AN ABSTRACT OF THE THESIS OF

Mary Elizabeth Marschall for the degree of Master of Arts in Applied Anthropology presented on December 17, 2004.

Title: A Preliminary Regional Analysis of Lithic Cache Sites in Central Oregon

Abstract approved:

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David R. Brauner

In the obsidian rich areas of central Oregon numerous lithic cache sites have been documented and strongly suggest the existence of a regional caching practice, however these sites remain poorly understood as cultural behavior. The primary objectives of this study are to develop and apply a research strategy addressing the caching behavior within a regional context, compile and expand data bases for known cache sites, identify and clarify patterns associated with the caching behavior, and interpret the results within the context of a preliminary investigation.

This researcher utilizes a regional methodology to study the caching practice. A regional focus is of paramount importance because Central Oregon is a vastly complex region in terms of its natural and cultural environments. The natural environment is highly dynamic, dominated by climatic variability and volcanism. The cultural environment is diverse and fluid as the caching region is geographically located at the confluence of the southern Columbia Plateau, northern Great Basin, and Cascade culture areas. A comprehensive regional approach allows the integration of these complexities within the context of the caching behavior.

This study assembles a comprehensive data base for each of the known cache sites. The data base includes material characteristics and geochemical attributes of individual cache sites, assemblages, and artifacts. New geochemical sourcing studies were obtained for some of the caches. These studies expand the existing data base and ultimately revise the obsidian sourcing data to comply with current XRF standards.

The data bases are then used to identify and clarify patterns associated with the caching behavior. The research suggests both a lanceolate and an ovate cache type are represented in the central Oregon region. The notion of two identifiable cache types is compared and contrasted with other regional archaeological sites, particularly the Paulina Lake site in the caldera of Newberry Volcano. This evaluation further supports the possibility of two cache types and suggests the lanceolate and ovate type caches are probably separated chronologically as well as culturally.

The comprehensive research design and subsequent results ultimately fosters the development of new hypotheses for both the lanceolate and ovate cache types. These hypotheses offer a new perspective for the chronological framework, cultural affiliation, and function of the caching behavior within the context of central Oregon's prehistory, and serves as a starting point for future research on central Oregon lithic caching behavior.

A Preliminary Regional Analysis of Lithic Cache Sites in Central Oregon

by

Mary Elizabeth Marschall

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I would like to express my heartfelt appreciation to my children; Mark, Jessica, Wesley, Justin, and Kevin for all your patience and support over the years of my academic and personal life. To my grandchildren, it is my sincere hope all of you will deeply value education and recognize learning is about wonder, growth, and possibilities and as such is a lifelong experience. To Pam, I would like to express my deepest respect for our friendship with so many years of support, patience, and laughter, thank you.

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This work is dedicated to my Grandmother and my Mother

INTRODUCTION

Lithic cache sites are a relatively rare site type or feature in archaeological records of North America (Swift 1990) although not uncommon throughout the northern Great Basin, southern Columbia Plateau, and western North America (Connolly 1999:20). Numerous caches of obsidian points have been documented in the upper Deschutes River Basin of central Oregon (figure 1) and strongly suggest the existence of a localized caching practice. Presently, no single hypothesis dominates the literature as a decisive and wholly explanatory model for this caching behavior. The objectives of this research are to assemble the existing cache data into a single document and identify spatial and temporal patterns associated with the caches. The data will be used to develop hypothesis concerning the antiquity, cultural affiliation, and function of the caching practice within the context of central Oregon prehistory.

My research design is directed toward clarifying and interpreting this prehistoric behavior and how it relates to the regional environmental history as well as the local archaeological record. The research includes a focused summary of the paleoenvironmental and cultural histories of the region. A compilation of cache site histories and artifact data is presented. These data sets are used to identify spatial and temporal patterns associated with the caches. Two distinct cache types are identified and defined. Ultimately hypotheses are offered to clarify the antiquity, cultural affiliation, and function of the caching practices within the context of a Deschutes River Basin prehistory.

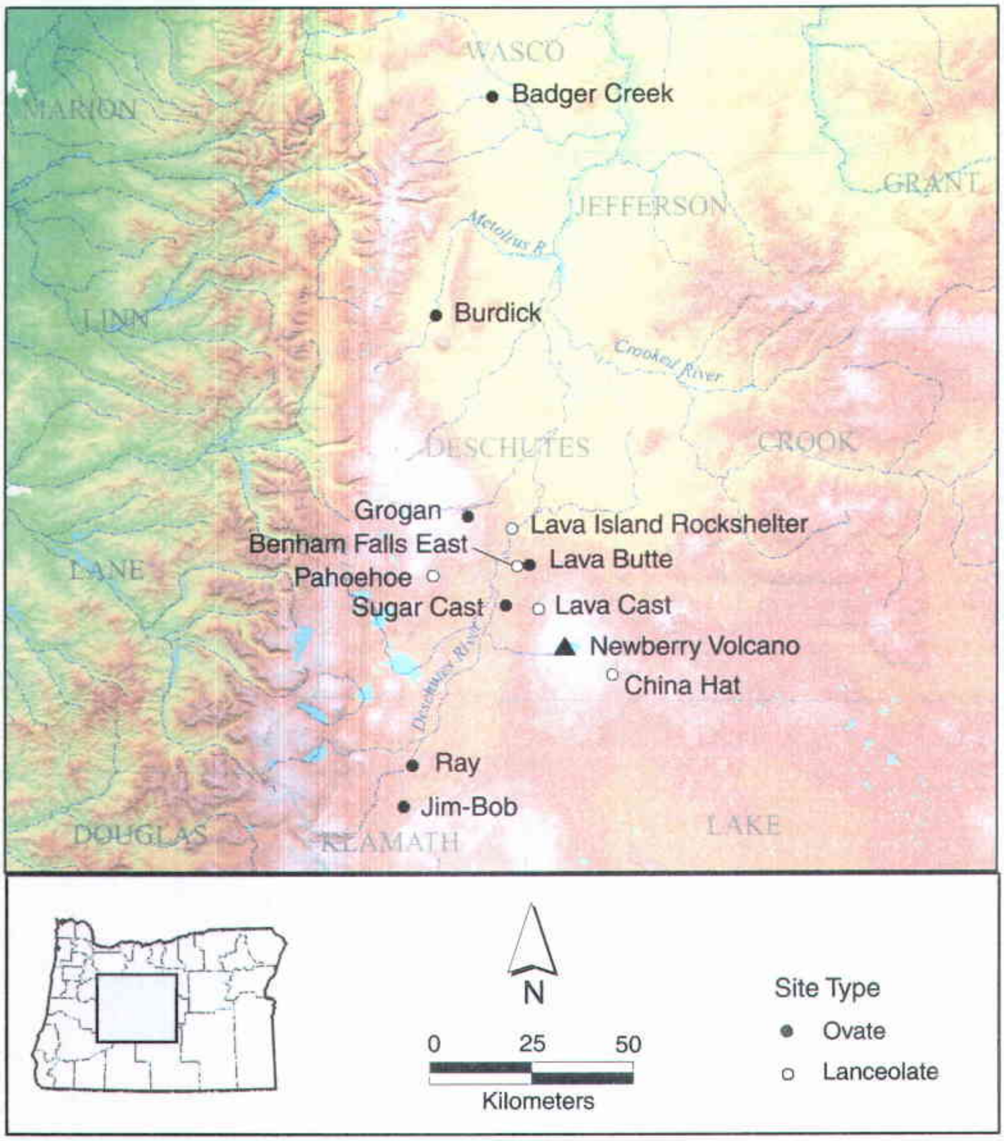


Figure 1. Map illustrating cache locations in the study area.

Research Background

Historically cache research in the Upper Deschutes River Basin began as a small project for archaeologist Carl Davis. The project was simply a compilation and documentation of statistical data for a single cache site, China Hat (Davis 1984). A subsequent research paper focused on understanding the data and cultural implications for the China Hat site and other lanceolate biface caches in the region. Two sets of authors proposed two different hypotheses pertaining to the age, cultural origin, and function for some of the cache sites. A review of these author's, theories, research focus, data, and conclusions defined my research direction and priorities. Two priorities were identified, a distributional model of their known occurrence and the establishment of a chronological context for the cache sites.

Initially the focus of this research centered on the investigation of three lanceolate biface caches; Pahoehoe, China Hat, and Lava Island Rockshelter. The object of this study was to view the archaeological data in terms of processes, not as explanation for specific events (Binford 1962:217). However, the quantity and quality (looting) of archaeological information became a limiting factor in defining the caches and the settlement system in which they functioned. In an attempt to correct this limitation information on the Benham Falls East, Paulina Fire, and Lava Cast caches, as well as the Dietz/Paulina Creek assemblage were added to the data base. These seven cache sites became the focus of a study addressing the age, origin, and function of caches. The fundamental aspect of this study was the development of a research design to identify cultural and environmental patterns associated with the cache sites. Despite this increase in sample size to seven caches only cursory environmental patterns began to emerge while the age, origin, and ultimately the function of the caches remained enigmatic. This dictated the establishment of the cultural-historical context of the cache sites as a priority

(Binford 1962; Schiffer 1983; Sharer and Ashmore 1993). An accurate temporal and spatial framework should provide the necessary foundation for further analysis. To advance this direction, the broad environmental patterns and a Geographic Information System (GIS) query were combined to identify cache sites as potential candidates for excavation. The ultimate goal of the excavation was to establish sorely needed chronometric controls for the cache sites.

The environmental pattern gleaned from the seven lanceolate caches suggested the ideal site would be located within a 50 km radius of the other cache sites. The landforms associated with the site should be rocky outcrops or knolls and located adjacent to or in very close proximity to a lava flow. The floral community would most likely be a Ponderosa pine vegetation zone or at an elevation consistent with that zone. By including elevation, alterations in the landscape such as forest fires and tephra deposits could be accounted for. Consideration of fresh water sources and site types associated with the caches were not give priority in the modeling process as these variables differed dramatically among the seven known lanceolate biface cache sites.

The query of the Deschutes National Forest's Geographic Information System (GIS) data base identified sites thought to represent caches or potential cache sites. Generally these sites were recognized as potential caches as a result of cultural resource management surveys. Additional queries were obtained to identify all prehistoric sites and associated site types, rockshelters, and obsidian quarries. These data sets were then reviewed to ascertain any spatial or temporal relationships between the known lanceolate biface caches and sites identified as potential caches. Historic sites including, cabins, grazing and herding locations, and logging areas were also pulled from the data base to identify areas of potential disturbance ultimately affecting the integrity of an excavation. Historic trails were identified within the query to help elucidate potential prehistoric land use patterns.

Archaeological site reports and/or surveys identifying caches or potential cache sites were collected from the Deschutes National Forest files and evaluated. A total of seventeen sites were reviewed. Nine of these sites were excavated caches of ovate-shaped lithics of which over half were located outside of the study area and therefore eliminated. The remaining eight sites were then reevaluated for compliance with the prescribed environmental pattern outlined above resulting in the elimination of three more sites. A site visit was attempted for each of the five remaining choices, eliminating two more due to road closures. The remaining three sites were all viable candidates for excavation, however one of the sites was a rockshelter and deemed too complex and extensive for the scope of this study. Of the remaining two candidates for excavation and analysis the Big Babbette site was chosen because the environmental qualities of the site most closely approximated those of the other known lanceolate cache sites.

The Big Babbette site was selected for excavation and analysis from this process with the intent of establishing chronometric controls for the caching practice. The complete data, discussion, and results of the excavation are located in Appendix A. The Big Babbette site did contain a cache although the excavated artifact assemblage was not comparable with the lanceolate biface caches in the study. The recovered artifact assemblage was comprised of a diversified collection of lithic tools. None of the tools were lanceolate shaped bifaces. Instead the assemblage contained 18 complete artifacts. These artifacts were functionally categorized as follows; eight expedient flakes, one large core/flake, one scraper, one biface/uniface blank, two bifacial tools, and five unifacial tools. The five large lanceolate shaped tools differed considerably from the lanceolate bifaces in the cache collections. The lanceolate tools from Big Babbette were unifacially flaked and nearly twice the size in length and width. The two bifacial tools from the excavation were also nearly double the size of the cached lanceolate bifaces and ovate in overall shape. Big Babbette's single ovate biface blank/preform was twice the size of any artifact in the lanceolate biface cache assemblages. All of Big

Babbette's bifaces were ovate in overall shape. Each closely approximated the morphological attributes of other cached artifacts in the Upper Deschutes River Basin containing ovate bifaces in their assemblages. This seemed to suggest, at least in this one instance, the environmental profile developed for lanceolate biface caches was probably not the only set of characteristics needed to identify a lanceolate biface cache location. Moreover a predictive model based solely on the environmental qualities closely associated with lanceolate type caches did recover a cache with large ovate artifacts, albeit one with a diversified assemblage. This discovery suggested in the Deschutes River Basin lanceolate biface caches and the other local caches containing the larger ovate biface artifacts may be potentially linked either spatially and/or temporally.

This investigative history became the background for the study presented in this research. The study directly addresses the archaeological records of both lanceolate and ovate biface caches. These records suggest a localized caching behavior in the prehistory of the Upper Deschutes River Basin of central Oregon. Clarifying and understanding this caching behavior is the subject of the research.

Aim and Scope

A literature review incorporating an overview of the Deschutes River Basin environmental and cultural histories precedes a discussion of existing cache sites. Fundamental elements of the environmental review include a geographic survey of the contemporary landscape, floral and faunal resources, and sources of freshwater. Paleoenvironmental and paleoclimatic data are also explored including data on the dramatic volcanic history of the region and the ensuing impact affecting the prehistoric human population and environment.

the contemporary landscape, floral and faunal resources, and sources of freshwater. Paleoenvironmental and paleoclimatic data are also explored including data on the dramatic volcanic history of the region and the ensuing impact affecting the prehistoric human population and environment.

A prehistoric and ethnographic survey of the northern Great Basin and southern Columbia Plateau populations is presented. This review provides a background for understanding the complex and fluid movements of these two distinct regional cultures who are believed to have inhabited the caching region in prehistory (Connolly 1999; Davis and Scott 1984, 1991; Minor and Toepel 1984, 1997; Scott 1989; Scott et al. 1986).

The recorded cache sites in the Upper Deschutes River Basin and Newberry Volcano region are then discussed. The review includes a discussion of each site's history, environment, material culture, and professional analysis. Application geochemical characterization studies using x-ray fluorescence (XRF) analysis are utilized as the primary tool to elucidate regional relationships between the caches, other archaeological sites, and the landscape. A comprehensive analysis of all geochemically characterized obsidians from the study is presented in appendix B.

An examination of the archaeology from the Paulina Lake site in Newberry caldera is summarized and used as a comparative data linking the caches and both the southern Columbia Plateau and northern Great Basin culture areas. Paulina Lake's extensive prehistoric record identifies cultural sequences as well as indications of shifts in resource strategies employed by the prehistoric inhabitants in the caching region. Although the site is not a cache site, the intact stratigraphy supported by serial radiocarbon dates offers valuable insights concerning both environmental and cultural changes within the caching region. Additionally geochemical characterization studies from the Paulina Lake site are used as a comparative tool to suggest temporal and spatial relationships between this site and obsidians identified in the cache assemblages.

Research Strategy

To obtain a regional perspective of the caching behavior individual cache site, artifact data, and geochemical characterization studies are organized utilizing a settlement archaeology approach. This approach allows assessment of both observable and ultimately inferred behaviors (Sharer and Ashmore 1993:484) as well as identification of changes in patterns of land use (Parsons 1972:141) of prehistoric populations. This facilitates the exposure of spatial and temporal distribution patterns to identify two distinct cache types.

The regional focus and inclusion of both lanceolate and ovate type caches is a new line of inquiry compared to past research. Historically, early cache research focused exclusively on lanceolate biface caches. These studies addressed the caches as a component of a single site (Minor and Toepel 1984, 1997) or as a comparison of manufacturing processes of the lithic assemblages to technology of neighboring cultures (Davis and Scott 1984 and 1991; Scott 1989; Scott et al. 1986). Typological cross dating and relative dating methods were used for chronological and cultural inferences. Such methods tend to limit discussions concerning the caches to descriptive discourse and constrain explanatory interpretations. This early research resulted in two divergent propositions concerning the age, cultural origin, and function of the lanceolate biface cache assemblages. One hypothesis suggested the assemblages may be representative of Paleo-Indian hunting tools of the southern Columbia Plateau people (Minor and Toepel 1984, 1997). The other advocates Archaic exchange items of northern Great Basin origin (Davis and Scott 1984, 1991; Scott 1989; Scott et al. 1986). Approximately a decade later, Connolly would have functioned within a southern Columbia Plateau exchange system between 4000 and 1300 BP (Connolly 1999:239).

These three hypotheses have completely different implications for the adaptive strategies used by prehistoric residents of the Upper Deschutes River Basin and the High Lava Plains in general. Essentially the hypotheses center on discriminating between forager and collector resource strategies (Binford 1980). The theoretical design for this research explores this dichotomy to consider the possible roles of the caching behavior in the technological and social constructs of the local prehistory.

Caveats

A regional study is inherently an extremely complex endeavor given the multitude of facets involved. The academic scope of this research has dictated the extent of the project. The range of archaeological methods available to research the caches is extensive. This requires a focused approach and a deliberate selection of methodology. Generally, priority was given to objective approaches while methods deemed more subjective in nature were minimized.

The analysis of lithic technology by classification, replicative experiments, or otherwise tends to have a subjective aspect involved in the analysis. The subjective nature of a lithic analysis is most problematic for the research on cache collections when one considers the number of researchers who have evaluated the caches, nearly all with different objectives. This is not to dismiss or diminish the value of any of the research endeavors as each has contributed significantly to the knowledge base of the cache assemblages. Many of the cache assemblages have undergone lithic analyses both individually and comparatively (see Connolly 1999; Davis and Scott 1984; Davis and Scott 1991; Minor and Toepel 1984; Minor and collections when one considers the number of researchers who have evaluated the caches, nearly all with different objectives. This is not to dismiss or diminish the value of any of the research endeavors as each has contributed significantly to the knowledge base of the cache assemblages. Many of the cache assemblages have undergone lithic analyses both individually and comparatively (see Connolly 1999; Davis and Scott 1984; Davis and Scott 1991; Minor and Toepel 1984; Minor and Toepal 1997: Scott 1985; Scott 1989; Scott et al. 1986; Swift 1990) especially by Scott and Davis. However no single comprehensive lithic analysis for all the caches has ever been completed. It is beyond the scope of this study to include an original comprehensive analysis of the lithic technology. This research will rely on the work of others and assume sufficient technological assessments have been compiled to support the general technological references in this study. Only broad generalizations regarding lithic technology are presented in this research and should be considered one of the significant limitations of the study. Future research should include a comprehensive lithic technology analysis as well as address quarry studies, reduction strategies, and a comparative analysis with northern Great Basin, southern Columbia Plateau, and Newberry Volcano caldera sites.

Published literature on the caches used in this study have not disclosed a specific and detailed definition of a Deschutes River Basin cache nor is a general cache definition offered. This void in the literature certainly imposes difficulties for determining if the caches sites are truly representative of a cache site as opposed to a collection of looted artifacts, a lost quiver, inconsistent application of the term cache by different authors, or any other number of possibilities. It is beyond the scope of this research to reevaluate each cache to determine the validity of a caching designation as a correct site type. Future cache studies should explore this possibility thereby eliminating any erroneous site type designations. This study will assume the application of the term cache most accurately reflects the site type and is correct. Nonetheless, understanding any comparative relationships for the cache kit will imply the assemblage represents a store of functioning tools utilized for subsistence activities. Caches or collections of similar artifacts are defined by the homogeneous nature of a collection in terms of lithic material, artifact size, artifact shape, and number of individual artifacts in a collection. The collection may or may not be finished tools implying both functional use and/or trade practices. A cache type will be defined by a collective similarity in characteristics associated with a group of caches.

Distribution pattern analysis as a research strategy offers a number of avenues to understand the cultural system in which the caches functioned, rather than viewing them as "aggregates of cultural traits" (Binford 1964:22). However this approach is not without limitations. Parsons has identified "problems related to sampling, refined chronologies to establish contemporaneity, and paleoenvironmental construction" (Parsons 1972:145). The following analysis is limited by these factors and other factors unique to the caches. Specifically unique to cache sites is the integrity of some of the cache sites. Many of the sites in this study have been compromised by looting activity. Nevertheless, subsequent archaeology by professional archaeologist, particularly Carl Davis, has minimized the amount of lost data and allowed logical inferences to be made regarding particular caches.

The sampling size of individual cache sites affects the patterned analysis of the cache sites. Five lanceolate biface caches and seven ovate type caches (table 1) contained sufficient data to be used in the comparative study. Three cache sites are presented in the descriptive archaeology but were not utilized in the comparative analysis, they are the Paulina, Paulina Creek, and Swamp Wells caches. The decision not to include these sites was due to an overall paucity of data or unavailability of the cache for analysis. Additional cache sites are known in Oregon they include; Paul's Fire, Delta, Doe Mountain, Glade, Champa, Shoestring, and other unnamed sites. None of these sites nor known caches in Washington, Idaho, or northern California have been included in this study as they are not located within the geographic boundaries of this research and therefore beyond the scope of this project. Overall the 12 cache sites reviewed in the following analysis should be considered a regional sample from the Upper Deschutes River Basin considering the number of cache sites known in Oregon, the Pacific Northwest, and neighboring regions. Regional patterns within the scope of this investigation do seem to be forthcoming and worthy of further discussion.

Table1. Chart of lanceolate and ovate caches.

Lanceolate caches	Ovate caches
Benham Falls East cache	Badger Creek cache
Lava Island Rockshelter cache	Burdick cache
Pahoehoe cache	Grogan cache
China Hat cache	Lava Butte cache
Lava Cast cache	Sugar Cast cache
	Ray cache
	Jim-Bob cache

Another significant limitation of the research is the highly irregular data bases for each cache. This caveat affects the sampling size of the artifacts from individual caches, artifact count totals, and all the associated comparisons. Artifact sample size from each individual cache is also a limitation. The total number of artifacts in each cache ranges from less than 10 to more than 400. Data bases for each cache were highly irregular. Ultimately this discrepancy influenced total artifact counts for measurements of length, width, thickness, and weights, as well as obsidian characterization studies. Artifact count totals for some of the caches include complete and fragmented artifacts, while others contained and/or counted only whole artifacts. Measurement data was available and complete for some of the cache collections while others were incomplete, simply never done, or unavailable. The 12 cache sites utilized in this study contain well over 1000 artifacts collectively thus it was considered beyond the scope of this research to co-join artifacts for measurements as well as measure and/or re-measure the totality of the collections to fill in the incomplete data base.

Sample size of artifacts with obsidian sourcing studies also varied between individual caches. In some instances 100 percent of a collection had been geochemically analyzed, others ranged from less than 10 percent up to 50 percent yet other caches had never been the subject of obsidian characterization studies. Several of the older geochemical studies contained questionable results by current obsidian characterization standards.

To compensate for these disparities a sampling and research strategy was developed to minimize inconsistencies, maximize the use of existing obsidian characterization studies, and fill voids in the overall data base. All available data bases for each cache assemblage were obtained. Artifact count totals were obtained from the total number of lithics including complete artifacts and fragments. A whole/complete artifact count was calculated from the total artifact count. For example, in the Sugar Cast cache assemblage the total artifact count is 122 complete or fragmented lithics. The majority of the collection had been reconstructed by co-joining fragments to identify complete artifacts. Both the complete and reconstructed artifacts were considered whole artifacts in the whole artifact counts. All measurement calculations in this study were based solely on whole artifact counts.

Existing geochemical analyses for each cache assemblage were reviewed with Dr. Craig Skinner at Northwest Research Obsidian Studies Laboratory. Studies deemed unreliable or invalid were eliminated; only studies compatible with current XRF analysis standards were utilized in this research. It should be noted that the Lava Island Rockshelter and China Hat cache XRF data contains results from obsidian source studies obtained in the late 1980s. These early studies were not capable of discriminating Newberry Volcano Group resources from McKay Butte resources yet are considered valid for the purposes of this research. The term Newberry Volcano Group/McKay Butte refers to this older classification from dated XRF studies and indicates a nondiscrimination between the Newberry Volcano Group and the McKay Butte obsidian resources. The term Newberry Volcano Group reflects current terminology and references obsidian resources (a composite chemical source) from within Newberry Volcano caldera proper and does not include McKay Butte obsidians. A third categorization, Newberry Volcano obsidians, is used in the following discussion referencing obsidian source data combined from both the Newberry Volcano Group/McKay Butte and Newberry Volcano Group categorizations to maximize to use of valid existing characterization studies. The percent of complete artifacts with existing material source studies was calculated to ascertain voids in the obsidian characterization data base. Additional obsidian source studies, through XRF analysis, were obtained on all available collections when sourcing studies totaled less than 20 percent of the whole artifact collection. Appendix B contains results of obsidian characterization studies obtained for this research.

Due to the inconsistencies in artifact totals and availability of some of the collections, weighted calculations of the sampled collections was not possible. Nonetheless, the sampling strategy employed did provide valuable information as well as elucidate generalized patterns of the caching behavior. The integrity of these patterns can be tested when newly discovered cache sites are compared to these findings, data used in this study is reevaluated, and/or voids in the data base are rectified.

This research should be considered a preliminary study to determine if identifiable patterns exist for the caching behavior and propose logical inferences therein. The study is not intended to be a definitive analysis of the caching behavior. Only by addressing and accounting for the inherent limitations of this preliminary research can a comprehensive regional analysis be developed.

My research will however contribute significantly to the regional prehistory of the Upper Deschutes River Basin. The identification and clarification of patterns associated with a caching behavior will elucidate relationships not only between the caches but also with other archaeological sites and the regional settlement system in which they functioned. It is from these relationships that the caching behavior can be more fully understood as an expression of cultural adaptation by the people who created, used, and eventually abandoned the caches. By exploring and understanding the adaptive significance of the caching behavior within the context of an Upper Deschutes River Basin culture this research expands and further develops our understanding of the regional prehistory.

PHYSICAL SETTING

Because the lanceolate biface cache sites exist in an array of ecological settings seemingly void of any particular patterning this review is used to help identify spatial relationships between the cache sites and the natural environment. Initially the historic environment is discussed to identify present day environs common to the cache sites. A review of the northern Great Basin and Southern Columbia plateau paleoenvironments is presented to help recognize regionally specific environmental characteristics and dynamics in prehistory. This review identifies ecological variables important for connecting regionally unique environmental qualities and potential cultural implications for the caching behavior as an adaptive strategy in the Upper Deschutes River Basin.

Historic Natural Environment

Landscape

The lithic caches are dispersed throughout the western portion of the High Lava Plains physiographic province. The boundaries of this province as defined by Baldwin (Baldwin 1964:117) extend eastward from the Upper Deschutes River Basin to the Harney Basin of eastern Oregon. The eastern edge of the province is transected by the Deschutes River. Immediately to the west of the Deschutes River are the eastern slopes of the Cascade Range. To the north, the High Lava Plains border the Columbia Plateau and Blue Mountain provinces. Southward, the Plains merge into the Basin and Range province. Figure 2 illustrates the geographical relationship of the High Lava Plains and neighboring provinces.

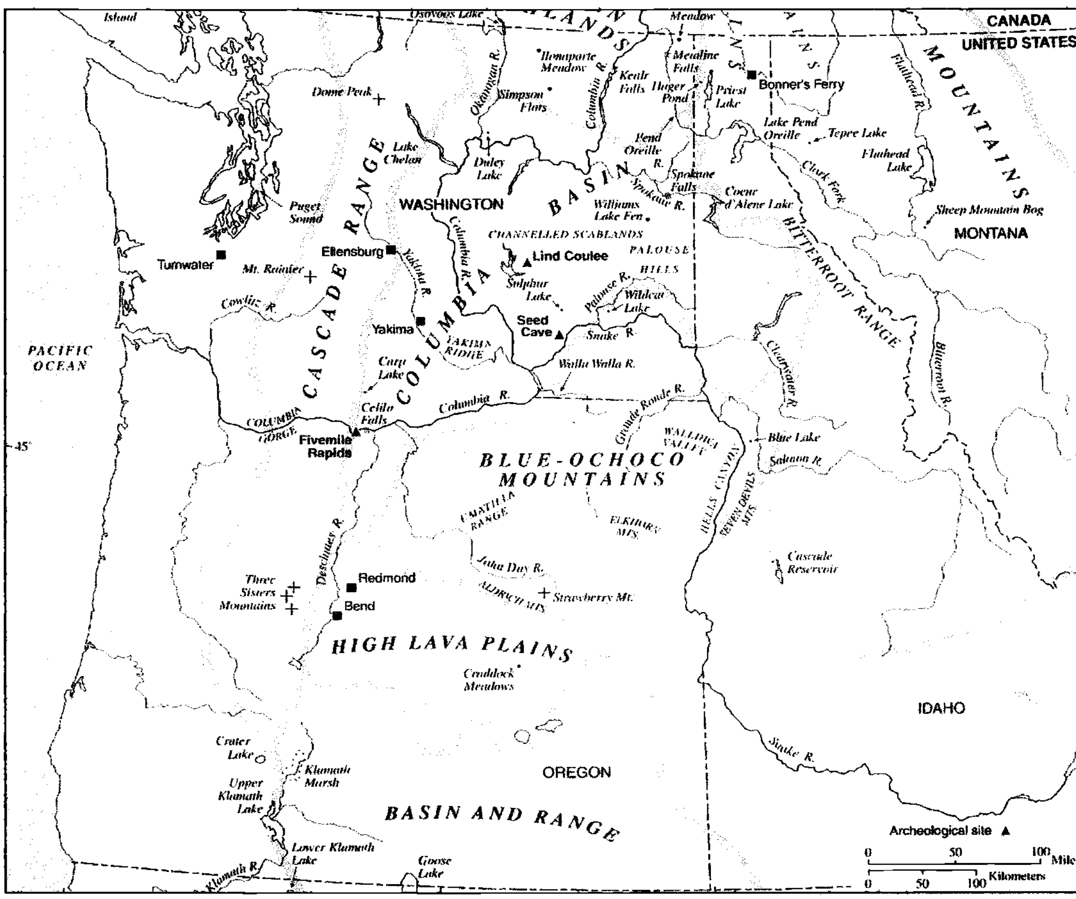


Figure 2. Map of High Lava Plains physiographic province (modified from Chatters 1998)

The geographic relief of the High Lava Plains is considered moderate throughout most of the region, elevations range between 900 and 2,400 m (3,000 and 8,000 ft) (Baldwin 1964:117). The western margin offers the most variation in topography and in the Three Sisters Wilderness area of the Cascades rises to a height of over 3,000 m (10,000 ft). In general the area is characterized by a gently sloping terrain and a variety of volcanic features. The landscape is scattered with small scale fault scarps, lava flows, lava buttes, cinder cones and lava tubes, as well as tephra-fall deposits (Baldwin 1964:120-124; Orr 1996:269).

The High Lava Plains lie in the rain shadow of the Cascade Mountain Range. The average annual precipitation is 33 cm combined with 99 cm of snowfall. Daily temperatures range from 18 to 39 degrees Fahrenheit in January, while in July the range is 46 to 85 degrees Fahrenheit. The overall effect of low precipitation combined with high summer and low winter temperature is a semiarid environment throughout most of the region (Minor and Toepel 1984:3).

Geographic Features

Two major geographic features, the Deschutes River and Newberry Volcano, dominate the western half of the High Lava Plains landscape. Other significant geographic features include; the Columbia River, Pleistocene lake beds, obsidian flows, and tephra rich soil.

The Deschutes River originates in the high lakes of the Cascade Mountains and flows north, transecting the western edge of the region, joining the Columbia River in the Columbia Plateau province. In spite of a long dry season in central Oregon the Deschutes River experiences an even water flow due to the slow melting of the heavy snow pack in the Cascades. The thick, aeolian, tephra rich soil deposits and underlying permeable basalt formations foster a stable, natural flow to the many perennial springs feeding the river. Historically and prehistorically this river is the main supply of water for fish and wildlife habitat in the western half of the High Lava Plains (Baldwin 1964:117,123).

The middle and lower Columbia River transects the southern region of the Columbia Plateau. While this river is not in the High Lava Plains *per se*, it is a significant geographic feature utilized by prehistoric populations occupying the region. Both the John Day and Deschutes Rivers of the High Lava Plains province flow north into this vast river along the Oregon and Washington boarder (Orr 1996:288). Climatic conditions and volcanic events had an adverse impact on riverine resources available to the prehistoric populations.

The eastern half and southern portion of the High Lava Plains contain a variety of internal drainage basins. A combination of permanent, seasonal, and dry lake beds are found in these basins (Orr 1996:277). Prehistorically the internal drainage basins contained great Pleistocene lakes. Prehistoric climatic conditions and volcanic events significantly altered the availability of lacustrine resources for local inhabitants.

Newberry Volcano is the prominent Paulina Mountain shield volcano containing Newberry Crater. This volcano rises approximately 1950 m (4,000 ft) above the surrounding plateau and is 1,600 km^2 (20 mi) in diameter. The caldera of Newberry Volcano contains East and Paulina Lakes. These lakes drain along the western flank of Newberry Volcano via Paulina Creek to the Deschutes River. The volcano has undergone at least 25 eruptive events over the last 12,000 years (Connolly 1999:21-23). Newberry Volcano's eruptive sequence produced six obsidian flows within the caldera important to prehistoric residents and visitors, they are; the Buried Obsidian Flow (late Pleistocene), Interlake and Game Hunt Obsidian Flows (6400 BP), Pumice Cone Obsidian Flow (4300 BP), East Lake Obsidian Flows (3400 BP), and Big Obsidian Flow (1300 BP) (Connolly 1999:166). Figure 3 illustrates these intra-caldera obsidian resources.

Interspersed throughout the High Lava Plains are other obsidian flows and volcanic features. Lava flows from eruptive events provided significant raw material sources for prehistoric lithic artisans. The primary glass flows significant to this research are Obsidian Cliffs in the Cascade Mountains, Newberry Volcano and McKay Butte on the flank of Newberry Volcano in the High Lava Plains. South of Newberry Volcano obsidian sources include; Quartz Mountain, Cougar Mountain, Riley, Silver Lake and Sycan Marsh, as well as Spodue Mountain.

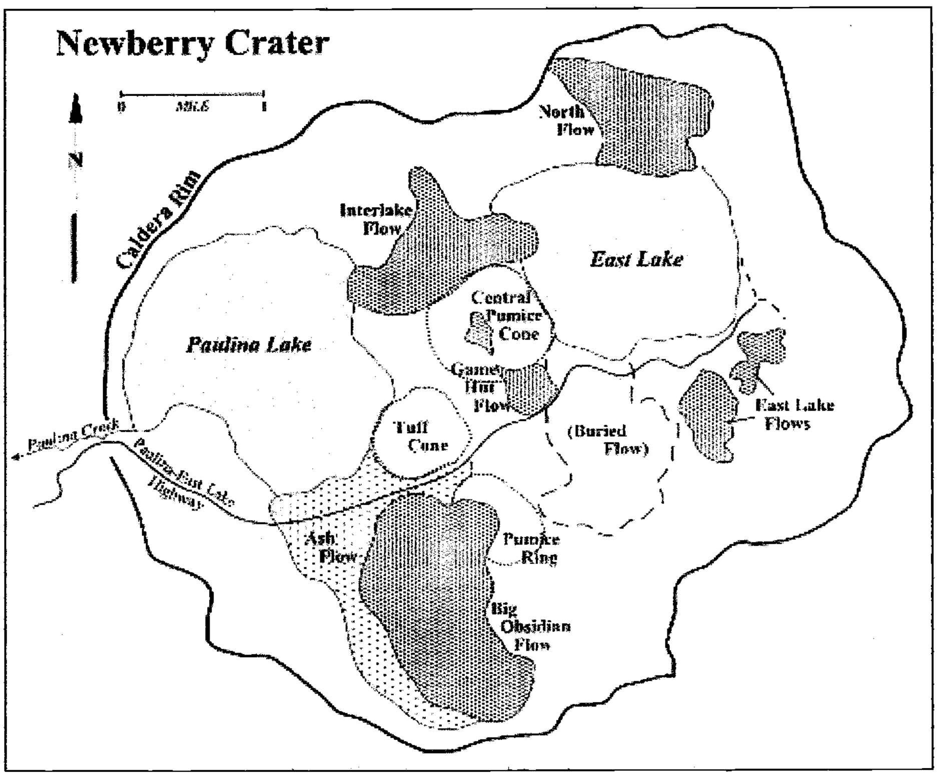


Figure 3. Map of Newberry caldera obsidian flows (after Connolly 1999).

(Connolly 1999:231). All of these resources were available during the Holocene however the chronologic availability varies among sources. This variation in availability and associated prehistoric implications will be discussed in later chapters. Figure 4 is a map of the geographic locations for these obsidian sources.

The High Lava Plains formations are predominantly Pliocene and Pleistocene lavas, tuffs, and alluvium. The resulting valley fill consists of alluvium and lake deposits and aeolian sediments primarily from volcanic rocks of the surrounding uplands. Along the outer margins of the province, stream and river courses change from typical valley fill grading into sand and gravels. Distinctive widespread ash from the eruptions of Mount Mazama, 7000 and 6800 BP, mantles the landscape (Matz 1991:30). This ash is typically interbedded at a depth of 0.9 to 1.8 m (3 to 6 ft) (Matz 1991:37).

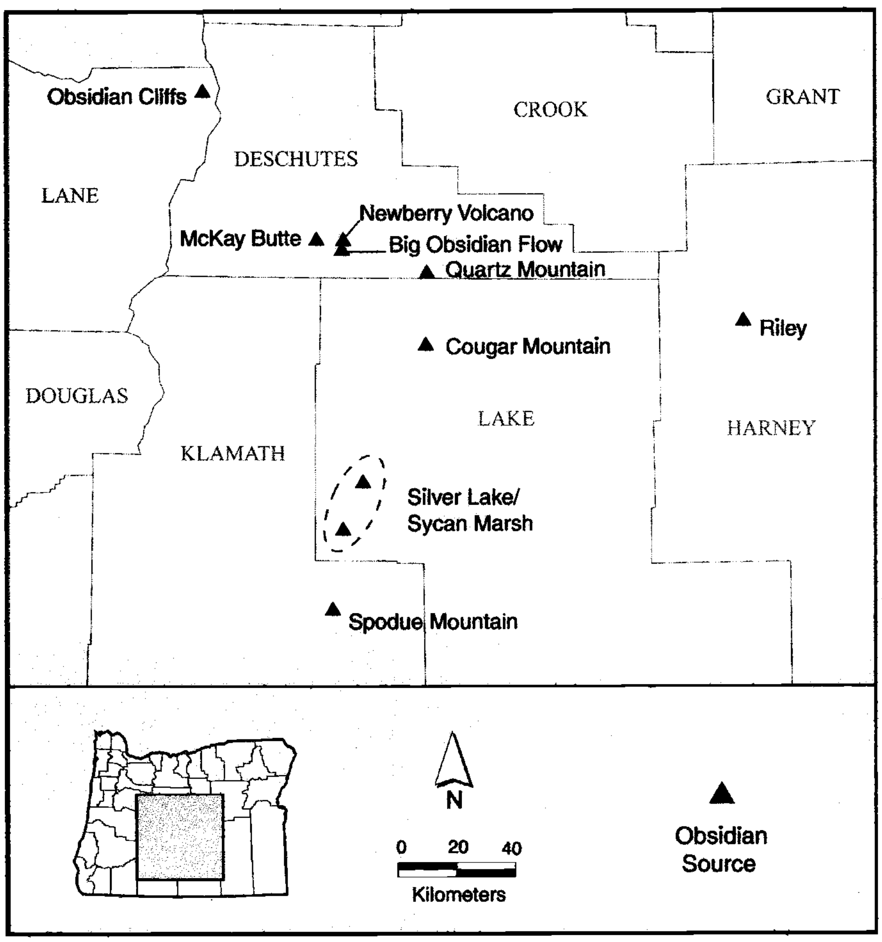


Figure 4. Map of regional obsidian resources.

Historic Flora

Three major vegetation zones based on elevation have been identified across the High Lava Plains landscape. They include: (1) the low and mid-elevation Pinus ponderosa zone, (2) the Juniper occidentalis zone found between the forest and shrub-steep, and (3) the Shrub-Steppe zone, the most xeric of the region. The Ponderosa Pine zone is dominated by *Pinus ponderosa* in an open forest setting. Understory vegetation consists of bitterbrush (*Purshia tridentata*) and snowbrush (*Ceanothus velutinus*) in central Oregon while Idaho fescue (*Festuca idahoensis*) is found toward the east (Jackson 1993:60-61). The Juniper occidentalis zone is open woodland dominated by western juniper (*Juniperus occidentalis*) in a rimrock habitat. The Understory is primarily big sagebrush (*Artemisia tridentata*) and Idaho fescue. The Shrub-Steppe zone is dominated by big sagebrush (*Artemisia tridentata*). Communities of Idaho fescue and Low sagebrush (*Artemisia arbuscula*), rabbit brush (*Chrysothamnus spp.*) are also common in this zone (Jackson 1993:60-61).

The Upper Deschutes River Valley can be thought of as a vegetational transition zone. The Ponderosa pine vegetation zone along the western edge of the Deschutes watercourse is a narrow band, 15 to 30 km wide, extending up the eastern slopes of the Cascade Range. Beyond this the flora changes to a Douglas fir forest in the Cascade Mountains. The transition zone east of the river is juniper merging into shrub-steppe vegetation on to an open desert (Connolly 1999:26-27; Harper 1986:58). A ribbon of Ponderosa pine forest reappears within the shrub-steppe zone where it encircles the flanks of Newberry Volcano. The Ponderosa pine vegetation is interrupted in certain locations throughout the region where forest ecology has been adversely affected by the depth of Mazama tephra-fall deposits. In these localities the post-Mazama succession forest is dominated by Lodgepole pine (*Pinus contorta*) (Connolly 1999:24; Franklin and Dryness 1988:170).

Historic Fauna

The present day large faunal species are relatively unchanged from species utilized by prehistoric populations and include: deer (*Odocoileus hemionus*), Pronghorn antelope (*Antilocapra americana*), elk or Wapiti of the *Cervus elaphus* family, bison (*Bison bison*), and smaller mammals of the Cricetidae family such as mice and other small rodents. In some regions rabbit (*Leporidae*), and pika (*Ochotona princeps*) were relied upon. The hunting of birds and waterfowl such as: sage grouse (*Centrocercus urophasianus*), coots (*Fulica americana*), varieties of geese (*Branta Canadensis*) and ducks (*Anas spp.*), as well as other Anatidae family species are also known. Fishing, netting, and trapping of resources from rivers, streams, lakes, and marshes contributed significantly to the prehistoric diet. Common fish include: salmon and trout or Salmonidae family, Tui chub (*Gila bicolor*), carp and minnow from the Cyprinidae family, and other sucker fish (*Catostomus ardens*) (Fowler 1986:79-91; Harper 1986:55-57). Noteworthy is the presence of numerous falls and rapids on the Deschutes River which pose an obstacle to the upstream migration of anadromous fish. Migratory fish are only able to ascend the river to a point 42 river miles downstream from Benham Falls and Lava Island.

Paleoenvironment

The northern Great Basin and southern Columbia Plateau environmental histories are equally important to this research as residents from both culture areas utilized the caching region through out prehistory. In many instances details are sorely lacking. Some general trends are apparent however and are supported by geologic and biologic studies as well as archaeological research (Mehringer 1986:34). These general trends are the focus of this discussion. The climatic sequences are based on Ernest Anteves's Neothermal sequence (Antevs 1948:167-191). Although Antevs model serves as a broad conceptual framework it is also well documented that regional climatic variability typifies the Great Basin and Columbia Plateau regions (Aikens 1993:18-20; Chatters 1998:43; Grayson 1993:209; Mehringer 1986:49). These fluctuations should be considered when evaluating climatic impact in a specific region.

Paleoenvironment of the Northern Great Basin

Paleoenvironment: 11,200 to 7000 BP

The general climate trend toward the end of the Pleistocene was a series of transitions from a cold-wet glacial environment toward the warmer-drier climate of the Altithermal. From 10,000 to 7000 BP (Anathermal) the climate shifted toward warmer conditions (Mehringer 1986:33). This transition resulted in vast expanses of great Pleistocene lakes occupying the internal basins of the Great Basin (Aikens 1986:158-159; Connolly 1999:26; Grayson 1993:216; Mehringer 1986:34, 50; Willig 1988:467). Figure 5 illustrates the location and breadth of these ancient lakes. The Pleistocene lakes and their surrounding environments offer evidence of these climatic changes and the adaptive responses of the human populations utilizing lake and marsh resources.

Archaeological investigations of the Dietz site in the northern Great Basin show a temporal relationship between the lithic artifact assemblages and lake fluctuations. The site is alongside a small marsh adjacent to Pleistocene Alkalai Lake. Willig's (1988:467) research shows lake levels were lower during the Clovis occupation (11,000-10,800 BP) and approximately 60-120 cm higher during the subsequent occupation with a Western Stemmed (10,000-8000 BP) artifact assemblage. The distribution of the artifact concentrations along these two strandlines suggests a brief lowering of lake levels at a time when Pleistocene megafauna were present and the gradual transition to a new lithic technology which coincides with the demise of the Pleistocene megafauna and a rise in lake levels.

Faunal evidence from Connley Caves and pollen evidence from Fort Rock Cave also supports this pattern of fluctuation in the vicinity of Pleistocene Fort Rock Lake. The Connley Caves faunal assemblage was examined by four stratagraphic levels representative of a time frame between 11,200-3000 BP.

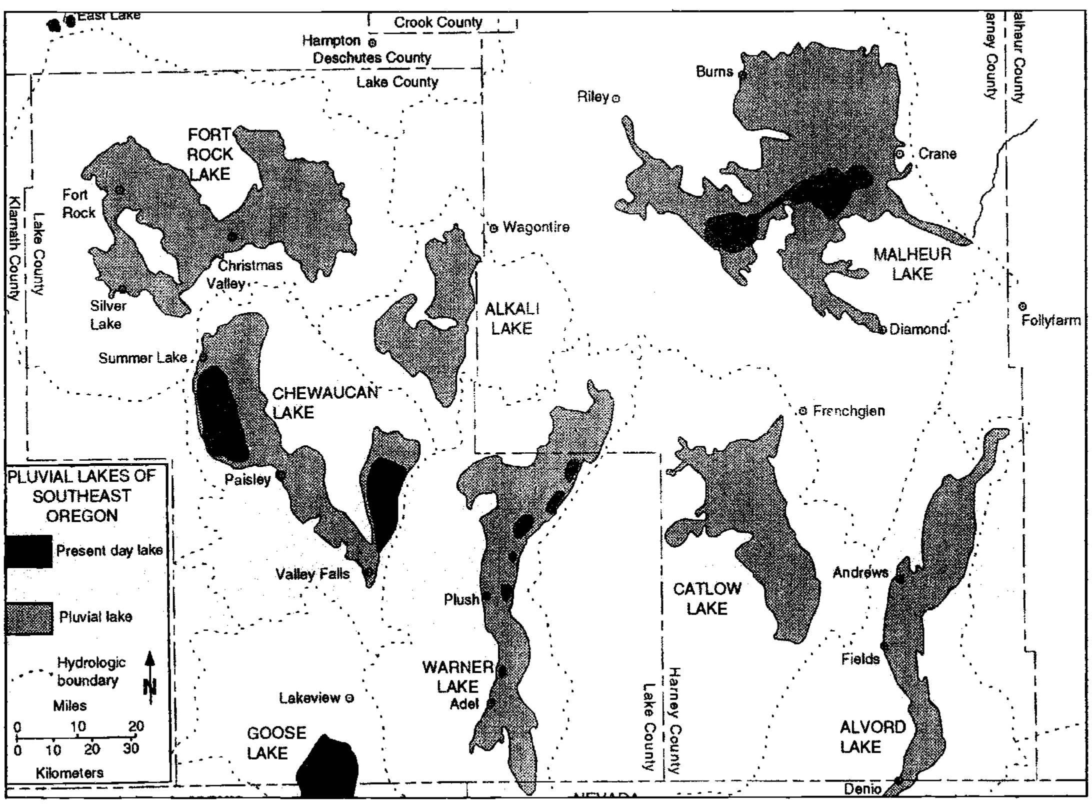


Figure 5. Map of the great Pleistocene lakes in southern Oregon (after Jensen 1995).

Strata 3 (9500-7200 BP) differs significantly from the other three levels in that the faunal assemblage shows a decreased reliance on rabbits, and increased reliance on waterfowl and grouse. Additionally, mountain sheep and pronghorn antelope were added to large herbivore assemblage of elk, black-tailed deer, and bison found in all four strata. It should be noted that large herbivores only comprised 10-2 percent of the faunal assemblages in any given strata. Grayson (1993) believes this overall pattern of change suggests a large, stable lake environment between 9500 and 7200 BP. The inhabitants of Connley Caves apparently shifted their subsistence strategies in response to these lacustrine cycles. In Fort Rock Cave pollen samples found on sandals dating to 9470 BP also suggest a moister environment. This evidence collaborates the notion of an increase in effective moisture between 13,000 and 10,000 BP in the Fort Rock Basin of southern Oregon (Connolly 1999:27-28).

Paleoenvironment: 7000 to 4000 BP

The magnitude of the Mazama eruption dated to 6845 +/- 50 years BP immediately taxed most of the High Lava Plain's landscape and people (Matz 1991:14). Figure 6 shows an isopatch of the geographic distribution and tephra-fall thickness from the climatic Mount Mazama eruption and the smaller eruptive events in the preceding 200 years. Each eruptive event is believed to have been relatively short in duration. Long periods of tephra-fall or darkness were not experienced and the initial effects on biotic populations are thought to be minimal. Long term consequences are generally dependant on resident time of the tephra on the landscape. Climatic variables such as temperature, air currents, and atmospheric and terrestrial water all influence tephra impact. The geomorphology also effects the stability of the tephra across the landscape and is significant when comparing the northern Great Basin's generally flat topography to the varied topography of the southern Columbia Plateau.

The greatest affects to people would be the destruction of plant and animal resources (Matz 1991:14). In the northern Great Basin populations practiced a generalized hunting and gathering lifeway at the time of the eruption. Subsistence strategies centered on lacustrine resources in the internal lake basins of the northern Great Basin and upland resources. In the Fort Rock Valley approximately 30cm of tephra covered the landscape, a level indicative of a significant disruption of subsistence activity (Matz 1991:89). The scope of this destruction has been the subject of debate. Grayson suggests only a faunal impact while Bedwell offers a more catastrophic view suggesting a substantial decrease in population to total abandonment of the area. Considering the complexities of factors influencing the

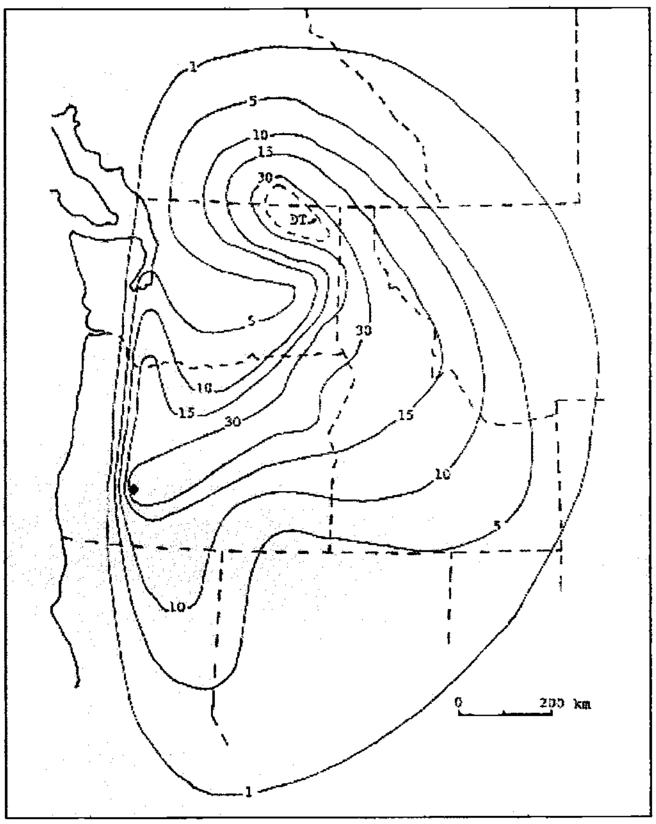


Figure 6. Isopatch map of geographic distribution and tephra-fall thickness from the Mount Mazama eruptions (after Matz 1991)

impact of the Mazama eruption definitive conclusions regarding impact prehistoric populations is not possible (Matz 1991:99). Pleistocene lakes all but evaporated reaching historic or lower lake levels between 7000 and 4000 BP. Geologic studies in the Fort Rock Basin have examined the relationship of beach terrace features and Mazama ash. These studies indicate the terraces date to a post-Mazama landscape and most likely a remnant of the increase in moisture during the Neopluvial. Pollen records from Lake Chewaucan and Upper Chewaucan Marsh indicate very low levels between 8000 and 4000 BP (Connolly 1999:27) and are supported by Hansen's pollen studies of southwest Oregon (Mehringer 1986:44). At Connley Caves faunal changes are evident and coincide with the generalized warming climate and the Mazama eruption (Mehringer1986:48). The human response to this climatic change and environmental degradation appears to have been dramatic. Both Connley Caves and Dirty Shame Rockshelter show a veritable hiatus for 2000 to 3000 years, suggesting the hot, dry climate of the Altithermal and possibly the eruption of Mount Mazama prevented populations from inhabiting these once reliable settings (Connolly 1999:27).

Paleoenvironment: 4000 BP to present

Climatic conditions after 4000 BP continued a trend toward aridity and rising temperatures. In general, effective moisture was reduced until 5000 BP, and temperatures increased until 4000 BP. Evidence of floral communities of Bristlecone pine (*Pinus aristata*) and sagebrush advanced upward to higher elevations replacing montane forests. Lake levels continued to shrink and marshes all but disappeared. Despite this general trend, the Mid-Holocene was a time of considerable and rapid climate fluctuations and instability (Mehringer 1986:49).

Southern Columbia Plateau Paleoenvironment

Paleoenvironment: 13,000-7500 BP

The overall climatic pattern associated with the Holocene begins earlier in the Columbia Plateau region. In the late glacial period, 13,000-10,000 BP, biological studies show evidence of alpine vegetation grading into a subalpine environment. By about 10,000 BP indications of a drier climate begin to emerge. Both pollen and geologic research offer supportive evidence of this drying trend (Barnosky et al. 1987:296-299; Connolly 1999:26). Most of the glacial ice had melted by 9000 BP and was entirely gone by 8000 BP. Steppe vegetation change from periglacial to temperate communities (Barnosky et al. 1987:296; Chatters 1998:43). By 8500 BP Ponderosa pine pollen is present and deposition of rock spalls slows in the Columbia Basin rockshelters, an indication of a sustained warmer climate (Connolly 1999:26; Chatters 1998:43). This warming pattern with increasing aridity is extended to 6300 BP along the Snake River Plain in the Blue-Ochoco Mountain region of the southern Columbia Plateau (Chatters and Pokotyio 1998:73). The central and southwestern portions of the Columbia Basin were the driest regions of the Plateau. These regions supported steppe vegetation with forests at higher elevations. Populations of elk, bison, deer, mountain sheep, and pronghorn utilized this landscape (Chatters 1998:43).

Paleoenvironment: 7500 to 4500 BP

From 7500 to 4400 BP the general climatic trend divided the northern Plateau, with its increasing effective precipitation, from the southern Plateau's continued maximum aridity. Research suggests the change coincides with a movement from a continental climate to maritime conditions (Chatters 1998:44). The effects of a maritime environment raised timberlines to 300 m above modern limits, deposition of wind blown loess surpassed water and rock spall deposition, expansive dune formations began, mountain glaciers were gone, and river and stream flows decreased (Chatters 1998:44). Changes in the floral and faunal communities resulted. Vegetative cover was reduced allowing further aggradations of the soils and riverine environments. Pronghorn (*Antilocapra americana*) populations increased at the expense of elk populations. Predictive modeling suggests this alteration may have reduced salmon runs (Chatters 1998:44).

In the southern Columbia Plateau, people resided in river canyon drainages exploiting riverine and upland resources on a seasonal basis. In the Lower Snake River region Mazama studies indicate 10 to 30cm of tephra blanked the landscape. The level of destruction toward the west end of the canyon is thought to have been relatively light, while to the east a more severe impact seems apparent (Matz 1991:89). The adoption of the Cold Springs side-notched projectile point may be an indicator of the stress caused by the Mazama tephra-falls (Matz 1991:99).

Paleoenvironment: 4500 to 3500 BP

Again the general climatic conditions changed as the Neopluvial climate of increasing effective moisture and generalized cooling set in between 4500 to 4000 BP. Indications of this widespread change are seen in the vegetation patterns as the timberline lowered and an overall increase in the density of plant communities progressed. A small glacier formed in the coast range and aeolian sediments decreased allowing the formation of a paleosol on the floodplains of the Snake and Columbia River systems (Chatters 1998:45).

Paleoenvironment: 3500 to 1000 BP

By 3400 to 3000 BP effective moisture and cool environmental conditions increased. Additional small glaciers formed. What was once a steppe habitat was edged out by approaching pine forests reflecting the increase in precipitation. Rock spalling slightly increased, indicative of periodic cold winters (Chatters 1998:44). The conifer forests of the central Basin again lowered in elevation. The faunal assemblage of the basin also changed. Pine martin (*Martes Americana*) and flying squirrel (*Glaucomys sabrinus*) are found at a Columbia River site for the first time in the Holocene. In the central Columbia Basin, the vole population (*Microtus supp.*), who enjoy a dense ground cover habitat, increase and coincide with a decrease in the pocket mouse (*Perognathus parvus*) population which prefer an open setting. Conditions were ideal and fostered extensive salmon runs (Chatters 1998:44).

Cultural History

Historically the physiographic regions of the Great Basin and Columbia Plateau have been classified as culture areas, erroneously defined by the combination of present day environment and tribal practices at the time of contact. This tie between environment and sociological expressions within a culture lead to the development of rather static cultural boundaries. While there is some reality to the boundaries, current emphasis is on the fluid, dynamic, and fundamentally interrelatedness of those boundaries (Aikens and Jenkins 1994:2; Connolly 1999:3, 11). For example, archaeological research of early Holocene assemblages in Fort Rock Basin no longer support the classic account of autonomous and isolated populations existing on the meager resources of highly unproductive desert environments. Nor is it argued that the makers of fluted points in this region hunted Pleistocene megafauna, an assumption derived from American Southwest archaeology (Connolly 1999:4). Early research in the Columbia River Plateau suggested subsistence strategies were dominated by salmon harvest criteria through out prehistory. The salmon subsistence focus has been modified and now addresses other resource strategies which accompany salmon procurement (Connolly 1999:10). The proposed the onset of intensive salmon exploitation has also been reevaluated. Current research suggests an inception date for intensive salmon procurement of approximately 3300 BP (Lucas 2000:51, 54). The cultural sequences and supporting archaeological research summarized below will illustrate these current ideas.

The research design proposes the unit of study to be confined to central Oregon and more specifically the Upper Deschutes River Basin. Because both northern Great Basin and southern Columbia Plateau residents are known to have inhabited the Upper Deschutes River Basin both cultural histories are explored. This review is necessary to help infer a probable cultural affiliation with the caching behavior, thus facilitating evaluation of the caches within their primary cultural context. This cultural context will then be used to analyze and evaluate the cache sites while considering their potential role or roles in the technological and social constructs (Binford 1962:219) of central Oregon prehistory.

Cultural History of the Northern Great Basin

In the northern Great Basin a strong, positive relationship exists between the productivity of the lake/marsh habitats and the intensity in which prehistoric populations utilized the resources (Connolly 1999:4; Mehringer 1986:33). Archaeological evidence suggests a lake basin settlement pattern of small, ephemeral populations at times of low biotic productivity while highly productive times support larger, more permanent settlements (Aikens and Jenkins 1994:1-10; Connolly 1999:4). Generally an overall pattern of maximizing and utilizing the lake and marsh habitats was preferred. At times of low lacustrine productivity an intensification of resource procurement in the upland setting is evident. Reviewing the general cultural sequences for the northern Great Basin will support these generalizations and add specific detail concerning major environmental changes and the ensuing adaptive cultural responses.

In the Fort Rock basin the Connley Caves were repeatedly occupied throughout most of the Holocene (figure 7). The caves lie at the base of Connley Hills within a mile of Paulina Marsh. Given this extended chronology in a lacustrine setting, Connley Caves offer a baseline reference point for archaeology of the northern Great Basin. The following review is based on Aiken's synopsis of the northern Great Basin, including Connley Caves (Aikens and Jenkins 1994:4-16). Figure 7 is a map of selected archaeological sites in the northern Great Basin and noted in this review.

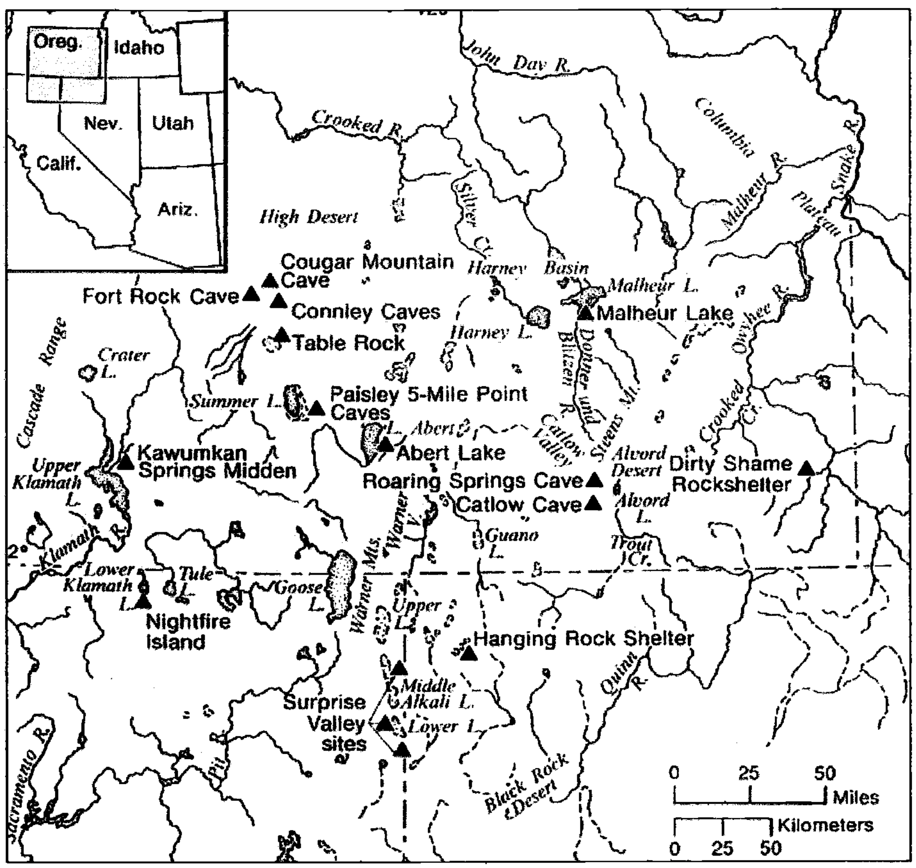


Figure 7 Map illustrating selected archaeological sites in the northern Great Basin (after Cressman 1986:120).

11,500 to 11,000 BP

In the Great Basin there are no buried sites that pre-date 11,500 BP. Claims of great antiquity have been made in the northern Great Basin at Fort Rock Cave (Aikens and Jenkins (1994:7) and from the Calico site but both are either flawed in documentation and/or unsupported by absolute dating (Grayson 1993:235). Two projectile point types, fluted and stemmed, are recognized as the earliest expression of material culture in the Great Basin. Fluted points remain undated simply because they have never been found in a buried context. Western Stemmed points have been found in a buried context in the lowest levels of Fort Rock Cave and in Connley Caves and consistently date between 11,200 and 7500 years ago (Grayson 1993:241).

Both fluted projectile points and stemmed points are known from isolated finds and open sites in the northern Great Basin. Research suggests fluted points precede stemmed points based on a relative dating methodology. For example, the Dietz site is an open site in the now dry basin of Pleistocene Lake Alkali. Archaeological research by Willig along the earliest shore lines of this lake recovered both fluted and Western Stemmed points (Connolly 1999:27; Grayson 1993:244; Mehringer 1986:49; Willig 1988:474). A discernable difference in location was noted for the concentrations of these two point types. Willig's research suggests a relative dating for the tool types. According to Willig (1988) Pleistocene Lake Alkali levels fluctuated several times. Toward the end of the Pleistocene the lake level was lower coinciding with the fluted points and then dried up completely by 11,000 BP. The lake recharged around 9610 BP and rose above the previous level. Western Stemmed points are associated with this stand. Later the lake stabilized at a lower level and was completely gone at the time of the Mount Mazama eruption (Grayson 1993:244). According to Willig, paleoenvironmental and geoarchaeological evidence suggests a pre-11,000 BP occupation of the northern Great Basin and shows fluted points precede Western Stemmed at the Dietz site (Willig 1988:412). Figure 8 is an illustration of a fluted point from the Dietz site.

The stylistic attributes of stemmed projectile points from the Dietz site, Fort Rock Cave, and Connley Caves show the wide range of stylistic variability for this point type (Grayson 1993:241). Figure 9 is an illustration of the stylistic variability noted by Grayson (1993). The dating of these collections suggests stemmed points span a 4,000 year depositional history. According to Grayson a 4,000 year history could account for some of the remarkable variability common to this point type. However Grayson dose not discount the possibility that the wide range of stylistic attributes may reflect change through time (Grayson 1993:241).

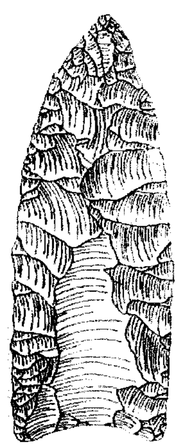


Figure 8. Illustration of a fluted point from the Dietz site in the Great Basin (after Grayson 1993:236)

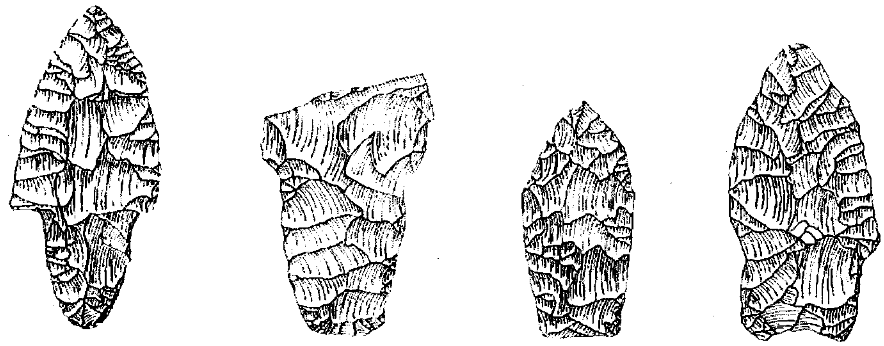


Figure 9. Illustration of Great Basin stemmed points (after Grayson 1993:239)

Initial Archaic 11,000 to 7000 BP

The Initial Archaic climate was cooler and wetter than today yet significantly drier than the preceding late Pleistocene. Pluvial Fort Rock Lake had almost entirely evaporated with the exception of Paulina Marsh and Silver Lake. Evidence from Connley Caves (Connolly 1999:28) and the Far Butte site (Aikens and Jenkins 1994:7) in Silver Lake Valley suggests a floral and faunal community consistent with a marsh habitat. The artifact assemblages associated with these sites offer evidence of hunting large game and waterfowl, fishing, and the gathering and processing of seeds. The assemblage includes projectile points, knives, scrapers, gravers, drills, and milling stones. To the east, in Christmas Valley, rabbit drives are documented and again the lithic inventory is rich and diverse. Taken together the archaeology from Connley Caves, Silver Lake Valley, Christmas Valley, and a few small sites in the upland zone, suggest a pattern of ephemeral camping sites on the basin floor exploiting a lake and marsh habitat with the occasional use of the upland slope resources (Aikens and Jenkins 1994:7-8).

Early Archaic 7000 to 5000 BP

The Early Archaic in this region is generally defined by a significant climate shift and a change in lithic traditions. During this time the climate dramatically shifts toward intense drying and higher temperatures altering available resources (Grayson 1993:244). The region's resources were stressed further by the 6800 BP tephra-fall following the eruption of Mount Mazama (Matz 1991). These events either individually or in combination seem to have initiated a change in adaptive strategies employed by the local residents. According to Grayson, "the end of the early Holocene in the Great Basin was marked by the desiccation of many low-elevation valleys" and "although this desiccation happened at different times in different places, the early Holocene era of shallow lakes and marshes, and the biological productivity that they imply, was over by about 7,500 years ago. As the lakes and marshes disappeared, so did the distinctive artifacts, and the distinctive distribution of the artifacts, that mark the stemmed point tradition" (Grayson 1993:244).

While the Northern Side-notched point is most commonly associated with the Columbia Plateau culture region, these points are also found in the northern Great Basin and date between 7200 and 4500 years ago. Figure 10 is an illustration of a Northern Side-notched point. However, in the northern Great Basin this point type is not found in any great abundance due to a scarcity of sites and a declining population (Grayson 1993:254-255). A dramatic decrease in population is realized in the archaeological assemblages at Connley Caves, where both faunal and lithic assemblages are significantly reduced (Aikens and Jenkins 1994:8-9). Radiocarbon dates from Fort Rock Cave and the Silver Lake valley do suggest small numbers of residents continuing to utilize the area (Connolly 1999:4) in spite of the low biological productivity. This notion is a departure from previous assertions claiming total abandonment of the region (Aikens and Jenkins 1994:8-9).

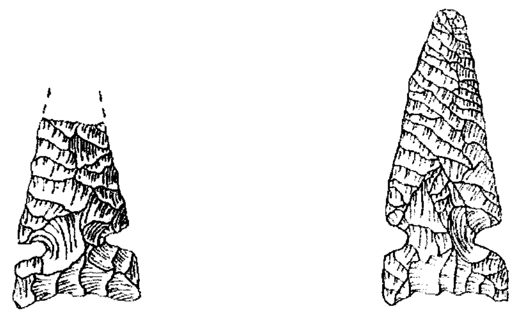


Figure 10. Illustration of Great Basin Northern Side-Notched points (after Grayson 1993:254)

Middle Archaic 5000 to 2000 BP

A greater number of archaeological sites in the Fort Rock basin date to the Middle Archaic. This evidential record draws from approximately 20 sites in addition to Connley Caves. The climatic hallmark of this period is the onset of the Neopluvial with its increase in effective moisture. During this time Paulina Marsh and Silver Lake filled to their maximum levels, overflowed and drained into the Fort Rock and Christmas Valley basins. In response to this increase in effective moisture villages and collecting camps are found in significant numbers along the wetland margins (Connolly 1999:4). Lithic scatters are known from the uplands and basin floors, an indication of ongoing hunting and gathering practices. Excavations of the sites show evidence of shallow, semisubterranean, wickiup-like structures and storage pits. Faunal assemblages contain fish bones of Tui chubs and waterfowl, all consistent with exploitation of a marsh/lake environment. Also included in the cultural assemblages are stone tools of obsidian and basalt, projectile points, knives, scrapers, pestles, grinding slabs/stones, as well as bone and shell beads. In nearby channels, remains of net weights and bone gorges are indicative of fishing strategies employed by the residents.

Lithic technologies characterized by the appearance of a series of projectile point types called Gatecliff, Elko, Rosegate, and the Desert Series. These projectile points dominate this period (Grayson 1993:250). These projectile point types differ from stemmed points in that they are smaller, have contracting stems or are side-notched, and have triangular or leaf-shaped blades (Aikens 1993:23; Grayson 1993:250-251). Figures 11-14 are illustrations of these point types. The points are also functionally different as they were "used to tip atlatl darts, which were then propelled with an atlatl or spear-thrower" (Grayson 1993:250). The Desert series and Rosegate points were later used as arrowpoints (Grayson 1993:252). Table 2 compares the dating of these major Great Basin projectile point series and types. The combination of semi-permanent structures, storage capabilities, and diversified faunal and lithic assemblages offer evidence of an increase in populations residing in the immediate vicinity of very productive biotic communities on a more permanent basis (Aikens and Jenkins 1994:9-10, 12-13; Connolly 1999:4).

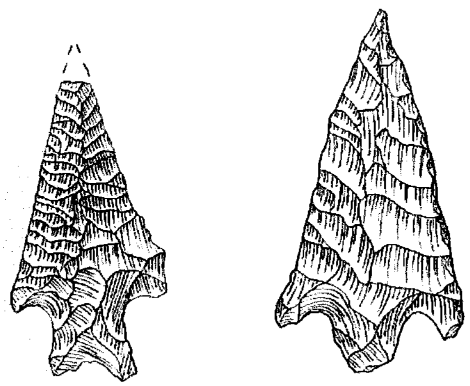


Figure 11. Illustration of Great Basin Gatecliff points (after Grayson 1993:251)

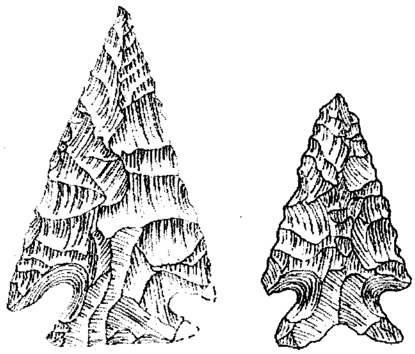


Figure 12. Illustration of Great Basin Elko points (after Grayson 1993:251)

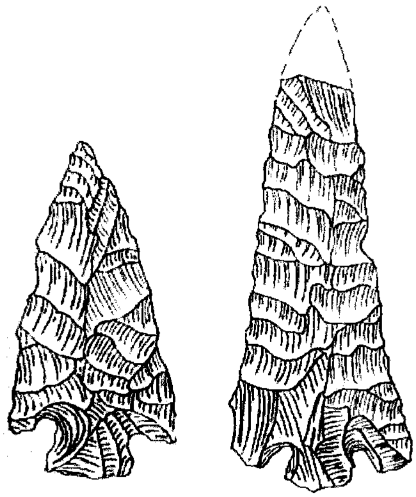


Figure 13. Illustration of Great Basin Rosegate points (after Grayson 1993:252)

Figure 14. Illustration of a Great Basin Desert series point (after Grayson 1993:252)

Table 2. Chart of dates for major Great Basin projectile point series and types (after Grayson 1993:253).

	Date (years ago)	
Series or Type	Central/western Great Basin	Eastern Great Basin
Gatecliff Split Stem	5,000-3,200	5,000-3,200
Gatecliff Contracting Stem	5,000-3,200	5,000-1,500
Elko Series	3,500-1,300	7,500-3,500 (Gap?) 2,000-1,000
Rosegate Series	1,300-700	1,700-1,000
Desert Series	700-Historic	1,000-Historic

Late Archaic 2000 BP to Historic

The Late Archaic in the northern Great Basin is noted for a large grouping (N=122) of stone-ringed house structures and cache pits (N=47) at the Boulder Village site in the uplands. Boulder Village utilized the natural landscape to create rock house circles measuring approximately 2-3 m across along the edge of a lava flow. Cache pits were created out of the flow by removing select rocks until a pit, 1 by 1 m wide and 2-3 m deep was exposed. This unique construction plus the lithic, floral, and faunal assemblages are all consistent with a substantial sedentary occupation with a storage focused on upland root gathering (Aikens and Jenkins 1994:10, 14; Connolly 1999:5).

Contact: The Northern Paiute

The Northern Paiute are believed to have occupied the southeastern portions of Oregon at the time of contact in the early 1800s (Connolly 1999:5). Linguistics have hypothesized that the Northern Paiutes moved into the northern Great Basin within the last 1,000 years. Their economic structure was a broad based hunting and gathering strategy utilizing uplands for procurement of berries, pine nuts, lowland settings for root crops, and basin locals for waterfowl and fish. The availability of plant and animal resources varied in each setting albeit limited. To maximize each resources availability seasonal rounds were scheduled. Summer months trended toward a nomadic lifestyle and winter months were more sedentary with a reliance on stored and dried resources particularly root and seed crops (Connolly 1999:7). Winter villages were comprised of 3-10 households, each household consisting of 15-40 people. Living structures for both winter and summer occupations were circular, dome shaped lodges covered with vegetative mats. Winter structures were constructed of heavier materials and built more substantially to protect the inhabitants from inclement conditions. The lighter construction of summer residences provided shelter from wind and sun.

Linguistically, this tribe is assigned to the Aztec-Tanoan language phylum. The political and social organization tended to be informal with leadership chosen by a group consensus and based on the specific activity (Connolly 1999:6; Fowler and Liljebald 1986:435-450). Figure 15 is a map illustrating the historic distribution of cultural groups, including the Northern Paiute, and natural landmarks found in the caching region.

Contact: The Klamath

In the higher elevations to the south of the Upper Deschutes River Basin the Klamath and Modoc exploited high lakes and forest resources (figure 15). The Klamath occupied the Upper Klamath Basin and surrounding uplands. Subsistence strategies focused on large lakes and lower sections of rivers and marshes. The fish, waterfowl, mammals, and the plants associated with this environmental setting provided dietary staples. To effectively exploit these resources the Klamath employed a sedentary way of life. Winter villages were typified by large, round, semi-subterranean lodges which were reoccupied over several years. Summer residences were similar but less formable in that they were of lighter construction and built on top of the ground. The Klamath tribe's linguistic affiliation belongs to the Penutian language phylum and social and political organization was based on wealth (Connolly 1999:6; Stern 1998:446-455).

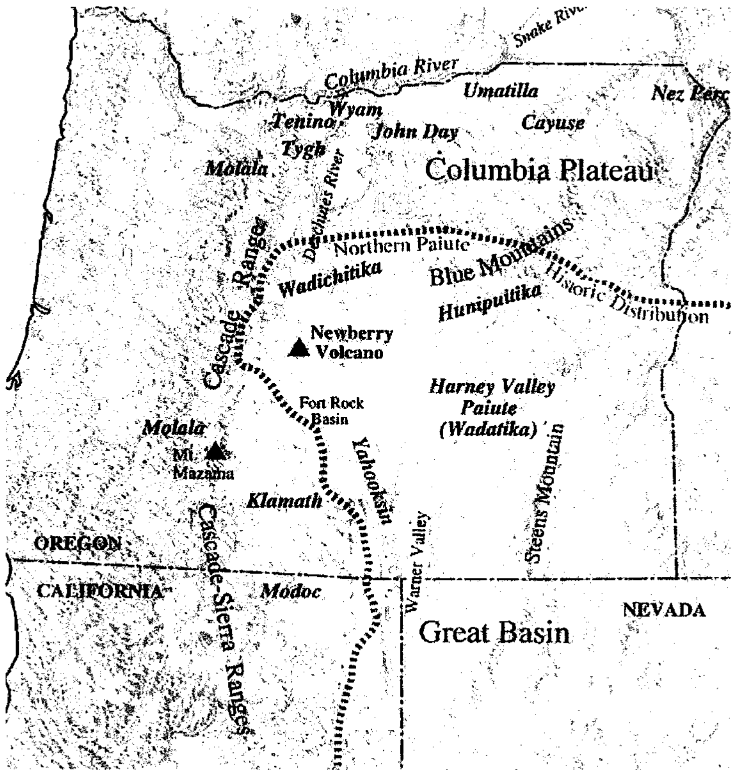


Figure 15. Map illustrating the historic distribution of cultural groups and natural landmarks in the caching region (after Connolly 1999:3)

Contact: The Modoc

The Modoc's subsistence practices were similar to the Klamath tribes yet had a greater reliance on hunting in both summer and winter. This resource strategy concentrated on environmental settings in elevations above 1200 m (4,000 ft). In response this environmental difference house structures were known to be constructed deeper in the ground for insulation from the cooler temperatures of higher elevations (figure 15). The Modoc are also descendents of the Penutian language phylum (Connolly 1999:6 and Stern 1998:446-455).

Summary of the Northern Great Basin Cultural History

Archaeological research has shown people visited and lived in the northern Great Basin throughout prehistory. The early presence by the makers of fluted and stemmed projectile points is evidence of a lake/marsh subsistence strategy extending as far back as the people themselves. Associated artifact assemblages from this period attest to an additional reliance on large terrestrial game. By 9000 years ago occupation had increased significantly as productivity of the natural resources flourished. People utilized the internal basin lakes and marsh systems and continued hunting large game. From 8000 to approximately 5000 years ago climatic conditions declined, the region became increasingly arid, and temperatures rose. Coupled with this climate degradation the eruption of Mount Mazama further taxed available resources. The archaeological record reflects these conditions in that few sites are known from this time period. The few sites which have been found suggest small populations exploiting the basin's limited resources whenever possible. With the onset of the Neopluvial, between 5000 and 3000 years ago, villages and camps were established along the now rich and productive marsh fringes. Unpredictably of the environment over the last 3,500 years forced occupants of the region to increase their reliance on upland resources, primarily root crops. As a result adaptive strategies shifted again and substantially large and nearly permanent settlements developed in the uplands. Root crops and the development of caching techniques to store crops are seen in the archaeological record. The prehistory shows that lacustrine subsistence strategies where never abandoned completely, even in the context of severe climatic conditions. Adaptive strategies did change in response to these environmental shifts.

Southern Columbia Plateau Cultural History

A review of the Columbia Plateau prehistory offers several major chronological schemes in the literature. Chatters utilizes three broad chronological units to summarize the regional sequences of the Columbia Plateau as a whole: Early 11,000 to 8000 BP; Middle 8000 to 4000 BP; and Late 4000 to 250 BP (Chatters and Pokotyio1998:73). Ames et al. (1998) separate the southwestern and southeastern regions of the Plateau into chronological periods defined as follows: Period IA 13,450 to 12,950 BP; Period IB 12,950 to 6950/5950 BP; Period II 6950/5950 to 3850 BP; Period III 3850 to 250 BP. Leonhardy and Rice (1970) divide cultural material, primarily lithics, into a number of cultural phases. The phases and their approximate dating are; Windust 10,000 to 9000 BP; Cascade 9000 to 5000 BP; and Tucannon 5000 to 2500 BP. The Harder, Piqunin, and ethnographic Numipu Phases address more recent adaptive strategies (Leonhardy and Rice 1970:23). Lucas (2000) refines Leonhardy and Rice's cultural chronology of the Tucannon phase through a review of archaeological and environmental studies from the Lower Snake River region. From this work the Tucannon cultural phase seems to have an inception date of approximately 5500 BP and a terminal dating of approximately 4000 BP (Lucas 2000). This discussion will primarily focus on the southern Columbia Plateau with specific attention to the southwestern and southeastern regions as defined by Ames (Ames et al. 1998). The review will utilize Leonhardy and Rice's 1970 regional cultural chronological scheme however the Tucannon phase will reflect the most current research by applying the temporal chronology defined by Lucas (2000). Table 3 compares this modified chronology and the associated archaeological units of the Lower Snake River region. Figure 16 is a reference map of archaeological sites noted in this discussion.

Table 3.Comparison of chronologies and the associated archaeological units of the Lower Snake River region (modified form Lucas 2000).

Date BP	Period Name Modified by Leonhardy and Rice (1970)	Phase Name and Chronology (Leonhardy and Rice)	Phase Name and Chronology (Lucas)
150	Ethnographic	Numipu	Numipu
300	Snake River	Piqunin Harder	Piqunin Harder
2500	Initial Snake River	Tucannon	
4,000			Tucannon
5500			Cascade
5000	Pioneer	Cascade	
9000 10,000		Windust	Windust

Pioneer Period prior to 9000 BP

The Pioneer Period reflects an overall consistency in material cultural remains of the Windust and Cascade Phases. Windust is the earliest phase followed by the Cascade phase which dates from approximately 9000 to 5000 BP. The following discussion is a review of the earliest sites in the southern Columbia Plateau.

The Windust phase begins with the recognition of a Clovis occupation (Ames et al. 1998:103) in the Columbia Plateau and in the Northwest in general.

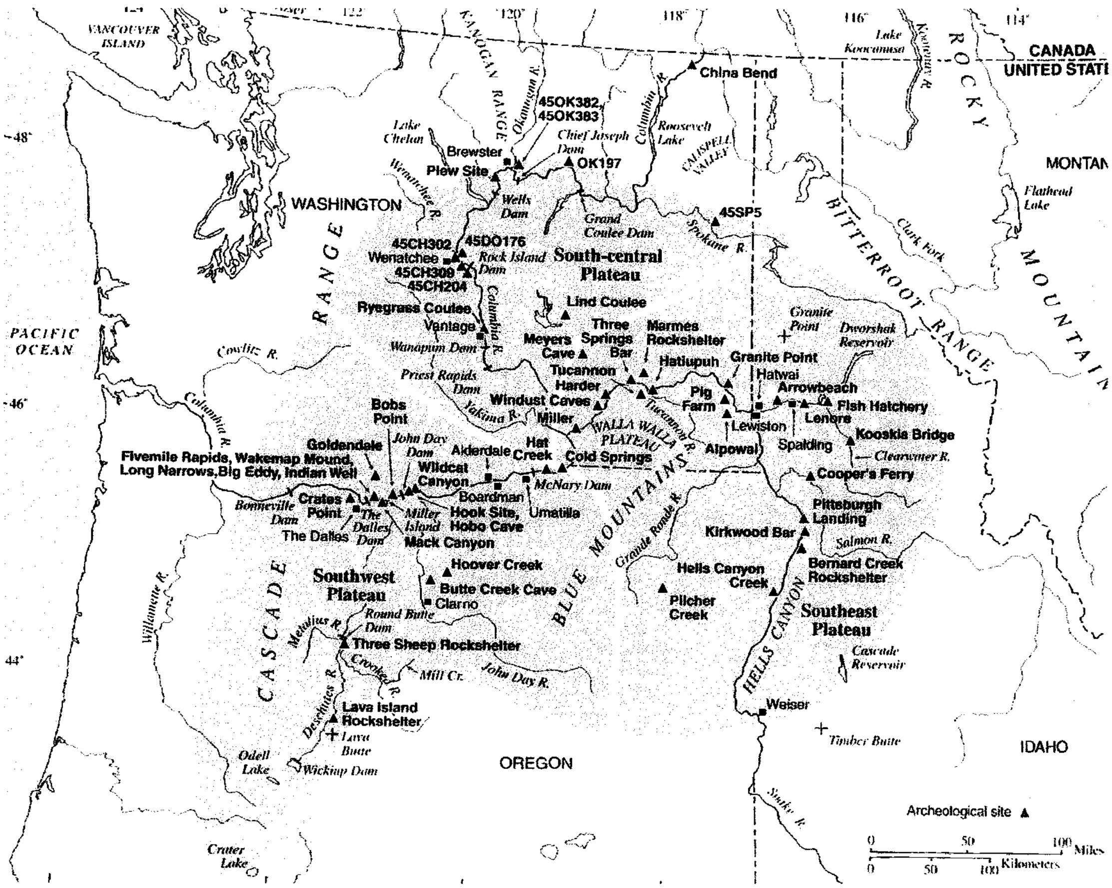


Figure 16. Map illustrating the southern Columbia Plateau archaeological sites and regions (after Ames et al 1998:104).

Isolated surface Clovis sites are rare but known. In the south-central region of the southern Columbia Plateau no Clovis age sites are supported by radiocarbon dating (Ames et al. 1998:103). Windust artifact assemblages are more common. Generally these sites contain "a variety of closely related projectile point forms with relatively short blades, shoulders of varying prominence, principally straight or contracting stems, and straight or slightly concave bases. Both uniface and biface lanceolate points occur, but are exceedingly rare" (Leonhardy and Rice 1970:4). Figure 17 is an illustration of the variability noted for the Windust phase artifacts. According to Ames et al. the Windust phase "is marked by the stemmed and unstemmed lanceolate points" (Ames et al. 1998:106). Lithic technology was well developed and the typical stone-tool material was cryptocrystalline silicates and occasionally fine-textured basalt (Leonhardy and Rice 1970:4). The earliest cultural material comes from Windust Caves, Marmes Rockshelter, and Granite Point Locality 1. Thorn Thicket and site 45WT36 may also contain artifacts from the Windust Phase (figure 16) (Leonhardy and Rice 1970:4).

Figure 17.Illustration of Windust phase lithic artifacts (after Jennings 1989:180)

Pioneer Period: 9000 to 5500 BP

The climatic conditions between 11,000 and 8000 BP had changed from a periglacial environment to dry winters and hot summers. This improved climate increased the stability of the Columbia River and salmon were beginning to populate sections of the river by 9000 BP (Chatters and Pokotyio 1998:73). Archaeological sites with cultural material from the Cascade Phase are Windust Caves, Marmes Rockshelter, Granite Point, and Thorn Thicket, all of which had an earlier Windust component. Sites with only Cascade Phase artifacts are the Tucannon site, Votaw, and 45WT7 (figure16) (Leonhardy and Rice 1970:6).

According to Leonhardy and Rice (1970) the hallmark lithic artifact during this time is the "lanceolate Cascade projectile point" (Leonhardy and Rice 1970:6). Ames et al. refer to this point as the "laurel-leaf shaped points (Cascade points)" (Ames et al. 1998:106). Figure 18 is an illustration of Early Cascade phase artifacts.

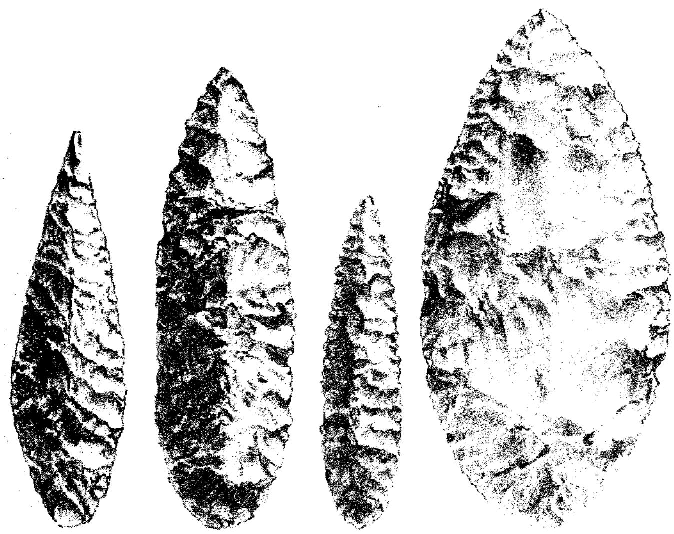


Figure 18. Illustration of Early Cascade phase lithic artifacts
(after Jennings 1989:180)

The Late Cascade Phase lithic assemblages differ from the preceding Phase by "the presence of Northern Side Notched and Cold Springs points with Cascade points" (Ames et al. 1998:106)

In the southwestern Plateau, the Wildcat Canyon site is an open site in the John Day reservoir dating between 9000 and 7500 BP. The site contains a typical artifact assemblage of this period: lanceolate projectile points with indented bases, knives, scrapers, gravers, burins, and a few milling stones along with remains of large mammals. Another short term camping site, Goldendale, is known on the camas flats of Washington. Numerous edge-ground cobbles, milling stones, and small hammer stones along with knives, drills, gravers, and points strongly suggest plant processing as an important resource procurement strategy (Ames et al. 1998:106-107).

In the southeast Plateau Marmes Rockshelter is one of the best known sites from this time. The rockshelters large, diverse artifact assemblage and faunal inventory, supported by radiocarbon dates have made this site the basis for interpretation of open sites found throughout the region. Lind Coulee, an open air site, is noted for its significant faunal assemblage dominated by bison. Upland sites located along tributaries of the major rivers also known at this time (Ames et al. 1998:105-106). In general projectile points were unstemmed or with constricted stems and did not exhibit intra-regional variation. Milling stones with associated stone-tools, bone, and antler are known while hopper mortars and pestles are rare (Lucas 2000:27). In a few sites year round residency may be indicated (Chatters and Pokotyio 1998:76; Connolly 1999:9). According to Ames, the locations of these sites along rivers, tributaries, and upland settings suggest a broadly oriented hunting and gathering adaptation, and is supported by the associated faunal remains (Ames et al. 1998:105-106). Lucas (2000) offers evidence of sites primarily scattered throughout the Lower Snake River with residents practicing a mobile foraging strategy. Aquatic assemblages, including fish and mussels, along with faunal assemblages suggest a riverine adaptation where salmonid exploitation was probably an important part of the mobile foraging strategy (Lucas 2000:24, 27, 54).

According to Ames et al., the Paulina Lake site in Newberry Crater is one of the oldest sites in the Plateau dating to 11,500 years ago. Clearly defined pre and post-Mazama (6800 BP) occupations are documented and supported with radiocarbon dating. Well defined wickiup-like structures are known with associated artifact assemblages of stemmed, lanceolate, Windust and Cascade points, as well as cobble and ground stone tools (Ames et al. 1998:107).

Tucannon Phase 5500-4000 BP

The archaeological record for the Tucannon Phase shows a change in settlements, technology, and subsistence patterns in the Columbia Plateau. During this interval the climate shifts in the northern region and conditions become cooler while moisture increases; southward the warming and drying trend continues (Chatters and Pokotyio 1998:74-75). The primary cultural changes are; housepit construction appears for the first time, an increase in the reliance of root crops, and salmon exploitation is evident. Projectile point frequency decreases as does the technological simplicity and quality while milling stones are larger and associated with pestles (Lucas 2000:27). Edge ground cobbles and prepared cores become rare or are not seen at all. The Tucannon site, Marmes Rockshelter, and Granite Point all contained cultural material from the Tucannon Phase (figure 16) (Leonhardy and Rice 1970:11). Leonhardy and Rice identify and describe two kinds of projectile points associated with the Tucannon Phase. The first "form has a short blade, shoulders of varying prominence, and a contraction stem. The second variety is notched low on the side or at the corner to produce an expanding stem and short barbs" these authors equate the two forms with the "Snake River Corner-Notched" point (Leonhardy and Rice 1970:11). Ames et al. suggests little change in the Tucannon point styles when they state styles "do not generally change as the continuation of Cascade, Bitterroot, Northern Side Notched and Cold Springs are all present) (Ames et al. 1998:108-109). Figure 19 is an illustration of Tucannon phase points.

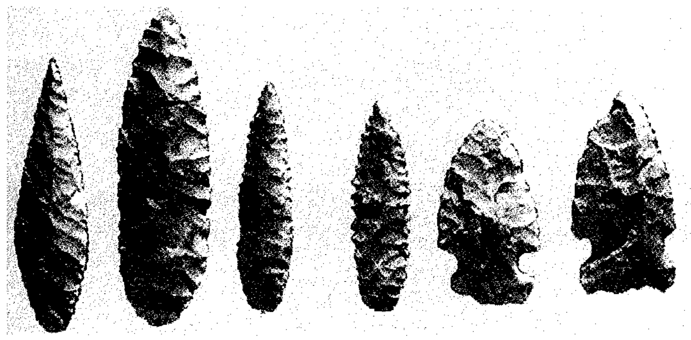


Figure 19. Illustration of Cascade Lanceolates (left), and side-notched points from the Tucannon phase (right) (after Ames et al. 1998:105)

The absence of identifiable habitation sites or living floors in the southwest region's archaeological record is distinctive compared to other Plateau regions during this time. Two sites, Hobo Cave and Wildcat Canyon, have artifact assemblages thought to represent this period but can only be loosely dated by disturbed stratigraphy. These assemblages are however consistent with other assemblages in the southern Plateau during this time. At Fivemile Rapids a 6000 BP date is assigned to artifacts showing little if any change from levels dating to 2500 BP thereby suggesting a hiatus between 6000 and 3000 BP. Archaeology in the southwest region of the southern Columbia Plateau also supports a notion of minimal change from earlier periods. Assemblages continue to suggest an ephemeral, shifting subsistence strategy when found or nothing for almost 3,000 years (Ames et al. 1998:110-111).

In the southeast region a substantial difference is noted in that archaeological research reveals a number of substantial occupations yet the total number of sites is less than preceding periods. Sites are no longer primarily located throughout the Lower Snake River. During this time populations deemphasized riverine resources instead focusing on an upland subsistence strategy. This strategy is centered on the collection of floral and game resources in the uplands (Lucas 2000:53). Settlement patterns suggest a model of villages concentrated at confluences of large and middle size waterways while campsites are found along confluences of large and small streams (Lucas 2000:13). Marmes Rockshelter, Granite Point, the Tucannon site, Alpowa, Hatwai, and Hatiuhpuh all significantly contribute to the archaeological record (figure 16). The latter three sites all have semisubterranean pit houses and date from 5800 to 4400 BP. The structures are 7 to 8 m across, circular to rectangular in shape, and approximately 2 m deep. Earthen benches along the inside walls are known. All three sites have similar artifact assemblages and are generally distributed in clusters suggestive of work areas. Hopper mortar bases, anvils, and pestles suggest plant processing. Faunal remains consist of elk, deer, pronghorn, and an array of small game. Large quantities of freshwater mussels, a small number of salmon, and other fish species are also present (Lucas 2000:27-28). Overall current evidence suggests a great reliance on terrestrial resources. Aquatic and avian fauna are found but to a lesser degree, an exception being river mussels which were collected intensively (Lucas 2000:25). Projectile point styles are side and corner-notched and a stemmed point (figure 19). An intense intra-regional development of lithic styles is evident (Lucas 2000:27).

Post Tucannon Phase 4000 BP to Historic

The post Tucannon Phases, dating from approximately 4000 BP to the ethnographic present, was a time in the Columbia Plateau when the general climate trend was cooling and seasonal variation increased. Terrestrial mammal populations declined while salmon abundance increased. The archaeological record indicates a transition in adaptive strategies from foraging toward a collector-type strategy augmented by a dependence on stored resources. Small settlements reappear with larger and deeper structures. Artifact densities increase and storage pits and processing ovens are found in housepit floors. A localization of projectile point styles is noted while lithic material is generally of poor quality. Figure 20 is an illustration of a Harder phase artifacts. Population densities are generally lower especially in the southwest region (Chatters and Pokotyio 1998:77).

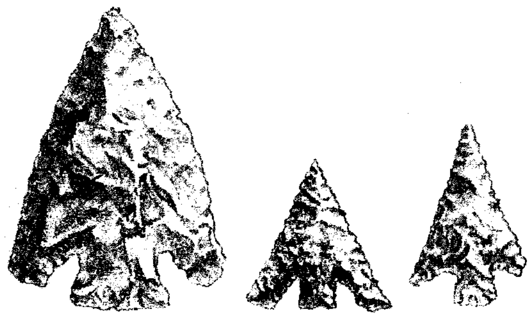


Figure 20. Illustration of Harder phase lithic artifacts (after Jennings 1989:180)

Contact: The Tenino/Tygh

The Tenino/Tygh tribal groups of the Western Columbia River Sahaptins are thought to have inhabited the northern most regions of the High Lava Plains at the time of contact (figure 21). They are known to be a semi-sedentary population residing in villages located on rivers, tributaries, and along the confluences of these settings in warm months. During the winter villages were built in the tributary canyons protecting the residences from the cold and wind of the Columbia River Gorge. An extended family would construct two house structures. One structure was an oval-shaped, semi-subterranean lodge for sleeping and storage. The other structure was a rectangular-shaped structure for cooking and day activities. In the summer months villages were repositioned at prime fishing locations along the Columbia River. Rectangular pole/mat structures were built for sleeping and salmon drying while mat covered tipi-like structures were used as temporary camps in the mountain tributaries for collection activities. Salmon, large and small game, as well as root crops were the primary food sources for the Tenino/Tygh. Salmon and a variety of other fish species were obtained by a number of techniques including traps, spearing, hooks, nets, dams, and weirs. Fish and plant resources comprised the majority of the diet while hunting of both large and small game contributed to a lesser degree. Trade with other Plateau groups resulted in a peaceful coexistence among most neighbors. However, contact with the Northern Paiute often spawned conflict and minimal trade transpired. The Tenino/Tygh tribes belong to the Penutian language phylum. Community size ranged from fifty persons to several hundred and exhibited social class distinction within a given community (Connolly 1999:10 and Hunn and French 1998:379-386).

Contact: The Molalla

The Molalla also utilized the resources along the western margin of the High Lava Plains (figure 21). Like the Northern Paiute and Tenino/Tygh tribes, the Molalla also practiced seasonal resource collection. Winter subsistence practices focused on stream resources in low elevations. In summer months large game and berry collection ensued at higher elevations. The use of neighboring resources and trade was directed to the north and west. Southward, the Northern Paiute and the Molalla relationships were strained and often hostile. The basic social unit was the family whom remained together year round. Extended families lived in large semi-subterranean earth lodges in winter, dispersing in the summer for collection activities. The Molalla also belong to the Penutian language phylum. Political and social structure was informal and task orientated. A person's reputation and ability determined the leadership role when needed for a specific undertaking (Zenk and Rigsby 1998:439-443).

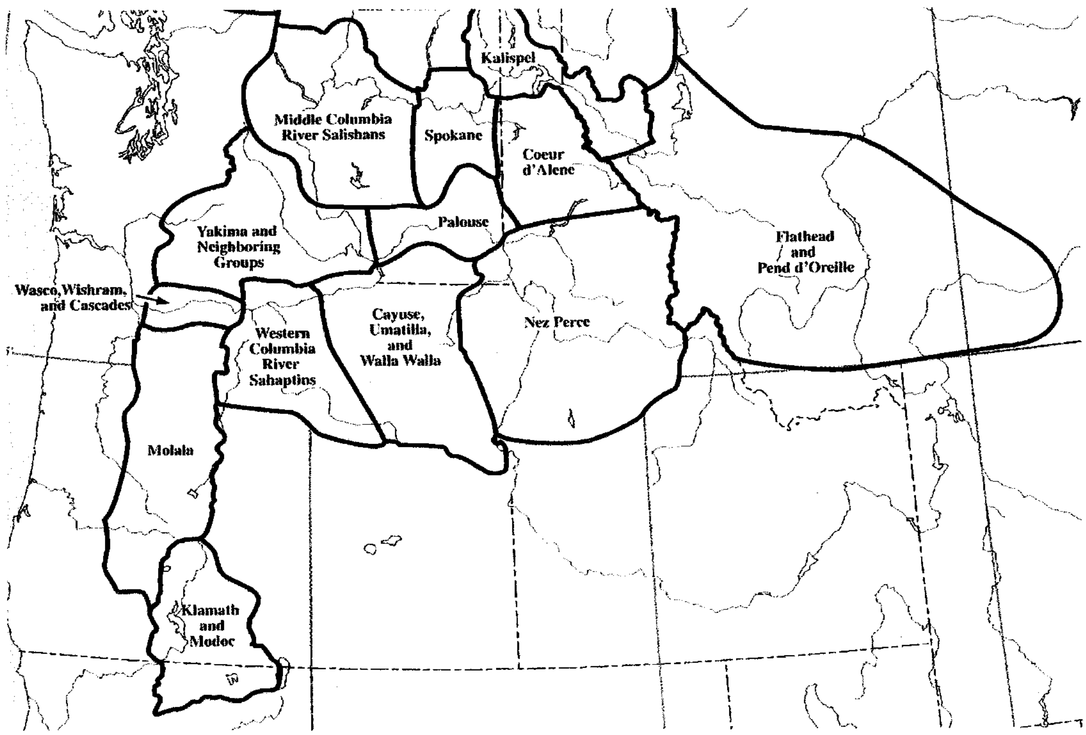


Figure 21. Map illustrating the geographic location of the southern Columbia Plateau historic tribal groups (modified from Chatters 1998)

Summary of the Southern Columbia Plateau Cultural History

This review of archaeological research has illustrated a continual occupation in the southern Columbia Plateau for at least 11,500 years. Isolated Clovis age sites are known in the Columbia Plateau although none are known in the southern region. Between 11,000 and 8000 BP the climate became drier and warmer stabilizing the river system thereby enhancing salmon populations. Diverse artifact and faunal assemblages indicate a broad based subsistence strategy centered on fishing, hunting, and plant processing along waterways and upland settings. A change is evident in the archaeology around 7000 BP as climatic conditions continued to become increasingly arid and warmer. A generalized decrease in population is noted. When present, pithouse villages are concentrated at river confluences while camp sites are located up smaller waterways. A de-emphasis on riverine resources along with a shift toward an increasing reliance on upland foods is noted in lithic and biotic assemblages. From 4000 BP to contact this trend reverses, terrestrial resources decline while salmon populations improved. Climatic conditions cooled and seasonal variation increased. A transition is seen in the archaeology in that a collector resource strategy is noted as evidenced by a dependence on stored resources. At the time of contact local tribes occupied villages along the larger waterways at prime fishing locations, moving up tributary canyons during the winter months to exploit storable root crops and hunt. The archaeology reveals a riverine subsistence strategy throughout prehistory augmented by the exploitation of upland resources. When climate change and environmental degradation limited river resources, populations supplemented dietary needs with upland resources and stored foods, returning to prime fishing locals as environmental conditions allowed.

Comparison of the northern Great Basin and southern Columbia Plateau Natural and Cultural Histories

The High Lava Plains region of central Oregon encompasses two cultural areas; the northern Great Basin and the southern Columbia Plateau. The first evidence of human populations occupying the High Lava Plains and surrounding environments begins in the late Pleistocene. Environmental conditions were ideal in both culture regions. The northern Great Basin people enjoyed a vast diversity of biotic resources especially around the great Pleistocene lakes. The northern Columbia Plateau people benefited from improved river conditions as the post glacial effects on river systems diminished and water courses stabilized. Archaeological evidence illustrates both the northern Great Basin and southern Columbia Plateau people utilized broad based resource strategies during this early period. Northern Great Basin residents focused on lake and marsh resources and hunted large mammals. Southern Columbia Plateau populations fished the Columbia River, hunted large game, and processed plant resources. In general both culture areas were home to small, mobile populations exploiting landscapes of great biotic diversity. Subsistence activities centered on a broad based hunting and gathering adaptive strategy.

Early Holocene climatic changes of increasing warmth and decreasing effective moisture began to stress both cultural regions. The northern Great Basin experienced the effects of these changes earlier than neighboring southern Columbia Plateau populations, as the large but relatively shallow Pleistocene lakes were highly sensitive to these climatic changes. In the southern Columbia Plateau tributary streams experienced reduced flows however the Columbia River sustained productive water levels.

In the northern Great Basin available lacustrine resources declined as climatic conditions became increasingly arid and temperatures rose. Adaptive strategies of the local populations initially made minor alterations to their Clovis weapon systems with a gradual movement toward an increasing reliance on stemmed projectile points, however the overall weapon inventory remained rich and diverse. At this time small, mobile populations were employing a generalized broad-based resource strategy with reliance on hunting, lake and marsh habitat resources, and to a lesser degree upland resources.

A similar scenario is evident in the southern Columbia Plateau as the adaptive strategies of local populations exploited a wide array of habitats also supported by hunting and gathering lifestyle. Archaeological research clearly illustrates a dependence on aquatic resources although terrestrial fauna were also an important dietary component. The location of Cascade period sites primarily along river banks reflects a focused resource procurement effort on productive river confluences while the less productive tributary streams where home to small ephemeral camping sites. Lithic assemblages change little during this time as a continuation of unstemmed and constricted stemmed projectile point technology is noted and intra-regional variation is absent. The archaeological record suggests these adaptive adjustments coupled with an overall population decrease are related to the declining climatic conditions of the early Holocene.

By the mid Holocene these compromised environments were strained again, this time by the impact of the Mount Mazama tephra-fall. In the northern Great Basin a blanket of tephra, 10-30 cm thick, covered the relatively flat landscape stressing floral communities and faunal populations. Coinciding with this event the archaeological record seems to indicate a near hiatus in occupation of the northern Great Basin lasting almost 3,000 years.

In the southern Columbia Plateau, river courses were compromised as Mazama ash blanketed the waterways during the eruptive phases. Tephra-fall continued to filter into the river system from the surrounding hillsides after the eruptive phase. The extent and duration of the Mazama tephra-falls impact on local populations is poorly understood in the southern Columbia Plateau primarily due to a paucity of faunal data in the archaeological record. However, a shift in economic focus does suggest an internal cultural adjustment, probably related to an altered environmental landscape; be it Altithermal conditions and/or the effects of Mount Mazama. Irrespective of cause, archaeological evidence indicates Tucannon phase economic strategies de-emphasized riverine resources while an increased reliance on upland food sources is evident. Coinciding with this economic shift is the appearance of residential permanence, recognized by pit house construction and storage of food resources. Projectile point frequency decreases as does the technological simplicity and quality. Point styles do not change for the most part except for the appearance of the Cold Springs side-notched projectile point after the Mount Mazama eruption.

A similar shift toward permanence is seen approximately 2,000 years later in the northern Great Basin with the onset to the Neopluvial when lake and marsh-side villages reappear in the internal basins in response to wetter conditions. As the short lived Neopluvial subsided a new climatic pattern emerged in the northern Great Basin typified by variable and unpredictable temperature and effective moisture fluctuations. Residents once again shifted resource procurement strategies now with a focus on upland root crops and the utilization of lacustrine resources when available. Residential permanence with and emphasis in storable crops continued into contact times. As northern Great Basin residents became less focused on lake and marsh habitats, the northern Columbia Plateau people were able to refocus resource strategies on improving river conditions as salmon populations flourished. Terrestrial game and upland food crops also remained as dietary staples to both populations but to a lesser degree for the southern Columbia Plateau residents. Both the northern Great Basin and southern Columbia Plateau cultures adapted to the changing available resources, although each cultural region focused on different resources in different environments. Both cultures employed a collector resource strategy, bringing the resources to the majority of the people as opposed to late Pleistocene times when people moved to the resources in a broad based resource strategy.

PREVIOUS ARCHAEOLOGY

This chapter summarizes three different sets of archaeological literature important for understanding the caching behavior of the Upper Deschutes River Basin. The first discussion is an historical review of three different hypotheses concerning the age, cultural origin, and function of the caching behavior. This is followed by a review of the archaeology from the Paulina Lake site in the Newberry Volcano caldera. The Paulina Lake site's extensive prehistory and associated studies are fundamental components of this research. Even though this site is not a cache site the archaeological investigations from Paulina Lake are used extensively as a comparative data base for this cache research. The rational for this approach is grounded in the quality and character of the archaeology at this noteworthy site. The Paulina Lake site is located in the center of the defined caching region and offers a well documented chronological sequence of the regional prehistory. The site's environmental and cultural histories are secured by intact stratigraphy and associated serial radiocarbon dates. Additionally, analyses of the recovered artifacts from the Paulina Lake site include extensive obsidian characterization studies. This research will rely heavily on these obsidian studies in later discussions. The chapter concludes with a summation of Binford's forager-collector model (Binford 1980). This is presented as a conceptual framework for understanding past hypotheses, highlighting changes in resource strategies at the Paulina Lake site, and as an aid in identifying temporal and spatial patterns associated with the cache sites.

Hypotheses

Historically the early lanceolate biface cache studies in the Upper Deschutes River Basin centered on two sets of authors, Scott, Davis, and Flenniken (Davis and Scott 1984; Davis and Scott 1991; Scott 1985; Scott 1989; Scott et al. 1986) as well as Minor and Toepel (Minor and Toepel 1984; Minor and Toepel 1997). Both sets of authors offered hypotheses concerning the Upper Deschutes River Basin caching practice. These hypotheses were presented through a series of journal articles published in the mid 1980s and early 1990s. The authors agreed that the stratigraphic context of each cache site had been severely compromised as a result of looting activity and an absolute dating of the sites was not possible. Each set of authors utilized alternative dating methods in an attempt to place the caches in a chronological context. The methods employed to address this limitation resulted in two significantly divergent hypotheses. The following is a summation of each hypothesis addressing the age, cultural origin, and function of lanceolate biface cache sites in the Upper Deschutes River Basin.

Scott, Davis, and Flenniken

Sara Scott, Carl Davis, and Jeffrey Flenniken suggest an overall similarity in antiquity for the cache sites through a comparison the Pahoehoe cache with other local cache sites. They suggest the relative position of the artifacts in Mazama tephra combined with obsidian characterization studies and obsidian hydration measurements (Scott et al. 1986:16) yield a cohesive and distinctively similar patterning among the caches (Scott et al. 1986:12). Additionally the authors state "the biface core technology used to produce the Pahoehoe cache was a dominant lithic reduction strategy associated with Archaic period sites in the northern and western Great Basin" (Scott et al. 1986:13-14). Based on these chronological indicators and lithic reduction strategies the authors assign an Archaic time frame, 6800 to 2000 BP, for the Pahoehoe, Lava Island Rockshelter, and China Hat cache sites and suggest a culturally affiliation with northern Great Basin occupations.

The investigation of the Pahoehoe site was also utilized to infer cache function. Scott et al. (1986:17) suggests "the bifacial point caches may by explained most logically within the context of a prehistoric exchange system". The impetus for this hypothesis is based on what the authors have identified as a distinctive lithic production technology as well as the abundant number and frequency of the lanceolate biface caches in the Upper Deschutes River Basin, the isolated location of the cache sites, and possible reasons for abandonment of the caches (Scott et al. 1986:107-113). They propose the expedient and homogeneous manufacturing methods of the artisans would serve to amass the number of lithics needed in an exchange system. Drawing on the ethnographic record of northern California, southern Oregon, and the northern Great Basin tribes, the authors view the cached obsidian as a highly valued exchange item during the Archaic period. (Scott et al. 1986:16-20). Scott et al. (1986) suggest a need for trade would have been a result of food and material shortages in central Oregon. They attribute this shortage to the environmental degradation caused by "frequent volcanic eruptions in the high desert throughout most of the Holocene" (Scott et al. 1986:18). In this scenario the authors account for the eventual abandonment of the lithic caches. One explanation offered addressing the abandonment was the demand of obsidian bifaces decreased with the transition from atlatl to bow and arrow. Another possible explanation offered was difficulties with "cache relocation" after eruptive events during the late Holocene (Scott et al. 1986:19). The authors suggest the fundamental characteristic of their exchange system hypothesis is the Archaic dating of the caches. They suggest this dating supports the notion of an exchange hypothesis because the "caches are contemporaneous with the Archaic dart points or possibly Late Period arrow points" (Scott et al. 1986:20) therefore supports both the ethnographic data and the identified production strategy of the lithics.

Minor and Toepel

An alternative hypothesis for the regional caching behavior is presented by Minor and Toepel based on their excavation of Lava Island Rockshelter. This hypothesis suggests the Upper Deschutes River Basin caches predate the Archaic Period and functioned within the context of a hunting subsistence strategy. Their archaeological investigation of the Lava Island Rockshelter site suggested this site's primary function was a hunting camp and storage site. The authors identified three distinct cultural components, one of which was a cache of lanceolate biface points. Based on typological cross dating the lanceolate biface points were deemed diagnostic of early northern Great Basin or southern Columbia Plateau cultures dating sometime prior to 6000-5000 BP (Minor and Toepel 1984:10). Other cultural components of the site, represented by broad neck dart points and arrow points, were considered to be representative of later Archaic occupations closely associated with a northern Great Basin culture (Minor and Toepel 1984:10).

Minor and Toepel (1997) drew on these conclusions to advance an alternative hypothesis for the Upper Deschutes River Basin caching behavior. According to these authors the range and diversity of the three putatively distinct cultural components identified in the archaeology of Lava Island Rockshelter suggest the regional cache sites can be "easily interpreted as preforms for lanceolate projectile points, reflecting the persistence of a pre-Mazama hunting technology into post-Mazama times" (Minor and Toepel 1997:106). They propose a hunting strategy which explains the range, diversity, and location of the cached tools in the Deschutes River Valley. This is expressed by Minor in the following statement, "While central Oregon contains a number of obsidian sources a need would still exist for wide-ranging prehistoric hunters to cache preforms in strategic locations at some distance from these sources. Viewed from the perspective of game migration patterns the isolated locations of the lanceolate biface caches in the Cascade foothills are exactly where one would expect hunter's caches to be found" (Minor et. al. 1988:85-86).

The Paulina Lake Site

Connolly's archaeological research within the Newberry Volcano caldera produced an alternative hypothesis for the age, cultural origin, and function of the cache sites. The Paulina Lake site within Newberry caldera illustrates a long occupational history in the region. The site offers a chronological organization to cultural behaviors related to sequentially dated occupations within the caching region. The combination of these archaeological studies provides a structure to address the age, origin, and ultimately the function of the caching behavior in central Oregon. This discussion will summarize the archaeology from Connolly's excavation of the Paulina Lake site. This is followed by his alternative hypothesis for the lanceolate biface cache sites in the Upper Deschutes River Basin.

Newberry Volcano's Paulina Lake site will be used in this research to identify temporal and spatial patterns associated with the Upper Deschutes River Basin cache sites. The identified patterns will then be used to categorize the caches into two distinct caches, the lanceolate and ovate type caches. These two cache types will be compared and contrasted with the Paulina lake site lithics and obsidian characterization studies to aid in interpreting cache chronology, cultural origin, and function on a local level. The Paulina Lake site will also be used to evaluate compliance with both trade/exchange and functional (hunting) hypotheses by looking at the cache sites as an archaeological "trace" (Binford 1980) of a forager or collector type subsistence strategy.

The Paulina Lake site was chosen as a comparative site for a number of reasons. The location of the site is central to the majority of cache sites in this research thus is ideally suited to explore local paleoenvironmental influences as well as the cultural histories of the region. The cultural history is of particular importance as the cache sites are located at the interface of the northern Great Basin and southern Columbia Plateau culture regions. Figure 22 illustrates the location of Newberry Volcano in relation to the northern Great Basin and the southern Columbia Plateau cultural areas.

The Paulina Lake site is a well documented stratified site with associated radiocarbon dating. Archaeological investigations have clearly identified pre and post-Mazama components within the ca 10,500 year cultural history of the site. The environmental and cultural histories associated with each component are used in this research to identify temporal and spatial relationships between these local histories and the caching behavior.

This research will rely heavily on the extensive obsidian characterization studies from the Paulina Lake site. The results of these studies will be used as a temporal window for dating the cache sites. Comparison between the Paulina Lake site and the individual cache sites identifies similarities and differences in the frequency of occurrence for specific obsidians sources, obsidian preferences, and distance to source relationships in the cache sites suggesting temporal and/or cultural inferences for the caching behavior.

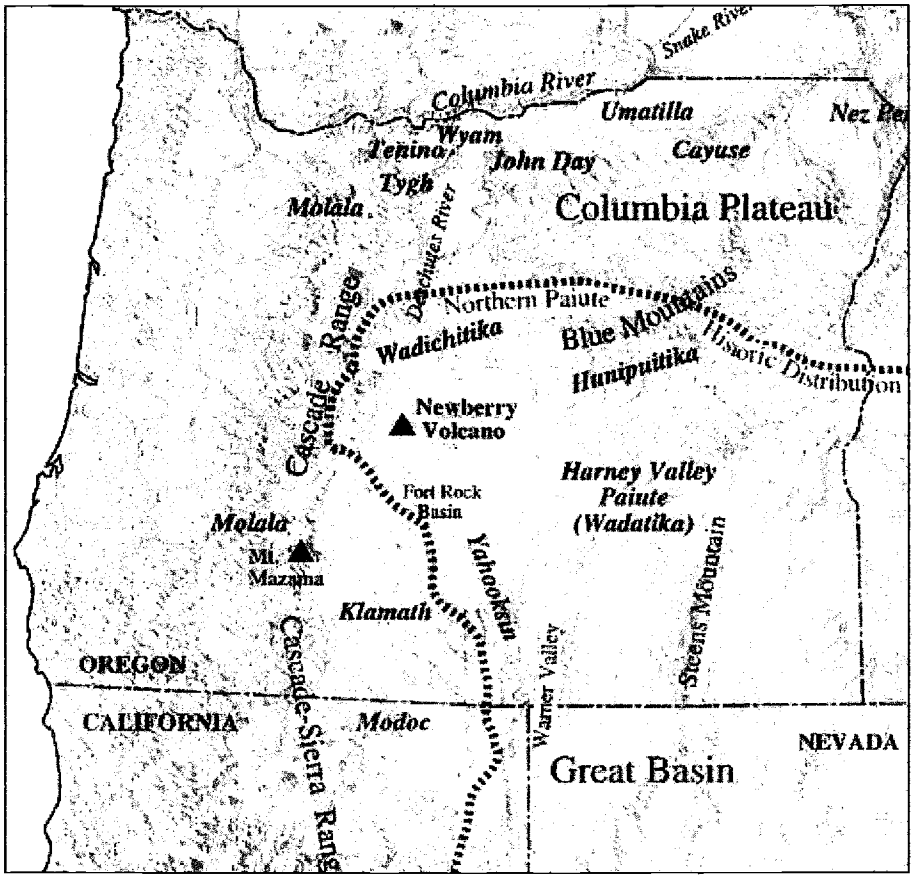


Figure 22. Map illustrating the location of Newberry Volcano and historic distribution of regional cultural areas (modified from Connolly 1999).

The Paulina Lake Site's horizontal boundaries are thought to cover approximately 15 acres of which approximately half are reasonably intact (Connolly 1999:93). The site is transected by Paulina Creek which flows west draining to the Deschutes River. Archaeological test investigations at the site began in the 1960s. The area was again tested in 1988, 1990, and 1991 with excavations beginning in 1992 to mitigate impact from road construction (Connolly 1999:89-96). From excavations in 1992 and 1993, natural and cultural stratigraphic sequences have been developed dividing the site's prehistory into five discrete components. Component 1 dates prior to ca. 10,500 years ago and component 2 ranges from ca. 10,500 to ca. 8500 years ago. Because component 1 contained minimal data, components 1 and 2 were combined to represent the Early pre-Mazama period, +/- 11,000 years ago to ca. 8500 years ago. The Late pre-Mazama period, ca. 8500-7500 years ago, is represented by component 3 which terminates with the eruption of Mount Mazama. Component 4 post dates 4000 years ago ending with the eruption of Big Obsidian Flow at approximately 1300 years ago. Component 5 is the uppermost portion of post-Mazama sediments to the modern ground surface. Components 4 and 5 are considered post-Mazama periods (Connolly 1999:126). During the two years of archaeological recovery no convincing evidence was found for human occupation in the caldera after the eruption of Mount Mazama in ca. 7600 years ago (6800 BP) until 4000 years ago when occupation resumed (Connolly 1999:124).

Pre-Mazama Occupation of the Paulina Lake Site

Component 1: 11,000 to 8500 Years Ago

Between 11,000 and 8500 years ago (component 1) the caldera's environmental setting was a mixed Ponderosa and Lodgepole pine forest with an understory of shrubs, herbs and grasses. Pollen and macrobotanical analysis reveal a mosaic pine forest and meadow-steppe or subalpine meadow floral community. Floral studies indicate a variety of roots, fruits, and seeds were consumed. Faunal remains were poorly preserved but blood residue studies suggest the possibility of bear, bison, deer, elk, and rabbit being butchered at the site (Connolly 1999:235).

Component 2: 10,500 to 8500 Years Ago

Dating between 10,500 and 8500 years ago (component 2) the site was used as a residential base camp for a variety of hunting and gathering pursuits. It was during this period that the most intensive pre-Mazama use of the caldera occurred (Connolly 1999:221). The archaeology indicates at least one domestic structure and possibly several more were built (Connolly 1999:221). Additional features associated with the features were also found, these include; a hearth, support posts, and an identifiable floor structure. An additional hearth area, not clearly associated with these structural assemblages, was also recovered from component 2. A Wickiup-like domestic structure dates to 9500 years ago while the unassociated hearth is assigned an 8700 years ago dating. Floral evidence associated with this period identifies Lodgepole pine as the dominant species with Ponderosa pine also in abundance. A minimum of 11 floral taxa were identified indicating an environment botanically rich and reflective of slightly moister conditions than any time subsequent to the Mazama pumice-fall. Evidence of fruits, nutlets, and seeds found in association with the domestic fire hearth, suggest a mid to late summer occupation. Given the elevation of the caldera, winter snow conditions would prohibit occupation until snow levels receded permitting access into the caldera, thus occupation would be restricted to the warmer seasons (Connolly 1999:225).

Lithic artifact assemblage of Components 1 and 2

Overall, the Paulina Lake site's lithic assemblage is predominately comprised of bifaces and represents over 55 percent of all classified tools in all of the assemblages. The pre and post-Mazama biface proportions are however very distinct. Pre-Mazama biface assemblages are about one third (35 percent) quarry-related artifacts with the remaining two thirds (65 percent) indicative of a hunting, processing, and manufacturing focus. The post-Mazama proportions change in that half of the assemblage is dominated by quarry related tools such as cores, quarry bifaces, blanks, preforms and miscellaneous biface fragments. The other half of the assemblage is consistent with subsistence and maintenance activities (Connolly1999:127). Obsidian source studies indicate significant amounts of exotic obsidians were being carried into the caldera during the pre-Mazama occupation. Local sources of obsidian were quarried but as a secondary focus to general subsistence activities of hunting and gathering.

The presence of domestic structures with central fire hearths suggests residential stability. The extensive floral and faunal inventory implies residents not only exploited but also processed floral and faunal resources at the site. The predominance of non-quarrying lithic artifacts such as projectile points, scrapers, abraders, and mauls supports this notion as does the import of exotic materials. Altogether, the archaeology suggests during this period the Paulina Lake site functioned as a residential base camp for small groups. (Connolly 1999:221).

Component 3: 8500 to 7000 Years Ago

Component 3 dates from 8500 to 7000 years ago and differs from the previous components in that domestic structures and hearths are absent. Lithic artifact concentrations decrease yet the overall composition of the assemblage are still dominated by hunting related tools. This shift seems to suggest a continuation of camping and hunting as the primary focus for visiting the caldera but to a lesser degree. Overall the changes indicate a land use strategy of increasing mobility and a decrease residential permanence possibly related to the increased aridity in the thousand years prior to the eruption of Mount Mazama (Connolly 1999:221).

Lithic artifact characteristics of the Pre-Mazama Components

The pre-Mazama components of the Paulina Lake site contained no notched projectile point specimens. The entire collection of recovered artifacts was stemmed forms "consistent with the Western Stemmed Tradition, or foliates" (Connolly 1999:231). Connolly identifies a graded pattern of occurrence for these two types. The author states "stemmed-and-shouldered points predominate in the earlier components, and the number of foliates expands in component 3" (Connolly 1999:231). The following set of illustrations is presented to show this pattern in the pre-Mazama occupations of Paulina Lake. Figures 23-27 are illustrations of the five identified point types from components 1 and 2. Figure 28 shows the chronological relationships of base element characteristics for these types. Figures 29-31 are illustrations of the three predominant point types from component 3.

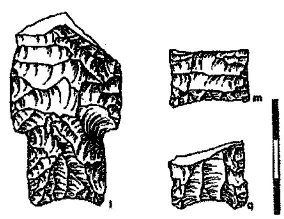


Figure 23. Illustration of projectile points (Stemmed Variety 1) from pre-Mazama components 1 and 2 at the Paulina Lake site (after Connolly 1999:113)

Figure 24. Illustration of projectile points (Stemmed Variety 2) from pre-Mazama components 1 and 2 at the Paulina Lake site (after Connolly 1999:113)

Figure 25. Illustration of projectile points (Foliate Variety B) from pre-Mazama components 1 and 2 at the Paulina Lake site (after Connolly 1999:112)

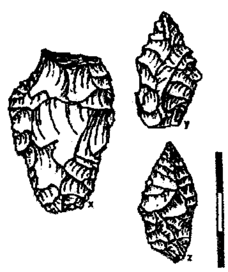


Figure 26. Illustration of projectile points (Stemmed Variety 3) from pre-Mazama components 1 and 2 at the Paulina Lake site (after Connolly 1999:112)

Figure 27. Illustration of projectile points (Foliate Variety A) from pre-Mazama components 1 and 2 at the Paulina Lake site (after Connolly 1999:112)

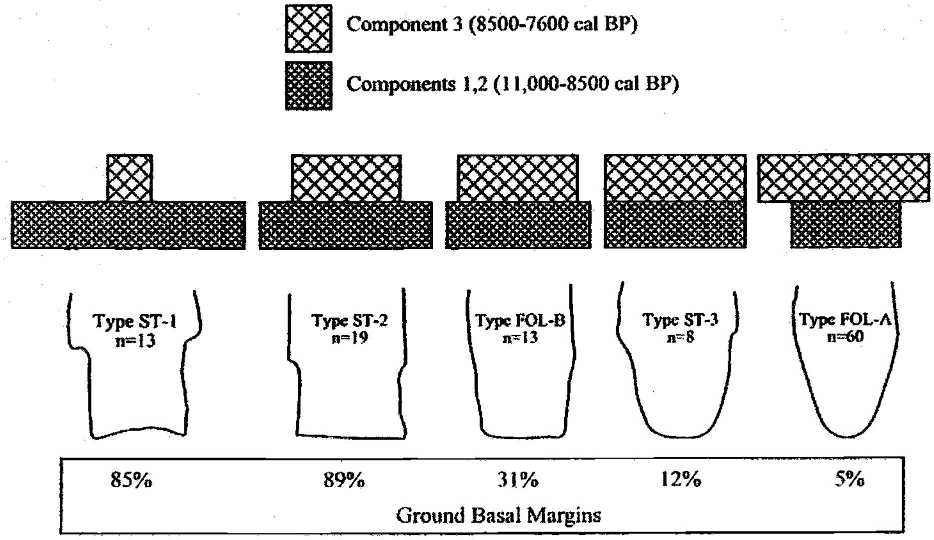


Figure 28. Illustration showing the chronological relationships of base element characteristics for pre-Mazama points at the Paulina Lake site (after Connolly 1999:231)

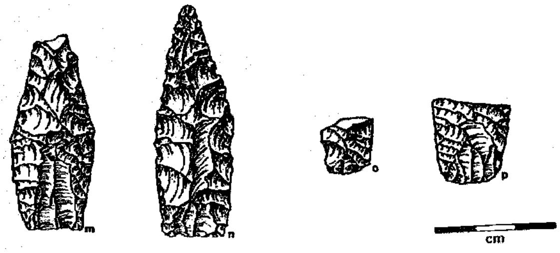


Figure 29. Illustration of projectile points (Foliate Variety B) from pre-Mazama component 3 at the Paulina Lake site (after Connolly 1999:111)

Figure 30. Illustration of projectile points (Stemmed Variety 3) from pre-Mazama component 3 at the Paulina Lake site (after Connolly 1999:111)

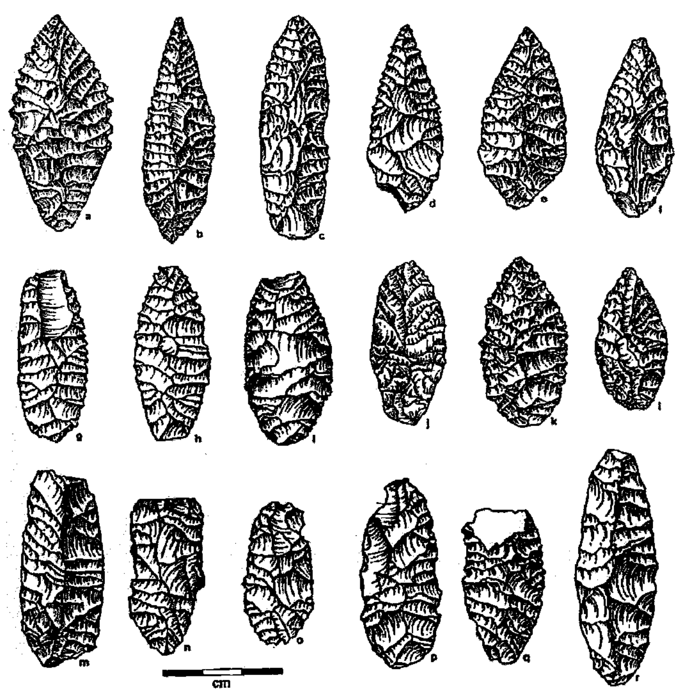


Figure 31. Illustration of projectile points (all Foliate Variety A) from pre-Mazama component 3 at the Paulina Lake site (after Connolly 1999:111)

Connolly has also identified a possible chronological marker for these points where the basal margins of the parallel-sided stemmed points exhibit edge grinding (>85%) while the contracting stemmed points rarely exhibit this characteristic (<12%) (Connolly 1999:231). Connolly suggests these basal characteristics may be reflective of two hafting techniques where the "parallel-sided stemmed points were set in a split haft and the contracting stem points were probably hafted with a socketing technique" (Connolly 1999:231). Connolly expands on these findings and offers an explanatory hypothesis for these patterns. The author suggests the absence of notched points in the pre-Mazama components of the Paulina Lake site and the predominant occurrence of these points in the region after the Mazama eruption implies a change in the "predator/prey relationships between Early and Middle Holocene times" (Connolly 1999:232). The author further states "I would argue that evidence of this trend is reflected in the changing frequencies of Early Holocene hafting systems in the millennium preceding the Mazama eruption" (Connolly 1999:232) which temporally correlates to Paulina Lake's pre-Mazama component 3 occupation.

Connolly expands on this concept and suggests "significantly, the early 'residential' component at the Paulina Lake site (35DS34-1, 2) is the most heterogeneous, while the late pre-Mazama component (35DS34-3) links most closely with the post-Mazama lithic reduction camps" (Connolly 1999:235) also located within Newberry caldera. The author suggests the noted change in "character of occupation and use of the caldera significantly changed between components 2 and 3, and in a way that appears to trend in the direction of greater logistical mobility" (Connolly 1999:235).

Post-Mazama Occupation of the Paulina Lake Site

The eruption of Mount Mazama about 7000 years ago (6800 BP) deposited more than 50 cm of pumice in the caldera. This event coupled with increasing aridity in the millennium prior to the eruption altered the available floral and faunal resources at the site. The caldera's landscape became an extensive field of pumiceous soils. A decrease in moisture retention as well as a lack of available nutrients in this new environment stressed floral communities and the animals dependent on their availability for food. The altered caldera ecosystem was not conducive to human occupation until about 4000 years ago and is confirmed by the archaeological findings (Connolly 1999:224).

Component 4: 4000 to 1300 Years Ago

Component 4 begins at about 4000 years ago as subsistence resources rejuvenate and became more available in the caldera. Both macrobotanical and pollen analysis indicate a significantly different biotic community when human occupation and exploitation resumed. (Connolly 1999:27). What was once a relatively diverse landscape, became a nearly monotaxal inventory of Lodgepole pine forests and low botanical diversity (Connolly 1999:224). Although available subsistence resources declined, a dramatic increase in use of the caldera's obsidian resources begins. The most intense quarrying activity peaks about 2000 to 1500 years ago, just prior the eruption of Big Obsidian Flow.

During component 4, lithic assemblage composition shifts to a predominance of quarry related artifacts such as; cores, quarry bifaces, blanks, preforms, and biface fragments. Figure 32 is an illustration of quarry related artifacts from component 4. These lithic reduction products now comprise approximately 50 percent of all post-Mazama artifacts at the site, an increase of 15 percent from pre-Mazama occupations.

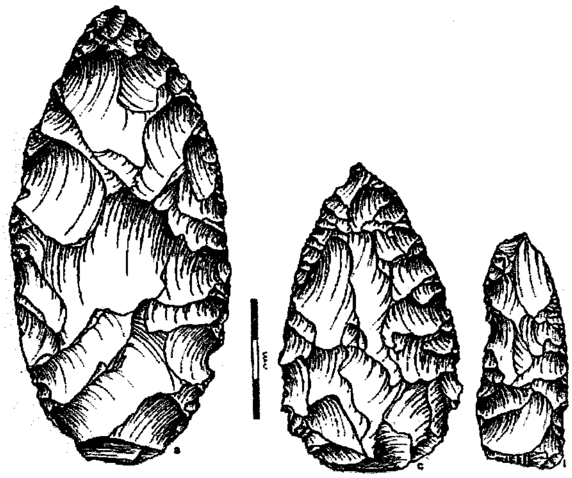


Figure 32. Illustration of quarry biface, bifacial blank, and preform from post-Mazama component 4 at the Paulina Lake site (after Connolly 1999:108)

Lithic sourcing studies also offer evidence of a change in resource strategies. The occurrence of exotic obsidian in all obsidian recovered from post-Mazama context (bifaces and flakes) is a meager 7 percent and is limited to a small number of finished or formed tools. Figure 33 is an illustration of component 4 projectile points. Conversely, obsidian derived from the caldera or near caldera sources accounts for a full 93 percent indicating obsidian moves almost exclusively out of the caldera during this time.

Domestic features are not associated with the site nor are structures, hearths or other indications of sustained occupation. Instead small, short term occupations or ephemeral camps, associated with quarrying activities, are revealed in the archaeology (Connolly 1999:238). The overall combination of a decrease in subsistence availability, a focus on local obsidian quarrying activities combined with a lack of exotic obsidian, and an absence of structures and associated cultural features signifies a dramatic change in site function during post-Mazama times. It now appears the Paulina Lake site and the caldera in general was occupied by small, short term, task oriented groups focused on the procurement of lithic resources from local obsidian flows for export out of the caldera (Connolly 1999:127).

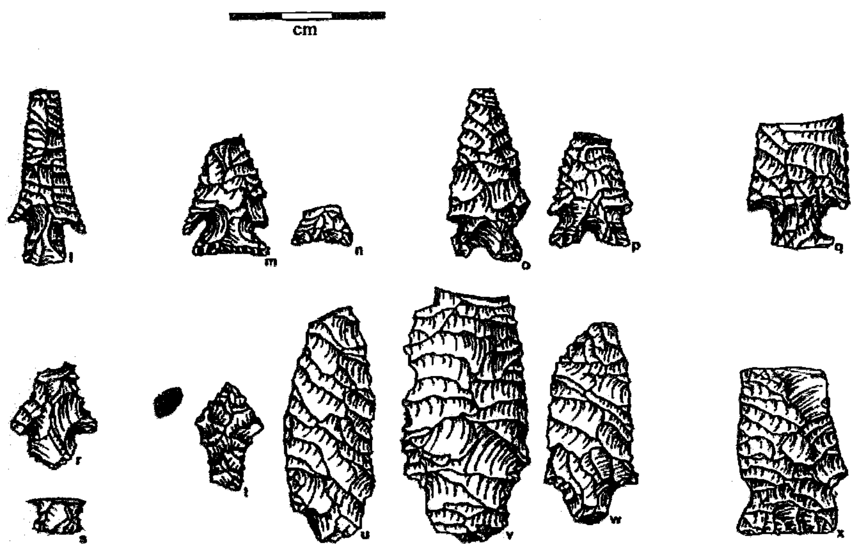


Figure 33. Illustration of projectile points from post-Mazama component 4 at the Paulina Lake site (after Connolly 1999:106)

Component 5: 1300 Years Ago to present

The Big Obsidian Flow eruption occurred approximately 1300 years ago and separates component 4 from component 5 archaeologically. Obsidian sourcing studies indicate Big Obsidian Flow and the late Pleistocene Buried Obsidian Flow are geochemically identical and therefore indistinguishable from each other. Given approximately 10,000 years separates these 2 flows, obsidian sourced to Big/Buried Obsidian Flows is only useful as a chronological marker when found in intact, datable, stratigraphic context (Connolly 1999:239). Obsidian from this geochemical type represents less than 5 percent of the combined total of the three Newberry area obsidians. When sourcing studies do identify Big/Buried Obsidian Flow in samples from the Paulina Lake site nearly 25 percent were from securely dated pre-Mazama contexts, therefore must have been derived from the late Pleistocene Buried Obsidian Flow and not the 1300 years ago Big Obsidian Flow (Connolly 1999:239).

Archaeological studies are able to document quarry activities associated with Big Obsidian Flow in late prehistoric times. **Figure** 34 is an illustration of a bifacial blank and a preform from component 5. The infrequent use of Big Obsidian Flow glass in late prehistoric times is thought to relate to a general decline in use of Newberry caldera quarries after the Big Obsidian Flow eruption. Within the caldera this decline is evident when artifact densities from components 4 and 5 are compared, as a drop in artifact concentrations is noticeable in component 5. **Figure** 35 is an illustration of projectile points from component 5. These artifacts suggest some subsistence activity by caldera visitors during component 5 albeit significantly less than earlier times.

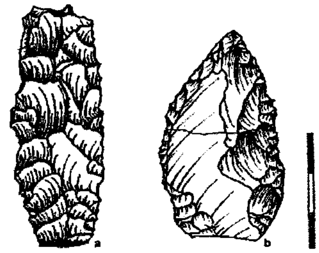


Figure 34. Illustration of a bifacial blank and preform from post-Mazama component 5 at the Paulina Lake site (after Connolly 1999:108)

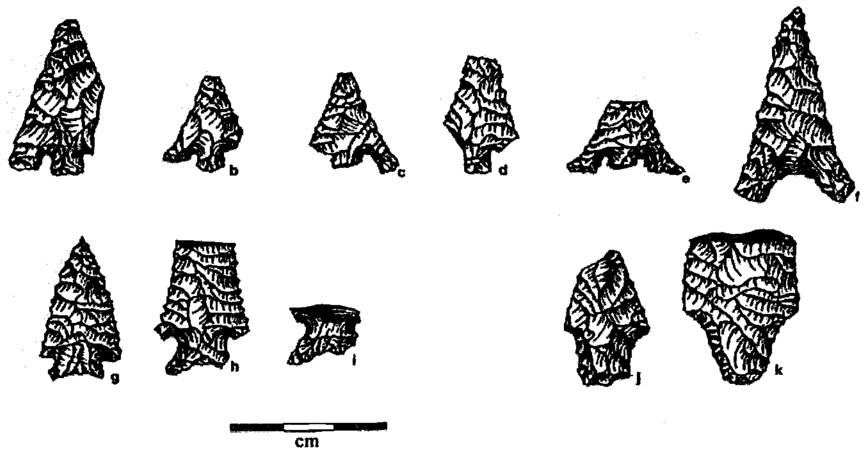


Figure 35. Illustration of projectile points from post-Mazama component 5 at the Paulina Lake site (after Connolly 1999:106)

The decline in use of Newberry caldera quarries after the Big Obsidian Flow eruption is evident elsewhere as the occurrence of Newberry obsidians in sites beyond the volcano also declines (Connolly 1999:240). Several reasons have been offered to explain the decline in the use of Newberry Volcano's obsidian during late prehistoric times and include; the environmental impact of the eruption itself, generalized increasing aridity of the region, poor quality of glass from Big Obsidian Flow, and altered trade routes (Connolly 1999:240). The post-Mazama use of the caldera by prehistoric people focused on the acquisition of lithic resources for export out of the caldera continues at the Paulina Lake site, albeit to a lesser degree (Connolly 1999:127).

Binford's Collector/Forager Model

Central to all three caching hypotheses is the dichotomy of a forager-collector subsistence-settlement strategy. Connolly utilizes this frame work as discussed by Binford (Binford 1980) to conceptualize the pre and post-Mazama components of the Newberry caldera sites (Connolly 1999:238). In addition he draws on the implications of this dichotomy for his hypothesis regarding the relationship between the Newberry Volcano sites and the Deschutes River Basin cache sites (Connolly 1999:239). The following discussion presents a summary of Binford's (1980) collector-forager model. The model will be used to evaluate past hypotheses and as a conceptual tool in understanding the subsistence-settlement strategies at the Paulina Lake site. Ultimately Binford's model will be used to compare and contrast spatial and temporal patterns associated with the caching behavior and as a framework to aid in the development of a new explanatory hypothesis for the cache sites.

Binford's article (1980) on hunter-gatherer settlement systems suggests different resource strategies solve different problems encountered by the populations employing the strategies. The two types of basic strategies, foraging and collecting, offer clues toward identifying the type of problems each strategy resolves. According to Binford "foragers move consumers to goods with frequent residential moves, while collectors move goods to consumers with generally fewer residential moves" (Binford 1980:16). Binford suggests identifiable and predictable spatial patterns can be recognized in the archaeological record for both types of resource strategies (Binford 1980:4).

Foragers establish a pattern of serial residential moves, with each move a band establishes a new residential base. The duration of residency varies and is dependant on availability of local resources. Once local resources no longer meet the needs of the group the group relocates establishing a new residential base. Each residential base serves as a center for processing, manufacturing, and maintenance of group related activities. Occupants utilize the "residential base" as a core activity center from which foraging parties originate to exploit nearby "locations" (Binford 1980:10). A particular residential base may or may not be reestablished in following years. The archaeological profile or "traces" (Binford 1980:4) from a band of foragers generated at residential base camp should be almost identical to other residential base camps. The archaeological profile should identify a broad range of subsistence and maintenance activities be it floral, faunal, or lithic remains (Binford 1980:5-10; Connolly 1999:238).

Collectors move resources to the people therefore establishing an entirely different spatial patterning in the archaeological record. Intrinsic to the collector model is the assumption that the residential group is larger than what local resources can support. Thus a collector resource strategy provides a means for minimizing logistical and/or temporal inadequacies in resource availability. Logistical strategies address problems such as a residential group located in an area where one critical resource is readily available while another critical resource is some distance away. Temporal strategies address issues such as seasonal availability of critical resources. The collector settlement strategy requires establishing specialized task groups to procure necessary group resources. Binford identifies three additional site types for the collector settlement strategy in addition to the "residential base" and "location" noted for the forager subsistence strategy. The additional collector site types are; the "field camp, the station, and the cache" (Binford 1980:10). A "field camp" is defined as a place where the task group temporally resides when away from the primary base camp (Binford 1980:10). "Station" sites are places where special-purpose task groups gather for exchange of information, observation of game movement, or other human activity (Binford 1980:12). "Caches" are defined by Binford as a "common components of a logistical strategy in that successful procurement of resources by relatively small groups for relatively large groups generally means large bulk. This bulk must be transported to consumers, although it may on occasion serve as the stimulus for repositioning the consumers. In either case there is commonly a temporary storage phase. Such 'field' storage is frequently done in regular facilities, but special facilities may be constructed to deal specifically with the bulk obtained" (Binford 1980:12). Ultimately, cache sites should be found within the context of a collector subsistence strategy exhibiting a high intersite variability among the different types of collector sites (Binford 1980:12).

The archaeological profile for a cache would look fundamentally different than a residential base profile. A residential base would exhibit high intrasite variability due to the broad range of subsistence and maintenance activities at the site. A cache site should therefore have low intrasite variability as the site is generally reflective of a specific task and/or resource. Additionally, according to Binford "Special-purpose (cache) sites should show a redundancy of the geographic placement of the sites and a greater buildup of archaeological debris in restricted sections of the habitat as a function of increasing logistical dependence" (Binford 1980:19).

Binford's article also identifies potential "determinants" (Binford 1980:13) favoring a foraging and collector resource strategy. The determinants essentially center on environmental conditions which are viewed as the primary subsistence strategy consideration for maximum stability in any system (Binford 1980:14-15). The effect of an increase in environmental stressors or climatic severity on the system increases the number of critical resources within a particular system (Binford 1980:18). It is important to recognize these patterns may be identifiable for both the forager and collector organizational strategies yet the two strategies are not considered opposing principals. Instead these strategies should be considered "organizational alternatives which may be employed in varying mixes in different settings. These organizational mixes provide the basis for extensive variability which may yield very confusing archaeological patterns" (Binford 1980:19).

Connolly's hypothesis for the "unusual numbers of biface caches identified in central Oregon" (Connolly 1999:239) suggests the caching behavior functioned within a southern Columbia Plateau exchange system between 4000 and 1300 years ago. This hypothesis assumes the validity of an Archaic dating for the caches (Connolly 1999:239). The combination of this chronology and the identified intense quarry activity between 4000 and 1300 years ago within the caldera supports a collector type subsistence strategy where resources (quarried bifaces) would be exported out of the caldera and stored. This adheres to Binford's collector strategy requisite characteristics where mobility, intersite variability, and storage are necessary components. Within this context the cache sites are explicable. However this research will suggest both the chronology and the notion of Upper Deschutes River Basin caches as a site type within collector resource strategy are uncertain and do not fully account for other temporal and spatial patterns associated with the caches.

DESCRIPTIVE ARCHAEOLOGY

Lanceolate Type Caches

Seven cache assemblages of lanceolate-shaped biface tools have been recovered in and around the Upper Deschutes River Basin and Newberry Volcano. The collections have been brought to the attention of archaeologists through investigation of looting activity, archaeological surveys, or from private artifact collections. All seven caches were included in a paper titled: *Lithic Caches of Central Oregon-A Descriptive Comparison* presented by Mark Swift (1990) at the 43rd Annual Northwest Anthropological Conference. Three of the sites have been the subject of further investigation by professional archaeologists after looting activity was halted. These sites are; Lava Island Rockshelter, the Pahoehoe cache, and the China Hat cache. Each of these three sites has been reported in professional journals or papers (see Connolly 1999, Davis and Scott 1984, Davis and Scott 1991, Minor and Toepel 1984, Minor and Toepel 1997, and Scott et al. 1986). Three other cache assemblages; Benham Falls East cache, Lava Cast cache (Stuemke 1988), and the Paulina (Fire) cache (Anderson 1989) are recorded as caches in the Deschutes County Cultural Resource Site Report Files. The Paulina Creek cache, also known as the Dietz cache or Dietz collection, is included in the following descriptive discussion and will be referenced as the Paulina Creek collection. This collection is a privately owned assortment of lanceolate type bifaces with a dubious history. Whether or not the collection is truly representative of a single cache remains unproven. It is however included in the descriptive discussion because of its history. The collection has been presented as a "cache" in both professional and public venues. For example, the collection was a featured article on central Oregon caches in "*Indian Artifact Magazine*" (Swift 1990), probably due to the massive number of artifacts in the collection. This is concerning as it may be misleading in terms of professional research and encourage illegal collecting activity. Only a descriptive discussion is presented in this research for both the Paulina Creek collection and the Paulina (Fire) cache. These "caches" (Swift 1990) and their associated characteristics are not included in the data sets or considered further in this research due to insufficient documentation, questionable history, and/or have not been referenced in written professional literature. Figure 36 is a locational map of all sites identified as lanceolate type caches presented in the descriptive review.

The amount of data gleaned from each of the seven sites varies. Information is dependent on the nature and amount of professional analysis conducted for each site as well as data availability. Data available prior to this research is presented for each cache location. This is essentially a descriptive review of the individual cache sites and associated artifacts. Each site is summarized in terms of site history, environmental and cultural settings, as well as quantity and quality of artifacts recovered. A scanned image or drawing of artifacts from the cache is presented when available. This is followed by a summation of obsidian characterization results (XRF studies) attained prior to and/or obtained specifically for this research. It should be noted the nomenclature utilized in XRF results is reflective of specific obsidian sourcing studies. Newberry Volcano/McKay Butte is an older classification from dated obsidian characterization studies and indicates a nondiscrimination between Newberry Volcano Group and the McKay Butte obsidian resource. Complete results from all newly obtained XRF studies are cited in appendix B, pages 251-257. References for XRF studies attained prior to this research are cited in appendix B, pages 258-308. A map illustrating the cache site location and its related spatial patterns of obsidian resources follows each discussion. Figure 36 is a map illustrating the location of each lanceolate type cache site and its geographic relationship to other lanceolate type caches in this chapter.

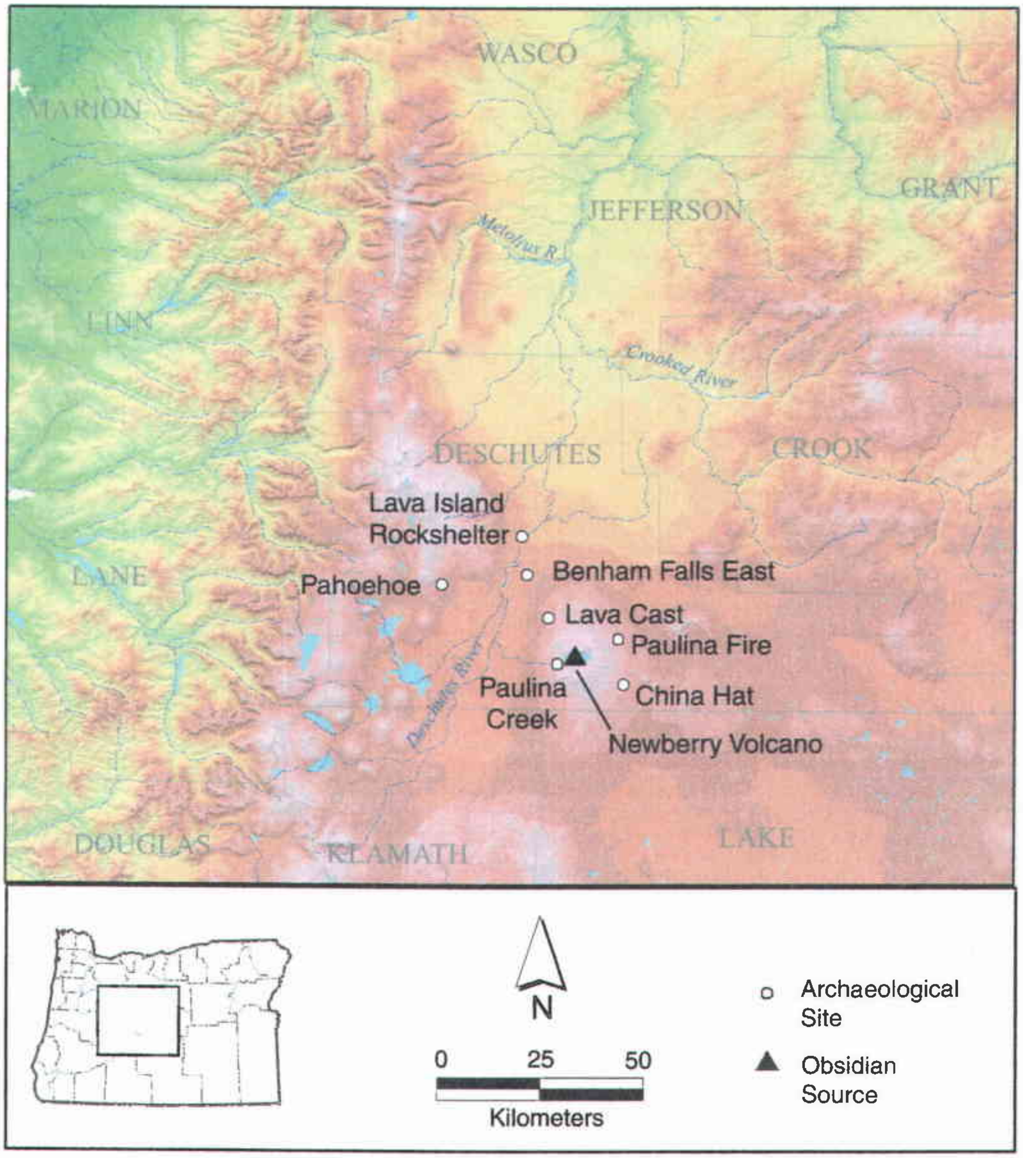


Figure 36. Map illustrating the geographic location of caches with lanceolate shaped artifacts.

The Benham Falls East Cache

The Benham Falls East site data is compiled from a series of less than conventional sources because no site report or formal literature exists. Available information is from a personal communication with Carl Davis (Davis 1994) a Deschutes National Forest archaeologist, five pages of hand drawn outlines of the bifaces, a five page supplemental report filed by Deschutes National Forest detailing the looting activity at the site, an office memo, two incident report citations for looting activity, and a USGS map indicating site location. Despite the paucity of documentation some generalities can be gleaned from the information and added to the data base of cache sites.

The Benham Falls East site is located on the east side of the Deschutes River approximately 5 km from the Lava Island Rockshelter site (figure 36). According to Carl Davis, U.S. Forest Service archaeologist, approximately 73 large lanceolate shaped bifaces were recovered from an illegal excavation of the site. The collection was seized in a sting operation involving local, state, and federal agencies. A supplemental government report quotes the looter's field notes saying one of the lithics was found "10 ft from the cache" (Jensen 1995:14). The general location of the site is known from the looters documents and maps. The exact location of the cache was identified by photographs recovered during the sting operation and a comparison of the sites natural features connecting the photographs with the specific site location. In the Deschutes National Forest's supplemental report a sketch map identifies the location of the excavated area in relation to some of the natural features of the site. The excavated area is located between two rock outcroppings north and south of the pit. A lithic scatter is noted in close proximity of the pit, toward the southeast. Further in the distance and to the east is a lava field. The USGS map also documents the site location adjacent to the Lava Butte lava field. The stratigraphic context of the cache remains questionable. Detailed notes of the artifact collector indicate the artifacts were found "in Mazama ash", yet the relative depth of the cache is unknown. The supplemental report's assessment of the excavated pit indicates the size to be 3 by 4 m long and dug to a depth of 50 cm. The USDA Incident Repot dated September 9, 1987, documents that backfill was screened by the looter and an estimate of 6 m^2 of earth was moved. The damage assessment report indicates the site was disturbed approximately 3-4 years prior to the recovery of the associated biface collection. Local floral species noted at the time of damage assessment were; needle grass, bitterbrush, and Ponderosa pine. Although five pages of hand drawn outlines of the bifaces indicates 20 of the lithics as obsidian characterization samples and the office memo requests lithic sourcing, no documentation was found indicating a completed obsidian characterization study. If the sizes of the biface outlines are to scale, as they appear to be, the approximate average dimensions of the bifaces are 6.6 cm long by 2 cm wide. Figure 37 is a scanned image of four of the Benham Falls East artifacts.

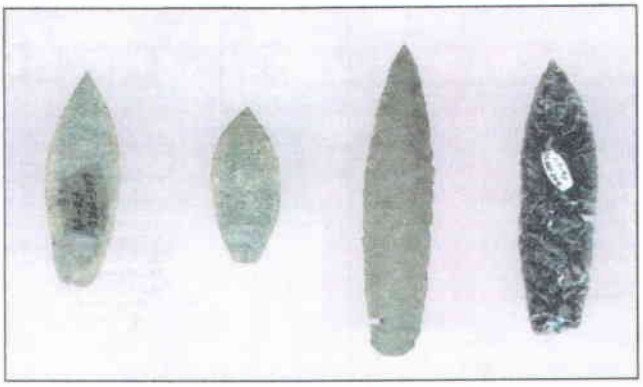


Figure 37. Scanned image of Benham Falls East artifacts.

All of the lithics are obsidian. According to Carl Davis, the technological and morphological attributes of the lithics are consistent with other known cache sites in the area and he believes this site to be typical of other lanceolate biface cache sites in the region (Davis 1994). Obsidian characterization analysis obtained for this research identifies the procurement of stone-tool from Newberry Volcano (83 percent) and Cougar Mountain (17 percent) (Skinner 2004). Figure 38 is a map of identified stone-tool resources for the Benham Falls East cache.

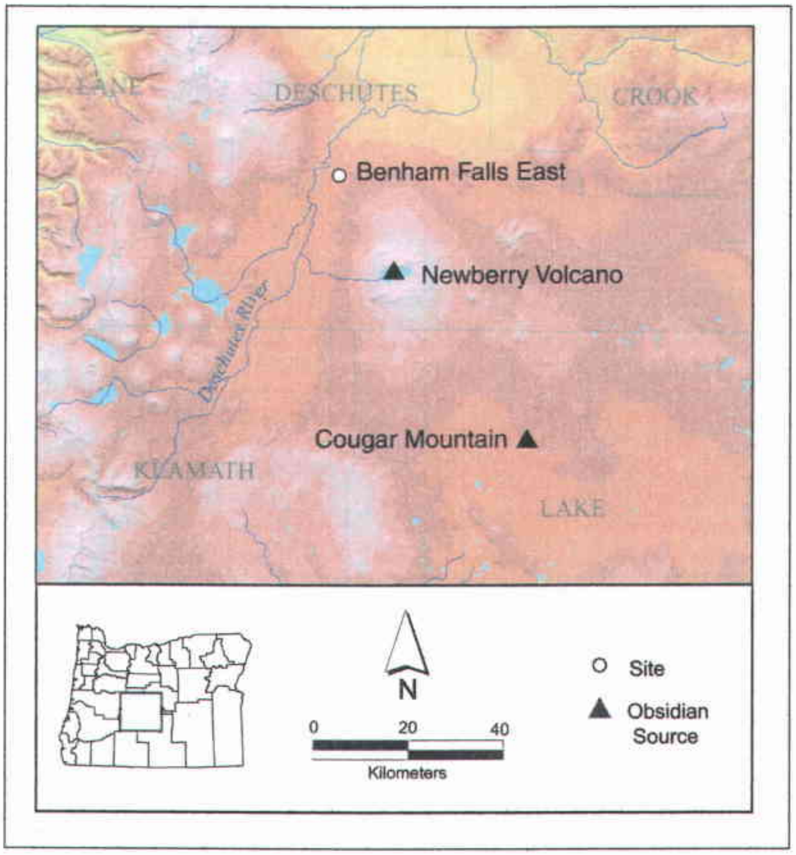


Figure 38. Map of identified stone-tool resources for the Benham Falls East cache.

The Lava Island Rockshelter Cache

The Lava Island Rockshelter is located approximately 8 km southwest of Bend, Oregon, in the Upper Deschutes River Valley. The site is positioned on the west bank of the Deschutes River near the top of an east-facing ridge approximately 15 m above the river (figure 36). This section of river is in close proximity to a series of falls and Lava Island. This island formed during the 6169 BP eruption of Lava Butte, 8 km to the south, when lava flowed into the Deschutes River. Lava Island Rockshelter was formed by the erosion of a cinder pocket in a Plio-Pleistocene basalt flow dating between one and four million years ago (Minor 1984:3).The site lies within the Ponderosa pine vegetation zone (Minor 1984:3) at an elevation of approximatly1200 m (3900 ft) ASL (Minor and Toepel 1984:3). Overall the area is a transitional environment between Ponderosa pine, Juniper occidentalis and a Shrub-steep vegetation (Minor and Toepel 1984:5).

The rockshelter was professionally excavated in 1981. The site identified three distinct cultural components. The earliest component is represented by a cache of 33 lanceolate bifaces (Minor and Toepel 1984:6). The site had been disturbed by relic collectors who uncovered a cache of 28 lanceolate-shaped points. This discovery was reported to the Deschutes National Forest Service and initiated the 1981 archaeological investigation.

Lava Island Rockshelter is semi-oval in plan. The mouth of the rockshelter is 8.1 m across and approximately 3.6 m deep. Deposits had filled the interior resulting in maximum height in the rockshelter of 75 cm prior to excavation. Cultural deposits within the rockshelter averaged 30-40 cm in depth extending to 120 cm toward the mouth. The extent of the cultural deposits in front of the rockshelter was also investigated. The south side was generally unproductive while the north side contained deep deposits of cultural material (Minor and Toepel 1984:6). Particles of volcanic ash and pumice were mixed into shelter deposits and no clear natural stratigraphy was identified. Consequently the stratigraphic integrity of the shelter was deemed extremely poor (Minor and Toepel 1984:9). Professional excavation in the south half of the rockshelter produced five additional lanceolate projectile points along with other stone tools and debitage (Minor and Toepel 1984:5). Figure 39 is a drawing of the lanceolate-shaped artifacts from the Lava Island cache.

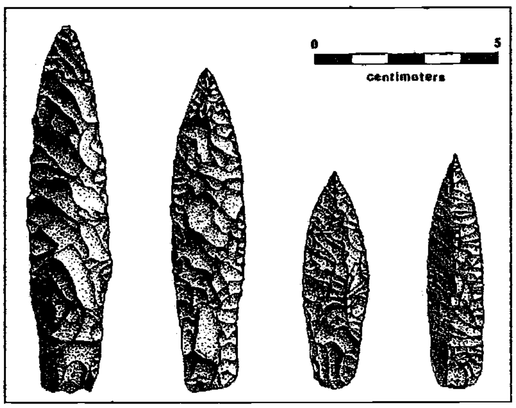


Figure 39. Drawing of lanceolate shaped artifacts from Lava Island Rockshelter (modified from Minor and Toepel 1984).

In totality, the cache lithic assemblage consists of 38 artifacts, all collected from a small area along or near the south wall of the rockshelter. The cache also contained a knife, a biface fragment, and eight scrapers, all obsidian, with the exception of one chert scraper (Minor and Toepel 1984:18).

All 28 lanceolate-shaped points from the Lava Island Rockshelter cache are obsidian and homogenous in nature. Length, width, and thickness vary proportionally to the individual points. These artifacts are characterized as lanceolate bifaces with symmetrically convex sides and blunt square bases. The widest portion is roughly midway between the tip and base. According to Minor and Toepel size variability seems to be related to the initial flake size on which the points were made. The collection appears to represent several different stages of completion (Minor and Toepel 1984:18). In some instances modification of the bases for hafting is evident as the proximal-lateral edges show evidence of retouch and/or grinding, suggesting they were probably mounted in socketed hafts (Minor and Toepel 1984:21). Eight of the scrapers recovered from Lava Island Rockshelter were from the cache, while eight others were recovered elsewhere during excavation. The average metric measurements of the scrapers are: length 5.1 cm, width 3.9 cm, thickness 6.4 cm, weight 12.2 g, and edge angle of 62 degrees (Minor and Toepel 1984:25).The cache scrapers are considerably larger than the excavated specimens. Radiocarbon analysis was inconclusive in determining a precise age for the cache. Based on typology, Minor and Toepel assign a pre 7000-8000 BP dating to the cache (Minor and Toepel 1984:12, 17).

In the north half of the shelter, stemmed and notched projectile points and a bark lined storage pit were identified in the archaeology. The pit measures 1 m in diameter with a tabular basalt slab base 60 cm below the surface. Layers of Ponderosa pine bark lined the pit. No evidence of former contents of the storage pit was found (Minor and Toepel 1984:12). The bark lining has been assigned a radiocarbon date of AD 1810 and is consistent with the occurrence of small stemmed and notched projectile points concentrated in this area (Minor and Toepel 1984:29).

All three projectile point styles; lanceolate, stemmed, and corner-notched found at the rockshelter were recovered in the uppermost 40 cm of cultural deposits indicating a total lack of stratigraphic integrity. Horizontal distribution pattering shows the lanceolate projectile points confined to the southern section while the later stemmed and corner-notched projectile points were in the northern section. The construction to the bark lined storage pit probably displaced much of the original horizontal distribution of cultural material; consequently activity areas can not be defined (Minor and Toepel 1984:29). Use of the site is thought to have been primarily a hunting camp due to the narrow range of tool types. Finishing or sharpening projectile points is evident from the mass amounts of debitage (8,000 pieces) found in the cultural deposits. Faunal remains recovered include a variety of large and small game, primarily deer and support this site function. Evidence of selective butchering is suggested by the lack of complete skeletal remains. Macrobotanical remains suggest evidence of plant gathering, especially pine nuts. According to Minor and Toepel this was probably a secondary activity as little species diversity is represented. The absence of plant processing tools adds support to this notion. Nothing in the archaeology suggests a reliance on fishing however a single fish bone and a small piece of fresh water mollusk shell were recovered. The small size of the shelter and the lithic technology suggests small size hunting groups occupied the site repeatedly throughout prehistory (Minor 1984:31). Obsidian characterization analysis for the lanceolate biface cache has identified procurement of stone-tool from Newberry Volcano/McKay Butte obsidians (100 percent) (Scott et al.1986). This XRF analysis could not geochemically discriminate between these two resources. Figure 40 identifies the stone-tool resources for the Lava Island Rockshelter cache.

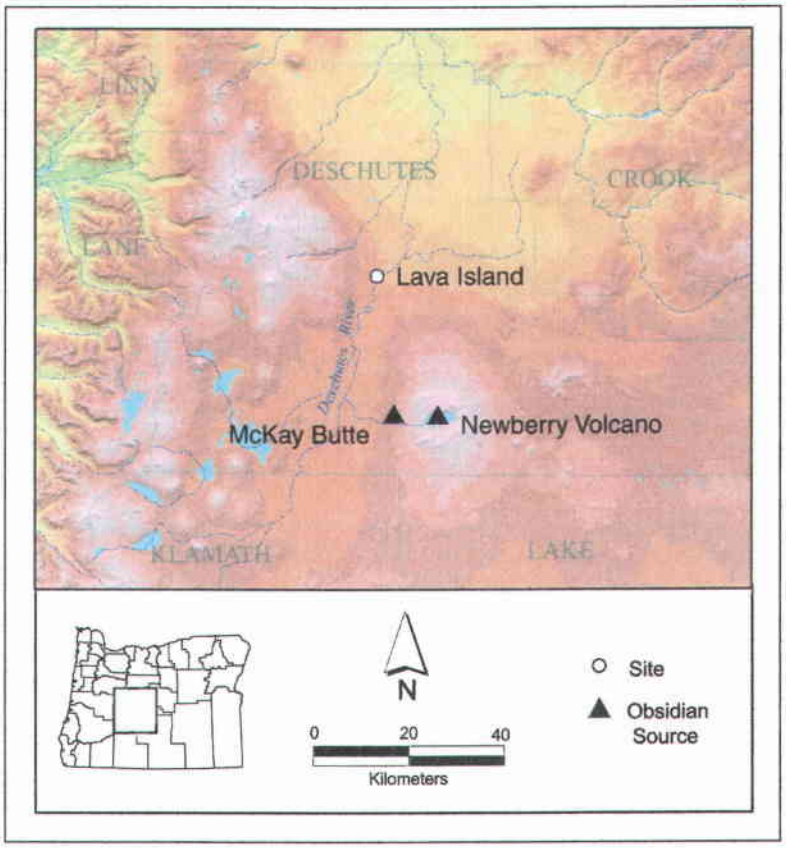


Figure 40. Map of identified stone-tool resources for the Lava Island Rockshelter cache.

The Pahoehoe Cache

The Pahoehoe lithic cache was discovered in 1984. The site is located on the eastern flanks of the Cascade Mountains at an elevation of 1450 m (4720 ft) ASL and lies adjacent to an extensive Pliocene age lava flow (figure 36). The present day floral community is consistent with a Ponderosa pine transitional zone. The surrounding area has been extensively logged but remnants of a Ponderosa pine community are present. The cached obsidian bifaces were recovered from the west and southwest side-slope of a small, lava-capped knoll (Scott et al. 1986:7). This cache consists of 90 lanceolate-shaped bifaces discovered by a work crew when a caterpillar exposed some of the lithics. Apparently some of the crew collected the exposed artifacts then later returned to the site collecting a majority of the buried collection. In the process of collecting the lithics looters vandalized the site by digging a 10 by 5 m pit to the depth of 30 cm (Craycroff 1984). The artifacts were eventually recovered by Forest Service personnel who then conducted controlled excavations at the site, recovering an additional 20 similar bifaces in stratigraphic context (Scott et al. 1986:7). The relative position of these 20 artifacts was approximately 30 cm below ground surface in a mixed deposit of Mount Mazama tephra. There were no artifacts recovered at the interface of the Mazama deposits and underlying paleosol approximately 70 cm below ground surface. No associated artifacts or features were found within this cache deposit. A "lithic workshop" (Scott et al. 1986:7) was discovered approximately 2 m south of the cache with vast amounts of bifacial point manufacturing debitage in the same stratigraphic level as the cached bifaces (Scott et al. 1986:7). To date, only the commonality of stratigraphic levels connects the cache with the lithic workshop debitage. The Pahoehoe cache totals 98 whole bifaces and 12 biface fragments (Scott et al. 1986:8). As a group the size, shape, and thickness of individual lithics display a high degree of variability (Scott et al. 1986:8). In a sample of 112 bifaces the average measurements are; length of 6.5 cm, width of 2.1 cm, and thickness of 0.6 cm. The morphological characteristics of the artifacts are generally described as bifaces with symmetrically convex sides and square to slightly rounded bases with the greatest width midway between tip and base (Scott et al. 1986:8). Most exhibit transverse parallel pressure flaking (Scott et al. 1986:16). Figure 41 is a scanned image of the Pahoehoe artifacts.

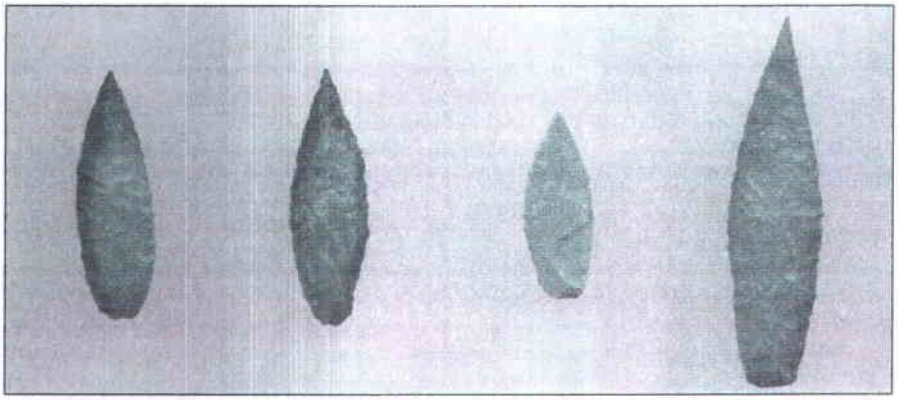


Figure 41. Scanned image of Pahoehoe cache artifacts.

The lithic reduction technology used to manufacture the artifacts was reconstructed by Scott, Davis, and Flenniken through replication experiments. The cache artifacts and the associated debitage from the nearby workshop were compared to the experimental data. Results of these experiments suggested the assemblage had varying degrees of finished products, although most had the appearance of being finished. The cache exhibited a "striking amount of morphological variability in what was otherwise a technological homogenous artifact assemblage" (Scott et al. 1986:13). An obsidian characterization study obtained prior to this research correlates this cache with McKay Butte obsidians (Scott et al. 1986:14). Additional XRF studies were obtained for this research and again identify McKay Butte (100 percent) obsidians (Skinner 2004). Figure 42 is a map of identified stone-tool procurement resources for the Pahoehoe cache.

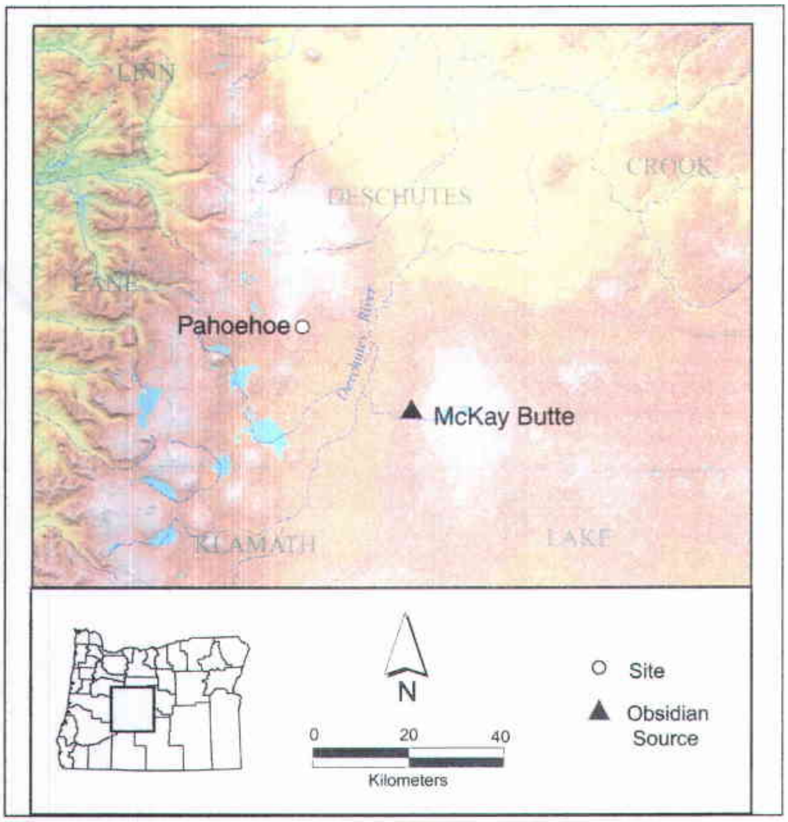


Figure 42. Map of identified stone-tool procurement resources for the Pahoehoe cache.

The China Hat Cache

The China Hat cache is located 50 km southeast of Bend, Oregon (figure 36). The site is positioned on the east flank of Newberry Volcano approximately 10 km from the caldera at an elevation of 1632 m (5440 ft). China Hat Butte is several miles east of this location. The landform is gently rolling pumice flat between two large, rough lava flows directly north and south of the site. Generally the soils are Newberry pumice and sand over a layer of reworked Mazama ash covering a pre-

Mazama paleosol. This remote location has no known nearby water source. Present day floral community is an isolated Ponderosa pine forest intermixed with Lodgepole pine and an understory of bitterbrush and fescue. The local area has a history of extensive logging with the most recent logging activity in 1984, just prior to the site's discovery. The initial discovery by artifact collectors damaged much of the site. During the illegal collection activities an area 30 by 30 m was disturbed and an additional 5 by 2 m pit was excavated by loggers using a large caterpillar. Over 200 lanceolate bifaces were recovered by Forest Service personal from these collection activities. Test excavations by Forest Service archaeologists in 1984 yielded another 20 similar bifaces. Thirteen of these were found in disturbed fill underneath a timber slash pile. Six more were recovered in the Forest Service test pits along the boundary of the vandalized area (Davis 1984). One lanceolate biface was found *in situ* in the wall of the looters pit. This biface was uncovered at a depth of approximately 25 cm in a reworked Mazama ash layer, in what appears to be its primary context (Davis 1984; Scott et al.1986:15). All of the other excavated bifaces are thought to be in a secondary context due to bioturbation, logging activities, and site vandalism. Although the stratigraphic context of the 200 looted bifaces is questionable, the artifact collector's information suggested they were found in Newberry ash and Mount Mazama pumice (Davis 1984; Scott et al. 1986:15). No flaking debitage, hearths, ash lenses or features of any kind were noted by either the collectors or Forest Service personnel (Davis 1984). In descriptive lithic analysis a total of 422 lanceolate-shaped artifacts from the China Hat site were measured and briefly described. Based on this data the average whole biface length is 6.3 cm, width 2.0 cm, thickness 0.7 cm, and average weight is 8.5g. Figure 43 is a scanned image of a sample of the China Hat artifacts.

The lithics were analyzed by Scott, Davis, and Flenniken in terms of their technological and morphological variation. This analysis concluded the China Hat cache is primarily composed of unfinished projectile point performs driven off of several biface cores. According to Davis, the lithics are believed to be in the initial stages of projectile point manufacture. Morphologically they appear more refined than the technological features suggest (Davis 1984).

Figure 43. Scanned image of China Hat artifacts.

Davis' (1984) assessment of the China Hat artifacts suggested all of the 220 bifaces were obsidian. Four colors, gray (77), black (175), and mahogany (49), and cream (1) were represented (Davis 1984). The original obsidian source studies indicated 50 percent of the obsidian was obtained from Newberry Volcano/ McKay Butte, 45 percent from Quartz Mountain, and 5 percent from an unknown source (Scott et al. 1986:14). When the obsidian characterization studies obtained for this research (Skinner 2004) were combined with the original obsidian study the analysis identified procurement of stone-tool from McKay Butte/Newberry Volcano obsidians (22 percent), Newberry Volcano (19 percent), McKay Butte (5 percent), BOF (2 percent), and Quartz Mountain (43 percent), Cougar Mountain (2.2 percent), Silver Lake/Sycan Marsh (2.2 percent), Unknown (2.2 percent), and Unknown Rhyolite (2.2 percent). Figure 44 is a map identifying the stone-tool resources for the China Hat cache.

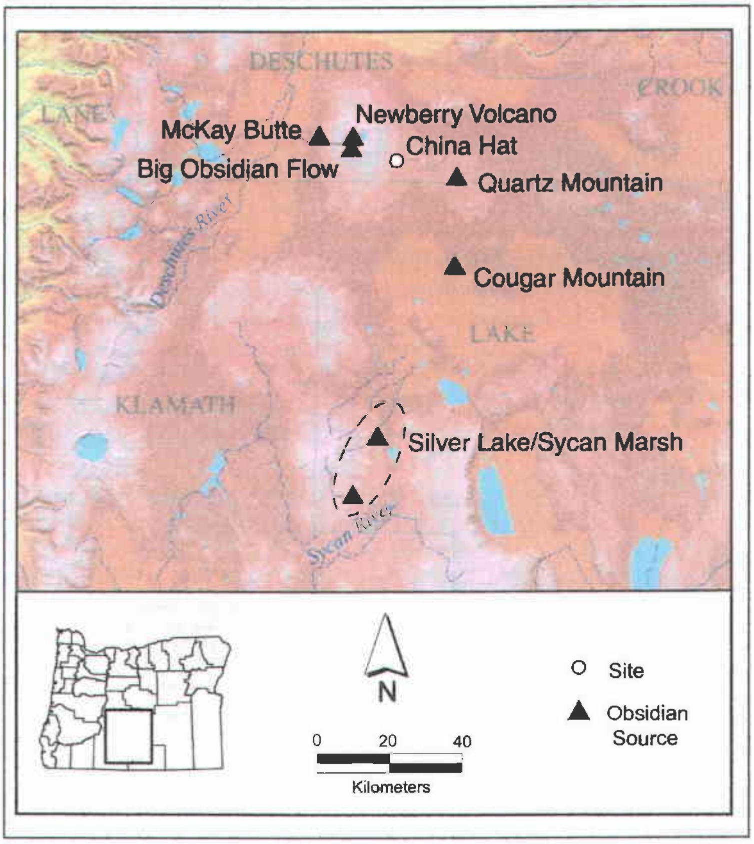


Figure 44. Map identifying the stone-tool procurement pattern for the China Hat cache.

The Lava Cast Cache

The Lava Cast cache was discovered during a Forest Service timber sale survey as a surface find (Swift 1990). This site is located on the northwestern flank of Newberry Volcano at an elevation of 1560 m (5200 ft) ASL (figure 36). The site is positioned on a small, flat area adjacent to the 6,300 year old Lava Cast Forest basalt flow. Local soils are comprised of loamy pumice sand and gravels over pumice sand. The local floral community is consistent with a Ponderosa pine forest.

The Little Deschutes River and Deschutes River are approximately 12.8 km (8 mi) west of the site. Site dimensions are 2 m by 2 m. The lithic assemblage is comprised of eleven bifaces, no other artifacts or debitage were noted. The average whole biface length is 5.9 cm, width 2.0 cm, and average thickness of 6.0 cm. Figure 45 is a scanned image of Lava Cast artifacts.

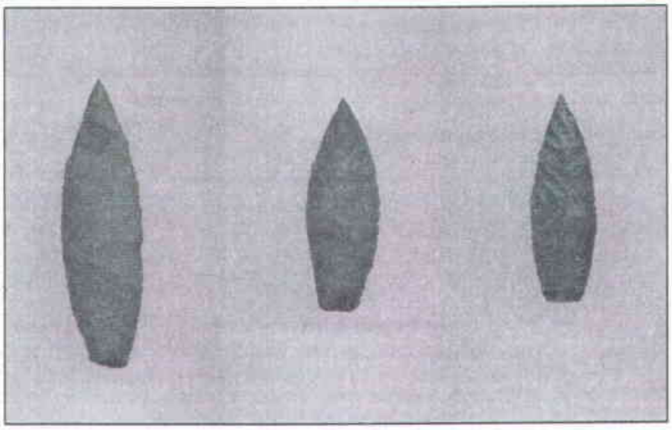


Figure 45. Scanned image of Lava Cast cache artifacts.

Seven of the bifaces were collected when the site was discovered; the remaining four bifaces were found during a monitoring visit and left *in situ*. To date the site has not been the subject of further testing and remains unexcavated (Stuemke 1988a).

The Lava Cast cache is comprised of eleven, small, lanceolate shaped bifaces formed by percussion and pressure flaking on large flake blanks. Most of the tools have been worked over the entire surface, however two are primarily unifacially flaked (Swift 1990). The bifaces and unifaces resemble those of other known local caches containing lanceolate-shaped artifacts (Stuemke 1988b). No obsidian characterization studies had been done on the collection (Swift 1990) prior to this research. Obsidian characterization analysis obtained for this study identifies the procurement of tool-stone from Newberry Volcano (72 percent), Quartz

Mountain (14 percent), and Obsidian Cliffs (14 percent) (Skinner 2004). Figure 46 is a map of identified stone-tool resources for the Lava Cast cache.

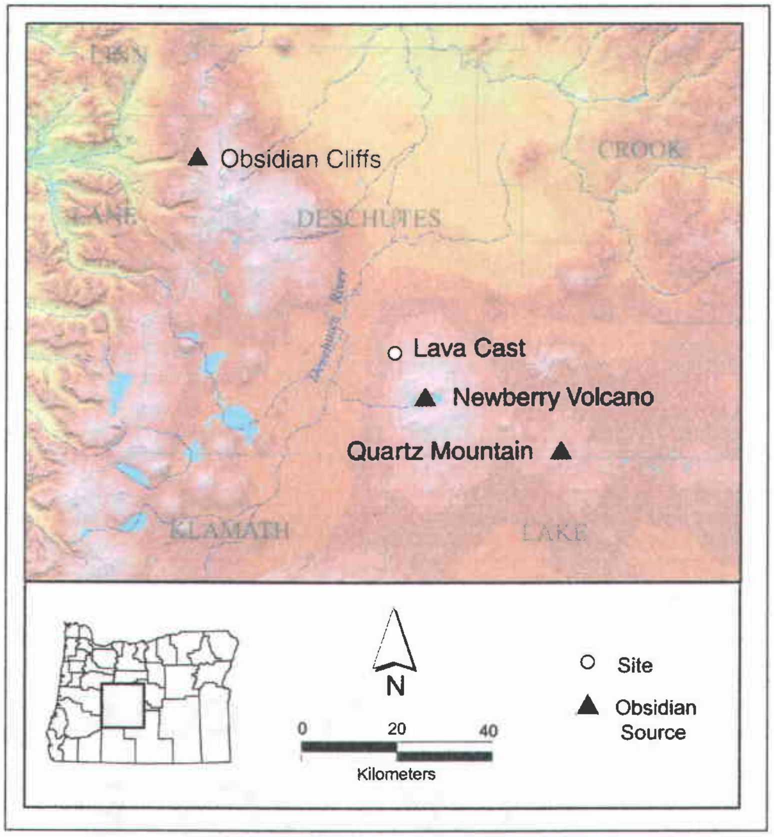


Figure 46. Map of identified stone-tool resources for the Lava Cast cache.

The Paulina Cache

The Paulina cache was discovered during a timber sale survey by the Deschutes National Forest, prior to the Paulina Fire Salvage Sale (Swift 1990). The site is located on the northeast flank of Newberry Volcano at an elevation of 1686 m (5620 ft) ASL. Figure 36 illustrates the location of the site. The site is situated in a flat area within a gently slopping terrain, close to an intermittent drainage. Site dimensions are 3.2 m by 2 m, the vertical limits are unknown. Surface soils are a bare, ashy, sandy soil with small lapilli extending to a depth of approximately 20 cm (8 in). Below the modern surface soil is an unidentified tephra layer at an unknown depth. Floral species are limited due to recent fire activity. The site is for the most part burned pine and void of understory or ground cover. Vegetation toward the north is a mix of living and dead pine with a few areas of bunchgrass ground cover. East Lake and Paulina Lake, within the caldera of Newberry Volcano, are 5.6 km (3.5 mi) away and are the nearest water source for the site (Anderson 1989).

The Paulina cache is a surface scatter of "small projectile points" (Swift 1990) including 17 whole specimens, one tip, and two flakes all of which are obsidian (Swift 1990). Disturbance to the site is minimal and attributed to natural causes. Distribution of the assemblage seems to be concentrated in three areas containing 10, 4, and 2 lithics each, while one projectile point was found outside of the concentrations (Anderson 1989). Each of the artifacts exhibits evidence of percussion and pressure flaking and three of the points retain 10 percent of their original surface (Swift 1990). All of the projectile points have been collected, however the site has not had subsurface testing or excavation. None of the collected points had been submitted for obsidian identification (Swift 1990), nor is the general shape and measurements of the collection known, albeit individual points are referred to as "small" and categorized as "lanceolate" by archaeologists (Swift 1990).

The Paulina Creek Collection

The Paulina Creek collection, also known as the Paulina Creek cache or Dietz collection, may represent a cache of approximately 2,500 lanceolate shaped bifaces. This collection is currently in private ownership and housed in the Favell

Museum in southern Oregon. Little is known about the exact original location or context of the assemblage. The person who discovered the artifacts states they were found near Newberry Crater (figure 36). According to archaeologist Carl Davis, who has studied nearly all of the caches in this region, this collection is similar to the other excavated collections and is thought to represent local caching behavior (Davis 1994). Although the Paulina cache and the Paulina Creek collection are of limited value due to the nature of their recovery and documentation, they may help illustrate the variety of locations and artifact qualities for Upper Deschutes River Basin caches.

Summary of Lanceolate Type Caches

In summary, all seven lanceolate cache sites are found within a 50 km radius of each other in a variety of environmental settings including the eastern slopes of the Cascade foothills, the Deschutes River Valley, and flanks of Newberry Volcano. The landforms associated with each of the cache sites are very similar in that all are located adjacent to or in very close proximity to lava flows. Furthermore half of the cache sites have a rocky outcrop or knoll in direct association with the site. Fresh water sources range from 10 km distant to directly adjacent to the site. The majority of the sites are found within a Ponderosa pine vegetation zone although two of the sites have Lodgepole pine intermixed with the ponderosa. Both of these sites are located on the northeast and eastern flanks of Newberry Volcano. Site types associated with the caches differ dramatically. Only Lava Island Rockshelter is associated with other artifacts and features and clearly contained three distinct cultural components, the earliest component represented by the cache. Benham Falls East cache has an associated lithic scatter and the Pahoehoe cache is positioned within 2 meters of a lithic workshop. The Paulina cache, China Hat cache, and Lava Cast cache are isolated finds without known associated cultural materials. The Paulina Creek collection has insufficient data to compare this site with the other cache site types. The number of lanceolate-shaped lithics in each cache ranges from 11 to 2,500, and all are obsidian. Obsidian characterization studies for 3 of the sites; China Hat, Pahoehoe, and Lava Island Rockshelter indicate approximately 75 percent of the artifacts are from Newberry obsidians, including Newberry Volcano and McKay Butte. The other 25 percent are identified as Quartz Mountain obsidian. This resource is located southeast of the cache sites. Carl Davis, Sara Scott, and Jeffery Flenniken have extensively studied the lithic technology associated with these caches. According to these authors the caches exhibit technological similarity but with a high degree of morphological variability. This variability is thought to represent the degree to which individual artifacts are finished.

Ovate Type Caches

Eight cache assemblages of ovate-shaped bifacial and unifacial tools have been recovered in and around the Upper Deschutes River Basin and Newberry Volcano. All eight caches were included in Mark Swift's paper on central Oregon caches presented at the 43rd Annual Northwest Anthropological Conference. Again the collections have been brought to the attention of archaeologists through a variety of circumstances. The Swamp Wells cache is included in the descriptive review but has not been included in the data sets or considered further in this research. The site is well documented (Swift 1990; Swamp Wells Cultural Resource Site Report) but the data sets tend to be conflicting. Figure 47 is a locational map of all sites identified as ovate type caches presented in this descriptive review.

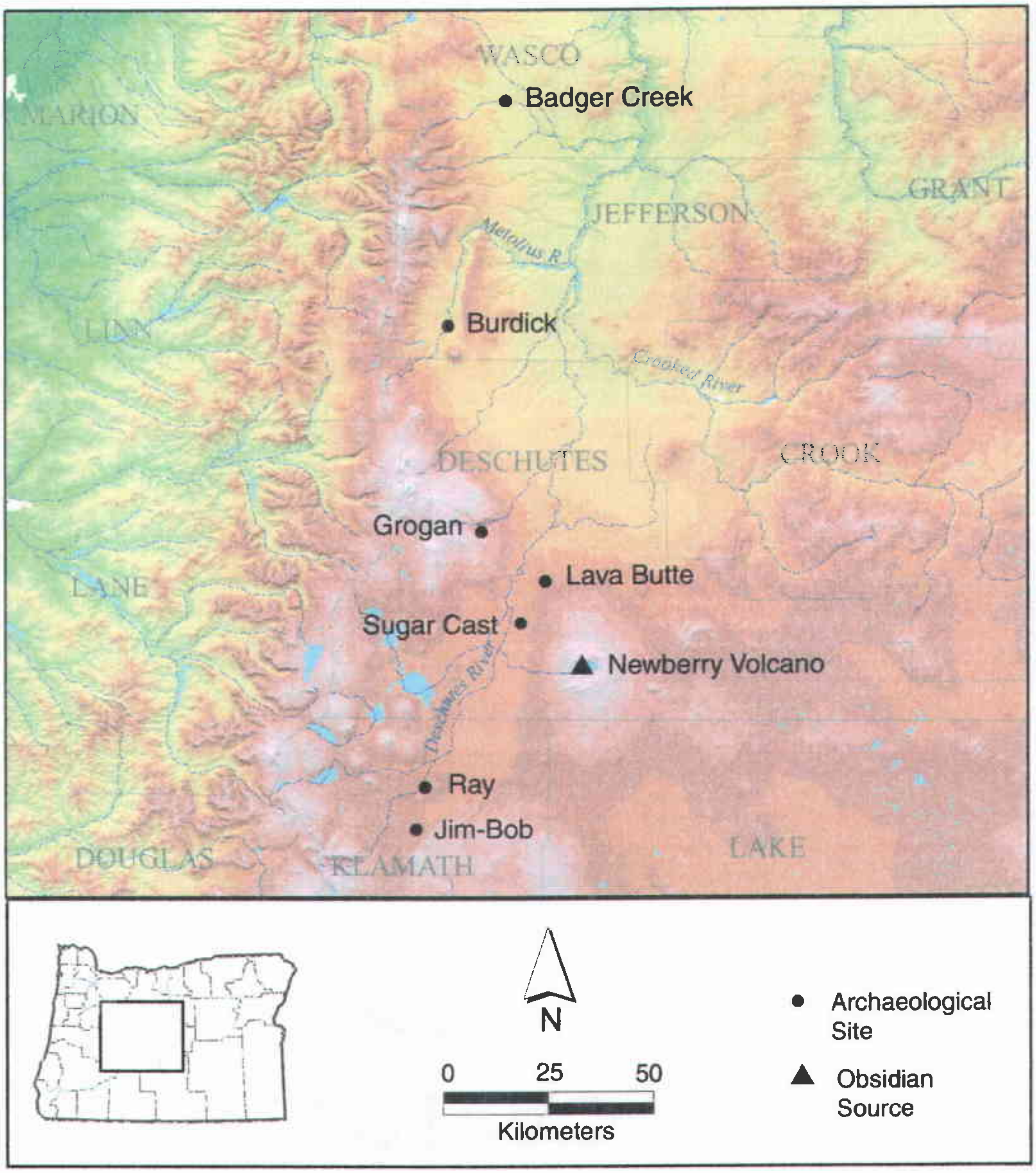


Figure 47. Map showing the locations of ovate cache sites.

The Badger Creek Cache

The Badger Creek site is located on the Warm Springs Indian Reservation in central Oregon. Figure 47 shows the approximate location of the cache. The initial discovery of a cache was made during the trenching of a ditch adjacent to Badger Creek. The cache was comprised of 36, large, ovate-shaped bifaces. During subsequent archaeological testing one additional artifact was found *in situ* approximately 40 cm below surface. All of the cached lithics are very thin and exhibit percussion flaking. As a group, the ovate bifaces are very large one measuring 17.0 cm in length. A sample of five artifacts had been submitted for XRF analysis prior to this research; all were derived from Obsidian Cliffs (figure 48) in the Cascade Mountains (Hughes, Origer 1989, and Swift 1990).

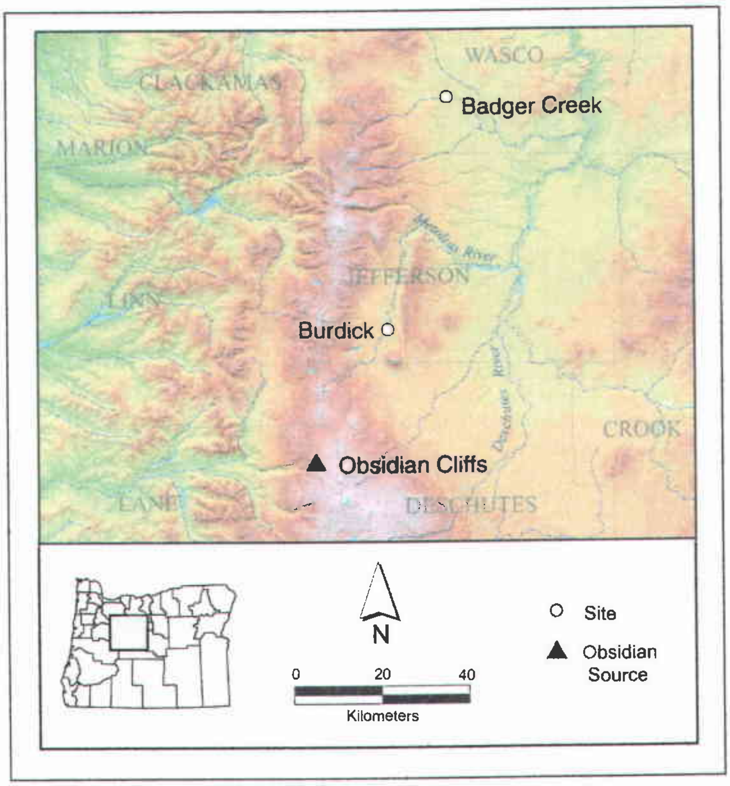


Figure 48. Map of the identified stone-tool resource for the Badger Creek and Burdick caches.

The Burdick Cache

The Burdick cache site is located along the Metolius River at an elevation of 900 m (3000 ft) in the Sisters Ranger District of the Deschutes National Forest. Initially this cache was thought to be a relatively small, isolated find. In 1990 the area was resurveyed and found the cache to be within a much larger site complex covering an area 1.6 km (1 mi) along the river bank and extending approximately 0.4 km (0.25 mi) up the first and second terraces. Figure 47 is a map showing the location of the site. The lithic assemblage from the site complex includes four formalized tools, two of which are bifaces and two projectile point fragments among several hundred obsidian flakes. The stone tool material also included several cryptocrystalline silicate and basalt flakes. The local flora community is a Ponderosa pine forest with an understory of bitterbrush, Manzanita, Idaho fescue, Peaune, squawcarpet, and Needlegrass. Generally the soil composition is sand and silt over clay (Zettel 1995).

Historically, the cache was discovered in 1986 during trenching activity of an access road. Initially the cached artifact assemblage was thought to contain a total of 18 lithics defined as flake blanks and biface cores, all of obsidian. Also noted were a number of obsidian flakes scattered across the surface in the surrounding 10 by 10 m^2 area (Zettel 1995). When the site was investigated by Forest Service archaeologists an additional biface and hopper mortar were recovered in an area near the cache. The relationship of this find and the cache assemblage is unknown (Swift 1990). The cache location was subsequently tested and 17 artifacts were recovered at a depth of 50 to 60 cm below the surface. Thirteen of the cache lithics are described as large, obsidian flakes with unworked surfaces and sharp edges removed. Four additional lithics had 30-100 percent of their surfaces altered by percussion flaking (Swift 1990). Ten of the cache artifacts were submitted for obsidian characterization prior to this research and all ten were derived from Obsidian Cliffs (Swift 1990; Hughes 1989). Exactly how the Burdick cache relates to the overall site complex identified in 1990 remains unclear. Figure 48 is a map of the identified stone-tool resource for the Burdick cache.

The Grogan Cache

The Grogan cache is located approximately 16 km (10 mi) south of Bend, adjacent to the Deschutes River. Figure 47 shows the location of the cache site. Historically, the cache was discovered and collected on private property approximately 20 years ago and given to the Deschutes National Forest in 1989. The property owner discovered the cache of 22 artifacts at the base of a rock outcrop within “a small rockslide” measuring approximately “10 by 20 ft” (Grogan 1987). The site’s environmental setting is a typical Ponderosa pine zone along the Deschutes River. The artifact assemblage consists of 17 whole ovate to pentagonal shaped tools which are unifacially flaked. No other artifacts or debitage were noted at the time of discovery. The ventral surfaces exhibit minimal percussion flaking if worked at all, while dorsal surfaces show evidence of heavy percussion and pressure flaking. Several of the lithics have been worked further on the dorsal surface, with the mid-section and tips showing extensive pressure flaking while the basal sections are only percussion flaked (Swift 1990). According to Swift the pentagonal shape and differential flaking may indicate possibility of use, resharpening, and hafting of the tools. Some of the tools have steep, unifacially worked edges, again suggesting finished tools as opposed to a cache of blanks (Swift 1990). Sourcing analysis had been obtained on the entire collection prior to this research. The obsidian characterization study identified the procurement of obsidian from Newberry Volcano (91 percent) and Obsidian Cliffs (9 percent) (Hughes 1991). Figure 49 is a map of identified stone-tool procurement resources for the Grogan cache.

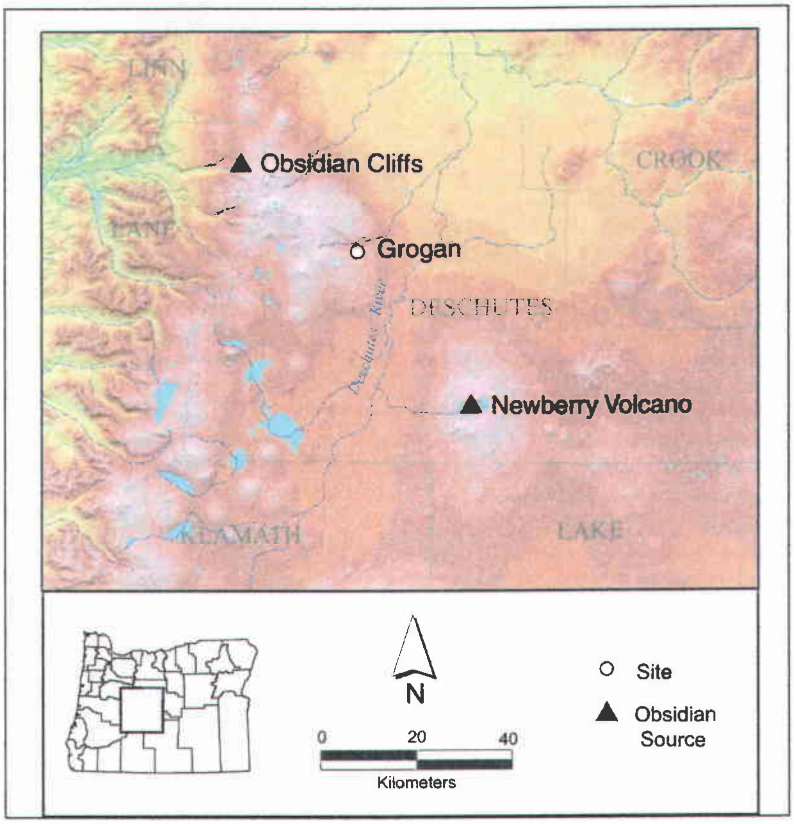


Figure 49. Map of identified stone-tool procurement resources for the Grogan cache.

The Lava Butte Cache

The Lava Butte Site is an extensive prehistoric site located 16.8 km (10.5 mi) south of Bend on the Deschutes National Forest. Figure 47 shows the site location. The following discussion is a summation of the Pacific Gas Transmission Company pipeline project's findings and interpretation of the site as written by Davis and Scott (Davis and Scott 1991:40-59). The site encompasses and area more than 370,800 m^2 on a gently undulating terrain. This landscape is dominated by a broad, northwest-southwest basalt flow that rises above the surrounding terrain.

The southern edge of this flow forms a prominent fissure containing several steeps. Riparian vegetation found in this location fosters a more mesic microenvironment than the surrounding landscape. The elevation of the site at approximately 1390 m (4550 ft) ASL supports a forest of secondary growth Ponderosa pine and Lodgepole pine. Fresh water sources are the Deschutes River 6.1 km (3.8 mi) west of the site and possibly the fissure in prehistoric times. The area near the fissure seems to have been the focus of prehistoric activity at the site (Davis and Scott 1991:40-59).

Historically, over the past 40 years the Lava Butte site has been surveyed, tested, and excavated numerous times, subsequently expanding the interpretation of its prehistoric use. Given the lengthy study history and extensive physical size of the site, only a very general review of the most current archaeological interpretation is presented here. The initial testing and excavations began in 1961 when Washington State University conducted a cultural resource inventory, testing, and ultimately excavation for the Pacific Gas Transmission Company's pipeline corridor. During these studies Dannie Ice (1962) excavated an approximately 60.45 m^2 (650 sq ft) area near the fissure. Most cultural material was recovered between the surface and 60 cm and included an inventory of 1742 artifacts (Ice 1962:15). Two features identified were a "knife cache" and a "scraper cache" (Ice 1962:56 Plates III A and B). However, in the original excavation report documentation details on these two features are limited due to archaeological standards applied in 1961. Subsequent archaeological investigations of the pipeline corridor utilized current archaeological standards and were applied to the 1961 fieldwork. A reexamination of the artifacts collected in 1961 suggests the Lava Butte site's occupational history began just after the eruption of Mount Mazama in 6800 BP and continued into the historic period. A dating of 4400 to 1400 BP is assigned to the range of projectile points recovered from the site. This dating is based on obsidian hydration measurements and three radiocarbon dates, although evidence of temporally discrete occupations pre and post-date this range. The site seems to have been most extensively occupied between 3500 and 1000 BP as a residential base camp. Visitation by the prehistoric occupants appears to have been of a relatively long duration while conducting a variety of tasks. The surrounding topography has numerous lava flows forming natural barriers across the landscape thought to influence deer migration patterns. Local deer populations occupy a winter range on the northern flank of the Paulina Mountains, and move in summer to the eastern slopes of the Cascade Range. The lava flows are ideally situated to intercept deer migrations moving through a narrow opening in the lava flows. Both the lithic and faunal assemblages at the Lava Butte site are consistent with an emphasis on hunting activities. Ground stone artifacts suggest gathering and processing plant resources was also an important site activity. Current lithic studies on artifacts collected in the 1962 excavations as well as recent excavation collections suggest flake stone tool manufacturing, preparation of hunting tools, and repair of damaged equipment were frequent site activities. As part of the reexamination, the knife and scraper caches were reevaluated by Davis and Scott (1991:40). In the original documents, a cache of seven "laurel-leaf shaped" (Davis and Scott 1991:40) obsidian bifaces was found *in situ* in levels 2-4, however today only four of the artifacts remain in the collection. Figure 50 is a photograph of the Lava Butte artifacts (Davis and Scott 1991:49). These four bifaces show evidence of percussion and pressure flaking and slight shouldering. Generally the bifaces are thought to be similar to the lithics found in the Ray, Sugar Cast, and Swamp Wells caches (Davis and Scott 1991:48). Obsidian hydration studies were obtained although no sourcing information was presented. Obsidian characterization analysis by Hughes identified the procurement of lithic resources from Newberry Volcano (100 percent) (Hughes 1989). Figure 51 is a map of identified stone-tool resources for the Lava Butte cache.

Figure 50. Photograph of the Lava Butte ovate shaped biface artifacts (modified from Davis and Scott 1991).

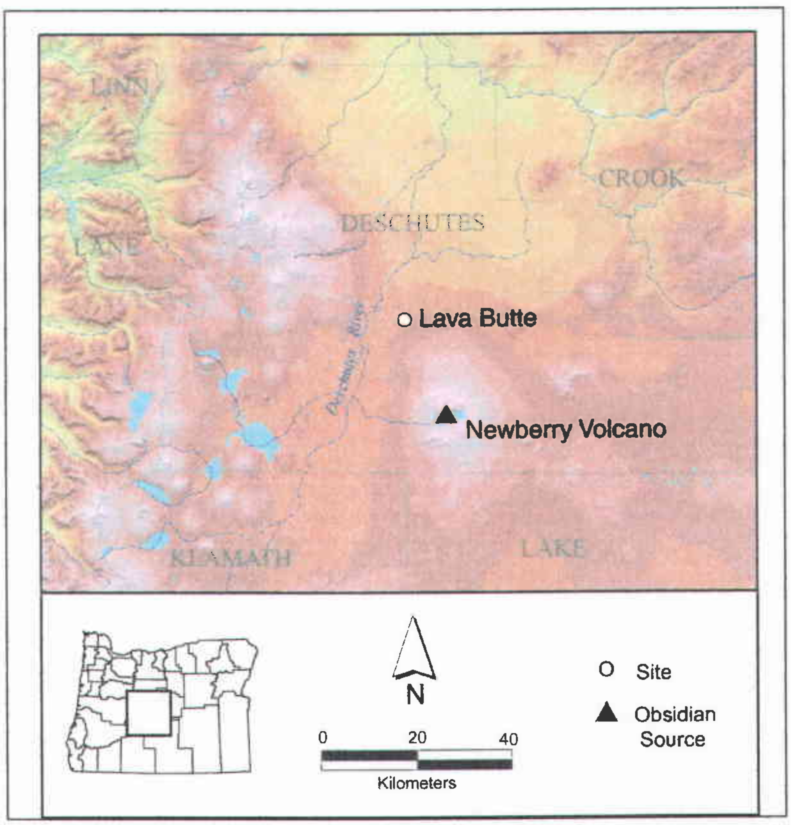


Figure 51. Map of identified stone-tool resources for the Lava Butte cache.

A separate flake cache of 33 large, obsidian, percussion flakes was recovered *in situ* from level 2 during the 1961 excavations. Davis and Scott believe this cache may more accurately reflect a lithic reduction area containing tool blanks within the site as opposed to an actual cache of stone tools (Davis and Scott 1991:49).

In summary, the Lava Butte site archaeology suggests an occupational history over the last 6,800 years and possible longer at small, discrete locals within the site. This occupation seems to be seasonal, primarily from early spring to late fall with evidence of some residential permanence. Site activities focused on hunting, plant harvest, and tool-stone activities. The two caches may or may not represent a caching intention by the occupants of the site.

The Sugar Cast Cache

The Sugar Cast Site was discovered in 1986 during a cultural resource survey prior to a proposed timber sale in the Deschutes National Forest. During this survey a 4 m^2 area containing 17 complete and broken ovate bifaces was documented adjacent to the South Sugar Pine Butte lava flow (Stuemke 1987). Figure 47 illustrates the location of the cache. Archaeologists believe the site may represent the remnants of an *in situ* lithic cache. The following information was taken from the Management Summary of Test Excavations and Evaluation of the Sugar Cast Site (Stuemke 1987) unless otherwise noted.

The environmental setting is within a secondary growth Ponderosa pine forest, intermixed with Lodgepole pine. Understory vegetation consists of antelope bitterbrush, squaw current, Manzanita, needlegrass, yarrow, and strawberry. The undulating soil surface is moderately covered with low herbaceous plants and duff. The elevation of the Sugar Cast site is 1293 m (4,310 ft) ASL (Stuemke 1988-B). Nearby water sources include the Little Deschutes River, 2.4 km (1.5 mi) away, and the main Deschutes River approximately 3.2 km (2 mi) beyond, both toward the west. The site shows evidence of disturbance attributed to bioturbation, historic cat logging, frost action, and aeolian soil transport. According to the Deschutes National Forest soils scientist, the soil is a mix composite closely associated with ash and tephra from the Mount Mazama eruption. Nevertheless an intact, thin salt-pepper ash can be identified and separates pre and post-Mazama soils. This ash lens is attributed to the original vent clearing eruptions of Mount Mazama. The Mazama tephra layer extends to a depth of 90 cm and caps a pre-Mazama paleosol. Despite the identification of these discrete layers, the overall site stratigraphy is not well defined.

Excavation of the Sugar Cast site was conducted in 1986 by Forest Service archaeologists. Fourteen units were placed over the area of exposed artifacts. Each unit measured 1 m^2 and province was further maximized through the use of 50 by 50 cm quadrants within each 1 m unit. Five shovel tests were dug outside the grid system to a depth of 40 cm to assure accurate horizontal boundaries. No cultural remains were noted in these test pits. Each of the 1 m^2 units was excavated to 30 cm using 10 cm arbitrary levels, additional sampling continued to a depth of 60 cm and all soil was screened using 1/8th inch hardware cloth. Subsurface cultural material was recovered from 10 of the 14 units and included 121 field specimens and 114 fragments. In total, the artifact assemblage contained 14 unbroken obsidian bifaces, 21 reconstructed bifaces, as well as 35 lithic fragments. The average artifact length is 14.0 cm, average width is 4.4 cm. Figure 52 is a scanned image of a sample of the recovered bifaces. Additionally noted was a complete absence of lithic debitage, shell, bone, and wood. All charcoal recovered was attributed to natural fires. The recovered biface assemblage is entirely obsidian and ovate in shape with symmetrically convex sides and slightly pointed to round bases. The widest portion of the individual bifaces is midway between tip and base. Technological descriptions state flake scar orientation is from proximal left to distal right, in an oblique or transverse pattern terminating roughly midline. Occasional primary flake scars are noted on some of the ventral surfaces. No basal modifications or any other indications of hafting or immediate use were noted.

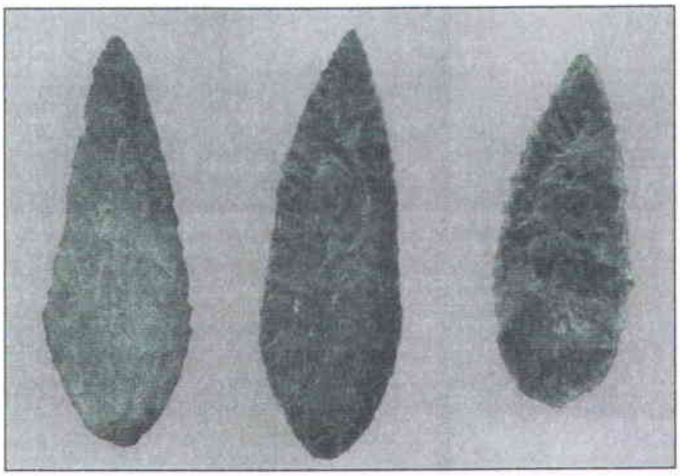


Figure 52. Scanned image of Sugar Cast ovate shaped artifacts.

The management summary tentatively dates the cache. Using stratigraphic and geological data, as well as a comparison to the Lava Butte ovate biface cache, this cache is thought to be younger than 5800 BP. This dating is primarily based on the cache site's proximity to the South Sugar Pine Butte lava flow. This flow is thought to date to approximately 5800 BP, although dating is based on correlations with similar lava flows associated within the Northwest Rift Zone of Newberry Volcano. Numerous suggestions as to the possible prehistoric function of the cache are discussed including, specialized and general tools, stores to off set resource shortages, and trade/exchange items (Stuemke 1987).

According to the site report obsidian color is black and blackish-gray, some with occasional streaking. A wax-like luster is noted on some of the lithics. Six of the ovate bifaces were submitted for XRF analysis prior to this research. Results of the obsidian characterization study revealed two artifacts were derived from the

Cougar Mountain source while four others were designated Newberry Volcano obsidians, although not related to Big Obsidian Flow (Hughes1987). Additional obsidian characterization studies were obtained for this research. When both sets of obsidian characterization studies were combined the results indicate obsidians where procured from Newberry Volcano (63 percent), Cougar Mountain (31 percent), and Silver Lake/Sycan Marsh (6 percent) (Hughes1987; Skinner 2004). Figure 53 is a map of the identified stone-tool procurement pattern for the Sugar Cast cache.

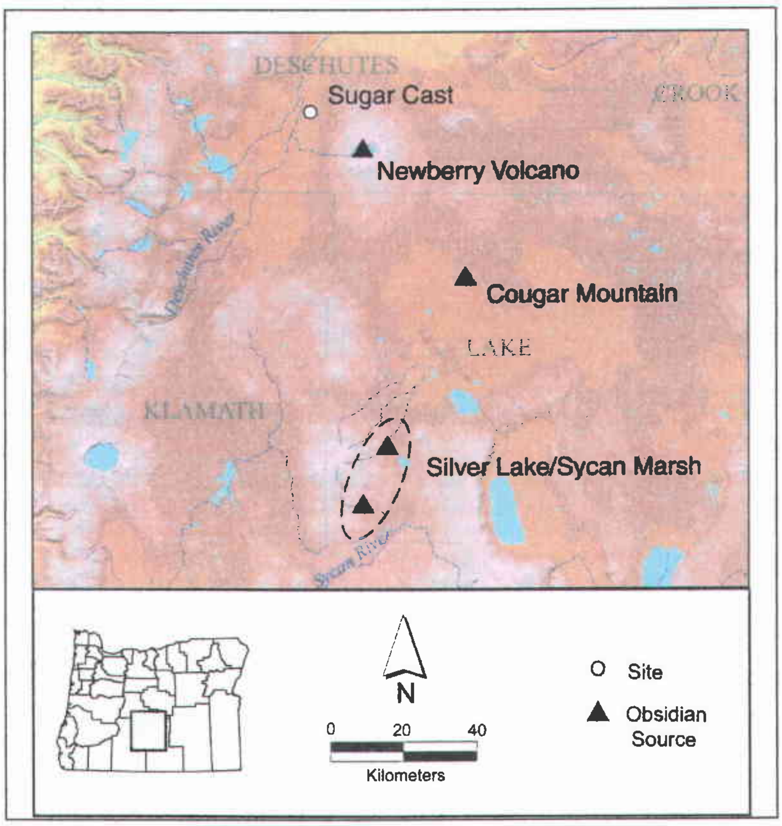


Figure 53. Map of identified the stone-tool procurement pattern of the Sugar Cast cache.

The Ray Cache

The Ray cache is located approximately 80 km (50 mi) south of Bend, in the town of Crescent. Figure 47 shows the site location. Historically, the cache was discovered on a privately owned lot adjacent to a remnant channel of the Little Deschutes River. The owner, Dick Ray, was rototilling a section of his back yard for a garden spot when he heard the blades hit something that sounded like glass. Subsequently Mr. Ray and his wife Pat unearthed 45 projectile points, 33 intact artifacts and 17 others which were later co-joined. The Rays contacted the Deschutes National Forest Service archaeologists at the Crescent Ranger District who evaluated the cache, conducted further testing of the site, and analyzed the cache lithics (Bend Bulletin-Chuck Mitchell 1987). No other artifacts or associated cultural material was found during the testing (Swift 1990). It should be noted this author personally interviewed Mr. Ray. Mr. Ray recounted the cache discovery and further disclosed the recovery of an associated "leather bag" in direct relationship with the lithic cache. When questioned as to the location of the bag today he stated the family had thrown it away because it was "all chewed up".

The Ray cache consists of 48 whole and fragmented unifacially and bifacially flaked ovate tools. Evidence of percussion flaking on the ventral surfaces is rare or do not exhibit flaking scars while the dorsal sides show heavy percussion and pressure flaking (Swift 1990). The points measure approximately 15.24 cm (6 in) long and from 7.62 to 8.89 cm (3 to 3 ½ in) at the widest point (Shotwell 1989). All of the lithics are obsidian. XRF analysis was conducted on some of the artifact fragments prior to this research. The results identified three of the fragments originated from Silver Lake/Sycan Marsh flow and the fourth sample was from Cougar Mountain obsidians (Mitchell 1987). Mark Swift states all five artifacts were identified as Silver Lake/Sycan Marsh obsidians (Swift 1990). Obsidian characterization analysis identifies the procurement of obsidian resources from Silver Lake/Sycan Marsh (75 percent) and Cougar Mountain (25 percent) (Hughes 1987). Figure 54 is a map of identified obsidian resources for the Ray cache. As of 2004, the cache remains in the position of the Ray family.

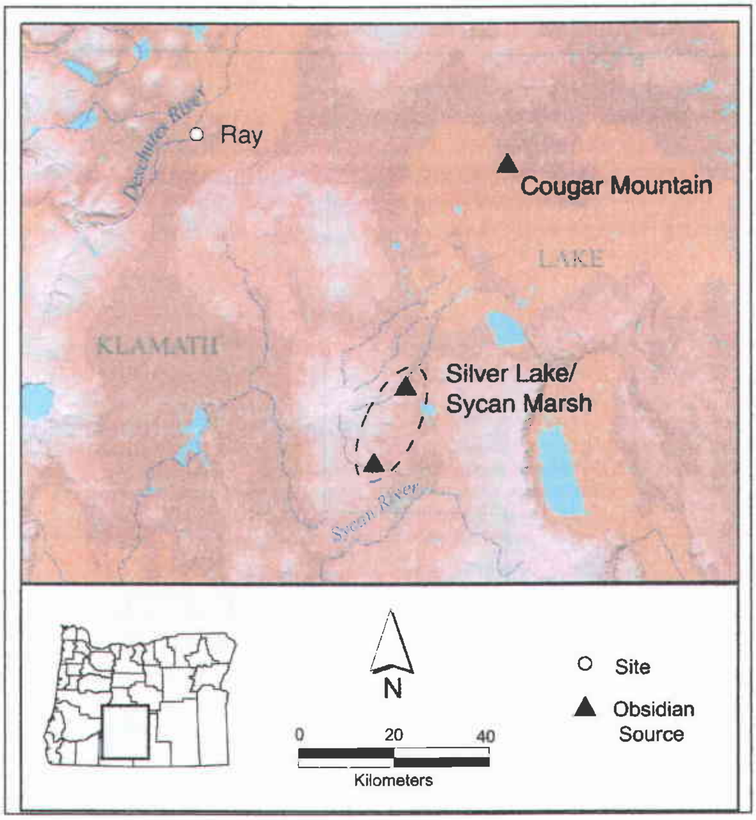


Figure 54. Map of identified obsidian resources for the Ray cache.

The Jim-Bob Cache

The Jim-Bob site is located 15 km south of Crescent, Oregon (figure 47). Jim-Bob is a large, open air lithic scatter running along both sides of an ephemeral stream, encompassing approximately 12 acres. The surrounding landscape is flat within a Ponderosa pine forest at an elevation of 1374 m (4529 ft). An understory floral community of Manzanita, Monkey flower, Beargrass, Idaho fescue, bitterbrush, and squaw current is found locally. This site's soil composition consists of a layer of pumiceous loamy sand to a depth of 2-3 m (7-10 ft), overlying pumiceous sand for another 50-100 cm (20-40 in), covering a gravelly glacial outwash. Freshwater resources include a spring approximately 75 m (3,000 ft) to the southwest and the Little Deschutes River is approximately 8 km (5 mi) to the west (Halloran et al. 1989).

Historically, the site was discovered during a timber sale survey when four large ovate biface points and one unifacially flake tool were found eroding from a road berm. All four ovate bifaces exhibit percussion flaking and a single series of pressure flakes (Swift 1990). The average size of the ovate lithics is; length 12.4 cm, width 4.0 cm, and a thickness of 1.4 cm. None of the lithics exhibit indications of hafting (Swift 1990). A single unifacially flaked tool has been percussioned flaked (Swift 1990). Figure 55 is a scan of a sample of the artifacts.

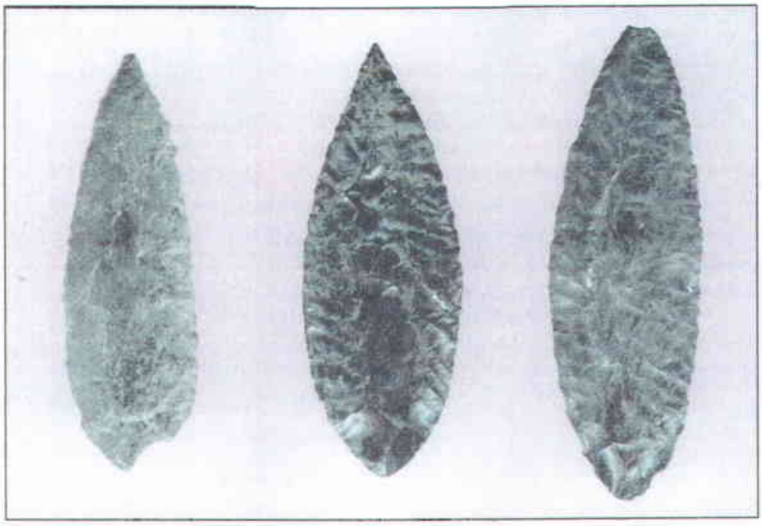


Figure 55. Scanned image of artifacts from the Jim-Bob cache.

All five of the Jim-Bob lithics were found within approximately three meters of each other in addition to three *in situ* fire cracked rocks. Also noted on the site surface was, debitage, utilized flakes, one scraper, and a small notched projectile point. All lithic material is obsidian of, gray, black, mahogany, or clear color (Halloran et al. 1989). None of the material has had lithic sourcing studies or formal analysis prior to this research nor has the site been excavated. Obsidian characterization analysis obtained for this research identifies the procurement of tool-stone from Silver Lake/Sycan Marsh (60 percent), Cougar Mountain (20 percent), Spodue Mountain (10 percent), and Newberry Volcano (10 percent) (Skinner 2004). Figure 56 is a map of the identified tool-stone procurement pattern for the Jim-Bob cache.

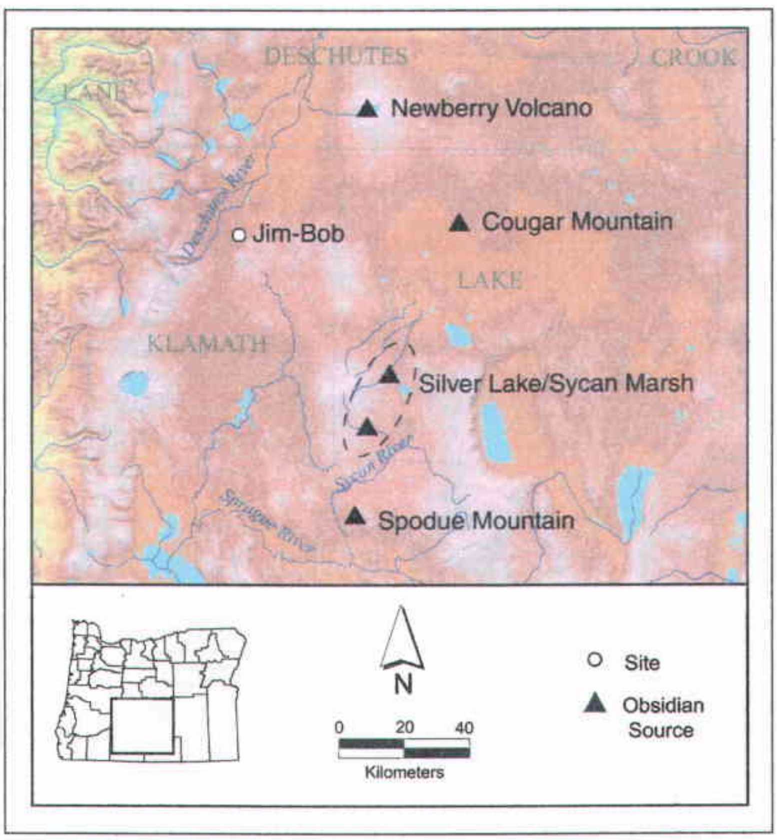


Figure 56. Map of the identified tool-stone procurement pattern for the Jim-Bob cache.

The Swamp Wells Cache

The Swamp Wells cache is located on the northern flank of Newberry Volcano in the Deschutes National Forest. Figure 47 shows the location of the cache. The cache is a component of the Swamp Wells site which is a large open-air lithic scatter. This site is situated on the periphery of a small marsh between two prominent buttes at an altitude of 1,658 m (5,440 ft). The local floral community consists of Lodgepole pine, bitterbrush, rabbitbrush, and fescue. Vegetation in the immediate vicinity of the small marsh contains willows, reeds, and grasses (Scott 1985:31). Historically, the site was located and recorded by Goddard (Swamp Wells Site Report 1979) during a site survey. In 1982 artifact collectors rediscovered the site and removed five ovate shaped lithics from the marshy area. Later the relic collectors turned the collection over to the Deschutes National Forest Service (Swift 1990). In 1983 Forest Service personnel conducted archaeological testing of the site by excavating a 1 m^2 unit to evaluate subsurface deposits (Scott 1985:31). During the testing one additional tool was recovered from a sand dune between the marsh and an adjacent deflated surface. The 1 by 1 m test unit was excavated to a depth of 1 m where sterile deposits were noted. From this test unit the one bifacially worked lanceolate shaped artifact, 372 obsidian flakes, and one pinkish-white cryptocrystalline silicate flake were recovered. A majority of the artifacts were located between 50 and 80 cm below ground surface. The lanceolate shaped biface was recovered at the 60-70 cm level and resembles the four bifacially worked artifacts found by the artifact collectors (Scott 1985:31). All five bifaces are obsidian, shaped by percussion flaking, fairly thick, and triangular in cross section. Four of the biface specimens have an original flake scar (Scott 1985:33). All six artifacts are predominantly unifacially flaked, two of the six artifacts are not worked on the ventral surface while the others have up to 50 percent of the ventral surface flaked by pressure flaking. The edges of the lithic collection appeared to be dulled (Swift 1990). Lithic debitage analysis suggests the Swamp Wells site was utilized by prehistoric populations producing large flakes from nearby quarries and using them as smaller flake cores or blanks for further refinement into useable tools (Scott 1985:34). The site report for the Swamp Wells does not identify this site as a cache; however it is included in Swift's descriptive summary of cache sites.

Summary of Ovate Caches

In summary, all eight cache sites are found in a wide distribution, within a 200 km radius of each other. The environmental settings are fairly consistent in that all are associated with water features. Four are located along river banks, one straddles an ephemeral stream near a marsh, and one is adjacent to a fissure within 6 km of the Deschutes River. The Swamp Wells site varies from this pattern as it is located on the northeast flank of Newberry Volcano and not within a stream or river valley. However this site is located adjacent to a marsh. Fresh water sources are available at all sites. The landforms associated with each cache site vary, only the Swamp Wells site is near a butte. Three of the eight sites are located next to rocky outcrops or a lava flow. The majority of the sites are found within the Ponderosa pine vegetation zone although three of the sites have Lodgepole pine intermixed. Site types associated with the caches differ dramatically. Only the Lava Butte site is associated with other artifacts and features and clearly contained distinct chronological components. Unfortunately, details regarding the province of the two caches at this site were not fully documented in the original research of the site. Swamp Wells and Jim-Bob caches are associated open-air lithic scatters; furthermore the Jim-Bob site has associated fire cracked rock. The Sugar Cast, Ray, and Grogan caches are all isolated sites without associated cultural materials. The number of ovate-shaped lithics in each cache ranges from five to forty-eight, and all are obsidian. Obsidian source studies for two of the sites indicate all are from

Obsidian Cliffs flows. Another two sites each have Cougar Mountain obsidians in addition to either Newberry Volcano or Silver Lake/Sycan Marsh sources. According to the cited references for nine caches (two from Lava Butte) all but two have evidence of both percussion and pressure flaking on some of the lithics while the other two cache assemblages were either minimally flaked or considered to be blanks.

DISCUSSION AND CONCLUSIONS

This chapter presents a comparison of physical attributes noted for the Upper Deschutes River Basin caches. The comparison should be considered a generalized preliminary analysis. This analysis is not intended to develop a comprehensive definition of a lanceolate or ovate type cache. Instead the comparison is offered as a review of major artifact and cache attributes and is based on the data available for each cache site. Again the irregularity of the cache data bases is a significant limitation in this comparison. The intention of this chapter is to identify potential patterns suggesting two or more types of caches may be represented in the cache collections. This research clearly recognizes that insufficient data, technological and morphological criteria, and comprehensive analyses are lacking. The comparison should be considered an initial survey to suggest two or more cache types may be represented in the cache collections, develop a working definition of the types as a conceptual frame work to aid other comparisons and discussions, as well as to assist in the development of future research direction. The statistical data set developed for this research is found in appendix B.

Prior to developing a working definition for lanceolate and ovate-shaped caches it is necessary to ascertain if two or more different types of caches are represented by the cache collections. Several possibilities seem apparent in explaining the ill defined cache assemblages including; inconsistency in descriptive language used by different authors, a gradation in size of the artifacts and not separate types, or different types may exist and are represented by the various collections. Caches or collections of similar artifacts have been referred to as lanceolate and ovate-shaped artifacts throughout this study. The employment of this categorization has been primarily based on the historic language used in discussions regarding central Oregon cache sites. Connolly's *Newberry Crater: A Ten-Thousand-Year Record of Human Occupation and Environmental Change in the Basin-Plateau Borderlands* references the caching practices in the region but does not distinguish between lanceolate and ovate forms (Connolly 1999:166). Scott and Davis reference "lanceolate-shaped obsidian bifaces" in the journal article *Biface Caches in Central Oregon* (Davis and Scott 1984:2), as well as in *The Pahoehoe Site: A Lanceolate Biface Cache in Central Oregon* (Scott et al 1986:7). Minor and Toepel refer to the cached artifacts from Lava Island Rockshelter as artifacts which "conform to the lanceolate point style" (Minor and Toepel 1984:12), and in *Exchange Items or Hunter's Tools? Another Look at Lanceolate Biface Caches in Central Oregon* (Minor and Toepel 1997:99) the term lanceolate biface cache is employed. These styles are not defined in any of the above references nor are particular styles compared to any other style. In Davis and Scott's journal article, *Lava Butte Site Revisited*, the authors refer to the cached bifaces (ovate-shaped) as "laurel-leaf shaped biface artifacts". Again the style is not defined nor is it distinguished from lanceolate bifaces. The artifacts are however said to be "similar to" those "found in the Ray, Sugar Cast, and Swamp Wells caches" (Davis and Scott 1991:48); which are considered ovate-shaped artifact caches. In Mark Swift's paper *Lithic Caches of Central Oregon-A Descriptive Comparison* (1990) the author references "small bifaces" and "lanceolate bifaces" as well as "large bifaces" and "ovate to pentagonal shaped bifaces" (Swift 1990). Although Swift's paper separates and discusses different sizes and shapes of artifacts in the cache collections they are not defined as distinct types. Suggestions toward identifying whether or not the cache assemblages are representative of separate types and not a gradation in size of individual artifacts may be possible through a comparison of artifact size and individual cache collections.

Physical Attributes of Lanceolate and Ovate Type Caches

Material

All caches discussed in this study contain nearly 100 percent obsidian artifacts; in rare instances a cache may contain occasional unknown rhyolite or basalt artifacts.

Artifact size within a cache

Individual artifact size within each assemblage is consistent. The material and artifact size within the individual caches illustrate a degree of uniformity within each of the assemblages. Table 4 illustrates the internal consistency of the cache assemblages as well as the inter-cache size variability ratios.

Artifact size between caches

Figure 57 is a scatter plot of all measured whole artifacts from each of the cache collections illustrating the possibility of two separate and distinguishable cache types based on size. All of the lanceolate-shaped artifacts are grouped together (lower left) as are the ovate-shaped artifacts (upper right). The possibility of a third group or sub-groups is also noted in the upper right quadrant of the scatter plot. This grouping represents the Burdick and Badger Creek caches located in the most northern region of the study area. While increasing the number of categorizations to three or more may provide a useful tool in describing and classifying some of the central Oregon caches, the limited number of caches and data in this study suggests additional divisions at this time would be premature.

Table 4. Chart of inter-cache size variability (modified from Swift 1990)

Cache		Ratios of smallest to largest: Shortest to longest	Ratios of smallest to largest: Narrowest to widest
Small bifaces	Lava Island Rockshelter cache bifaces	.45	.56
	Pahoehoe	.46	.68
	China Hat	.48	.71
	Lava Cast	.68	.86
Larger bifaces, unifaces, flake blanks	Burdick	.64	.65
	Lava Island Rockshelter cache, flakes	.75	.66
	Grogan	.68	.56
	Lava Butte biface cache	.85	.77
	Badger Creek	.62	.74
	Sugar Cast	.61	.66
	Ray	.75	.65
	Jim-Bob	.57	.85

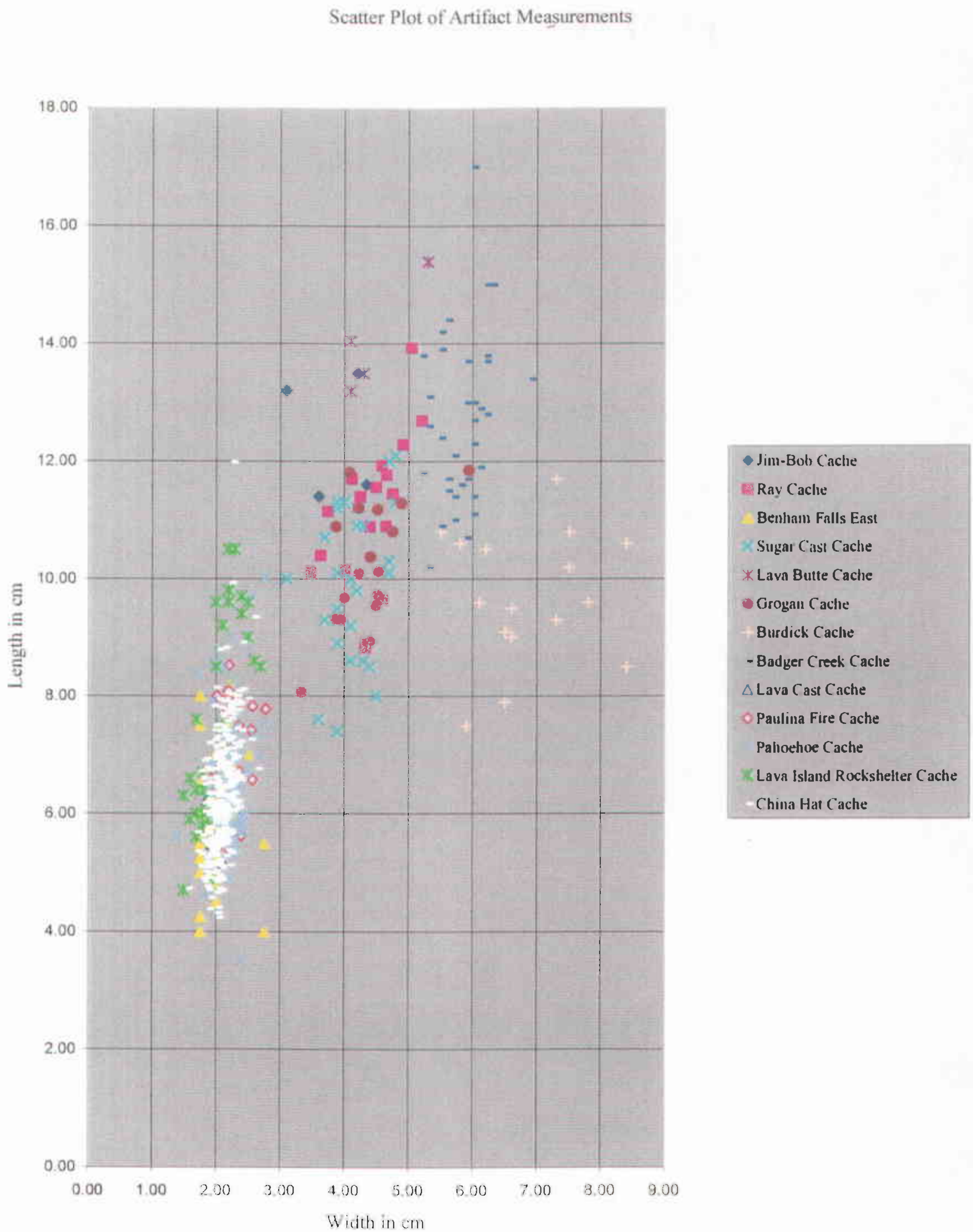


Figure 57. Scatter plot of all measured whole artifacts from the cache collections (modified from Swift 1990).

Artifact shape in a collection

Supporting evidence for two distinguishable cache types is also noted when comparing the overall shape of artifacts in each of the cache assemblages. Figure 58 is two scanned images comparing a prototypical lanceolate-shaped artifact (top) and a prototypical ovate-shaped artifact (bottom). Morphologically some basic differences are apparent. Ovate artifacts are approximately twice the size of lanceolate artifacts. Lanceolate artifacts generally have base characteristics that range from unshouldered square-base grading to contracting stems with rounded bases. Essentially the base element characteristics are morphologically comparable with the "foliate type" (see Connolly 1999:110-114) defined by Connolly (see figures 23-31). Ovate type artifacts have base element characteristics which are rounded grading toward a rounded point at times. The greatest width of lanceolate artifacts is roughly mid-artifact while the ovate type tends to have the greatest width closer to the distal third of the artifact.

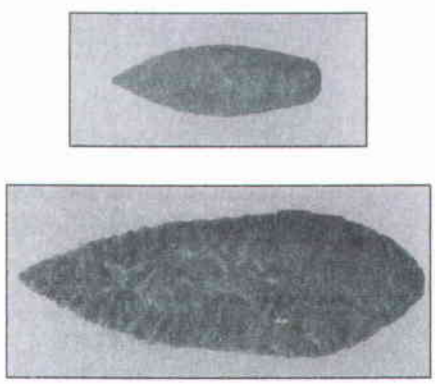


Figure 58. Scanned images comparing lanceolate and ovate artifacts.

Number of individual artifacts in a collection

Total artifact count in each cache type also supports a distinction between the two types although the numbers do overlap. In general, lanceolate type caches have a large total artifact count and range from 11-424 in number. Ovate type caches generally have a much smaller total artifact count and range from 4-48 artifacts.

Summary of physical attributes for lanceolate and ovate type caches

Lanceolate type artifact caches can be summarized as caches containing artifacts approximately 4-10 cm in length and 1-3 cm in width with an overt lanceolate-shape appearance. Total artifact count in an assemblage is substantial, usually exceeding 100 artifacts. Ovate type artifact caches differ from the lanceolate type caches in that the artifacts range from 8-16 cm in length and 3-9 cm in width; nearly twice the length and width of the lanceolate artifacts yet with similar proportions. Total artifact count in the assemblage is generous although not excessive as noted in the lanceolate type caches, typically not surpassing 50 in number. The widest portion of a lanceolate artifact is approximately mid-artifact. The widest portion of an ovate artifact is approximately the distal third. Although the majority of artifacts from lanceolate and ovate type caches are bifaces some collections (more frequently ovate-shaped) contain unifacial artifacts. Limiting these two types of caches to only bifaces seems overly restrictive at this time. In the future both an ovate-shaped biface and an ovate-shaped uniface classification may be evident but presently the data sample size and the scope of this research prohibits such a distinction. While this working definition is a morphological definition and not a technological definition patterns are evident. This suggests the development of a morphological and technological definition should be a high priority in future research

Environmental Attributes of Lanceolate and Ovate Type Caches

Two separate and distinguishable cache types has been proposed based on lithic material, artifact size and shape, as well as total artifact counts; lanceolate and ovate. Through a comparison of the two types and their associated environmental attributes the identification of these two types is further supported and begins to yield clues suggesting chronological relationships of the cache types, regional affiliation of the cache artisans, and cache function. Table 5 compares environmental characteristics of the two proposed cache types and an identifiable distinction is noted in the patterns. However, the categorizations utilized in this table were primarily derived from cultural resource site reports. The use of these categorizations was chosen to maximize uniformity in the available data bases thereby allowing comparable categorizations. When a cache site did not have a site report other literature and site visits were used for the data. In these instances only gross categorizations were used to most closely approximate the cultural resource site report categorizations. The identified patterns should be considered a preliminary survey, again identifying the utility of such a comparison in future research.

Comparing the environmental characteristics of the lanceolate and ovate cache sites identifies another layer of similarities and differences between the two types. Both types are found exclusively within a Ponderosa pine floral community as well as adjacent to or near lava flows. This commonality suggests a deliberate selection of these two environmental features associated with the caching behavior.

Table 5. Chart of environmental attributes for lanceolate and ovate type caches.

Environmental Data		Lanceolate Caches	Ovate Caches	Pattern Similar	Pattern Different
Environmental Setting	Foothills	17%	0%		X
	River Basin	33%	86%		
	Basin	17%	14%		
	Newberry Volcano	33%	0%		
Land Forms	Lava Flow Rimrock Outcrop	100%	100%	X	
Elevation ASL	800-1000 m	0%	28%		X
	1000-1200 m	0%	0%		
	1200-1400 m	40%	71%		
	1400-1600 m	40%	0%		
	1600-1800 m	20%	0%		
Water Resources	River	40%	71%		X
	Seasonal Stream	40%	29%		
	Marsh/Spring	0%	0%		
	None	20%	0%		
Distance to Water	At site	40%	86%		X
	< 2km	0%	0%		
	2-5 km	20%	14%		
	> 5 km	40%	0%		
Flora	Ponderosa Pine Zone	100%	100%	X	
	Juniper occidentalis Zone	0%	0%		
	Shrub-Steppe Zone	0%	0%		

Lanceolate type caches tend to be found in an array of environmental settings while the majority of ovate types are located along or near river courses. The dissimilarities in elevation between the lanceolate and ovate type caches seem to be reflective of this finding. The elevations of the ovate type caches are typical of a riverine setting in this region as river courses in the Deschutes River basin are generally between 1200-1400 m ASL elevations. The ovate type cache sites located in the 800-1000 m ASL elevations are the northern most sites and are not found in the Deschutes River basin proper. Lanceolate type cache site elevations reflect the array of environmental settings in which the caches are found; Cascade foothills, Deschutes River valley, as well as locations in the Newberry Volcano vicinity.

Water resources and the distance to water characteristics for the ovate caches are essentially unremarkable given their locations along or near waterways. The lanceolate type caches are extraordinary when considering distance to water, as the majority of the sites are located 2 km or more from a fresh water resource. This does not seem to be a reflection of the range of environmental settings in which the caches are found; each locality has available areas near or adjacent to water resources. Apparently access to water resources was not a primary concern to the people who used the lanceolate type caches and is suggestive of temporary occupation.

Site Type Attributes of Lanceolate and Ovate Type Caches

Given the unique environmental qualities between the two cache types it is a bit surprising to find remarkable similarities between the cache types when site profiles are compared. However, these findings should be considered with caution. Overall the similarities are rather ambiguous and the validity may be suspect given the information available for each site. Environmental profiles previously cited are unaffected by the serious looting activity at the majority of the sites. Site type attributes could be altered by this activity and obscure evidence of lithic scatters or other significant information. Additionally, the quantity and quality of professional analysis varied between sites and may have had an impact on these results. Nevertheless, given the nearly identical percentages, this pattern may well be valid; yet it would be presumptuous to infer substantial meaning at this time. Once again the pattern can be tested should new and intact cache sites be discovered. Table 6 shows the distribution percentages of the lanceolate and ovate cache types and their respective site types.

Table 6. Chart of site type attributes for lanceolate and ovate type caches.

	Site Type Data	Lanceolate Caches	Ovate Caches	Pattern Similar	Pattern Different
Site Type	Isolated find-cache only	60%	57%	X	
	Lithic Scatter	20%	14%		
	Lithic Scatter with Features	0%	0%		
	Complex Site	20%	29%		

Obsidian Resource Attributes for Lanceolate and Ovate Caches

A comparison of the lanceolate and ovate type caches and their associated stone-tool resources begins to establish an obsidian resource profile for each of the two types. Again the notion of separate and distinguishable cache types seems to be supported and offers indications of chronological relationships, regional affiliation of the cache artisans, and potentially inferences regarding cache function.

Comparing obsidian source characteristics of the cache assemblages identifies similarities and differences in the two types. Obsidian source distribution frequencies of the two cache types can then be compared to primary and secondary obsidian resources as well as to other distributional characteristics. Figure 59 illustrates the location of each stone-tool resource identified for the cache assemblages. Tables 7 and 8 compare procurement choices of the identified obsidian resources with each cache site.

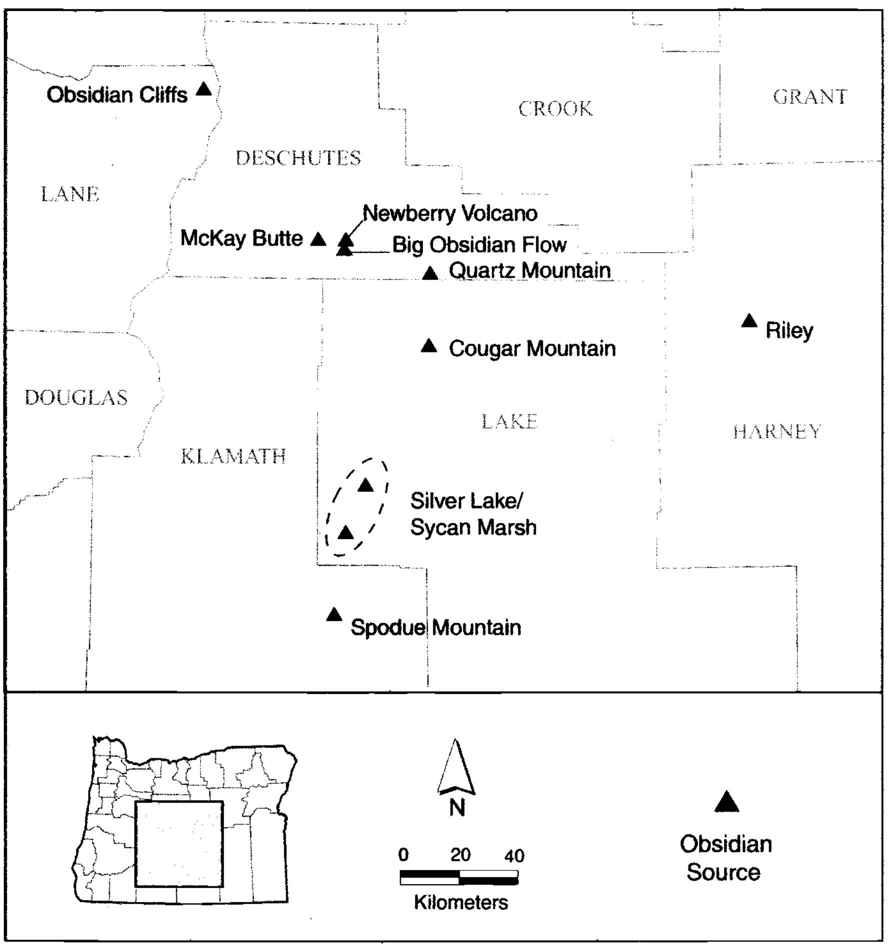


Figure 59. Map showing the location of each stone-tool resource identified in the lanceolate and ovate cache assemblages.

Table 7. Chart showing the distribution frequency of Newberry Volcano obsidians in lanceolate and ovate type caches.

Cache Name	Newberry Volcano/ McKay Butte	Newberry Volcano Group	McKay Butte	BOF
Benham Falls Cache		83%		
Lava Island Rockshelter Cache	100%			
Pahoehoe Cache			100%	
China Hat Cache	22%	19%	5%	2%
Lava Cast Cache		72%		
Lanceolate Cache Total	21%	22%	27%	1%
Badger Creek Cache				
Burdick Cache				
Grogan Cache		91%		
Lava Butte Cache		100%		
Sugar Cast Cache		63%		
Ray Cache				
Jim-Bob Cache		10%		
Ovate Cache Total		50%		

Table 8. Chart showing the distribution frequency of non-Newberry Volcano obsidians lanceolate and ovate type caches.

Cache Name	Obsidian Cliffs	Quartz Mountain	Cougar Mountain	Silver Lake/Sycan Marsh	Spodue Mountain	Unknown
Benham Falls Cache			17%			
Lava Island Rockshelter Cache						
Pahoehoe Cache						
China Hat Cache		43%	2.2%	2.2%		4.4%
Lava Cast Cache	14%	14%				
Lanceolate Cache Total	1%	23%	2%	1%		2%
Badger Creek Cache	100%					
Burdick Cache	100%					
Grogan Cache	9%					
Lava Butte Cache						
Sugar Cast Cache			31%	6%		
Ray Cache			25%	75%		
Jim-Bob Cache			20%	60%	10%	
Ovate Cache Total	23%		11%	14%	1%	

Primary and secondary obsidian resources

When comparing the obsidian source distribution frequencies of the two cache types a single similarity seems apparent. Lanceolate (70 percent) and ovate (50 percent) types both utilize the Newberry Volcano obsidians as their principal obsidian source albeit to a lesser degree among the ovate type caches. The proportions of Newberry Volcano obsidians to secondary sources are dissimilar in that the lanceolate group shows a 70/30 percent distribution ratio while the ovate group is a 50/50 percent distribution ratio.

A distinction is also noted in the secondary obsidian resource preference. The lanceolate type caches almost exclusively utilized Quartz Mountain obsidians (23 percent) as a secondary resource while none of the ovate type caches were identified to this supply. Instead the artisans of the ovate type show a preference for diversity including Cougar Mountain (11 percent), Silver Lake/Sycan Marsh (14 percent), and Obsidian Cliffs (22 percent) in the listed proportions. Table 9 illustrates these distributions.

It is interesting to note how these ratios change when the two northern caches, Burdick and Badger Creek, are removed from the data. While the primary obsidian resource remains Newberry Volcano obsidians the secondary obsidian resource proportions change significantly almost eliminating Obsidian Cliffs as a secondary obsidian resource. In this scenario, southern resources become important as the artisans of ovate type caches show a penchant for Cougar Mountain (14 percent) and Silver Lake/Sycan Marsh (18 percent) while Obsidian Cliffs (4 percent) becomes a relatively minor secondary resource. Tables 9 and 10 illustrate these preference differences.

Table 9. Graph of primary and secondary obsidian resource preferences for lanceolate and ovate cache types

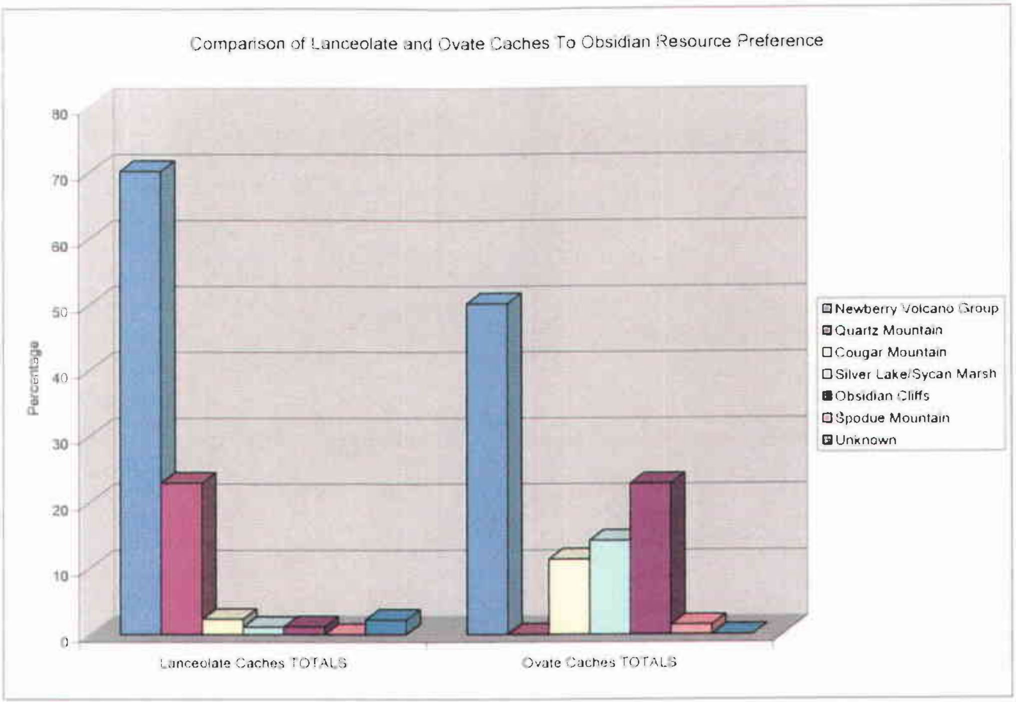
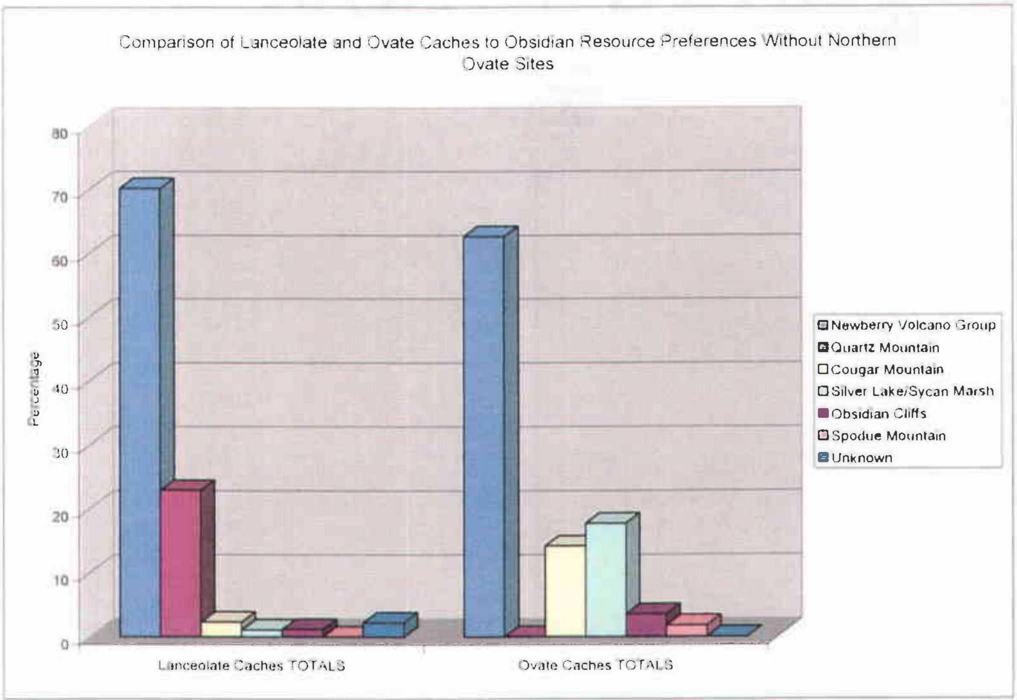


Table 10. Graph of primary and secondary obsidian resource preferences for the lanceolate and ovate cache types without the northern ovate type cache sites.



Obsidian resource attributes of lanceolate and ovate caches are summarized in table 11. The chart compares characteristics of the two cache types and their respective obsidian resource frequencies, distributions, and preferences.

Table 11. Chart summarizing obsidian resource attributes associated with the two cache types.

Comparison	Lanceolate Type	Ovate Type
Principal obsidian source	Newberry Volcano obsidians	Newberry Volcano obsidians
Newberry Volcano Group to secondary source proportions	75/25 percent distribution ratio	50/50 percent distribution ratio
Preference of Quartz Mountain obsidians	25%	None
Preference of secondary obsidians	Cougar Mountain (2%) Silver Lake/Sycan Marsh (1%) Obsidian Cliffs (1%)	Cougar Mountain (11%) Silver Lake/Sycan Marsh (14%) Obsidian Cliffs (22%)
Ovate ratios change without northern sites	---	Cougar Mountain (14%) Silver Lake/Sycan Marsh (18%) Obsidian Cliffs (4%)

Alignment and directionality

Obsidian resource attributes for the caches also reveal directional relationships between caches and their respective obsidian resources. In general, lanceolate type cache sites have a focused distribution in and around Newberry Volcano and to some extent align in an east-west distribution. The ovate type caches are found in a strong north-south distribution pattern. Figures 60 and 61 illustrate these directional tendencies. Additionally, the three northern most ovate cache sites; Badger Creek, Burdick, and Grogan, all utilize Obsidian Cliffs resources; ovate sites located near and south of Newberry Volcano do not. Instead the ovate cache sites located near Newberry Volcano and south show an overall trend toward procurement of southern secondary obsidian resources. Table 12 compares the identified locational and directional tendencies.

Table 12. Chart comparing the directional and locational qualities of lanceolate and ovate cache types.

Comparison	Lanceolate Type	Ovate Type
Directional alignment	Focused with a slight East and West tendency	North and South
Pattern-utilization of Obsidian Cliffs	Rare	Northern sites
Pattern-utilization of Newberry Volcano and southern obsidian resources	Frequent	Southern sites

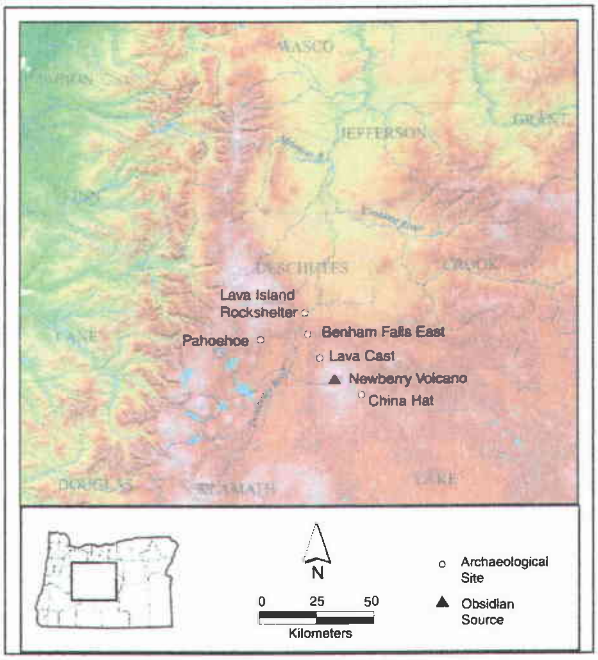


Figure 60. Map illustrating the focused distribution of the lanceolate type caches.

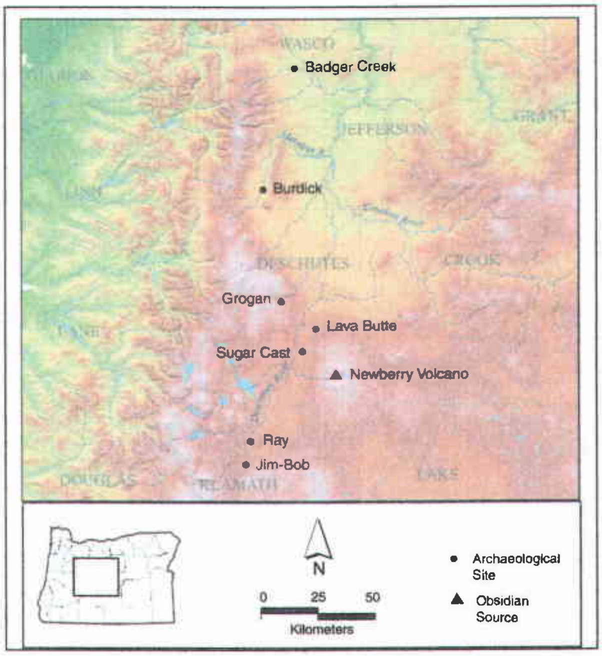


Figure 61. Map illustrating the north-south alignment of the ovate cache sites.

Distance to obsidian resource

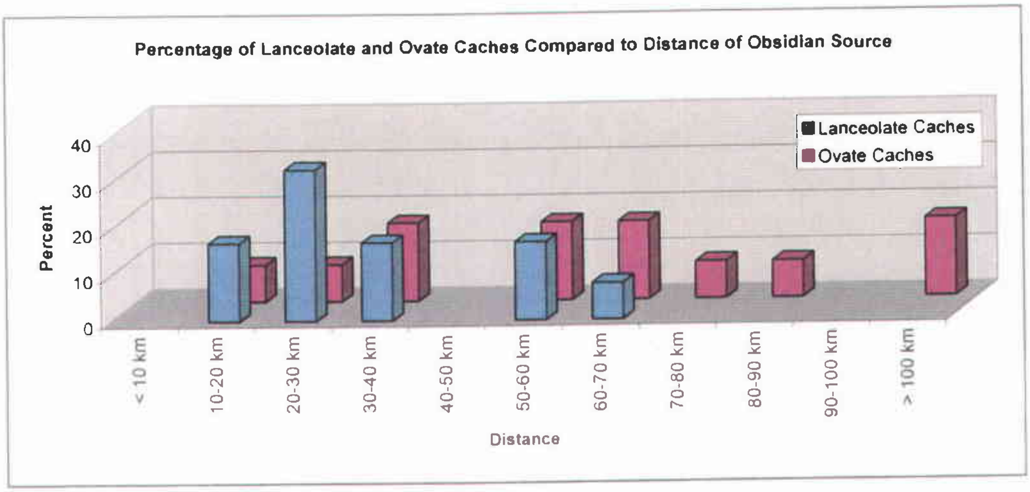
In the above obsidian resource comparison the lanceolate and ovate type cache attributes suggest different obsidian procurement patterns exist for the two cache types. One possible explanation may be simply a function of distance to obsidian resource. However a comparison of the two cache types and the percentages of each type to the distance traveled to obtain obsidian resources suggests other factors influence obsidian stone-tool resource procurement choices. Table 13 summarizes these comparisons. The artisans of the lanceolate type caches traveled shorter distances, primarily within a 50 km radius of the cache sites with the majority of the sites within a 30 km distance of the site. The artisans of the ovate type caches traveled greater distances, over 100 km in some instances. The majority of the resources are 50-70 km from the site.

Table 13. Chart comparing cache type and distance to stone-tool resource characteristics.

Comparison	Lanceolate Type	Ovate Type
Travel distance	limited	widespread
Obsidian	within a 50 km radius	over 100 km radius
Majority of sites	within a 30 km radius	within a 60 km radius
Percentage distribution	focused	dispersed

A more uniform percentage distribution is noted in the overall procurement pattern when the two cache types are compared. The lanceolate type cache artisans concentrated near local resources while the ovate type cache artisans utilized resources dispersed across the region. Table 14 illustrates a comparison of the two cache types and the distance traveled to obtain obsidian resources.

Table 14. Graph comparing the lanceolate and ovate cache types and distance traveled to obtain obsidian resources.



Summary of lanceolate and ovate cache type characteristics

The physical attributes of the lanceolate and ovate cache assemblages have suggested two cache types may be represented in the archaeological record of the Upper Deschutes River Basin. Environmental, site, and obsidian attributes support this distinction. The environmental qualities identify ecological characteristics which are both common and unique to the specific cache types. The two cache types seem to share similar site profiles however the significance of this commonality remains questionable. Obsidian resource attributes identify Newberry

Volcano obsidians as a similarity between the two cache types. Other stone-tool resources differ significantly. These characteristic differences suggest particular obsidian procurement strategies were employed by the artisans of the lanceolate and ovate type caches.

Obsidian sources associated with each cache site have been presented (see chapter 4) and potential procurement patterns inferred from the spatial relationships. Furthermore, lanceolate and ovate type caches each seem to have a unique spatial relationship and distinctive preferential choices of local obsidians. Just as each cache site and cache type have particular characteristic patterns so does each obsidian resource. In the following discussion obsidian characterization studies will identify spatial distribution patterns of individual obsidian resources. A correlation of procured resources at each cache site and spatial distribution patterning of regionally available obsidians is necessary to develop additional behavioral inferences associated with the caching practice. Significant implications from these co-relationships address chronological and cultural associations for the caching behavior.

Obsidian use patterns of the cache artisans at a particular cache site can add temporal and cultural dimensions for understanding how local obsidians were used prehistorically. Dated eruptive histories associated with some of the identified stone-tool resources can help place a cache in chronological context. Spatial patterning of specific obsidian sources facilitates the identification of possible prehistoric lithic procurement systems. Both the chronological and distributional qualities of a specific obsidian sources can be applied to lanceolate and ovate cache types. By examining patterns of use over time, evidence of changes in; land use, geographic (cultural and environmental) boundaries, subsistence practices, and trade alliances seem to be forthcoming.

Chronological and Spatial Patterns of Regional Obsidian Sources

Obsidian characterization studies can be utilized as "a unique temporal window" (Northwest Research Obsidian Studies Laboratory Source Catalog 2004) placing the caching behavior within a chronological context.

Newberry volcano and McKay Butte chronology

Newberry Volcano caldera contains seven distinct obsidian flows (Figure 4). These seven flows are separated into two "chemically distinguishable groups" (Skinner 1995:4-29). One of the groups is a combination of four flows, together identified as Newberry Volcano chemical group, and are geochemically indistinguishable from each other based on trace element composition. These flows are; Interlake Flow and Game Hunt flows (6400 BP), Central Pumice Cone (4300 BP), and East Lake (3400 BP). All of the Newberry Volcano chemical group flows extruded during the mid-Holocene and after the Mount Mazama eruption in 6800 BP. The second chemical group, known as the Big Obsidian Flow chemical type, is represented by the late-Holocene Big Obsidian Flow (1300 BP) and the late-Pleistocene Buried Obsidian Flow (estimated 10,000 BP). These two flows are also chemically indistinguishable yet significantly separated chronologically (Connolly 1999:170 and Skinner 1995:4-29).

McKay Butte is located on the western flank of Newberry Volcano and is comprised of three Pleistocene rhyolite domes. The geologic age of this obsidian source is a calculated K-Ar age of 0.60 0.10 Ma (Northwest Research Obsidian Studies Laboratory Source Catalog 2004).

Newberry Volcano and McKay Butte obsidians in lanceolate and ovate caches

The obsidian characterization studies obtained and utilized in this study unequivocally identify the occurrence of Newberry Volcano Group obsidian in a majority of both lanceolate and ovate type caches (table 15); firmly dating the Benham Falls, China Hat, and Lava Cast lanceolate type caches as well as the Grogan, Lava Butte, Sugar Cast, and Jim-Bob ovate type caches to a time frame after the eruption of Mount Mazama in 6800 BP. The Pahoehoe cache can not be placed within a Mazama chronological context because McKay Butte obsidian was available in both pre and post-Mazama times. Lava Island Rockshelter cache XRF studies were obtained in 1986 and did not discriminate between McKay Butte and Newberry Volcano Group therefore a possibility exists that the entire collection may have been derived from a McKay Butte resource therefore this cache may predate the eruption of Mount Mazama. The Badger Creek, Burdick, and Ray caches do not contain artifacts from Newberry Volcano or associated resources therefore XRF analysis is inconclusive in terms of a diagnostic Newberry Volcano Group temporal window.

Should the Lava Island Rockshelter cache be reanalyzed with current XRF capabilities a post-Mazama temporal marker may be evident. The entire Pahoehoe cache sample has been identified as McKay Butte obsidian and nearby Newberry Volcano obsidian is completely absent in the assemblage; thus an absolute post-Mazama chronology is not disclosed. The absence of Newberry Volcano obsidian in both the Badger Creek and Burdick caches is explicable given the northern locations of the cache sites. The Ray cache's absence of this geochemical type may also be a function of distance and its southern location however the Jim-Bob cache is the most southern cache site and does contain artifacts from this resource (figures 48, 54, and 56). Overall the absence of Newberry Volcano chemical group can be accounted for when consideration is given to dated XRF studies and distance to source relationships however neither explanation unequivocally precludes a pre-Mazama dating.

Table 15. Chart showing percentage of Newberry Volcano obsidians identified in each cache site.

Cache Name	Newberry Volcano/ McKay Butte**	Newberry Volcano Group	McKay Butte	BOF ***
Benham Falls Cache		83%		
*Lava Island Rockshelter Cache	100%			
*Pahoehoe Cache			100%	
China Hat Cache	22%	19%	5%	2%
Lava Cast Cache		72%		
Lanceolate Caches total	21%	22%	27%	1%
*Badger Creek Cache				
*Burdick Cache				
Grogan Cache		91%		
Lava Butte Cache		100%		
Sugar Cast Cache		63%		
*Ray Cache				
Jim-Bob Cache		10%		
Ovate Caches total		50%		

Notes: Cache sites with blank spaces indicate 0%

* indicate caches with a possibility of pre-Mazama dating.

** Newberry Volcano/McKay Butte is an older classification from dated XRF studies and indicates a nondiscrimination between Newberry Volcano Group and the McKay Butte obsidian resource. Caches based only on this characterization have the possibility of a pre-Mazama dating.

*** BOF is geochemically identical in both the Buried Obsidian Flow (pre-Mazama) and the Big Obsidian Flow (post-Mazama) characterizations, therefore has a possibility of pre-dating the Mazama eruption.

Distribution of individual obsidian resources

The following discussion relates the obsidian characterization studies in this research to basic distribution patterns of individual obsidian sources. The utility of obsidian source distribution analysis is vast and diverse especially considering the plethora of environmental and cultural influences affecting the distribution pattern of a particular obsidian source (Skinner 1995:4-10). For this reason only primary or potentially diagnostic obsidian sources identified within the cache assemblages will be discussed.

The application of spatial distribution pattern analysis for the respective cache types has developed a comparison of the obsidian resource frequencies, distributions, and preferences unique to both cache types. Distribution patterns for individual obsidian resources are also distinctive. The unique quality in both of these data sets fosters the development of temporal and behavioral inferences from the combined spatial patterns. The goal of this discussion is to expand on the previously identified chronology and offer clues toward the identification of regional (geographic and/or cultural) affiliations associated with the caching behavior. Information and data concerning the distribution patterns of the specific obsidian sources in this discussion is from the PGT-PGE&E pipeline expansion project archaeological investigations (Skinner 1995) unless otherwise noted.

The Newberry Volcano Group

Following the Mazama eruption the onset of utilization for this resource was rapid and widespread in central and north central Oregon and extends as far north as British Columbia (Skinner 1995:4-37). Figure 62 illustrates the spatial distribution of Newberry Volcano obsidian in other Pacific Northwest archaeology sites (Connolly 1999:171). The pattern illustrates a strong northerly trend and almost a complete absence of this resource south of the volcano.

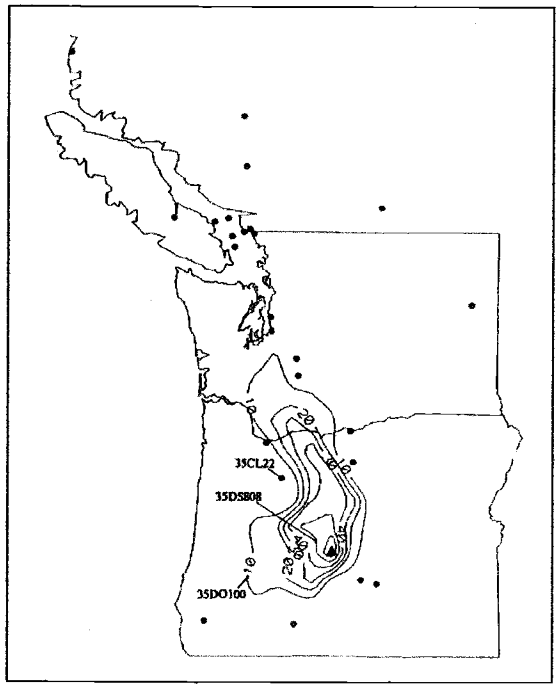
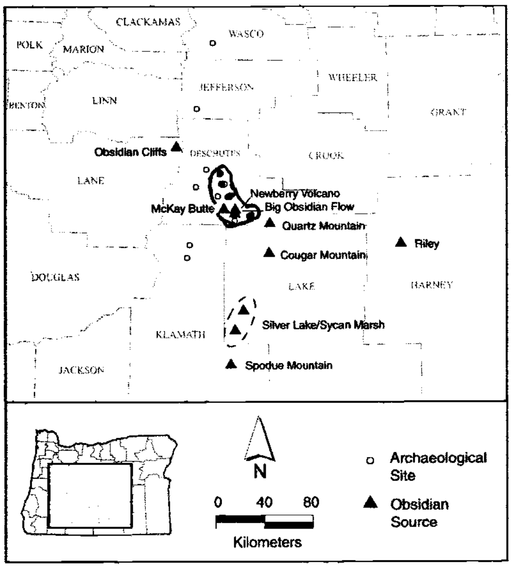


Figure 62. Map illustrating the distribution pattern of Newberry Volcano obsidians in archaeological sites (after Connolly 1999).

Typical of this model, ovate type caches containing Newberry obsidians cluster near the volcano. However the distinctive northerly directional pattern is not apparent for the cache type as a whole. Newberry obsidian is not found in the northern most cache sites, Burdick and Badger Creek, while the most southern site, Jim-Bob, does contains Newberry obsidian. Considering the strong north-south alignment of the ovate type caches this finding is somewhat unexpected. The northerly distribution pattern of Newberry obsidians is also not apparent for the lanceolate type caches. However this is not surprising because the lanceolate type caches tend to cluster near the volcano.

Overall both cache types utilize Newberry Volcano obsidian as their primary resource. Caches containing Newberry obsidian geographically cluster near the parent source yet neither cache type can be said to hold the directional quality noted in Newberry Volcano obsidian spatial distribution pattern. Figure 63 illustrates the distributional pattern of Newberry Volcano obsidians in lanceolate (top) and ovate (bottom) caches.



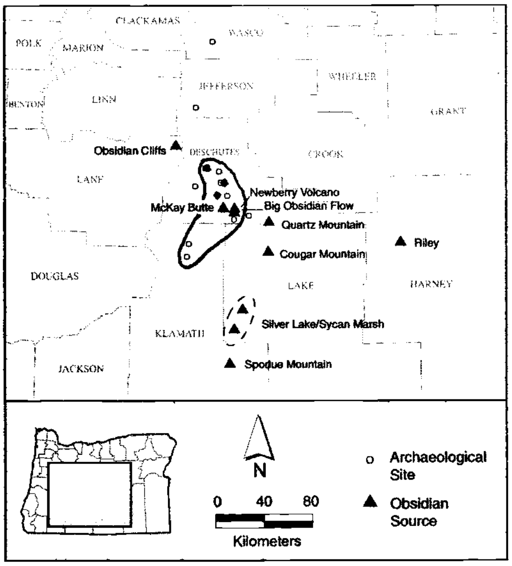


Figure 63. Maps identifying the distributional pattern of Newberry Volcano obsidians in lanceolate and ovate caches.

The lack of directionality may be significant as well as diagnostic of cache sites and related to their function. Connolly's study of the Newberry caldera sites suggests after the eruption of Mount Mazama, obsidian from caldera sources were "systematically quarried for lithic tool stone, and this material was used most extensively in the Deschutes River basin to the north" (Connolly 1999:173). The peak of the intensive quarry activity is dated to the component 4 occupations between 4000-1000 years ago. Connolly's archaeological research also suggests the cache sites may have functioned within an exchange system as stores of lithic tool stone intended for trade northward. The ovate type cache distribution pattern of Newberry obsidian suggests this is not a likely function of this cache type. The focused distribution of the lanceolate type caches in the Newberry Volcano region initially seems to be compatible with this inferred cache function. However, in some instances significant quantities of Newberry obsidians are transported in a southerly direction as noted in the China Hat cache and to a lesser degree in the Jim-Bob cache. Additionally, the distribution pattern of secondary obsidian resources from cache sites in close proximity of Newberry Volcano suggests contact to the south.

McKay Butte Obsidian

A comparison of distribution patterns for Newberry Volcano obsidian and McKay Butte obsidian illustrates significant differences for these two resources. Both Skinner and Connolly suggest the patterns hold important spatial and possibly temporal implications for the regional prehistory (Connolly 1999:171). Figure 64 compares these patterns.

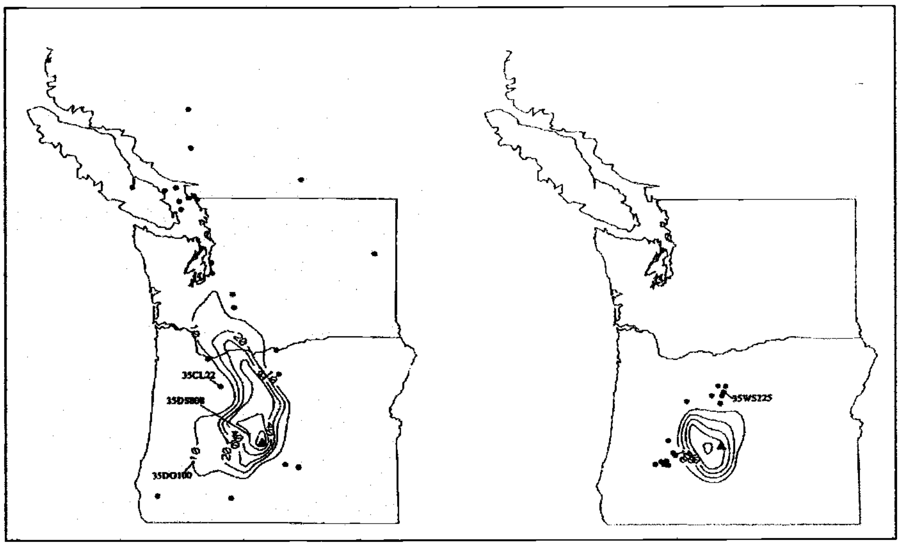


Figure 64. Contour plots comparing of distribution patterns of Newberry area obsidian (Left) and McKay Butte (right) obsidian (after Connolly 1999).

Skinner explores the temporal significance and offers possible explanations for the finding. The PGT-PGE&E pipeline expansion project's spatial patterning of obsidian from McKay Butte offers evidence of a temporal component to the distribution pattern. The pipeline project noted three sites within 10 km (6mi) of McKay Butte, primarily along or near Paulina Creek, contained large proportions of McKay Butte obsidians. Additionally, the archaeology shows the prehistoric use of this glass dominated the region prior to the Mazama eruption (Skinner 1995:4-34). A substantial diachronic shift is noted in the distribution pattern after the eruption of Mount Mazama when the once dominant McKay Butte glass was supplanted by Newberry Volcano obsidian (Skinner 1995:4-33-34). Skinner postulates several possibilities for this dramatic temporal shift including; competing Newberry sources and burial of the McKay Butte source by Mazama tephra-fall. The first explanatory hypothesis is deemed inadequate because it can not account for the "near disappearance of high-quality obsidian from a source considerably closer than those in the caldera" (Skinner 1995:4-34). The second hypothesis is generally favored suggesting the Mazama tephra-fall may have hindered access to an already scant exposure of the fine quality glass available prior to the eruption (Skinner 1995:4-34). Geographically both lanceolate and ovate type caches are located in close proximity to McKay Butte obsidian. While none of the ovate type caches contained McKay Butte glass this resource is found in two of the lanceolate type caches.

The lanceolate type Pahoehoe cache is intriguing given 100 percent of the collection is sourced to McKay Butte thereby allowing for the possibility of a pre-Mazama dating. This cache has remarkable similarities common to all of the lanceolate type caches; intra-cache consistency in size, shape, and appearance of the artifacts, as well as compatible environmental attributes. Given these similarities, the Pahoehoe cache certainly seems to be related to the other lanceolate type caches yet a 100 percent McKay Butte obsidian frequency remains unique and possibly significant to the cache type as a whole. The dominant use of McKay Butte glass prior to the eruption of Mount Mazama and this resource's near complete disappearance after Newberry Volcano obsidian became available suggests the Pahoehoe cache may illustrate an incidence of a caching behavior prior to 6800 BP. While this inference is certainly tentative the finding is noteworthy and may prove to be a valuable chronological indicator in determining a relative dating for the lanceolate type caches to a period very near the eruption of Mount Mazama.

China Hat is the only other lanceolate type cache containing McKay Butte glass. China Hat sourcing studies indicate a mere 5 percent of the collection is derived from this resource. However, the overall composition of the assemblage is a rather eclectic compilation of obsidians. The small amount of the McKay Butte resource in the China Hat cache may be related to reuse or curation of stone tool artifacts and not necessarily indicative of a pre-Mazama dating. The occurrence of McKay Butte glass in this cache is not as distinctive as the Pahoehoe assemblage.

Overall XRF studies suggest the artisans of the two cache types are probably not culturally related. Both cache types are located in the same general region yet only the lanceolate type cache artisans utilized McKay Butte glass and the makers of the ovate type artifacts did not. The presence of McKay Butte obsidians in the lanceolate type caches also suggests a possible temporal separation between the two cache types. Should future research support this notion the caching behavior associated with the lanceolate type caches could prove to be related to an adaptive response to Holocene climatic changes and/or the dynamic volcanic history in central Oregon.

Quartz Mountain Obsidian

Obsidian resources from Quartz Mountain have been accessible throughout the Holocene with no known interruption in availability. Archaeological sites containing obsidian from this resource tend to course northward up into the Columbia Plateau region. Archaeological sites south of Quartz Mountain are generally dominated by southern glass resources (Skinner 2004).

The complete absence of Quartz Mountain glass in the ovate type caches is quite remarkable and a bit perplexing. Nearly half of the ovate type caches are sourced to Newberry Volcano yet Quartz Mountain is only 25 km southeast and none of the ovate artisans utilized this resource. This absence of a Quartz Mountain preference does not seem to be related to cache location. The Sugar Cast cache is an excellent example of this because of its locality on the north-west flank of Newberry Volcano (figure 53). Twenty-five percent of this assemblage has been submitted for XRF analysis; 63 percent of the sample is derived from Newberry Volcano Group. More distant southern stone tool resources include; 31 percent from Cougar Mountain and 6 percent from Silver Lake/Sycan Marsh. The close proximity of Quartz Mountain to the cache site coupled with the utilization of more distant obsidian resources suggest a cultural component for the nonappearance of

Quartz Mountain glass in this cache assemblage. Figure 65 illustrates the perplexing procurement pattern of the Sugar Cast site.

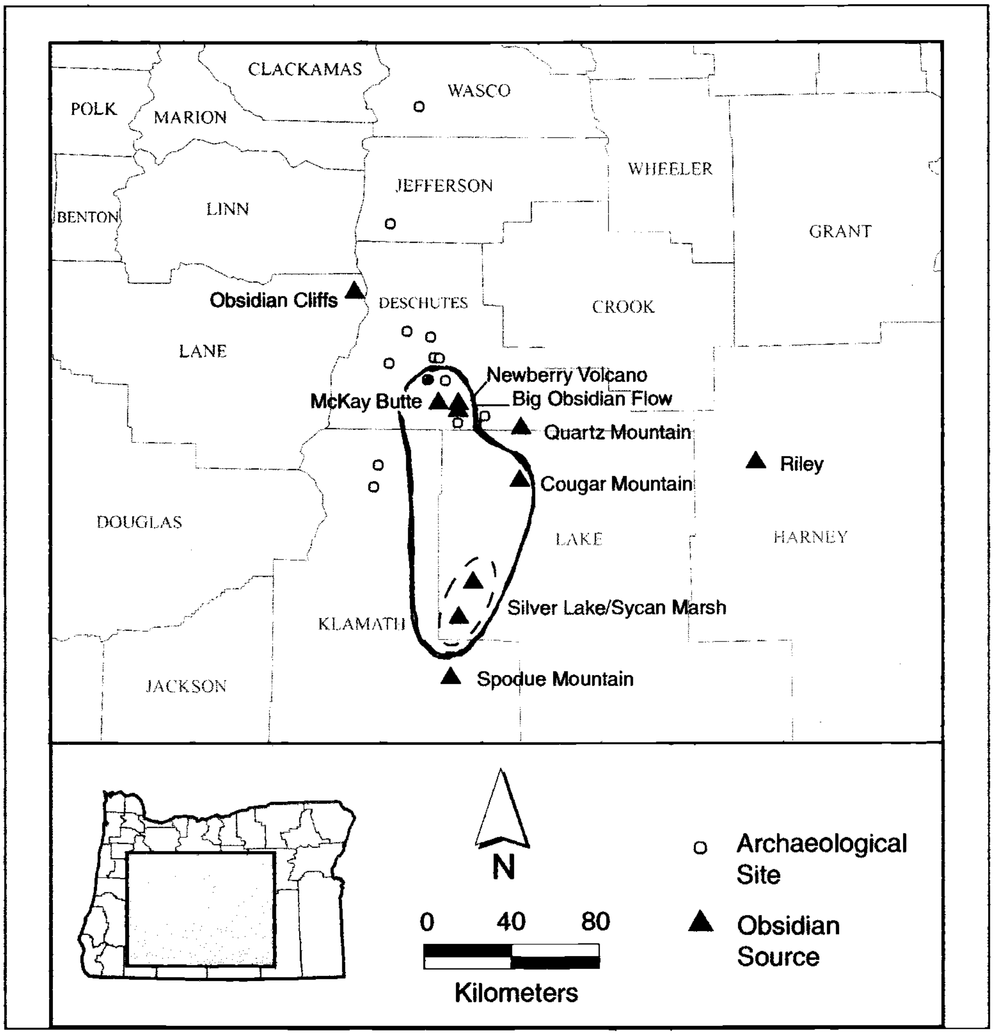


Figure 65. Map illustrating obsidian procurement pattern of Sugar Cast cache site in relation to Quartz Mountain.

The occurrence of Quartz Mountain obsidian in the lanceolate type caches is reminiscent of the findings for Newberry Volcano obsidian in this cache type. The lanceolate caches containing Quartz Mountain obsidian are located near the parent source and a northerly directional trend of the resource is not apparent in the cache type as a whole. This distributional pattern may simply be related to the local geography and the focused distribution of this cache type.

The complete absence of Quartz Mountain stone-tool obsidian in the ovate type caches and the importance of this resource in the lanceolate type caches helps identify another significant difference between the two cache types. The exploitation of Quartz Mountain glass may be related to geography. However a cultural distinction also seems apparent when comparing obsidian selections made by the two cache type artisans. The availability of Quartz Mountain resources throughout the Holocene does not allow recognition of a temporal division between the cache types.

Silver Lake/Sycan Marsh Obsidians

Silver Lake/Sycan Marsh widespread spatial distribution of obsidians is found principally within the southern half of Oregon and more specifically along the western slopes of the Cascade Range (Thatcher 2001:117-118). The distribution extends throughout central and western Oregon and on occasion in northwest California and southwest Washington but to a lesser degree. Figure 66 shows this distribution pattern. The most prevalent occurrence of these resources is in the Umpqua and Deschutes basins (Thatcher 2001:121). These concentrations are attributed to a "trans-Cascade procurement and exchange system" and collection from "local sources during seasonal subsistence activities of highly mobile populations" respectively (Thatcher 2001:121).

Silver Lake/Sycan Marsh obsidians are found most commonly in the southern ovate type caches. Sixty to seventy-five percent of the Ray and Jim-Bob caches contain Silver Lake/Sycan Marsh obsidians. The Sugar Cast site near Newberry Volcano has a minor occurrence of this glass while none of the caches north of Newberry Volcano have been identified to this resource. The only Silver

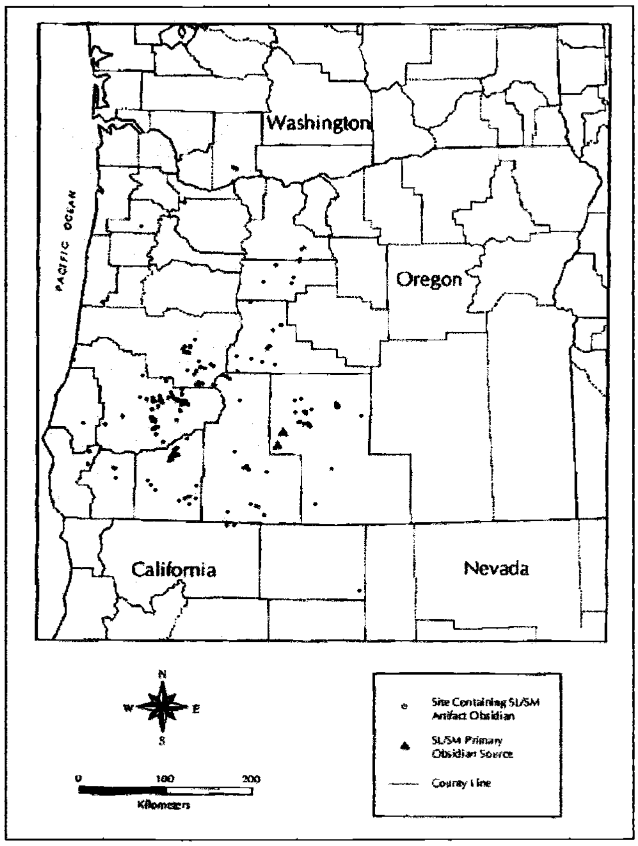


Figure 66. Map illustrating distribution of cultural obsidian from Silver Lake/Sycan Marsh (after Thatcher 2001)

Lake/Sycan Marsh resource identified in the lanceolate type caches was the China Hat site in which only 2 percent of the assemblage was identified to this source. Again, given the vast array of obsidians identified in this cache the finding is not unexpected. Overall the artisans of lanceolate type caches did not utilize this southern resource to any significant degree.

The near absence of Silver Lake/Sycan Marsh obsidians in the lanceolate cache type sites seems to imply a regional significance associated with its use.

Again this may be simply a function of geography and procurement strategies exploiting nearby resources. However this recognized absence does not preclude the possibility of a cultural component in the distribution pattern. As stated previously, Silver Lake/Sycan Marsh pattern of distribution courses along the western slopes of the Cascade Range in southern Oregon. Research has shown a predominant use of this source by the Klamath, Modoc, and northern Great Basin populations. Overall these distributional characteristics suggest an unlikely cultural affiliation between the artisans of lanceolate type caches and northern Great Basin cultures.

In contrast, within the southern portion of the caching boundary, makers of the ovate type artifacts utilized Silver Lake/Sycan Marsh obsidians as their primary stone-tool obsidian as noted in the Ray and Jim-Bob cache assemblages. Secondary obsidian resources for these caches are Cougar and Spodue Mountains. All three of these stone-tool resources are commonly associated with northern Great Basin, Klamath, and Modoc cultures (Skinner 1995:4-36-38). Both the Silver Lake/Sycan Marsh obsidian distribution pattern and the obsidian profile of the southern ovate type caches suggest a potential cultural affiliation with any or all of the northern Great Basin, Klamath, and/or Modoc cultures.

Summary of attributes associated with the cache types and associated behavioral inferences

An identifiable distinction has been noted between the lanceolate and ovate caches in artifact size and shape, environmental attributes, as well as obsidian resource procurement patterns. The notion of two types of caches is supported. Chronological inferences have been identified. Mobility patterns and possible regional affiliations are inferred for both cache types. Viewed as a comprehensive pattern it seems likely different populations created the two cache types. Whether or not these populations are separated in time remains unresolved although the possibility has not been dismissed. Regional affiliation of the artisans seems to correspond to geographical location as well as to cultural affiliation and in some instances both. Lanceolate type caches may have functioned within the context of trade practices and/or fulfilled hunting practice strategies however these hypothesized functions remain provisional. The ovate type caches are found across a number of geographic regions yet a comprehensive pattern is not readily apparent. Instead what seems to be intrinsic to this cache type is a series of individual caches each utilizing obsidian resources in close approximation to the particular cache site; yet all linked by a similar environment. Figure 67 illustrates this pattern.

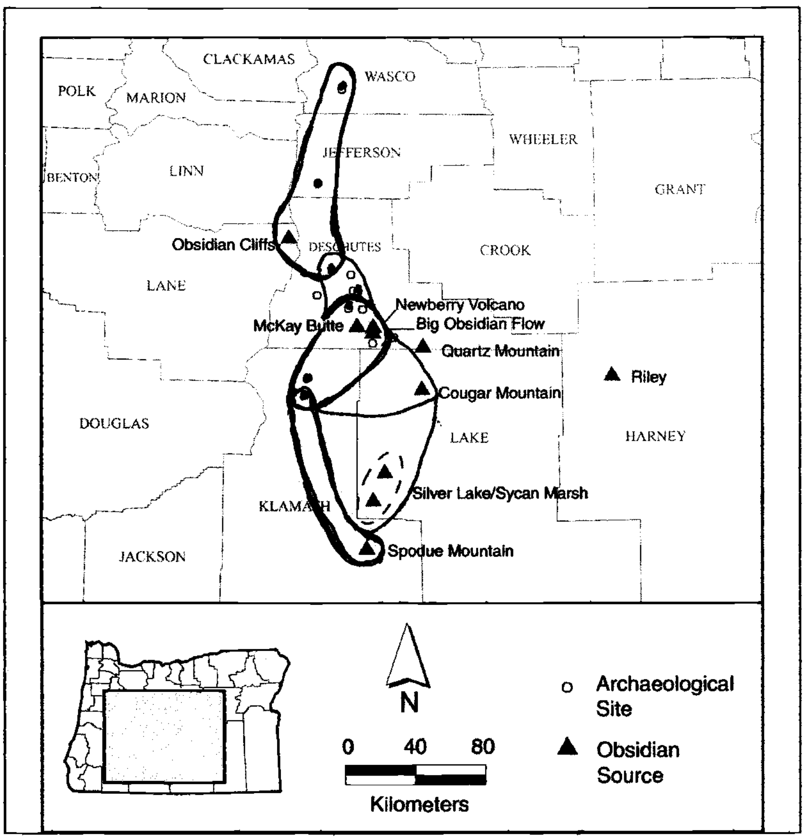


Figure 67. Map illustrating ovate cache types linked by a series of obsidian resources and river basin geography.

Cache function remains unidentified but given the smaller assemblage size a trade function seems unlikely. Overall the combination of physical, environmental, and obsidian preference attributes has offered a number of clues addressing chronological relationships of the cache types, regional affiliation of the cache artisans, and cache function.

Caching Behavior Context

According to Sharer (1993:559), the full set of interactions within such a complex system as a culture is difficult to present initially. By isolating the subordinate systems general patterns should emerge which will further dictate the nature and context of more specific hypotheses. Based on this theoretical stance the following hypotheses are offered addressing the age, cultural origin, and function of the two cache types in prehistory. Table 16 is presented to facilitate the following discussion by comparing major cultural and environmental changes in the southern Columbia Plateau, northern Great Basin, and the Paulina Lake site throughout prehistory. The shaded areas denote possible chronologies associated with the caching behavior.

The lanceolate cache type

Lanceolate type artifact caches have been tentatively defined as lithic assemblages with low intrasite size variability. The lithics are obsidian and measure containing artifacts approximately 4-10 cm in length and 1-3 cm in width and an overt lanceolate-shape appearance. The widest portion of the lithic is approximately mid-artifact. Although the majority of artifacts from lanceolate caches are bifaces some assemblages contain unifacial artifacts. Total artifact count in the assemblage is usually large, frequently exceeding 100 artifacts implying a need for storage of the tools in a functional location, possibly related to hunting or trade/exchange practices.

Table 16. Chart of cultural and environmental chronologies associated with the lanceolate type caching behavior.

Years BP	Southern Columbia Plateau		Paulina Lake	Northern Great Basin	
	Ecology	Culture	Culture	Ecology	Culture
0					
			decrease quarry activity		
1000			Component 5		
					upland focus
2000			quarry activity peaks		Late Archaic
			intense quarry activity		
3000		river focus &		drying & warmth	upland focus
	seasonal variation	stored resources	quarry activity		
4000	cooling begins	post-Tucannon	Component 4 begins		
	salmon increase	upland focus		lakes fill	lacustrine focus
5000		Tucannon		Neopluvial	Middle Archaic
6000			First Newberry obsidians		upland focus
		broad based resource	Mazama eruption		
7000	increasing warmth	strategy	broad based resource	intense drying & warmth	Early Archaic
	increase drying		strategy		broad based resource
8000					strategy
		less lg. river focus			
9000		Pioneer Phase	less residential	warming and drying	
			Component 3		
10,000		hunting & gathering	residential	Pleistocene lakes gone	upland &
	lg. rivers ok		Component 2	Silver Lake/Sycan Marsh ok	lacustrine focus
11,000	warming & drying			warming and drying	Initial Archaic
		Windust	? residential		Hunting & Gathering
12,000			Component 1		Western Stemmed
			Hunting & Gathering		Fluted points

Generally the caches are found in an array of environmental settings, adjacent to or very near lava outcrops, and usually 2 km or more from water resources. The environmental qualities of the sites suggest a preference for geographic diversity ranging from lower elevations of the Cascades into the High Lava Plains. Regardless of geographic location all of the lanceolate type caches are found exclusively within the *Pinus ponderosa* floral community. This setting serves as a narrow band of transitional vegetation fostering easy access to floral and faunal resources within three major vegetation zones. The implications of this finding suggest access to ecological variety in flora and faunal resources was a major consideration in cache location. This locational characteristic may also reflect the use of the first stable habitats after the eruption of Mount Mazama. Cache location adjacent to or near lava flows may be significant. A number of authors have speculated about the rational for this association including; ease in relocation of the caches and strategic positioning along game migration trails or both. An apparent disregard for access to water suggests the lanceolate cache sites have transitory quality and occupation was temporary or limited. Artisans associated with the lanceolate caches utilized Newberry Volcano obsidian as their primary stone-tool resource and Quartz Mountain obsidian as an important secondary material. Obsidian characterization studies have shown that after 4000 years ago Newberry Volcano and Quartz Mountain obsidian is distributed north of the quarries. This directional trend has identified the Newberry Volcano and surrounding area as a geographic and cultural boundary. Cache location and the focused distributional quality of the lanceolate type caches may be reflective of this geographic and/or cultural boundary.

Several hypotheses have been offered to account for the lanceolate type cache characteristics. In one hypothesis the Newberry Volcano obsidian preference and associated distributional pattern is tied to the intensive systematic quarrying of tool-stone material from Newberry caldera sources. Connolly's research identifies the onset of quarry activity in the caldera to about 4000 years ago with peak quarry activity about 2000-1500 years ago (1999:238-9). In this postulated scenario, task oriented groups travel to Newberry Volcano to exploit caldera obsidians. The quarried resources would have been transported out of the caldera and cached in strategic locations prior to their extensive northerly distribution. A similar hypothesis has been offered by Davis and Scott (1984); Scott (1989); Scott et al. (1986) except the trade/exchange distribution was believed to have moved in a southerly direction. Based on a trade/exchange hypothesis specific cache locations may be a function of distance to source and/or camp, small trade centers, or simply easily identifiable storage locations. Any of these behavioral choices regarding cache location would comply with the intention of further movement of the resource at a later time in a collector type resource strategy. Irregardless of cache locational choice in either hypothesizes, the lanceolate type caches are thought to have functioned as stores of lithic tool-stone for trade within an exchange system between 4000-1000 BP.

Within the context of a 4000 BP chronology the climatic and cultural histories, both north and south of Newberry Volcano, suggest a need for stone-tool obsidians. The onset of Neopluvial conditions in approximately 4500 BP in the northern Great Basin marks a resurgence of lacustrine adaptation with a shift toward permanence when lake and marsh side villages reappear in the internal basins in response to wetter conditions. An increase in population coincides with these improved environmental conditions. Five hundred years latter Neopluvial conditions subside and a new climatic pattern arises; typified by variable moisture and temperature fluctuations. Residents once again shift resource procurement strategies now with a focus on upland root crops and utilization of lacustrine resources when available. Associated with this change is residential permanence with and emphasis in storable crops. During this time, both an increase in population and an increased reliance of upland resources would present a need for stores of lithic tools. However, people residing in the northern Great Basin had access to and exploited other more readily available southern obsidian sources as noted in the Silver Lake/Sycan Marsh obsidian distributional patterns. In this context the near absence of Silver Lake/Sycan Marsh obsidians in the lanceolate type caches becomes culturally significant. The predominant use of this source by the northern Great Basin populations suggests an unlikely cultural affiliation between the lanceolate type cache artisans and these southern cultures.

As northern Great Basin residents became less centered on lake and marsh habitats the southern Columbia Plateau people were refocusing resource strategies on improving river conditions as salmon populations flourished. Terrestrial game and upland food crops remained dietary staples but to a lesser degree. Coinciding with the Tucannon period economic shift is the appearance of food storage and residential permanence both compatible with a need for lithic stone-tool material within a collector resource strategy. Unlike the northern Great Basin populations, the southern Columbia Plateau residences had limited access to obsidian resources. Certainly both a need and a function for obsidian resources exists in the southern Columbia Plateau be it trade, lack of a more readily available obsidian, or otherwise. This does not necessarily imply a need for a caching behavior. If a caching behavior is a component of this northerly distribution trend around 4000 BP then collaborating evidence in the environmental, site, and/or obsidian characteristics of the lanceolate type caches should be apparent.

Environmental qualities of the lanceolate type caches suggest the apparent disregard for water at the cache sites suggesting a temporary quality to the sites. The predominance of a Ponderosa pine ecological setting suggests ecological variety as preferential choice. While the Ponderosa pine setting may signify stability of the landscape after the Mount Mazama eruption, this is a less important consideration in this hypothesis as ecological recovery from the Mazama impact was well underway in all regions by 4000 BP. The focused distribution of lanceolate cache sites suggest a pattern consistent with earlier times, before and just after the Mazama eruption, although the pattern is not inconsistent with a post-

Mazama distribution. Neither of these environmental qualities are requisite precursors for transportation of lithic material northward.

A hypothesis centered on a 4000 BP chronology becomes problematic when the identified patterns of obsidian procurement are considered. Within this context a link between a caching behavior and the intense quarry activity of stone-tool resources in Newberry caldera is not readily apparent. What should be observed within a 4000-2000 BP timeframe is the nearly exclusive use of Newberry Volcano obsidian in the cache collections yet this is not the case. As a type, lanceolate caches are dominated by Newberry obsidian which comprises approximately 70 percent of the entire sourced collections. Despite this dominant occurrence, the entire sampled collection is not reminiscent of a post-Mazama assemblage were a near exclusive use of Newberry Volcano obsidian is the norm and frequency ranges are higher. Table 17 is a chart illustrating distributional frequencies for Paulina Lake site obsidians during the pre and post-Mazama occupations. When lanceolate type caches are reviewed individually the occurrence of Newberry obsidian is reduced; with an overall average of approximately 46 percent. While the high percentage of Newberry obsidian assures artisans of the lanceolate type caches where practicing a caching behavior after 6800 BP it does not seem to correlate with frequencies expected in a post 4000 BP pattern.

The obsidian attributes of the China Hat assemblage is an excellent example of these discrepancies. In this cache, the frequency of Newberry Volcano obsidian is approximately 35-40 percent and the frequency of Quartz Mountain obsidian is approximately 43 percent. The use of a single dominant primary stone-tool resource is not apparent nor is the frequency of Newberry glass exclusive. The eclectic collection of minor secondary resources does suggest mobility (figure 44). If the function of the China Hat cache was related to northerly trade this nearly equal split of two resources would not be expected nor would the vast array of southern secondary resources. However if the cache functioned within the context of a localized adaptive behavior at the pre and post-Mazama interface the seemingly eclectic collection appears to be more explicable. In this context, Newberry obsidians would have been exploited when they became available although not with the intensity as is seen by 4000 BP. Quartz Mountain obsidians, available just to the south of the China Hat site, would have been exploited simply as another high quality glass in close proximity to the cache location.

Table 17. Chart of source distribution frequencies of obsidian bifaces and debitage by pre and post-Mazama components of the Paulina Lake site (modified from Connolly 1999).

	Pre-Mazama Components	Post-Mazama Components	Total
		Bifaces	
Caldera/near caldera sources	38 (35%)	35 (81%)	73
Exotic Obsidian sources	70 (65%)	8 (19%)	78
		Debitage	
Caldera/near caldera sources	37 (74%)	45 (100%)	82
Exotic Obsidian sources	13 (26%)	0 (0%)	13

Note: Specimens from Unknown sources in the Paulina Lake site are tabulated as exotic.

The modicum of secondary obsidians from Cougar Mountain, Silver Lake/Sycan Marsh, Obsidian Cliffs, and McKay Butte suggest a local interaction sphere among the artisans of the lanceolate type caches as all of these obsidians, except Silver Lake/Sycan Marsh, are found in the other lanceolate type caches. In other words, this lanceolate profile seems to imply a localized foraging behavior with southern contact/interaction as opposed to a trade/exchange network in a northerly direction. The characteristic attributes associated with the China Hat cache suggests an earlier dating as well as a non-trade function and are rather compelling when the totality of the assemblage is reviewed.

The inconsistency between the lanceolate type cache obsidian distribution frequencies and what would be expected in a post-Mazama profile after 4000 BP suggest an earlier date for the cache type as a whole. These discrepancies may have their origins in the chronology of Newberry Volcano resources. XRF analysis does not have the ability to discriminate between the intra-caldera flows dating to 6400 BP, 4300 BP, and 3400 BP. The distribution frequencies of lanceolate type artifacts suggest cache artisans may have been exploiting the 6400 BP obsidians from the Interlake and Game Hunt flows. This would imply the caching behavior is not linked to the 2000-1500 BP intensive quarry activity within the caldera.

Lanceolate type caches certainly have a post-Mazama chronological component. The possibility of a pre-Mazama expression of this behavior has not been discounted. The exclusive use of McKay Butte obsidian in the Pahoehoe cache is suggestive of a pre-Mazama feature. The dominant use of McKay Butte glass prior to the eruption of Mount Mazama and this resource's near complete disappearance after Newberry Volcano obsidian became available suggests an approximate relative dating for the lanceolate type caches to a time very near the eruption of Mount Mazama. This chronological context could account for the presence of both Newberry Volcano obsidian and McKay Butte obsidian in the lanceolate type caches and tentatively date inception of the caching behavior just prior to the eruption of Mount Mazama in 6800 BP.

Further corroboration of this inference seems apparent when environmental and cultural histories of the northern Great Basin, southern Columbia Plateau and Newberry Volcano caldera site are integrated into this hypothesis. Essentially the early Cascade phase in the southern Columbia Plateau, the Early Archaic in the Great Basin, and component 3 in the Paulina Lake site are all contemporaneous and approximately represent the millennium prior to the eruption of Mount Mazama.

In the Great Basin the Early Archaic climate shift toward intense drying and higher temperatures stressed economic resources. Pleistocene lakes were gone and marsh habitats were meager, overall available lacustrine resources had declined. A combination of wetland habitat deterioration and local populations maximizing the available resources necessitated an expansion of subsistence resources. Throughout the lake basins a population decrease is noted in the archaeology. An increase in mobility into upland environs seems to account for this population shift as well as the change in resource procurement patterns toward a more diverse set of resources.

Around 7000 BP increasing warmth and aridity also stressed the southern Columbia Plateau populations. However this climatic change was delayed relative to the northern Great Basin and not as severe as environmental strain experienced in the south. The archaeology suggests a subtle shift to this climatic stress by an increase in mobility, limited residential duration yet with a continuation of the hunting and gathering lifestyle. Overall what was once a generalized broad-based resource strategy with a reliance on riverine resources shifts to an exploitation of a wider array of habitats including both aquatic and terrestrial resources. The Columbia River became an important site location because productive water levels were sustained. Tributary streams were less reliable due to reduced flows yet where home to small ephemeral camping sites exploiting faunal resources. The archaeological record suggests these adaptive adjustments, coupled with a generalized population decrease are related to the declining climatic conditions of the mid-Holocene.

A similar change is noted in the archaeology of the Paulina Lake site within the Newberry caldera. This shift is represented as an adaptive change between the early pre-Mazama components 1 and 2 and the late pre-Mazama component 3. During the component 3 occupation, domestic structures disappear as do hearth features. Lithic artifact concentrations decrease yet overall assemblage composition remains hunting related tools. A change in land use strategy is noted indicating an increase in mobility and a decrease in residential permanence. This shift is described by Connolly as a change "from a functionally diverse residential base to an increasingly specialized hunting camp" suggesting these changes represent a time when "the caldera was still regularly visited by hunting parties, possibly to access obsidian quarries (Buried Obsidian Flow), but may have been less frequently hunting base camps" (Connolly 1999:236). This adaptive shift seems to be compatible with a transitional state between forager and collector type settlement systems.

Essentially all three regions exhibit parallel patterns of cultural adjustments to pre-Mazama climatic stress although each region redirected their adaptive response to the closest neighboring alternative resources while maintaining a mobile broad-based hunting and gathering focus. These nearly identical adaptive strategies and initial adaptive responses to climatic stressors seem to reflect a regional cultural similarity in the High Lava Plains. Both the paleoenvironmental and cultural histories of each region could support the possibility of lanceolate caches functioning within the context of these modified adaptive strategies. Enhanced mobility and limited duration of site occupation is compatible with a caching behavior where obsidian resources are exploited and moved to a strategic location for use or recovery at a latter time. This behavior may have functioned to extend seasonal access, maximize the extractive efficiency of group hunting in accord with deer migration patterns, minimized time spent in given location because of poor environmental conditions or any number of reasons related to the ecological strain. All of these inferences could account for the excessive quantity of artifacts in an assemblage, a locational setting focused on ecological diversity and the transitory quality of those locations, as well as the diversity and consistency of obsidian resources within each of the cache assemblages.

In the northern Great Basin the eruption of Mount Mazama in the mid-Holocene further stressed the climatically degraded environment when thick tephra-fall covered the landscape. Coinciding with this event the archaeological record indicates residents' again adjusted adaptive responses by refocusing their broad-based hunting and gathering lifeway on upland resources and nearly abandoning the lake and marsh habitats in the basins.

In the southern Columbia Plateau the extent and duration of the Mazama tephra-falls impact on local populations is poorly understood. Evidence suggests river courses degraded as a result of the Altithermal conditions and Mazama ash further compromised river environs at the time of eruption. After the eruptive episode, the tephra-fall continued filtering into the river system from the surrounding hillsides. The level of destruction in the southern Columbia Plateau was relatively light in comparison to the northern Great Basin. Not only was the tephra depth less but local biotic and abiotic factors seem to have favored a more rapid recovery after the tephra-fall impact subsided. The paucity of archaeology sites from this time suggests a population reduction although it appears little changed in overall cultural behavior from earlier time periods. Archaeological assemblages still suggest an ephemeral, shifting subsistence strategy.

Such was not the case in the Newberry caldera a short distance to the south. The combination of a tephra-fall 50 cm thick as well as a unique set of biotic and abiotic factors logically associated with a confined caldera setting would most likely be devastating. The archaeology supports this notion as seen in the near occupational abandonment of the caldera until approximately 4000 BP. However, an occupational abandonment does not necessarily preclude exploitation of caldera or near caldera resources by the occupants of the southern Columbia Plateau or northern Great Basin.

The first Newberry Volcano caldera obsidians became available within 400 years of the Mazama eruption when the Interlake Flow and Game Hunt flows (6400 BP) extruded. The intra-caldera environment was not conducive to human occupation due to environmental and ecological conditions and possibly the eruptive history of Newberry Volcano itself. However neither factor would preclude the small, mobile task parties from exploiting the newly available caldera stone-tool resources and storing them in more favorable locations away from the caldera proper. This notion is supported by obsidian characterization studies in other Deschutes River basin archaeological sites by both Connolly (1999:237) and Skinner (1995:4-36).

Connolly's research within the caldera did not identify any indication of Newberry caldera area use in the millennia following the Mazama eruption. Connolly suggests this may be a reflection of a lack of research in the Interlake Obsidian Flow area; a significant and important flow for identifying early mid-Holocene caldera use. The author states "present evidence suggests very intermittent and low-impact use of the caldera during this interval" (Connolly 1999:237). Connolly cites research by others (see Horne 1994; Jenkins and Connolly 1996; Pettigrew and Hodges 1994) where Newberry obsidians have been recovered in an archaeological context beyond the caldera and date to this time period. These sites document procurement episodes to Newberry Volcano where obsidians were quarried and transported into the middle and upper portions of the Deschutes River basin (Connolly 1999:237).

Skinner (1995:4-36) has also reported on the use of newly available caldera obsidians in two sites (35DS263 and 35DS557) located along the western base of Newberry Volcano. Each of these sites contained a pre-Mazama component dominated by McKay Butte and Unknown X obsidians (related to temporally to McKay Butte) while the post-Mazama components were almost exclusively Newberry Volcano obsidian. A quote from Skinner summarizes the dramatic change in obsidians after the first obsidians became available in the Newberry caldera, "Obsidian from McKay Butte and Unknown X sources nearly disappear(s) from the archaeological record. The eruption of several obsidian flows within Newberry Caldera closely following the Mazama ashfall, combined with the possible burial of the McKay Butte and Unknown X sources, provides a possible explanation for this dramatic shift in obsidian source utilization in the Newberry

Volcano region" (Skinner 1995:4-36). These two sites exemplify and support a notion for very early use of caldera obsidian as well as a pre and post-Mazama chronology for the lanceolate type caches.

This research suggests the caching behavior may have had an inception prior to the eruption of Mount Mazama and continued into post-Mazama times. Within this chronological framework a number of unexplained caching behaviors can be accounted for. A pre-Mazama origin of the behavior could account for the abandonment of some of the caches as both access and cache relocation may have been hindered after the Mazama tephra-fall. Post-Mazama visitors to the caldera would have visits of limited duration within the caldera because of the inhospitable landscape. This would offer a plausible explanation for the need to cache stores obsidian in locations away from the resource. This also could account for the need to cache obsidian resources in an obsidian rich area. The scant archaeological evidence for this post-Mazama activity can be explained by population size in the region. A few, small, local mobile task groups would leave little if any archaeological record of quarrying activity of the newly available Newberry obsidians.

The distributional frequency of Newberry Volcano obsidian within the cache type and within individual caches is consistent with a pre and post-Mazama interface chronological pattern. The occurrence of McKay Butte obsidians is also explicable in the context of a pre-Mazama behavior. Within this chronological context lanceolate caches containing Quartz Mountain obsidians would not necessarily be reflective of a geographic or cultural boundary because the northerly obsidian distribution pattern was not established prior to 4000 BP. Cache locations are however in close proximity to the parent obsidian source. Procurement patterns for this glass seem to be tied to local geography suggesting distance to source is the important characteristic for Quartz Mountain obsidians. Overall the artisans of the lanceolate type caches did not utilize the Silver Lake/Sycan Marsh stone-tool resource to any significant degree. Again this finding is not necessarily regionally significant in a 6800 BP context. The finding is possibly related to local geography and may also be a function of distance to source.

The resource preference and distributional patterns identified in this research suggest the caching of lanceolate type lithics is a local behavior and not readily identifiable with a particular cultural region. The composite portrait of this cache type suggests local prehistoric populations were exploiting the nearest available obsidian resources and caching the artifacts as stores of tools to be used in a local adaptive context. This inference is clearly compatible with the generalized broad-based adaptive strategies found throughout the northern Great Basin and southern Columbia Plateau prior to and just after the eruption of Mount Mazama. The shift in adaptive behavior noted in component 3 of the Paulina Lake site, less residential permanence and an increase in mobility, is also reflective of a localized broad based adaptive strategy and compliments the suggested caching behavior inception just prior to 6800 BP.

The combined environmental, site, obsidian attributes, and paleoenvironmental and cultural histories repeatedly suggest the lanceolate type caches may date to a time near the eruption of Mount Mazama in 6800 BP. The patterns seem to suggest the caching behavior had an inception prior to this event and continued until sometime after 6400 when the first Newberry Volcano obsidians became available. The patterns also suggest the practice of caching lanceolate type stone tools was a localized behavior culturally similar to the southern Columbia Plateau residents, northern Great Basin populations, and caldera visitors.

Given this chronology and cultural cohesiveness, the caches seem to have functioned initially as an adaptive response to Altithermal conditions and latter to the impact of the Mazama eruption. This adaptive response may have augmented hunting strategies and/or enhanced obsidian availability. Abandonment of the caches may have simply been a result of relocation or access difficulties from the dynamic and dramatic mid-Holocene environmental changes. However this research suggests an alternative hypothesis. Abandonment may not have been an abandonment of the caches themselves as much as an abandonment of the caching behavior. The significant cultural changes between the late Cascade and Tucannon phases in the southern Columbia Plateau, the onset of the Neopluvial in the northern Great Basin, and the pre and post-Mazama components in the Newberry Volcano caldera sites reflect substantial and dynamic adaptive shifts throughout central Oregon. Within the context of the caching behavior this shift may be signaled by the abandonment of the caching practice as an adaptive strategy in favor of another; movement toward the intensification of quarrying Newberry Volcano obsidians for transport northward in trade.

The ovate cache type

The following hypotheses are offered addressing the age, cultural origin, and function of the ovate cache type in prehistory. Table 18 is presented to facilitate the following discussion by comparing major cultural and environmental changes in the southern Columbia Plateau, northern Great Basin, and the Paulina Lake site throughout prehistory. The shaded areas denote possible chronologies associated with the caching behavior.

Ovate type caches have been tentatively defined as lithic assemblages with low intrasite size variability. The lithics are obsidian and measure approximately 8-16 cm in length and 3-9 cm in width. The widest portion of the artifact is approximately mid-artifact. Although the majority of artifacts from this cache type are bifaces it is not uncommon to find unifacial artifacts. Total artifact count in each assemblage is generous but typically does not exceed 50 in number suggesting a functional use by small, mobile populations.

Table 18. Chart of cultural and environmental chronologies associated with the ovate type caching behavior.

	Southern Columbia Plateau		Paulina Lake	Northern Great Basin	
Years BP	Ecology	Culture	Culture	Ecology	Culture
0					
			decrease quarry activity		
1000			Component 5		
					upland focus
2000			quarry activity peaks		Late Archaic
			intense quarry activity		
3000		river focus &		drying & warmth	upland focus
	seasonal variation	stored resources	quarry activity		
4000	cooling begins	post-Tucannon	Component 4 begins		
	salmon increase	upland focus		lakes fill	lacustrine focus
5000		Tucannon		Neopluvial	Middle Archaic
6000			First Newberry obsidians		upland focus
		broad based resource	Mazama eruption		
7000	increasing warmth	strategy	broad based resource	intense drying & warmth	Early Archaic
	increase drying		strategy		broad based resource
8000					strategy
		less lg. river focus			
9000		Pioneer Phase	less residential	warming and drying	
			Component 3		
10,000		hunting & gathering	residential	Pleistocene lakes gone	upland &
	lg. rivers ok		Component 2	Silver Lake/Sycan Marsh ok	lacustrine focus
11,000	warming & drying			warming and drying	Initial Archaic
		Windust	? residential		Hunting & Gathering
12,000			Component 1		Western Stemmed
			Hunting & Gathering		Fluted points

Overall, ovate type cache locations are very similar and include three fundamental characteristics; access to water usually along a river course, a Ponderosa pine floral community, and an association with rimrock features. This combination of environmental preferences is interesting in that no single distinguishing environmental characteristic has been identified aside from the remarkable consistency of the pattern itself. These commonalities suggest a deliberate selection of these three environmental factors as a priority. In general, the environmental and site type attributes of this cache type suggest a vague and generalized but consistent pattern. When compared to the lanceolate type caches where variation of geographic location has been identified as a hallmark of the cache type, the internal consistency of this repeated pattern becomes significant. The overall setting preference is more restrictive in the ovate cache type and suggests a focused resource procurement strategy.

The implications of these finding suggests this preferential choice may be reflective of an overall reliance on a river ecology and the associated resources; water and transitional zone flora and fauna. Given this propensity, the complete absence of aquatic foods and tool assemblages associated with fishing becomes somewhat significant and supports the possibility of an importance on early, stable environments after the Mazama eruption. Overall the environmental and site characteristics suggest a lifeway focused on a broad-based hunting and gathering adaptive strategy. Artisans of the ovate caches utilized Newberry stone-tool obsidians as their primary resource however half of the sampled artifacts are obsidians from a variety of secondary sources. Obsidian characterization studies have suggested travel distance to stone-tool resource is wide-ranging, sometimes more than 100 km. The cache sites themselves are also dispersed extensively across the landscape extending over a 60 km in a north-south alignment. Obsidian preferences and ovate cache site location seems to be related and divided; northern sites frequenting Obsidian Cliffs while southern sites focus on Newberry Volcano glass and obsidian resources to the south. The overall directional trend and associated obsidian resources suggest Newberry Volcano is a central feature in the obsidian distribution pattern.

When evaluating the significance of this geographic feature as an environmental or cultural boundary both cache location and the north-south alignment of the site distribution pattern become important. Nearly half of the ovate type caches contain Newberry Volcano obsidian. However, the occurrence of this glass in individual caches is primarily found in sites within close proximity to the resource and not in cache sites north and south of the volcano. Conversely, the environmental attributes are nearly identical in all of the ovate cache sites, north and south, implying a preferential choice of a riverine setting. These relationships suggest Newberry Volcano may not be reflective of a geographic or cultural boundary but rather an expression of the ovate type cache artisans exploiting the nearest available stone-tool resource. Support for this notion is found in the composition of identified obsidians in cache sites not located near the volcano. The two northern most sites, Burdick and Badger Creek caches, do not contain Newberry obsidian in the sampled cache assemblages. Obsidian characterization studies from both caches indicate 100 percent of the identified obsidians are from Obsidian Cliffs northwest of Newberry Volcano. No occurrence of Silver Lake/Sycan Marsh resource has been identified from the obsidian characterization studies in the ovate type caches north of Newberry Volcano. In contrast, ovate type cache artisans along the southern caching boundary utilized Silver Lake/Sycan Marsh obsidians as their primary stone-tool resource. Secondary resources in these southern ovate type cache sites are derived from Cougar and Spodue Mountains, also southern resources. The complete absence of Quartz Mountain glass in the ovate type caches is remarkable. This finding does not seem to be related to cache location as nearly half of the ovate type caches are sourced to nearby Newberry Volcano. Many possibilities could account for this behavioral choice and have been identified in other obsidian characterization studies including; glass preference by the cache artisans, cultural procurement strategies and territories, cultural affiliation and physical geographic boundaries (Thatcher 2001:90-120). Relative to this research, the primary significance is the presence of Quartz Mountain obsidian in the lanceolate caches and the complete absence in the ovate caches. This implies the artisans of the two cache types are separated either culturally, temporally, or both. Although this study has not identified a potential causal factor for this discovery the finding seems to represent an expression of culturally dictated behavior and warrants further study.

The ovate type cache obsidian distribution frequencies do not seem to correspond to an overall regional pattern. However, when individual or small subsets of the ovate type caches are used in a comparison subtle approximations do seem apparent. Newberry Volcano seems to be a central feature to a pattern linking a series of repeated smaller patterns. Each subset overlaps with the joining set connected by shared obsidian resources all of which share a common river basin setting. As a composite pattern no specific geographic or cultural boundary can be identified in this long but narrow north-south resource model (figure 67).

The presence of Newberry caldera obsidian clearly identifies a post-Mazama chronology for the ovate type caches. The total absence of McKay Butte obsidian in all of the ovate type caches suggests a pre-Mazama component is unlikely. This evidence suggests the caching behavior had an inception no earlier than 6400 BP when the first Newberry Volcano obsidians became available.

Obsidian characterization analysis of ovate type caches located near Newberry Volcano have high distributional frequencies of Newberry Volcano obsidian. Typically the frequencies range from 91-100 percent in the sampled collection. This strong and predominant use of caldera glass suggests a profile consistent with the intense quarry activity in the caldera around 2000 years ago. However, the two northern most ovate type caches exclusively utilized Obsidian Cliffs as an obsidian resource. This differential characteristic is significant because it suggests the distinctive northerly distributional trend noted for Newberry obsidian after 4000 years ago is not apparent in the ovate cache type as a whole. These findings suggest a post-Mazama chronology probably at a time when Newberry obsidian was quarried from the caldera in fairly high proportions yet prior to the intense quarry activity and northerly distribution beginning around 2000-1000 years ago. Nothing in the ovate type cache environmental or site distributional qualities indicates the caching behavior is related to the caldera quarry activity of the obsidians for trade. This would bracket the chronology of the ovate type caches to a time between 6400 and 4000 years ago. The combined environmental, site, obsidian attributes repeatedly support approximate date of 5000-4000 years ago for the ovate type caches.

The environmental and cultural histories of the northern Great Basin, southern Columbia Plateau, and the Newberry Volcano caldera sites can be linked to this chronological context for the ovate type cache attributes and their associated inferences. The ovate type cache profile illustrates a wide assortment of obsidian resources were exploited over a great distance in a north-south alignment. Cultural distinctions do not seem evident when considering the ovate caches as a composite type. However, individual cache distribution frequencies have revealed a series of 3-4 separate procurement areas each exploiting the closest stone-tool resources (figure 67). All of the procurement spheres are linked to each other by common stone-tool resources. Obsidian characterizations unique to each of these groupings can be linked to known distributional patterns of the local resources. This perspective helps identify possible cultural distinctions within each localized pattern.

Within the context of a 6400 and 4000 BP chronology residents of the northern Great Basin and southern Columbia Plateau were shifting adaptive strategies in response to improved ecological conditions. Environmental degradation from Mazama tephra-fall had begun to stabilize and local floral and faunal resources were recovering. In the northern Great Basin the intense aridity and elevated temperatures of the Altithermal were beginning to subside. In the southern Columbia Plateau climatic conditions initially remained dry and warm as regional cooling and seasonal variation was slightly delayed compared to the northern Great Basin.

About 5000 BP Neopluvial conditions recharged lake basins and marsh habitats in the northern Great Basin. Local residents refocused adaptive strategies to exploit these newly available resources. The Spodue Mountain, Silver Lake/Sycan Marsh, and Cougar Mountain obsidian resources are all located within the context of this basin ecology. The two most southern ovate cache sites, Ray and Jim-Bob, exploited Silver Lake/Sycan Marsh resources as their primary stone-tool obsidians. One third of the Sugar Cast cache has been identified with this resource as well. Silver Lake/ Sycan Marsh obsidian distributional patterns demonstrate a connection between these stone-tool resources and the northern Great Basin cultures. The overall implication suggests the artisans of the most southern cache sites may have had a cultural connection with a northern Great Basin culture. The overall subsistence and stone-tool procurement pattern identified for these three caches focuses on a river basin and lake/marsh ecology.

At approximately 5000 BP the southern Columbia Plateau residents had begun to focus adaptive strategies primarily on upland resources as Altithermal conditions continued for another 1500 years. This upland focus in the southern Plateau utilized the Lower and Middle Deschutes River basin ecology as an important subsistence resource base. The two northern most sites, Burdick and Badger Creek caches are located within tributaries of these river basins thereby suggesting an affiliation with a southern Columbia Plateau culture. Obsidian characterization studies identify the exclusive use of Obsidian Cliffs stone-tool resource by the artisans of these two caches. Obsidian Cliffs is located in the high elevations of the Cascade Range allowing only seasonal access to the resource. Because many of the obsidian sources are located in the higher elevations of the volcanoes snow lines would have prohibited access as much as half the year. Extra stores of obsidian may have functioned to extend availability of the resource well beyond the summer months. The lower elevations of the ovate type caches would support this notion. The overall subsistence and stone-tool procurement spheres include both a river basin and a high Cascade mountain ecology.

In the region of Newberry Volcano environmental conditions were very similar to the southern Columbia Plateau, as this region is an extension of the Deschutes River basin. Obsidian source studies identify the primary stone-tool resource for caches located in this region as Newberry Volcano obsidian. Again the overall subsistence and stone tool procurement area includes both a river basin and high elevation mountain ecology.

Within the caldera proper ecological conditions were beginning to improve allowing longer visits to access resources. Connolly identifies this period as component 4 in the archaeological record and marks the beginning of quarry activity within the caldera. During this time visits to the caldera were limited and focused on procurement of stone-tool obsidians for export out of the caldera.

All of these adaptive shifts are compatible with a need to cache stone-tool resources in strategic locations along waterways. The southern Columbia Plateau and Newberry Volcano region residents may have used these stores to ensure seasonal access of obsidian tools in concert with an adaptive shift to an upland resource focus. This inference is compatible with ovate type cache locations within the biologically productive communities of river basin ecology. The alignment of ovate type sites in a north-south direction primarily along the Upper and Lower Deschutes River Basins also supports this notion. Based on the cohesive pattern of environmental and site locational characteristics as well as the repeated pattern of obsidian procurement from local resources the ovate type caches seem to be most closely linked with a southern Columbia Plateau culture. However the utilization of Silver Lake/Sycan Marsh and other dominant southern obsidian resources by the artisans of the ovate caches suggests a possible cultural connection to the south.

This finding may represent interaction and/or contact as opposed to a cultural affiliation.

Abandonment of the ovate type caches may have simply been unintentional; however this seems less than adequate to offer as the only explanation. Abandonment can not be connected to tephra-fall deposits as was hypothesized for the lanceolate type caches. Ecological recovery from the Mount Mazama tephra-fall was well underway and ash-fall from Newberry Volcano eruptive events was negligible by comparison. Additionally, ash from the Newberry Volcano eruptive events fell toward the north-east, away from the ovate type cache locations suggesting nominal impact on the Deschutes River Basin. Given the absence of an identifiable environmental cause, abandonment as a result of cultural changes seems possible. As was noted in the lanceolate type caches, abandonment when related to cultural change; is not an abandonment of the caches but a discontinuation of an adaptive practice in favor of a more productive behavior. Within the context of a 6400-4000 BP chronology and an inferred southern Columbia Plateau cultural affiliation, a review of this region's cultural history may provide clues necessary to identify a causal factor influencing the abandonment.

In the southern Columbia Plateau a dramatic and sustained change is noted in the archaeology at approximately 4000 BP. Climatic conditions cooled, seasonal variation increased, and salmon populations began to flourish. A movement toward summer residential permanence along large waterways and a winter shift into tributary canyons is noted. This post-Tucannon cultural shift in procurement strategy, away from terrestrial resources and hunting and gathering toward a collector strategy focused on salmon and root crops may well account for the abandonment of the ovate type caches. In the northern Great Basin the Neopluvial waned while variable and unpredictable moisture became the climatic hallmark of the region. Adaptive strategies adjusted with this climate change. Now a focus on upland root crops became a priority and use of lake/marsh resources was limited to availability. Given these environmental conditions artisans of the ovate caches may

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Appendices

Appendix A

The Big Babbette Archaeological Site

Appendix A

The Big Babbette Site

The Big Babbette cache site is located within and just in front of a blister-like lava formation and adjacent to several small lava outcrops. The local, present day floral community consists of Lodgepole pine, bitter brush, current, and occasional grasses. Upon initial discovery of the cache the interior floor of the lava blister was covered by moss. This suggested the cached artifacts had been undisturbed since their original placement in prehistoric times and may represent an intact cache location. The site was discovered during the Topso cultural resource inventory by Paul Christy and Thomas E. Churchill in August of 1990 (Jenkins and Churchill 1990). The site name, Big Babbette, refers to a song written by Frank Zappa titled *Babbette* (Zappa 1988). The Big Babbette site is located on the Deschutes National Forest, within Newberry National Volcanic Monument, on the southern flank of Newberry Volcano in central Oregon. Figure A-1 illustrates this geographic location.

Components of the site are found along the edge of a lava outcrop, within a rocky area, and on top of the rocky area, all at different elevational levels, yet clearly representing a single site. As separate entities overall surface size varies, yet each elevational section is generally flat and open. Figure A-2 illustrates the cache location within the site complex. The cache is a single feature within this larger site complex. Excavation of the cache did not disturb the integrity of other areas of the site. Excavation of the remainder of the site would contribute significantly to this study and possibly subsequent research on caches as well as local and regional prehistories.

Dimensions of the entire site are 100 m by 45 m in a southwest by northeast alignment covering approximately 0.6 acres. Lithic debitage litters most areas of

Appendix A (Continued)

the site. The majority of obsidian flakes cover the flat area from the base of the rocks and extends toward the northwest.

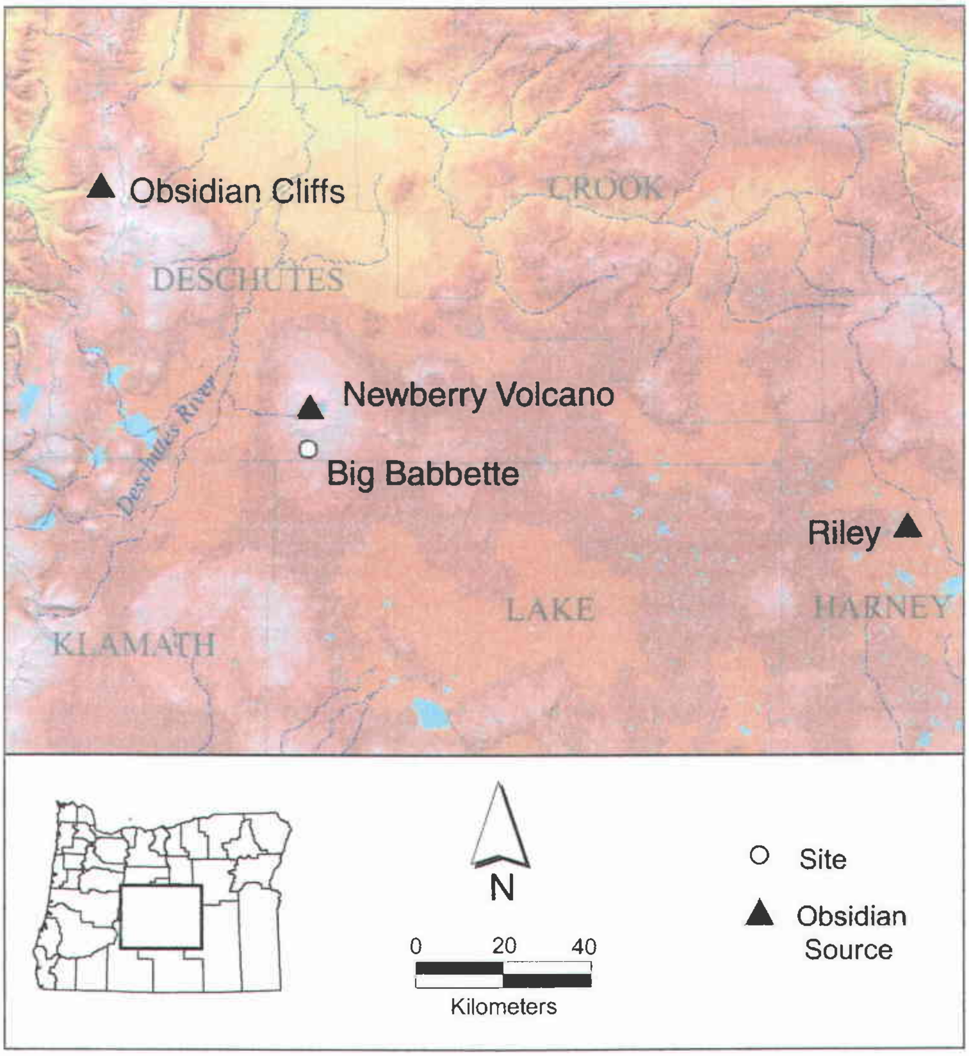


Figure A-1. Map illustrating the location of the Big Babbette site.

Appendix A (Continued)

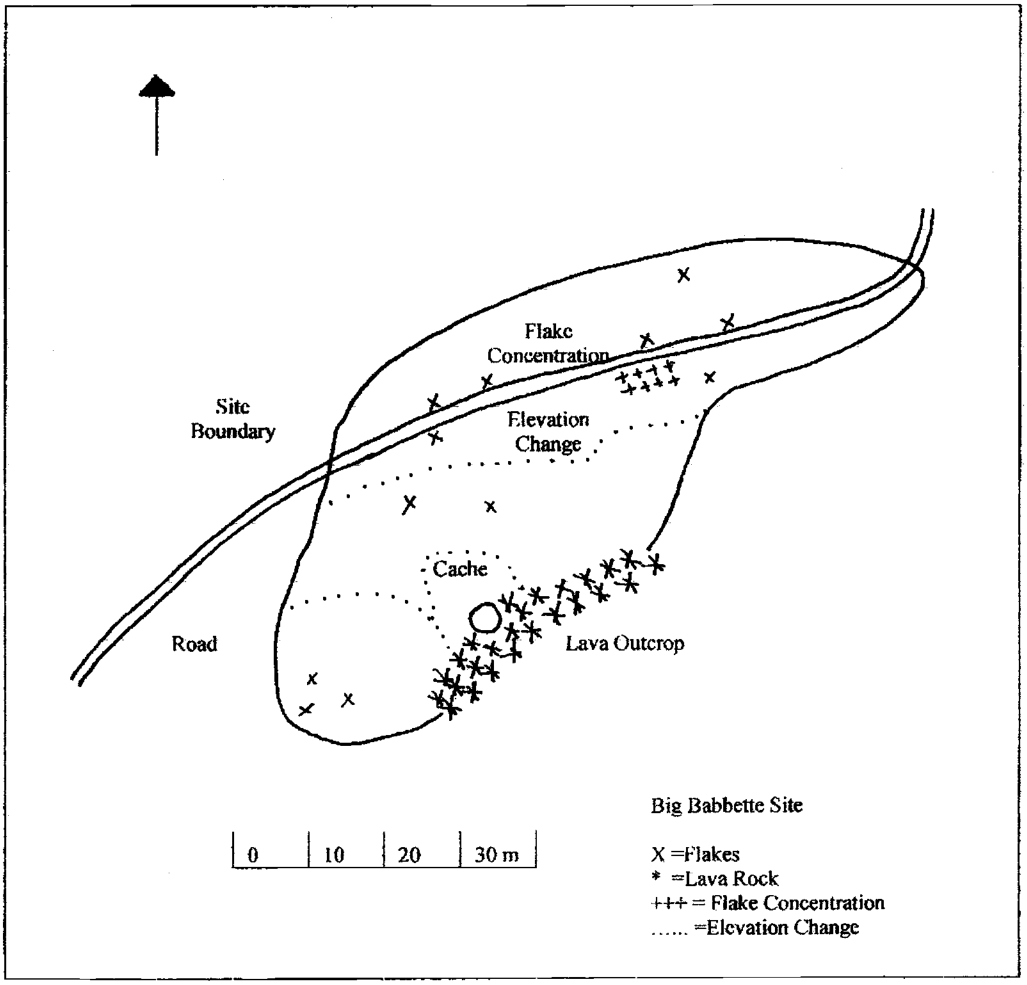


Figure A-2. Site map of the Big Babbette site.

In this area of the site the greatest concentration of flakes does not exceed eight flakes per square meter. In the small flat area southwest of the cache, and at a slightly higher elevation, is a very light scatter of flaked material. No evidence of flakes or debitage was found in the immediate vicinity of the cache location. A dirt road transects the lower area of the site as does an intermittent drainage. This road and recent clear cutting activities impact the integrity of the northern edge of the site (Jenkins and Churchill 1990).

Within the immediate vicinity of Big Babbette is a mixture of volcanic features including buttes, domes, vents, and associated flows. All of these natural features contribute to the site formation process; however none of them seem to have adversely affected the cultural deposits. Local soils are primarily comprised of ash and pumice, covered by a thin layer of duff.

Excavation Procedures

The primary unit of investigation was the cache feature (test unit A) within its discrete geological formation and the area immediately front of the opening (test unit B). Horizontal control was maintained by placing a 1 m^2 unit over the cache location. Approximately half of unit A is encompassed by the anterior portion of the lava formation. Vertical control was maintained with a line level at an arbitrary elevation. Surface features and artifacts were mapped prior to any excavation. Figure A-3 illustrates the site after excavation with the associated rock features and cache artifacts.

The lava blister is roughly a half circle containing a central lava extrusion in the center of the floor. East of the central lava extrusion the ventral surface of a large obsidian core/flake (FS #1) was visible. Between the lava extrusion and the posterior wall of the blister a large unfinished uniface (FS #2) was partially exposed. All excavated material was screened using 1/8 inch mesh hardware cloth.

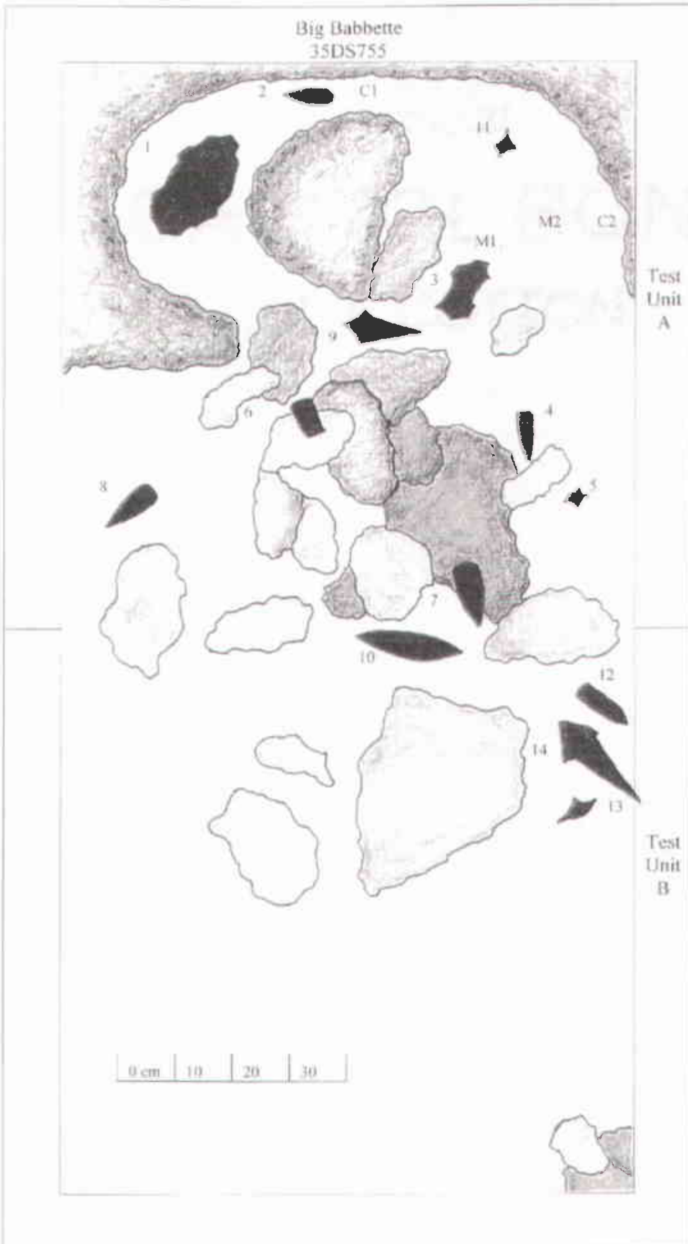


Figure A-3. Map of the Big Babbette cache site and artifact location after excavation.

Initially excavation of the lava blister and the half m^2 area in front of the feature was attempted in 10 cm levels but proved impossible due to the movement of the pumiceous deposits and the confined space of the interior of the blister. The site matrix was entirely comprised of ashy and pumiceous volcanic deposits and very fragile. This matrix composition prohibited any possibility of pedestaling artifacts in place. To compensate for this lack of control each artifact was recorded and mapped *in situ* when first encountered with point provenance detail. Removal of the deposits was very gradual, centimeter by centimeter, so as to not disturb artifact positioning when uncovered. As encountered, each artifact was mapped, recorded, and bagged separately until a depth of 20 cm was reached, at which time a floor map of the level was generated. This process was repeated in the interior of the lava blister until only stationary volcanic rock remained on the floor. A depth of approximately 64 cm was reached in a very small vertical pocket encased by rock formations. Overall, the floor was an uneven arrangement of volcanic rock formations. Outside of the blister the same process was employed reaching a depth of approximately 100 cm at which time all small sized yellow pumices was removed and an exposed rock bed with thin layers and small pockets of ash, fine pumice, and paleosol were encountered. Although the deepest cultural material was found at a depth of 40 cm below surface, the removal of the remaining volcanic deposits identified any stratigraphic changes and associated volcanic depositional events in the immediate area of the cache.

Stratigraphy

The stratigraphic sequence of the site (Figure A-4) is almost exclusively one of layers of volcanic tephra and ash. Outside of the lava blister only a 1 cm layer of duff (A), capped the ash and tephra layers. Just below the duff was a 5 cm lens of very fine-powdery gray ash (B). This ash lens grades into a 9 cm thick layer (C) of fine gray colored pumice. An obvious and abrupt change is noted between the C and D layers when a yellow, kitty litter size, pumice begins and continues for 77 cm to a depth of 92 cm below surface.

Surface	Level A	1 cm duff
	Level B	5 cm fine, gray powdery ash
10cm		
	Level C	9 cm fine, gray colored pumice
20cm		
30cm		
40cm		
50cm		
	Level D	77 cm yellow, kitty-litter size pumice
60cm		
70cm		
80cm		
90cm		
100cm		
110cm	Pumice and Paleosol	18 cm sandy-grainy pumice and soil mix

Figure A-4. Chart of the stratigraphic sequence for the Big Babbette cache site.

A sample of level D tephra was sent to Washington State University for identification. The composition of glass in the sample had a similarity coefficient =.99 with 1.0 indicating a perfect match to the Mazama climactic eruption (6850 BP) standards. Results of the tephra analysis follow this discussion and are also included in this appendix. The stratigraphic sequence terminates in an 18 cm thick layer of sandy-grainy pumice and soil mix (E). This soil forms small concretions approximately 5 mm in size. The stratigraphy was consistent and uniformly distributed across the test units outside of the lava blister. Occasional small to midsize tree roots transected the tephra layers but generally did not appear to have altered the artifact distribution or the stratigraphic sequence. No rodent burrows were noted but given the fragility of the tephra any unconformities would fill in with the surrounding material.

Artifact Distribution

The Babbette cache's lithic artifacts were distributed within and in front of the lava blister alcove (figure A-3). A scan for each of the Big Babbette artifacts and the artifact catalog follow this discussion and are also included in this appendix. The surface immediately adjacent to the enclosure slopes very gently away from the protected area within. Almost centrally located within the alcove is a lava extrusion which rises above the interior surface level. Field specimen (FS) #1 is a very large obsidian flake/core weighing 728 g. The artifact's position within the shelter was most likely an original location due to the weight of the artifact. FS# 2, a lanceolate-shaped uniface, was found between the back wall of the enclosure and the extrusion, again suggesting a prehistoric placement of the artifact deep within the alcove. FS# 3 is a large, thin, flat flake. Given the smooth surface of the artifact, the original placement of this artifact within the shelter is uncertain except for its location within the alcove. Artifact #9 was recovered near the mouth of the enclosure. This biface fragment (tip to midsection) was one of the more deeply buried artifacts of the cache located 22 cm below surface. The biface fragment was wedged between the shelter's extruding lava rocks and a lava rock buried at the 20-30 cm level just outside the shelter opening. Two other biface fragments (#'s 13 and 17) recovered during the excavation co-join with this fragment forming the basal section of a complete biface tool. Fragment #13 was recovered approximately 1 meter south of FS# 9 (tip to midsection) while fragment FS# 17 was recovered while screening test pit A. Also located within the shelter was a large obsidian flake at a depth of 22 cm below surface. These five artifacts; FS#'s 1, 2, 3, 9, and 11 were distributed throughout the shelter's interior from surface level to a depth of 22 cm.

A total of 10 artifacts were recovered outside of the lava enclosure. One of the 10 has been previously discussed (FS# 13) due to its relationship to an artifact (FS# 9) within the shelter. Of the remaining nine exterior artifacts, two co-join (FS #'s 4 and 6) to form a complete uniface. The assemblage of cached artifacts outside of the shelter is composed of a total of eight complete artifacts. Half of these artifacts (FS#'s 4 and 6, 7, 8, and 12) are complete unifacial tools. Each of these four tools has obvious basal modifications. Artifact FS# 4 (uniface tip-midsection) was found with its light weight tip angled toward the surface and the tip pointing toward the shelter. This angle and direction is consistent with a depositional process of an unevenly weighted artifact slowly moving down slope overtime; the heavier end affected by gravity. The distribution of the remaining three unifaces and base of the aforementioned uniface tip are unique. All of these artifacts were aligned with the heavier base toward the mouth of the enclosure and the lighter weighted tips pointing away from the shelter. As a group they fan out and away from the shelter opening. To understand this unique patterned distribution a look at the site formation process is required. The Big Babbette cache consists of a total of 21 artifacts, 15 of which were recovered *in situ*. Of these 15 artifacts, five were recovered within the shelter and the remaining 10 artifacts recovered outside of the shelter and had a fanning distribution. Together this suggests all of the Big Babbette artifacts were cached within the lava alcove in prehistoric times. The mouth of the shelter is open and wide enough to facilitate the interior filling with snow each winter subsequently melting away during summer months. The depositional process of repeated snow melting would create an interior environment where movement of some of the artifacts out of the shelter would be likely. The distribution of the artifacts outside of the shelter in a fan-like pattern offers supporting evidence for this scenario. The directionality of the unifaces are explicable by a number of hypothesis. One possible explanation is the unifaces were hafted tools as opposed to a collection of unfinished bifaces. Figure A-5 illustrates the artifact locations and proposed hafting elements.

Appendix A (Continued)

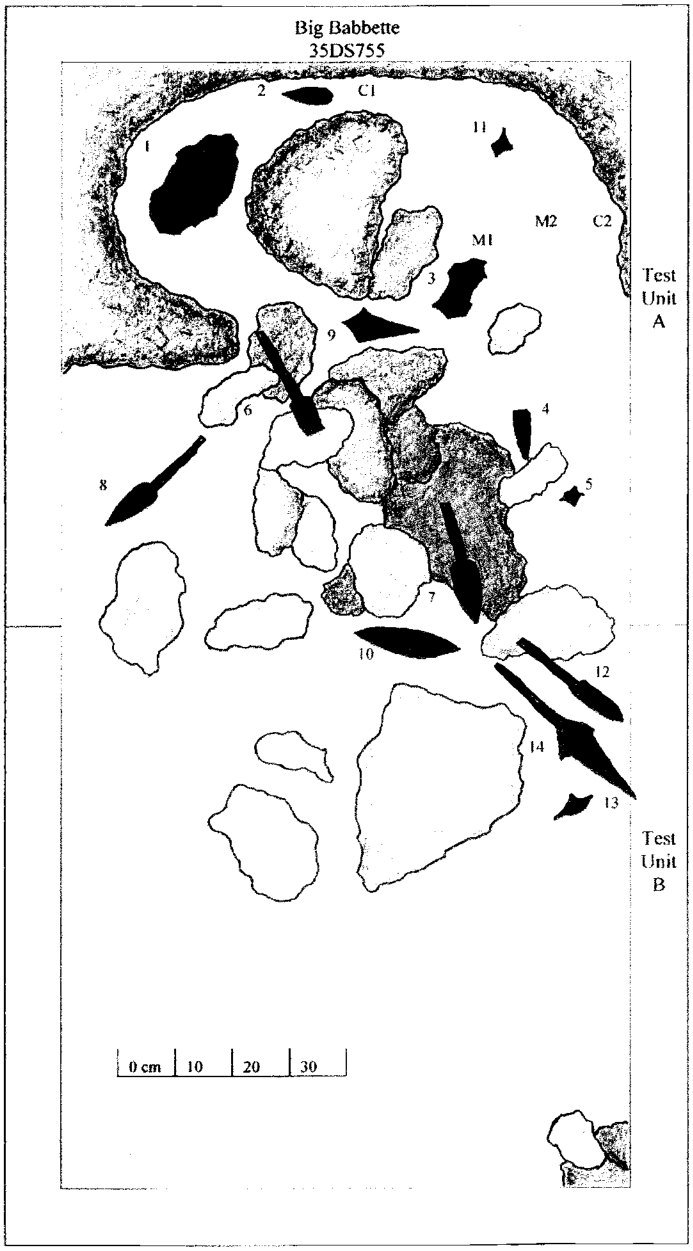


Figure A-5. Map of Big Babbette excavational levels, rock features, and artifacts. Artifacts shown with proposed organic shafts.

In this hypothesized explanation the cycle of repeated snowmelts redistributed the cached assemblage outside of the shelter and the hafting element would add a drag effect to the tools. The drag effect would align the lithics with the weighted-end up slope. Eventually the organic hafted element would decompose and the obsidian uniface become buried, leaving these lithics in the unique positional direction noted at the time of archaeological recovery. Artifact FS# 14 is an undisputable re-sharpened biface stone tool. This artifact was also recovered with its heavier base pointed toward the lava alcove's opening. The artifact was found resting at an angle with the large point (base) toward the surface and the smaller point (tip) downward in the gray-tan tephra matrix. Both the position and angle are consistent with a hafted tool and adds credence to the scenario proposed for the depositional process of the four uniface tools. Artifact FS# 15 is a large obsidian flake/blank void of any basal modification. The artifact is essentially symmetrically ovate and evenly weighted. This lithic was recovered a half meter outside the shelter lying horizontally to the mouth of the shelter. The position is consistent with an even-weight distribution, non-hafted lithic artifact. Of the nine artifacts found outside of the alcove, the remaining two artifacts (FS#'s 5 and 15) are small to midsize obsidian flakes. The majority of the lithic assemblage is concentrated in the western half of the 1x2 meter cache site and is not unexpected considering the shape of the shelter opening and the gentle slope of the site.

Lithic Technology

The Big Babbette cache site report briefly addresses a "unique" lithic technology thought to be exhibited in the Babbette cached artifacts (Jenkins and Churchill 1990). When the report was written only surface artifacts recorded during the survey were used to identify the unique technology.

From this small surface sample a unifacial reduction strategy to eventually produce bifaces was thought to be exhibited by the cached unifacial artifacts. This reduction strategy was defined and explained in the site report by Jenkins and Churchill (Jenkins and Churchill 1990) and is summarized as follows:

The method uses a series of unifacial flaking steps to reduce a flake blank to a long, narrow, and thin ovate or pentagonal shaped lanceolate uniface in three steps. The first step is the removal of the flake blank and initial unifacial edge preparation along the left lateral edge margin on the dorsal surface. The next step involves unifacial shaping and thinning for size, shape, and thickness, all on the dorsal surface. The third step removes flakes from the unworked surface of the uniface creating a biface. According to the site report the unifaces observed during the survey represented different stages of the above manufacturing process (Jenkins and Churchill 1990). The report states this unifacial reduction strategy is known but rare at other Deschutes National Forest sites, including other cache sites but does not identify a particular site. However it is stated in the report that when the technology of the Babbette artifacts was compared to other unifaces and bifaces on the forest they were found "not to exhibit the diagonal parallel flaking pattern that is typical of many of the bifaces found at other cache sites" (Jenkins and Churchill 1990).

While the lithic technology of the Big Babbette cached artifacts seems to be unique and rare, the small sample size (N=2-3) of artifacts discussed in the site report may have created an erroneous interpretation of the artifact assemblage. For example, the recovery of the entire assemblage has identified a diagonal parallel flaking pattern for some of the artifacts, a pattern noted in other local biface caches. Excavation of the Big Babbette site and recovery of the entire assemblage suggests the unifaces may have been finished functioning tools as opposed to lithics representative of different stages of the manufacturing process as described in the report.

Appendix A (Continued)

Geochemical Source Analysis

The entire Big Babbette cache was submitted for geochemical source analysis to Dr. Craig Skinner at the Northwest Research Obsidian Studies Laboratory (Skinner 2004). The entire geochemical source analysis is included in this appendix. The assemblage consists of a total of 21 lithic artifacts recovered during the cache excavation; three of these artifacts co-join to form a total of 18 complete artifacts. These 18 complete artifacts from the assemblage are functionally categorized as follows; eight expedient flakes, one large core/flake, one lacustrine, one biface/uniface blank, two biface finished tools, and five finished unifacial tools. The geochemical source analysis identifies 89 percent of the collection was derived from Newberry Volcano obsidians, 6 percent from Obsidian Cliffs, and 6 percent from Riley obsidians. Newberry Volcano geochemical sources unequivocally post-date the eruption of Mount Mazama (Skinner 1995:4-29) therefore the cache post-dates 6800 BP.

The post-Mazama dating of the cache, source distribution frequencies, and distance to source data can be used to compare the Big Babbette cache to the Paulina Lake site within Newberry caldera (Connolly 1999). The following is a brief synopsis of the Paulina Lake site as it pertains to this discussion. The Paulina Lake site is an intact, stratified site; securely dated by serial radiocarbon samples. In Connolly's study of this site the chronology has been divided into five stratigraphic components. Components 1-3 are pre-Mazama occupations while components 4 and 5 are post-Mazama occupations (Connolly 1999:165). Connolly compares the obsidian distribution frequencies of recovered bifaces in the site's pre and post-Mazama components. In this comparison, caldera and near caldera (McKay Butte) obsidian sources comprise 35 percent of the pre-Mazama components obsidians, while 65 percent are derived from exotic (distant) sources.

Appendix A (Continued)

In the post-Mazama components this ratio changes, 81 percent are local obsidians and 19 percent are exotic obsidians. The Big Babbette site's source distribution frequencies are most closely comparable to the post-Mazama distribution pattern in that 89 percent of these artifacts are from caldera sources and 11 percent are exotic sources. Table A-1 compares source distribution frequencies of the pre and post-Mazama components from the Paulina Lake site to the Big Babbette cache.

Table A-1. Source distribution frequencies of obsidian bifaces and debitage by pre and post-Mazama components of the Paulina Lake site compared to the Big Babbette cache artifacts (modified from Connolly 1999).

	Pre-Mazama Components	Post-Mazama Components	Total	Big Babbette
	Bifaces			Tools
Caldera/near caldera sources	38 (35%)	35 (81%)	73	8 (80%)
Exotic Obsidian sources	70 (65%)	8 (19%)	78	2 (20%)
	Debitage			Flakes
Caldera/near caldera sources	37 (74%)	45 (100%)	82	8 (100%)
Exotic Obsidian sources	13 (26%)	0 (0%)	13	0 (0%)

Note: Specimens from Unknown sources in the Paulina Lake site are tabulated as exotic. Specimens from the Big Babbette cache with sources greater than 10 km distant are tabulated as exotic.

This comparison supports a post-Mazama dating for the Big Babbette site. Excavation of the Paulina Lake site identified pre and post-Mazama occupational histories and suggested resource strategies associated with those occupations. The research suggests Pre-Mazama occupations centered daily activity on hunting and gathering of subsistence resources within the caldera. Obsidian procurement appears to have been a secondary activity. The foundation of this interpretation is derived from a comparison of pre and post-Mazama obsidian source frequencies as well as a comparison of distance to source data. Pre-Mazama source distribution frequencies for all tested debitage showed 26 percent was from distant sources and 74 percent were local obsidians. When the biface tools were compared, 35 percent were found to be derived from intra-caldera sources and 65 percent from distant sources. Table A-2 compares distance to source averages of the pre and post-Mazama components of the Paulina Lake site to the Big Babbette cache. This distribution pattern is interpreted as hunting tool kits (exotic obsidians) brought into the caldera and local obsidians procured only to replace broken or lost tools during hunting activity. The average distance to source for all pre-Mazama bifacial tools was 50 km. All stages of lithic stone-tool production including finished projectile points, early stage quarry bifaces, and blanks were sourced to exotic obsidians (Connolly 1999:165).

Table A-2. Comparison of source distances for cultural obsidian from Newberry caldera sites and the Big Babbette cache site (modified form Connolly 1999).

Source to distance	Pre-Mazama Total	Post Mazama Total	Big Babbette
<10 km	59 (50%)	80 (93%)	16 (89%)
10-100 km	42 (36%)	5 (6%)	0 (0%)
>100 km	16 (14%)	1 (1%)	2 (11%)

The focus changed during post-Mazama occupations when primary resource activities were directed toward quarrying obsidian for export out of the caldera. During this occupation source distribution frequencies shifted and all tested debitage, as well as 79 percent of the bifaces, were derived from within or near the caldera. Implements from exotic sources comprised only 19 percent of the recovered artifacts. The average distance to source for the post-Mazama bifaces was 11 km. Furthermore, tools from more distant sources were limited exclusively to finished projectile points (Connolly 1999:163). Connolly suggests this evidence again represents finished tools brought into the caldera as part of a standard traveling tool kit. However the post-Mazama tool kit was used for ancillary hunting and gathering activities while undertaking the primary pursuit of quarrying obsidian for export out of the caldera (Connolly 1999:163).

The obsidian source frequencies of the five unifacial tools from the Big Babbette cache can be compared to the obsidian source frequencies of the Paulina Lake site tools. These five unifacial tools were derived from three different obsidian sources. The source distribution frequency of these tools is 60 percent Newberry Volcano (n=3), 20 percent Obsidian Cliffs (n=1), and 20 percent Riley (n=1). This obsidian procurement pattern is consistent with the post-Mazama procurement pattern at the Paulina Lake site in that a greater number of tools were derived from local obsidian sources. Additionally, in the Big Babbette cache only the unifacial tools were sourced to exotic obsidians. Examination of these comparisons further supports the interpretation of the Babbette unifaces as finished tools.

The Big Babbette cache seems to exemplify an occurrence of Connolly's propositional notion suggesting hunting tool kits were brought into the Newberry caldera for subsistence activities while the occupants quarried Newberry obsidians for export out of the caldera during post-Mazama times.

Discussion

The Big Babbette cache is a single feature within a large complex site and was the primary unit of investigation in the excavation. A total of 21 artifacts were recovered during the excavation, all obsidian. Two charcoal samples and two matrix samples were also collected during excavation. Additionally, soil/tephra samples were obtained from each stratigraphic level of the site. The only sample tested was the tephra identified as the Mount Mazama climactic eruption (6850 BP). The tephra identification along with the artifact's position in the upper portion of the Mazama tephra suggests a post-Mazama dating of the cache.

The artifact assemblage is comprised of a single large flake/core, one scraping tool, a large ovate biface blank/preform, two bifacial tools, five unifacial tools, and eight expedient flakes. The stratigraphy of the site as well as the patterned distribution of this assemblage suggests an overall depositional integrity for the cache location. The depositional process of repeated snow melting could account for the distribution pattern of the artifacts as they appear to have flowed out of the lava blister. This documented distribution pattern suggests the unifaces may be recognized as finished tools as opposed to previous a interpretation suggesting the unifaces represent stages of biface manufacture. The excavation also demonstrated possible similarities with other local cache sites. The Big Babbette stone tools were made utilizing a lithic technology which produces a diagonal parallel flaking pattern; a pattern recognized on bifaces found at other cache sites in central Oregon.

All of the obsidian artifacts were submitted for obsidian characterization analysis. Approximately 90 percent of the artifacts were derived from Newberry Volcano and 10 percent were derived from more distant sources; Riley to the southeast and Obsidian Cliffs to the northwest. Identification of Newberry Volcano obsidian as the dominant obsidian resource of the cache explicitly dates the cache to a time period after the eruption of Mount Mazama in 6800 BP.

The sourcing study results also offers insight into the possible logistical mobility of the prehistoric occupants of the Big Babbette site. The residents seem to have utilized a highly diverse resource strategy ranging from the high elevations of the Cascade Mountains (Obsidian Cliffs) to the lake/marsh environments in the High Lava Plains (Riley). Figure A-1 illustrates the recognized mobility/contact range of the Big Babbette occupants. When the sourcing study results are applied to Big Babbette uniface collection, two of the five uniface tools are from distant sources; implying the possibility of curation and/or trade of the finished stone-tools.

The diversity of the stone tool artifact assemblage suggests the Big Babbette collection may have functioned as a portable tool kit in prehistoric times; one similar to Connolly's proposition for the Paulina Lake site artifacts. If the cache represents a functioning tool kit it seems likely the cache would have been carried in a leather pouch or fiber bag when in use and later stored in such a container. Figure A-6 is a photograph of a pouch found in a Nevada cave containing seven atlatl foreshafts (Strong 1969:213) and is an excellent model of this notion. The photograph is from *Stone Age In The Great Basin* (Strong 1969). The intended audience for this book was non-professional people interested in prehistory. Unfortunately neither the name nor location of the Nevada cave is referenced in the text, nor is the present day location of the collection, consequently limiting further comparison. Given the similarities of the Nevada cave pouch and the Big Babbette cache, the notion of a contained tool kit stored within a protected alcove seems plausible although speculative without a formal technological analysis of the cached artifacts.

Appendix A (Continued)

Figure A-6. Photograph of a pouch found in a Nevada cave containing seven atlatl foreshafts (after Strong 1969).

In summary, data gleaned from the excavation has established the stratigraphic integrity of the Big Babbette site. The lithic typology is consistent with both a pre and post-Mazama chronology. However the position of the artifacts within the upper most layers of the Mazama tephra sequence and the geochemical identification results clearly date the cache to sometime after 6850 BP. The obsidian characterization results and a comparison to the Paulina Lake characterization studies also suggest a post-Mazama age for the Big Babbette site. Additionally, these studies and comparisons as well as depositional patterning have suggested the Babbette unifaces may be finished tools. The potential identification of the Big Babbette artifacts as a contained tool kit is supported through several lines of evidence; its prehistoric cached location in an protected lava nook, the distribution pattern of the artifacts across the site, the possibility of curated finished stone-tools, a similarity to both Connolly's proposed use of the Paulina Lake site's artifacts, and the photograph a contained tool kit found in a Great Basin cave. Additional support for a tool kit hypothesis is found in the diversity of the stone tool artifact assemblage including; a large core/flake, a possible lacustrine, bifacial and unifacial points, re-sharpened tools, expedient flakes. The noted absence of debitage in the immediate vicinity of the cache location also seems to supports this notion.

Data from this excavation was generally inconclusive in terms of identifying a cultural affiliation of the prehistoric occupants of the Big Babbette site. The unique lithic technology of some of the artifacts is not associated with a definitive cultural practice in any of the neighboring cultural areas. Additionally, the diverse lithic procurement resource strategy employed by the occupants ranges from the high elevations of the Cascade Mountains northwest of the site, to the lake/marsh environments southeast of the site. These environs are known to have been utilized prehistorically by people culturally affiliated with the Cascades, southern Columbia Plateau, and the northern Great Basin regions. Apart from this void, propositional conclusions for this study suggest the Big Babbette cache may have functioned as a traveler's tool kit, stored in a protective nook for latter use, during a post-Mazama occupation of the Big Babbette site.

Appendix A (Continued)

WASHINGTON STATE UNIVERSITY

Department of Geology

April 12. 2004

Mary Marschall
6 NW Edgewood Drive
Corvallis, OR 97330

Dear Mary,

I've completed the analysis of the tephra sample you provided. The composition of the glass in this sample is an excellent match (Similarity Coefficient =. 0.99 with 1.0 indicating a perfect match) to one of our Mazama climactic eruption standards. See high-lighted values on search output. I am not surprised since tephra from the Mazama climactic eruption of 6850 BP thickly blankets much of the lower slopes of Newberry volcano

For you information I've included a description of the procedure we follow in the analysis and identification of tephra.

I trust these results will be useful in your research. If you have any questions please do not hesitate to email me (foit@mail.wsu.edu).

Sincerely,

Nick

F. Nick Foit
Professor and Director of the Microbeam Lab

PO Box 642812, Pullman, WA 99164-2812
509-335-3009 • Fax: 509 335-7816 • geology@wsu.edu • www.wsu.edu/~geology

Figure A-7. Letter form Washington State University documenting results of the Big Babbette site tephra study.

TECHNIQUE FOR THE CHEMICAL ANALYSIS AND SOURCING OF TEPHRA

Microbeam Facility, GeoAnalytical Laboratory, Department of Geology, Washington State University, Pullman, WA 99164

Sample Preparation and Instrumental Parameters

A small amount (<1/2 gram) of the tephra sample is dispersed in epoxy on a glass slide, ground on a lap, polished using quarter micron diamond paste, and then carbon coated. The glass component of the tephra sample is then analyzed using a Cameca "Camebax" electron microprobe (EMP) using an acceleration voltage of 15 kV, a beam diameter of 5-8 microns, a beam current of 11.7 nA and peak and background counting times of 10 seconds. LiF, PET and TAP crystal spectrometers are used for the wavelength dispersive analysis of 9 elements. The standards used to calibrate the instrument are: obsidian glass CCNM211 for Na, K, Al, and Si; USNM-VGA99 for Fe, NBS glass K-412 for Mg and Ca; and titanite for Ti and KCl for Cl.
ZAF (atomic number, absorption and fluorescence) corrections are applied to all analytical data.

Data Collection, Reduction, and Presentation

The analysis of the glass in the tephra sample involves searching for fragments of clear glass (free of microlites) which are significantly larger than the beam diameter. A minimum (when possible) of 16 glass shards are analyzed and cast into oxide weight percents. The oxide weight percents are normalized to 100 % (water free basis), averaged, and the standard errors are calculated. The oxide weight percents and standard errors are then tabulated. The magnitudes of the standard errors reflect both the chemical variability of the glass and experimental errors.

Tephra Identification

The tephra data based is searched using the normalized oxide weight percents for Si, Ti, Al, Mg, Ca, Fe, Na, and K. With exception of Mg and Ti all of the oxides are given unit weighting (1.0) in the search routine. Because Ti and Mg are generally present in low concentrations and their standard errors of measurement are high relative to the amounts present, they are given less weighting (0.25) in the search. The search database consists of all the tephra standards and samples analyzed to date by this laboratory as well as a large volume of published chemical data on tephras found in the western U.S. and Canada. As of December 1997 the database contained 1145 analyses. The search routine prints out the tephras which represent the 15 best similarity coefficient (Borchardt et al., 1972, J. Sed. Pet., 42, 301-306) matches for the eight oxides listed above. Although values of the similarity coefficient >0.88 are considered

Figure A-7. Letter form Washington State University documenting results of the Big Babbette site tephra study (continued).

Appendix A (Continued)

significant (Borchardt et al., 1972), we normally do not consider the match to be reliable unless the coefficient is in the range 0.95-1.0 with 1.0 signifying a perfect chemical match.

The probable source of the tephra is then determined taking into account the similarity coefficient, the quality of the match for the key elements K, Fe, and Ca, the location of the source and sample. It is important to note that an identification of a source is not always possible because (1) tephras from many volcanic centers have yet to be analyzed and the results published (2) samples occasionally consist of mixtures of tephras either because of poor sampling techniques or the reworking of the tephra deposit by physical and biological agents (3) a volcanic center may erupt tephras of different ages but very similar glass compositions and (4) different volcanic centers may erupt tephras having similar glass compositions. The best candidate for identification is a sample from a primary and undisturbed airfall.

Figure A-7. Letter form Washington State University documenting results of the Big Babbette site tephra study (continued).

Appendix A (Continued)

TABLE 1. GLASS CHEMISTRY OF NEWBERRY VOLCANO TEPHRA

Oxide	Sample 35DS799
SiO_2	73.04(0.21)
Al_2O_3	14.52(0.17)
Fe_2O_3	2.07(0.03)
TiO_2	0.43(0.03)
Na_2O	4.85(0.17)
K_2O	2.74(0.05)
MgO	0.46(0.02)
CaO	1.69(0.06)
Cl	0.20(0.03)
Total**	100
Number of shards analyzed	13
Probable Source/Age	Mazama Climactic 6850 BP
Similarity Coefficient***	0.99

* Standard deviations of the analyses given in parentheses
** Analyses normalized to 100 weight percent
*** Borchardt et al. (1972) J. Sed. Petrol., 42, 301-306

Figure A-7. Letter form Washington State University documenting results of the Big Babbette site tephra study (continued).

Appendix A (Continued)

Tephra Glass Comparison 4/12/04

35DS799

Sample name: #RBFI

SiO2	TiO2	Al2O3	MgO	CaO	BaO	MnO	Fe2O3	Na2O	K2O	Cl	Total
73.04	0.43	14.52	0.46	1.69	0.00	0.00	2.07	4.85	2.74	0.20	100.00
1.00	0.25	1.00	0.25	1.00	0.00	0.00	1.00	1.00	1.00	weighting factor (only for oxides in bold type)	

Similiarity Coefficients for 15 closet matches

SiO2	TiO2	Al2O3	MgO	CaO	Fe2O3	Na2O	K2O	sim coef weighted avg	rec#	Std	Date	State	Source/Age	Notes	weighted a'
1.000	1.000	0.989	1.000	0.994	1.000	0.984	0.982	0.992	872		3-Jan-95	MT	Mazama Climactic 6850 BP ?	Sample 804-466; in soil horizon A to B1. depth 6cm bs; terrace top, Kootenai National Forest; Rebecca Timmons,Kootenai National Forest, 506 Hwy 2 West, Libby, MT 59923	
0.998	0.977	0.988	1.000	0.988	1.000	0.984	0.985	0.990	873		3-Jan-95	MT	Mazama Climactic 6850 BP ?	Sample 691-18B; in soil horizon Bw1, depth 15-25cm bs; sand dune, Kootenai National Forest; Rebecca Timmons,Kootenai National Forest, 506 Hwy 2 West, Libby, MT 59923	
0.998	1.000	0.997	0.958	1.000	0.981	0.974	0.985	0.989	705		31-Jan-94	OR	Mazama 6850 BP	Sample 913-01-P7-ASH recovered from Unit N196E174 at a depth of 30-35 cm from Site 35KL2101 (La Sere Site) in Drews Valley, roughly 17 miles west of Lakeview, OR, Dennis Jenkins, OR Museum of Anthropology, O of O	
0.999	0.853	0.997	0.957	0.976	0.995	0.998	0.982	0.988	706		1-Mar-94	ID	Mazama 6850 BP	Sample #1, soil E horizon, 5 cm depth, Selkirk Mountains, Boundary County, Idaho; Paul McDaniels, Dept Of Plant, Soil & Entomological Sciences, U of Idaho	
0.999	0.977	0.995	0.978	0.970	1.000	0.978	0.989	0.988	775		8-Jul-94	WA	Mazama Climactic? 6850 BP	Sample Gough #3, Colville River Bridga Ash, depth 1m, NW of Colville River Bridge, Stan Gough, Archaeological & Historical Services, Eastern Washington University, Cheney, WA	
1.000	1.000	0.995	0.979	0.976	0.990	0.972	0.989	0.987	1102		3-Jan-97	WA	Mazama Climactic 6850 BP ??	Sample 45KT344 Tephra 2, depth 6.1m along Squaw Creek (SW1/4, SE1/4 of Sec 9, Badger Gap 7.5 Quad, Yakima Firing Center); Jeff Flenniken, Lithic Analysts, POB 684, Pullman, WA 99163	
0.999	0.953	0.990	1.000	0.976	0.995	0.968	0.996	0.987	719		7-Apr-94	MT	Mazama 6850BP ?	Sample MRT-2, SWNW, S6, east end of Mission Reservoir, sample from top 50cm, St Marys Lake 7.5' Quad, Daniel Levish, D-3611, Bur. of Reclamation, Denver, CO 80225-0007	
0.999	0.930	0.997	1.000	0.994	0.986	0.972	0.982	0.987	1012		12-Oct-95	WA	Mazama Climactic 6850 BP ???	Sample TR2.1, in lluvial sands, Saddle Mts., WA, NW SE SE Sec 12, T16N, R22E, Vantage 7.5' Quad; Stan Gough, Archaeological and Historical Services, Eastern Wash. Univ., Cheney, WA	
1.000	0.977	1.000	0.979	0.988	0.963	0.992	0.978	0.986	914	S	14-Apr-95	OR	Mazama Llao Rock [illegible] BP	Cloud Cap pumice collected by Mehringer, Wigand and Bacon on Aug 22, 1982 at Cloud Cap locality	
0.999	1.000	0.997	0.979	0.994	0.995	0.958	0.971	0.986	1046		11-May-96	NV	Mazama climactic 6850 BP ??	Sample Rodeo Creek,from 3.5 cm bs in a Rodeo Ck cutbank, in Little Boulder Basin on the W side of the Tuscarora Mtns in the extreme north end of Eureka Cty in N-central NV, R. Bernie, P-III Associates Inc., 2759 South 300 West Salt Lake City, UT 84115	
0.998	0.953	0.988	1.000	0.988	0.986	0.988	0.993	0.986	874		3-Jan-95	MT	Mazama Climactic 6850 BP ?	Sample 691-18D; in soil horizon 2AB, depth 50-60cm bs; sand dume, Kootenai National Forest; Rebecca Timmons,Kootenai National Forest, 506 Hwy 2 West, Libby, MT 59923	
0.996	0.977	0.993	0.978	0.970	0.990	0.990	0.978	0.986	1036		7-Mar-97	WA	Mazama 6850 BP ??	Sample from sediments within rock shelter on upper Wenatchee River above Leavenworth, WA (Winton 7.5' Quad, NW1/4, NW1/4, NE1/4 of Sec 21, T25N, R17E); Rebecca Stevens Archaeological & Historical Services, Eastern Washington University, Cheny, WA 99004	
1.000	0.977	1.000	0.958	0.953	1.000	0.978	0.989	0.985	892		10-Jan-95	WA	Mazama Climactic 6850 BP	Sample 1003-10.7, depth = 1.3m bs, Foster Creek Drainage Basin, NW, SW, NE, Sec. 11, T16N, R21E, Boylston Quad., Stan Gough, Archaeological & Historical Services, EWU	
0.997	0.956	0.999	0.978	0.947	0.988	0.998	0.993	0.985	779	S	26-Aug-94	OR	Mazama Climactic 6850 BP	USGS Mazama Climactic Standard W-97, from Wasco OR, Andre Sarna	
1.000	0.977	0.999	0.978	0.953	1.000	0.968	0.993	0.985	194			ID	Mazama/6850	Site 10-2N-93, 173cm, Tephra A, Kevin's Cave, J. Woods, Herrett Museum	

number of records searched: 1145

WSU GeoAnalytical Laboratory *Analyses by electron microprobe*

Figure A-7. Letter form Washington State University documenting results of the Big Babbette site tephra study (continued).

Appendix A (Continued)

Figure A-8. Scanned image of Big Babbette artifact FS #1

Figure A-9. Scanned image of Big Babbette artifact FS #2

Appendix A (Continued)

Figure A-10. Scanned image of Big Babbette artifact FS #3

Figure A-11. Scanned image of Big Babbette artifact FS #5

Appendix A (Continued)

Figure A-12. Scanned image of Big Babbette artifact FS #6 (dorsal and ventral)

Figure A-13. Scanned image of Big Babbette artifact FS #7 (dorsal and ventral)

Appendix A (Continued)

Figure A-14. Scanned image of Big Babbette artifact FS #8 (dorsal and ventral)

Figure A-15. Scanned image of Big Babbette artifact FS #9

Appendix A (Continued)

Figure A-16. Scanned image of Big Babbette artifact FS #10 (dorsal and ventral)

Figure A-17. Scanned image of Big Babbette artifact FS #11

Figure A-18. Scanned image of Big Babbette artifact FS #12 (dorsal and ventral)

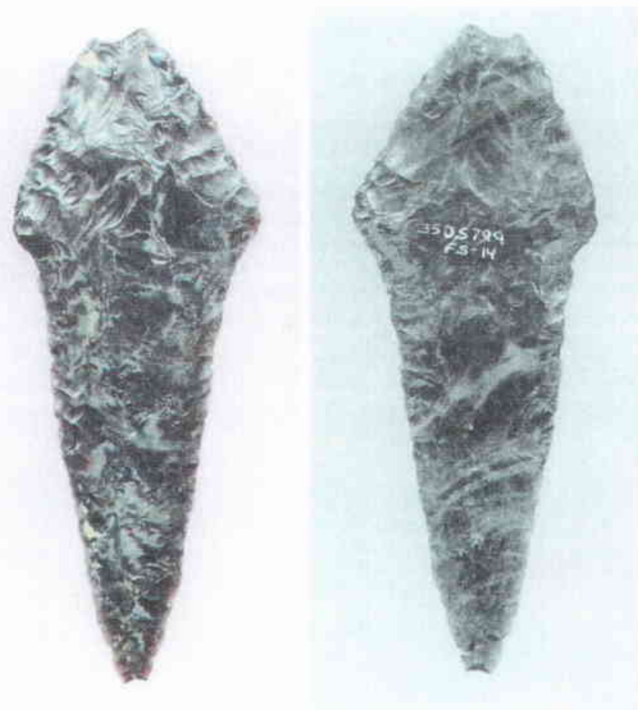


Figure A-19. Scanned image of Big Babbette artifact FS #14 (dorsal and ventral)

Appendix A (Continued)

Figure A-20. Scanned image of Big Babbette artifact FS #15

Appendix A (Continued)

Table A-3. Big Babbette Artifact Catalog (35DS799)

Artifact #	Artifact or Sample	Unit	Level/Depth	Description
FS# 1	Artifact	A	1 (0-20cm) @ surface Inside shelter	Large, black obsidian core/flake with platform preparation and unifacial edge modification. Found ventral side down in the back left corner of lava enclosure.
FS# 2	Artifact	A	1 (0-20cm) @ approximately 11cm	Black obsidian, lanceolate-shaped uniface. Flat in cross section with curve. One edge with pressure flaking. Base less worked. Found ventral side down.
FS# 3	Artifact	A	1 (0-20cm) @ 14.5cm	Large, black obsidian flat flake with section of steep unifacial edge modification. Found ventral side down in the middle of lava enclosure, between surface duff and gray-tan ash matrix.
FS# 4	Artifact (joins with #6)	A	1 (0-20cm) @ 15.5cm	Black obsidian, lanceolate-shaped uniface, midsection to tip. Triangular in cross section. Base is #6. Diagonal parallel flaking on both edges. Found resting at angle, tip up in gray-tan ash matrix.
FS# 5	Artifact	A	1 (0-20cm) @ 16.0cm	Black obsidian flake without edge modification.
FS# 6	Artifact (joins with #4)	A	1 (0-20cm) @ 15.0cm	Black obsidian, lanceolate-shaped uniface, base to midsection. Triangular in cross section. Midsection to tip is #4. No diagonal parallel flaking, percussion flaking. Found lying on lava rock, ventral surface down, broken edge of base toward mouth of lava enclosure.
FS# 7	Artifact	A	1 (0-20cm) @ 15.0cm	Black obsidian, lanceolate-shaped uniface. Estimate 1-2mm of tip missing. Very slight waxy feel. Triangular in cross section. One row of pressure flaking on both anterior edges. Base less worked and no pressure flaking. Found ventral side down.
FS# 8	Artifact	A	1 (0-20cm) @ 17.0cm	Black-gray, lanceolate-shaped uniface. Triangular in cross section. Diagonal parallel flaking on anterior left side. Base less worked and no pressure flaking. Found ventral side down, base toward mouth of lava enclosure.

Appendix A (Continued)

Table A-3. Big Babbette Artifact Catalog (35DS799)
(Continued)

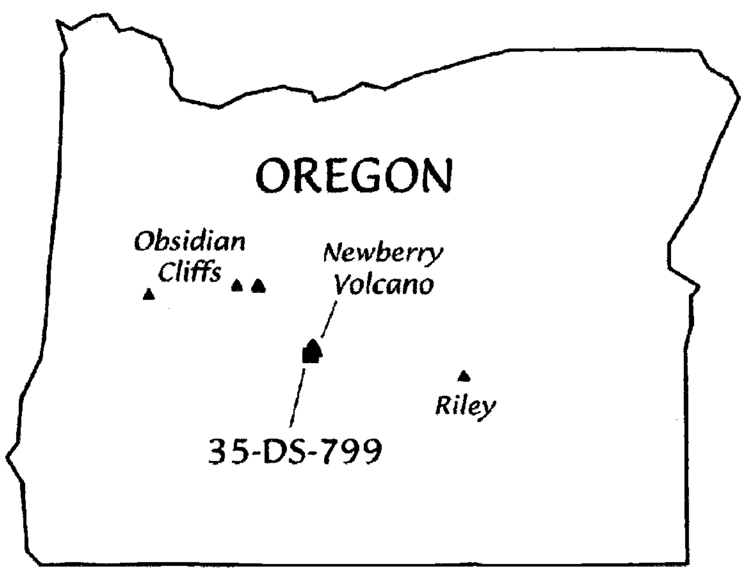
Artifact #	Artifact or Sample	Unit	Level/Depth	Description
FS# 9	Artifact (joins with #'s 13&17)	A	2 (20-30cm) @ 22.0cm	Black obsidian, lanceolate-shaped biface, midsection to tip. Slightly ovoid in cross section. Base edges are #'s 13 and 17. Transverse parallel flaking on left anterior edge. Found resting parallel to and in line with mouth of lava enclosure, tip toward west.
FS# 10	Artifact	B	1 (0-20cm) @ 18.5cm	Black obsidian, ovate-shaped biface/uniface, minimally worked on ventral side. Slight transverse parallel flaking. Trace evidence of a base. Minimally triangular in cross section. Artifact is symmetrically elliptical. Found tip toward west, below duff and above ash.
FS# 11	Artifact	A	2 (20-30cm) @ 22.0cm	Black obsidian flake without edge modification. Found very close to back wall, right side, of lava enclosure.
FS# 12	Artifact	B	1 (0-20cm) @ surface	Black obsidian, lanceolate-shaped uniface. Triangular in cross section with slight curve. Estimate approximately 2cm of tip missing. Diagonal parallel flaking on left edge of dorsal surface. Base without pressure flaking. Found ventral side down, base toward mouth of lava enclosure just below duff.
FS# 13	Artifact (joins with #'s 9&17)	B	2 (20-30cm) @ 24.0cm	Black obsidian biface fragment with edge modification. Joins with the left side of #9. Found within gray-tan ash matrix.
FS# 14	Artifact	B	2 (20-30cm) @27.5cm	Black obsidian, lanceolate-shaped biface. Slightly ovoid in cross section. Transverse parallel flaking on left anterior edge. Base is the widest section, midsection to tip smaller due to repeated resharpening of tool. Found resting at angle with large point (base) upward, smaller point (tip) downward in gray-tan ash layer.
FS# 15	Artifact	B	1 (0-20cm)	Black obsidian flake without edge modification. Found while troweling, unknown exact point province. Found just below duff on top of gray-tan ash layer.
FS# 16	Artifact	B Screen	3 (30-40cm)	Black obsidian flake without edge modification.

Appendix A (Continued)

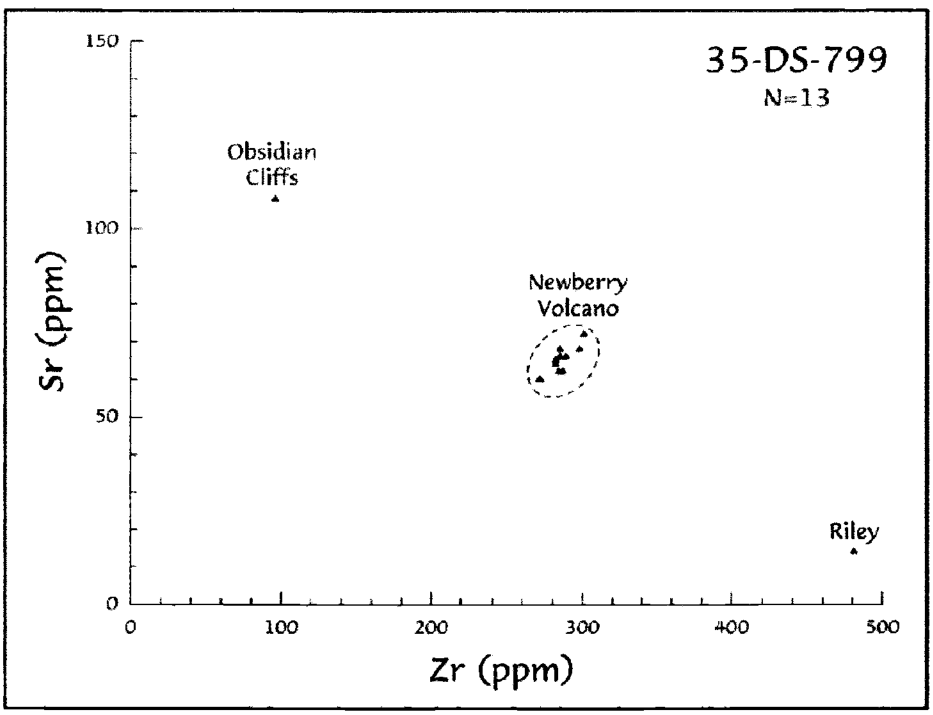
Table A-3. Big Babbette Artifact Catalog (35DS799)
(Continued)

Artifact #	Artifact or Sample	Unit	Level/Depth	Description
FS# 17	Artifact (joins with #'s 9&13)	A Screen	2 (20-30cm)	Black obsidian biface fragment with edge modification. Joins with the right side of #9. Found during troweling in and around rocks, within ash. Unknown point province.
FS# 18	Artifact	A Screen	2 (20-30cm)	Black obsidian flake without edge modification.
FS# 19	Artifact	A Screen	2 (20-30cm)	Black obsidian flake without edge modification.
FS# 20	Artifact	A Screen	2 (20-30cm)	Black obsidian flake without edge modification.
FS# 21	Artifact	A Screen	2 (20-30cm)	Black obsidian flake without edge modification.
FS# S	Sample #1	A	1 (0-20cm) @ 16cm	Gray-tan ash matrix from within mouth of lava enclosure.
FS# S	Sample #2	A	1 (0-20cm) @18cm	Charcoal from within mouth of lava enclosure
FS# S	Sample #3	A	2 (20-30cm) @ 28cm	Tan-ash/yellow-orange pumice matrix from within mouth of lava enclosure.
FS# S	Sample #4	A	2 (20-30cm)	Charcoal from within mouth of lava enclosure and within tan-ash/yellow-orange pumice matrix. Near sample #3.

Appendix A (Continued)



Location of 35-DS-799 and the sources of the analyzed artifacts.



Scatterplot of zirconium (Zr) plotted versus strontium (Sr) for the analyzed artifacts.

Figure A-21. Map and scatter plot of obsidian characteristic results for Big Babbette

Appendix A (Continued)

Table A-4. Results of XRF Studies: Big Babbette Site (35DS799), Deschutes County, Oregon.

Northwest Research Obsidian Studies Laboratory

Table A-2. Results of XRF Studies: Big Babbette Site (35-DS-799), Deschutes County, Oregon

Site	Specimen No.	Catalog No.		Trace Element Concentrations									Ratios			Geochemical Source
				Rb	Sr	Y	Zr	Nb	Ti	Mn	Ba	$Fe_2O_3^T$	Fe:Mn	Fe:Ti	Sr:Zr	
Big Babbette	1	FS 1		134	66	40	285	18	NM	NM	NM	NM	45	43	15	Newberry Volcano
			±	4	9	3	7	1	NM	NM	NM	NM				
Big Babbette	2	FS 2		142	62	42	287	15	NM	NM	NM	NM	40	45	14	Newberry Volcano
			±	4	9	3	7	1	NM	NM	NM	NM				
Big Babbette	3	FS 3		129	60	40	272	15	NM	NM	NM	NM	41	47	14	Newberry Volcano
			±	4	9	3	7	1	NM	NM	NM	NM				
Big Babbette	4	FS 5		140	68	41	285	16	NM	NM	NM	NM	49	43	16	Newberry Volcano
			±	4	9	3	7	1	NM	NM	NM	NM				
Big Babbette	5	FS 6		141	62	45	284	17	NM	NM	NM	NM	42	46	14	Newberry Volcano
			±	4	9	3	7	1	NM	NM	NM	NM				
Big Babbette	6	FS 7		138	64	42	282	17	NM	NM	NM	NM	47	42	15	Newberry Volcano
			±	4	9	3	7	1	NM	NM	NM	NM				
Big Babbette	7	FS 8		77	108	16	96	10	NM	NM	920	NM	33	54	85	Obsidian Cliffs
			±	4	9	3	7	1	NM	NM	32	NM				
Big Babbette	8	FS 9		124	14	66	481	26	NM	NM	1151	NM	26	51	1	Riley
			±	4	9	3	7	1	NM	NM	32	NM				
Big Babbette	9	FS 10		151	66	43	289	16	NM	NM	NM	NM	44	41	15	Newberry Volcano
			±	4	9	3	7	1	NM	NM	NM	NM				
Big Babbette	10	FS 11		147	72	41	301	17	NM	NM	NM	NM	52	46	16	Newberry Volcano
			±	4	9	3	7	1	NM	NM	NM	NM				
Big Babbette	11	FS 12		135	60	39	271	16	NM	NM	NM	NM	50	45	15	Newberry Volcano
			±	4	9	3	7	1	NM	NM	NM	NM				
Big Babbette	12	FS 14		158	68	41	298	18	NM	NM	NM	NM	47	44	15	Newberry Volcano
			±	4	9	3	7	1	NM	NM	NM	NM				
Big Babbette	13	FS 15		134	65	39	282	17	NM	NM	NM	NM	43	42	15	Newberry Volcano
			±	4	9	3	7	1	NM	NM	NM	NM				
Big Babbette	54	FS 16		143	69	42	290	17	1638	373	NM	2.09	47	43	16	Newberry Volcano
			±	4	9	3	7	1	92	28	NM	0.11				

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.

Appendix A (Continued)

Table A-4. Results of XRF Studies: Big Babbette Site (35DS799), Deschutes County, Oregon (Continued)

Northwest Research Obsidian Studies Laboratory

Table A-2. Results of XRF Studies: Big Babbette Site (35-DS-799), Deschutes County, Oregon

Site	Specimen No.	Catalog No.		Trace Element Concentrations									Ratios			Geochemical Source
				Rb	Sr	Y	Zr	Nb	Ti	Mn	Ba	$Fe_2O_3^T$	Fe:Mn	Fe:Ti	Sr:Zr	
Big Babbette	55	FS 18		131	64	42	282	19	1484	357	NM	2.05	48	46	15	Newberry Volcano
			±	4	9	3	7	1	92	28	NM	0.11				
Big Babbette	56	FS 19		148	71	44	300	17	1403	363	NM	1.78	41	42	15	Newberry Volcano
			±	4	9	3	7	1	91	28	NM	0.11				
Big Babbette	57	FS 20		128	67	45	286	18	1359	316	NM	1.83	49	45	15	Newberry Volcano
			±	4	9	3	7	1	91	28	NM	0.11				
Big Babbette	58	FS 21		136	65	41	281	20	1298	340	NM	1.68	42	43	15	Newberry Volcano
			±	4	9	3	7	1	91	28	NM	0.11				

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.

Appendix A (Continued)
Table A-5. Table of Big Babbette Cache Statistical Data

Big Babbette Cache
Artifact count: 21
Whole artifact count: 18
(N=4) References the exclusion of FS#2, (N=5):Referances the inclusion of FS#2
Average length unifaces and bifaces: 11.49 cm
Average length unifaces (N=5): 10.67 cm
Average length unifaces (N=4): 10.80 cm
Average length bifaces: 12.42 cm
Average width unifaces and bifaces: 4.01 cm
Average width unifaces (N=5): 3.63 cm
Average width unifaces (N=4): 3.65 cm
Average width bifaces: 4.36 cm
Average thickness unifaces and bifaces: 1.43 cm
Average thickness unifaces (N=5):1.48 cm
Average thickness unifaces (N=4):1.57 cm
Average thickness bifaces: 1.22 cm
Total weight: 1329.2 g
Total weight (excluding FS#1):601.2 g
Average weight (excluding FS#1),unifaces and bifaces only: 51.66 g
Average weight (excluding FS#1) unifaces (N=5): 50.92 g
Average weight (excluding FS#1) unifaces (N=4): 53.35 g
Average weight (excluding FS#1) bifaces: 51.85 g
Sourced artifacts count: 18
Percent sourced: 100%
Percent by source:NV 89%, OC 5.5%, Riley 5.5%

Appendix A (Continued)
Table A-5. Table of Big Babbette Cache Statistical Data (Continued)

Count	FS#	Length	Width	Thickness	Weight	Fragment	Source Study	Reference
1	1	18.8	11.0	4.09	728g	no	NV	Skinner, C: 2004
2	2	10.16	3.57	1.12	41.2	no	NV	Skinner, C: 2004
3	3	14.23	6.83	1.12	106.4	no	NV	Skinner, C: 2004
4	4	7.17	3.9	1.54	33.2	yes-co-joins with #6	(NV)	Skinner, C: 2004
5	5	4.27	3.61	.79	8.4	unbroken flake	NV	Skinner, C: 2004
6	6	7.37	4.22	19	53	yes-co-joins with #4	NV	Skinner, C: 2004
7	7	9.46	3.72	1.48	49.8	no	NV	Skinner, C: 2004
8	8	10.37	3.27	1.37	35.4	no	OC	Skinner, C: 2004
9	9	8.45	3.42	.96	25	yes-co-joins with #'s 13&17	Riley	Skinner, C: 2004
10	10	13.71	5.18	1.62	98.3	no	NV	Skinner, C: 2004
11	11	5.26	4.58	.56	9.1	no	NV	Skinner, C: 2004
12	12	8.99	3.39	1.58	42	no	NV	Skinner, C: 2004
13	13	5.12	2.08	.9	8	yes-co-joins with #'s 9&17	(Riley)	Skinner, C: 2004
14	14	13.44	5.16	1.44	66.2	no	NV	Skinner, C: 2004
15	15	3.27	1.69	.43	1.4	unbroken flake	NV	Skinner, C: 2004
16	16	3.01	1.43	.31	1	unbroken flake	NV	Skinner, C: 2004
17	17	3.72	1.75	.82	4.5	yes-co-joins with #'s 9&13	(Riley)	Skinner, C: 2004
18	18	4.17	3.36	.56	5	unbroken flake	NV	Skinner, C: 2004
19	19	2.93	2.61	.46	3	unbroken flake	NV	Skinner, C: 2004
20	20	3.85	3.33	.4	4.5	unbroken flake	NV	Skinner, C: 2004
21	21	6.17	2.43	.32	5.8	unbroken flake	NV	Skinner, C: 2004
					601.2	Total		

Appendix A (Continued)
Table A-5. Table of Big Babbette Cache Statistical Data (Continued)

Unifaces and bifaces comparison-averages:

Count	FS#	Length	Width	Thickness	Weight	Fragment	Source Study
1	1					no-core/flake	NV
2	2	10.16	3.57	1.11	41.2	no-uniface (?unfinished)	NV
3	3					no-scrapper	NV
4	4&6	14.40	4.23	1.88	86.2	complete uniface-#4cojoins with #6	(NV)
5	5				8.4	unbroken flake	NV
6	6					yes-co-joins with #4	NV
7	7	9.46	3.72	1.48	49.8	no-uniface	NV
8	8	10.37	3.27	1.37	35.4	no-uniface	OC
9	9&13&17	11.4	3.56	1.0	37.5	complete biface-#9 co-joins with #'s 13&17	Riley
10	10	13.71	5.18	1.62	98.3	no-ovate uniface/biface	NV
11	11					no-flake	NV
12	12	8.99	3.39	1.58	42	no-uniface	NV
13	13					yes-co-joins with #'s 9&17	(Riley)
14	14	13.44	5.16	1.44	66.2	no-resharpened biface	NV
15	15					unbroken flake	NV
16	16					unbroken flake	NV
17	17					yes-co-joins with #'s 9&13	(Riley)
18	18					unbroken flake	NV
19	19					unbroken flake	NV
20	20					unbroken flake	NV
21	21					unbroken flake	NV
		11.49	4.01	1.43	51.66	Averages	

Appendix A (Continued)
Table A-5. Table of Big Babbette Cache Statistical Data (Continued)

Unifaces [(N=4) and (N=5) tools] comparison-averages:

Count	FS#	Length	Width	Thickness	Weight	Fragment	Source Study
1	1					no-core/flake	NV
2	2	10.16	3.57	1.11	41.2	no-uniface (?unfinished)	NV
3	3					no-scrapper	NV
4	4&6	14.40	4.23	1.88	86.2	complete uniface-#4cojoins with #6	(NV)
5	5					unbroken flake	NV
6	6					yes-co-joins with #4	NV
7	7	9.46	3.72	1.48	49.8	no-uniface	NV
8	8	10.37	3.27	1.37	35.4	no-uniface	OC
9	9&13&17					complete biface-#9 co-joins with #'s 13&17	Riley
10	10					no-ovate uniface/biface	NV
11	11					no-flake	NV
12	12	8.99	3.39	1.58	42	no-uniface	NV
13	13					yes-co-joins with #'s 9&17	(Riley)
14	14					no-re-sharpened biface	NV
15	15					unbroken flake	NV
16	16					unbroken flake	NV
17	17					yes-co-joins with #'s 9&13	(Riley)
18	18					unbroken flake	NV
19	19					unbroken flake	NV
20	20					unbroken flake	NV
21	21					unbroken flake	NV
20	20					unbroken flake	NV
21	21					unbroken flake	NV
		10.67	3.63	1.48	50.92	Average 5 unifaces	
		10.80	3.65	1.57	53.35	Average 4 unifaces	

Appendix A (Continued)
Table A-5. Table of Big Babbette Cache Statistical Data (Continued)

Biface (N=2) comparison-averages

Count	FS#	Length	Width	Thickness	Weight	Fragment	Source Study
1	1					no-core/flake	NV
2	2					no-uniface (?unfinished)	NV
3	3					no-scrapper	NV
4	4&6					complete uniface-#4cojoins with #6	(NV)
5	5					unbroken flake	NV
6	6					yes-co-joins with #4	NV
7	7					no-uniface	NV
8	8					no-uniface	OC
9	9&13&17	11.4	3.56	1.0	37.5	complete biface-#9 co-joins with #'s 13&17	Riley
10	10					no-ovate uniface/biface	NV
11	11					no-flake	NV
12	12					no-uniface	NV
13	13					yes-co-joins with #'s 9&17	(Riley)
14	14	13.44	5.16	1.44	66.2	no-re-sharpened biface	NV
15	15					unbroken flake	NV
16	16					unbroken flake	NV
17	17					yes-co-joins with #'s 9&13	(Riley)
18	18					unbroken flake	NV
19	19					unbroken flake	NV
20	20					unbroken flake	NV
21	21					unbroken flake	NV
		12.42	4.36	1.22	51.85	Averages	

Appendix A (Continued)
Table A-5. Table of Big Babbette Cache Statistical Data (Continued)

Uniface (N=5) comparison sorted by length:

Count	FS#	Length	Width	Thickness	Weight	Fragment	Source Study
12	12	8.99	3.39	1.58	42	no-uniface	NV
7	7	9.46	3.72	1.48	49.8	no-uniface	NV
2	2	10.16	3.57	1.119	41.2	no-uniface (?unfinished)	NV
8	8	10.37	3.27	1.37	35.4	no-uniface	OC
4	4&6	14.40	4.23	1.88	86.2	complete uniface-#4cojoins with #6	(NV)
1	1					no-core/flake	NV
3	3					no-scrapper	NV
5	5					unbroken flake	NV
6	6					yes-co-joins with #4	NV
9	9&13&17					complete biface-#9 co-joins with #'s 13&17	Riley
10	10					no-ovate uniface/biface	NV
11	11					no-flake	NV
13	13					yes-co-joins with #'s 9&17	(Riley)
14	14					no-re-sharpened biface	NV
15	15					unbroken flake	NV
16	16					unbroken flake	NV
17	17					yes-co-joins with #'s 9&13	(Riley)
18	18					unbroken flake	NV
19	19					unbroken flake	NV
20	20					unbroken flake	NV
21	21					unbroken flake	NV

Appendix A (Continued)
Table A-5. Table of Big Babbette Cache Statistical Data (Continued)

Biface (N=2) comparison sorted by length

Count	FS#	Length	Width	Thickness	Weight	Fragment	Source Study
9	9&13&17	11.4	3.56	1.0	37.5	complete biface-# 9 co-joins with #'s 13&17	Riley
14	14	13.44	5.16	1.44	66.2	no-re-sharpened biface	NV
1	1					no-core/flake	NV
2	2					no-uniface (?unfinished)	NV
3	3					no-scrapper	NV
4	4&6					complete uniface-#4cojoins with #6	(NV)
5	5					unbroken flake	NV
6	6					yes-co-joins with #4	NV
7	7					no-uniface	NV
8	8					no-uniface	OC
10	10					no-ovate uniface/biface	NV
11	11					no-flake	NV
12	12					no-uniface	NV
13	13					yes-co-joins with #'s 9&17	(Riley)
15	15					unbroken flake	NV
16	16					unbroken flake	NV
17	17					yes-co-joins with #'s 9&13	(Riley)
18	18					unbroken flake	NV
19	19					unbroken flake	NV
20	20					unbroken flake	NV
21	21					unbroken flake	NV

Appendix B

Lanceolate and Ovate Cache Assemblage Statistical Data

Appendix B

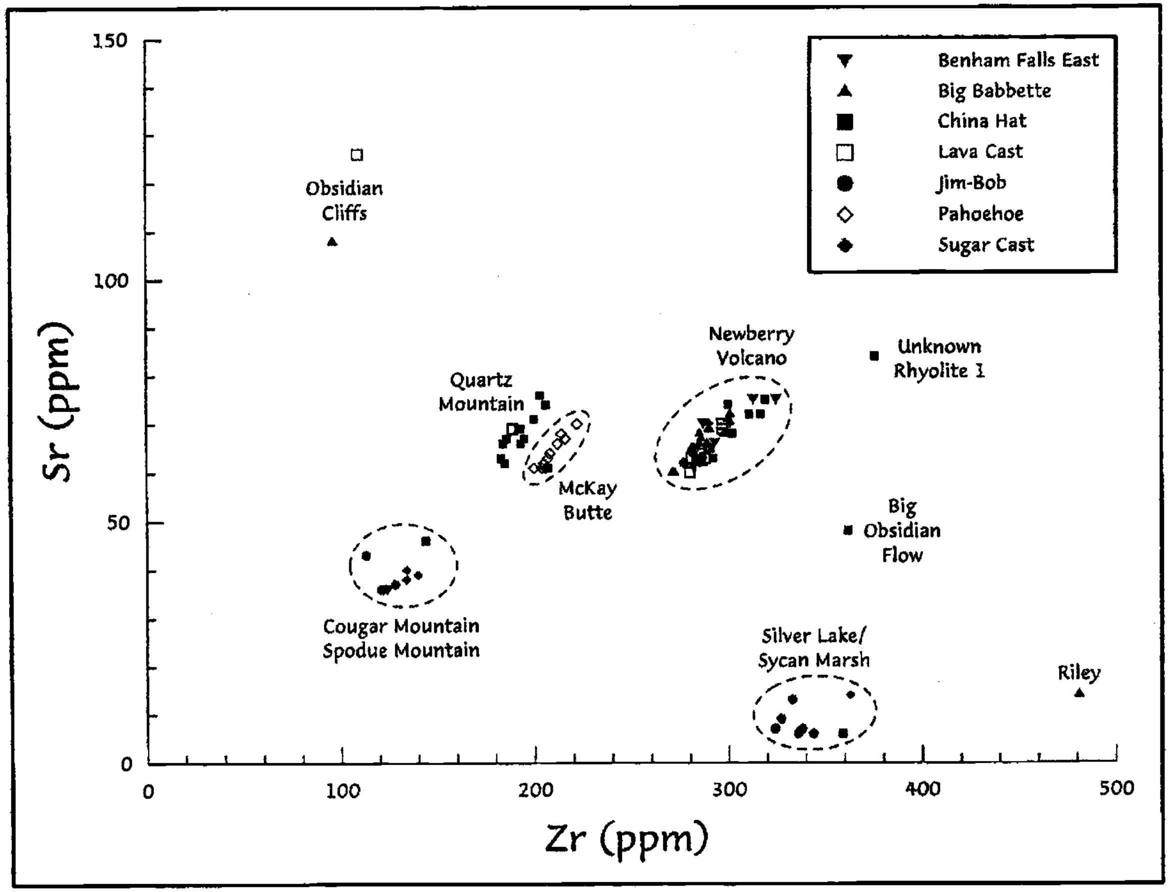


Figure B-1 Map and scatter plot of obsidian characteristic results for all cache sites.

Appendix B

Table B-1.Results of XRF Studies: Benham Falls East Cache (61300605), Deschutes County, Oregon.

Northwest Research Obsidian Studies Laboratory

Table B-1. Results of XRF Studies: Benham Falls East Cache (61300605), Deschutes County, Oregon

Site	Specimen No.	Catalog No.		Trace Element Concentrations									Ratios			Geochemical Source
				Rb	Sr	Y	Zr	Nb	Ti	Mn	Ba	Fe2O3[T]	Fe:Mn	Fe:Ti	Sr:Zr	
Benham Falls East Cache	69	FS 8		174	75	51	325	17	NM	NM	903	NM	33	34	15	Newberry Volcano
			±	4	9	3	7	2	NM	NM	33	NM				
Benham Falls East Cache	70	FS 19		88	36	48	124	11	NM	NM	1266	NM	34	56	20	Cougar Mountain
			±	4	9	3	7	1	NM	NM	33	NM				
Benham Falls East Cache	71	FS 24		145	70	42	287	17	NM	NM	894	NM	45	36	16	Newberry Volcano
			±	4	9	3	7	1	NM	NM	33	NM				
Benham Falls East Cache	72	FS 32		143	61	41	282	19	NM	NM	911	NM	45	36	14	Newberry Volcano
			±	4	9	3	7	1	NM	NM	32	NM				
Benham Falls East Cache	73	FS 39		163	75	45	313	19	NM	NM	915	NM	48	38	16	Newberry Volcano
			±	4	9	3	7	1	NM	NM	33	NM				
Benham Falls East Cache	74	FS 54		135	66	43	293	17	1270	353	939	1.72	41	45	15	Newberry Volcano
			±	4	9	3	7	1	91	28	32	0.11				

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.

Appendix B

Table B-2.Results of XRF Studies: China Hat Cache (35-DS-270), Deschutes County, Oregon.

Northwest Research Obsidian Studies Laboratory

Table B-2. Results of XRF Studies: China Hat Cache (35-DS-270), Deschutes County, Oregon

	Specimen		Trace Element Concentrations									Ratios			
Site	No.	Catalog No.	Rb	Sr	Y	Zr	Nb	Ti	Mn	Ba	$Fe2O3^T$	Fe:Mn	Fe:Ti	Sr:Zr	Geochemical Source
China Hat Cache	13	FS 8	120	46	61	144	14	476	210	NM	0.77	33	54	22	Cougar Mountain
			± 4	9	3	7	1	89	27	NM	0.11				
China Hat Cache	14	FS 51	167	72	46	311	17	1388	352	NM	1.60	38	39	15	Newberry Volcano
			± 4	9	3	7	1	91	28	NM	0.11				
China Hat Cache	15	FS 164	126	48	61	362	22	909	376	NM	1.40	32	51	8	Big Obsidian Flow
			± 4	9	3	7	1	91	28	NM	0.11				
China Hat Cache	16	FS 165	146	66	43	193	9	551	231	NM	1.26	47	75	23	Quartz Mountain
			± 4	9	3	7	1	89	27	NM	0.11				
China Hat Cache	17	FS 217	160	75	46	319	20	1274	280	NM	1.49	45	39	15	Newberry Volcano
			± 4	9	3	7	1	91	27	NM	0.11				
China Hat Cache	18	FS 240	173	72	48	317	20	931	295	NM	1.31	38	47	15	Newberry Volcano
			± 4	9	3	7	1	90	27	NM	0.11				
China Hat Cache	19	FS 242	154	68	46	302	19	1290	288	NM	1.69	50	44	15	Newberry Volcano
			± 4	9	3	7	1	91	27	NM	0.11				
China Hat Cache	20	FS 243	143	63	43	283	15	1588	336	NM	1.82	46	39	15	Newberry Volcano
			± 4	9	3	7	1	91	28	NM	0.11				
China Hat Cache	21	FS 248	158	76	48	203	9	548	289	NM	1.16	35	70	25	Quartz Mountain
			± 4	9	3	7	1	89	27	NM	0.11				
China Hat Cache	22	FS 249	151	69	43	192	8	771	199	NM	1.04	46	46	24	Quartz Mountain
			± 4	9	3	7	1	89	27	NM	0.11				
China Hat Cache	23	FS 253	146	63	46	292	20	1404	325	NM	1.76	46	42	14	Newberry Volcano
			± 4	9	3	7	1	91	28	NM	0.11				
China Hat Cache	24	FS 265	139	62	42	185	9	547	243	NM	1.38	49	83	22	Quartz Mountain
			± 4	9	3	7	1	89	27	NM	0.11				
China Hat Cache	25	FS 271	142	65	41	291	16	1378	327	NM	1.85	47	45	15	Newberry Volcano
			± 4	9	3	7	1	91	28	NM	0.11				
China Hat Cache	26	FS 272	147	66	44	184	10	639	323	NM	1.38	36	71	24	Quartz Mountain
			± 4	9	3	7	1	89	28	NM	0.11				

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.

Appendix B

Table B-2.Results of XRF Studies: China Hat Cache (35-DS-270), Deschutes County, Oregon. (Continued)

Northwest Research Obsidian Studies Laboratory

Table B-2. Results of XRF Studies: China Hat Cache (35-DS-270), Deschutes County, Oregon

			Trace Element Concentrations										Ratios			
Site	Specimen No.	Catalog No.		Rb	Sr	Y	Zr	Nb	Ti	Mn	Ba	$Fe2O3^T$	Fe:Mn	Fe:Ti	Sr:Zr	Geochemical Source
China Hat Cache	27	FS 313		139	61	36	207	11	949	214	NM	1.33	54	47	20	McKay Butte
			±	4	9	3	7	1	90	27	NM	0.11				
China Hat Cache	28	FS 314		134	6	57	359	20	812	486	NM	1.55	27	63	1	Silver Lake/Sycan Marsh
			±	4	9	3	7	1	90	28	NM	0.11				
China Hat Cache	29	FS 337		153	69	42	193	9	773	258	NM	1.25	42	54	24	McKay Butte
			±	4	9	3	7	1	90	27	NM	0.11				
China Hat Cache	30	FS 365		148	74	47	300	17	1352	292	NM	1.71	49	42	16	Newberry Volcano
			±	4	9	3	7	1	91	27	NM	0.11				
China Hat Cache	31	FS 366		144	63	43	183	11	494	315	NM	1.36	37	90	23	Quartz Mountain
			±	4	9	3	7	1	89	27	NM	0.11				
China Hat Cachc	32	FS 380		153	67	43	195	8	963	275	NM	1.36	42	47	23	Quartz Mountain
			±	4	9	3	7	1	90	27	NM	0.11				
China Hat Cachc	33	FS 382		173	74	47	206	14	511	322	NM	0.96	26	62	24	Quartz Mountain
			±	4	9	3	7	2	89	27	NM	0.11				
China Hat Cache	34	FS 390		146	67	45	186	8	618	274	NM	1.29	40	69	24	Quartz Mountain
			±	4	9	3	7	1	90	27	NM	0.11				
China Hat Cache	35	FS 399		131	84	58	376	19	1418	385	NM	1.83	40	43	15	Unknown Rhyolite
			±	4	9	3	7	1	91	28	NM	0.11				
China Hat Cache	36	FS 420		169	71	47	200	8	504	218	NM	1.19	47	77	24	Quartz Mountain
			±	4	9	3	7	1	89	27	NM	0.11				

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.

Appendix B

Table B-3.Results of XRF Studies: Jim-Bob Cache (35-KL-879), Klamath County, Oregon.

Northwest Research Obsidian Studies Laboratory

Table B-3. Results of XRF Studies: Jim-Bob Cache (35-KL-879), Klamath County, Oregon

	Specimen		Trace Element Concentrations										Ratios			
Site	No.	Catalog No.		Rb	Sr	Y	Zr	Nb	Ti	Mn	Ba	$Fe2O3^T$	Fe:Mn	Fe:Ti	Sr:Zr	Geochemical Source
Jim-Bob Cache	59	FS 1		125	6	52	336	16	779	598	704	1.63	23	69	1	Silver Lake/Sycan Marsh
			±	4	9	3	7	1	90	28	32	0.11				
Jim-Bob Cache	60	FS 2		144	62	41	277	17	1293	335	851	1.78	45	46	15	Newberry Volcano
			±	4	9	3	7	1	91	28	32	0.11				
Jim-Bob Cache	61	FS 3		124	6	54	344	17	798	509	797	1.68	28	70	1	Silver Lake/Sycan Marsh
			±	4	9	3	7	1	90	28	32	0.11				
Jim-Bob Cache	62	FS 4		91	36	47	121	11	939	234	1164	0.91	34	33	20	Cougar Mountain
			±	4	9	3	7	1	90	27	33	0.11				
Jim-Bob Cache	63	FS 5		95	37	49	128	11	378	296	1231	1.13	33	97	20	Cougar Mountain
			±	4	9	3	7	1	89	27	32	0.11				
Jim-Bob Cache	64	FS 6		122	7	54	338	18	797	570	779	1.69	25	70	1	Silver Lake/Sycan Marsh
			±	4	9	3	7	1	90	28	32	0.11				
Jim-Bob Cache	65	FS 7		118	9	49	327	15	NM	NM	764	NM	29	46	1	Silver Lake/Sycan Marsh
			±	4	9	3	7	1	NM	NM	32	NM				
Jim-Bob Cache	66	FS 8		107	43	22	113	15	NM	NM	819	NM	14	33	27	Spodue Mountain
			±	4	9	3	7	1	NM	NM	33	NM				
Jim-Bob Cache	67	FS 10		117	7	52	324	18	NM	NM	776	NM	28	43	1	Silver Lake/Sycan Marsh
			±	4	9	3	7	1	NM	NM	33	NM				
Jim-Bob Cache	68	FS 11		119	13	51	333	18	1004	710	812	2.01	24	66	2	Silver Lake/Sycan Marsh
			±	4	9	3	7	1	91	28	32	0.11				

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.

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Table B-4.Results of XRF Studies: Lava Cast Cache (35-DS-751), Deschutes County, Oregon.

Northwest Research Obsidian Studies Laboratory

Table B-4. Results of XRF Studies: Lava Cast Cache (35-DS-751), Deschutes County, Oregon

Site	Specimen No.	Catalog No.		Trace Element Concentrations Rb	Sr	Y	Zr	Nb	Ti	Mn	Ba	$Fe2O3^T$	Ratios Fe:Mn	Fe:Ti	Sr:Zr	Geochemical Source
Lava Cast Cache	37	FS 1		148	69	43	189	11	1048	318	NM	1.36	36	44	25	Quartz Mountain
			±	4	9	3	7	1	90	27	NM	0.11				
Lava Cast Cache	38	FS 2		141	63	44	288	19	1466	306	NM	1.70	47	39	14	Newberry Volcano
			±	4	9	3	7	1	91	28	NM	0.11				
Lava Cast Cache	39	FS 3		159	70	47	297	18	1435	341	NM	1.45	36	34	16	Newberry Volcano
			±	4	9	3	7	1	91	28	NM	0.11				
Lava Cast Cache	40	FS 4		158	69	45	297	18	1341	308	NM	1.31	36	33	15	Newberry Volcano
			±	4	9	3	7	1	91	27	NM	0.11				
Lava Cast Cache	41	FS 5		131	60	41	280	19	1412	358	NM	1.64	39	39	14	Newberry Volcano
			±	4	9	3	7	1	91	28	NM	0.11				
Lava Cast Cache	42	FS 6		95	126	17	109	9	474	207	NM	0.78	34	55	86	Obsidian Cliffs
			±	4	9	3	7	1	89	27	NM	0.11				
Lava Cast Cache	43	FS 7		133	63	43	281	16	1489	344	NM	1.87	46	42	15	Newberry Volcano
			±	4	9	3	7	1	91	28	NM	0.11				

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.

Appendix B

Table B-5.Results of XRF Studies: Pahoehoe Cache (35-DS-268), Deschutes County, Oregon.

Northwest Research Obsidian Studies Laboratory

Table B-5. Results of XRF Studies: Pahoehoe Cache (35-DS-268), Deschutes County, Oregon

Site	Specimen No.	Catalog No.	Trace Element Concentrations Rb	Sr	Y	Zr	Nb	Ti	Mn	Ba	$Fe2O3^T$	Ratios Fe:Mn	Fe:Ti	Sr:Zr	Geochemical Source
Pahochoc Cachc	1	FS 29	126	61	38	200	11	1139	370	NM	1.66	38	49	20	McKay Butte
			± 4	9	3	7	1	91	28	NM	0.11				
Pahoehoe Cache	2	FS 31	143	61	39	204	11	1063	313	NM	1.58	43	50	20	McKay Butte
			± 4	9	3	7	1	91	28	NM	0.11				
Pahoehoe Cache	3	FS 33	136	61	39	200	12	983	372	NM	1.49	34	51	20	McKay Buttc
			± 4	9	3	7	1	90	28	NM	0.11				
Pahoehoe Cache	4	FS 34	135	61	40	206	9	1026	297	NM	1.55	44	50	20	McKay Butte
			± 4	9	3	7	1	91	28	NM	0.11				
Pahoehoe Cache	5	FS 42	156	67	40	216	11	987	315	NM	1.49	40	51	21	McKay Butte
			± 4	9	3	7	1	91	28	NM	0.11				
Pahochoc Cachc	6	FS 49	140	61	35	206	10	1009	254	NM	1.56	52	52	20	McKay Butte
			± 4	9	3	7	1	91	27	NM	0.11				
Pahochoc Cache	7	FS 52	161	70	41	222	13	870	301	NM	1.22	35	47	21	McKay Butte
			± 4	9	3	7	1	90	27	NM	0.11				
Pahoehoe Cache	8	FS 65	141	64	40	208	10	783	200	NM	1.15	50	49	21	McKay Butte
			± 4	9	3	7	1	90	27	NM	0.11				
Pahoehoe Cache	9	FS 80	142	62	40	205	10	971	287	NM	1.34	40	46	20	McKay Buttc
			± 4	9	3	7	1	90	27	NM	0.11				
Pahochoc Cachc	10	FS 125	152	68	39	214	12	1002	348	NM	1.45	35	48	21	McKay Butte
			± 4	9	3	7	1	90	28	NM	0.11				
Pahoehoe Cache	11	FS 132	143	66	39	212	10	941	353	NM	1.40	34	50	21	McKay Butte
			± 4	9	3	7	1	90	28	NM	0.11				
Pahoehoe Cache	12	FS 140	144	63	38	207	11	1033	266	NM	1.55	50	50	20	McKay Butte
			± 4	9	3	7	1	91	27	NM	0.11				

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 measurcd.; * = Small samplc.

Appendix B

Table B-6.Results of XRF Studies: Sugar Cast Cache (35-DS-752), Deschutes County, Oregon.

Northwest Research Obsidian Studies Laboratory

Table B-6. Results of XRF Studies: Sugar Cast Cache (35-DS-752), Deschutes County, Oregon

Site	Specimen No.	Catalog No.		Trace Element Concentrations Rb	Sr	Y	Zr	Nb	Ti	Mn	Ba	$Fe2O3^T$	Ratios Fe:Mn	Fe:Ti	Sr:Zr	Geochemical Source
Sugar Cast Cache	44	FS 1		153	70	44	301	18	1248	290	NM	1.56	46	42	15	Newberry Volcano
			±	4	9	3	7	1	91	27	NM	0.11				
Sugar Cast Cache	45	FS 8		101	40	54	134	13	524	309	NM	1.14	32	72	20	Cougar Mountain
			±	4	9	3	7	1	90	27	NM	0.11				
Sugar Cast Cache	46	FS 19		104	39	56	140	9	336	245	NM	0.94	34	90	19	Cougar Mountain
			±	4	9	3	7	1	89	27	NM	0.11				
Sugar Cast Cache	47	FS 20		150	65	44	284	19	1507	329	NM	1.80	46	40	15	Newberry Volcano
			±	4	9	3	7	1	91	28	NM	0.11				
Sugar Cast Cache	48	FS 26		139	70	41	290	18	1453	447	NM	1.85	35	43	16	Newberry Volcano
			±	4	9	3	7	1	91	28	NM	0.11				
Sugar Cast Cache	49	FS 31		105	38	56	134	13	613	264	NM	1.05	34	57	19	Cougar Mountain
			±	4	9	3	7	1	90	27	NM	0.11				
Sugar Cast Cache	50	FS 89		137	14	54	363	19	931	543	NM	1.76	27	63	2	Silver Lake/Sycan Marsh
			±	4	9	3	7	1	90	28	NM	0.11				
Sugar Cast Cache	51	FS 98		142	63	42	287	17	1375	419	NM	1.83	37	45	14	Newberry Volcano
			±	4	9	3	7	1	91	28	NM	0.11				
Sugar Cast Cache	52	FS 104		151	65	41	288	17	1261	306	NM	1.64	45	44	15	Newberry Volcano
			±	4	9	3	7	1	91	27	NM	0.11				
Sugar Cast Cache	53	FS 105		135	62	43	285	18	1393	318	NM	1.65	44	40	14	Newberry Volcano
			±	4	9	3	7	1	91	28	NM	0.11				

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.

Appendix B
Table B-7. Benham Falls East Cache Statistical Data

Benham Falls East Cache
Artifact count: 73
Whole artifact count: unknown
Average length: 5.82 cm
Average width: 2.01 cm
Sourced artifacts count: 6
Percent sourced: 8.2%
Percent by source: Newberry Volcano (NV) 83%, Cougar Mountain. (CM) 17%

Count	FS#	Length	Width	Thickness	Complete	Fragment	Obsidian	Reference
1	1	6.00	2.00					
2	2	5.50	1.75					
3	3	5.00	1.75					
4	4	5.25	1.75					
5	5	5.00	1.75					
6	6	6.50	2.00					
7	7	5.00	2.00					
8	8	8.25	2.25				NV	Skinner:2004
9	9	6.50	1.75					
10	10	6.00	1.75					
11	11	6.50	2.25					
12	12	5.50	2.00					
13	13	6.00	2.00					
14	14	5.50	2.00					
15	15	6.00	2.00					
16	16	5.00	2.00					

Appendix B

Table B-7. Benham Falls East Cache Statistical Data (Continued)

Count	FS#	Length	Width	Thickness	Complete	Fragment	Obsidian	Reference
17	17	6.25	2.00					
18	18	6.25	2.00					
19	19	5.50	2.00				CM	Skinner:2004
20	20	5.50	2.00					
21	21	4.50	2.00					
22	22	6.50	2.00					
23	23	5.50	2.75					
24	24	4.00	2.75				NV	Skinner:2004
25	25	4.50	2.00					
26	26	8.00	2.25					
27	27	6.50	2.00					
28	28	5.00	2.00					
29	29	5.75	2.00					
30	30	6.50	1.75					
31	31	6.00	2.00					
32	32	7.00	2.00				NV	Skinner:2004
33	33	6.50	1.75					
34	34	4.50	2.00					
35	35	5.50	1.75					
36	36	5.50	2.00					
37	37	4.50	2.00					
38	38	6.25	2.00					
39	39	8.00	1.75				NV	Skinner:2004
40	40	6.20	2.00					
41	41	5.25	2.00					

Appendix B
Table B-7. Benham Falls East Cache Statistical Data (Continued)

Count	FS#	Length	Width	Thickness	Complete	Fragment	Obsidian	Reference
42	42	6.00	2.25					
43	43	5.00	2.00					
44	44	5.50	2.00					
45	45	5.00	2.00					
46	46	6.75	2.25					
47	47	5.50	2.00					
48	48	5.50	2.00					
49	49	4.00	1.75					
50	50	4.25	1.75					
51	51	5.75	2.25					
52	52	6.50	2.25					
53	53	5.50	2.00					
54	54	7.00	2.00				NV	Skinner:2004
55	55	7.50	2.25					
56	56	5.25	1.75					
57	57	5.50	2.00					
58	58	6.00	2.00					
59	59	6.00	2.00					
60	60	5.25	2.00					
61	61	6.50	2.25					
62	62	4.75	2.00					
63	63	5.50	1.75					
64	64	5.00	1.75					
65	65	6.00	2.25					

Appendix B
Table B-7. Benham Falls East Cache Statistical Data (Continued)

Count	FS#	Length	Width	Thickness	Complete	Fragment	Obsidian	Reference
66	66	4.50	2.00					
67	67	8.00	2.25					
68	68	7.75	2.25					
69	69	5.50	2.00					
70	70	7.00	2.50					
71	71	5.00	1.75					
72	72	5.50	1.75					
73	73	7.50	1.75					

Appendix B
Table B-8. Lava Island Rockshelter Statistical Data

Lava Island Rockshelter
Artifact count: 43
Whole artifact count: unknown (33)
Average length: 7.6 cm
Average width: 2.0 cm
Sourced artifacts count: 8
Percent sourced: 24.24%
Percent by source: Mc Kay Butte/Newberry
Volcano (McKB/NV) 100%

Count	FS#	Length	Width	Thickness	Complete	Fragment	Obsidian	Reference
1	1							
2	2							
3	3							
4	4							
5	5							
6	6							
7	7							
8	8							
9	9	9.7	2.4	0.9				
10	10	10.5	2.2	0.9				
11	11	9.8	2.2	0.9				
12	12	9.6	2.5	1				
13	13	10.5	2.3	0.9				
14	14	9.4	2.4	0.9				
15	15	9.6	2.2	0.9				
16	16	8.6	2.6	0.8				
17	17	8.5	2.7	0.8			McKB/NV	Scott et al.:1986

Appendix B
Table B-8. Lava Island Rockshelter Statistical Data (Continued)

Count	FS#	Length	Width	Thickness	Complete	Fragment	Obsidian	Reference
18	18	9.6	2	0.9				
19	19	9.2	2.1	0.8				
20	20							
21	21							
22	22	9	2.5	0.9			McKB/NV	Scott et al.:1986
23	23	7.5	2.1	0.9				
24	24	6.2	1.9	0.8				
25	25	6.7	1.8	0.7				
26	26	6.4	1.8	0.9				
27	27	6.6	1.6	0.7				
28	28	6.4	1.7	0.8				
29	29	5.9	1.6	0.8			McKB/NV	Scott et al.:1986
30	30	6.2	1.9	0.5				
31	31	6.3	1.5	0.8				
32	32	6.4	1.7	0.8			McKB/NV	Scott et al.:1986
33	33	5.6	1.7	0.9				
34	34	5.8	1.9	0.6			McKB/NV	Scott et al.:1986
35	35	5.7	1.8	0.5				
36	36	4.7	1.5	0.6			McKB/NV	Scott et al.:1986
37	37	7.1	2.1	0.7			McKB/NV	Scott et al.:1986
38	38	4.9	1.9	0.6				
Average		7.5857	2.021					

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Table B-8. Lava Island Rockshelter Statistical Data (Continued)

Count	FS#	Length	Width	Thickness	Complete	Fragment	Obsidian	Reference
39	J-4-1	5.8	1.8	0.8			McKB/NV	Scott et al.:1986
40	K-2-1	6	1.7	0.9				
41	W-3-1	7.6	1.7	0.8				
42	X-2-1	8.5	2	0.8				
43	PP-2-1	6	1.8	0.8				
Average		6.78	1.8					

#'s 9-38 identified as cache

#'s 39 -43 identified as excavated collection

Appendix B
Table B-9. Lava Butte Cache Statistical Data

Lava Butte Cache
Artifact count: 4
Whole artifact count: 4
Average length: 14.0 cm
Average width: 4.45 cm
Sourced artifacts count: 4
Percent sourced: 100%
Percent by source: Newberry Volcano (NV) 100%

Count	FS#	Length	Width	Thickness	Complete	Fragment	Obsidian	Reference
1	A29/741	13.2	4.1	1.2			NV	Hughes:1989
2	A29/738	15.4	5.3	1.4			NV	Hughes:1989
3	A29/740	14.05	4.1	1.1			NV	Hughes:1989
4	A29/736	13.5	4.3	1.1			NV	Hughes:1989

Appendix B
Table B-10. Pahoehoe Cache Statistical Data

Pahoehoe Cache
Artifact count: 141
Whole artifact count: 98
Average length: 7.4 cm
Average width: 3.2 cm
Sourced artifacts count: 20
Percent sourced: 20.04%
Percent by source: McKay Butte (McKB) 100%

* indicates data not calculated in average measurements

Count	FS#	Length	Width	Thickness	Complete	Fragment	Obsidian	Reference
1	*1							
2	*2							
3	*3							
4	*4	*4.5	*1.95	0.57		Fragment		
5	*5							
6	*6							
7	*7					Fragment		
8	*8							
9	*9					Fragment		
10	10	6.56	2	0.57				
11	*11	*5.48	*2.79	0.76		Fragment		
12	12	5.9	2.18	0.44				
13	*13					Fragment		
14	*14					Fragment		
15	15	5.8	2.1	6.2				
16	16	6.5	2.35	0.38				
17	17	8.5	2.05	0.88				
18	18	7.48	2.32	0.94				
19	19	6.48	2.36	0.49				

Appendix B
Table B-10. Pahoehoe Cache Statistical Data (Continued)

Count	FS#	Length	Width	Thickness	Complete	Fragment	Obsidian	Reference
20	20	5.77	2.13	0.68				
21	21	5.37	2.32	0.5				
22	22	5.97	2.45	0.59				
23	23	5.68	2.41	0.55				
24	*24	*5.46	*2.36	*0.68		Fragment		
25	25	6.93	2.1	0.61				
26	26	6.95	2.2	0.7				
27	27	6.26	2.09	0.95				
28	28	5.54	2.27	0.56				
29	29	5.6	2.26	0.49			McKB	Skinner:2004
30	30	5.3	2.26	0.6				
31	31	4.68	1.96	0.67			McKB	Skinner:2004
32	32	5.96	2.22	0.69				
33	33	6.6	2.33	0.6			McKB	Skinner:2004
34	34	6.31	2.25	0.66			McKB	Skinner:2004
35	35	3.5	2.4	0.6			McKB	Scott et al.:1986
36	36	5.72	2.33	0.43				
37	37	6.72	2.48	0.84				
38	38	5	2.06	0.35				
39	39	5.17	2.01	0.7				
40	40	6.22	2.14	0.52				
41	41	6.15	2.33	0.64				
42	42	6.57	2.08	0.54			McKB	Skinner:2004
43	43	7.51	2.76	0.63				
44	44	7.26	2.2	0.9				

Appendix B
Table B-10. Pahoehoe Cache Statistical Data (Continued)

Count	FS#	Length	Width	Thickness	Complete	Fragment	Obsidian	Reference
45	45	6.99	2.2	0.64				
46	46	8.58	2.02	0.72				
47	47	6.98	2.1	0.69				
48	48	6.97	2.4	0.65				
49	49	5.73	2.14	0.7			McKB	Skinner:2004
50	50	6.84	1.93	0.69				
51	51	5.8	2.35	0.54				
52	52	6.76	2.16	0.79			McKB	Skinner:2004
53	53	6.8	2.16	0.78				
54	54	5.88	2.12	0.48				
55	*55	*5.08	*2.53	*0.53		Fragment		
56	56	6.36	2.3	0.74				
57	57	6.9	1.95	0.78				
58	*58	*6.38	*2.31	*0.89		Fragment		
59	59	6.15	2.25	0.5			McKB	Scott et al.:1986
60	60	8.27	2.28	0.69				
61	61	7.1	2.28	0.92				
62	62	5.9	2.35	0.45			McKB	Scott et al.:1986
63	63	7.93	1.96	0.52				
64	*64	*5.87	*2.25	*0.63		Fragment		
65	65	7.36	2.12	0.87			McKB	Skinner:2004
66	66	5.35	2	0.77				
67	67	4.63	1.83	0.88				
68	68	4.33	2.01	0.89				
69	*69							
70	70	7.03	2.36	0.84				
71	71	5.87	2.03	0.92				

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Table B-10. Pahoehoe Cache Statistical Data (Continued)

Count	FS#	Length	Width	Thickness	Complete	Fragment	Obsidian	Reference
72	72	4.9	2.24	0.51				
73	*73							
74	74	7.04	2.22	0.57				
75	75	5.6	1.4	0.45				
76	76	7.02	2.28	0.8				
77	*77							
78	78	5.78	2.3	0.56				
79	79	7.82	2.26	0.75				
80	80	4.9	1.88	0.46			McKB	Skinner:2004
81	81	6.66	2.19	0.69				
82	82	5.36	2.24	0.8				
83	83	5.45	2.2	0.3			McKB	Scott et al.:1986
84	*84					Fragment		
85	85	6.16	2.02	0.92				
86	*86							
87	*87							
88	*88							
89	*89							
90	*90							
91	91	5.83	2.02	0.6				
92	92	8.12	2.36	0.76				
93	93	6.4	2.23	0.46				
94	*94	*5.16	*2.23	*0.62		Fragment		
95	95	7.31	2.17	0.63				
96	96	6	2.1	0.35				

Appendix B
Table B-10. Pahoehoe Cache Statistical Data (Continued)

Count	FS#	Length	Width	Thickness	Complete	Fragment	Obsidian	Reference
97	97	6.95	2.69	0.84				
98	*98							
99	*99							
100	*100							
101	101	8.47	2.15	0.81				
102	102	6.2	2.2	0.97				
103	*103							
104	*104							
105	105	5.94	2.38	0.71				
106	106	6.4	1.9	0.6				
107	*107							
108	108	7.22	2.37	0.56				
109	*109							
110	110	6.59	2.33	0.84				
111	111	5.39	1.92	0.72				
112	*112	*4.89	*2.14	*0.78		Fragment		
113	113	6.09	2.1	0.57				
114	114	6.48	1.94	0.48				
115	115	5.95	2.15	6.2				
116	*116							
117	117	8.4	1.7	0.65			McKB	Scott et al.:1986
118	118	6.35	1.95	5.5				
119	119	7.18	2.12	0.74				
120	120	8.9	2.5	0.8			McKB	Scott et al.:1986
121	*121							
122	122	6.43	2.33	0.78				

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Table B-10. Pahoehoe Cache Statistical Data (Continued)

Count	FS#	Length	Width	Thickness	Complete	Fragment	Obsidian	Reference
123	123	5.99	1.98	0.5				
124	124	7.4	2.3	0.65			McKB	Scott et al.:1986
125	125	9.72	2.58	1.04			McKB	Skinner:2004
126	126	8.81	2.05	0.64				
127	*127	*5.17	*2.16	*0.87		Fragment		
128	*128							
129	129	5.83	2.41	0.6				
130	130	7.33	2.6	0.87				
131	*131							
132	132	10.04	2.78	0.95			McKB	Skinner:2004
133	133	5.4	2	0.3				
134	*134						McKB	Scott et al.:1986
135	135	5.72	2.1	0.38				
136	*136					Fragment		
137	*137							
138	*138	*3.4	*2.28	*0.55		Fragment		
139	139	9	2.25	0.9				
140	140	7.67	2.32	0.75			McKB	Skinner:2004
141	141	5.77	2.23	0.62				

Appendix B
Table B-11. Lava Cast Cache Statistical Data

Lava Cast Cache
Artifact count: 7
Whole artifact count: 7
Average length: 5.9 cm
Average width: 2.0 cm
Sourced artifacts count: 7
Percent sourced: 100%
Percent by source: Newberry Volcano (NV) 72%, Obsidian Cliffs (OC) 14%, Quartz Mountain (QM) 14%

Count	FS#	Length	Width	Thickness	Complete	Fragment	Obsidian	Reference
1	1	5.65	2.04	0.50			QM	Skinner:2004
2	2	7.73	2.19	0.62			NV	Skinner:2004
3	3	6.23	1.85	0.63			NV	Skinner:2004
4	4	5.60	2.00	0.59			NV	Skinner:2004
5	5	5.57	1.98	0.67			NV	Skinner:2004
6	6	5.48	1.92	0.75			OC	Skinner:2004
7	7	5.17	2.12	0.43			NV	Skinner:2004

Appendix B
Table B-12. China Hat Cache Statistical Data

China Hat Cache
Artifact count: 424
Whole artifact count: 305
Average length: 7.30 cm
Average width: 2.1 cm
Average thickness: 0.70 cm
Sourced artifacts count: 42
Percent sourced: 13.77%
Percent by source: Quartz Mountain (QM) 43%, McKay Butte/Newberry Volcano (McKB/NV) 22%, Newberry Volcano (NV) 19 %, McKay Butte (McKB) 5%, (McKB/NV+NV+McKB 46%), Buried/Big Obsidian Flow (BOF) 2%, Cougar Mountain (CM) 2.2%, Silver Lake/Sycan Marsh (SL/SM) 2.2%, Unknown 2.2%, Unknown Rhyolite 2.2%

Count	FS#	Length	Width	Thickness	Complete	Fragment	Obsidian	Reference
1	1	5.62	2.07	0.68			QM	Scott et al.:1986
2	2	7.77	2.32	0.81				
3	3					fragment		
4	4					fragment		
5	5	6.52	1.98	0.85			unknown	Scott et al.:1986
6	6					fragment		
7	7					fragment	McKB/NV	Scott et al.:1986
8	8	6.35	1.86	0.66			CM	Skinner:2004
9	9					fragment		
10	10					fragment		
11	11					fragment		
12	12					fragment		
13	13	6.14	2.07	0.65				
14	14	7.50	1.97	0.86				
15	15	5.55	2.16	0.75				
16	16	6.05	1.92	0.83			QM	Scott et al.:1986

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Table B-12. China Hat Cache Statistical Data (Continued)

Count	FS#	Length	Width	Thickness	Complete	Fragment	Obsidian	Reference
17	17	5.34	2.23	0.51				
18	18	7.32	2.13	0.91				
19	19	7.18	2.31	0.86				
20	20					fragment		
21	21	6.92	1.97	0.84				
22	22	7.31	1.99	0.64			QM	Scott et al.:1986
23	23	6.03	1.99	0.70				
24	24	5.19	1.86	0.59				
25	25	5.77	1.89	0.48				
26	26					fragment		
27	27					fragment		
28	28	6.81	2.02	0.67				
29	29	7.80	2.06	0.77			QM	Scott et al.:1986
30	30	6.09	1.98	0.80				
31	31	7.20	1.88	0.72			QM	Scott et al.:1986
32	32	6.05	2.25	0.59				
33	33					fragment		
34	34					fragment		
35	35	4.39	1.88	0.57				
36	36	5.03	1.98	0.67				
37	37					fragment		
38	38	4.90	1.78	0.55				
39	39					fragment		
40	40	7.94	2.04	0.91				
41	41	6.33	1.88	0.63				
42	42	6.93	1.84	0.53				
43	43	6.45	2.00	0.61				

Appendix B
Table B-12. China Hat Cache Statistical Data (Continued)

Count	FS#	Length	Width	Thickness	Complete	Fragment	Obsidian	Reference
44	44	6.33	2.00	0.71				
45	45	5.51	1.83	0.54				
46	46	6.81	2.07	0.65				
47	47	6.76	1.95	0.70				
48	48					fragment	McKB/NV	Scott et al.:1986
49	49	7.00	1.97	0.80			QM	Scott et al.:1986
50	50	5.99	1.95	0.68				
51	51	6.52	2.25	0.74			NV	Skinner:2004
52	52					fragment		
53	53	6.19	1.92	0.83				
54	54	6.26	2.19	0.67				
55	55	5.59	2.10	0.80				
56	56	6.23	1.88	0.68			McKB/NV	Scott et al.:1986
57	57	6.62	1.97	0.81				
58	58	6.72	1.75	0.77				
59	59	7.78	2.14	0.83				
60	60	5.33	1.77	0.54				
61	61	7.66	2.10	0.53			McKB/NV	Scott et al.:1986
62	62	6.97	2.28	0.74			McKB/NV	Scott et al.:1986
63	63	6.87	2.06	0.65				
64	64	7.89	2.37	0.79				
65	65	6.30	2.02	0.59				
66	66					fragment		
67	67					fragment		
68	68					fragment		

Appendix B
Table B-12. China Hat Cache Statistical Data (Continued)

Count	FS#	Length	Width	Thickness	Complete	Fragment	Obsidian	Reference
69	69	4.74	2.04	0.76			McKB/NV	Scott et al.:1986
70	70	6.45	2.17	0.78				
71	71	5.73	1.84	0.62				
72	72					fragment		
73	73	5.73	2.02	0.93				
74	74					fragment		
75	75					fragment		
76	76	5.13	2.20	0.69				
77	77					fragment		
78	78					fragment		
79	79					fragment		
80	80					fragment	McKB/NV	Scott et al.:1986
81	81					fragment		
82	82	5.62	1.96	0.63				
83	83	6.42	2.05	0.67			QM	Scott et al.:1986
84	84	5.51	2.07	0.78				
85	85	5.66	2.07	0.62				
86	86	4.77	1.84	0.51				
87	87	5.42	1.94	0.61				
88	88	5.34	1.97	0.67			QM	Scott et al.:1986
89	89					fragment		
90	90	6.18	1.96	0.72				
91	91					fragment		
92	92	6.18	1.80	0.64				
93	93	6.25	1.88	0.61				
94	94	5.95	2.00	0.67				

Appendix B
Table B-12. China Hat Cache Statistical Data (Continued)

Count	FS#	Length	Width	Thickness	Complete	Fragment	Obsidian	Reference
95	95	6.13	1.92	0.64				
96	96					fragment		
97	97					fragment		
98	98					fragment	McKB/NV	Scott et al.:1986
99	99					fragment		
100	100					fragment		
101	101	5.73	2.12	0.72				
102	102					fragment		
103	103					fragment		
104	104	4.95	2.04	0.62				
105	105	5.11	1.77	0.58				
106	106	4.92	1.86	0.63			McKB/NV	Scott et al.:1986
107	107					fragment		
108	108					fragment		
109	109					fragment		
110	110					fragment		
111	111					fragment		
112	112	5.00	1.88	0.61				
113	113	4.88	2.07	0.67				
114	114					fragment		
115	115					fragment		
116	116					fragment		
117	117					fragment		
118	118	4.32	2.01	0.55				
119	119					fragment		
120	120					fragment		

Appendix B
Table B-12. China Hat Cache Statistical Data (Continued)

Count	FS#	Length	Width	Thickness	Complete	Fragment	Obsidian	Reference
121	121					fragment		
122	122					fragment		
123	123					fragment		
124	124					fragment		
125	125	5.58	1.90	0.59				
126	126					fragment		
127	127					fragment		
128	128					fragment		
129	129					fragment		
130	130					fragment		
131	131					fragment		
132	132					fragment		
133	133					fragment		
134	134					fragment		
135	135					fragment		
136	136					fragment		
137	137					fragment		
138	138					fragment		
139	139	7.72	2.19	0.56				
140	140	6.62	1.80	0.70				
141	141	7.02	2.24	0.78				
142	142	6.57	2.38	0.68				
143	143	5.47	1.91	0.80				
144	144	5.90	2.10	0.63				
145	145	6.81	2.15	0.58				
146	146	5.52	1.90	0.77				

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Table B-12. China Hat Cache Statistical Data (Continued)

Count	FS#	Length	Width	Thickness	Complete	Fragment	Obsidian	Reference
147	147	7.15	1.99	0.65				
148	148					fragment		
149	149	6.03	2.14	0.68				
150	150					fragment		
151	151	5.96	1.97	0.67				
152	152					fragment		
153	153	7.02	2.08	0.77				
154	154	6.77	2.63	0.75				
155	155	5.42	1.92	0.64				
156	156	6.19	2.04	0.76				
157	157	6.17	2.04	0.57				
158	158	5.11	2.07	0.73				
159	159	6.47	2.02	0.61				
160	160	5.44	1.91	0.59				
161	161	6.36	2.28	0.68				
162	162	7.86	2.31	0.83				
163	163	7.91	2.10	0.76				
164	164	8.92	2.40	0.96			BOF	Skinner:2004
165	165	6.97	2.31	0.64			QM	Skinner:2004
166	166	9.93	2.22	0.83				
167	167	6.30	2.12	0.57				
168	168	7.14	2.33	0.57				
169	169	9.35	2.58	0.89				
170	170	4.74	1.55	0.52				
171	171	7.86	2.33	0.69				

Appendix B
Table B-12. China Hat Cache Statistical Data (Continued)

Count	FS#	Length	Width	Thickness	Complete	Fragment	Obsidian	Reference
172	172	11.99	2.25	0.73				
173	173	5.64	2.00	0.61				
174	174					fragment		
175	175	5.68	2.02	0.69				
176	176	5.40	1.98	0.68				
177	177	8.01	2.32	0.76				
178	178	5.77	1.87	0.74				
179	179	7.11	2.16	0.54				
180	180	8.05	2.16	0.85				
181	181	6.84	2.02	0.71				
182	182	7.93	2.30	1.14				
183	183	8.79	2.03	0.78				
184	184	5.09	2.10	0.53				
185	185	6.92	2.07	0.79				
186	186					fragment		
187	187	5.45	1.95	0.70				
188	188	7.43	2.08	0.63				
189	189	6.91	1.79	0.87				
190	190	6.18	2.07	0.69				
191	191	5.36	1.93	0.89				
192	192					fragment		
193	193					fragment		
194	194					fragment		
195	195					fragment		
196	196	6.86	2.18	0.78				
197	197					fragment		

Appendix B
Table B-12. China Hat Cache Statistical Data (Continued)

Count	FS#	Length	Width	Thickness	Complete	Fragment	Obsidian	Reference
198	198					fragment		
199	199					fragment		
200	200					fragment		
201	201					fragment		
202	202					fragment		
203	203					fragment		
204	204					fragment		
205	205	6.32	2.23	0.69				
206	206	6.64	2.35	1.01				
207	207	7.19	2.26	0.68				
208	208	5.96	2.00	0.81				
209	209	6.60	1.79	0.87				
210	210	5.91	2.12	0.68				
211	211					fragment		
212	212	5.50	2.05	0.87				
213	213	4.71	2.07	0.46				
214	214	6.21	1.88	0.72				
215	215	6.49	2.15	0.69				
216	216	4.58	1.91	0.67				
217	217	6.17	2.13	0.64			NV	Skinner:2004
218	218	5.99	1.87	0.70				
219	219	6.09	2.03	0.93				
220	220					fragment		
221	221	4.85	1.81	0.52				
222	222					fragment		

Appendix B
Table B-12. China Hat Cache Statistical Data (Continued)

Count	FS#	Length	Width	Thickness	Complete	Fragment	Obsidian	Reference
223	223					fragment		
224	224					fragment		
225	225	4.41	2.02	0.67				
226	226					fragment		
227	227-2	7.78	2.21	0.67				
228	228-3	6.22	2.25	0.83				
229	229-4	5.68	1.86	0.47				
230	230-5	6.81	2.03	0.75				
231	231-6	6.55	2.20	0.62				
232	232-7	6.12	2.14	0.73				
233	233-8	6.14	1.88	0.87				
234	234-9	6.46	2.03	0.72				
235	235-10	7.70	2.24	0.59				
236	236-11	6.25	2.22	0.76				
237	237-13	6.64	2.16	0.66				
238	238-14	5.84	2.10	0.66				
239	239-15	7.41	2.39	0.62				
240	240	8.03	2.22	0.90			NV	Skinner:2004
241	241	6.22	2.04	0.75				
242	242	7.83	1.95	0.69			NV	Skinner:2004
243	243	6.07	2.30	0.49			NV	Skinner:2004
244	244	5.92	2.06	0.50				
245	245	6.60	1.99	0.86				
246	246					fragment		

Appendix B
Table B-12. China Hat Cache Statistical Data (Continued)

Count	FS#	Length	Width	Thickness	Complete	Fragment	Obsidian	Reference
247	247	7.25	2.17	0.55				
248	248	6.76	2.06	0.75			QM	Skinner:2004
249	249	4.86	1.99	0.77			QM	Skinner:2004
250	250	5.64	2.14	0.65				
251	251	5.66	2.10	0.71				
252	252	7.62	2.21	0.91				
253	253	6.49	2.15	0.68			NV	Skinner:2004
254	254	5.20	2.00	0.62				
255	255	6.17	1.95	0.64				
256	256	7.30	2.22	0.60				
257	257	5.67	2.22	0.77				
258	258	5.69	1.86	0.64				
259	259	6.81	2.11	0.67				
260	260	5.96	2.16	0.75				
261	261	4.90	1.96	0.55				
262	262	4.66	2.00	0.54				
263	263	5.46	1.86	0.58				
264	264	5.46	2.05	0.66				
265	265	5.57	2.02	0.69			QM	Skinner:2004
266	266	7.41	2.03	0.77				
267	267	6.93	2.25	0.69				
268	268	5.02	1.81	0.72				
269	269	5.50	1.96	0.58				
270	270	6.84	2.06	0.65				

Appendix B
Table B-12. China Hat Cache Statistical Data (Continued)

Count	FS#	Length	Width	Thickness	Complete	Fragment	Obsidian	Reference
271	271	5.13	2.03	0.63			NV	Skinner:2004
272	272	6.07	2.11	0.66			QM	Skinner:2004
273	273	6.87	2.11	0.86				
274	274	5.11	2.09	0.65				
275	275	5.31	1.90	0.68				
276	276	5.63	1.78	0.64				
277	277	4.91	2.05	0.48				
278	278	6.78	2.17	0.85				
279	279	6.01	1.98	0.79				
280	280	6.37	2.05	0.83				
281	281	5.19	1.83	0.67				
282	282	5.50	2.14	0.74				
283	283	5.22	2.05	0.60				
284	284	7.14	1.98	0.50				
285	285	5.95	2.07	0.54				
286	286	6.00	2.06	0.73				
287	287	5.71	2.22	0.65				
288	288	6.15	2.04	0.73				
289	289	7.34	2.12	0.87				
290	290	8.83	2.12	0.94				
291	291	5.64	2.10	0.59				
292	292	6.21	1.86	0.75				
293	293	7.12	2.24	0.70				
294	294	7.50	2.00	0.92				
295	295	7.27	2.53	0.62				

Appendix B
Table B-12. China Hat Cache Statistical Data (Continued)

Count	FS#	Length	Width	Thickness	Complete	Fragment	Obsidian	Reference
296	296	7.84	2.20	0.80				
297	297	7.20	2.07	0.78				
298	298	6.17	2.28	0.60				
299	299	5.10	1.88	0.69				
300	300	7.90	2.21	0.73				
301	301	7.06	2.00	1.01				
302	302	6.32	2.05	0.77				
303	303	6.94	1.98	0.65				
304	304	5.91	2.10	0.75				
305	305	6.03	1.82	0.68				
306	306	5.56	2.01	0.57				
307	307	7.15	2.06	0.63				
308	308	5.14	1.88	0.65				
309	309	7.23	2.36	0.67				
310	310	7.42	1.96	0.76				
311	311	6.83	2.15	0.80				
312	312	4.24	2.02	0.59				
313	313	5.95	2.02	0.94			McKB	Skinner:2004
314	314	6.50	1.81	0.67			SL/SM	Skinner:2004
315	315	6.43	2.03	0.75				
316	316	6.35	1.97	0.74				
317	317	7.30	2.17	0.79				
318	318	5.36	1.70	0.61				
319	319	6.53	1.87	0.64				
320	320	5.52	2.10	0.55				

Appendix B
Table B-12. China Hat Cache Statistical Data (Continued)

Count	FS#	Length	Width	Thickness	Complete	Fragment	Obsidian	Reference
321	321	5.53	1.95	0.56				
322	322	5.47	2.01	0.64				
323	323	5.29	2.14	0.51				
324	324	6.47	2.21	0.82				
325	325	6.16	1.97	0.71				
326	326					fragment		
327	327	6.44	2.11	0.84				
328	328	6.20	2.06	0.64				
329	329	5.53	1.95	0.54				
330	330					fragment		
331	331					fragment		
332	332					fragment		
333	333					fragment		
334	334					fragment		
335	335					fragment		
336	336	6.78	2.05	0.85				
337	337	6.68	2.27	0.78			McKB	Skinner:2004
338	338	6.11	2.34	0.88				
339	339					fragment		
340	340	5.12	1.74	0.69				
341	341	6.74	2.16	0.87				
342	342	5.97	2.03	0.50				
343	343	4.94	1.83	0.55				
344	344	6.75	2.23	0.61				
345	345	5.55	1.79	0.73				

Appendix B
Table B-12. China Hat Cache Statistical Data (Continued)

Count	FS#	Length	Width	Thickness	Complete	Fragment	Obsidian	Reference
346	346	7.13	1.97	0.67				
347	347	7.04	2.10	0.65				
348	348	7.25	1.96	0.69				
349	349					fragment		
350	350					fragment		
351	351					fragment		
352	352					fragment		
353	353					fragment		
354	354					fragment		
355	355					fragment		
356	356					fragment		
357	357					fragment		
358	358					fragment		
359	359					fragment		
360	360					fragment		
361	361					fragment		
362	362					fragment		
363	363	4.72	1.87	0.70				
364	364	6.31	2.15	0.88				
365	365	6.07	2.17	0.67			NV	Skinner:2004
366	366	7.45	2.31	0.73			QM	Skinner:2004
367	367					fragment		
368	368					fragment		
369	369	7.00	2.04	0.65				
370	370	6.58	2.29	0.73				

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Table B-12. China Hat Cache Statistical Data (Continued)

Count	FS#	Length	Width	Thickness	Complete	Fragment	Obsidian	Reference
371	371	6.31	2.15	0.58				
372	372	5.69	1.88	0.51				
373	373	5.76	2.12	0.56				
374	374					fragment		
375	375	7.70	2.09	0.70				
376	376	6.77	2.04	0.87				
377	377					fragment		
378	378	6.93	2.06	0.57				
379	379	5.58	2.04	0.77				
380	380	5.17	1.93	0.65			QM	Skinner:2004
381	381	6.22	2.33	0.55				
382	382	7.51	2.02	0.70				
383	383	5.65	2.04	0.84				
384	384	6.64	2.15	0.75				
385	385	5.51	1.97	0.69			QM	Skinner:2004
386	386	5.99	2.06	0.68				
387	387	5.18	2.03	0.69				
388	388	6.24	2.22	0.55				
389	389	6.61	2.22	0.68				
390	390	6.87	2.14	0.77			QM	Skinner:2004
391	391	7.08	2.10	0.79				
392	392	5.85	1.98	0.71				
393	393	8.09	2.33	0.55				
394	394	5.53	1.89	0.61				

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Table B-12. China Hat Cache Statistical Data (Continued)

Count	FS#	Length	Width	Thickness	Complete	Fragment	Obsidian	Reference
395	395	5.69	1.69	0.42				
396	396					fragment		
397	397	5.26	1.84	0.57				
398	398	6.70	2.14	0.69				
399	399	7.41	2.15	1.04			Unknown Rhyolite	Skinner:2004
400	400	7.97	2.48	0.73				
401	401	6.68	2.19	0.88				
402	402	6.75	1.87	0.77				
403	403	5.56	1.99	0.66				
404	404					fragment		
405	405					fragment		
406	406	7.49	2.11	0.77				
407	407	6.01	1.99	0.61				
408	408	6.78	1.83	0.73				
409	409	6.67	2.26	0.62				
410	410	5.74	1.87	0.58				
411	411	5.90	1.97	0.77				
412	412	6.90	2.05	0.83				
413	413					fragment		
414	414	5.38	2.18	0.70				
415	415	5.14	2.00	0.73				
416	416	5.63	2.04	0.85				
417	417	5.29	1.98	0.58				

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Table B-12. China Hat Cache Statistical Data (Continued)

Count	FS#	Length	Width	Thickness	Complete	Fragment	Obsidian	Reference
418	418	8.14	1.98	0.70				
419	419	5.00	1.97	0.61				
420	420	8.12	2.39	0.60			QM	Skinner:2004
421	421	7.57	2.16	0.80				
422	422	6.76	1.99	0.90				
423	80	6.54	2.02	0.73				
424	80	6.54	2.02	0.73				

Appendix B

Table B-13. Jim-Bob Cache Statistical Data

Jim-Bob Cache
Artifact count: 11
Whole artifact count: 4
Average length: 12.4 cm
Average width: 3.81 cm
Sourced artifacts count: 10
Percent sourced: 100%
Percent by source: Silver Lake/Sycan Marsh (SL/SM) 60%, Cougar Mountain (CM) 20%, Newberry Volcano (NV) 10%, Spodue Mountain (SM) 10%
* not calculated in average-possible fragment

Count	FS#	Length	Width	Thickness	Complete	Fragment	Obsidian	Reference
1	1	13.20	3.09	1.6	lanceolate point		SL/SM	Skinner:2004
2	2	11.40	3.60	1.1	lanceolate point		NV	Skinner:2004
3	3	11.60	4.35	1.25	lanceolate point		SL/SM	Skinner:2004
*4	*4	*1.75	*3.7	0.6	projectile point		CM	Skinner:2004
*5	*5	*4.1	*7.5	1.25	biface		CM	Skinner:2004
6	6	13.50	4.20	1.6	lanceolate point		SL/SM	Skinner:2004
7	7						SL/SM	Skinner:2004
8	8						SM	Skinner:2004
9	9				missing			Skinner:2004
10	10						SL/SM	Skinner:2004
11	11						SL/SM	Skinner:2004

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Table B-14. Ray Cache Statistical Data

Ray Cache
Artifact count: 33
Whole artifact count: 18
Average length: 12.9 cm
Average width: 4.4 cm
Average thickness 1.2 cm
Sourced artifacts count: 4
Percent sourced: 22%
Percent by source: Silver Lake/Sycan Marsh (SL/SM) 75%, Cougar Mountain (CM) 25%.
*indicates in used in average calculation.

Count	FS#	Length	Width	Thickness	Complete	Fragment	Obsidian	Reference
1		10.16	4.02	0.94	uniface		SL/SM	Hughes:1987
2		8.83	4.33	1.05	biface		SL/SM	Hughes:1987
*3		*8.46	*3.98	*1.13		uniface tip	SL/SM	Hughes:1987
*4		*9.88	*4.37	*1.18		biface missing tip	CM	Hughes:1987
5		10.89	4.4	1.05	biface			
6		8.9	4.35	1.09	biface			
7		9.66	4.6	1.1	biface			
8		11.93	4.59	1.26	biface			
9		12.29	4.92	1.25	biface			
10		11.71	4.12	1.21	uniface			
11		11.4	4.25	1.14	biface			
12		11.15	3.74	1.16	uniface			
13		10.9	4.65	1.02	biface			
14		11.45	4.76	0.99	biface			
15		11.56	4.5	1.28	biface			
*16		*6.7	*5.02	*1.47		biface fragment		
*17		*6.65	*4.03	*0.98		biface fragment		
*18		*7.86	*4.83	*1.04		uniface fragment		
19		13.93	5.05	1.47	biface			
20		10.12	3.48	1.05	biface			
21		12.7	5.21	1.33	uniface			
*22		*8.2	*4.83	*1.22		uniface fragment		

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Table B-14. Ray Cache Statistical Data (Continued)

Count	FS#	Length	Width	Thickness	Complete	Fragment	Obsidian	Reference
*23		*6.32	*4.89	*1.09		uniface fragment		
*24		*7.56	*4.26	*1.03		biface fragment		
25		10.4	3.63	1.12		biface fragment		
*26		*7.33	*4.3	*0.91		biface fragment		
*27		*7.11	*4.93	*1.14		biface fragment		
*28		*8.35	*4.01	*1.11		biface fragment		
*29		*7.82	*4.8	*1.1		biface fragment		
30		11.77	4.66	1.44	biface			
*31		*7.9	*4.52	*1.42		uniface fragment		
*32		*6.9	*4.63	*1.31		biface fragment		
*33		*8.02	*4.54	*1.33		biface fragment		

Appendix B
Table B-15. Sugar Cast Cache Statistical Data

Sugar Cast Cache
Artifact count: 122
Whole artifact count: 63
Average length: 9.8 cm
Average width: 4.2 cm
Average thickness 1.2 cm
Sourced artifacts count: 16
Percent sourced: 25.39%
Percent by source: Newberry Volcano (NV) 63.5%, Cougar Mountain (CM) 31%, Silver Lake/Sycan Marsh (SL/SM) 6%. * indicates measurements not included in data average calculations.

Count	FS#	Length	Width	Thickness	Complete	Fragment	Obsidian	Reference
1	1	8.60	4.10	0.91			NV	Skinner:2004
*2	2					Fragment		
3	3	10.10	4.70	*			NV	Hughes:1987
4	4	9.80	4.20	1.10				
5	5	7.60	3.60	*			NV	Hughes:1987
6	6	10.90	4.20	*			NV	Hughes:1987
7	7	9.30	3.70	*			CM	Hughes:1987
8	8	9.80	4.20	1.10			CM	Skinner:2004
9	9	10.70	3.70	1.00				
10	10	7.40	3.90	0.09				
11	11	10.00	3.10	0.90				
12	12	9.50	3.90	*			CM	Hughes:1987
13	13	10.10	3.90	0.80				
14	14	11.20	4.20	1.10				
*15	15					Fragment		
16	16	12.10	4.80	*			NV	Hughes:1987

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Table B-15. Sugar Cast Cache Statistical Data (Continued)

Count	FS#	Length	Width	Thickness	Complete	Fragment	Obsidian	Reference
17	17	10.90	4.30	0.96				
*18	18					Fragment		
19	19	11.20	3.90	1.20			CM	Skinner:2004
20	20	10.70	3.70	1.00			NV	Skinner:2004
*21	21					Fragment		
*22	22							
23	23	9.20	4.10	1.10				
*24	24							
*25	25					Fragment		
*26	26						NV	Skinner:2004
27	27	10.90	4.30	0.96				
28	28	12.00	4.70	1.20				
29	29	12.00	4.70	1.20				
30	30	10.30	4.70	0.96				
31	31	10.00	3.10	0.90			CM	Skinner:2004
32	32	10.00	4.10	1.00				
33	33	11.20	4.20	1.10				
34	34	8.00	4.50	0.75				
35	35	8.50	4.40	1.00				
36	36	8.00	4.50	0.75				
*37	37							
38	38	8.00	4.50	0.75				
*39	39					Fragment		

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Table B-15. Sugar Cast Cache Statistical Data (Continued)

Count	FS#	Length	Width	Thickness	Complete	Fragment	Obsidian	Reference
40	40	12.00	4.70	1.20				
41	41	12.00	4.70	1.20				
*42	42							
*43	43							
*44	44							
*45	45							
*46	46							
*47	47							
*48	48							
*49	49							
*50	50							
*51	51							
*52	52							
53	53	10.00	4.10	1.00				
54	54	10.00	4.10	1.00				
*55	55					Fragment		
*56	56					Fragment		
57	57	8.00	4.50	0.75				
58	58	8.60	4.30	0.90				
*59	59					Fragment		
*60	60							
*61	61					Fragment		
62	62	8.60	4.30	0.90				
*63	63							
*64	64					Fragment		

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Table B-15. Sugar Cast Cache Statistical Data (Continued)

Count	FS#	Length	Width	Thickness	Complete	Fragment	Obsidian	Reference
65	65	8.60	4.30	0.90				
*66	66							
67	67	8.60	4.30	0.90				
*68	68					Fragment		
*69	69					Fragment		
70	70	8.60	4.30	0.90				
*71	71					Fragment		
*72	72							
*73	73							
*74	74					Fragment		
*75	75					Fragment		
*76	76							
77	77	8.60	4.30	0.90				
*78	78					Fragment		
*79	79							
*80	80							
*81	81							
82	82	8.60	4.30	0.90				
83	83	8.90	3.90	0.96				
*84	84							
85	85	8.60	4.30	0.90				
86	86	8.90	3.90	0.96				
87	87	8.60	4.30	0.90				
88	88	8.60	4.30	0.90				
89	89	11.30	3.90	0.93			SL/SM	Skinner:2004

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Table B-15. Sugar Cast Cache Statistical Data (Continued)

Count	FS#	Length	Width	Thickness	Complete	Fragment	Obsidian	Reference
90	90	10.30	4.70	0.96				
91	91	10.30	4.70	0.96				
92	92	10.90	4.30	0.96				
93	93	10.30	4.70	0.96				
*94	94							
*95	95							
96	96	11.30	4.80	1.00				
97	97	11.30	4.80	1.00				
98	98	11.30	4.80	1.00			NV	Skinner:2004
99	99	9.20	4.10	1.10				
*100	100							
101	101	8.00	4.50	0.75				
102	102	8.00	4.50	0.75				
*103	103							
104	104	11.30	4.00	0.99			NV	Skinner:2004
105	105	9.30	3.90	1.20			NV	Skinner:2004
*106	106							
*107	107					Fragment		
*108	108					Fragment		
*109	109					Fragment		
*110	110					Fragment		
*111	111					Fragment		
*112	112							
*113	113							
*114	114							

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Table B-15. Sugar Cast Cache Statistical Data (Continued)

Count	FS#	Length	Width	Thickness	Complete	Fragment	Obsidian	Reference
*115	115							
*116	116					Fragment		
117	117	8.00	4.50	0.75				
*118	118					Fragment		
*119	119					Fragment		
120	120	10.00	4.10	1.00				
121	121	10.00	4.10	1.00				
122	122	10.90	4.30	0.96				

Appendix B

Table B-16. Grogran Cache Statistical Data

Grogran Cache
Artifact count: 22
Whole artifact count: 17
Average length: 10.2 cm
Average width: 4.3 cm
Average thickness 1.3 cm
Sourced artifacts count: 22
Percent sourced: 100%
Percent by source: Newberry Volcano (NV) 91%, Obsidian Cliffs (OC) 9%. * indicates measurements not included in calculations.

Count	FS#	Length	Width	Thickness	Complete	Fragment	Obsidian	Reference
1	1	9.32	3.86	1.24			NV	Hughes:1991
2	2	9.68	4.00	1.31			NV	Hughes:1991
3	3	9.55	4.49	1.61			NV	Hughes:1991
4	4	8.94	4.40	1.46			NV	Hughes:1991
5	5	9.73	4.52	1.42			NV	Hughes:1991
6	6	10.10	4.22	1.24			NV	Hughes:1991
7	7	10.81	4.75	1.65			OC	Hughes:1991
8	8	11.81	4.08	1.07			NV	Hughes:1991
9	9	10.38	4.41	1.17			NV	Hughes:1991
10	10	11.21	4.22	1.53			NV	Hughes:1991
11	11	10.13	4.53	1.24			NV	Hughes:1991
12	12	10.89	3.87	1.27			NV	Hughes:1991
13	13	11.18	4.52	1.29			NV	Hughes:1991
14	14	11.29	4.89	1.45			NV	Hughes:1991
15	15	8.07	3.33	1.00			NV	Hughes:1991
16	16	9.31	3.94	1.07			NV	Hughes:1991

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Table B-16. Grogran Cache Statistical Data (Continued)

Count	FS#	Length	Width	Thickness	Complete	Fragment	Obsidian	Reference
*17	17	*7.78	*4	1.31		fragment	NV	Hughes:1991
18	18	11.85	5.94	1.49			NV	Hughes:1991
*19	19	*6.28	*4.18	1.28		fragment	NV	Hughes:1991
*20	20	*4.25	*4.45	1.05		fragment	NV	Hughes:1991
*21	21	*4.37	*5.08	1.31		fragment	NV	Hughes:1991
*22	22						OC	Hughes:1991

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Table B-17. Burdick Cache Statistical Data

Burdick Cache
Artifact count: 22
Whole artifact count: 17
Average length: 9.7 cm
Average width: 6.8 cm
Average thickness: 1.3 cm
Sourced artifacts count: 10
Percent sourced: 45%
Percent by source: Obsidian Cliffs (OC) 100%

Count	FS#	Length	Width	Thickness	Complete	Fragment	Obsidian	Reference
1	1							
2	2							
3	3							
4	4	10.20	7.50	2.40			OC	Origer:1989
5	5	8.50	8.40					
6	6	11.70	7.30					
7	7	9.30	7.30	1.10				
8	8	10.50	6.20	2.30			OC	Origer:1989
9	9	10.60	8.40					
10	10	9.10	6.50					
11	11	9.50	6.60					
12	12	7.50	5.90	2.10			OC	Origer:1989
13	13	9.50	6.60	2.80			OC	Origer:1989
14	14							
15	15							
16	16	10.80	5.50					
17	17	9.60	6.10					

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Table B-17. Burdick Cache Statistical Data (Continued)

Count	FS#	Length	Width	Thickness	Complete	Fragment	Obsidian	Reference
18	18	9.60	7.80	2.60			OC	Origer:1989
19	19	7.90	6.50	1.80			OC	Origer:1989
20	20	10.80	7.50	2.30			OC	Origer:1989
21	21	9.00	6.60	2.10			OC	Origer:1989
22	22	10.60	5.80	3.90			OC	Origer:1989

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Table B-18. Badger Creek Cache Statistical Data

Badger Creek Cache
Artifact count: unknown (Swift reference a count of 36 yet artifacts are numbered 97-120 on measurement data sheet in Badger Creek file from Swift)
Whole artifact count: unknown
Average length: 12.7 cm
Average width: 5.8 cm
Sourced artifacts count: 4
Percent sourced: 9%
Percent by source: Obsidian Cliffs (OC) 100%. References include Swift 1990, Origer 1989, and Hughes unknown date.

Count	FS#	Length	Width	Thickness	Complete	Fragment	Obsidian	Reference
*1	1							
*2	2							
*3	3							
*4	4							
*5	5							
*6	6							
*7	7							
*8	8							
*9	9							
*10	10							
*11	11							
*12	12							
*13	13							
*14	14							
*15	15							
*16	16							
*17	17							
*18	18							

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Table B-18. Badger Creek Cache Statistical Data (Continued)

Count	FS#	Length	Width	Thickness	Complete	Fragment	Obsidian	Reference
*19	19							
*20	20							
*21	21							
*22	22							
*23	23							
*24	24							
*25	25							
*26	26							
*27	27							
*28	28							
*29	29							
*30	30							
*31	31							
*32	32							
*33	33							
*34	34							
*35	35							
*36	36							
*37	37							
*38	38							
*39	39							
*40	40							
*41	41							
*42	42							
*43	43							
*44	44							
*45	45							
*46	46							

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Table B-18. Badger Creek Cache Statistical Data (Continued)

Count	FS#	Length	Width	Thickness	Complete	Fragment	Obsidian	Reference
*47	47							
*48	48							
*49	49							
*50	50							
*51	51							
*52	52							
*53	53							
*54	54							
*55	55							
*56	56							
*57	57							
*58	58							
*59	59							
*60	60							
*61	61							
*62	62							
*63	63							
*64	64							
*65	65							
*66	66							
*67	67							
*68	68							
*69	69							
*70	70							
*71	71							
*72	72							
*73	73							

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Table B-18. Badger Creek Cache Statistical Data (Continued)

Count	FS#	Length	Width	Thickness	Complete	Fragment	Obsidian	Reference
*74	74							
*75	75							
*76	76							
*77	77							
*78	78							
*79	79							
*80	80							
*81	81							
*82	82							
*83	83							
*84	84							
*85	85							
*86	86							
87	87	13.40	6.90					
88	88	15.00	6.20					
89	89	13.90	5.50					
90	90	12.70	6.00					
91	91	13.80	6.20					
92	92	13.70	6.20					
93	93	11.90	6.10					
94	94	14.20	5.50					
95	95	11.40	5.70					
96	96	11.70	5.90					
97	97	11.60	5.80				OC	see above
98	98	10.90	5.50					
99	99	12.90	6.10					
100	100	13.00	5.90					
101	101	10.70	5.90					

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Table B-18. Badger Creek Cache Statistical Data (Continued)

Count	FS#	Length	Width	Thickness	Complete	Fragment	Obsidian	Reference
102	102	12.10	5.70					
103	103	13.00	6.00					
104	104	12.60	5.30					
105	105	12.40	5.50					
106	106	11.80	5.20					
107	107	12.30	6.00					
108	108	11.40	6.00					
109	109	13.10	5.30					
110	110	13.80	5.20				OC	see above
111	111	11.10	6.00					
112	112	10.20	5.30					
113	113	11.50	5.60					
114	114	17.00	6.00					
115	115	15.00	6.30				OC	see above
116	116	13.70	5.90					
117	117	14.40	5.60					
118	118	11.00	5.70					
119	119	11.70	5.60				OC	see above
120	120	12.80	6.20					