use or utility extracted, expressed as a relationship between how much utility a tool starts out with-- its maximum utility—and how much of that utility is realized before discard"* (Shott 1996:267 emphasis original). Such a definition begs yet another definition. *What is maximum utility?* Shott suggests that *maximum utility* can be thought of as "the amount of usable material found on the tool at the start of its use, and realized utility as the amount removed following episodes of use" (1996:270). Defined this way, curation still accommodates most of the behaviors commonly associated with it, but is not restricted to them. As such, a *formal* tool or technology is curated to a greater extent than an expedient tool.

As opposed to formal tools, which are crafted using systematic and patterned techniques to reduce cores, expedient tools are produced more hastily with little concern for the final shape or longevity. Parry and Kelly (1987:287) state that the defining characteristics of expedient core technologies are: "flaking [that is] not intended to control the form of the resulting flakes..."; no "explicit distinction is made between tools and waste..."; and the tools are rarely reduced or modified further. The production of expedient tools does not require training or experience, and thus was near universal throughout prehistoric North America. Assemblages dominated by expedient technologies are generally associated with sedentary land use patterns.

In sum, groups who are highly mobile will tend to produce formal, curated tools that are multifunctional and easily transported. As groups become less mobile, they can relax constraints on tools that are based on transportation cost and a need for multifunctionality.

Measures of Mobility

Although the influences on the creation and maintenance of tool kits are complex, much attention has been given to isolating and analyzing functional aspects of stone tool assemblages (Frison 1968). In addition to function, stone tool production is also influenced by group mobility, stylistic constraints, efficient use of time, minimization of risk, and portability (Shott 1986:17). Chief among these is the frequency and duration of both group and individual movement. As Shott (1986:19) puts it:

> *Mobility should place constraints upon technology by imposing carrying costs. The size of a technology cannot increase indefinitely in order to meet the functional demands or requirements of a cultural system unless the ability to carry tools increases at the same time.*

Technological measures of mobility currently used in the literature (Andrefsky 1998; Lebow 1995; Lebow and Atwell 1995; Parry and Kelly 1987) include: platform preparation, percentage of cortical flakes, percentage of bifacial thinning flakes, presence of bifacial artifacts, tool maintenance, and raw material source / quality variability. Tables 3.1, 3.2, and 3.3 provide an explanation of these technological attributes.

For groups with high residential mobility, a formal bifacial technology provides several distinct advantages. Chief among these are its portability, multifunctionality and the efficient use of raw material. Formal tools of various bifacial and unifacial design are lightweight, yet contain a large amount of usable cutting edge. This is possible because they also can function as cores to produce extremely sharp flake tools, thus performing the work of several expedient tools (Parry and Kelly 1987). The working edge of a formal tool is maintainable through flake removals, thus increasing the use life of the implement. Although such an approach confers some clear advantages, formal technologies require an investment of time and energy to manufacture, use, and maintain.

Tool maintenance is closely tied to curation. As the working edges of stone tools dull or break, additional retouch is necessary in order to maximize utility. Among highly mobile groups and in areas with poor quality raw material, the finer tool stones will be laterally cycled into other uses. This is especially true if the next anticipated retooling event is distant or uncertain. In areas where quality tool stone is infinitely available, tool maintenance should be minimal or non-existent.

Analyses of debitage assemblages are useful, as they are representative of lithic reduction activities conducted at a site. Examination may reveal which raw material source was most recently encountered, the techniques used to reduce a piece, and the amount of time and care taken to manufacture and maintain it. The amount of time and care taken to reduce a tool is often indicative of the degree to which the tool is curated. High percentages of debitage that exhibit platform preparation are viewed as evidence of care taken to direct flake detachments from the piece.

In general, the presence of cortex in debitage assemblages is suggestive of a recent retooling event. As an objective piece moves away from the point of procurement, it follows that the amount of cortex will rapidly diminish as the piece is worked for use and transport. In central Oregon contexts, however, cortex is not a very useful measure because of the large size of parent material. Since the amount of surface area of an object is inversely proportional to its size, large boulders of obsidian will have relatively less cortex than small nodules. Furthermore, many obsidian flows in the region are fairly recent, and have yet to form much of a patina, let alone cortex.

It is clear that lithic technology and land use patterns are closely linked. Technological organization is influenced by several cultural and natural phenomena, most notably, group mobility, availability of high quality raw material, concern for efficient use of time, and social norms. The lithic analysis that follows in Chapter 6 is used to estimate the degree of prehistoric group mobility in the region, and to identify spheres of interaction.

CHAPTER 5: METHODOLOGY

Analysis of lithic materials in this study emphasized sourcing of raw materials, reduction strategies, use (modification, rejuvenation and lateral cycling), and discard / loss. Data collected from stone tools are used in conjunction with limited spatial analysis that examines the distribution of sourced obsidian within the study sites through time. These results are then discussed in light of their implications for prehistoric group mobility. This section outlines the methods used to collect and analyze the data, as well as some of the models and expectations that guide this research.

DATA COLLECTION

A cooperative agreement was established with the Deschutes National Forest (DNF) that allowed for the study of artifacts maintained by the agency and access to DNF archeological site records. The research began with a thorough literature review, including DNF reports, archives, and unpublished reports. Next, sites for this study were chosen on the basis of assemblage size, the presence of diagnostics, and the completeness / accuracy of site records. Sites were also selected to provide a variety of environmental contexts. Site locations include upland (35KL528, -878, ISO 2031, and ISO 2175), valleys (35KL879 and –880), and lake-side settings (35KL888 and –1111). Table 7.2 provides a summary of each site's characteristics.

Most of the cultural materials analyzed as part of this study were collected by DNF personnel during site recording, monitoring, and testing. A small number of artifacts were initially collected by recreational users of the Forest.

Determining the exact *in situ* position of artifacts within each site was limited by the records kept at the time of collection. While the provenience of many artifacts was well documented by trained professionals, some artifacts retained very little information as to their original archaeological provenience. Whenever possible, the position of artifacts is indicated on site maps and in the text.

LITHIC ANALYSIS

The analysis of artifacts from sites within the project area focused on two categories of lithic materials, flaked stone tools and debitage, with five goals in mind. The primary goals were to: 1) identify the production technology represented, 2) describe tool morphology in order to place diagnostic artifacts into a time-sensitive typology, 3) establish the systematic context of each specimen, 4) identify the raw material sources represented, and 5) use functional categories derived from the analysis to characterize the diversity of each stone tool assemblage. Ground stone artifacts from the study area, although potentially a great source of information, were not analyzed in any detail simply because so few have been collected and curated on the USFS Crescent District. It is unclear whether the relatively small amount of ground stone collected is due to a bias in collection, or a reflection of the types of activities that were being pursued, although I suspect the former.

Flaked Stone Tools

In order to divide the formed artifacts into manageable units for analysis, a basic stone tool typology is applied to the assemblages. First, formed artifacts were segregated from debitage. An artifact is considered formed if it exhibited any retouch subsequent to being struck from a core. Next, formed artifacts are categorized according to gross morphological characteristics. Tool types recognized here include cores, bifaces, unifaces, drills, gravers, scrapers, and flake tools (Appendix 3). Several of these classes were further divided. The biface category, for example, could be broken down into projectile points, preforms, blanks, knives, etc. Although specific functions have often been ascribed to particular tool types, the designations used here refer primarily to morphology. These data then provide a basis for comparison among the sites.

A maximum of 21 attributes were recorded for stone tools. Tool types identified in the assemblages under study include: projectile points, bifaces, unifaces, utilized flakes, scrapers, denticulates, gravers, cores, core tools, cobble tools, and groundstone. See Table 5.1 for a complete description of the attributes used and why they were important for this analysis.

Projectile Point Typology

Of chief concern for the present analysis is placing the projectile points into standard typology so that changes in technology and raw material use could be detected through time. Implicit in many projectile point typologies in use today is the notion that certain morphological styles have chronological and spatial meaning (Holmer 1986). Projectile point classifications presented below are common to the archeological literature in the Northern Great Basin, Plateau, and High Lava Plains. Determinations for individual artifacts were made by analyzing the size and morphology of several defining characteristics (haft element, neck width, presence of tangs, and overall size). The system used here derives primarily from Heizer and Hester (1978), Holmer (1986), and Hanes (1988). The following discussion describes each of the five types of projectile points identified in the assemblages under study.

Western Stemmed

Early occupation of the Great Basin and Plateau is attested to by the presence of a variety of un-notched, stemmed projectile points. Such points are sometimes found in association with the well known fluted variety of points, such as Clovis (Hanes 1988). Within the Great Basin, several variants of the stemmed class have been identified. These include Lind Coulee, Haskett, Lake Mohave, and Odell lake, among others. Defining characteristics of stemmed points include an "elongated, losenge-shaped stem with marked edge grinding on the haft element" (Hanes 1988:22). These artifacts are very distinctive, and one of the more readily identifiable types.

Table 5.1. Attributes recorded for stone tools.

Type	***Tool Type*** This field refers to common tool classes currently in used in the literature pertaining to the prehistory of the Far West. Although the names of some types may imply a certain function, their use here simply denotes general morphology. Tool types recognized in the present analysis are as follows: *core, blank, preform, biface, uniface, projectile point, scraper, denticulate, graver, drill, utilized flake, cobble tool, and groundstone.*
DC	***Data Class*** This field refers to the degree of completeness of a given artifact. Attributes include: *complete, proximal, medial,* and *distal. Complete* tools retain the bulk of their diagnostic features; *Proximal* fragments are those which are missing the distal end; *Medial* fragments do not have proximal or distal ends; *Distal* fragments are those lacking a proximal end.
Ctx	***Cortex*** This field documents the presence of cortex or patina on each artifact. When present, the amount of surface area on each side of the artifact covered is given as a percentage.
Tech 1, Tech 2	***Technology*** This field describes the most prevalent reduction technique apparent on each flaked stone tool. If more than one technique was observed, the most recent (as inferred from flake scar superpositioning) is listed first. Possible attributes for this field include: *Hard-hammer percussion, soft-hammer percussion, bipolar, and pressure.*
Rt1	***Retouch1*** This field indicates whether retouch (interior flake removals) *was unifacial, bifacial, or clustered* (retouch that is confined to limited portion of margin). This information can be useful when interpreting function, or estimating the amount of utility a tool has, or the degree to which it was curated.
Rt2	***Retouch2*** This field indicates whether retouch is *continuous* or *discontinuous.* This attribute may be useful when attempting to distinguish between curated and expedient tools.
#RtE	***Number of Retouched Edges*** This field describes the number of retouched edges on a stone tool. Possibilities include *1, 2, or 3* edges. This attribute is primarily descriptive, but may be useful when tying to determine whether a tool was hafted.
Loc	***Location of Retouch*** This field refers to the placement of retouch on the stone tools. Possibilities include *right margin, left margin, proximal, distal,* or any combination thereof. This attribute is primarily descriptive.

Table 5.2 Additional attributes recorded for stone tools.

ES	***Edge Shape*** This field refers to the shape of the working edge(s) of the stone tools. Possibilities include *convex, concave, straight, pointed, and round.* This attribute is useful when attempting to assign a tool type or place within a typology.
EA	***Edge Angle*** This field provides information regarding the edge angle of the working edge (or average if more than one) of the stone tools. Angles are given in three ordinal classes, which are: *1* (< or = 30 degrees); *2* (31 – 60 degrees); and *3* (> or = 61 degrees). This attribute is useful when attempting to assign a function to a stone tool.
Pt	***Platform Type*** This field only applies to flake tools. Flake tools were identified by the presence of patterned retouch that could not be attributed to natural or postdepositional causes. It documents the type of platform (if present) on striking platforms. Possibilities are *cortical, plain, complex, abraded, removed, or crushed.* This attribute is suggestive of the type and amount of preparation done to the piece prior to removal. It may also be indicative of the technique used to detach the flake (i.e. hard hammer percussion, soft hammer percussion, or pressure).
L, W, xW, xT	***Standard Metric Attributes*** These four fields record standard metric attributes commonly recorded for stone tools. These include *length of longitudinal axis (L), width at midpoint (W), maximum width (xW), and maximum thickness (xT).*
W:T	***Weight to Thickness Ratio*** This attribute is calculated by dividing the width of each stone tool by its thickness. The resulting number is used to calculate an artifact reduction stage.
Sv/d	***Stage of Ventral and Dorsal Surfaces*** This attribute refers to the reduction stage represented for each side of bifacial and unifacial artifacts. It is determined by calculating the weight to thickness ratio, and by making objective observations related to use wear, hafting, etc.
NW	***Neck Width*** This attribute is measured only for projectile points. This attribute can be used to determine whether the projectile was used on the end of an arrow or dart shaft.
BW	***Basal Width*** This attribute is measured only for projectile points. This attribute is primarily descriptive.
HL	***Haft Length*** This attribute is recorded only for stone tools that were once hafted. This attribute can be used to ascertain the type of hafting technology applied to the biface.
StC	***Stem to Corner Length*** This attribute is only recorded for projectile points with notches. This attribute is primarily descriptive.

Stemmed points tend to be rather large, provided that they have not been extensively resharpened or exhausted. Based on radiocarbon dates taken in association with stemmed points at sites located within Marmes Rockshelter (Ames 1988), Fort Rock Basin (Bedwell 1973), Bonneville Basin (Bryan 1979), and Chewaucan Marsh (Oetting 1989), such tools were in use from approximately 12,000 – 7,000 BP.

Elko

Elko points have a relatively long history in the some parts of the Great Basin. Sites such as Hogup Cave (Aikens 1970) and Connolly Caves (Bedwell 1973) provide stratigraphic evidence for the introduction of the style as early as 7,000 BP. It appears that Elko occurs much earlier in the northern and eastern Great Basin, where Hanes (1988) suggests they were most prevalent prior to 5,500 BP, although they have been documented as late as 1,000 BP in the area. In the southern Great Basin, Elko points do not appear to be present until 3,500 BP (Heizer and Hester 1978). Defining characteristics include a triangular blade outline, straight to excurvate edges, sometimes with concave bases producing an "eared" effect. Ears can be round or flat. Notches are usually initiated at the corner and are directed towards the longitudinal axis of the piece. Cross sections tend to be lenticular to plano-convex (Hanes 1988:23).

The Elko point provides a good example of how complex and confusing typological classifications can be. Confusion results primarily from disagreement in classification and the introduction of similar point styles throughout the Great Basin and Columbia Plateau at different times. Whereas the style is thought to first occur in the northern Great Basin around 7,000 BP, Aikens suggests that they do not occur on the Columbia Plateau until between 4,500 and 2,500 BP (Aikens 1993:95). This presents a unique problem for this study because all of the sites lie in an area that is on the border between the two cultural / physiographic regions. As such, the Elko point is not very useful as a time marker and must be considered to be associated with a rather large time span.

Rosegate

The Rosegate series is comprised of Rosespring and Eastgate style projectile points. These points were originally defined as separate types, but are now widely thought to "represent a continuum" (Heizer and Hester 1978). Both types have been found together at many sites throughout the Great Basin. In total, Heizer and Hester have described five sub-variants. They are: Rosespring (RS) side-notched, RS corner-notched, RS contracting stem, Eastgate (EG) expanding stem, and EG split stem. For the purpose of this study, all specimens that fall under one of these types will be considered Rosegate for chronological placement, but were recorded as either RS or EG. The following brief descriptions provide an idea of the range of variability present in the Rosegate series.

Within the Rosespring class, some points exhibit corner notches that produce sharp or shouldered tangs and a triangular outline. Other RS points have narrow blades and broad side notches. Rosespring points generally have expanding stems with a convex base. Eastgate points may be

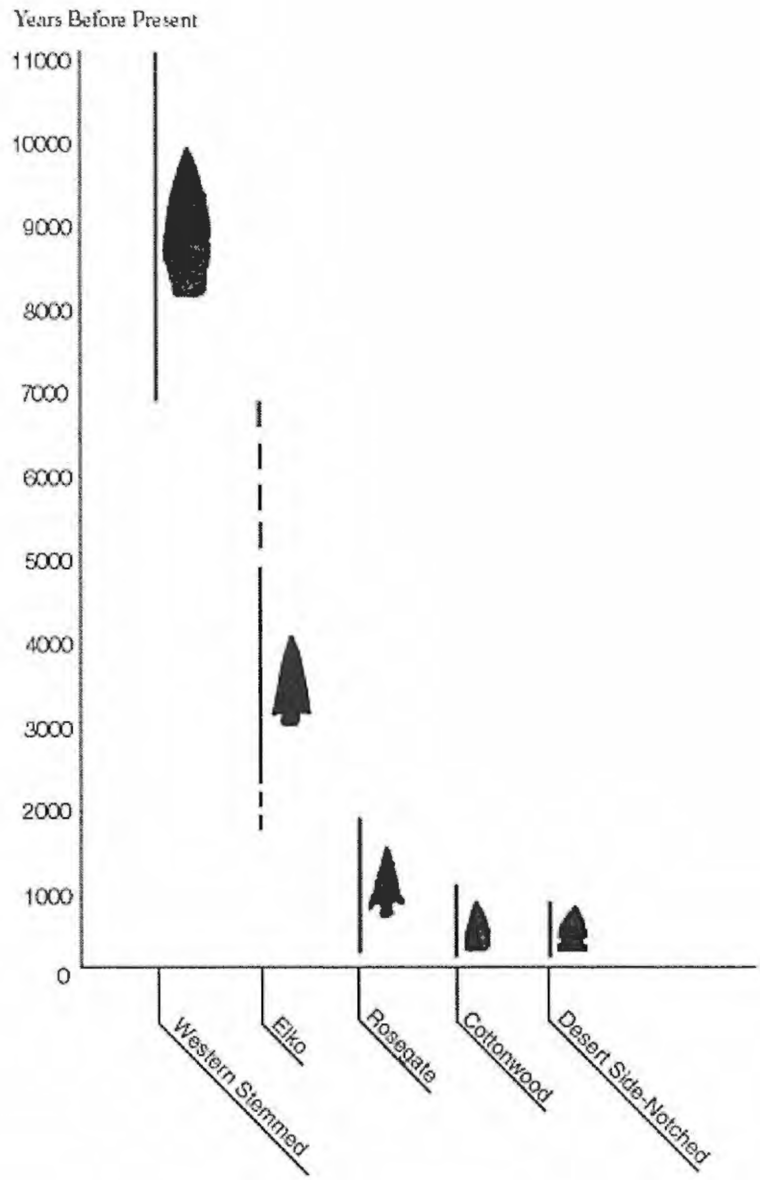


Figure 5.1 Projectile point chronology.

basally notched with long square barbs, whereas others are basally notched and have expanding stems. Clearly there is a great deal of morphological variability, yet the class as a whole still retains usefulness as a time-sensitive type.

Holmer (1986:107) argues that introduction of the Rosegate series coincides with the adoption of the bow and arrow in the Far West. He places the date for this introduction at around 1,300 BP and suggests that they are replaced in the east at around 700 BP by the Desert Side-Notched and Cottonwood series. Oetting (1989), however, found evidence for the use of Rosespring points at Chewaucan Marsh beginning at 2,000 BP and continuing until contact.

Desert Side-Notched

The Desert Side-Notched (DSN) series consists of small, triangular points with narrow side notches. These points tend to be straight blades, have their maximum width at the base, and have thin, lenticular cross-sections. DSN points appeared first in the eastern Great Basin around 1,200 BP and in the rest of the Basin around 800 BP. Holmer (1986) notes that DSN are commonly found alongside Numic ceramics and were common until 300 BP. Heizer and Hester (1978) suggest that they were in use up to the historic period.

Cottonwood

The Cottonwood (CW) series of projectile points occur throughout the Great Basin and often co-occur with Desert Side-Notched points. The Cottonwood series is sometimes subsumed under the Desert Series, which also includes Desert Side-Notched. The points are small, triangular and un-notched. Edges are generally straight, and bases are concave. Holmer (1986) puts the date of introduction as early as 1,000 BP, but notes that they are most common from after 700 BP to contact.

Debitage Analysis

Although debitage has been noted at six of the study sites, only three small assemblages were available for study (35KL879, -888, and –1111). The attributes for all three debitage assemblages are listed in Appendix 2. Only site 35KL888 has been sufficiently collected to justify a thorough analysis. One factor severely limiting the analysis of debitage from the study sites is the lack of control in the samples. At most sites where debitage was collected, it was done so on more than one visit, and with varying degrees of documentation. As a result, it is not possible to determine the entire range of lithic reduction activities that took place at site 35KL888. What can be accomplished, however, is a description of *some* of the reduction activities represented.

Table 5.3 describes the attributes recorded for the debitage. The hierarchical key that was used here was adapted from Sullivan and Rosen (1985). The one used here differs in that five debitage categories are recognized instead of four. While adding another analytical category, this distinction retains the objectivity of the typology in that it does not presuppose any knapping technology. Flake completeness categories include: complete, proximal, medial, distal and debris. Flakes were considered complete when the striking platform was present, lateral margins were intact and the distal end exhibited a feather, step or hinge termination. Proximal flakes were discerned by the presence of a striking platform

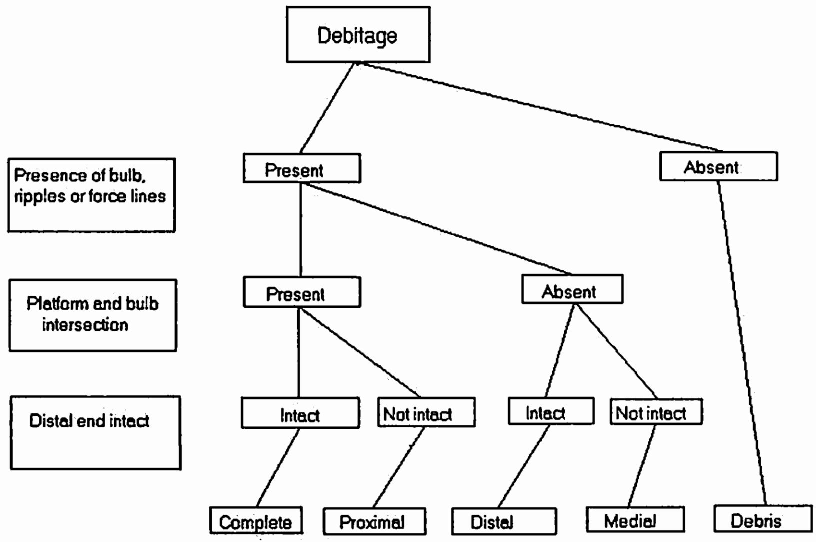


Figure 5.2 Dichotomous key used to categorize debitage.

and the absence of a feather, step or hinge termination. Medial flake fragments were those which had neither an intact striking platform nor intact distal ends, but which did exhibit ripples or lines of force. Distal flake fragments were identified based on the presence of ripples, lines of force and intact terminations, but lacking any discernible platforms. The debris category encompassed all angular waste and flake fragments, which could not be confidently assigned to any other category. The type of debitage categories that characterize an assemblage are indicative of the type of reduction activity undertaken (primary, secondary, rejuvenation, etc.) and the amount of care taken in the preparation and reduction processes.

Additional attributes recorded for all flakes include the presence of splitting, lipping, the percentage of cortex and type of raw material. Splitting of flakes was indicated by a break running perpendicular to ripple marks, which is thought to be associated with hard-hammer percussion. Lipping was determined to be present if a small projection on the proximal ventral surface running parallel to the platform could be seen or could be felt with a finger. This feature is formed on the ventral surface of a detached flake when it is struck off. Some researchers (Andrefsky 1998; Crabtree 1970) have suggested that its presence points to the use of soft hammer percussion.

Continuous, metric data were recorded for all complete flakes. Length, width, thickness, platform width and platform thickness measurements were made with the aid of digital calipers. Platform width and thickness measurements were taken on all proximal flakes. Length was taken by measuring from the intersection of the platform and ventral surface to the furthest point along the centerline. Width was measured at the midpoint of each flake. Flake thickness was measured at the point where it was greatest. Platform width was measured from the intersection of the lateral margin of the platform and the flake margin. In cases where the platform was crushed, preventing exact delineation of the platform surface, an attempt was made to approximate its extent as indicated by the bulb of percussion. Platform thickness was measured from the intersection of the platform and the ventral surface to the intersection of the platform and dorsal surface, at the thickest point. All incomplete flakes and debris were assigned to a size class based on one-centimeter increments. Size class determinations were made by measuring the longest axis. Size is an important attribute to measure because it is one of the strongest indicators of the type of reduction activity represented.

The type of striking platform present of all proximal and complete flakes was recorded. Possible platform types that were recognized include cortical, crushed, plain, complex and abraded (Andrefsky 1998:94). Plain (i.e. *flat*) platforms are those that have a relatively flat, even surface. Complex platforms showed evidence of previous flake removals or trimming and had more than one surface. Abraded platforms show evidence of having been ground to influence (or so it has been generally assumed). Platform preparation is an important attribute to consider because it generally increases as a piece nears the final stages of production.

Technological Classes

The process of transforming a naturally occurring stone into a usable implement with an effective cutting edge is a reductive process. The term *technological classes* is used here to refer to the primary mode of reduction, as well as the amount and type of reduction of the parent material. This approach requires that stone tools are segregated into one of two categories: formal (patterned) and informal (unpatterned). The shape of a formal tool is the result of decisions made in the reduction process that do not necessarily reflect constraints in design imposed by the size and shape of the object. The resulting tool should also reflect strategic decisions made to accommodate the task at hand and anticipated needs. Tools are considered patterned if they exhibit extensively, or at least regularly, flaked margins or surfaces. As an example, bifacial and unifacial tools, in addition to those that contain hafts or working edges that have been intentionally shaped, are patterned. Tools lacking any clear pattern, those that were haphazardly flaked with no concern for general morphology, or those whose shape is primarily the result of the size and shape of the original parent material, are classified as expedient. Observations made regarding diagnostic features of stone tools and debitage are used to infer the method of reduction.

In an effort to place each artifact within a reduction sequence, the surface morphology of each biface was analyzed. Analysis was restricted to the bifacial tool class because they are the most numerous in the assemblages and they were highly curated. The reduction trajectory proposed by Callahan (1979) has been widely cited in the literature and has been used as a model for interpreting assemblages in Oregon and elsewhere. In this strategy, seven stages are recognized as the artifact is transformed through reduction.

Stage One is the *selection of raw material*. At Central Oregon quarry sites where the parent material is in some cases massive (e.g. Newberry Crater), large obsidian flakes were detached from boulders (Connolly et al. 1999:58). At other sources, smaller nodules were quarried from less concentrated distributions such as outcrops and stream beds. Regardless of the initial size

Table 5.3. Attributes recorded for debitage. Names in parentheses refer to field names used in Appendix 1, *Flaked Stone Attributes.*

type	***Data Class*** This field indicates the relative completeness of flakes. Flake types include *complete (C), proximal (P), medial (M), distal (D), and debris (Deb).*
Split	***Split*** Indicates presence of a break running perpendicular to ripple marks on a flake.
Lip	***Lipping*** Indicates the presence of a projection just below, and running parallel to, the platform.
Ctx	***Cortex*** This field indicates the presence of *cortex (C)* or *patina (P)* on the dorsal surface of the flake. It is given as a percentage of the dorsal surface covered.
RM	***Raw Material*** This field indicates the raw material of the flake. Possible types of raw material include *obsidian (ob), basalt (bs), and cryptocrystal silicate (CCS).*
Sz Class	***Size Class*** Indicates the size grade the flake fall into. Size grades used for this assemblage include *0 – 1, 1 – 2, 2 – 3, 3 – 4, 4 – 5, and 5 – 6 cm.*
L, W, T	***Length, Width, and Thickness*** Standard metric measurements of the length, width, and thickness of the flake.
Plat	***Platform Morphology*** Refers to the morphology of the striking platform. Possible types include *abraded (ab), complex (cpx), cortical (ctl), crushed (cr), plain (p), and absent (*).*
PlatW, PlatTh	***Platform Width and Thickness*** Standard metric measurement of the width and thickness of the striking platform.
DFS	***Dorsal Flake Scar*** Indicates the presence of prior flake detachments from the dorsal surface of the flake. Possible types include: *0 (no scars / 100% cortex); 1 (single scar and cortex); 2 (one or two scars without cortex; and 3 (three or more scars).*
FlkTyp	***Flake Type*** Indicates technological flake type. Possible types include: *alternate (alt); bifacial thinning (bft); notching (nch);* and *other (*).*

and shape of the material, it was first tested for faults and inclusions. Any cortex present was generally removed at this point.

Stage Two involves *core preparation and initial trimming*. At this point, the piece may exhibit a thick cross-section. Edges may be sinuous, as the percussion flakes are widely spaced or irregular. Portions of the original flake scar may be evident.
During Stage Three, *primary trimming,* flake scars are more closely spaced allowing for the piece to be shaped. Often, original flake surfaces will be removed during this stage. Flakes scars tend to be quite invasive, traveling to the midpoint of the piece. Connolly et al (1999) suggest that at the end of this stage the knapper has the option to temporarily stop reduction and transport the piece as a bifacial core or blank, or may proceed with the reduction process to produce preforms and tools.

Stage Four, *secondary trimming and thinning,* is indicated by a thinner cross-section approximating a lenticular shape, and closely spaced flake scars that travel past the midline.

Stage Five, *shaping,* gives the tool a final shape. Edges are straightened and the tool takes on a more symmetrical appearance. All original flake scars have been obliterated and retouch around the margins is regularly spaced with few or no irregularities such as areas of high mass or step/hinge terminations. Soft hammer percussion and/or pressure flaking is used to achieve this level of refinement.

Stage Six refers to *tool use.* At this phase the tool is subjected to the many tasks it is suited for. Stage Seven is *optional maintenance and modification.* At this juncture, tools that have been utilized or broken may be rejuvenated to serve their original or a different function. Tools that have been exhausted or are no longer useful may be discarded at this point. Assigning tools to stage 6 or 7 is somewhat subjective for several reasons. First, in areas where high quality raw material is abundant, tools may be discarded while they still retain utility. That is, they may require minimal rejuvenation to be reused for a similar purpose, or slight modification to be recycled for other purposes, yet a decision was made that time and energy were better spent replacing the tool. Secondly, tools, most notably projectile points, may be lost while in use and still retain all of their utility. Thus, while still completely useful, they are considered "discarded." Two important considerations then, are the context in which an artifact is found (isolated, flake station, habitation site, etc.) and the local availability of quality raw material.

It is likely that more than one reduction strategy was used at localities around Central Oregon quarries (Connolly 1999; Musil 1999). Such reduction behavior was documented by Skinner and Ainsworth (1991) in eastern California. They proposed a reduction strategy for sites associated with the Casa Diablo obsidian source where they observed a large number of bifaces that had been worked primarily on the dorsal surface. They found that it was difficult, if not impossible, to assign such artifacts to a traditional reduction trajectory. They dubbed these artifacts *bifacial unifaces*. Many of these artifacts show very little evidence of retouch on their ventral surfaces, while the dorsal surfaces could be assigned to a Stage 4 (after Callahan 1979).

According to Skinner et al. (1991:161):

> *It became clear that although the bifaces and flakes at the sites represented a biface reduction trajectory, the approach and techniques used appeared to differ from those described by Callahan (1979) and Muto (1971), and the debitage could not be classified according to lists defined from these works.*

The proposed staging model grew out of archaeological observation and experimentation. It basically follows Callahan, yet differs in the sequence of stages. The five stages recognized by Skinner et al. (1991: 161-166) are as follows: (1) *Obtaining the blank,* (2) *initial edging,* (3) *primary and secondary thinning (dorsal aspect),* (4) *primary and secondary thinning (ventral aspect),* and (5) *tertiary thinning of both faces.*

At sites near Casa Diablo, Skinner et al. identified two distinct techniques used for obtaining blanks. One was to detach large flakes (referred to as *plates* by the authors) by sectioning cobbles. The other was the production of biconvex flakes from large cores. The two methods result in different debitage assemblages. Large flakes are detached with sectioning, but this approach doesn't allow for a great deal of control by the knapper. More debitage is created using the biconvex method because it requires more preparation to set up a complex core. The effort spent early on to prepare a core to detach biconvex flakes pays off later because less time is required to shape and thin the piece. The biconvex method makes more efficient use of raw materials (Skinner and Ainsworth 1991:163).

Stage 2 involves the initial edging of the piece. The authors state that edging a plate is similar to the method described by Callahan. Biconvex flakes generally require little or no such retouch, because they often possess a sharp edge. In this phase of the trajectory, blanks are not significantly reduced.

Stage 3 is the point at which the dorsal surface is thinned significantly. Reduction of the dorsal surface and margins may approximate "an early to middle Stage 4 as defined by Callahan" (Skinner and Ainsworth 1991:164). Flakes are struck from platforms on the ventral surface. It is suggested that little or no platform preparation is undertaken at this stage. In rare circumstances where it was observed, platform preparation is restricted to the surface from which the flake is detached. It is argued that this method allows the knapper to use a rather hard hammer stone.

Depending on the texture and shape of the surface, a few flakes may be detached from the ventral surface during Stage 4. This may not be necessary if the right amount of convexity was achieved when the blank was first struck. When flakes are taken from the ventral side, platform preparation will be on the dorsal surface. Debitage created during this phase may be multifaceted, and may have a simple dorsal surface or remnants of the original ventral surface on the dorsal side.

Stage 5 encompasses the final thinning of the piece by percussion. Soft hammer percussion replaces hard hammer at this point. Early in this stage, the base of the piece is thinned (to reduce the original bulb of percussion), followed by the lateral margins. Pressure flaking may be used to set up platforms or to guide the shape with more control. Debitage from this stage will look like late-stage bifacial thinning flakes. Later stages are comparable to those described by Callahan (Skinner and Ainsworth 1991).

To allow for comparison with other assemblages, the trajectory proposed by Callahan (1979) is used to classify bifacial artifacts, although more attention will be given to surface morphology and not thickness/width ratios. Following Connolly et al. (1999), both aspects of bifacial artifacts have been assigned a reduction stage, except for artifacts assigned to Stage 7 because they had been removed from a systematic context.

Although observations made about fractures on tools may be suggestive of a cause, an exhaustive study was not undertaken to explain the breakage patterns on fragmentary tools. Although such an approach has the potential to provide information about stone tool use, rejuvenation, and discard in the area, the available information was not sufficient to address this. The primary obstacle is the highly disturbed nature of the deposits from which most of the specimens were collected. Like use-wear patterns, breakage patterns are difficult to interpret without a basic understanding of the formation processes that the specimens were subject to. Most of the deposits in this study have endured a variety of postdepositional alterations including timber harvesting activities, road building, looting, scavenging, and trampling. Thus, conclusions reached about the actual mode of breakage are somewhat speculative without other lines of supporting evidence.

Obsidian Source Characterization

Geologic sourcing of obsidian tools was achieved with the use of X-ray fluorescence spectrometry (XRF). A sample of 32 (~42%) formed artifacts was submitted to Northwest Research Obsidian Studies Lab in Corvallis, Oregon, for source characterization. Specimens were chosen on the basis of their ability to address the research questions outlined in Chapter 1. Special attention was given to diagnostic projectile points, which are useful because they were often curated and allow for rough chronological control. Because the goal is to gauge the procurement range of the tool users and not to identify the sources most recently used, only formal artifacts were analyzed. Specimens were also chosen based on the appearance and uniqueness of obsidians with the goal of sampling the diversity of sources represented in each assemblage.

XRF is a non-destructive method for measuring the relative abundance of trace elements present in volcanic glass and fine-grained basalt (Skinner 2000). This is achieved by directing high energy electrons (X-ray frequencies) at the surface of a geofact or artifact. At the molecular level, this bombardment results in the movement of electrons between orbits, causing the piece to emit secondary X-rays that are detected and measured by a spectrometer. The proportions of eleven diagnostic elements are represented as spectra lines or peaks, which are then translated into parts per million values. The resultant trace element "fingerprints" are then compared to a database of geologic source samples. This account of the process is simplified and can be augmented by referring to Skinner (2000) and Glascock et al. (1998).

OBSIDIAN AND SITE DISTRIBUTION PATTERNS

In an effort to understand the use of obsidian sources through time, a spatial analysis was conducted. To facilitate the spatial analysis, a geographic information system was developed with ArcView GIS software. Archaeological site locations were plotted as points and polygons based on cultural spatial data provided by the Central Oregon Heritage Group. Digital Raster Graphs (DRG) were used as a base layer (primarily USGS Quads) and were augmented with Digital Elevation Models (DEM) to represent the local topography. Other georeferenced points, lines and polygons, representing environmental features such as surface water, forest composition, geology, and known tool stone sources, were then overlain.
GIS technology was used to calculate the linear distance between obsidian sources and Upper Deschutes sites. Obsidian use is examined during all periods to detect changes in source representation.

The GIS was also used to analyze the distribution of the study sites in relation to key environmental features. Archaeological site locations were plotted on top of several natural layers including vegetation, geology, and surface water. The local topography was modeled with the use of 50+ digital elevation models (DEM), which were merged to form a single three-dimensional grid of surface features. This process made it possible to establish links between site location and important natural phenomena. The GIS also allowed for measurements to be taken between sites and environmental features of interest.

GIS data pertaining to cultural features were obtained from the Central Oregon Heritage Group (archaeological spatial and tabular data), while environmental data was downloaded free of charge on the Internet from two primary sources: the Oregon Geospatial Clearinghouse (http://www.gis.state.or.us/data/index.html), and the Regional Ecosystem Office (http://www.reo.gov/).

CHAPTER 6: RESULTS

This chapter presents the results of the lithic analysis performed on the eight assemblages under study. In total, 68 formed tools were examined, along with eight expedient flake tools and 62 pieces of debitage. Table 6.1 shows the number and type of stone tools analyzed from each site. Of these, 32 (43 percent) formed tools were sent to Northwest Research Obsidian Studies Lab in Corvallis, OR for obsidian source characterization.

	Projectile Points	Bifaces	Unifaces	Cores	Core Tools	Preforms	Blanks	Drills	Gravers	Scrapers	Utilized Flakes	Ground Stone	Total
35KL528	8	2	*	*	*	*	*	*	1	*	1	*	12
35KL878	*	6	*	*	*	4	*	*	*	*	*	*	10
35KL879	1	5	*	*	*	*	1	*	*	1	2	*	10
35KL880	1	2		*	1		*	*	*	*	*	*	4
35KL888	2	3	*	*	1	*	*	1	1	2	1	*	11
35KL1111	17	2	1	*	*	*	*	*	*	*	3	1	24
ISO2031	1	*	*	*	*	*	*	*	*	*	1	*	2
ISO2175	1	2	*	*	*	*	*	*	*	*	*	*	3
Total	31	22	1	*	1	4	1	1	2	3	8	1	**76**

Table 6.1. Number and type of stone tools analyzed from study sites.

The first section provides a brief discussion of each formed tool, categorized by site, in terms of its general morphology, technology, raw material source, and placement within a time-sensitive typology (when possible). Next, the results from the debitage analysis from site 35KL888 are presented. These data are combined with insights gathered from the associated formed tools to characterize the technological organization represented. Appendix 1 and 2 present an exhaustive record of each tool and flake's metric and technological attributes.

SITE 35-KL-528 (SHIBIKASHE)

Twelve flaked stone artifacts were analyzed from site 35KL528. Table 6.2 lists basic attributes recorded for the artifacts analyzed from site 35KL528. Digital images of the artifacts are presented in Figure 6.1. Figure 6.2 shows the relative proportion of each functional tool class represented.

#	Type	Raw Mat	L	W	T	Reduction	Sub Type
528_1	Projectile	Obsidian	1.68	2.4	.32	5/5	Cottonwood
528_2	Projectile	Obsidian	3.58	2.5	.69	6/6	Rosespring
528_4	Projectile	CCS	3.7	2.0	.52	7/7	Elko
528_5	Projectile	Obsidian	6.11	2.4	.72	6/6	Western
528_6	Projectile	Obsidian	3.59	1.7	.51	5/5	Elko
528_7	Projectile	Obsidian	2.02	1.3	.42	6/6	Desert Side
528_9	Projectile	Obsidian	2.42	1.8	.53	5/5	Western
528_10	Projectile	Obsidian	6.36	2.5	.9	7/7	Western
528_14	Biface	Obsidian	5.42	3.6	.89	5/5	*
528_15	Graver	Obsidian	4.0	3.4	.48	*	*
528_16	Projectile	Obsidian	1.46	1.8	.61	7/7	Western
528_17	Utilized	CCS	4.32	1.7	.56	*	*

Table 6.2 Stone tools from site 35KL528.

Projectile Points

Artifact 528-1 is a small, triangular projectile point crafted from opaque, grey obsidian. The proximal end of the piece is missing, likely as a result of a bending fracture. The point lacks a stem and has a slightly convex base. Retouch is invasive, bifacial and continuous. Pressure flaking is the only reduction technology
evident. It has a width to thickness ratio of 7.65 and has been assigned to stage 7. This point has been classified as part of the Cottonwood series. An obsidian source determination was not made for this artifact.

Artifact 528-2 is a medium-sized, triangular projectile point. The point is markedly asymmetrical, with one edge being longer and more diagonal in orientation. The piece is corner-notched, with a flat, expanding stem. It is made from opaque, grainy, grey obsidian that resembles McKay Butte sourced material. Retouch is sub-parallel bifacially, and continuous. Pressure flaking is the primary reduction technique observed on the piece. It has a width to thickness ratio of 3.68 and has been assigned to stage 6. This artifact has been classified as a Rosegate series point. An obsidian source determination was not made for this artifact. Artifact 528-4 is a medium-sized, triangular projectile point. The tip and one side of the distal end are missing. The edges are slightly convex and very sinuous. Retouch is bifacial and continuous. The piece is corner-notched and made from red cryptocrystaline silicate. Pressure flaking is invasive and alternately flaked on the

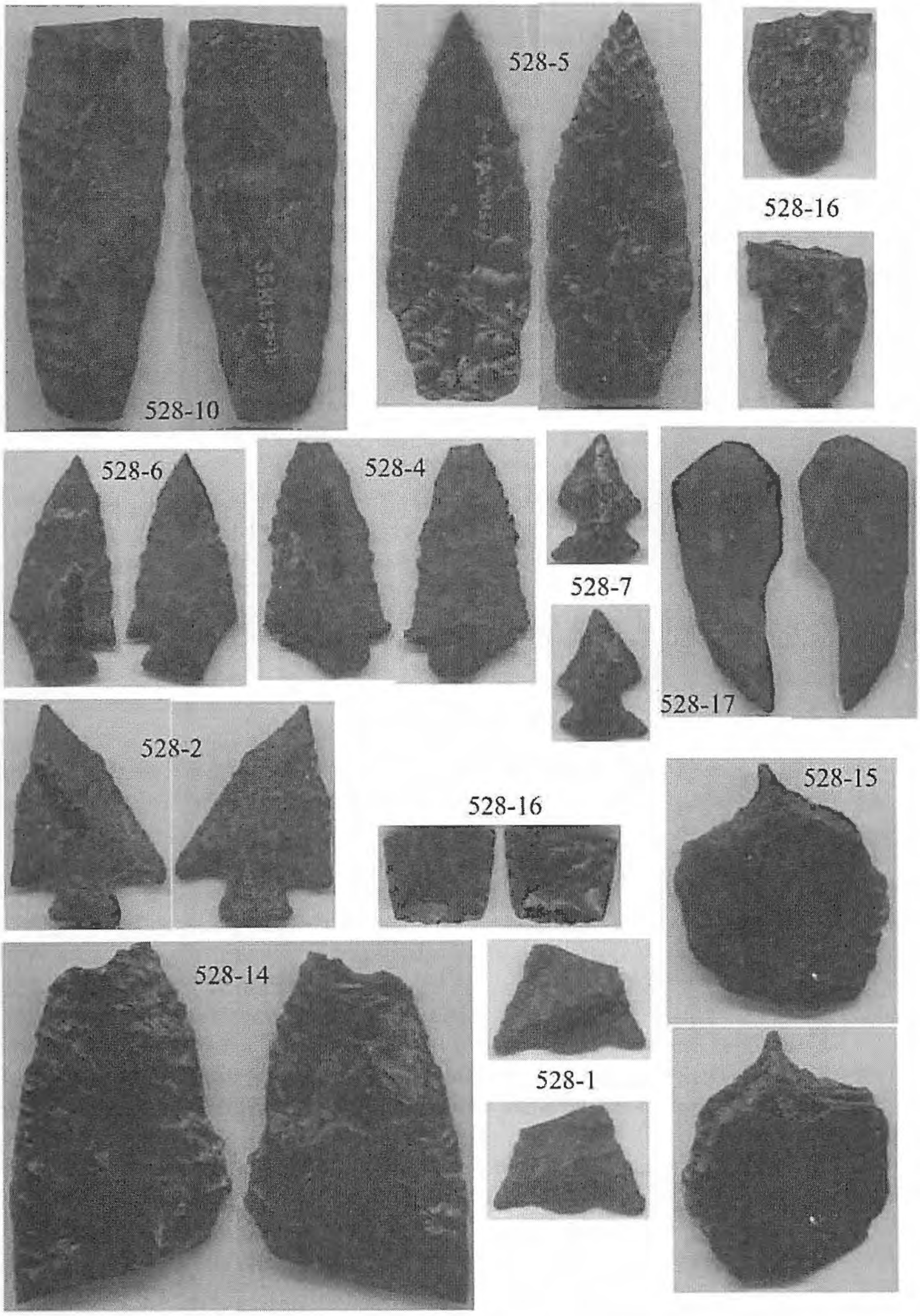
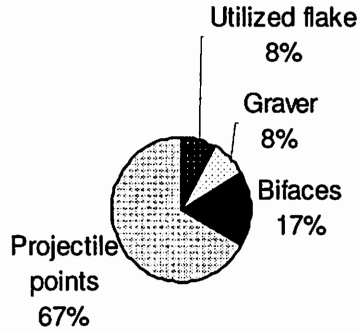


Figure 6.1. Stone tools from site 35KL528.

Figure 6.2 Proportion of each tool class represented at site 35KL528.



margins, producing a serrated edge. The break at the top is a perverse fracture. The break that detached the corner was caused by a bending fracture, with pressure being applied to the corner. It is possible that it occurred while re-hafting the point. It has a width to thickness ratio of 3.96 and has been assigned to stage 7. Due to the absence of a large portion of the hafting element, it was not possible to place this point within a typology.

Artifact 528-5 is a large, stemmed projectile point. It is complete and crafted from opaque, black obsidian. It has small shoulders and slightly convex sides. The base is flat and its margins have been lightly abraded. The sides of the base contract slightly. At the proximal end, both faces exhibit regularly spaced flake detachments, traveling diagonally down towards the longitudinal axis. Retouch on the piece is late stage and primarily pressure flaking. It has a width to thickness ratio of 3.33 and has been assigned to stage 6. This artifact has been classified as a Western Stemmed series point. The raw material for this tool has been traced to the Obsidian Cliffs obsidian source.

Artifact 528-6 is a medium-sized, triangular projectile point. Formed on a piece of opaque, grey obsidian, this specimen is missing a corner of the distal end. The piece is corner-notched with a convex base, and an expanding stem. Retouch is irregular, bifacial and continuous. Pressure flaking is the primary reduction technique represented on the point. The missing corner appears to be the result of an outrepasse flake that ran down from the opposite margin. It has a width to thickness ratio of 3.3 and has been assigned to stage 5. This artifact has been classified as an Elko series point. The raw material source for this tool has been traced to the McKay Butte obsidian source.

Artifact 528-7 is a small, triangular projectile point. The specimen is complete and is made from opaque, black obsidian. It is side-notched with an expanding, slightly convex base. Retouch is irregular, bifacial and continuous. Pressure flaking is the primary reduction technique evident on the point. It has a width to thickness ratio of 3.15 and has been assigned to stage 6. This artifact has been classified as a Desert Side-Notched series point. The raw material used to manufacture this tool has been traced to the Silver Lake / Sycan Marsh obsidian source.

Artifact 528-9 is the distal end of a stemmed projectile point. What remains is the whole haft element and a small portion of the blade. One side has a pronounced shoulder, while the other is more gradual. The sides of the base constrict slightly. The bending fracture running across the transverse axis suggests that the piece was snapped prior to shouldering the other side. Retouch is invasive, bifacial and continuous. Pressure flaking is the primary reduction technique in evidence. It has a width to thickness ratio of 3.54 and has been assigned to stage 5. This artifact has been classified as a Western Stemmed series point. The tool stone has been determined to be from the Obsidian Cliffs obsidian source.

Artifact 528-10 is the medial and distal portion of a large, obsidian biface. Retouch on the piece is continuous and bifacial. One face has long, regularly spaced, pressure flakes that travel towards the longitudinal axis. The other side is irregularly retouched. The grainy quality of the obsidian appears to have contributed to the formation of several step and hinge fractures on both sides of the piece. The haft element shows evidence of abrasion and contains a flat, slightly thinned base. The sides of the piece contract considerably. Its outline is convex, although the blade shape is uncertain. The broken proximal end appears to have occurred due to impact burination. It has a width to thickness ratio of 2.8 and has been assigned to stage 7. This artifact has been classified as a Western Stemmed series point. The raw material for this tool has been traced to the Silver Lake / Sycan Marsh obsidian source.

Artifact 528-16 is the basal fragment of a stemmed projectile point. Crafted from opaque, black obsidian, the fragment may have been severed as a result of impact burination. Retouch is bifacial and continuous on both sides, with one displaying parallel retouch. The base is flat and slightly thinned. The breakage morphology below the blade suggests that it may have detached as a result of an impact burination. Retouch was achieved through the use of pressure flaking. It has a width to thickness ratio of 3.3 and has been assigned to stage 7. This artifact has been classified as a Western Stemmed series point. Obsidian source characterization points to Spodue Mountain as the tool stone source.

Bifacial Tools

Artifact 528-14 is a black obsidian biface fragment. Retouch is bifacial and continuous, though irregular in some places. Both sides are convex, although one is much more regular than the other is. A bending fracture runs across the transverse axis of the piece. The opposite end is blunted and shows evidence of crushing. The primary reduction technique evident on the piece is pressure flaking. The artifact has a width to thickness ratio of 4.07 and has been assigned to reduction stage 5. It appears that the artifact was broken while it was being shaped, and may have been discarded, despite retaining some utility. XRF was not performed on this artifact.

Other Stone Tools

Artifact 528-15 is a black obsidian graver made on a secondary reduction flake. Its edge shape is round with a pointed end. Retouch is continuous and bifacial. This complete artifact has four edges that show evidence of retouch. The reduction techniques used to reduce the piece appear to be both soft hammer percussion and pressure flaking. No source characterization was made for this artifact.

Artifact 528-17 is a unifacially retouched utilized flake. It is made from a flake of reddish-yellow cryptocrystal silicate. Retouch is on the proximal and distal ends, and is restricted to the dorsal surface. This artifact was produced using both soft hammer percussion and pressure flaking reduction technologies.

Two obsidian scrapers, 528-11 and 528-12, which were collected in 1984, were unavailable for analysis because they were on loan for an educational during the research phase. Based on the original site report and subsequent updates, their descriptions are as follows. Artifact 528-11 is an obsidian steep-end scraper measuring 5.5 x 4.4cm. Produced on a primary or large secondary reduction flake, retouch is primarily on the dorsal surface. Artifact 528-12 is a grey obsidian scraper measuring 4.4 x 3.2cm. Retouch is primarily on the dorsal surface, while the original flake scar is mostly intact on the ventral surface.

SITE 35-KL-878 (LITTLE BUTTE)

Ten flaked stone artifacts were analyzed from site 35KL878. Basic attributes recorded for the artifacts are presented in Table 6.3. Digital images of the artifacts are presented in Figure 6.3. Figure 6.4 shows the relative proportion of each functional tool class represented at the site.

#	Type	Raw Mat	L	xW	xT	Reduction
878_1	Preform	Obsidian	5.3	2.1	.59	4/4
878_2	Biface	Obsidian	6.5	2.4	1.0	4/5
878_3	Preform	Obsidian	5.2	2.2	.65	4/4
878_4	Preform	Obsidian	5.0	1.8	.8	4/4
878_5	Biface	Obsidian	2.9	1.9	1.0	4/4
878_6	Biface	Obsidian	2.0	1.6	.91	5/5
878_7	Biface	Obsidian	7.9	2.3	1.1	7/7
878_8	Biface	Obsidian	1.8	1.6	.43	7/7
878_9	Preform	Obsidian	4.4	2.3	.94	4/4
878_10	Biface	Obsidian	2.2	1.6	.49	7/7

Table 6.3 Stone tools from site 35KL878.

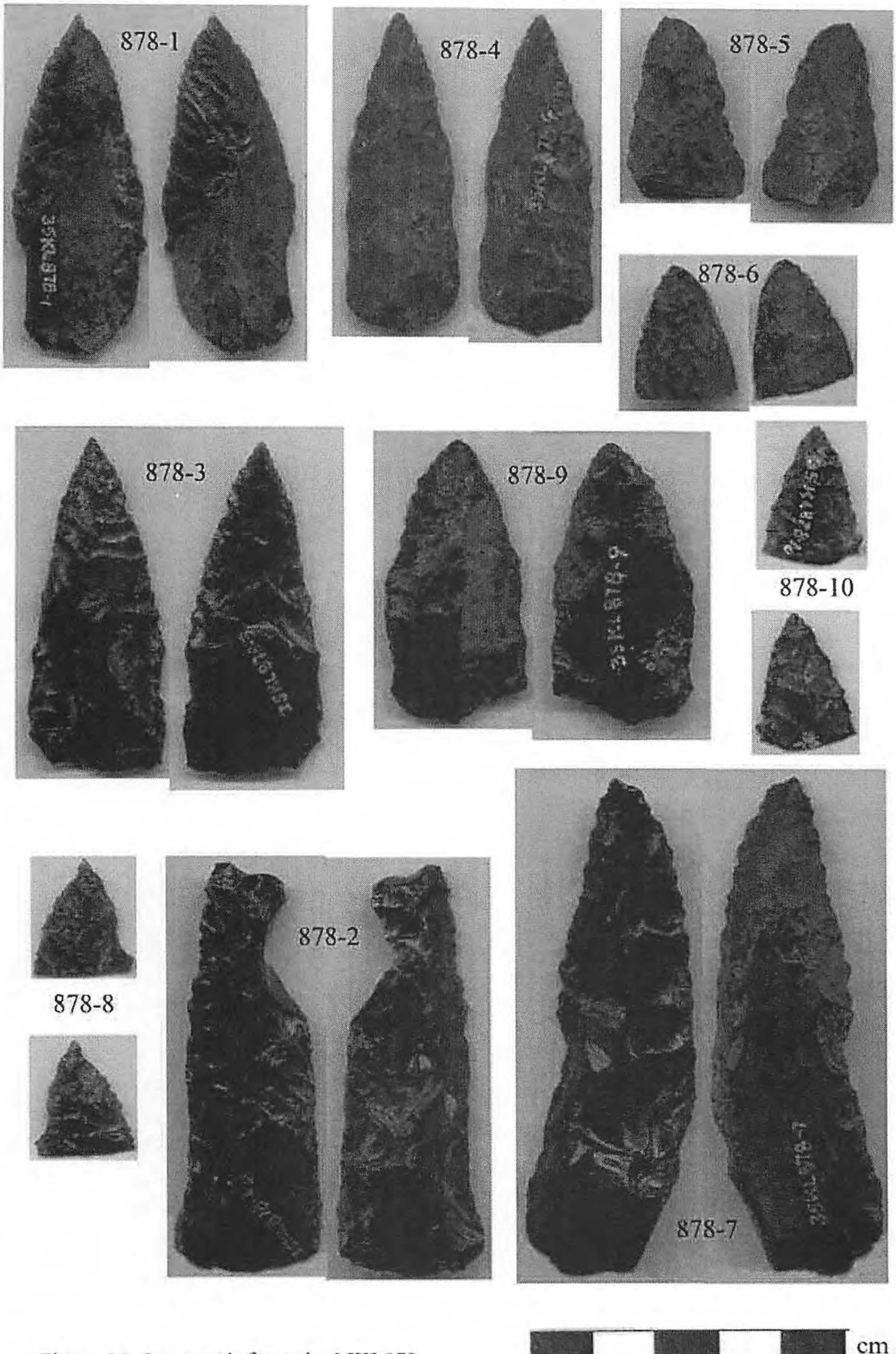


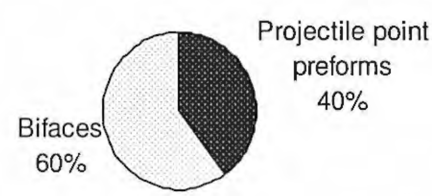
Figure 6.3 Stone tools from site 35KL878.

Projectile Point Preforms

Artifact 878-1 is a black obsidian projectile point preform. It is triangular and was produced on a flake blank. It has a light patina on approximately 70 percent of its surface. Retouch is bifacial and clustered. Pressure retouch is primarily restricted to the proximal blade margins. The basal end of the piece is relatively thick and has not been prepared to accept a haft. It has a width to thickness ratio of 3.69 and has been assigned to reduction stage 4. The raw material for this artifact was traced to the Silver Lake / Sycan Marsh obsidian source.

Artifact 878-3 is a black obsidian projectile point preform. Its shape is triangular and has a light patina covers approximately 30 percent of the piece. The proximal end received the greatest amount of pressure retouch resulting in a thin cross-section and a sharp tip. The distal end retains percussion flake scars and areas of high mass on both aspects. Pressure retouch on the distal end is very limited and discontinuous. No haft element was applied. The width to thickness ratio for the piece is 3.5 and it has been assigned to stage 4. Obsidian used to produce the preform was traced to the Silver Lake / Sycan Marsh source.

Figure 6.4 Tool classes represented at site 35KL878.



Artifact 878-4 is a grey obsidian projectile point preform, which is triangular in shape. Like the two above, the proximal end has received the most reduction. Pressure retouch is primarily located on near the tip and proximal blade margins, while the distal end needs additional thinning. No haft element is present. The piece has a width to thickness ratio of 2.35 and has been assigned to reduction stage 4. XRF analysis indicates the raw material for the artifact is from the McKay Butte obsidian source.

Artifact 878-9 is a small obsidian projectile point preform. The piece retains some cortex on approximately 20 percent of its surface. Retouch is bifacial and irregular producing sinuous edges. Most pressure retouch is on the proximal end. The original ventral surface of the flake blank still covers 50 percent of one aspect. The base of the preform is thick and terminates in a blunt, flat break. The fracture appears to be the result of a bending fracture that should not have hindered the production of a hafted point. A haft element had not been applied. Its width to thickness ratio is 2.45 and has been attributed to stage 4. XRF was not performed on this artifact.

Bifacial Tools

Artifact 878-2 is a medium-sized, black obsidian biface. The piece is broken in two places, thus removing the proximal end and one proximal margin. The artifact's edges are straight and appear to have converged into a point or rounded tip. The edge angle is fairly steep for a biface, at more than 31°. The base is slightly convex. Retouch is bifacial and continuous. One aspect has a number of diffuse percussion flake scars, while the other face shows signs of considerably more pressure retouch. The side with pronounced percussion scars also retains an area of high mass at the distal end. The reduction staging and type of breaks are suggestive of a break during manufacture or rejuvenation. The piece has a width to thickness ratio of 1.87 and is assigned to stage 4/5. The raw material for this biface was traced to the Newberry Volcano obsidian source complex.

Artifact 878-5 is a proximal fragment of an obsidian biface. A bending fracture traveled across the transverse axis to detach the piece. The piece is covered in cortex on approximately 10 percent of its surface. Retouch is bifacial and continuous. The edges are very sinuous, and converge in a rounded tip. Invasive percussion flaking is the predominant reduction evident, with limited pressure retouch along the margins. The piece has a width to thickness ratio of 1.8 and has been assigned to stage 4. No source characterization was made for this artifact.

Artifact 878-6 is a medial biface fragment. It is made from grainy black obsidian. Retouch is bifacial and continuous with extensive pressure flaking on both sides of the piece. The edge is sharp, yet sinuous. The break is suggestive of a bending fracture. It has a width to thickness ratio of 1.85 and has been attributed to stage 5. No source characterization was made for this artifact.

Artifact 878-7 is a medium sized unhafted biface. It is made from fine grained black obsidian and is covered in a light patina on 50 percent of its surface. The piece is backed along the distal margins. Retouch is bifacial and most extensive on the proximal end. The ventral surface of the flake blank still covers approximately 60 percent of one aspect. The dorsal surface is more invasively retouched, but has an irregular, chunky surface. The dorsal surface shows evidence of broad flake removals, but very little pressure retouch. The biface does not appear to be exhausted. Its width to thickness ratio is 2.04 and it has been assigned to stage 7. The raw material for this tool was traced to the Silver Lake / Sycan Marsh obsidian source.

Artifact 878-8 is a small bifacial proximal fragment made from black obsidian. It is triangular in shape and may have come from a projectile point. Pressure retouch is bifacial and continuous. It has a width to thickness ratio of 3.72 and has been assigned to stage 7. A source characterization was not made for this artifact.

Artifact 878-10 is a small bifacial proximal fragment. Made from black obsidian, the piece exhibits extensive pressure retouch on both aspects. The edges are slightly sinuous and end in a blunt bending fracture. It has a width to thickness ratio of 3.34 and has been assigned to stage 7. No source characterization was made for this artifact.

SITE 35-KL-879 (JIM-BOB)

Ten flaked stone artifacts were analyzed from site 35KL879. Basic attributes recorded for the artifacts are presented in Table 6.4. Digital images of the artifacts are presented in Figures 6.5, 6.6, and 6.7. Figure 6.8 shows the relative proportion of each functional tool class represented at the site.

Bifacial Tools

Artifact 879-1 is a large (12.88cm) obsidian biface. Its shape is leaf-like, one end having a sharp point, the other a fairly round point. A heavy patina covers approximately 60 percent of one side of the piece. Retouch is bifacial and continuous. Broad flake scars produced by soft hammer percussion are overlain with long, narrow pressure flake scars. Patterned retouch is evident on the unpatinated side with scars running diagonally from the upper left to lower right on both sides of the longitudinal axis. All of the tool's margins retain relatively sharp edges and don't show evidence of abrasion or backing as would be expected if it was hafted. The artifact has a width to thickness ratio of 3.07 and is assigned to stage 5. The raw material for this biface was traced to the Silver Lake / Sycan Marsh obsidian source.

#	Type	Raw	L	xW	xT	Reductio	Sub Type
879_1	Biface	Obsidian	12.88	4.0	1.3	5/5	*
879_2	Biface	Obsidian	11.06	3.53	.9	5/5	*
879_3	Biface	Obsidian	11.48	4.24	.89	5/5	*
879_4	Projectile	Obsidian	3.55	1.85	.23	7/7	Rosespring
879_5	Blank	Obsidian	7.25	3.92	1.0	2/4	*
879_6	Biface	Obsidian	12.56	4.09	1.3	5/5	*
879_7	Biface	Obsidian	3.9	2.76	1.1	2/2	*
879_8	Utilized	Obsidian	3.46	1.8	.26	*	BFT
879_10	Utilized	Obsidian	2.59	2.08	1.6	*	*
879_11	Scraper	Obsidian	2.65	3.04	.56	2/2	*

Table 6.4 Stone tools from site 35KL879.

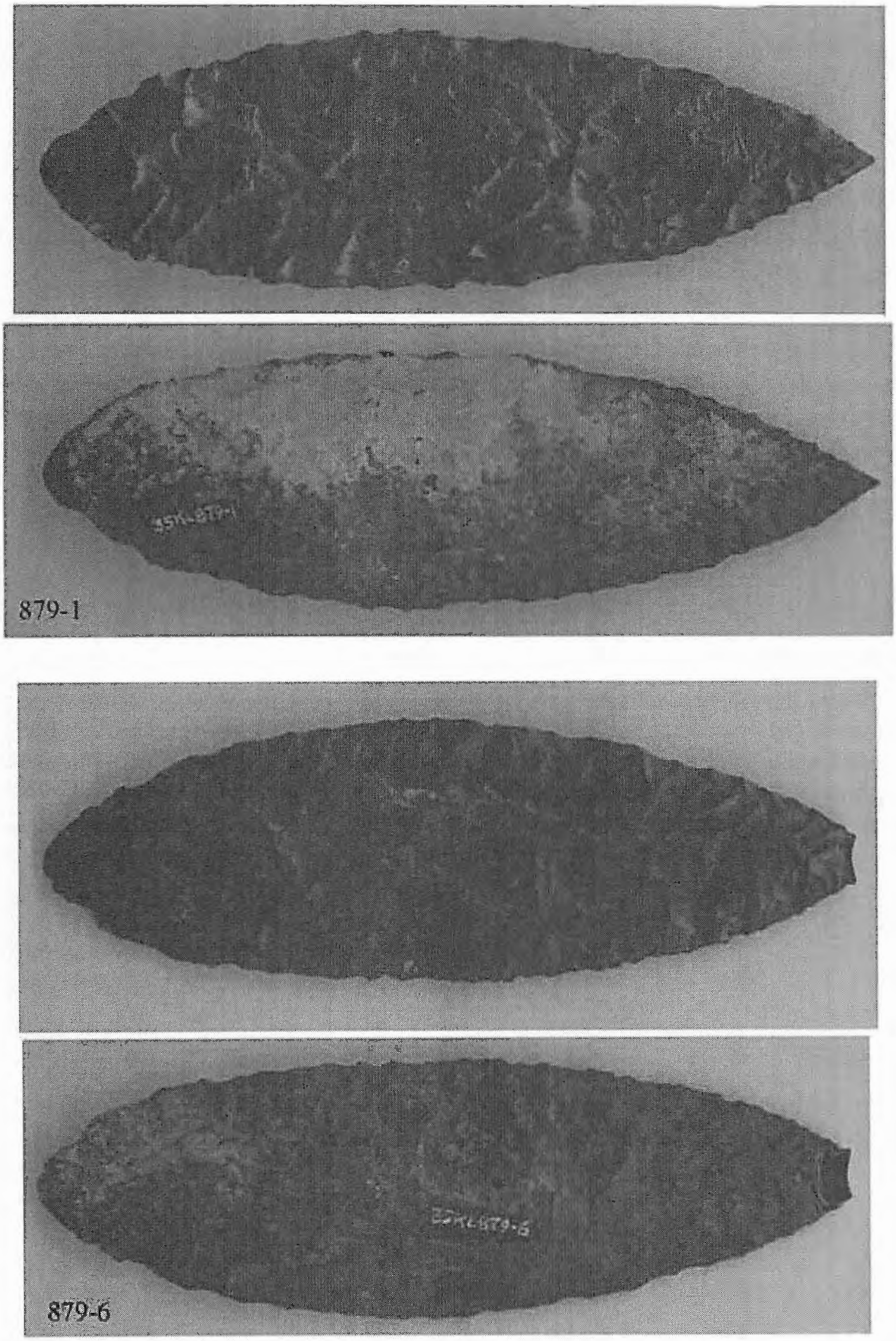


Figure 6.5. Stone tools from 35KL879. cm.

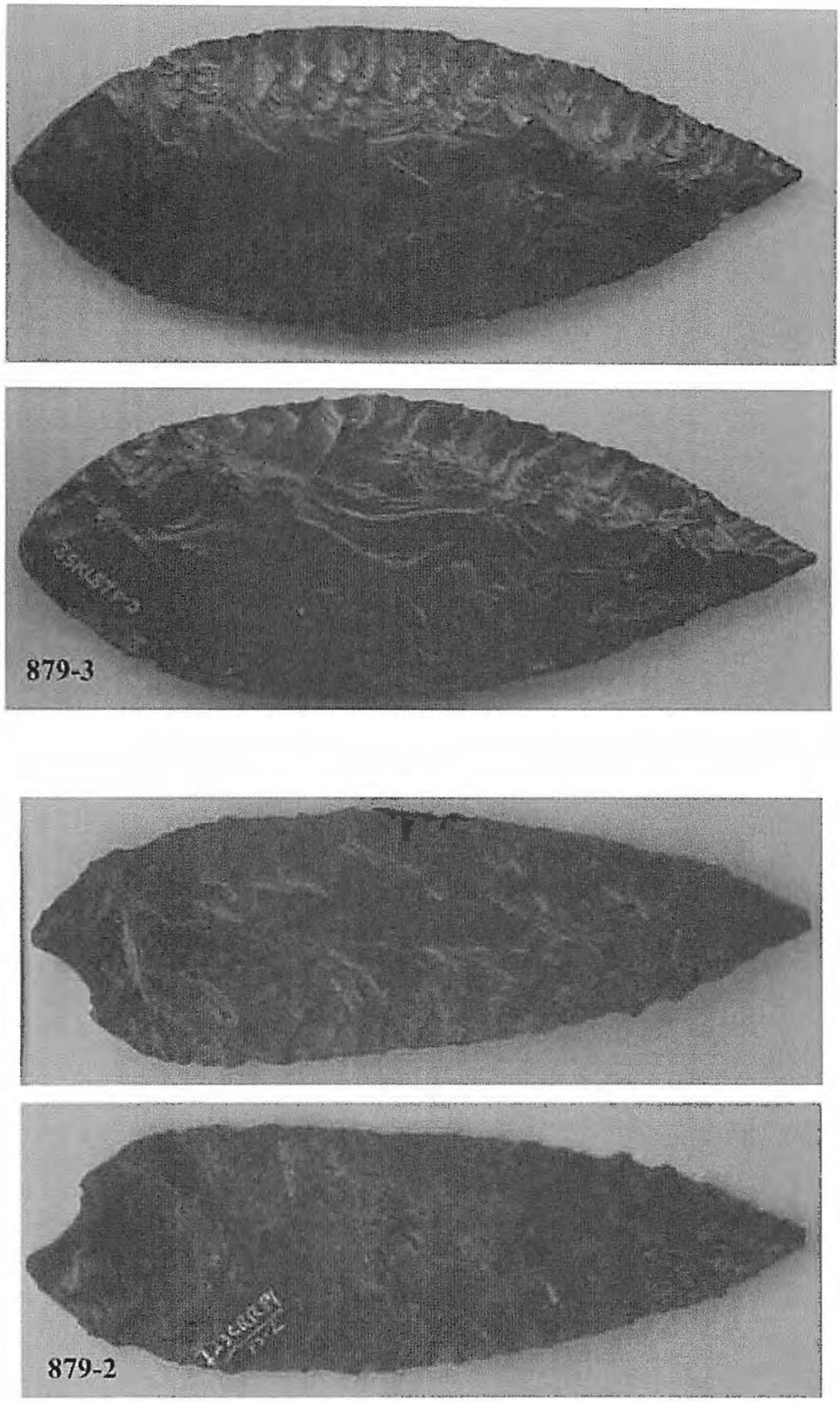
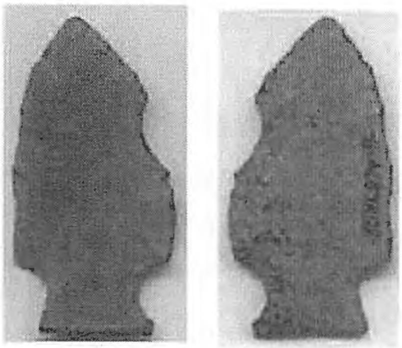
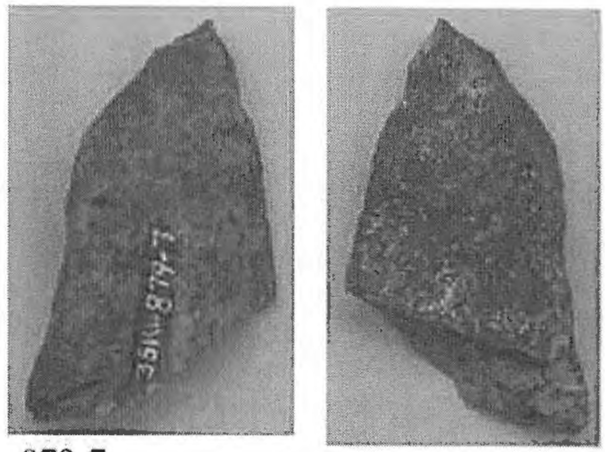


Figure 6.6. Bifaces from site 35KL879.

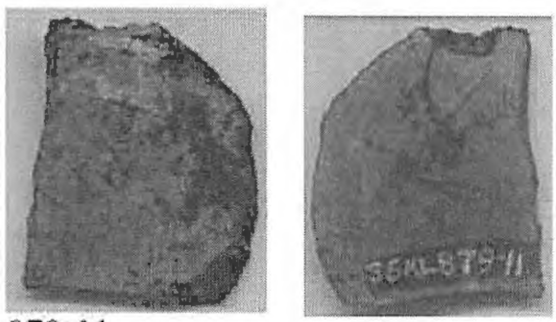
cm.



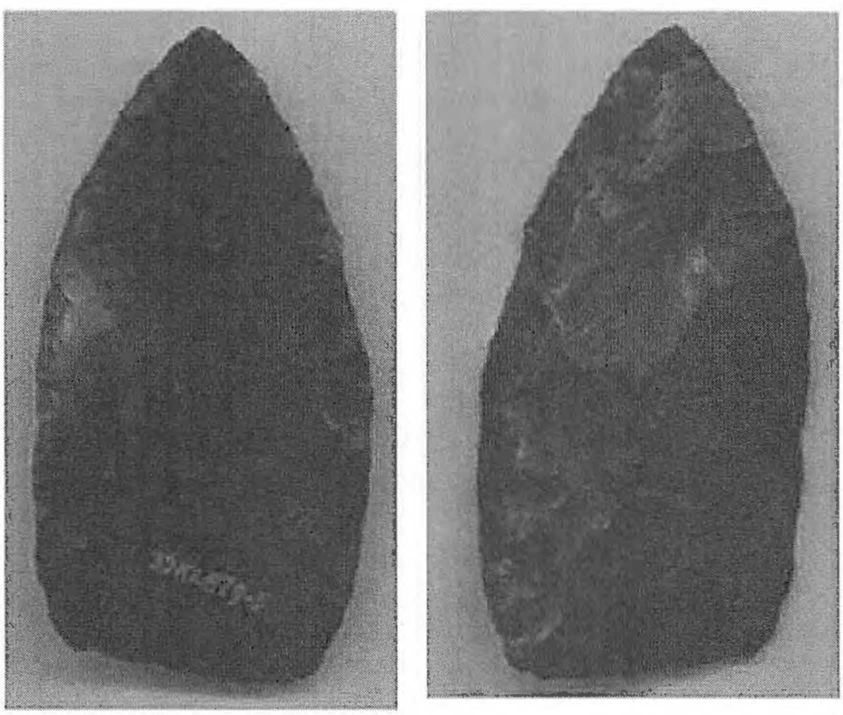
879-4



879-7



879-11

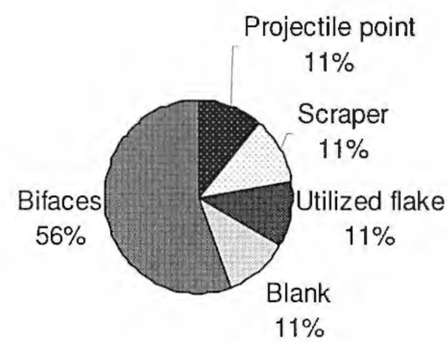


879-5

Figure 6.7. Stone tools from site 35KL879. cm.

Artifact 879-2 is a large obsidian biface measuring 11.06cm in length. One end comes to a sharp point, whereas the other is less acute and has a substantial chip missing along one basal margin. A light patina covers less than 5 percent of one face. Retouch is bifacial, with large, invasive flakes traveling past the midline, which are obscured in places by clustered pressure flaking. Pressure flaking produced long, slender scars that generally travel diagonally toward the

Figure 6.8 Proportion of each tool class represented at site 35KL879.



longitudinal axis. One side of the piece has been pressure flaked on approximately 90 percent of the margins, whereas the other side exhibits clusters of pressure retouch. Although the morphology of the biface suggests its use as a projectile, it doesn't display any basal thinning, grinding or abrasion that a haft would require. It has a width to thickness ratio of 3.92 and is assigned to stage 5. A source characterization was not made for this artifact.

Artifact 879-3 is a large obsidian biface, measuring 11.48 cm in length. This piece is finely worked with bifacial, patterned pressure retouch. One end comes to a sharp point. The other is slightly round with abraded margins. The backed portions of the basal margins extend approximately 2.5cm above the longitudinal axis on both sides. Large thinning flake scars can be seen along the middle of both aspects. One side has a broad step termination that left an area of high mass. This imperfection would not have affected the utility of the tool and would have been difficult or impossible to remove. Overall, the tool is quite refined and ready to be used or fitted with a haft. The width to thickness ratio for this tool is 4.75 and it has been assigned to stage 2/4 (ventral / dorsal). The raw material for this tool has been traced to the Silver Lake / Sycan Marsh obsidian source.

Artifact 879-4 is a small, rather crude projectile point. Produced on a flake blank, retouch is continuous and unpatterned. The raw material is black obsidian covered with a heavy patina. The point has broad side notches and a flat to convex base. One blade margin has a 1cm crescent-shaped chip missing. Pressure retouch is limited to the outer margins. With a width to thickness ratio of 8.04, it has been categorized as a stage 7 biface. The point was assigned to the Rosegate series. The raw material for this piece was traced to the Cougar Mountain obsidian source.

Artifact 879-5 is a medium-sized trimmed flake blank. Triangular in outline, the piece is unifacially worked. The dorsal aspect is the only surface exhibiting extensive retouch, composed primarily of large thinning flake scars. Flake detachments on the ventral surface appear to be the result of backing and platform preparation. Ventral flake detachments tend to be very small. A light patina is evident on the dorsal surface. The width to thickness for the artifact is 3.76 and has been assigned to stage 2/4 (ventral / dorsal). A source characterization was not made for this artifact.

Artifact 879-6 is a large obsidian biface (12.56cm) with a light patina completely covering one side. It is leaf-shaped and has a broken tip that occurred relatively recently. Retouch is bifacial with extensive pressure flaking. On one side of the piece, pressure flaking is patterned, whereas the other side exhibits less patterning. Both aspects retain earlier percussion flake scars along the centerline. The base is round and has not been prepped for a haft by grinding or abrasion. The artifact has a width to thickness ratio of 2.98 and has been assigned to stage 5. The raw material for this tool was traced to the Silver Lake / Sycan Marsh obsidian source.

Artifact 879-7 is a medial biface fragment. The piece is made from grainy black obsidian. Retouch is continuous. Flake scars suggest that soft hammer percussion was used to thin the piece. The fracture appears to be the result of bending forces, which may have occurred during the thinning process. The artifact was discarded at stage 2. A source characterization was not made for this artifact.

Other Stone Tools

Artifact 879-10 is a utilized flake made of obsidian. This expedient tool was made on a classic alternate flake that shows retouch on the distal end. Retouch is unifacial, clustered, and likely the result of use. A light patina covers approximately 60 percent of the artifact's surface. An obsidian source determination was not made for this artifact.

Artifact 879-11 is a small obsidian end scraper. The piece has a rather acute edge angle of less than 60°. A thick patina covers approximately 80 percent of the artifact's surface. Retouch is unifacial and restricted to the dorsal surface.

SITE 35-KL-880 (JUNE BUG)

Four flaked stone artifacts were analyzed from site 35KL880. Table 6.5 lists the basic attributes recorded for the artifacts from the site. Digital images of the artifacts are presented in Figure 6.9. The relative proportion of each functional tool class represented at the site is shown in Figure 6.10.

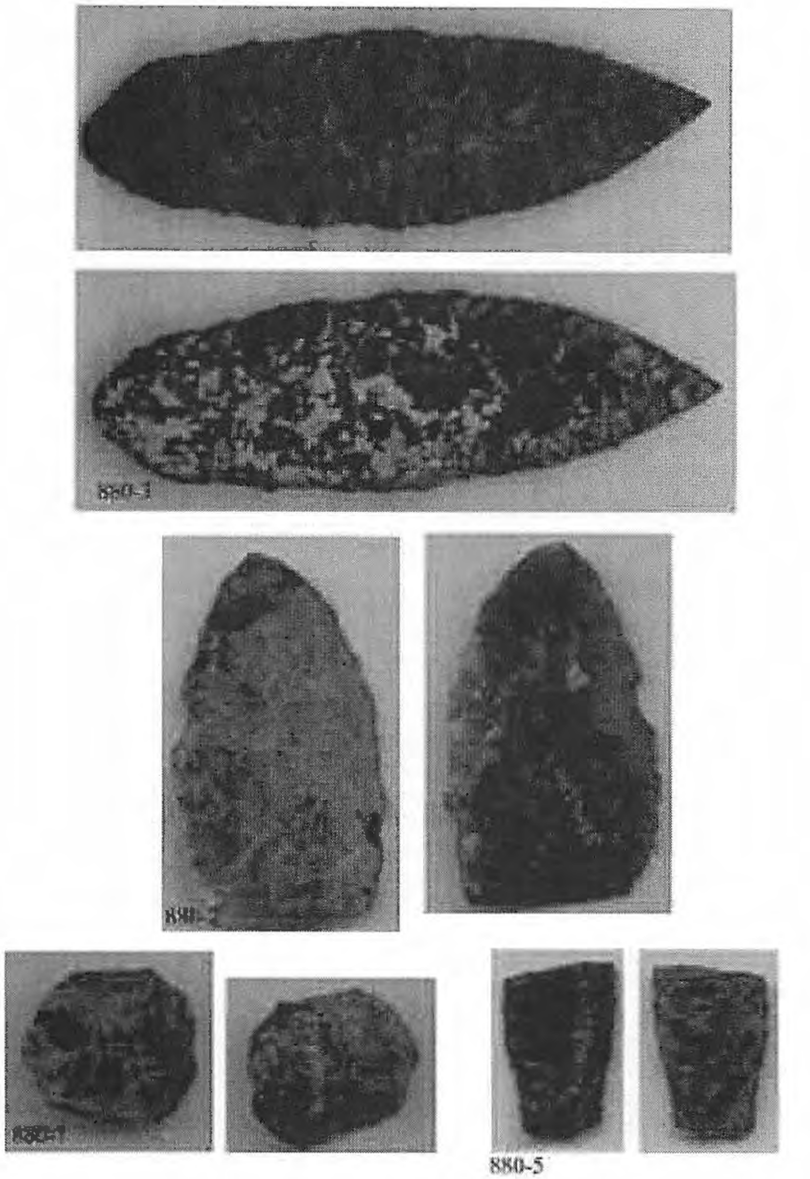


Figure 6.9. Stone tools from site 35KL880. cm.

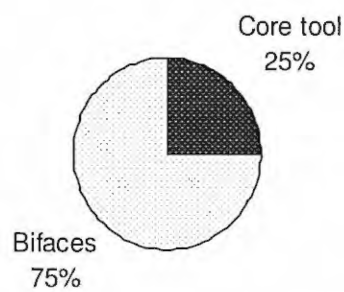
#	Type	Raw	L	xW	xT	Reduction	Sub Type
880_1	Core Tool	Obsidian	3.3	2.95	1.6	*	*
880_2	Biface	Obsidian	6.3	4.13	.93	3/3	*
880_3	Biface	Obsidian	11.	3.67	.98	5/5	*
880_5	Projectile	Obsidian	3.0	2.14	.73	7/7	Western

Table 6.5. Stone tools from site 35KL880.

Bifacial Tools

Artifact 880-2 is a medium-sized edged blank. It is made from opaque black obsidian traced to the Newberry Volcano source group. The piece has an ovate outline with a blunt distal end, which is the result of an apparent bending fracture. Retouch is bifacial and irregular. Large flake scars on most of the piece are indicative of soft hammer reduction. The smaller retouch observed on several margins suggest abrasion by the knapper or post-depositional alteration. One side is covered in a heavy patina, with the exception of ~2cm of the proximal end that exhibits a fresh surface likely the result of a modern detachment. It has a width to thickness ratio of 4.44 and has been assigned to stage 3.

Figure 6.10 Proportion of each tool class represented at site 35KL880.



Artifact 880-3 is a large, complete (11.4cm) obsidian biface. The outline of the piece is lenticular and resembles a leaf. The proximal end comes to a sharp point, while the dorsal end is slightly rounded. Patina covers approximately 10 percent of one side of the piece. Retouch is bifacial and highly patterned. Large flake scars produced by soft hammer percussion are present on a portion of the base. Long and narrow pressure flakes cover most of the artifact's surface. The flakes extend diagonally down towards the longitudinal axis. Only a small amount of abrasion was observed on the base of the piece, suggesting it had yet to be hafted or backed for use. It has a width to thickness ratio of 3.74 and has been assigned to stage 5. The obsidian used in the production of the tool was traced to the Cougar Mountain source.

Artifact 880-5 is the basal end of a hafted biface. The base is roughly rectangular in shape, with slight shoulders on either margin approximately 1.5cm from the base. It has been classified as a Western Stemmed series point. The basal edge is missing a corner and suggests a slightly concave shape prior to the break. Basal grinding is apparent on the entire haft element. Retouch is bifacial and patterned. Pressure flaking runs parallel to the transverse axis and flake scars terminate at the midline. The break at the proximal end was caused by a perverse fracture. It is not clear whether the break occurred during manufacture, use or rejuvenation. A light patina covers approximately 40 percent of the tool's surface. It has a width to thickness ratio of 2.93 and has been assigned to stage 7. The obsidian used for this tool was traced to the Silver Lake / Sycan marsh source.

Other Stone Tools

Artifact 880-1 is a small, obsidian core tool. Flake scars are multi-directional and were likely detached with a bipolar technique. Measuring just 3.39 x 2.95 cm, the piece exhibits long and narrow flake scars on both ventral and dorsal surfaces. Several portions of the tool's margin has clustered retouch suggesting its use as a cutting or scraping tool. It is round in shape with steep edge angles. The original platform is visible on the dorsal side of the tool. Cortex covers approximately 20 percent of the artifact's surface. Given the steep edge angles and small size, the tool may have been discarded after exhaustion of most of its utility. An obsidian source determination was not made for this artifact.

Three additional artifacts from site 35KL880 have been documented, but were unavailable for this study. 880-4 is described in the site record as a basalt grinding stone. It measures 13.85 x 8.75 x 4.15 cm and exhibits substantial battering at two ends. It is not clear whether the function attributed to the tool was a result of observed polish or faceting on the stone's surface, or was assumed on the basis of its general shape. The battering at either end detached many irregular flakes, producing acute edge angles. The tool appears well suited to processing animals, particularly bones. Shovel testing at the site produced one artifact, which was reburied after being documented. It was a small fragment of a basalt "handstone" measuring approximately 7 x 5cm. Finally, a late-stage, obsidian biface midsection was located on the surface and not collected. It measured approximately 3 x 2cm.

SITE 35-KL-888 (WEST DAVIS LAKE CAMPGROUND)

Eleven flaked stone artifacts were analyzed from site 35KL888. Table 6.6 lists the basic attributes recorded for the artifacts from the site. Digital images of the artifacts are presented in Figure 6.11. The relative proportion of each functional tool class represented at the site is shown in Figure 6.12.

Projectile Points

Artifact 888-1 is a small, triangular projectile point, made of opaque, black obsidian. It is missing the proximal end and one tang. It exhibits continuous, bifacial retouch. The sides are straight and slightly sinuous. The piece is basally-notched with a convex, slightly expanding base. The one remaining barb is somewhat round and jagged. The primary reduction technique observed on the

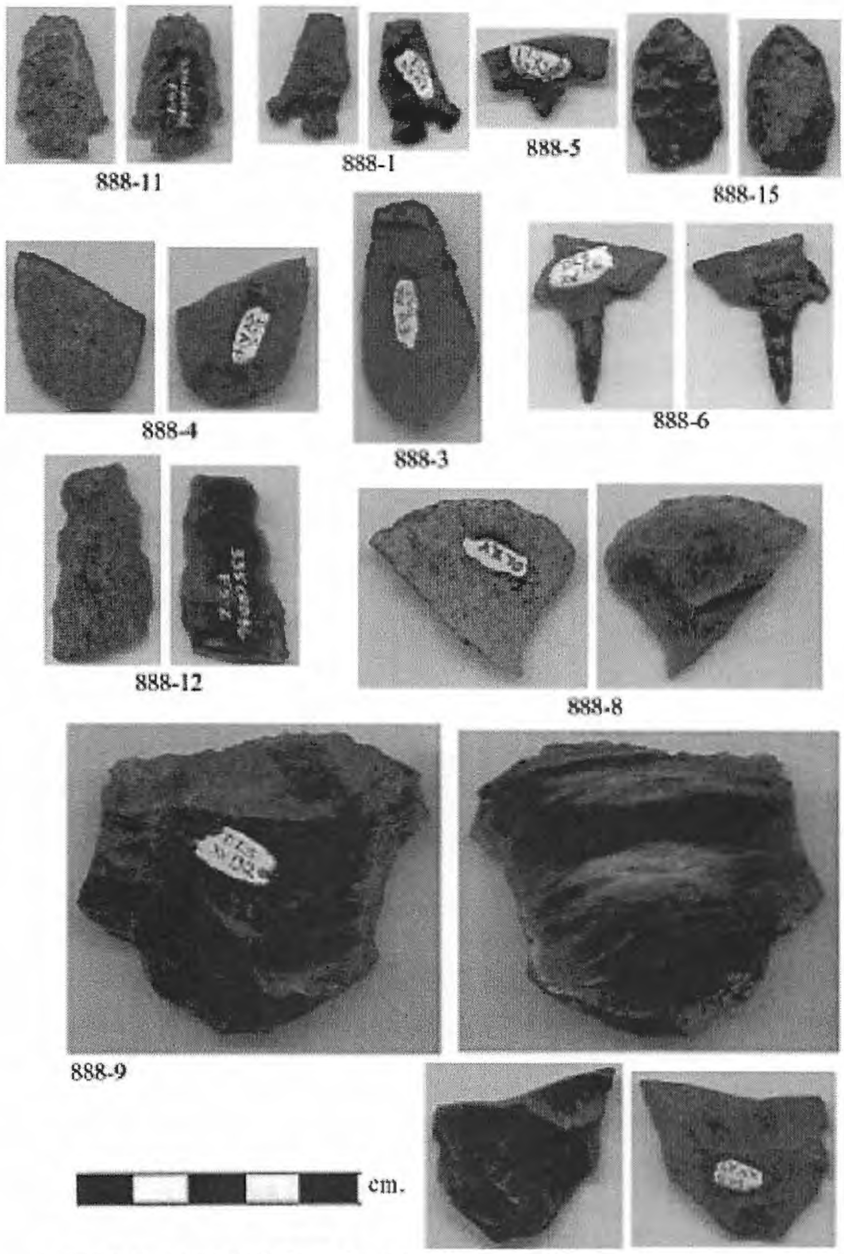


Figure 6.11. Stone tools from site 35KL888.

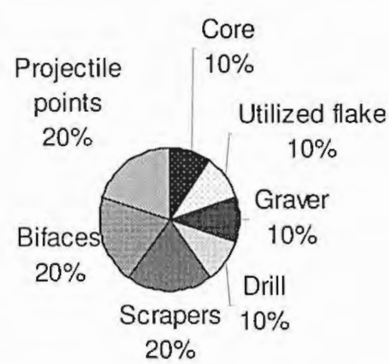
point is pressure flaking. It has a width to thickness ratio of 3.62 and has been assigned to stage 7. This artifact has been classified as a Rosegate series point. The raw material for this tool has been traced to the Spodue Mountain obsidian source.

Artifact 888-11 is a small projectile point, made of opaque, black obsidian. One face of the tool is heavily patinated, while the other is to a lesser degree. The tip is blunted and it is missing part of the base. The sides of the point are straight, and quite sinuous. It is corner notched, with a slightly convex base. The primary reduction technique observed on the point is pressure flaking. It has a width to thickness ratio of 3.39 and has been assigned to stage 7. This artifact has been classified as a Rosegate series point. The raw material for this tool has been traced to the Newberry Volcano obsidian source complex.

Catalog#	Type	Raw	L	xW	xT	Reduction	Sub Type
888_1	Projectile	Obsidian	2.22	1.27	.35	7/7	Rosespring
888_3	Scraper	CCS	3.96	2.22	.66	1/2	*
888_4	Biface	Obsidian	2.6	2.4	.71	3/3	*
888_5	Graver	Obsidian	1.42	2.36	.5	5/5	*
888_6	Drill	Obsidian	2.85	2.0	.26	5/5	*
888_7	Biface	Obsidian	2.75	3.42	.71	3/3	*
888_8	Scraper	Obsidian	3.7	3.23	.58	1/2	*
888_9	Core	Obsidian	5.09	5.91	1.52	1/1	*
888_11	Projectile	Obsidian	2.5	1.63	.48	7/7	Rosespring
888_12	Utilized	Obsidian	3.2	1.9	.45	*	*
888_15	Biface	Obsidian	2.6	1.62	.42	5/5	*

Table 6.6. Stone tools from site 35KL888.

Figure 6.12 Proportion of each tool type represented at site 35KL888.



Bifacial Tools

Artifact 888-4 is a fragment of an ovate, black obsidian biface. The raw material is somewhat coarse-grained and opaque. Flaking is continuous and bifacial, although irregular. There is some crushing evident on the margin of the ventral surface. The primary technology observed on the piece is soft hammer percussion, with limited pressure flaking. The break, which runs diagonally across the transverse axis appears to be the result of a bending fracture. The piece has a width to thickness ratio of 3.38 and has been assigned to stage 3. An obsidian source characterization was not made for this artifact.

Artifact 888-7 is an opaque, black obsidian biface fragment. The piece was apparently in the process of being thinned and shaped when it snapped from an bending fracture. Retouch is bifacial and unpatterned. A soft hammer percussiontechnology is suggested. The piece has a width to thickness ratio of 4.81 and has been assigned to stage 3. An obsidian source characterization was not made for this artifact.

Artifact 888-15 is a small, complete biface, made of opaque, black obsidian. It is roughly ovate in shape, and retains what looks like a shouldered haft element. Retouch is continuous and bifacial. The primary technology observed on this biface is pressure flaking. It has a width to thickness ratio of 3.85 and was assigned to stage 7. It is probable that it was originally crafted as a projectile point, then laterally cycled to another use. The small size and limited capacity for rejuvenation suggests that it was discarded once the user decided its utility had been exhausted. An obsidian source characterization was not made for this artifact.

Other StoneTools

Artifact 888-3 is a scraper produced from a flake blank. The tool is made from a brownish cryptocystal silicate, and still retains the flake platform on the distal end. The ventral surface is slightly concave, while the dorsal side retains a long ridge running the length of its convex surface. The piece is unifacially retouched on the dorsal side in two clusters. Retouch on the ventral surface is limited to a single flake scar. The working edges in excess of 45 degrees. Both soft hammer percussion and pressure flaking techniques are evident on the piece.

Artifact 888-5 is an opaque, grey obsidian graver. With its working edge pointed down, it looks like a recycled projectile point base. Two basal notches set up the working point, 0.8cm in length. Opposite the working edges, a straight bending fracture runs across the transverse axis. Retouch is clustered on the piece and is concentrated on the point. The raw material source represented by the tool was traced to the McKay Butte obsidian source.

Artifact 888-6 is an opaque, black drill or perforator. It is crafted on a thin flake that was backed by abrasion. A patina covers the piece, except on the retouched blade and backed margins. The superposition of flake scars atop the patina suggests that the tool was not manufactured until years after it was originally struck off of an objective piece. Pressure flaking is the primary technique observed on the artifact. The tool stone was traced to the Newberry Volcano obsidian source group.

Artifact 888-8 is a black obsidian end scraper. The tool is made from a backed flake, and retouched along one margin. Its working edges are steep and vary between <45 - >60 degrees. Retouch is continuous and regular on the dorsal aspect, and discontinuous on the ventral. A heavy patina covers 90 percent of the tool's surface. Both pressure flaking and soft hammer percussion technologies are represented. An obsidian source characterization was not made for this point.

Artifact 888-9 is a black obsidian flake core. In addition to the several large flake detachments on the dorsal surface, the flake termination exhibits retouch. These two distinguishing aspects point to a multifunctionality of the tool. Yet, without a detailed knowledge of the site's formation processes, postdepositional forces can't be ruled out as a cause of the apparent use wear. Based on the size of the original flake blank, and the pressure it took to drive it off of its parent material, hard hammer percussion is suggested. On the other hand, the rather diffuse bulb of percussion points to soft hammer percussion. Subsequent flakes struck from the dorsal surface were most likely detached by soft hammer percussion. An obsidian source characterization was not made for this artifact.

Artifact 888-12 is a utilized flake crafted from streaked, grey-black obsidian. It was produced by retouching the two longitudinal margins of a snapped bifacial thinning flake. Retouch is bifacial and the edges are straight. The edge angle is acute (<30 degrees). Both soft hammer percussion and pressure flaking techniques are evident. An obsidian source characterization was not made for this artifact.

SITE 35-KL-1111 (EAST DAVIS LAKE CAMPGROUND)

Twenty-three flaked stone artifacts and one piece of ground stone were analyzed from site 35KL1111. Table 6.7 lists the basic attributes recorded for the artifacts from the site. Digital images of the artifacts are presented in Figures 6.13 and 6.14. The relative proportion of each functional tool class represented at the site is shown in Figure 6.15.

Projectile Points

Artifact 1111-1 is a very small, triangular projectile point. It is complete (pointed tip missing), bifacially worked, and exhibits continuous retouch. The point is made of semi-translucent obsidian and is basally-notched. Sides are straight, although slightly sinuous. The haft element is a constricting stem, and the barbs are narrow and blunted. The primary reduction technique observed on the specimen is pressure flaking. It has a width to thickness ratio of 4.52, and has been assigned to stage 6 of the reduction sequence proposed by Callahan (1979). This artifact has been classified as a Rosegate point. A source determination was not made for this point.

#	Type	Raw Mat	L	xW	xT	Reduction	Sub Type
1111_1	Projectile	Obsidian	1.46	1.13	.24	6/6	Rosespring
1111_2	Projectile	Obsidian	2.47	1.44	.41	6/6	Rosespring
1111_3	Projectile	Obsidian	1.56	1.58	.42	7/7	Rosespring
1111_4	Projectile	Obsidian	1.3	1.63	.25	7/7	Rosespring
1111_5	Projectile	Obsidian	1.11	1.45	.28	5/5	*
1111_6	Biface	Obsidian	2.8	2.22	.5	5/5	*
1111_7	Utilized Flake	Obsidian	2.04	2.1	.32	*	BFT
1111_7	Utilized Flake	Obsidian	3.23	1.89	.75	*	BFT
1111_8	Projectile	Obsidian	3.07	1.95	.39	6/6	Eastgate
1111_9	Projectile	Obsidian	1.74	1.32	.23	7/7	Eastgate
1111_1	Projectile	Obsidian	1.78	1.47	.48	7/7	*
1111_1	Uniface	Obsidian	3.48	1.88	1.05	7/7	*
1111_1	Projectile	Obsidian	2.11	1.57	.16	7/7	*
1111_1	Utilized Flake	Obsidian	2.94	1.9	.26	1/4	*
1111_1	Ground Stone	Basalt	10.8	8.05	4.52	*	*
1111_1	Projectile	Obsidian	3.75	1.76	.42	5/5	Elko
1111_1	Projectile	Obsidian	1.52	1.11	.21	5/5	Eastgate
1111_1	Projectile	Obsidian	4.09	2.25	.39	5/5	Eastgate
1111_1	Projectile	Obsidian	2.58	1.67	.42	5/5	Desert Side
1111_1	Biface	Obsidian	2.67	1.43	.34	2/3	*
1111_2	Projectile	Obsidian	1.5	.89	.14	7/7	*
1111_2	Projectile	Obsidian	3.98	2.19	.65	6/6	Elko
1111_2	Projectile	Obsidian	2.22	1.93	.48	5/5	Elko
1111_2	Projectile	Obsidian	2.07	1.24	.29	5/5	Eastgate

Table 6.7. Stone tools from site 35KL1111.

Artifact 1111-2 is a small, triangular projectile point with an expanding stem. This complete point is made of opaque, dark grey obsidian and exhibits continuous bifacial retouch. It is corner-notched, with a slightly concave base. The primary reduction technique observed on the specimen is pressure flaking. It has a width to thickness ratio of 3.51 and has been assigned to stage 6. It has been classified as a Rosegate point. A source determination was not made for this point.

Artifact 1111-3 is a small projectile point basal fragment. It is made of obsidian, and has continuous, bifacial retouch. It is corner-notched with an expanding stem and a concave base. The primary reduction technique evident on the artifact is pressure flaking. It has a width to thickness ratio of 3.76 and has been assigned to stage 7. This point has been classified as a Rosegate series. A source determination was not made for this point.

Artifact 1111-4 is a small projectile point basal fragment. Made of obsidian, the point exhibits continuous, bifacial retouch. It is basally-notched and has a parallel sided haft element with a convex base. The primary reduction technique evident on the point is pressure flaking. It has a

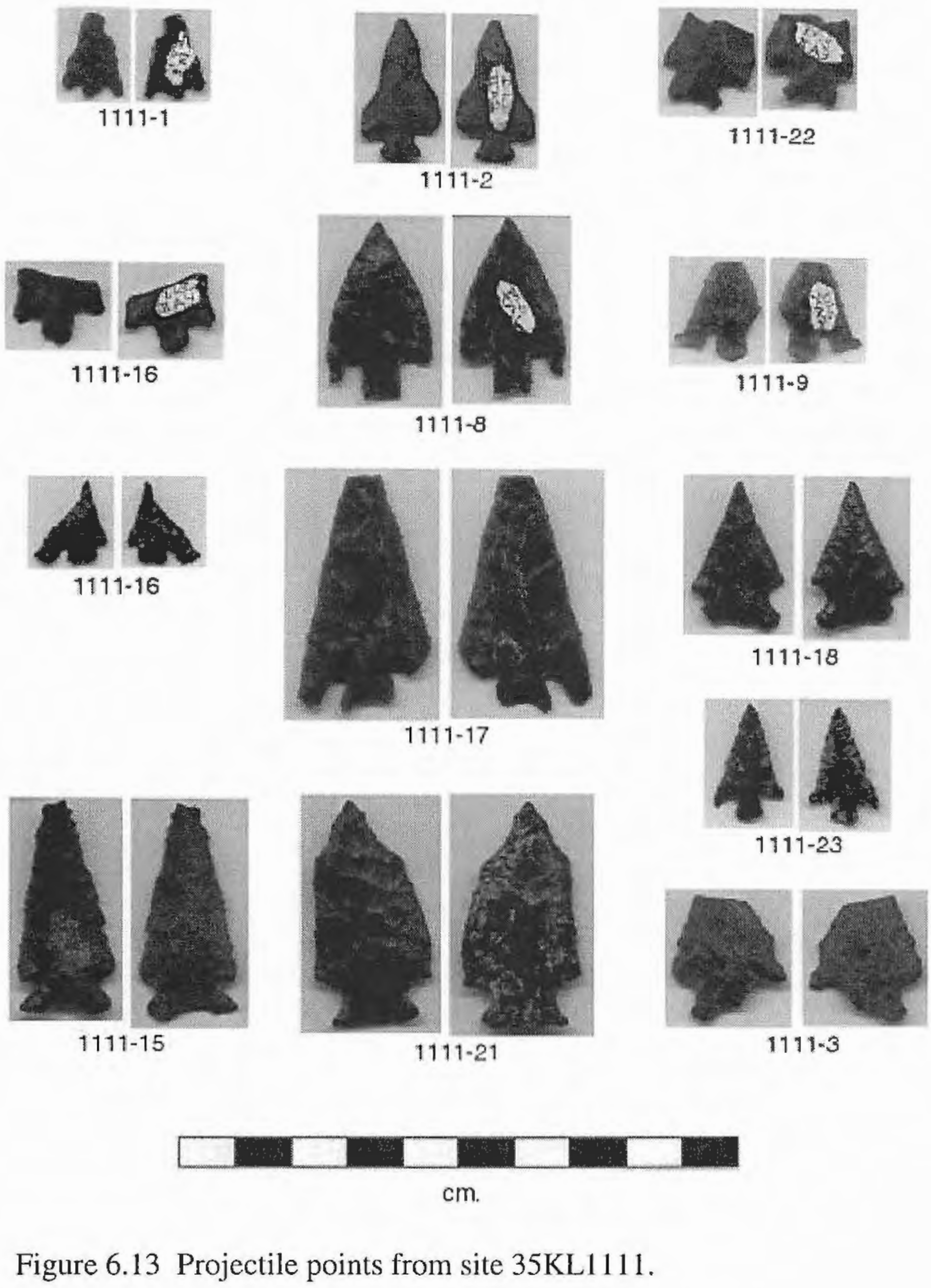


Figure 6.13 Projectile points from site 35KL1111.

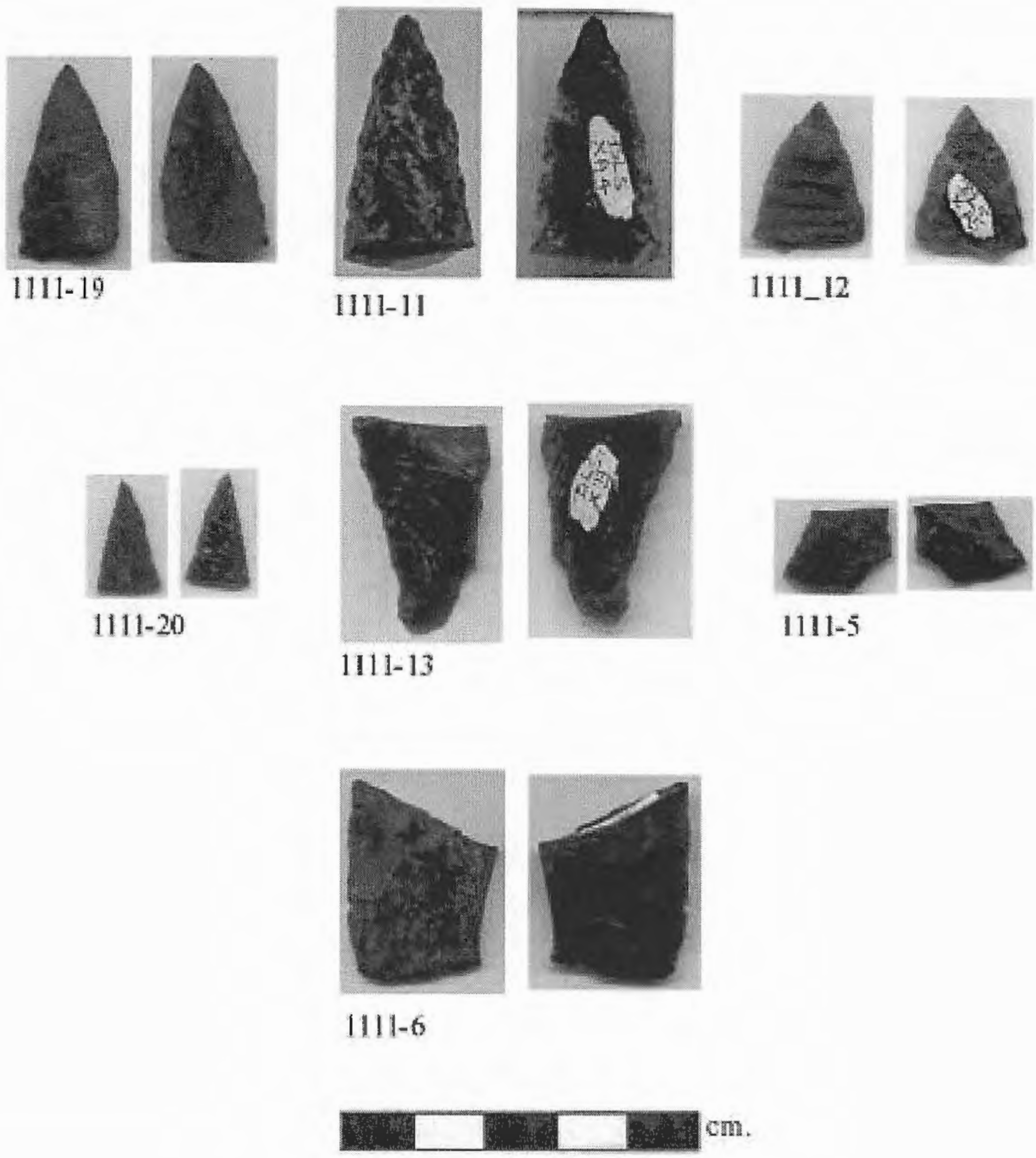
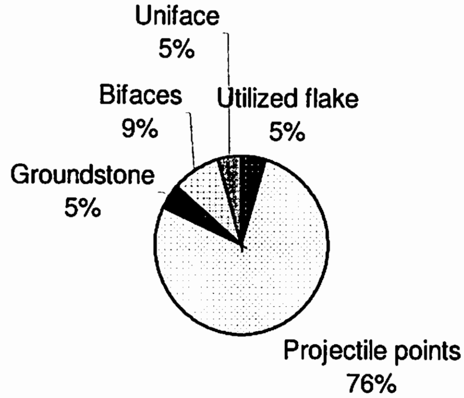


Figure 6.14 Other bifacial and flake tools from site 35L1111.

Figure 6.15 Proportion of each tool class represented at site 35KL1111.



width to thickness ratio of 6.52 and has been assigned to stage 7. This artifact has been classified as a Rosesgate series point. A source determination was not made for this point.

Artifact 1111-8 is a medium-sized, obsidian projectile point with a broad blade. This specimen is complete, except it has one missing tang. It is roughly triangular in shape and exhibits continuous, bifacial retouch. It is basally-notched, with a long, parallel-side haft element. The base is straight to slightly convex. The primary reduction technique evident on the point is pressure flaking. It has a width to thickness ratio of 5, and has been assigned to stage 6. This artifact has been classified as a Rosegate series point. A source determination was not made for this point.

Artifact 1111-9 is a small, triangular, projectile point. Made on semi-translucent obsidian, it is missing the tip and one tang. It is basally-notched, with a convex base. The remaining tang is blunt with parallel sides. Retouch is bifacial and continuous. The primary reduction technique evident on the point is pressure flaking. It has a width to thickness ratio of 5.73 and has been assigned to stage 7. This artifact has been classified as a Rosegate series point. The artifact has been traced to the Obsidian Cliffs obsidian source.

Artifact 1111-15 is a medium, triangular projectile point. It is side-notched with a slightly convex base, producing an "eared" effect. The specimen is complete, although a very small portion of the tip is missing. One face of the piece has a slight patina covering approximately 5 percent of its surface. Retouch is bifacial and continuous. The primary reduction technique evident on the point is pressure flaking. It has a width to thickness ratio of 4.19 and has been assigned to stage 6. This artifact has been classified as an Elko series point. The raw material for this tool has been traced to the Silver Lake / Sycan Marsh obsidian source.

Artifact 1111-16 is a very small, triangular projectile point. It is made out of opaque black obsidian. While it is mostly complete, it is missing one tang. Retouch is bifacial and continuous. It is basally-notched, with a long, parallel-sided tang that has a blunt end. The stem has parallel sides and a slightly convex base. The primary reduction technique evident on the point is pressure flaking. It has a width to thickness ratio of 5.28 and has been assigned to stage 7. This artifact has been classified as a Rosegate series point. The raw material for this tool has been traced to the Quartz Mountain obsidian source.

Artifact 1111-17 is a medium-sized, triangular projectile point. It is made of opaque grey-black obsidian. While it is mostly complete, it is missing part of one tang and the tip. Retouch is bifacial, continuous, and exhibits fine serration on the blade. It is basally notched with an expanding, convex base. The primary reduction technique evident on the point is pressure flaking. It has a width to thickness ratio of 5.76 and has been assigned to stage 7. As alluded to in the chapter on methods, this specimen provides a challenge to placement within the proposed reduction trajectory. Although the tool retains a large amount of utility, its archaeological and spatial context suggest that a conscious decision was made to discard it. This artifact has been classified as a Rosegate series point. The raw material for this tool has been traced to the Newberry Crater obsidian source complex.

Artifact 1111-18 is a small, triangular projectile point. It is made out of obsidian and is missing one tang, but otherwise complete. Retouch is bifacial and continuous. Both blades exhibit a slight amount of concavity. It is side-notched with a concave base, producing an "eared" appearance. The primary reduction technique observed on the point is pressure flaking. It has a width to thickness ratio of 3.97 and has been assigned to stage 6. This artifact has been classified as a Desert Side Notched series point. An obsidian source determination was not made for this point.

Artifact 1111-21 is a medium-sized, opaque, black obsidian projectile point. One blade is straight, and the other is convex. Invasive flaking on the proximal end suggests that the tool had been, or was in the process of being, rejuvenated. The piece is corner-notched with a flat, expanding base. Retouch is bifacial and continuous. The primary reduction technique observed on the artifact is pressure flaking. It has a width to thickness ratio of 3.36 and has been assigned to stage 6. This artifact has been classified as an Elko series projectile point. The raw material for this point has been traced to the Cougar Mountain obsidian source.

Artifact 1111-22 is a medium-sized projectile point made from dark grey, opaque obsidian. It is missing the proximal end and one half of the base. It is corner-notched with a concave base, producing an "eared" appearance. Retouch is both bifacial and continuous. The primary reduction technique used on the piece is pressure flaking. It has a width to thickness ratio of 4.02 and has been assigned to stage 7. This artifact has been classified as an Elko series point. An obsidian source determination was not made for this artifact.

Artifact 1111-23 is a small, triangular projectile point made from black, opaque obsidian. One barb is slightly broken, although otherwise the specimen is complete. The sides are straight and slightly sinuous. The piece is corner-notched with a slightly expanding, convex base. Retouch is bifacial and continuous. The primary reduction technique observed on the artifact is pressure flaking. It has a width to thickness ratio of 4.27 and has been assigned to stage 6. This artifact has been classified as a Rosegate series point. The raw material for this point has been traced to the Deer Creek obsidian source.

Bifacial Tools

Artifact 1111-5 is a small, medial biface fragment. It is made from opaque, black obsidian. Its size and shapes are suggestive of a projectile point mid-section. Retouch is continuous. The primary reduction technique observed on the piece is pressure flaking. It has a width to thickness ratio of 5.17 and has been assigned to stage 7. A source determination was not made for this artifact.

Artifact 1111-6 is small biface fragment made of opaque, black obsidian. Retouch is bifacial and continuous. One side is completely covered in patina. Flake scars tend to be small to medium in size, reflecting use of both soft hammer percussion and limited pressure flaking. Some of the larger flake removals travel past the longitudinal axis. The piece appears to have suffered a bending fracture across the transverse axis, at which time it was discarded. The biface has a width to thickness ratio of 4.44 and was in stage 3 of the proposed reduction strategy when discarded. A source determination was not made for this artifact.

Artifact 1111-10 is a small, pointed biface fragment. It is made of opaque, black obsidian. Its sides are straight, and slightly sinuous. Retouch is continuous. A light patina covers approximately 75 percent of the tool's surface. Its size and shape suggests that it is the proximal end of a projectile point. The primary reduction technique observed on the artifact is pressure flaking. It has a width to thickness ratio of 3.06 and has been assigned to stage 7. A source determination was not made for this artifact.

Artifact 1111-11 is a unifacial-biface fragment made from black obsidian. Retouch on the dorsal surface is continuous and invasive. In contrast, the ventral surface retains most of the original flake scar with minimal, discontinuous retouch. There is a light patina on the ventral side covering approximately 5 percent of the surface. The piece appears to have been broken by a bending fracture, which followed the transverse axis of the piece. A source determination was not made for this artifact.

Artifact 1111-12 is a small, pointed biface fragment. It is made of opaque, grey-black obsidian. Its sides are convex and slightly sinuous. One face of the piece has long, straight pressure flake removals that travel perpendicular to the longitudinal axis, from one margin to the other. These regular flake removals give one side a "ribbed" appearance. The size and shape of the fragment suggest it was once the proximal end of a projectile point. The primary reduction technique evident on it is pressure flaking. It has a width to thickness ratio of 9.81 and has been assigned to stage 7. A source determination was not made for this artifact.

Artifact 1111-19 is a small, triangular biface made on opaque, black obsidian. The artifact has a slight patina on one face, covering approximately 5 percent of the surface. With its marked triangular shape, flat base, and slightly convex blades, it resembles a Cottonwood series projectile point. However, the artifact does not exhibit basal grinding or abrasion as would be expected for a hafted projectile point. It could be that the tool was still being crafted when it was discarded. Retouch is primarily restricted to the dorsal face of the piece, where it is irregular and clustered. The ventral face still retains most of the original flake scar (most likely detached with a soft hammer), and has limited, discontinuous pressure retouch. It has a width to thickness ratio of 4.2 and has been assigned to stage 3. The raw material for this biface has been traced to the Obsidian Cliffs tool stone source.

Artifact 1111-20 is a small, pointed biface fragment. It is made of semi-translucent, black obsidian. Its sides are straight, and suggest it is the proximal end of a projectile point. The primary reduction technique observed on the piece is pressure flaking. Retouch is continuous. It has a width to thickness ratio of 6.35 and has been assigned to stage 7. A source determination was not made for this artifact.

Flake Tools

Artifact 1111-13 is a utilized flake made of black obsidian. Retouch is primarily restricted to the dorsal surface, where it is continuous. Retouch on the ventral surface is slight and clustered. Small flake detachments of the ventral surface may have resulted from use. A source determination was not made for this artifact.

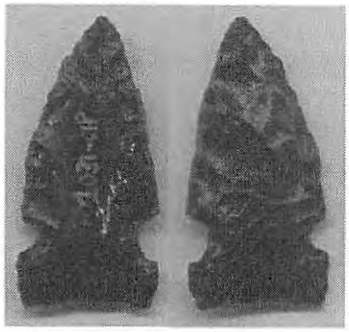
Groundstone

Artifact 1111-14 is a groundstone tool. It measures 10.8 cm in length, 8.05 cm in width, and has a maximum thickness of 4.52 cm. The parent material of the tool is a fine vesicular granular basalt. In cross-section, the tool is plano-convex, with multiple facets. Facets are concentrated on the edge of the piece, and exhibit polish on the larger surfaces. The ends of the tool appear to be battered. Based on its morphology, and the presence of polish on some facets, the tool likely functioned as a hand-stone for processing vegetable foods.

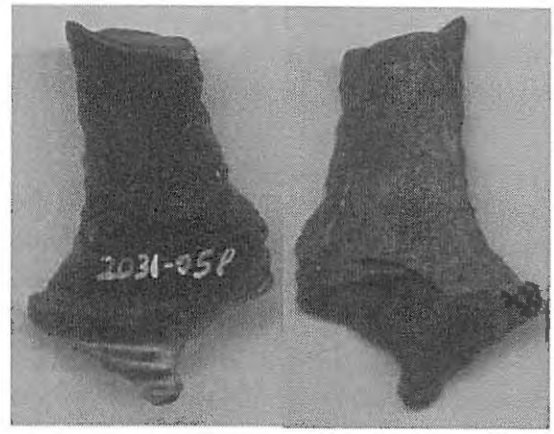
ISO-2031

Two flaked stone artifacts were analyzed from ISO 2031. Table 6.8 lists the basic attributes recorded for the artifacts from ISO 2031 and ISO 2175. Digital images of the artifacts from both sites are presented in Figure 6.16. The relative proportion of each functional tool class represented at these sites is shown in Figure 6.17.

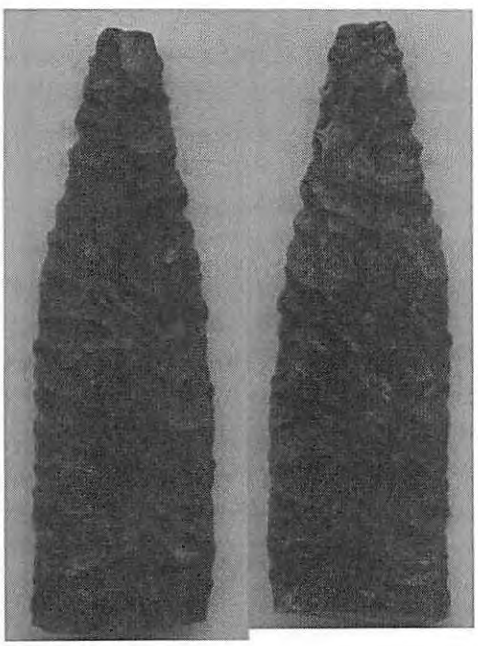
Artifact 2031-1 is a small, triangular projectile point. It is fashioned out of opaque, black obsidian traced to the Obsidian Cliffs source. The point is complete and exhibits continuous, bifacial retouch on ventral and dorsal surfaces. Invasive pressure flaking produced flake scars that are multi-directional and unpatterned. The point is side-notched with a thinned, concave base. The point has a width to thickness ratio of 2.71 and is assigned to stage 6. It has been classified as a Desert Side-Notched series point.



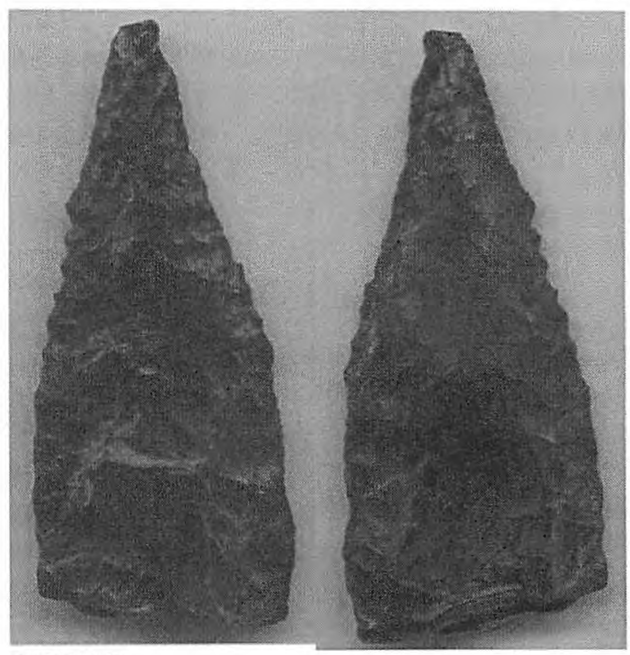
2031-5



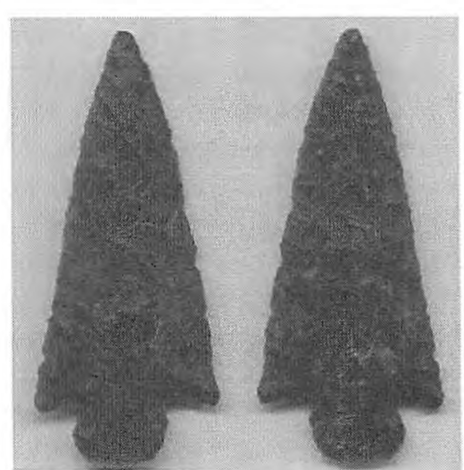
2031-1



2175-1A



2175-1B



2175-2

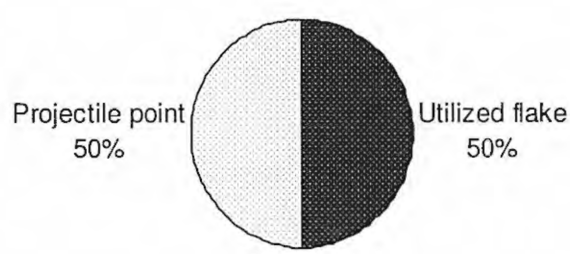
Figure 6.16 Stone tools from sites ISO 2031 and ISO 2031.

#	Type	Raw Mat	L	xW	xT	Reductio	Sub Type
2031_1	Utilized Flake	Obsidian	4.59	3.22	.87	1/2	BFT
2031_5	Projectile	Obsidian	3.55	1.74	.64	6/6	Desert Side Notched
2175_1A	Biface	Obsidian	7.38	2.37	.84	5/5	*
2175_1B	Biface	Obsidian	7.39	3.38	.9	5/5	*
2175_2	Projectile	Obsidian	5.33	2.33	.45	6/6	Elko

Table 6.8 Stone tools from sites ISO 2031 and ISO 2175.

Artifact 2031-5 is a utilized flake. This expedient tool is made from opaque, black obsidian. Retouch is limited to the dorsal surface. A heavy patina covers the entire dorsal surface. The working edges have a very steep edge angles (>60°). Soft hammer percussion was used to detach the flake, while use wear likely accounts for the retouch on the working edges. A source determination was not made for this artifact.

Figure 6.17 Tool types from Isolate 2031.



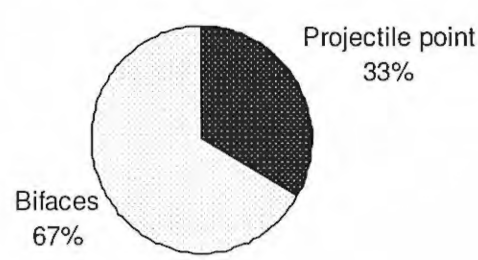
ISO-2175

Three flaked stone artifacts were analyzed from ISO 2175. Artifact 2175-2 is a medium-sized, obsidian projectile point. It is complete and made from opaque obsidian traced to the Spodue Mountain obsidian source. The point has a flat, expanding base. Deep, obtuse notches extend towards the longitudinal axis from the corners. Pressure flaking is the only reduction technique plainly evident on the piece. Retouch is continuous, but not patterned. It has a width to thickness ratio of 5.17 and has been assigned to stage 6. This artifact has been classified as an Elko series point.

Artifact 2175-1A is a medium-sized black obsidian biface. The piece is long and slender with a burinated distal end and a pointed tip. The fracture was the result of bending forces. No cortex is evident on the piece. Retouch is bifacial and somewhat patterned with many flakes following the transverse axis at regular intervals. Pressure flaking produced all retouch apparent on the piece. It has a width to thickness ratio of 2.82 and has been assigned to stage 5. The tool stone for this piece has been traced to the Spodue Mountain obsidian source.

Artifact 2175-1B is a medium-sized black obsidian biface. Its outline is triangular and it has a blunt base where it was broken. The break was caused by a bending fracture. There is no cortex on the piece. Retouch is bifacial, with both soft hammer and pressure flake scars evident. The edges are markedly sinuous, producing serrated margins at several points. It has a width to thickness ratio of 3.75 and has been assigned to stage 5. An obsidian source characterization was not made for this artifact.

Figure 6.18 Tool types from Isolate 2175.



OBSIDIAN SOURCE CHARACTERIZATION

Thirty-two (42 %) formed obsidian artifacts were submitted to Northwest Research Obsidian Studies Lab for XRF analysis. Specimens were chosen on the basis of their ability to address the research questions outlined in Chapter 1. Special attention was given to diagnostic projectile points. These artifacts are useful because they were often curated and allow for rough chronological control. Because the goal is to gauge the procurement range of the tool users and not to identify the sources most recently used, only formal artifacts were analyzed. Given that there were few Initial Archaic (Western Stemmed) specimens, all were submitted for XRF analysis (n=5). Eighty percent of Early – Mid Archaic points (Elko) were selected (n=4). Because Late Archaic projectile points (Desert Side-Notched, Cottonwood, and Rosegate) were most numerous (n=17), ten were chosen for XRF analysis (58%). Specimens were also chosen based on the appearance and uniqueness of obsidians with the goal of sampling the diversity of sources represented in each assemblage. Other tools selected for obsidian source characterization include bifaces (n=9), preforms (n=2), a graver and a drill. The results of the analysis are listed in tables 6.9 and 6.10. Chapter 7 presents a thorough discussion of the XRF results.

Table 6.9 Obsidian sources represented at study sites.

Source	No. of Specimens	% of all SourcedAssemblages
Silver Lake / Sycan Marsh	10	31
Obsidian Cliffs	5	16
Newberry Volcano	5	16
Spodue Mountain	4	13
Cougar Mountain	3	9
McKay Butte	3	9
Deer Creek	1	3
Quartz Mountain	1	3
Total	**32**	**100%**

Table 6.10 Sourced obsidian artifacts from study sites.

No.	Type	Sub-type	Source
528-5	Projectile point	Western Stemmed	Silver Lake / Sycan Marsh
528-6	Projectile point	Elko	McKay Butte
528-7	Projectile point	Desert Side-Notched	Silver Lake / Sycan Marsh
528-9	Projectile point	Western Stemmed	Obsidian Cliffs
528-10	Projectile point	Western Stemmed	Silver Lake / Sycan Marsh
528-16	Projectile point	Western Stemmed	Spodue Mountain
878-1	Biface	*	Silver Lake / Sycan Marsh
878-2	Biface	*	Newberry Volcano
878-3	Preform	*	Silver Lake / Sycan Marsh
878-4	Preform	*	McKay Butte
878-7	Biface	*	Silver Lake / Sycan Marsh
879-1	Biface	*	Silver Lake / Sycan Marsh
879-3	Biface	*	Silver Lake / Sycan Marsh
879-4	Projectile Point	Rosespring	Cougar Mountain
879-6	Biface	*	Silver Lake / Sycan Marsh
880-2	Biface	*	Newberry Volcano
880-3	Biface	*	Cougar Mountain
880-5	Projectile Point	Western Stemmed	Silver Lake / Sycan Marsh
888-1	Projectile Point	Rosespring	Spodue Mountain
888-5	Graver	*	McKay
888-6	Drill	*	Newberry Volcano
888-11	Projectile Point	Rosespring	Newberry Volcano
1111-9	Projectile Point	Eastgate	Obsidian Cliffs
1111-15	Projectile Point	Elko	Silver Lake / Sycan Marsh
1111-16	Projectile Point	Eastgate	Quartz Mountain
1111-17	Projectile Point	Eastgate	Newberry Volcano
1111-18	Projectile Point	Desert Side-Notched	Obsidian Cliffs
1111-21	Projectile Point	Elko	Cougar Mountain
1111-23	Projectile Point	Eastgate	Deer Creek
2175-2	Projectile Point	Elko	Spodue Mountain
2175-1A	Biface	*	Spodue Mountain
2031-1	Projectile Point	Desert Side-Notched	Obsidian Cliffs

DEBITAGE

Lithic debitage from three sites was analyzed as part of this study (35KL879, -888, and –1111). Sites –879 and –1111 provided very small samples and are therefore not discussed in any detail (refer to Chapter 7 and Appendix 2 for the attributes of the assemblages). Sixty-two flakes were analyzed from site 35KL888 (West Davis Campground). Of those, 46.7 percent (n=29) were complete, 4.8 percent (n=3) proximal, 30.6 percent (n=19) medial, 3.2 percent (n=2) distal, and 12.9 percent (n=9) debris (See Figure 6.18). All of the specimens analyzed were obsidian. Although the debitage was not sourced, six flakes were made of grainy, grey obsidian that resembles obsidian from the distinct McKay Butte variety.

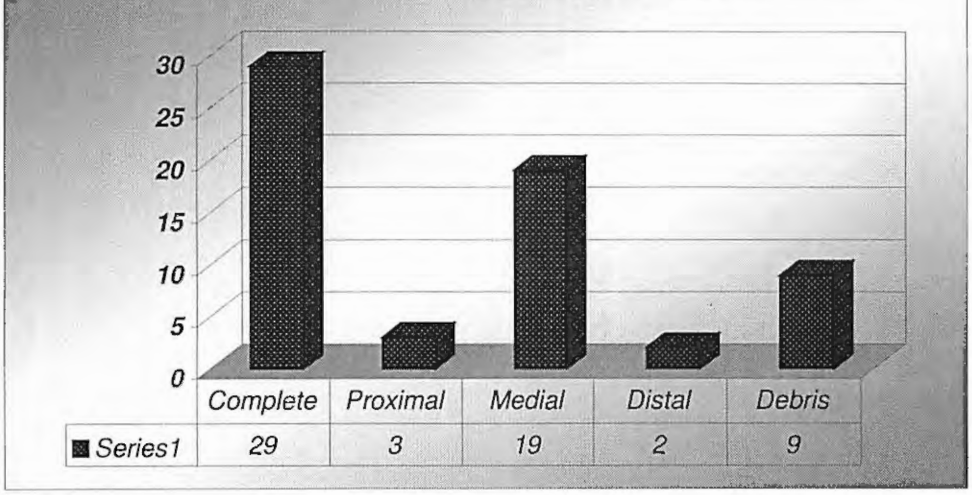


Figure 6.19 Flake types from site 35KL888.

Flake Size

Flake size is an important variable to consider when attempting to determine the type of lithic reduction activity represented by assemblages (core reduction, flake blade production, biface manufacture, hafting, resharpening, etc). All complete, proximal, medial and distal flake fragments were assigned a size class according to the length of their longest axis. The 0 – 1 cm size class comprises 40 percent (n=25), 1 - 2 cm 43 percent (n =26), 2 – 3 cm 8 percent (n =5), 3 – 4 cm 3 percent (n =2), 4 – 5 cm 3 percent (n =2), and 5 – 6 cm 3 percent (n =2). Clearly, all flakes from the 35KL888 assemblage tend to be small. The average flake length for complete and proximal flakes is 0.7 cm, ranging from 0.37 to 6.05 cm. Flake width averages 0.65 cm and has a range of 0.4 to 6.5 cm. Thickness varied between 0.02 to 1.45 cm, and averaged 0.197 cm. Figure 6.19 shows the flake size grades from site 35KL888. Information regarding flake size is useful because it is suggestive of the stage of stone tool reduction represented (i.e. primary, secondary or maintenance) (Stahle and Dunn 1982). The small size of flakes from the site point to reduction activities focused on use and rejuvenation, suggesting that pieces were primarily reduced elsewhere and imported in late stages.

Although flake size is often used to infer the method of reduction, there is some overlap in the size of flakes produced The size and morphology of the striking platform can be suggestive of the reduction technology.

Striking Platform Size

The mean, standard deviation and range for complete and proximal flakes is shown in Table 6.11. For complete and proximal flakes, the platform width varies considerably. The average platform width for complete and proximal flakes is 0.39 cm. The widest platform, measuring 1.6 cm, is a full 6 standard deviations larger than average. Platform thickness is also quite variable on complete flakes, ranging from 0.03 to 0.85 cm, and averaging 0.149 cm. The rather small size of the striking platforms indicate that reduction activities represented were limited to pressure flaking and possibly some soft-hammer percussion.

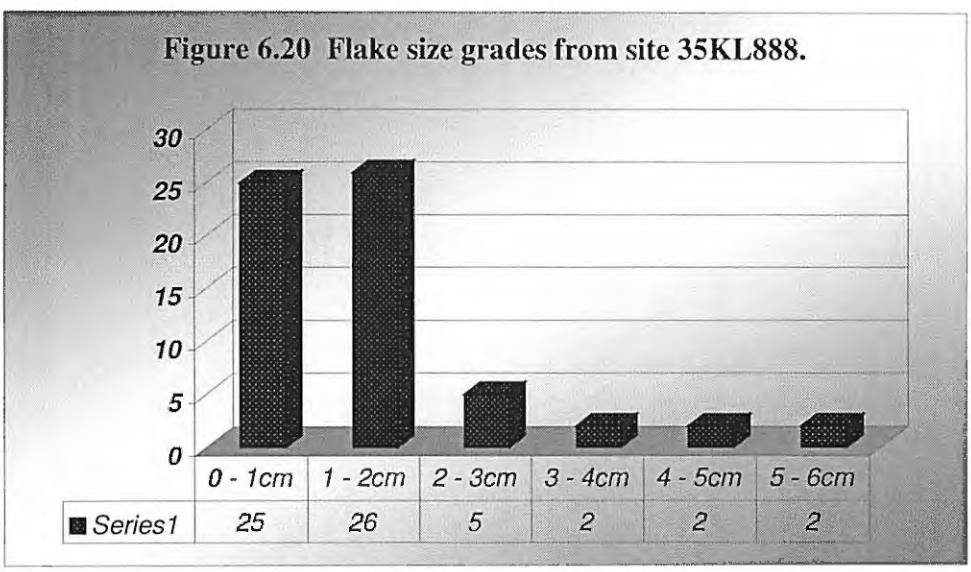


Figure 6.20 Flake size grades from site 35KL888.

Replication studies suggest that platform preparation becomes increasingly important as a tool nears the final stages of completion (Andrefsky 1998). Platform preparation comes in several forms, the most common being abrasion and faceting. Abrasion and faceting are both useful for helping to direct and control the direction and size of flake removals. Platform faceting has also been interpreted as indicative of bifacial retouch (Frison 1968).

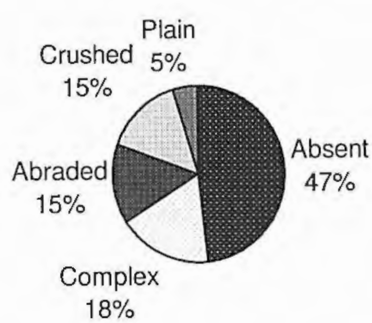
Table 6.11. Mean, range, and standard deviation for complete and proximal flakes.

(cm)	Mean (cm)	Range (cm)	Standard Deviation
Length	0.71	0.44 – 6.05	0.18
Width	0.65	0.4 – 6.05	0.18
Thickness	0.22	0.03 – 1.45	0.19
Platform Width	0.39	0.14 – 1.6	0.21
Platform Thickness	0.149	0.03 - .85	0.21

Striking Platform Morphology

Within the complete and proximal flake categories, three (4.8 %) specimens had plain platforms. Complex platforms were observed on 11 (17.7 %) flakes, and abraded platforms on 9 (14.5 %). Crushed platforms accounted for 9 (14.5 percent) of the flakes. 30 (48.3 %) flakes did not retain a platform. The fact that over 62 percent of flakes that retained a platform showed evidence of platform preparation is indicative of late stage reduction.

Figure 6.21 Striking platform morphology of flakes from site 35KL888.



Lipping

Twelve of the 22 complete and proximal flakes exhibited lipping on the proximal ventral surface. Lipping was observed on 34 percent (n=11) of all complete flakes. On proximal flakes, lipping was noted on 33 percent (n=1) of proximal ventral surfaces. Lipping is often taken to be an indication of soft hammer percussion (Crabtree 1970). Andrefsky (1998:115), however, points out that other studies have reached different conclusions. He cites the experimental work of Patterson and Sollberger (1978) who argue that flake lipping in not a good indicator of soft-hammer percussion. Although the presence of lipping on flakes alone does not provide unequivocal evidence of the use of a billet, it does strengthen other lines of evidence that point in the same direction.

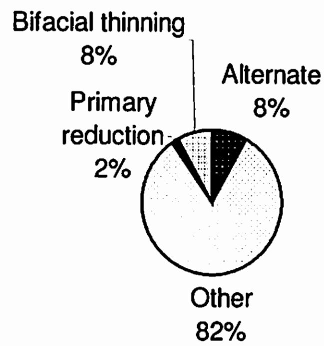
Dorsal surface morphology

Of the 62 flakes examined, three retained cortex. Two cortical flakes were covered on approximately 50 percent of their dorsal surface, while the third was covered on 25 percent. The presence of cortex is generally considered an important variable in lithic analysis. Debitage assemblages with a relatively high percentage of cortical flakes tend to be close to quarries and represent early reduction stages. In the Upper Deschutes area, however, cortical flakes are quite rare, even in near-quarry contexts. Jenkins and Connolly (1994) suggest that this results from the rather large size of the source material (as large as small cars at some quarries such as at Big Obsidian Flow in Newberry Crater) in the area. They go on to state that "for obsidian debitage in the Deschutes Basin, cortex classes may have little meaning except in quarry and near-quarry contexts" because most cortex was removed near the margins of the quarries" (Jenkins and Connolly 1994:93). The abundance of obsidian from young flows in the area also helps explain the paucity of cortical flakes because recently erupted material has not had enough time to weather and form substantial cortex. The fact that a very small fraction of the debitage retained cortex appears to suggest that objective pieces had been substantially reduced at another location.

Technological Flake Types

Bifacial thinning flakes and alternate flakes each make up eight percent (n=5) of the debitage assemblage. One utilized and one primary reduction flake comprise the smallest percentage (2 % each). The vast majority of flakes fall under the "other" category, at 80 percent (n=50). The presence of bifacial thinning flakes in the assemblage is indicative of secondary reduction. As noted earlier, bifacial thinning flakes are also indicative of curated technologies. The presence of alternate flakes suggests reduction of angular material. Given that there is no evidence of primary reduction at the site, these flakes may have been produced while attempting to rejuvenate a broken tool with a rectangular cross-section. It is possible that the large primary flake was transported from the quarry site because of its acute edge angle and large termination margin, which make it useful for cutting.

Figure 6.22 Technological flake types from site 35KL888.



Summary

Given the small number of flakes analyzed from the site, and the lack of systematic collection, the goal of the debitage analysis was to identify some of the reduction activity represented at 35KL888. The conclusions drawn from this analysis cannot positively identify all of the potential reduction activities represented at the site, but they provide a baseline for speculation and future research. It is likely that additional debitage is present on the surface and below ground. The effects of postdepositional processes such as fluvial transport, sheet wash, and scavenging have not been investigated and thus limit the conclusions drawn.

With these considerations in mind, a tentative interpretation of the activities represented in the assemblage can be made. As Table 6.11 shows, the complete and proximal flakes recovered from the site are quite small, with a mean length and width of 0.71 and 0.65 cm. Complete flakes also tend to be thin, averaging less than 0.22 cm. Examination of the flake size class frequency distribution (Figure 6.19) shows that 82 percent of the flake fragments are 2 cm or smaller. Although far from definitive, the small size of the flakes has implications for the type of reduction activity and the technology used. Observations made by Stahle and Dunn (1982:85) suggested to them that:

> *The size of waste flakes from the manufacture of bifacial projectile points, knives, or large handaxes will systematically decrease from the initial to final stages of manufacture as the emerging tools is reduced, thinned, and shaped. This underlying regularity suggests that the size distribution of waste flakes may be used to distinguish sequential stages of biface manufacture.*

It remains difficult to clearly define the metric boundaries of hard hammer, soft hammer and pressure flaking (Andrefsky 1998:115; Jenkins and Connolly 1996:88). Acknowledging the presence of overlap in flake size produced by various knapping techniques, it is generally accepted that percussion flaking produces larger flakes than pressure flaking (Ahler 1989).

Figure 6.20 shows the relative frequency of platform types observed on flakes. Complex platforms were noted on 34 percent (n=12) of all complete and proximal flakes. Approximately 28 percent of complete and proximal flakes showed evidence of abrasion. Although complex platforms may be produced by other means, they are often the result of platform preparation (Andrefsky 1998:95). Abraded platforms are also a good indication of prepared platforms. Andrefsky (1998:96) notes that: "Such care is often taken when the objective piece is in its final stages of production or when there has been a great deal of investment made in production of the tool." Frison (1968:149) has found that faceted platforms are a common attribute of bifacial retouch flakes. These flakes are thought to be the result of resharpening a dulled tool. Often, the care taken to set up the flake removal is evident in the trimming and abrading of the platform surface.

Cortex is useful when looking at the staging of lithic production. The fact that few of the specimens in this study exhibit substantial amounts of cortex is not surprising. This fact suggests that most of the pieces were substantially reduced at other locations. It has been argued that cortex is not a very useful attribute to emphasize in the Deschutes Basin given the large size of the locally available raw material (Jenkins and Connolly 1994). Cortex remains an important attribute in quarry and near-quarry contexts, however.

Viewed together, the attributes discussed above suggest that the debitage assemblage is the result of late stage tool production and/or rejuvenation activities at the site. While staying at the site, plant and animal processing activities would likely have contributed flakes to the deposit. After considering postdepositional processes and sampling bias, the need to view these findings as tentative is clear.

CHAPTER 7: DISCUSSION & CONCLUSIONS

This chapter provides a discussion of the results presented in the preceding section in light of the pertinent research questions posed in Chapter 1. The questions are dealt with in the context of an interpretive summary of the eight archaeological sites, followed by a discussion of their implications for prehistoric lithic technology and land use in the Upper Deschutes.

CHRONOLOGY

Based on typological analysis of stone tools from the study sites, aboriginal human occupation of the Upper Deschutes is suggested for the period spanning +7,000 – 150 years BP. The classification of projectile points used here recognized six time-sensitive styles. Table 7.1 lists all of the diagnostic projectile points identified at the sites. Western Stemmed series points and fragments (n=4) were identified at two sites (35KL528 and –880) and represent the earliest occupation (11,500 – 7,000 B.P.). Elko (~5,000 – 2,000 B.P.) points (n=6) were found in three assemblages (35KL528, -1111, and ISO2175), but are less useful as time markers. Elsewhere, Elko points have been reported in contexts dated to between 7,000 – 2,000 B.P. (Aikens 1970; Bedwell 1973; Heizer and Hester 1978). Despite the lack of resolution, the style is still useful as a post-Mazama horizon indicator. Late Archaic point styles such as Rosespring (n=8), Eastgate (n=5), Cottonwood (n=1), and Desert Side-Notched (n=3) were identified in five assemblages (35KL528, -879, -888, -1111, and ISO2031) and represent the period spanning 2,000 – 200 B.P. For the purposes of the discussion, the Rosespring and Eastgate categories have been collapsed into one because they have been shown to have been used contemporaneously (Heizer and Hester 1978).

INTERPRETIVE SUMMARY OF UPPER DESCHUTES SITES

Occupation of the study area during the Initial Archaic is attested to by sites 35KL528 and –880. Both have yielded diagnostic artifacts attributed to the Western Stemmed Tradition (11,500 – 7,000 B.P.).

Site 35KL528 is a diffuse lithic scatter located around a spring on the northern flank of Cryder Butte, at an elevation of 4,780 ft. The site is above a broad drainage that feeds the Deschutes River to the east. This upland site provided a reliable water source in an otherwise arid environment. The site's low assemblage diversity, location and lack of features suggest its use as an ephemeral game interception and processing site. While pursuing game such as deer and elk, mobile groups of people would have found the spring a draw throughout the Holocene

Four discrete lithic concentrations have been identified at the site, with numerous individual artifacts scattered about. The earliest component of the site appears limited to the northeast corner of the site. The majority of the lithic material reported is obsidian, with very small proportions of CCS and basalt represented.

Table 7.1 Diagnostic projectile points from study sites.

No.	Type	Source
528-7	Desert Side-Notched	Silver Lake / Sycan Marsh
1111-18	Desert Side-Notched	Obsidian Cliffs
2031-1	Desert Side-Notched	Obsidian Cliffs
528-1	Cottonwood	*
528-2	Rosegate	*
879-4	Rosegate	Cougar Mountain
888-1	Rosegate	Spodue Mountain
888-11	Rosegate	Newberry Crater
1111-1	Rosegate	*
1111-2	Rosegate	*
1111-3	Rosegate	*
1111-4	Rosegate	*
1111-8	Rosegate	*
1111-9	Rosegate	Obsidian Cliffs
1111-16	Rosegate	Quartz Mountain
1111-17	Rosegate	Newberry Crater
1111-23	Rosegate	Deer Creek
528-4	Elko	*
528-6	Elko	McKay Butte
1111-15	Elko	Silver Lake / Sycan Marsh
1111-21	Elko	Cougar Mountain
1111-22	Elko	*
2175-2	Elko	Spodue Mountain
528-5	Western Stemmed	Obsidian Cliffs
528-9	Western Stemmed	Obsidian Cliffs
528-10	Western Stemmed	Silver Lake / Sycan Marsh
528-16	Western Stemmed	Spodue Mountain
880-5	Western Stemmed	Silver Lake / Sycan Marsh

The 31 artifacts reported from site 35KL528 are predominately bifacial tools, with the exception of three drills, two scrapers, and one utilized flake. Unfortunately, only twelve were available for study. Of these, nine were diagnostic projectile points and fragments. In addition to the four Western Stemmed bifaces mentioned above, two Elko, one Rosegate, one Desert Side-Notched, and one Cottonwood series points were examined. These artifacts indicate that the site was used repeatedly from pre-Mazama times until the ethnographic period. Very little debitage was noted at the site and none was collected. Six obsidian source determinations were made. Obsidian sources represented in the pre-Mazama component include Silver Lake / Sycan Marsh (n=2), Obsidian Cliffs (n=1), and Spodue Mountain (n=1). Post-Mazama sources represented include Silver Lake / Sycan Marsh (n=1) and McKay Butte (n=1).

Site 35KL880 also produced evidence of a Western Stemmed occupation. Characterized by the presence of a very sparse lithic scatter covering approximately 3,500m², the site is situated around a spring flowing parallel to a seasonal drainage. At an elevation of 4,580 ft., the site sits within a small valley surrounded by low ridges. The Little Deschutes River lies just over four miles to the west.

Fifteen flakes, two bifaces, a core tool, a piece of ground stone, and one Western Stemmed projectile point were documented at the site. Artifacts available for study included the bifaces, core tool and projectile point. Based on the sketch of the basalt "grinding stone"' its morphology is more suggestive of a large hammer stone used to crush bone. The assemblage composition, low artifact diversity, site setting, and lack of features suggest the site was used as a short-term base and specialized processing camp. Three obsidian source determinations were made for the assemblage. Two biface fragments were traced to Newberry Crater and Cougar Mountain. The stemmed point was from the Silver Lake / Sycan Marsh obsidian source.

In addition to site 35KL528, sites ISO2175 and 35KL1111 show signs of human occupation during the Middle to Late Archaic as indicated by the presence of Elko series projectile points. ISO2175, located on the western flank of Royce Mountain, produced a total of three artifacts, one of which is an Elko series projectile point. The remaining two artifacts are relatively large biface fragments. Their original discovery within a dirt road hints at the possibility of additional subsurface deposits. The site's constituents, along with the positioning of the site within a short walk of both Crescent and Odell Lakes, suggests its use as a kill or butchering site. The sparse deposit discovered there implies the site was used for a short period by a small group of mobile hunter-gatherers. The site served as a small component of a larger strategy of upland resource exploitation. One biface fragment and the Elko point were traced to the Spodue Mountain obsidian source.

35-KL-1111 presents a unique example of prehistoric land use in the Upper Deschutes River Basin. Post-Mazama occupation is suggested for the site based on observed site stratigraphy, projectile point typological assignments, and its location on the flank of Davis Lake (which formed subsequent to the Black Rock Eruptive Episode ~5,540 B.P.). Although no formal testing has been undertaken at the site, shovel and auger probes produced cultural material above the Mazama horizon, which is widespread in the area. Of the 13 projectile points analyzed as part of this study, all 13 retained enough diagnostic features to allow for their placement within a time-sensitive typology. Three distinct types of projectile points were identified in the projectile point assemblage from the East Davis site. They are Elko, Desert Side Notched, and Rosegate. The presence of these time-sensitive artifacts indicates that the site was used repeatedly since shortly after the formation of Davis Lake some 5,500 years ago and until the Contact period. The earliest occupation of the site, as represented by the Elko point, could have conceivably occurred prior to the Black Rock eruptive episode and subsequent formation of the lake, although it is unlikely.

The tool assemblage from 35KL1111 is composed primarily of bifacial tools that represent late stages of their respective reduction sequence. The character of the debitage assemblage lends support to the notion that tools were brought to the site after having been primarily reduced elsewhere. Although conclusions drawn from the debitage assemblage for this site are severely limited by the small number of flakes and their non-systematic collection, a few points can be gleaned. Secondary reduction, in the form of both soft hammer thinning and pressure flaking, is represented at the site. Bifacial thinning flakes make up 41.6 percent (n=5) of the assemblage. Despite the high percentage of bifacial thinning flakes, the size of flakes in the assemblage tends to be small, with 58 percent (n= 7) measuring 2 cm or less. All complete and proximal flakes showed evidence of platform preparation, thus bolstering the suggestion of late stage reduction. Cortex is completely absent from all of the flakes, and argues against any primary reduction activities.

Recycling of broken tools is not apparent at the site during any of the three broad periods of occupation. In fact, many tools were discarded prior to exhaustion. This fact suggests that the site occupants were not very concerned with tool stone conservation. Such behavior indicates that lithic raw materials were brought to the site in sufficient abundance to sustain them for their stay, or that a procurement visit was expected in the near future.

It is interesting to note that despite the presence of 29 circular depressions, 35KL1111 has produced a lithic assemblage that more closely resembles what would be expected for an ephemeral camp and task area. Yet, if the assemblages from 35KL1111 and 35KL888 are viewed together, what emerges is more along the lines of what would be expected for a seasonal semi-sedentary occupation.

Site 35KL888 is located on the west side of Odell Creek, in what is now West Davis Campgrounds. Four concentrations of flaked stone tools and debitage have been described. Since first recorded, twelve stone tools and 62 pieces of debitage have been collected. The two projectile points described here for the site have been attributed to the Rosespring series and suggest a Late Archaic occupation for the site.

Overall, the attributes of the debitage assemblage point to late stage reduction. Reduction activities at the site appear to be geared to the use and maintenance of bifacial tools with some evidence for expedient flake production from prepared cores.

The artifact assemblage from –888 exhibits the greatest amount of artifact diversity of all sites, with seven classes of artifacts represented, including bifaces, projectile points, scrapers, a core tool, graver, drill, and utilized flake. Maintenance and lateral cycling of tools are evident within the assemblage. One artifact, 888-15, is a biface reduced to exhaustion. Artifact 888-5 is a bifacially flaked graver that was produced on the distal end of a broken projectile point. The two Late Archaic points recovered from the site were traced to Newberry Crater and Spodue Mountain. A graver and drill were attributed to the McKay Butte and Newberry Crater sources, respectively.

The site's location across Odell Creek from –1111 suggests that it represents a task area of a larger occupation that made use of the greater Davis Lake area. The wide variety of tools represented at the site suggest a broad range of activities including hunting, meat and hide preparation, as well as bone and wood working. Although no faunal or botanical remains have been reported, the site's strategic positioning at the margin of Davis Lake also implies that users of the site were taking advantage of local aquatic resources.

ISO2031 consists of an obsidian projectile point found in association with a utilized flake. The artifacts were discovered in a relatively steep, wooded area north of Crescent Lake. Diagnostic attributes of the finished point place it in the Desert Side-Notched series dated to between 800 – 300 B.P. in the northern Great Basin. Surrounded by a diverse modern forest of ponderosa pine, lodgepole pine, and several fir species, this isolated find is within a mile and a half of at least 18 other prehistoric sites. Activities represented at the site are limited to the pursuit and possible butchering of game. Like ISO2175, this site likely represents a small component of the seasonal upland subsistence strategy used during the Late Archaic. An obsidian source assignment indicates that the Desert Side-Notched point was produced from Cougar Mountain obsidian.

Site –879 is a diffuse open-air lithic scatter located in a small drainage, approximately 100 m northeast of –880, at an elevation of 4,520 ft. Artifacts collected from the site indicate that it was used as a specialized task area and cache. Several of the artifacts point to hunting related activities. In addition to utilized flakes, a scraper and a projectile point (Rosespring), four large, expertly flaked bifaces and a unifacial blank appear to have been buried for use at a later time. Three of the large bifaces were sourced to the Silver Lake / Sycan Marsh obsidian source. The lone projectile point was traced to the Cougar Mountain source. Given the disturbed nature of the site, it is unclear whether the cache of bifaces is temporally related to the projectile point, which suggests a Late Archaic occupation. This site, as well as –880, would have been convenient stop-over points for groups on their way to upland spring and summer grounds.

Although the assemblage from site 35KL878 did not contain diagnostic artifacts, it nonetheless proved informative. Located atop Ringo Butte at an elevation of 5,360 feet, the lithic assemblage from site –878 points to the site's use as an ephemeral camp, task site, and cache. The ten lithic artifacts analyzed include four obsidian preforms, two medium-sized bifaces and four proximal biface fragments. Sourcing results for the site revealed that two of the preforms are from the Silver Lake / Sycan Marsh source and one is from McKay Butte. One of the bifaces also sourced to Silver Lake / Sycan Marsh, while the other was traced to Newberry Crater.

The upland setting of site –878 appears suited to little but tasks related to hunting. The surrounding forest of ponderosa and lodgepole pine is resource poor, and little water is available in the immediate vicinity. Larger water bodies nearby include Davis Lake, 4.5 air miles to the northwest, and Crescent Creek 4 miles to the south.

SITE DISTRIBUTION PATTERNS

Table 7.2 provides a summary of the environmental context of each site examined. The patterns that emerge are not surprising when the area's resource distribution is taken into account. The availability of surface water appears to be a major factor in the location of prehistoric sites in the area. All but one site has a water source on site in the form of a lake, spring, creek, or intermittent drainage. The lone site without water in the immediate vicinity (ISO 2031) is only ¼ mile from the shore of Crescent Lake. Additionally, six of the eight sites lie within five miles of a large lake. Not only did well-watered localities provide potable water for human populations, they acted as magnets for economically important plants and animals. The region's numerous creeks, streams and rivers also served as attractive overland travel routes, which offered gentle gradients and the possibility for opportunistic hunting and gathering. Forests of ponderosa and lodgepole pine dominate the landscape around seven of the eight sites. These forests, interspersed with open meadows, provide forage for migrating deer and elk populations that move into the area shortly after the snow pack melts. Unlike the others, ISO 2031 is located within a sub-alpine forest dominated by mountain hemlock and red fir. Such forests also provide habitat for deer and elk, though they tend to come on-line slightly later in the season than the more xeric adapted ponderosa and lodgepole pine forests, which occur in drier contexts.

All of the sites studied here occur at the base or on the lower flanks of large buttes and mountains. The positioning of most of the sites (excepting 35KL888 and –1111) point to their use as ephemeral camping, hunting and processing sites. Sites 35KL888 and –111 (4,395 ft.), strategically situated at the southern end of Davis Lake, were the most intensely used of all study sites. All other sites have been attributed to hunting related activities and range in elevation from 4,520 – 5,360 ft. None of the sites were located on top of the numerous buttes in the area.

These findings are in agreement with those made by Burtchard et al. (1997) regarding site distributions in the Upper Deschutes River Basin. Their 1997 survey of the northern portion of the study area, including Davis Lake, and the southern shore of Wickiup Reservoir, found that site locations were closely associated with the presence of surface water (1997:65). Burtchard et al. found only one site located on top of a butte in the area. All others were located at lower elevations, generally in association with streams, creeks, and lakes. The exception is a large site consisting of 23 piles of large rocks (cairns) atop Hamner Butte. They suggest that mountain and butte summit locations did not confer much utility for observation or hunting of large game due to the dense nature of the local forests (Burtchard et al. 1997:65).

TECHNOLOGICAL CONSIDERATIONS

Not surprisingly, the vast majority of lithic artifacts analyzed from the study sites are made from high quality obsidian. Out of 76 stone tools analyzed, only three were made from cryptocrystal silicate (CCS). CCS does not occur naturally in the area, but is common on the southern Columbia Plateau to the north.

Within the study sites, there is a clear preference for bifacial tools and projectile points. Almost 70 percent of all the assemblages are composed of one of these tool classes. The heavy reliance

Table 7.2 Environmental setting of study sites.

Site No.	Period	Function	Elevation	H2O Type / Proximity	Landform	Vegetation
35-KL-528	Initial Archaic	Ephemeral camp; game interception & processing	4,780	Spring on site / drainage; Davis L. 5.3 mi. w; Deschutes R. 5 mi. SE	Upland / Butte	Ponderosa P. forest and woodland
35-KL-878	Unknown	Cache; ephemeral camp	5,360	Intermittent drainages .5 mi.; Davis L. 4.6 mi. west; Deschutes R. 4.5 mi. SE.	Upland / Saddle	Ponderosa P. forest and woodland
35-KL-879	Late Archaic	Cache; Ephemeral camp & processing	4,520	Intermittent drainage on site; Little Deschutes R. 4 mi. w.	Valley	Ponderosa P. & lodgepole P. forest
35-KL-880	Initial Archaic	Ephemeral camp; game processing.	4,580	Spring & intermittent drainage on site; Little Deschutes R. 4 mi. w.	Valley	Ponderosa P. & lodgepole P. forest
35-KL-888	Late Archaic	Multi-use task site	4,396	Davis L. and Odell Cr. on site.	Lake-side	Lodgepole P. forest & woodland
35-KL-1111	Mid to Late Archaic	Ephemeral base; Semi-sedentary residential base	4,394	Davis L. and Odell Cr. on site.	Lake-side	Lodgepole P. forest & woodland
ISO 2031	Late Archaic	Game interception	4,960	Crescent L. .25 mi SE.	Upland / Hillside	Mountain Hemlock & Red Fir Woodland
ISO 2175	Mid to Late Archaic	Game interception	4,940	Crescent Cr. on site; Odell L. 1.75 mi nw; Crescent L. 2.5 mi. sw.	Upland / Valley	Lodgepole P. forest

on these tools is not surprising given their versatility. Within the projectile point class, two main hafting types are present. Stemmed points represent the earliest type represented in the study area, while the notched hafting tradition characterizes the post-Mazama occupations. The stemmed tradition, which survived until sometime around the eruption of Mt. Mazama, is composed of two sub-varieties. Parallel-sided stemmed points are thought to have been hafted by binding the point to a split shaft. This technique is very similar to the technique used to haft fluted points. None of the stemmed points from assemblages examined here is parallel sided. The second sub-variety, contracting stem points, is represented by all of the stemmed points described here. Instead of a split shaft, the points were fitted within a socket on the foreshaft (Musil 1988). The socketed haft design represents an advance in efficiency in two important ways. One, it allowed for deeper penetration of the blade into the target animal. Secondly, the socketed design transferred less stress to the shaft, resulting in less damage to the wooden shaft. This was an important technological change since the shaft is the most expensive to produce, modify and repair in terms of time and energy required (Keely 1982; Musil 1988).

The notched hafting tradition first appeared in the Far West sometime around 7,000 B.P. and is represented by the introduction of the Elko series point. This hafting method was used for thousands of years until Euroamerican Contact. The development of the notched haft was another advance in efficiency. By moving the binding underneath the blade to the notches, more surface area of the cutting surface was freed up without increasing the size of the blade. In fact, the size of projectile points was reduced significantly with the advent of the notched design. Additionally, the notched configuration directs the brunt of the impact force onto the base of the point. If impact resulted in a break, the notches could be easily moved farther up the blade, allowing the point to be rejuvenated (Musil 1988).

Large, unhafted bifaces were noted at five of the eight sites in various stages of reduction. Four large bifaces from 35KL879 range in size from 11.06 – 12.88cm. All exhibit extensive pressure retouch with width to thickness ratios between 3.53 – 4.24. No use wear is evident on the pieces. Three of the bifaces were traced to Silver Lake / Sycan marsh. Artifact 880-3 is quite similar to those from –879 (it measures 11.4 cm in length), although it appears slightly further along the reduction trajectory. Although the piece was not hafted or significantly abraded, broad, intrusive flake detachments suggest its use as a flake core. 880-3 was traced to the Cougar Mountain obsidian source. Artifacts 880-2 and 528-14 are end fragments of large bifaces that may have also served as flake cores as evidenced by the diffuse soft hammer flake scars on both aspects. These tools clearly demonstrate the staging of bifacial reduction. Such staging of lithic reduction has been documented elsewhere in Central Oregon (Connolly 1999; Ozbun 1991).

Several smaller artifacts also exhibit signs of staged reduction. The cached projectile point preforms from site 35KL878 are a prime example. Three of the four preforms were reduced to the point of requiring only minimal work to apply a haft element. Such tools were probably kept in an unfinished state until they were fitted with a haft. It has been observed that it is easier to modify a projectile point base to fit a shaft, than vice versa (Musil 1988).

Assemblages from the study sites and elsewhere in Central Oregon suggest that more than one reduction strategy may be responsible for late stage bifaces that have similar morphologies. Several bifaces suggest a reduction trajectory similar to that proposed by Callahan (1979), whereby the ventral and dorsal surfaces of the object piece are reduced in roughly equal proportions. Artifacts 879-5, 878-7, as well as several others documented on the High Lava Plains, suggest that an alternative reduction trajectory must be taken into account (Connolly 1999; Taggart 2000). Artifact 879-5 is a medium sized unifacial blank. The vast majority of the retouch to the piece is on the dorsal surface, leaving the original flake scar on the ventral surface. A pronounced twist in the flake surface is also visible on the ventral surface. Artifact 878-7, is an unhafted biface with most flake detachments taken from the dorsal surface. The ventral surface has also been retouched, but primarily along the margins and not intrusively. Like 879-5, this artifact has been primarily reduced unifacially, with the dorsal surface serving as a flake core. Most retouch on the ventral surface appears to be rejuvenation used to keep the cutting edge sharp. The artifacts described above illustrate the shortcomings of Callahan's model.

It is apparent that two or more reduction strategies may be convergent, producing similar end products by very different means. It is likely that as unfacial bifaces become reduced, they are laterally cycled to different uses. Initially, a unifacial flake blank can be an excellent flake core. As it is further reduced, the working edges take shape and the piece is used for cutting and scraping. As it continues to be reduced it may eventually be used as a projectile point or other small tool. Such a reduction trajectory would be punctuated by use events.

It is unclear at this point whether the different reduction trajectories observed from the Upper Deschutes assemblages have any spatial and/or temporal meaning. In other parts of Oregon, different reduction techniques have been attributed to the same occupations, indicating a functional explanation (Musil 1991). Elsewhere, variability in reduction techniques have been attributed to temporal and ethnic differences (Flenniken and Ozbun 1988).

Users of the Upper Deschutes River Basin relied heavily on bifacial tools and made use of tool caches. Stone tools were brought into the Upper Deschutes in various stages of reduction. None of the sites in the study area provided evidence of primary reduction activities. On the contrary, most sites produced small amounts of debitage more in line with what is expected from the use, modification and rejuvenation of stone tools.

LAND USE & MOBILITY

Given the relatively limited resource base provided by the Upper Deschutes River Basin, prehistoric subsistence strategies were constrained in terms of the abundance and distribution of economically important plants and animals. Shifts in subsistence economies in the region can be understood as changes in the relative importance of specific components of the diet. The concomitant shift in settlement patterns reflect the economic pursuits by modifying the location, frequency, duration, and redundancy of occupations. Thus, while there is evidence of aboriginal human presence in the Upper Deschutes dating to between +7,000 – 150 B.P., the range of activities and intensity of occupation varied.

Evidence from the study sites indicates that pre-Mazama occupation of the Upper Deschutes was based on pursuit of large game such as deer and elk by small groups of highly mobile hunter-gatherers. Prior to 7,000 B.P., the eastern slope of the Cascades in the vicinity of Odell Lake was dotted with a juniper woodland, in stark contrast to the more mesic forest that exists today (Chatters 1994).

Several documented and inferred shifts in land use patterns during the Holocene coincide with major geologic, meteorological, and cultural phenomena. Judged from the 1 – 3 m of tephra that blankets the area today, the climactic eruption of Mt. Mazama 6,845 B.P. had an awesome impact on human populations by temporarily extinguishing the biotic productivity of the Upper Deschutes. Unfortunately, the data from this study cannot directly address the intensity of occupations immediately following the eruption due to lack of chronological resolution in the assemblages for the period spanning 7,000 – ~2,500 B.P.

It appears safe to speculate that the uplands of the eastern Cascade Range, in particular the Upper Deschutes, saw decreased use by humans in the two millennia following the eruption of Mt. Mazama. This supposition is bolstered by the co-occurrence of a general warming and drying trend across the West that lasted from ~7,000 – 5,000 B.P. in the northern Great Basin. Fagan (1974) unearthed evidence that showed such xeric conditions drew populations to lowland wet sites such as seeps, springs, ponds and shallow lakes that remained productive during this period. In fact, some low-lying wetlands actually improved during the Altithermal. At Hogup Cave in Utah, a nearby marsh thrived during the period spanning 8,000 – 3,000 B.P. with a continuous human presence (Aikens 1970). When a lake took over the marsh sometime around 3,000 B.P., the productivity of the area declined substantially. This example serves to illustrate that the effects of a Mid Holocene warming trend are highly localized.

Other major geologic phenomena linked to shifts in prehistoric settlement patterns in the Upper Deschutes occurred throughout the Mid to Late Holocene. Unlike the cataclysmic eruption of Mt. Mazama, several of the more recent events proved advantageous. The Black Rock Eruptive Episode is a case in point. Although tame by comparison, this basaltic eruption produced the Davis Lake flow and a nearby cinder cone. As the lava crept across Odell Creek, it cooled and began to slowly back up water behind it. The lake that formed behind it provided new habitat for aquatic resources and acted as a magnet for other economically important plants and animals. Combined with an improving climate in the late Mid Holocene, Davis Lake was increasingly cycled into the seasonal round of local groups.

With the onset of the Late Holocene, human populations were on the rise throughout the Pacific Northwest (Gilsen 2001; Jenkins and Connolly 1994). Population pressure has been cited as a major reason for the optimization of resources which led some groups to increase their mobility (northern Paiute), and others to decrease their mobility (southern Columbia Plateau groups). The features suggestive of house pits recorded at 35KL1111 provide a rare example of semi-sedentary occupations in the area. While such settlement patterns were common to the south in the Klamath Basin, and to the north on the middle and lower Deschutes and John Day River Basins during the Late Archaic, their presence in the Upper Deschutes is much more rare. Given their circular shape and semi-subterranean design, the depression features suggest cultural affinities between the people who used them and Plateau groups to the north and south. Additionally, the formation of new obsidian sources in Central Oregon would have influenced settlement patterns in the area. The copious amounts of high quality tool stone to be had at Newberry Crater has been shown to be a draw to mobile hunter-gatherers for at least 11,000 years (Connolly 1999). As the Interlake Flow (7,200 BP), East Lake Flow(3.550 BP), and Big Obsidian Flow erupted in the Crater, people increasingly included Newberry into their seasonal rounds.

OBSIDIAN SOURCE CHARACTERIZATION

Eight Central Oregon obsidian sources are represented in the study assemblages (see Table 6.10; Figures 7.1 & 7.2). Sources represented include Silver Lake / Sycan Marsh (n=10), Obsidian Cliffs (n=5), Newberry Crater (n=5), Spodue Mountain (n=4), Cougar Mountain (n=3), McKay Butte (n=3), Deer Creek (n=1), and Quartz Mountain (n=1).

Based on typological assignment of diagnostic projectile points, pre- and post-Mazama assemblages reflect differing procurement strategies. Assemblages attributed to these two periods differ primarily in regards to the number and location of sources exploited, rather than the distance from the quarry.The greatest amount of source variability is found in assemblages attributed to the Late Archaic. This category produced six diagnostic points representing six different obsidian sources. The sources range is distance from 25 (Deer Creek) to 73 miles away (Spodue Mountain). During this period Obsidian Cliffs is the dominant source, representing 33 percent (n=3) of the total. Thirteen other sourced artifacts were not diagnostic.

The Early and Mid Archaic periods are represented by four Elko series projectile points traced to four different sources (Cougar Mountain, McKay Butte, Silver Lake / Sycan Marsh, and Spodue Mountain). Distance from sources range from 20 (McKay Butte) to 73 miles (Spodue Mountain). The lone diagnostic point traced to McKay Butte is an Elko series, establishing its use in the Early to Mid Archaic. As such, it is not possible to support or refute Skinner's (1996) supposition that the use of McKay Butte obsidian dropped off precipitously after the eruption of Mt. Mazama.

The least amount of obsidian source variability is evident in the Initial Archaic (Figure 7.2) lithic assemblage. Here, only three sources are present: Silver Lake / Sycan Marsh, Spodue Mountain, and Obsidian Cliffs. The Silver Lake / Sycan Marsh (n=2) and Obsidian Cliffs (n=2) sources each represent 40 percent of the entire assemblage, with Spodue Mountain claiming 20 percent (n=1). Distances to sources vary between 43 (Obsidian Cliffs) and 73 miles (Spodue Mountain).

The rather restricted procurement range indicated by the Initial Archaic lithic assemblage is somewhat surprising given the high degree of mobility suggested for this period across the West (Connolly 1999). A possible explanation for this observation lies in the high productivity of the Northwest, which may have tethered groups to fewer key resources located around wetlands endemic to the Klamath and Chewaucan Basins to the south. A more parsimonious explanation

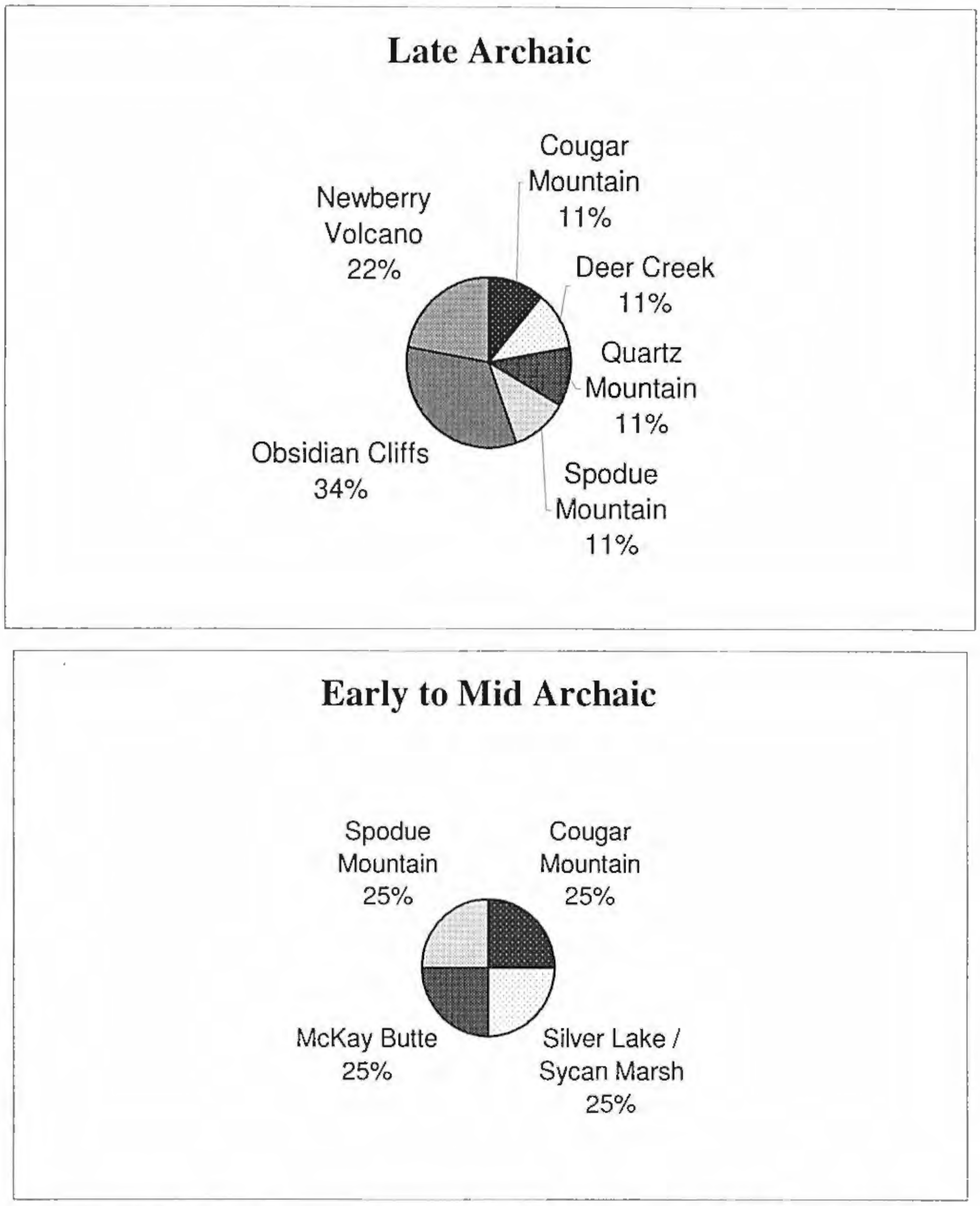


Figure 7.1 Obsidian source proportions in Late Archaic and Early to Mid Archaic tool assemblages.

is that fewer obsidian sources were available in the Initial Archaic compared to the Late Archaic. As new obsidian flows erupted within Newberry Crater, its toolstone became widely distributed in Central Oregon.

Another way to view the data is to discriminate between pre- and post-Mazama lithic assemblages. The pre-Mazama category mirrors the Initial Archaic, with three sources represented, dominated by the Silver Lake / Sycan Marsh and Obsidian Cliffs sources. The post-Mazama assemblage is the most variable with all eight sources represented with the highest proportions attributed to Obsidian Cliffs (n=3), Newberry Crater (n=2), Spodue Mountain (n=2),

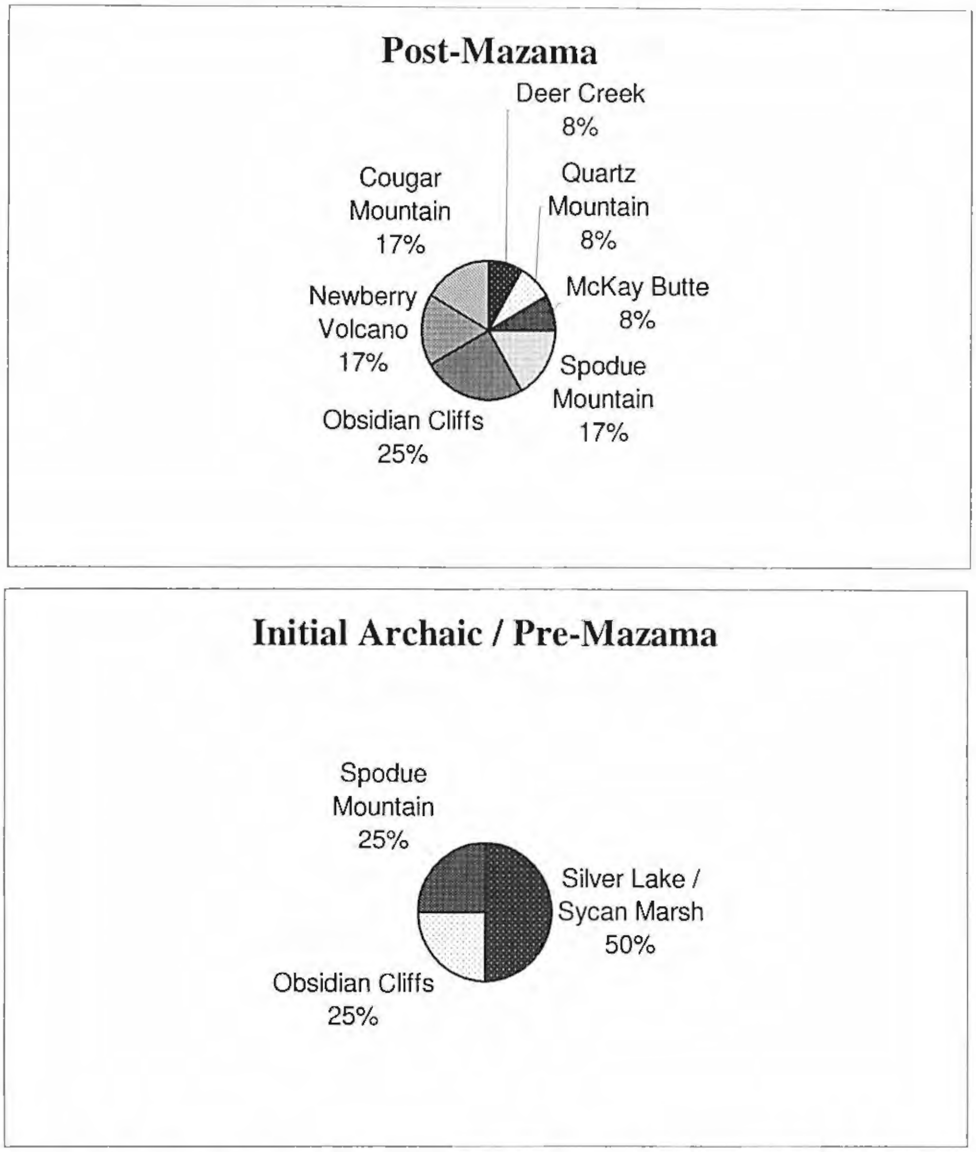


Figure 7.2 Obsidian source proportions in Post Mazama and Initial Archaic/ Pre-Mazama tool assemblages.

and Cougar Mountain (n=2). Clearly, Silver Lake / Sycan Marsh and Spodue Mountain were major sources of obsidian early on, comprising 80 percent of the Initial Archaic assemblage. Both are present in the post-Mazama assemblage, though they only comprise 23 percent, cumulatively.

The decline in use of southern obsidian sources coincides with the growing availability of high quality obsidian at Newberry Crater, the eruption of Mt. Mazama, and the subsequent warming trend of the Mid Holocene. These data suggest that during the Initial Archaic, groups spending weeks or months in the Upper Deschutes during the spring and summer imported tool stone from points south. The presence of the northernmost source, Obsidian Cliffs, in the early assemblage

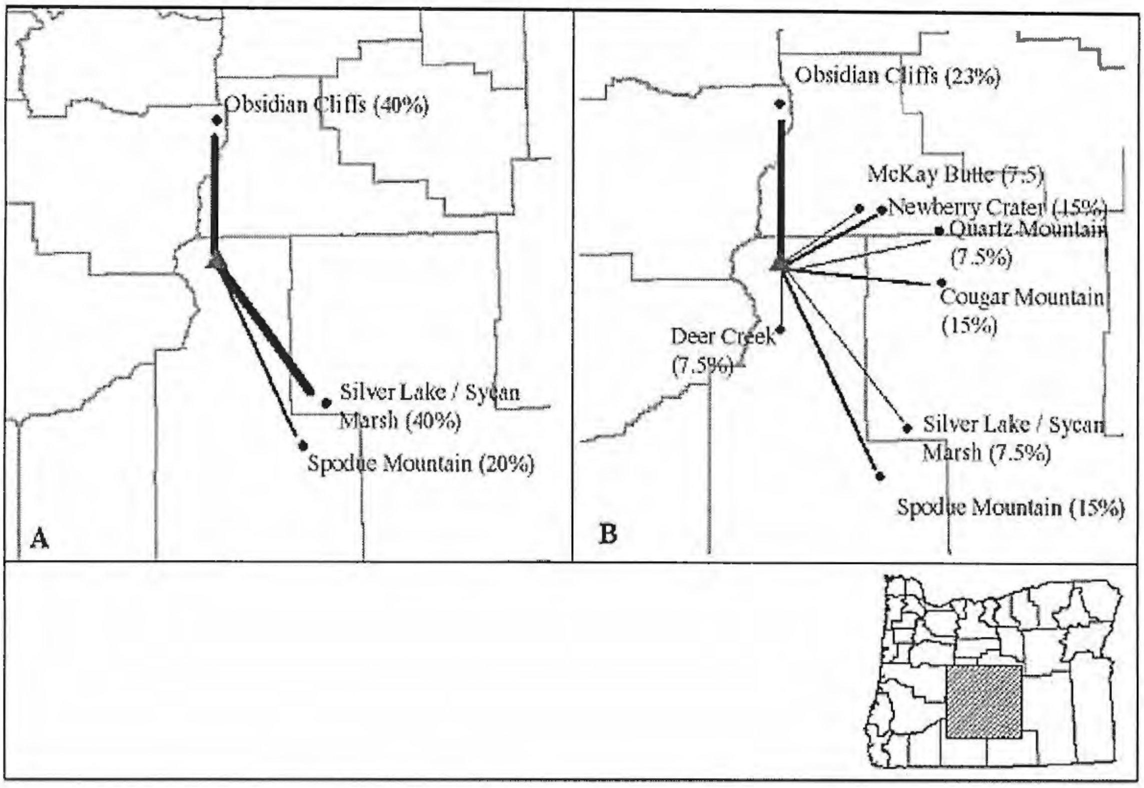


Figure 7.3 Obsidian sources represented in pre- (A) and post-Mazama (B) tool assemblages.

implies either interaction with groups to the north, or a rather large territory encompassed in seasonal rounds during that period. As the Mid Holocene set in, local groups were using the uplands less, if at all. Following this apparent contraction of territory, Silver Lake / Sycan Marsh never regained dominance.

Overall, the patterns described here imply a greater amount of source variability and more extended procurement ranges during the post-Mazama period. This finding contrasts with what Connolly (1999) concluded from Newberry Crater sites. There he found the highest source variability and the largest procurement range in pre-Mazama contexts. As has been suggested here, Connolly found Silver Lake / Sycan Marsh and Spodue Mountain to be the primary sources in the pre-Mazama assemblages. The post-Mazama assemblage from Newberry Crater reflects a smaller procurement range and less dependence on any one source (Connolly 1999).

Causes of the divergent findings may be related to preservation and sampling bias. Pre-Mazama sites are much more likely to be buried and undetected. Thus the specimens studied here may not be representative of the entire population. Additionally, characterization of debitage would likely reveal evidence of visits to sources closest to the sites, in all periods. Finally, much more time is represented in the post-Mazama assemblage.

CONCLUSIONS

Prehistoric occupations of the Upper Deschutes River Basin are characterized by a high degree of residential mobility in all periods, with the possible exception of a Mid / Late Archaic episode of increased seasonal sedentism at Davis Lake. Evidence from the study area suggests small groups ventured into the uplands for short periods in the warmer months where base and task sites were established, and in some cases used repeatedly.

Based on observed site distribution patterns (Table 7.2) discussed in this study, as well as those presented by Burtchard et al. (1997), occupation of the Upper Deschutes River Basin was centered on the productive lakes, streams and springs, which provided a pivot point from which task groups could move out to acquire locally available game and vegetable resources. Not surprisingly, site distribution patterns in the area indicate that residential base camps were most likely to be located along the margins of upland lakes in the area.

There is mounting evidence that Davis Lake provided a rather unique and productive environment in the region. Of particular interest is the lake's elevation and depth. Situated at 4,386 ft., Davis lake is substantially lower than other lakes in the area such as Odell (4,788), Crescent (4,839), and Cultus (4,668). And unlike all others in the vicinity, Davis Lake is very shallow, averaging nine feet, with a maximum depth of twenty feet. These two factors combine to produce a relatively warm water lake that provides habitat for a wide array of economically important plants and animals including deer, elk, waterfowl, fish, and reeds. Perhaps most importantly, the lake provides habitat for the yellow water lily, a staple of the Klamath diet.

Observations made regarding the drastic fluctuation of water levels (Hickerson 2000) in the lake may provide an important clue concerning its productivity. Given the shallow depth of the lake, a small drop in water levels over a prolonged period of several years may have fostered the development of marsh-like conditions. Such an arrangement could have significantly increased the productivity of the lake. Although only circumstantial evidence is available at this point, it appears probable that the lake was at its lowest levels for the millennium following its formation, which co-occurred with the warming and drying trend of the Altithermal.

As Burtchard et al. (1997) point out, the size and position of Davis Lake may have conferred other advantages to prehistoric people in the area. The lake's size would conceivably allow for individuals based on the lake to exploit game at relatively large distances since transportation costs could be significantly reduced with the use of watercraft such as dug-out canoes.

The Upper Deschutes River and its tributaries also provided travel corridors and access to hunting and gathering grounds for groups entering the area from points north, south, and east. The rather bleak environment around sites 35KL878 and –880 suggest that the La Pine Valley was one such stop over point used in transit to and / or from the more productive (in the warm months) upland lakes and rivers.

Along travel corridors, high quality obsidian could be obtained nearby. Many large biface caches have been reported from the area, most within a few days walk of the obsidian source (Davis et al. 1991; Minor & Toepel 1984, 1989; Scott et al. 1986, 1989; Taggart 2000).

Mounting evidence suggests that many users of Central Oregon obsidian sources were producing a surplus of bifaces, known as *production blanks*. Given the proximity of several such caches to travel corridors, it is plausible that the Upper Deschutes was a meeting ground where people gathered to trade. Such happenings would have also functioned to facilitate group exogamy and provide a context for socializing with other groups.

It now appears that several land use strategies were used in the Upper Deschutes including rest-rotation (documented ethnographically), a period of semi-sedentary collecting centered on Davis Lake, and something more closely resembling a foraging strategy during the Initial Archaic. Hunting of large game and waterfowl would have been a major draw to human groups in all periods, but would have likely been supplemented by more extensive use of plant foods during periods of population growth or increased sedentism.

Regardless of the land use systems practiced within the Upper Deschutes, none could function exclusively within the uplands and would have been supplemented by lowland resources (Atwell 1994). During the cold season, upland settings such as Davis, Odell, and Crescent Lakes are blanketed with deep snow. Such conditions, which generally begin in November and last until April, drastically reduce biotic productivity and severely limit access to the area. Ethnographic users of the Upper Deschutes took refuge from deep snow and frigid temperatures by wintering in the low-lying basins to the north (Bend area), east (Fort Rock Basin and Christmas Valley), and south (Klamath Basin). With the spring thaw, groups would slowly begin making their way to the uplands, following migrating deer and elk. It is likely that the ethnographic pattern of spending the warm months in the uplands hunting and gathering, and wintering in the lowlands, is quite ancient, having its origins in the Initial Archaic, some 7,000+ years ago.

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APPENDICES

Appendix 1:

Stone Tool Attributes

Catalog	Loci	Type	DC	Ctx	RM	Tech1	Tech2	RT1	RT2	#RTE	Loc	EA	PT	L	W	xW	xT	W:T	Sv/d	NW	BW	HL	Stc	Source	Point type
888_9	*	UT	C	P/10	OB	SHP	P	UF	D	1	D	1	CPX	5.09	5.32	5.91	1.52	3.88	1/1	*	*	*	*		
888_8	*	SC	C	P/90	OB	P	SHP	UF	C	1	R	3	*	3.7	3.23	3.23	.58	5.56	1/2	*	*	*	*		
888_7	*	BF	D	P/50	OB	SHP	*	BF	C	2	RLD	2		2.75	2.92	3.42	.71	4.81	3/3	*	*	*	*		
888_6	*	DR	C	P/80	OB	P	*	BF	C	2	RL	1	*	2.85	.7	2.0	.26	7.69	5/5	*	*	*	*	Newberry	
888_5	*	GR	P	0	OB	P	*	BF	D	2	RL	2	*	1.42	2.36	2.36	.5	4.72	5/5	*	*	*	*	Mckay	
888_4	*	BF	D	P/50	OB	P	*	BF	C	3	RLD	2		2.6	2.4	2.4	.71	3.38	5/5	*	*	*	*	*	
888_3	*	SC	C	0	C	SHP	P	UF	C	2	LR	3	CPX	3.96	2.08	2.22	.66	3.36	1/2	*	*	*	*	*	
888_15	*	BF	C	P/25	OB	P	*	BF	C	3	RLD	1		2.6	1.56	1.62	.42	3.85	5/5	*	*	*	*	*	
888_12	*	UT	M	0	OB	SHP	P	BF	CL	2	RL	1	*	3.2	1.58	1.9	.45	4.22	2/2	*	*	*	*	*	
888_11	*	PR	C	P/60	OB	P	*	BF	C	3	RLD	2		2.5	1.3	1.63	.48	3.39	5/5	1.02	1.14	.45	.44	Newberry	Rosespring
888_1	*	PR	D	0	OB	P	*	BF	C	3	RLD	1		2.22	1.13	1.27	.35	3.62	5/5	.54	.63	.45	.38	Spodue	Rosespring
880_5	*	BF	D	P/25	OB	P	*	BF	C	3	RLD	2		3.09	1.85	2.14	.73	2.93	5/5	1.64	1.45	1.35	*	Silver L	GB Stemmed
880_3	*	BF	C	P/5	OB	P	SHP	BF	C	3	RLD	1		11.4	3.67	3.67	.98	3.74	5/5	*	*	*	*	Cougar	
880_2	*	BF	D	P/50	OB	P	SHP	BF	C	2	RL	1	*	6.34	3.46	4.13	.93	4.44	4/4	*	*	*	*	Newberry	
880_1	AG	CO	C	C/25	OB	BP	*	*	C	3	*	*	*	3.39	2.68	2.95	1.6	*	*	*	*	*	*	*	
879_7	AC	BF	M	P/80	OB	SHP	*	BF	C	1	L	2	*	3.9	2.47	2.76	1.12	*	2/2	*	*	*	*	*	
879_6	*	BF	C	P/25	OB	P	SHP	BF	C	2	RL	1	*	12.56	4.02	4.09	1.37	2.98	5/5	*	*	*	*	Silver L	
879_5	F	BL	C	0	OB	SHP	P	BF	C	3	RLD	1		7.25	3.88	3.92	1.04	3.76	2/4	*	*	*	*	*	
879_4	*	PR	C	P/70	OB	P	*	UF	D	2	RL	2	*	3.55	1.79	1.85	.23	8.04	5/5	1.05	1.34	.76	*	Cougar	Rosespring
879_3	*	BF	C	0	OB	P	SHP	BF	C	2	RL	1	*	11.48	4.24	4.24	.89	4.75	5/5	*	*	*	*	Silver L	
879_2	B	BF	C	0	OB	P	SHP	BF	C	2	RL	1	*	11.06	3.29	3.53	.9	3.92	5/5	3.52	3.52	4.6	3.07	*	
879_11	AH	SC	C	P/80	OB	P	*	UF	C	1	P	2	*	2.65	3.04	3.04	.56	5.42	2/2	*	*	*	*	*	
879_10	AV	DE	C	P/60	OB	P	*	UF	CL	1	D	1	*	2.59	2.08	2.08	1.65	*	*	*	*	*	*	*	
879_1	*	BF	C	P/30	OB	P	SHP	BF	C	2	RL	1	*	12.88	3.93	4.0	1.3	3.07	5/5	*	*	*	*	Silver L	
878_9	C	PF	C	C/20	OB	P	SHP	BF	C	2	RL	2	*	4.46	2.25	2.31	.94	2.45	4/4	*	*	*	*	*	
878_8	E	BF	P	0	OB	P	*	BF	C	2	RL	1	*	1.83	1.12	1.6	.43	3.72	5/5	*	*	*	*	*	
878_7	*	BF	C	P/50	OB	P	SHP	BF	CL	3	RLD	2		7.9	2.08	2.35	1.15	2.04	5/5	*	*	*	*	Silver L	
878_6	J	BF	M	0	OB	P	*	BF	C	1	R	3	*	2.05	1.4	1.69	.91	1.85	4/4	*	*	*	*	*	
878_5	A	BF	P	C/10	OB	P	*	BF	C	2	RL	3	*	2.95	1.41	1.94	1.04	1.8	4/4	*	*	*	*	*	
878_4	*	PF	C	0	OB	P	*	BF	C	3	RLD	1		5.04	1.71	1.88	.8	2.35	4/4	1.71	1.86	2.14	*	Mckay	
878_3	*	PF	C	P/30	OB	P	*	BF	C	3	RLD	1	*	5.23	1.93	2.28	.65	3.5	4/4	2.06	1.82	3.5	*	Silver L	
878_2	*	BF	D	0	OB	P	SHP	BF	C	3	RLD	2	*	6.5	2.06	2.4	1.09	1.87	5/5	*	*	*	*	Newberry	
878_10	*	BF	P	0	O	P	*	BF	C	2	RL	1	*	2.2	1.18	1.64	.49	3.34	5/5	*	*	*	*		
878_1	*	PF	C	P/65	OB	P	*	BF	C	2	RL	1	*	5.31	1.98	2.18	.59	3.69	4/4	1.82	.97	1.64	*	Silver L	
528_9	*	PR	D	0	OB	P	*	BF	C	3	RLD	1		2.42	1.56	1.88	.53	3.54	5/5	1.66	1.21	1.67	1.45	Obsidian	GB Stemmed
528_7	*	PR	C	0	OB	P	*	BF	C	3	RLD	2		2.02	1.2	1.33	.42	3.16	5/5	.75	1.43	.84	.64	Silver L?	Desert Side Notch
528_6	*	PR	C	0	OB	P	*	BF	C	3	RLD	1		3.59	1.42	1.7	.51	3.33	5/5	1.0	1.03	.75	.44	Mckay	Elko
528_5	*	PR	C	0	OB	P	*	BF	C	3	RLD	1		6.11	2.21	2.4	.72	3.33	5/5	1.86	1.66	1.28	1.0	Obsidian	GB Stemmed
528_4	*	PR	C	0	C	P	*	BF	C	3	RLD	1		3.7	1.56	2.06	.52	3.96	5/5	1.44	.76	.47	.63		Unidentifiable
528_2	*	BF	C	0	OB	P	*	BF	C	3	RLD	1		3.58	1.9	2.54	.69	3.68	5/5	.97	1.18	.7	.8		Rosespring
528_17	*	UT	P	0	C	P	SHP	UF	C	2	PD	1	CPX	4.32	1.34	1.72	.56	3.07	2/2	*	*	*	*		
528_16	*	PR	D	0	OB	P	*	BF	C	3	RLD	2		1.46	1.66	1.85	.61	3.3	5/5	*	*	*	*	Spodue	GB Stemmed
528_15	*	GR	C	0	OB	P	*	BF	C	4	*	1	*	4.0	3.24	3.47	.48	7.23	2/2	*	*	*	*		
528_14	*	BF	M	0	OB	P	SHP	BF	C	2	RL	2	*	5.42	3.13	3.63	.89	4.07	5/5	*	*	*	*		
528_10	*	PR	D	0	OB	P	*	BF	C	3	RLD	2	2	6.36	2.28	2.52	.9	2.8	5/5	2.32	1.32	3.48	*	Silver L	GB Stemmed
528_1	*	PR	D	0	OB	P	*	BF	C	3	RLD	1		1.68	1.76	2.45	.32	7.65	5/5	.93	.93	.16	*		Cottonwood
2175_2	*	PR	C	0	OB	P	*	BF	C	3	RLD	1		5.33	1.7	2.33	.45	5.17	5/5	1.07	1.13	.88	.5	Spodue	Elko

Note: Refer to Tables 5.1 & 5.2 for attribute abbreviation definitions (p. 67 – 68)

Catalog	Type	DC	Ctx	RM	Tech1	Tech2	RT1	RT2	#RTE	Loc	EA	PT	L	W	xW	xT	W:T	Sv/d	NW	BW	HL	Stc	Source	Point type
2175_1A	BF	P	0	OB	P	*	BF	C	2	RL	2	*	7.38	2.15	2.37	.84	2.82	5/5	*	*	*	*	Spodue Mtn	
2175_01B	BF	P	0	OB	P	SHP	BF	C	2	RL	1	*	7.39	2.84	3.38	.9	3.75	5/5	*	*	*	*		
2031_5 7	UT	D	P/50	OB	P	*	UF	C	2	RL	3	*	4.59	1.86	3.22	.87	3.7	1/2	*	*	*	*		
2031_1	PR	C	0	OB	P	*	BF	C	3	RLD	1	*	3.55	1.57	1.74	.64	2.71	5/5	1.27	1.8	1.15	*	Obsidian Cliffs	DSN
1111_9	PR	P	0	OB	P	*	BF	C	3	RLD	1	*	1.74	1.1	1.32	.23	5.73	5/5	.5	.53	.59	.23	Obsidian Cliffs	Eastgate
1111_8	PR	C	0	OB	P	*	BF	C	3	RLD	*	1	3.07	1.7	1.95	.39	5	5/5	.73	.67	.73	.69		Eastgate
1111_6	BF	D	0	OB	P	*	BF	C	2	RD	1	*	2.8	1.96	2.22	.5	4.44	5/5	*	*	*	*		
1111_5	PR	M	0	OB	P	*	BF	C	2	RL	1	*	1.11	1.45	1.45	.28	5.17	5/5	*	*	*	*		Unidentifiable
1111_4	PR	D	0	OB	P	*	BF	C	3	RLD	*	1	1.3	1.63	1.63	.25	6.52	5/5	.61	.54	.55	.57		Rosesring
1111_3	PR	D	0	OB	P	*	BF	C	3	RLD	*	1	1.56	1.58	1.58	.42	3.76	5/5	.78	.97	.6	.49		Rosespring
1111_23	PR	C	0	OB	P	*	BF	C	3	RLD	*	1	2.07	.7	1.24	.29	4.27	5/5	.42	.48	.46	.39	Deer Cr	Eastgate
1111_22	PR	D	0	OB	P	*	BF	C	3	RLD	*	1	2.22	1.73	1.93	.48	4.02	5/5	1.1	.91	.51	.83		Elko
1111_21	PR	C	0	OB	P	*	BF	C	3	RLD	*	1	3.98	1.9	2.19	.65	3.36	5/5	1.19	1.58	.93	.71	Cougar Mtn	Elko
1111_20	PR	P	0	OB	P	*	BF	C	2	RL	1	*	1.5	.52	.89	.14	6.35	5/5	*	*	*	*		Unidentifiable
1111_2	PR	C	0	OB	P	*	BF	C	3	RLD	*	1	2.47	.92	1.44	.41	3.51	5/5	.52	.73	.53	.49		Rosesping
1111_19	PR	P	P/5	OB	P	SHP	BF	CL	3	RLD	*	1	2.67	1.24	1.43	.34	4.2	2/4	*	*	*	*		Cottonwood
1111_18	PR	C	0	OB	P	*	BF	C	3	RLD	*	1	2.58	1.25	1.67	.42	3.97	5/5	1.15	1.43	.9	.7	Obsidian Cliffs	DSN
1111_17	PR	C	0	OB	P	*	BF	C	3	RLD	*	1	4.09	1.85	2.25	.39	5.76	5/5	.81	.95	.69	.55	Newberry	Eastgate
1111_16	PR	C	0	OB	P	*	BF	C	3	RLD	*	1	1.52	.96	1.11	.21	5.28	5/5	.49	.5	.36	.26	Quartz Mtn	Eastgate
1111_15	PR	C	P/50	OB	P	*	BF	C	3	RLD	*	1	3.75	1.4	1.76	.42	4.19	5/5	1.2	1.61	.7	.58	Silver L	Elko
1111_14	GS	C	0	BS	*	*	*	*	*	*	*	*	10.8	8.05	8.05	4.52	*	*	*	*	*	*		
1111_13	UT	D	0	OB	P	SHP	UF	C	2	RL	*	1	2.94	1.31	1.9	.26	7.3	1/4	*	*	*	*		
1111_12	PR	P	0	OB	P	*	BF	C	2	RL	*	1	2.11	1.15	1.57	.16	9.81	5/5	*	*	*	*		Unidentifiable
1111_11	UF	P	0	OB	P	*	UF	C	2	RL	*	3	3.48	1.43	1.88	1.05	1.02	1/5	*	*	*	*		Unidentifiable
1111_10	PR	P	0	OB	P	*	BF	C	2	RL	*	1	1.78	.96	1.47	.48	3.06	5/5	*	*	*	*		Unidentifiable
1111_1	PR	C	0	OB	P	*	BF	C	3	RL	*	1	1.46	.75	1.13	.24	4.52	5/5	.43	.21	.26	.4		Rosespring

Note: Refer to Tables 5.1 & 5.2 for attribute abbreviation definitions (p. 67 – 68)

Appendix 2:

XRF Results

Northwest Research Obsidian Studies Laboratory

Table A-1. Results of XRF Studies: Several Sites in Klamath County, Oregon

Site	Specimen No.	Catalog No.	Trace Element Concentrations: Zn	Pb	Rb	Sr	Y	Zr	Nb	Ti	Mn	Ba	$Fe2O3^T$	Ratios: Fe:Mn	Fe:Ti	Artifact Source
35-KL-1111	1	1111-15	109	21	125	13	57	352	17	NM	NM	NM	NM	NM	NM	Silver Lake/Sycan Marsh
			± 7	4	3	6	3	5	2	NM	NM	NM	NM			
35-KL-1111	2	1111-16	71	21	123	59	41	166	5	NM	NM	NM	NM	NM	NM	Quartz Mountain
			± 8	4	4	6	3	5	2	NM	NM	NM	NM			
35-KL-1111	3	1111-17	70	16	143	64	45	300	17	NM	NM	NM	NM	NM	NM	Newberry Volcano
			± 6	3	3	6	3	5	2	NM	NM	NM	NM			
35-KL-1111	4	1111-18	77	15	82	108	21	101	8	NM	NM	NM	NM	NM	NM	Obsidian Cliffs
			± 6	3	3	6	3	5	2	NM	NM	NM	NM			
35-KL-1111	5	1111-21	81	18	101	40	57	137	15	NM	NM	NM	NM	NM	NM	Cougar Mountain
			± 6	3	3	6	3	5	2	NM	NM	NM	NM			
35-KL-1111	6	1111-9	41	16	71	92	16	85	4	NM	NM	NM	NM	NM	NM	Obsidian Cliffs
			± 6	3	3	6	3	5	2	NM	NM	NM	NM			
35-KL-1111	7	1111-23	72	11	90	10	42	267	18	NM	NM	NM	NM	NM	NM	Silver Lake/Sycan Marsh?
			± 7	4	3	6	3	5	2	NM	NM	NM	NM			
ISO 2031	8	2031-1	64	14	83	111	15	103	8	NM	NM	NM	NM	NM	NM	Obsidian Cliffs
			± 6	3	3	6	3	5	2	NM	NM	NM	NM			
ISO 2175	9	2175-1A	82	18	112	46	24	129	15	NM	NM	NM	NM	NM	NM	Spodue Mountain
			± 6	3	3	6	3	5	2	NM	NM	NM	NM			
ISO 2175	10	2175-2	59	22	103	48	25	123	12	NM	NM	NM	NM	NM	NM	Spodue Mountain
			± 5	3	3	6	3	5	2	NM	NM	NM	NM			
35-KL-528	11	528-10	127	22	127	6	53	350	19	NM	NM	NM	NM	NM	NM	Silver Lake/Sycan Marsh
			± 6	3	3	6	3	5	2	NM	NM	NM	NM			
35-KL-528	12	528-16	44	17	97	40	25	114	10	NM	NM	NM	NM	NM	NM	Spodue Mountain
			± 6	3	3	6	3	5	2	NM	NM	NM	NM			
35-KL-528	13	528-5	40	12	84	111	15	104	7	NM	NM	NM	NM	NM	NM	Obsidian Cliffs
			± 6	3	3	6	3	5	2	NM	NM	NM	NM			
35-KL-528	14	528-6	92	22	147	64	40	218	8	NM	NM	NM	NM	NM	NM	McKay Butte
			± 6	3	3	6	3	5	2	NM	NM	NM	NM			
35-KL-528	15	528-7	53	13	74	84	26	251	10	NM	NM	NM	NM	NM	NM	Deer Creek
			± 6	4	3	6	3	5	2	NM	NM	NM	NM			

All trace element values reported in parts per million; ± = analytical uncertainty estimate (in ppm). Iron content reported as weight percent oxide.
NA = Not available; ND = Not detected; NM = Not measured.; * = Small sample.

Northwest Research Obsidian Studies Laboratory

Table A-1. Results of XRF Studies: Several Sites in Klamath County, Oregon

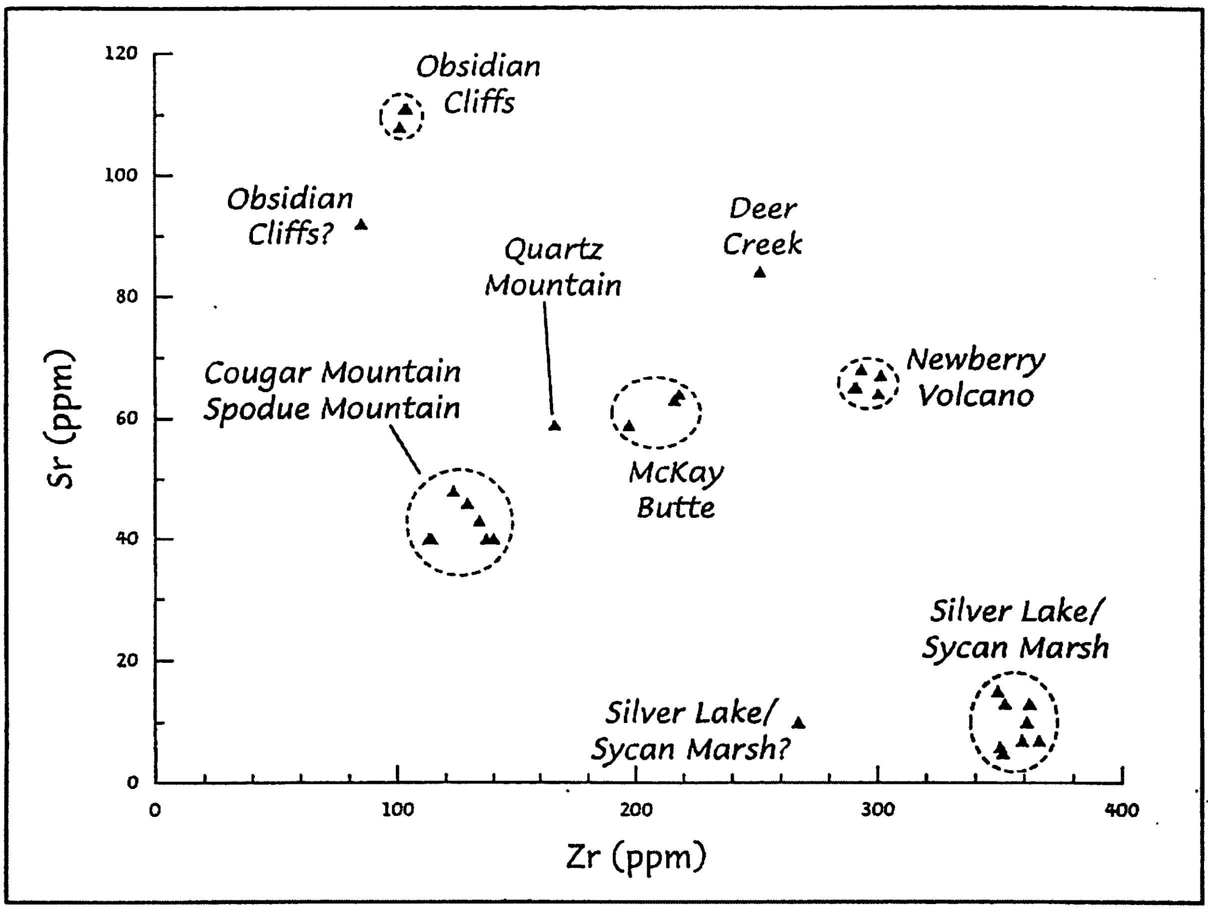
Site	Specimen No.	Catalog No.	Zn	Pb	Rb	Sr	Y	Zr	Nb	Ti	Mn	Ba	$Fe2O3^T$	Fe:Mn	Fe:Ti	Artifact Source
			Trace Element Concentrations											Ratios		
35-KL-528	16	528-9	74	19	80	111	13	104	10	NM	NM	NM	NM	NM	NM	Obsidian Cliffs
			± 6	4	3	6	3	5	2	NM	NM	NM	NM			
35-KL-878	17	878-1	145	24	120	15	54	349	19	NM	NM	NM	NM	NM	NM	Silver Lake/Sycan Marsh
			± 7	3	3	6	3	5	2	NM	NM	NM	NM			
35-KL-878	18	878-2	78	16	143	68	44	293	18	NM	NM	NM	NM	NM	NM	Newberry Volcano
			± 6	3	3	6	3	5	2	NM	NM	NM	NM			
35-KL-878	19	878-3	111	25	126	10	53	361	21	NM	NM	NM	NM	NM	NM	Silver Lake/Sycan Marsh
			± 6	3	3	6	3	5	2	NM	NM	NM	NM			
35-KL-878	20	878-4	62	24	139	63	41	216	12	NM	NM	NM	NM	NM	NM	McKay Butte
			± 6	3	3	6	3	5	2	NM	NM	NM	NM			
35-KL-878	21	878-7	124	26	122	13	55	362	20	NM	NM	NM	NM	NM	NM	Silver Lake/Sycan Marsh
			± 6	3	3	6	3	5	2	NM	NM	NM	NM			
35-KL-879	22	879-1	104	25	128	7	55	359	17	NM	NM	NM	NM	NM	NM	Silver Lake/Sycan Marsh
			± 6	3	3	6	3	5	2	NM	NM	NM	NM			
35-KL-879	23	879-3	92	29	130	7	60	366	17	NM	NM	NM	NM	NM	NM	Silver Lake/Sycan Marsh
			± 6	3	3	6	3	5	2	NM	NM	NM	NM			
35-KL-879	24	879-4	122	17	94	43	53	134	14	NM	NM	NM	NM	NM	NM	Cougar Mountain
			± 6	3	3	6	3	5	2	NM	NM	NM	NM			
35-KL-879	25	879-6	101	24	125	5	51	351	17	NM	NM	NM	NM	NM	NM	Silver Lake/Sycan Marsh
			± 6	3	3	6	3	5	2	NM	NM	NM	NM			
35-KL-880	26	880-2	69	22	137	65	44	291	15	NM	NM	NM	NM	NM	NM	Newberry Volcano
			± 5	3	3	6	3	5	2	NM	NM	NM	NM			
35-KL-880	27	880-3	74	15	99	40	57	140	10	NM	NM	NM	NM	NM	NM	Cougar Mountain
			± 5	3	3	6	3	5	2	NM	NM	NM	NM			
35-KL-880	28	880-5	87	25	130	7	53	359	16	NM	NM	NM	NM	NM	NM	Silver Lake/Sycan Marsh
			± 6	3	3	6	3	5	2	NM	NM	NM	NM			
35-KL-888	29	888-1	57	16	93	40	22	113	15	NM	NM	NM	NM	NM	NM	Spodue Mountain
			± 6	4	3	6	3	5	2	NM	NM	NM	NM			
35-KL-888	30	888-11	98	21	140	65	45	290	17	NM	NM	NM	NM	NM	NM	Newberry Volcano
			± 6	3	3	6	3	5	2	NM	NM	NM	NM			

All trace element values reported in parts per million; ± = analytical uncertainty estimate (in ppm). Iron content reported as weight percent oxide.
NA = Not available; ND = Not detected; NM = Not measured.; * = Small sample.

Table A-1. Results of XRF Studies: Several Sites in Klamath County, Oregon

Site	Specimen No.	Catalog No.		Trace Element Concentrations											Ratios		Artifact Source
				Zn	Pb	Rb	Sr	Y	Zr	Nb	Ti	Mn	Ba	$Fe2O3^T$	Fe:Mn	Fe:Ti	
35-KL-888	31	888-5		42	16	132	59	37	197	12	NM	NM	NM	NM	NM	NM	McKay Butte
			±	7	3	3	6	3	5	2	NM	NM	NM	NM			
35-KL-888	32	888-6		81	20	146	67	42	301	18	NM	NM	NM	NM	NM	NM	Newberry Volcano
			±	6	3	3	6	3	5	2	NM	NM	NM	NM			
NA	RGM-1	RGM-1		52	22	153	105	29	225	11	NM	NM	NM	NM	NM	NM	RGM-1 Reference Standard
			±	5	3	3	6	3	5	2	NM	NM	NM	NM			

All trace element values reported in parts per million; ± = analytical uncertainty estimate (in ppm). Iron content reported as weight percent oxide.
NA = Not available; ND = Not detected; NM = Not measured.; * = Small sample.


Sr (ppm)
Zr (ppm)
0
20
40
60
80
100
120
0
100
200
300
400
Obsidian Cliffs
Obsidian Cliffs?
Deer Creek
Quartz Mountain
Newberry Volcano
Cougar Mountain Spodue Mountain
McKay Butte
Silver Lake/ Sycan Marsh
Silver Lake/ Sycan Marsh?