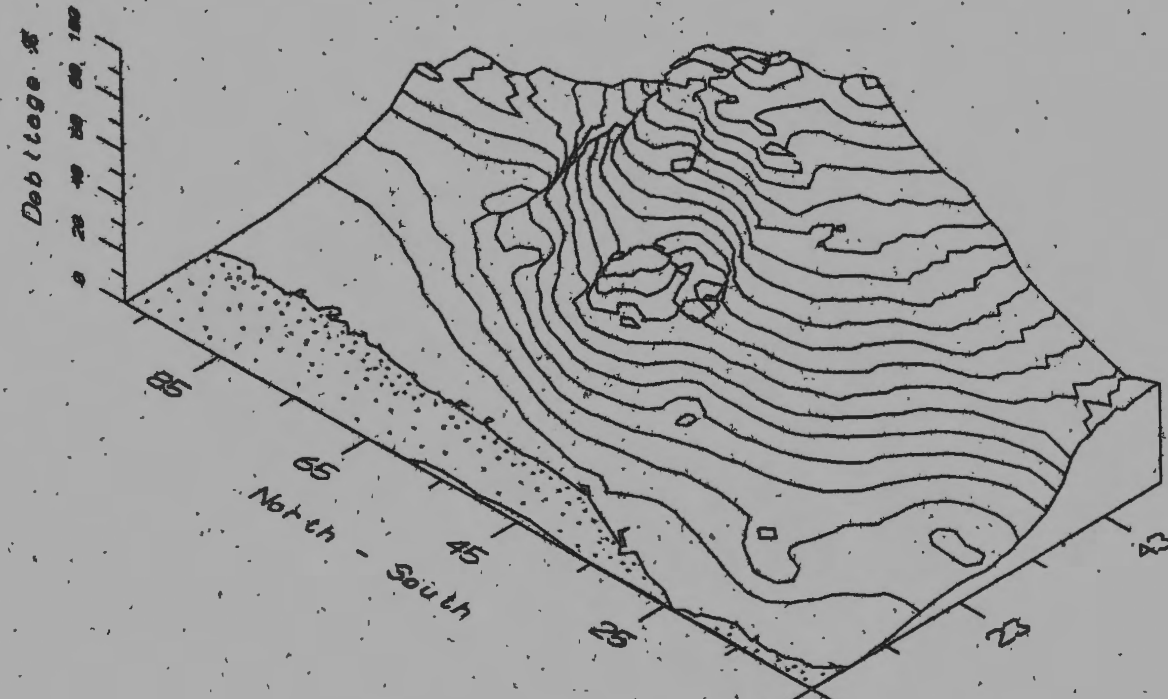
OBSIDIAN AT INMAN CREEK: GEOARCHAEOLOGICAL INVESTIGATIONS OF AN UNEXPECTED GEOLOGIC SOURCE OF OBSIDIAN IN THE SOUTHWESTERN WILLAMETTE VALLEY, OREGON



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▪ MASTER'S PROJECT ▪

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PREFACE AND ACKNOWLEDGEMENTS

The report that follows might be more accurately titled *Obsidian at Inman Creek: A Geoarchaeological Mystery*. The solution to the enigmatic presence of obsidian in the southwestern Willamette Valley is now close, but not quite complete. I have yet to locate the primary source of the Inman Creek "B" glass, although I suspect I'm getting close. More INAA and atomic absorption data are forthcoming and will perhaps shed some additional light on the two discrete geochemical groups of obsidian intermixed at Inman Creek. I also strongly suspect that there are other still unidentified secondary outcrops of the Inman obsidian located in northwestern Oregon, though they have so far eluded my many hours of gravel bar crawling. Additionally, thanks to a recent policy decision by the Willamette National Forest, obsidian characterization information from Western Cascades archaeological sites is beginning to appear with increased frequency. Much of the recent data that I have used in this report is a direct outcome of this research. This will add valuable information to the still very limited database of characterized Western Oregon artifacts. As to where this will all lead, only time and more numbers will tell.

A note on the sterograms (figures 15 and 18): A steroscope is usually required to obtain the three-dimensional effect produced by the stereo pairs. It is possible, however, to examine the figures in the report steroscopically **without** a steroscoope. This can be done by looking at the pair of diagrams and letting the eyes fall out of focus until the two images merge, producing a stereoscopic effect. Once mastered, this method is surprisingly effective.

Though the conclusions I have drawn from this research are entirely my own, a number of persons have knowingly or inadvertently helped out along the way with ideas and copies of the ever-elusive archaeological reports. My thanks to C.M. Aikens, William Ayres, Ewart Baldwin, Paul Baxter, Ann Rogers, Richard Cheatham, Linda Clark, Paul Claeyssens, Don Dumond, Pam Endzweig, Gordon Goles, Cathy Lindberg, Elena Nilsson, Lance Peterson, Rick Pettigrew, Richard Ross, Felicia Rounds, Jon Silvermoon, Edward Taylor, Richard Wiland, and Carol Winkler. I thank David Whitson for his contribution to the debris flow hypothesis. My special thanks to Rick Minor, who first introduced me to the enigma of the Inman Creek and Siuslaw River sources and who supplied the initial samples, **and** to the staff of the Oregon State University Radiation Center without whose assistance the neutron activation analyses would not not have been possible.

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OBSIDIAN AT INMAN CREEK: GEOARCHAEOLOGICAL INVESTIGATIONS OF AN UNEXPECTED GEOLOGIC SOURCE OF OBSIDIAN IN THE SOUTHWESTERN WILLAMETTE VALLEY, OREGON

Abstract

An unexpected secondary source of obsidian has recently been recognized in the Inman Creek area of the southwestern Willamette Valley of Oregon. The results of X-ray fluorescence and instrumental neutron activation analysis trace element studies indicate that two discrete and clearly-distinguishable geochemical populations make up the Inman Creek source. Obsidian nodules from the mouth of the Siuslaw River, from the gravels of the Willamette River, from the gravels of Salt Creek in the Western Cascades, and from a primary obsidian source in the Western Cascades were also analyzed and correlated with the Inman sources. The distribution of the glass from the two Inman geochemical groups was found to be unusually widespread in Western Oregon. Though diachronic data are sparse, results of obsidian characterization studies as well as graphical analyses of regional artifactual data indicate that the Inman source was widely utilized by prehistoric inhabitants of Western Oregon. The primary source location of at least one of the Inman Creek geochemical groups appears to lie in the Western Cascades, though the abundance and diameter of glass nodules in the southwestern Willamette Valley remains enigmatic.

I. INTRODUCTION

For many years, Oregon archaeologists took it for granted that the only natural indigenous source of obsidian available to the prehistoric inhabitants of the Willamette Valley was in the river gravels of the McKenzie and Willamette Rivers. They also assumed that the small obsidian pebbles occasionally found in these river gravels originated at Obsidian Cliffs, a large glaciated Pleistocene obsidian flow located at the western base of the North Sister in the Oregon High Cascades. Waterworn obsidian nodules have also been recovered from archaeological sites throughout the Willamette Valley, seemingly corroborating the prehistoric river gravel procurement and use of Obsidian Cliffs glass in Western Oregon (Strong et al., 1930:147; Laughlin, 1943; Follansbee, 1975; Pettigrew, 1975; Pettigrew, 1980:43,56,65-66; Sanders et al., 1983:221; Toepel and Minor, 1980:21; Toepel, 1985a:65; 1980:21; Toepel and Sappington, 1982).

Obsidian raw materials and artifacts with dimensions exceeding four or five centimeters, the maximum size available in Willamette Valley river gravels, were thought by archaeologists to have been obtained from geologic sources in the High Cascades, Central Oregon, and Northern California. The presence of these large artifacts was attributed to the existence of active trade and exchange networks. Along the Oregon central Coast,

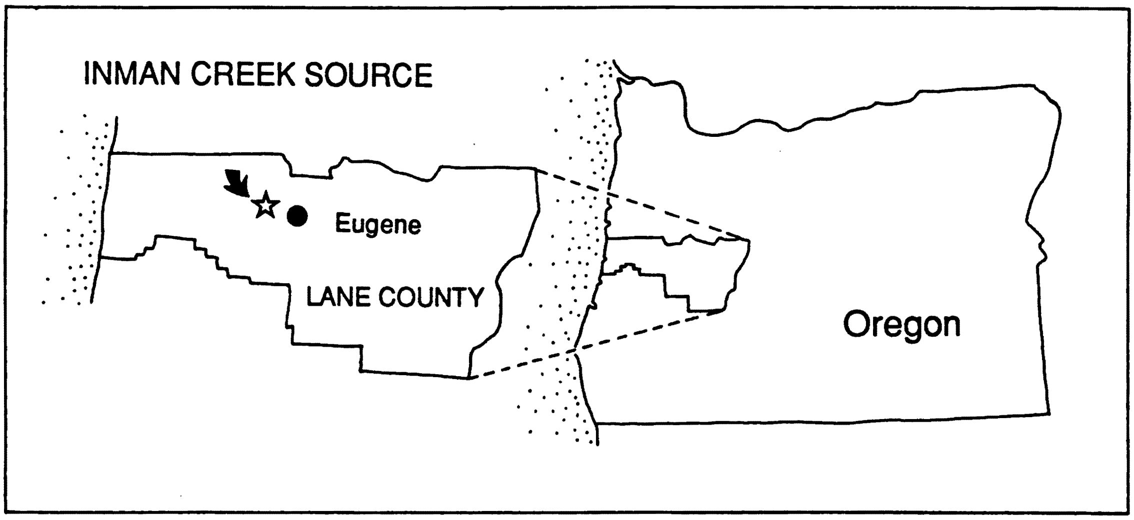


Figure 1. Location of the Inman Creek obsidian source.

the small quantities of natural glass found at excavated sites were assumed by researchers to have made their way west through trade relations with interior aboriginal groups having more direct access to sources.

Recent research, however, has been suggested that the almost ubiquitous presence of obsidian at interior Western Oregon archaeological sites is due not to well-developed long-distance procurement and/or exchange systems, but to an unexpected Western Oregon source of natural glass. This Willamette Valley obsidian source, usually referred to as the Inman Creek source (after the best source exposure) or the Fern Ridge source was not recognized until comparatively recently (figure 1).

The presence of a major Willamette Valley obsidian source is not only quite unexpected, but rather geologically enigmatic as well. The relatively abundant quantities of obsidian and the fairly large size of the available obsidian nodules point to a local *primary* source, perhaps one located in the Coast Range. Conversely, regional geologic studies and, more recently, geochemical studies of the obsidian, point to a High Cascades origin.

Objectives

Despite the fact that the Inman Creek obsidian source has been known to the archaeological community for over a decade, basic geoarchaeological and geochemical studies of the source have still not been completed. As a result, considerable confusion still surrounds both the geologic occurrences and archaeological distribution of Inman Creek obsidian. Archaeologists, in their haste to produce archaeologically-relevant data, have neglected to take care of the basic geologic steps that **must** precede the reliable application of characterization methods in any obsidian characterization study (Earle and Ericson, 1977; Skinner, 1983:4-6). Although considerable money has been spent to date by researchers on *trace element* studies of obsidian artifacts in Western Oregon, little has been invested in the geoarchaeological studies needed to validate and support them. These research development stages, illustrated in figure 2, have been almost universally abbreviated by archaeologists whose interests are, understandably, focused on the data that characterization studies might provide. Nevertheless, it is absolutely crucial to adhere to these initial, non-archaeological steps.

Survey of All Regional Obsidian Source Outcrops
↓
Determine of Source Boundaries (Primary and Second Distribution)
↓
Sample Obsidian Source Outcrops
↓
Select Characterization Method
↓
Characterize Geologic Sources of Obsidian
(Ascertain Intraunit Variation)
↓
Sample Archaeological Obsidian
↓
Characterize Archaeological Obsidian
↓
Correlate Archaeological Obsidian with Characterized Obsidian Sources
↓
Spatial Analysis of Resultant Data
(Intra-site or inter-site)
↓
Behavioral Reconstruction (Mid-Range Theory)
(Direct Procurement, Trade)

Figure 2: Methodological steps needed to reliably characterize and correlate obsidian artifacts and sources in any given geographic region. The geological precursors to reliable archaeological obsidian studies are shown in bold.

The methodological shortcomings in the study of the Inman Creek obsidian have so far resulted in the identification of Tucker Hill obsidian in western Oregon, speculation about the unusual procurement system needed to explain the presence of central Oregon glass in a Willamette Valley site, and the postulation of a Staley Creek source of unknown location. There also appears to be a misconception that the presence of Inman Creek obsidian in upper Willamette River drainage archaeological sites is due to direct or indirect procurement from the Willamette Valley type source (rather than from primary and *secondary* outcrops of a local and largely undocumented obsidian flow near Salt Creek Falls). Archaeologists, playing without a full deck, have suffered predictably unsatisfying results.

It is crucial for current and future obsidian characterization studies in western Oregon that the ambiguity surrounding the Inman Creek obsidian source be clarified. The major objective of the research that is reported in this paper, then, is to present fundamental geologic, geomorphic, and geochemical data to further the accurate and reliable understanding of the prehistoric utilization of obsidian from Western Oregon.

In addition, preliminary results concerning the prehistoric utilization of the Inman Creek obsidian are presented. Although usable data are still sparse, the use of statistical and microcomputer-based graphical methods of data analysis are explored in an attempt to generate future research hypotheses and to expand the analytical methods available to obsidian and lithic material researchers.

II. RESEARCH METHODS

X-Ray Fluorescence (XRF) Analysis

The trace element composition of nine obsidian samples from Inman Creek and two from the mouth of the Siuslaw River was initially established by X-ray fluorescence spectrographic methods. All XRF data was acquired using a GE XRD-7 vacuum spectrometer located at the University of Oregon X-Ray Fluorescence Laboratory. Quantitative XRF analysis, the technique used here, is a comparative one requiring the use of standards of known composition. The standards AGV-1, GSP-1, G-2, and W-1 were used in this investigation (Abbey, 1981).

The Fern Ridge area glass was initially characterized in this and earlier research by abundances of Rb, Sr, and Zr (Skinner, 1983:304-320). These elements have been found to exhibit a remarkably consistent degree of intrasource homogeneity as well as a marked tendency to intersource heterogeneity, the two key characteristics necessary for the successful characterization of archaeological materials (Cann et al., 1970; Ericson, 1981).

During sample preparation, each nodule of obsidian was broken into small pieces and a minimum of 100 gm of cortex-free fragments collected. Spherulites, when present, were separated from the analyzed portion of the sample. These chips were placed in a tungsten carbide Spex shatterbox for six minutes and reduced to a fine powder. The smaller Siuslaw River samples were powdered in a Spex ball mill. Approximately 5 gm of the powered glass from each sample was placed with boric acid as a backing agent in a mold and pressed at 10,000 pounds pressure into a cohesive disk. The disk was then used for analysis in the XRF spectrometer (Norrish and Chappell, 1967). Samples were counted for 300 seconds in an air pathway. The results of the XRF analyses are discussed in a later section of this report.

Instrumental Neutron Activation Analysis (INAA)

Following the analysis of XRF data, the Inman Creek and Siuslaw River obsidian sources were further characterized using instrumental neutron activation analysis (INAA). Irradiation and subsequent data reduction were carried out at the Oregon State University Radiation Center in Corvallis, Oregon.

This stage of the investigation used obsidian samples from Inman Creek, Obsidian Cliffs, Vine Rockshelter, and the gravels of the Siuslaw and Willamette rivers. Approximately .5 gm of fresh glass (free of cortex and spherulites) from each sample was ground to a fine powder in a mullite mortar and pestle and immediately stored in a sealed sterile plastic vial. Several of the original XRF samples were also reanalyzed during this phase of the research; when this was done, the same obsidian nodule was used as the source of the sample for both analytical methods.

National Bureau of Standards SRM-1633a and U.S. Geological Survey GSP-1 and BCR-1 standards were used for the quantitative analysis. The analytical uncertainty for all elements is reported in percent and reflects the relative standard deviation (using one standard deviation) obtained for each element, based on repeated counts of standards containing that element. The analytical uncertainty reported in table 2 is not related to the sample counting error. The net counts in some photopeaks were relatively high and the resultant counting error shown for the corresponding analytical results were comparatively small. Used as the only measure of confidence, these values would indicate a misleadingly large degree of accuracy. (The counting error values, not listed in table 2, were determined and are available from the author). The principles and practices of INAA methods are discussed in more detail elsewhere (Goles, 1978).

Software and Graphical Methods

The Inman Creek source data was compiled and analyzed with the help of a variety of IBM-PC microcomputer software. All tabular data used in the tables were organized on Quattro Pro 2.0 (Borland) spreadsheets, stored as Lotus-compatible files, and printed with Sideways 3.21. Geochemical data were visually analyzed and plotted with the Geochemical Program Package (Center for Volcanology, University of Oregon) and Quattro Pro. An IBM XT-compatible microcomputer equipped with a numerical coprocessor, a 60MB hard disk, and 1MB of extended memory was used for all microcomputer operations.

The geochemical data were graphically analyzed by visually plotting different pairs of elements as **bivariate** scatterplots and examining them clustering tendencies. When visual clusters were found, the particular pair of elements was considered as potentially useful for the later correlation of known sources and secondary samples of unknown source provenience. Different pairs of elements may successfully distinguish different source clusters and by examining many different pairs it is possible to determine which elements can be most effectively used to identify different specific sources. The more geochemically dissimilar a single source is from the other sources it is being compared with, the more easily distinguishable it becomes with a variety of different element pairs. Ternary plots were also occasionally used in the exploratory analysis of the data, although scatterplots proved more useful in distinguishing among the sources of obsidian.

Grapher 1.75 (Golden Software), utilizing data drawn directly from the table 3 spreadsheet, was used to generate the distance-decay graphs. The logarithmic regression lines that were added to the graphs are used here to illustrate data trends and are not intended to demonstrate statistically valid relationships among data points. Too much has perhaps been construed by some researchers regarding the significance of the types of fall-off curves derived from data like those examined here; the linear best-fit lines were chosen simply to illustrate the general trends of the data sets.

The Surfer 4.05 (Golden Software) graphics package was used to construct the *trend surface* topographic and perspective diagrams. The XYZ triplets needed for the graphics operations were directly imported from edited table 3-1 spreadsheet files. The x and y coordinates describe geographic locations in Western Oregon and were compiled from a U.S. Geological Survey Oregon base map (1:500,000) gridded at 1 cm intervals. The z values represent obsidian-related indices drawn from Western Oregon archaeological sites (obsidian debitage percentages and obsidian source utilization percentages) and were assembled from a variety of different sources (see Appendix 2). The trend surface diagrams were created from irregularly spaced data points gridded with inverse distance algorithms. This method uses a weighted average technique to interpolate grid nodes from the XYZ data. The weights are inversely proportional to the distance from the node so that data points farther from the node will have less influence. A quadrant search was used to insure that data points from all sides of the grid node were used. (See Davis, 1986:353-377,405-425, and Hodder and Orton, 1976:155-174, for detailed discussions of contouring and trend surface techniques). The stereograms of the archaeological data surfaces in figures 15 and 18 were constructed following the suggestions of Todd (1987). A cautionary note: the trend surface and contour diagrams created as part of this investigation were of an exploratory nature and should be considered as very preliminary - data points were often clustered and/or sparse and very irregularly spaced, particularly for the source utilization percentages. Some of the topographic expression of the data surfaces was due to a lack of, rather than the presence of, any meaningful archaeological information. Additionally, no attempt was made to avoid edge effects by including data points outside of the boundaries of Western Oregon (Davis, 1986:428). Nevertheless, the graphical data representation methods that were used are useful in that they provide a means of viewing the directionality of regional trends, a feature not easily inferable using the more traditional two-dimensional distance-decay graphs of figures 14 and 17.

The three-dimensional graphical methods of archaeological data analysis such as those used here are only now becoming possible on widely-accessible microcomputer systems. The optimal use of these methods will require some careful reconsideration of both the ways in which archaeological data is collected and recorded and in which it is interpreted (Colley et al., 1988).

Statistical Methods

COEFFICIENT OF VARIATION (CV%)

A simple descriptive statistic, the relative standard deviation or coefficient of variation (CV%), was used to quantitatively ascertain the degree of intrasource homogeneity and intersource heterogeneity of the samples (tables 1 and 2). This statistic is used as a way of expressing the variation of a set of data relative to its mean and is defined as:

$$CV\% = \frac{S}{X} \times 100 \qquad (1)$$

where CV% is the coefficient of variation, S = 1 standard deviation of the data set, and X = average of the data set (Anderson and Sclove, 1986:136). The coefficient of variation is particularly useful for assessing the relative homogeneity of groups independent of their respective means.

When the abundances of individual elements from geochemical data sets are compared, a small CV% indicates a small degree of intrasource variation. When applied to a geochemical data set from a single geologic source, a CV% of less than approximately five percent for a selected element suggests that the element will prove useful in characterizing that source, i.e. its dispersion within the source is relatively small. Conversely, when data from two different sources are compared, a large CV% indicates that the selected element may be useful in distinguishing between the two sources. An ideal element for the purposes of obsidian characterization, then, is one that exhibits a small intrasource CV% and a large intersource CV%.

The coefficient of variation has been used in investigating sources of obsidian by Hughes (1982 and 1986d), though he cautions that care must be taken when interpreting trace element abundances which approach their instrumental limits. Chase (1974), in a study of bronze artifacts, found the coefficient of variation a useful measure in comparing interlaboratory analytical results. Mello et al. (1988) used the method to analyze the trace element homogeneity of Mediterranean marbles. In the current study, the author used the coefficient of variation to identify the most effective trace elements for fingerprinting the different obsidian sources. The method was particularly useful in examining the relatively large trace element data set that resulted from neutron activation analysis of the obsidian.

REGRESSION ANALYSIS

Following the leads of Hodder (1974) and Hodder and Orton (1976:98-126), the author here examined the relationship of distance and selected artifactual variables with basic bivariate linear regression techniques. Distance was treated as the independent variable while the artifact variables were treated as dependent variables. Linear best-fit regression lines were computed with Grapher 1.75 and added to the distance-decay diagrams to graphically indicate the trend of the data sets. The correlation coefficient (r^2) was used as a measure of the degree of interrelationship between the two variables and was computed with Quattro Pro 2.0.

CLUSTER ANALYSIS

Cluster analysis classification methods were used to examine the data for groups or clusters once the initial examination of the geochemical data set was completed. Only major and trace elements exhibiting measurable intraunit homogeneity (low CV%) and observable interunit heterogeneity were used in the data matrices to be analyzed. All cluster analyses were performed with the MVSP 2.0 multivariate statistical package. A dissimilarity matrix for each analyzed data set was constructed using the Euclidean distance coefficient while the cluster analyses were carried out with the unweighted pair-group method (Romesburg, 1984:10-28). Additional analyses of the data using different clustering methods yielded almost identical results. The results of the cluster analyses are presented here as dendrograms.

Cluster analyses were used both to verify visually identified groups and to **heuristically** examine the data sets for clusters relating to tephra sources. Parametric statistical methods such as cluster analysis assume that geochemical sample concentrations are normally distributed, an assumption that may sometimes be without merit. This presupposition can lead to the misclassification of chemically-characterized samples and Leach et al. (1986) recommend that parametric **and** non-parametric clustering techniques be used in tandem for the reliable classification of specimens. For exploratory purposes, however, cluster analyses provide a useful method for quickly examining multi-element arrays of geochemical data.

III. OBSIDIAN AT INMAN CREEK: GEOLOGIC CONSIDERATIONS

Geologic Setting

Inman Creek is a short perennial stream located on the western margin of the southern Willamette Valley about 19 km east-northeast of downtown Eugene. Although the creek is now a tributary to the Fern Ridge Reservoir, before construction of the Fern Ridge Dam in 1941 the stream fed the Long Tom River. Inman Creek would now be of little interest to archaeologists were it not for the somewhat enigmatic presence of numerous obsidian nodules in the gravels of this and several other nearby small streams in the reservoir area. When the exterior cortex of these nodules is removed an artifact-quality black and occasionally black and red volcanic glass is revealed.

Nodules of obsidian ranging in size from less than 1 cm to a maximum of over 10 cm in diameter are common in the stream gravels of Inman Creek and, to a lesser extent, in the gravels of other creeks entering the west and southwest margins of the Fern Ridge Reservoir (figure 6). The obsidian nodules appear to originate from a locally widespread bed of poorly sorted and moderately indurated conglomerate that dips gently towards the northeast (the floor of the Willamette Valley). This conglomerate, best exposed 2-3 m below the ground surface in the streambed and banks of Inman Creek, contains abundant rounded to subangular nodules of obsidian and other volcanic rocks set in a clay matrix. Obsidian nodules appear to be distributed throughout the conglomerate. The obsidian-bearing stratum is poorly exposed in all locations in the Fern Ridge Reservoir area and the thickness and areal extent of the bed are not known. Obsidian in other streambeds in the area appears after the water has intersected a bed of resistant clay and gravel conglomerate similar in appearance to the one at Inman Creek. These outcrops are all normally covered by the Fern Ridge Reservoir Lake and are accessible only in the winter months during the annual reservoir drawdown. The current erosional surface appears to locally intersect the obsidian-bearing stratum at an elevation of between 105 and 120 m (350 and 400 ft)(figure 3).

Inman Creek and other local streams in the Fern Ridge Reservoir area cut as much as 3 m into the Dolph or Ingram geomorphic surfaces, a former high flood plain of the Willamette River (Balster and Parsons, 1968:6,9, and 1969). At least 60 m of alluvial sand, gravel conglomerates, and mudstone were deposited in this area during the late Pleistocene and Holocene (Baldwin and Howell, 1949; Frank, 1973). These deposits originated in the Western Cascades and the east-central Coast Range and were fluvially transported to the Fern Ridge area. Some of the alluvial fill in this area may have also been deposited during the multiple late Pleistocene floods of the Willamette Valley that were caused by the repeated failure of ice dams that contained Glacial Lake Missoula (Allison, 1978; Baker and Bunker, 1985). Evidence of these catastrophic floods, dated at between 12,000 and 16,000 years B.P. (Baker and Bunker, 1985), have been found in numerous locations in the southern Willamette Valley as ice-rafted boulders of exotic, non-local materials (Allison, 1935).

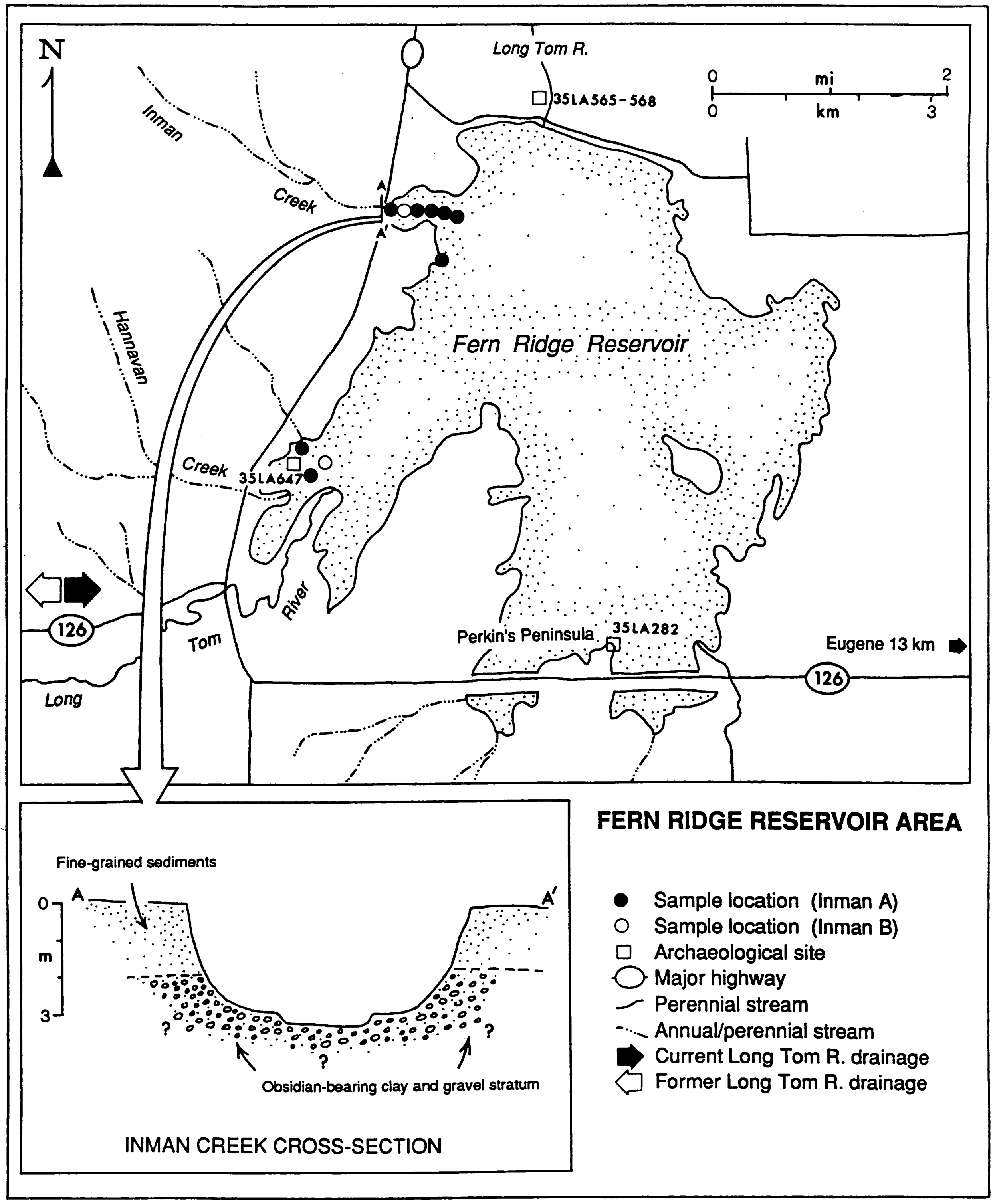


Figure 3. Fern Ridge Reservoir area map and cross-section of the Inman Creek obsidian source "type" exposure. The locations and geochemical subgroups of all Inman obsidian samples analyzed for this investigation are indicated by the open and filled circles.

The grain-size increases significantly as the obsidian-bearing stratum is reached in the vertical section of sediments exposed in the banks of Inman Creek. This, along with the poorly sorted nature of the deposits, suggests the presence of a higher-energy depositional regime than now exists in the area, one perhaps related to pluvial activity or to the wetter climate of Western Oregon that existed during the late Pleistocene and early Holocene epochs (Hansen, 1941 and 1942).

The age of deposition of the obsidian-bearing conglomerates at Inman Creek is not known. A radiocarbon date of >39,000 years B.P. (I-4068; Buckley and Willis, 1970) from wood recovered at a depth of 4.1 m in a comparable geomorphic surface in the area weakly suggests a late Pleistocene maximum to the terminal phase of the depositional period. Glacial erratics deposited by the floods of Glacial Lake Missoula are associated with the Dolph geomorphic surface (which overlies the obsidian-bearing gravels) and the silts beneath it, again suggesting a late Pleistocene date for the deposition of the obsidian (Balster and Parsons, 1968:6).

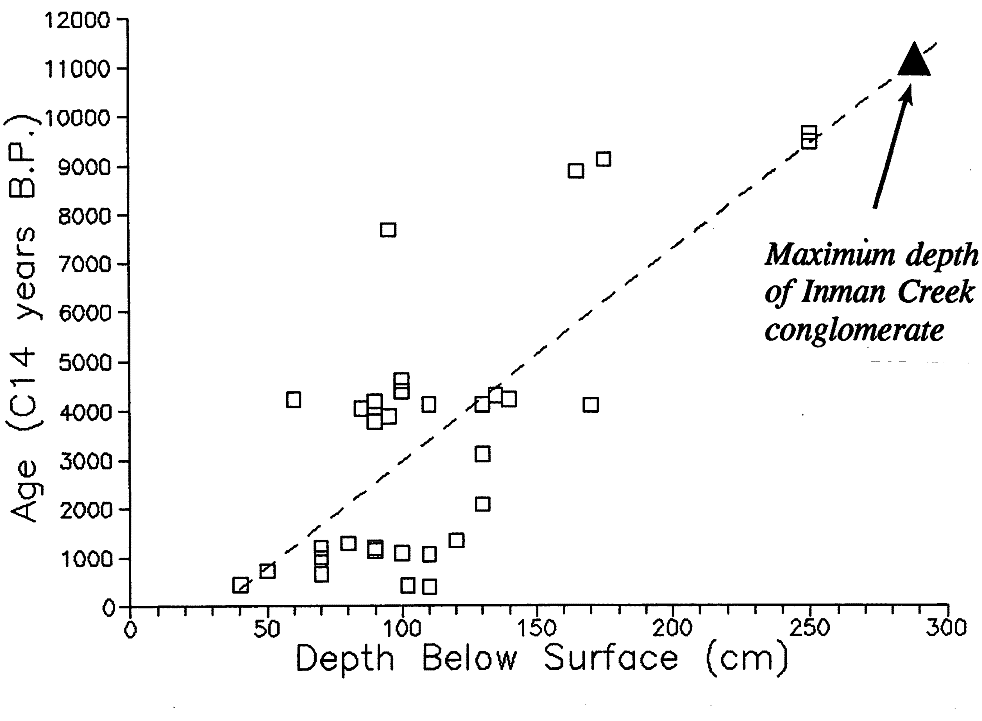


Figure 4. Linear regression analysis of ^{14}C ages and depth of sediments in the Inman Creek area. The approximate 2-3 m depth of the obsidian-bearing conglomerates at Inman Creek suggests an early Holocene to very late Pleistocene age of deposition.

An estimation of the age of the conglomerate can also be inferred from the regression analysis of radiocarbon dates from nearby archaeological sites (figure 4). In an archaeological survey and geomorphic study of an area located about 5 km south-southwest of the Inman Creek type location, samples from nine sites yielded 32 radiocarbon dates (Freidel et al., 1989:32,94-95). These dates were associated with materials recovered from known depths below a geomorphic surface comparable to the one at the Inman Creek exposure (Balster and Parsons, 1968). Given a similar depositional rate at both localities, linear regression analysis of the ^{14}C ages and depth of dated samples suggests that the Inman Creek obsidian-bearing conglomerate dates from the early Holocene to the late Pleistocene (figure 4). It seems likely, then, that the obsidian at Inman Creek and at other Willamette Valley locations has been available throughout the entire range of known human occupation in western Oregon.

Petrographic Characteristics

MEGASCOPIC

The color of the Inman Creek obsidian was most often found to be a uniform black (94%), sometimes a mottled red/mahogany and black (3%), and rarely a gray-black (2%) to gray (1%) (percentages are from a sample of 175 obsidian nodules greater than 1 cm diameter that were collected at the Inman Creek source locality; see figure 5 for grain size distribution). A faint milky banding is also occasionally visible in the glass. The luster of the obsidian is glassy. Visible inclusions such as spherulites have not been found, though many specimens are slightly porphyritic, resulting in the "flawed" surface appearance pictured in plate 9. The numerous small flaws in the glass are the result of the presence of microscopic *phenocrysts* of plagioclase that are invisible to the naked eye (see plate 3). A significant proportion of the nodules examined were slightly porphyritic (33%), though a larger percentage (67%) were not (n=175). It should be noted that this "flawed" surface has not been found at any Western Oregon primary obsidian sources. It has been observed in several coastal artifacts that were characterized by trace element abundances and correlated with the Inman source, however, and may prove to be an important megascopic indicator of the Inman Creek source. The obsidian glass is translucent in a 1 mm thick section - light passes through but printed letters are obscured and cannot be read. (Descriptive terminology is from Adams, 1980:132-136, and Skinner, 1987c).

MICROSCOPIC

All obsidian samples analyzed for trace element composition (with the exception of SIU-1 and SIU-2 which were completely destroyed for XRF analysis) were prepared as thin sections and examined with a petrographic microscope.

Though obsidian is often considered a *holohyaline* volcanic glass, it will almost invariably contain a variety of microscopic *phenocrysts*, *skeletal crystals*, *microlites*, and *crystallites* (Johannsen, 1931:11-15; Ross, 1962). The microscopic petrographic characteristics of

PLATES 1-9 (Opposite)

Plates 3-8 are photomicrographs; the scale bars in the upper right corners of the pictures are 10 microns long. Differences in the overall color of the photomicrographs are due to the photographic process, not to the color of the glass.

PLATE 1: Obsidian-bearing sediments exposed in the north bank of Inman Creek. The primary obsidian-bearing stratum lies at the base of the 45 cm-long shovel. This bed is more resistant than the overlying sediments and tends to form a small erosional shelf when encountered by Inman Creek and other local streams.

PLATE 2: A 5 cm-diameter nodule of obsidian (INM-12) shown *in situ* at the location marked by the arrows in both plates 1 and 2.

PLATE 3: Strongly aligned *margarites* and acicular to normal *prismatic microlites* wrap around a small phenocryst of plagioclase in this sample (INM-9). Small crystals like this one give the surface of the glass a "flawed" appearance. Nicols not crossed, 93x.

PLATE 4: This sample (INM-5) is dominated by the presence of *acicular* and *asteroidal trichites*, common microlitic structures found in the Inman Creek obsidian. Nicols not crossed, 93x.

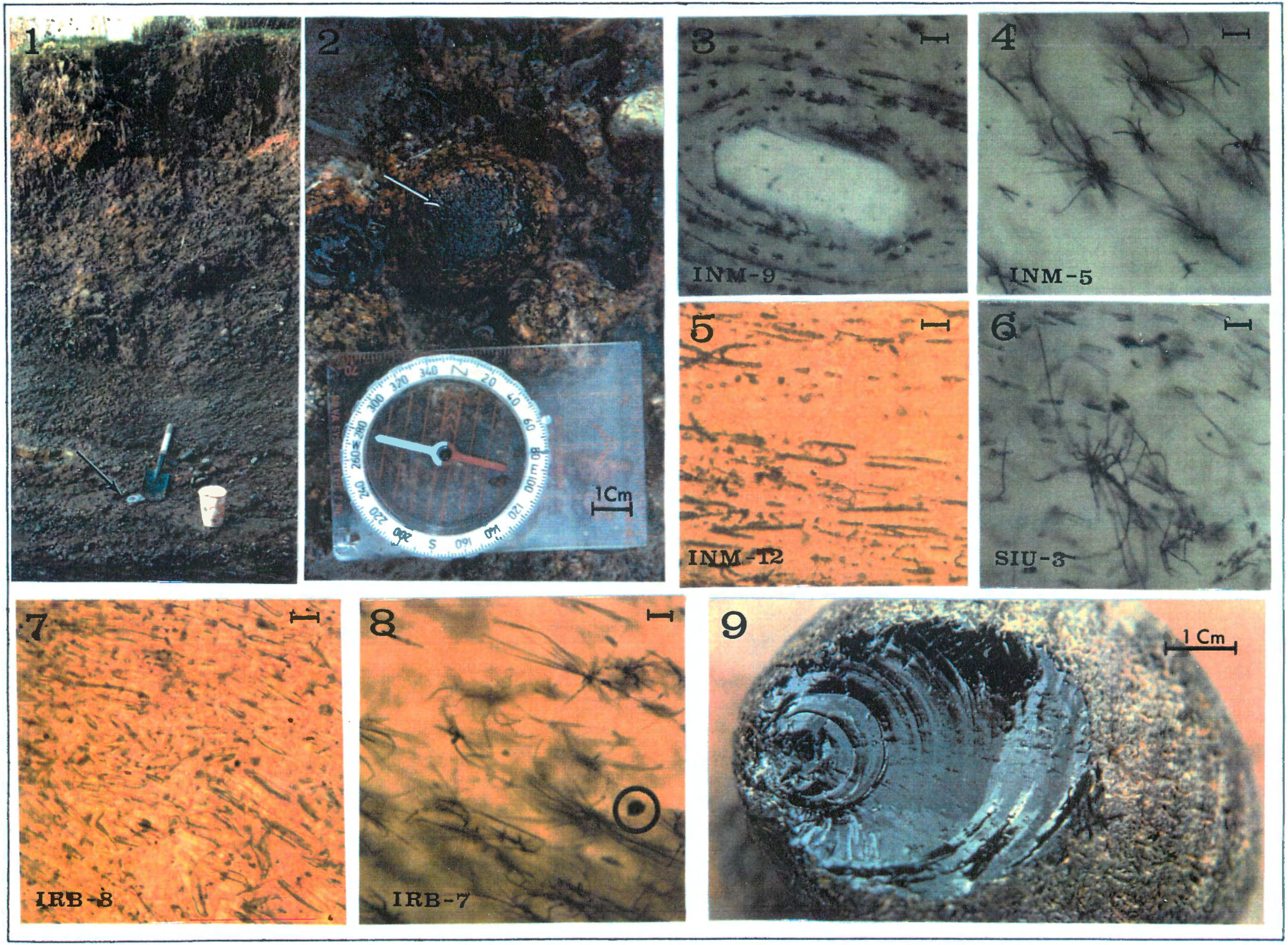
PLATE 5: Abundant aligned *longulites*, coalesced chains of *globulites*, dominate the microlitic forms in this sample (INM-12). Nicols not crossed, 93x.

PLATE 6: Photomicrograph of an obsidian nodule (SIU-3) collected at a gravel bar near the mouth of the Siuslaw River at the Oregon Coast. Acicular to normal prismatic microlites are common in the glass, as are acicular and asteroidal trichites. These microlitic structures are commonplace at the Fern Ridge source and INAA trace element characterization indicates that this sample is a member of the Inman A geochemical group. Nicols not crossed, 93x.

PLATE 7: This sample from the gravels of the Willamette River (IRB-8) exhibits the dense swarms of acicular prismatic microlites that are typical of the Obsidian Cliffs source. INAA trace element characterization confirms the geologic origin of the obsidian at Obsidian Cliffs. Nicols not crossed, 100x.

PLATE 8: An additional sample (IRB-7) collected from Willamette River gravels at Irish Bend is characterized by the presence of easily-recognizable asteroidal and acicular trichites. These petrographic traits were observed in several Inman Creek specimens; INAA trace element characterization indicates that the Fern Ridge source was the origin of this specimen. A single grain of magnetite is circled. Nicols not crossed, 100x.

PLATE 9: Nodule of glass from Inman Creek showing the conchoidal fracture and glassy luster of the obsidian. The numerous small flaws that are visible in the flake scar are representative of many of the Inman nodules and are due to the presence of abundant microscopic phenocrysts in the glass (see Plate 3). The "wormy" cortex is typical of obsidian nodules from this source and suggests that fluvial transport played a role in the deposition of the glass in this area.


1
2
1Cm
3
INM-9
4
INM-5
5
INM-12
6
SIU-3
7
IRB-8
8
IRB-7
9
1 Cm

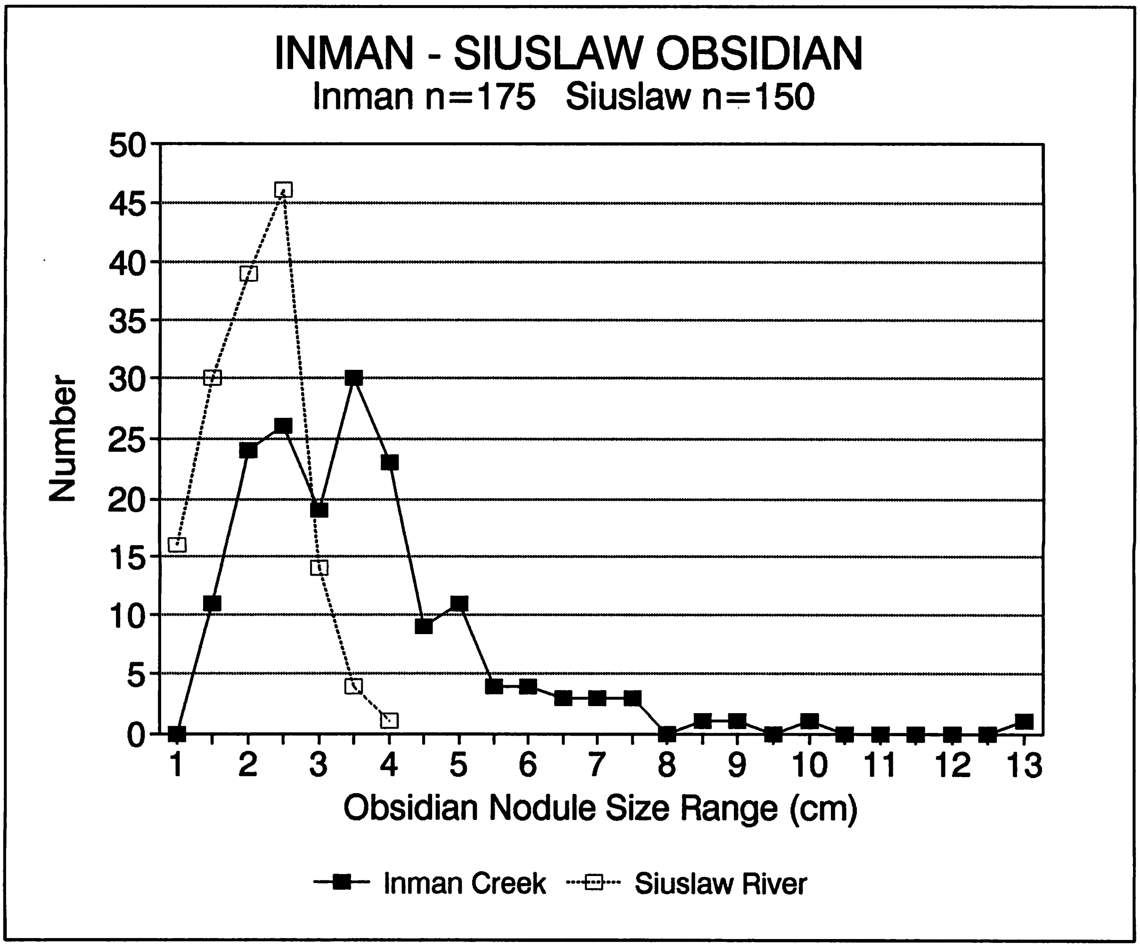


Figure 5. Grain size frequency of obsidian nodules collected at the Inman Creek type locality and at the mouth of the Siuslaw River on the Oregon Coast.

the Inman Creek obsidian and the use of these features in the characterization of the glass have been discussed in detail elsewhere and will be only briefly considered here (Skinner, 1986:29-43, 93-95).

The varieties of microscopic structures that can be observed in the Inman Creek glass display an unusual degree of intraunit variability. Some of these microscopic features are illustrated in plates 3-5, though the actual range of variation is considerably greater than is pictured here. Preliminary research indicates that these microscopic structures may be of at least limited use in distinguishing among the numerous Western Oregon obsidian sources (Skinner, 1986:29-43, and Skinner, unpublished data). Obsidian nodules from the Siuslaw River mouth and the Willamette River (plates 6 and 8) show petrographic similarities to the Inman Creek glass and were geochemically correlated (this study) with the Inman source. An obsidian pebble from the Willamette River gravels (plate 7) is easily petrographically differentiated from the Inman Creek glass and was found to originate from the Obsidian Cliffs High Cascades source.

IV. TRACE ELEMENT CHARACTERIZATION

Results of X-Ray Fluorescence Analysis (XRF)

The results of XRF trace element analysis of eight samples from the Inman Creek area and two samples from the mouth of the Siuslaw River are presented in table 1. When the trace element abundances are plotted (figures 7 and 8), two geochemically-distinct subgroups from the Inman Creek obsidian are distinguishable. This geochemical evidence suggests that the Inman Creek obsidian originated not from one, but from **two** different primary sources. These two sources are termed Inman A (after the most common group; n=6) and Inman B (n=2). Based on the limited number of samples analyzed, it appears that the two sources are not petrographically distinguishable, nor is there any apparent pattern to their spatial distribution in the Fern Ridge area (figure 3). Glassy and slightly porphyritic textures were found in both Inman Creek geochemical populations. CV% values calculated from the trace element abundances of the Inman Creek sources, once the two sources were distinguished, predict that Sr and Rb abundances will best characterize the glass, a fact confirmed by visual analysis of the data (figure 7). It is also apparent that Obsidian Cliffs was not the parent location of either of the Inman Creek sources; this High Cascades source is easily distinguishable in the ternary diagram and scatterplots of figures 6 and 7.

SAMPLE NO.	TRACE ELEMENTS						INMAN SOURCE GROUP
	RB	(±)	SR	(±)	ZR	(±)	
INM-1	88.8	(2.7)	116.5	(2.4)	76.5	(2.4)	B
INM-2	82.8	(2.6)	156.9	(2.6)	106.2	(2.5)	A
INM-3	85.1	(3.0)	150.6	(2.8)	107.4	(2.6)	A
INM-5	80.1	(2.6)	151.8	(2.6)	109.0	(2.5)	A
INM-7	81.8	(2.6)	154.0	(2.6)	104.1	(2.5)	A
INM-9	82.3	(2.7)	153.8	(2.7)	104.2	(2.6)	A
INM-11	89.1	(2.7)	111.8	(2.7)	76.7	(2.4)	B
INM-12	84.8	(2.7)	154.2	(2.6)	106.0	(2.5)	A
SIU-1	83.8	(2.6)	144.3	(2.6)	100.7	(2.5)	A
SIU-2	92.4	(2.7)	115.9	(2.4)	76.7	(2.4)	B
CV% INMAN A	2.1		1.3		1.6		
CV% INMAN B	0.2		2.1		0.1		
CV% ALL INMAN	3.6		12.0		13.0		

INM - OBSIDIAN SAMPLES FROM THE INMAN CREEK SOURCE
SIU - OBSIDIAN SAMPLES FROM THE SIUSLAW RIVER MOUTH
CV% - COEFFICIENT OF VARIATION ((STANDARD DEVIATION / AVERAGE) × 100)

TRACE ELEMENT ABUNDANCES ARE REPORTED IN PARTS PER MILLION
ANALYTICAL UNCERTAINTY APPEARS IN PARENTHESES

Table 1. XRF trace element abundances of obsidian samples from the Inman Creek/Fern Ridge Source and the gravels of the Siuslaw River at the Oregon Coast.

Two obsidian nodules collected from the mouth of the Siuslaw River on the Oregon Coast (SIU-1 and SIU-2) were also analyzed and were correlated with the two Inman sources (figures 6 and 7), a finding explained by the unusual depositional history of the glass (discussed shortly).

Cluster analysis of the XRF data was consistent with the results of the graphical analyses. The two geochemically-distinct groups, Inman A and Inman B, and the Obsidian Cliffs source (data are from Skinner, 1983) are clearly distinguishable in the cluster analysis dendrogram in figure 8. The success of cluster analysis in classifying the major western Oregon obsidian sources also suggests that the method will be of use in future XRF studies of artifacts of unknown geologic provenience.

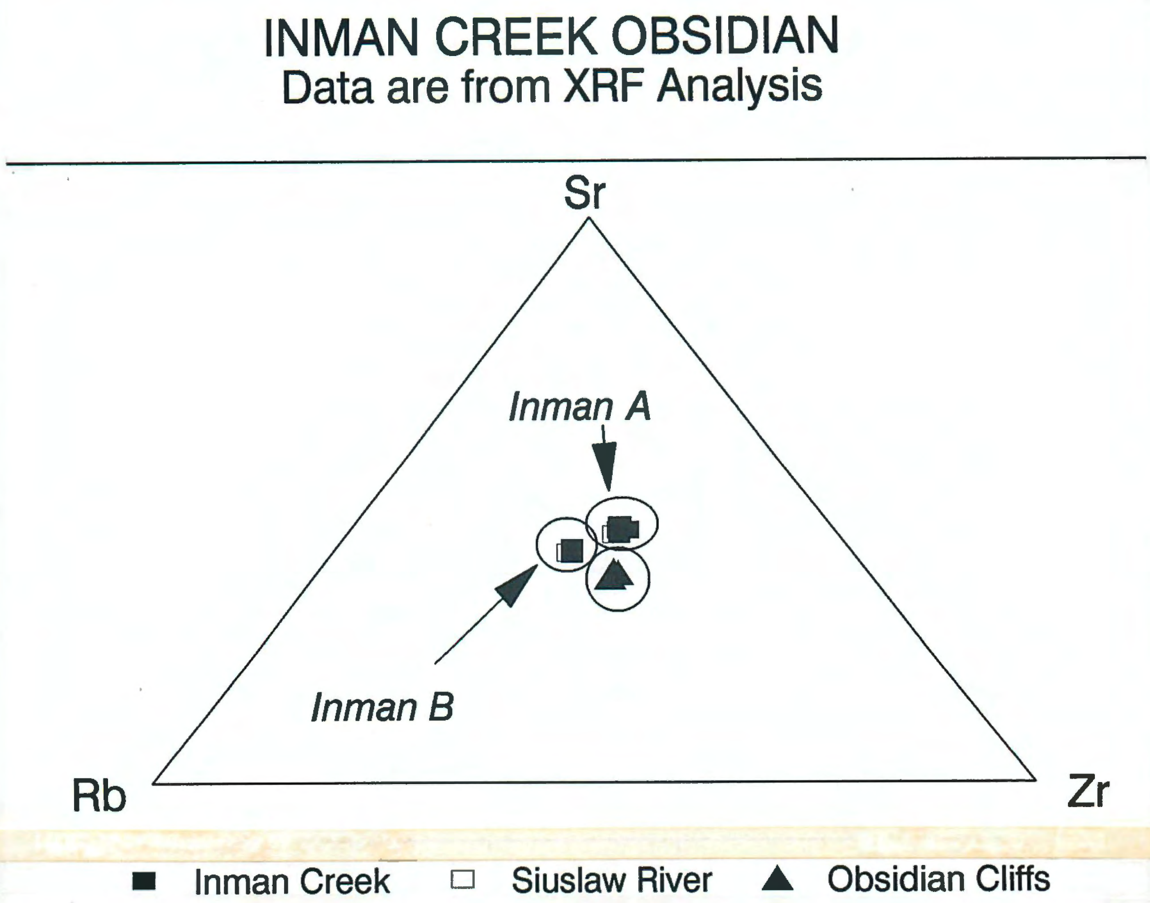
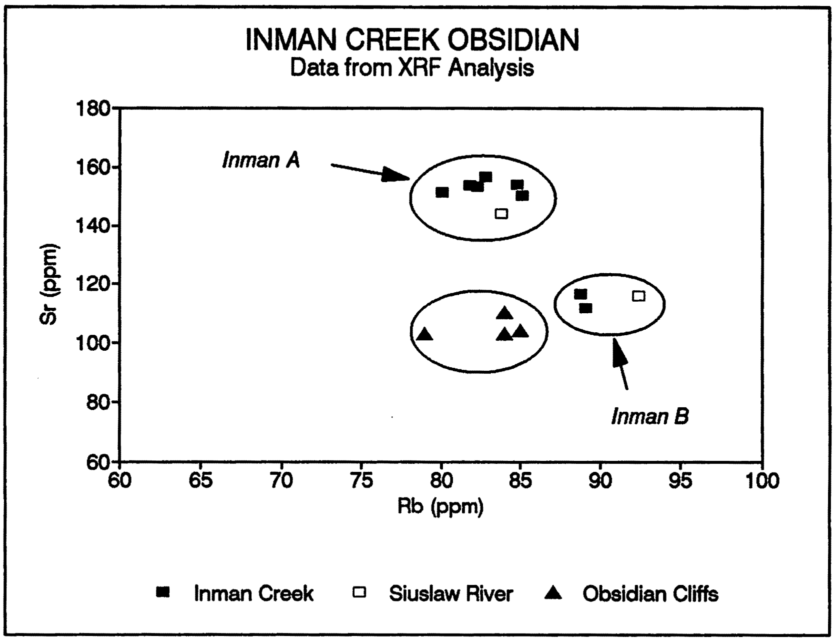


Figure 6. Ternary plot of XRF trace element abundances from Inman Creek, Siuslaw River, and Obsidian Cliffs obsidian. The Inman A and B geochemical groups are easily distinguishable in the Rb-Sr-Zr ternary plot, as are the samples from the Obsidian Cliffs source. Obsidian Cliffs data are from Skinner (1983).



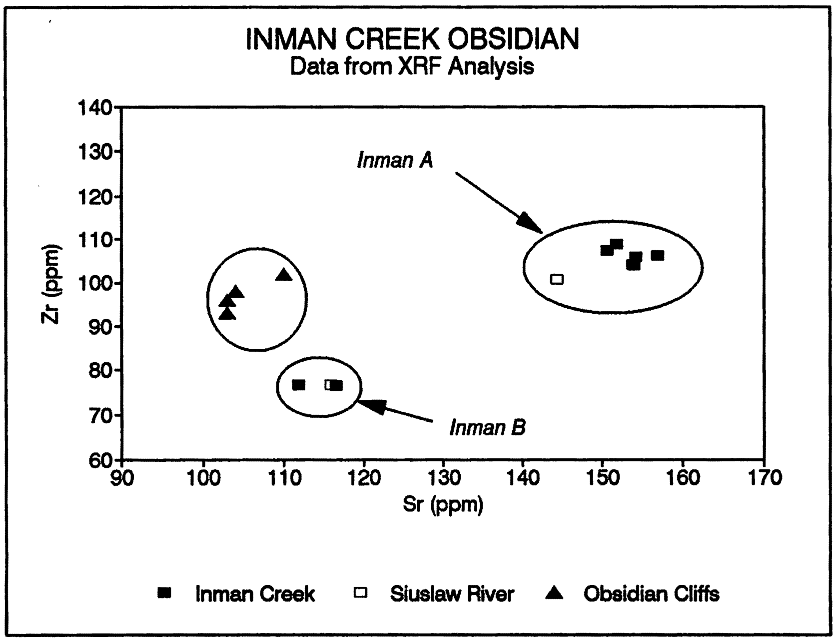


Figure 7. **A** - As predicted by the trace element CV%, Rb plotted versus Sr best discriminates the two Inman groups. **B** - Obsidian sources can also be successfully distinguished using Zr plotted versus Sr. Obsidian Cliffs data are from Skinner (1983).

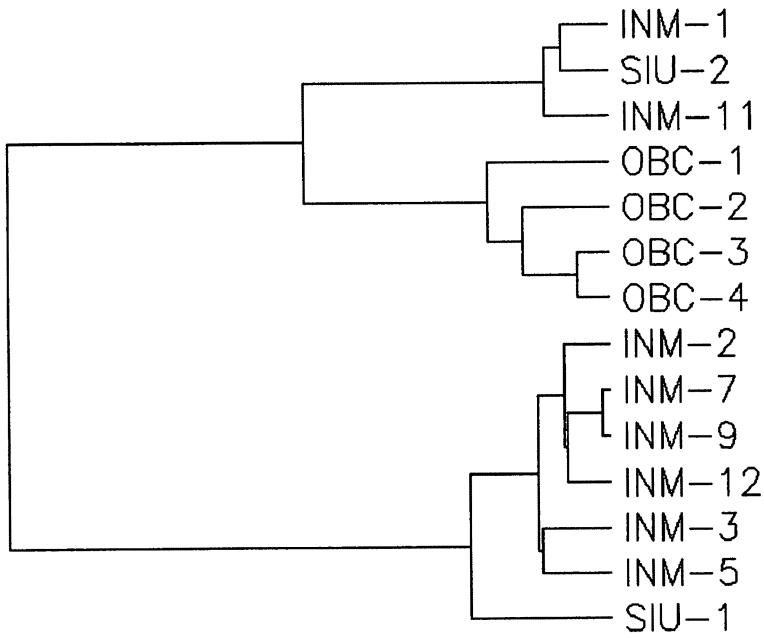


Figure 8. Dendrogram results of the cluster analysis of Inman Creek, Siuslaw River, and Obsidian Cliffs obsidian. Data are from XRF analysis (Sr, RB, Zr).

Results of Instrumental Neutron Activation Analysis (INAA)

The results of INAA trace element analyses of obsidian samples from the Inman Creek sources, the mouth of the Siuslaw River, Willamette River gravels at Irish Bend, Obsidian Cliffs, Salt Creek, and Vine Rockshelter are presented in table 2.

THE SAMPLES

The obsidian samples for INAA analysis were chosen for several different reasons (see figure 13 for source locations). Samples from Inman Creek (INM) and the Siuslaw River gravels (SIU) were selected to verify the existence of the two geochemical source groups previously identified by XRF studies, Inman A and B, and to investigate additional

SAMPLE NO.	FEO	NA2O	K2O	SC	CO	ZN	RB	SR	CS	BA	LA	CE	ND
INM-1	1.17	4.73	2.87	1.6	0.4	64.2	110.9	109.3	4.2	662.9	19.6	40.4	15.0
INM-2	1.43	4.85	3.07	1.6	0.5	69.9	87.5	116.3	3.6	719.6	21.5	42.6	16.1
INM-3	1.53	4.88	3.19	1.6	0.6	70.8	92.0	121.4	3.7	650.7	24.3	43.2	16.7
INM-5	1.47	4.91	2.60	1.6	0.5	69.6	94.7	153.5	3.5	708.7	21.4	43.8	13.9
INM-7	1.40	4.94	2.43	1.5	0.4	65.6	95.1	150.9	3.5	632.9	23.5	40.2	12.7
INM-9	1.41	4.81	3.01	1.5	0.5	66.8	92.5	150.2	3.5	637.3	20.9	40.5	16.6
INM-10	1.46	4.87	2.60	1.6	0.5	70.4	93.4	162.1	3.7	641.2	22.9	41.1	13.6
INM-11	1.15	4.62	2.74	1.6	0.3	59.6	103.5	85.1	4.0	632.7	18.3	36.2	12.1
INM-12	1.45	5.02	4.02	1.6	0.5	68.6	92.7	163.4	3.4	656.1	23.6	41.6	16.2
INM-13	1.47	4.86	2.90	1.6	0.5	65.4	103.0	131.9	3.5	708.4	21.5	40.9	14.3
IRB-3	1.83	4.74	3.24	3.3	1.9	35.5	79.6	252.2	2.3	680.3	20.7	39.4	15.3
IRB-7	1.46	4.90	2.48	1.6	0.5	63.0	87.2	127.7	3.7	640.6	22.0	41.0	15.8
IRB-8	0.97	4.58	3.31	1.8	0.5	32.0	83.5	114.6	2.6	742.9	21.5	37.6	11.3
OBC-1	0.99	4.52	4.30	1.7	0.5	37.2	85.9	108.1	2.3	676.8	21.4	35.7	10.1
OBC-2	0.92	4.34	3.23	1.7	0.5	36.1	62.8	98.9	2.3	715.7	20.3	37.6	15.3
OBC-3	0.96	4.49	3.87	1.8	0.4	39.3	64.3	90.5	2.4	692.6	21.1	38.3	14.6
OBC-4	0.94	4.40	2.79	1.8	0.5	39.9	69.9	88.6	2.6	715.6	20.9	38.8	9.1
OBC-8	0.92	4.34	4.63	1.8	0.5	38.3	64.2	106.4	2.3	647.4	20.7	37.3	12.6
SACR-2	1.43	4.78	2.89	1.5	0.4	40.9	70.8	123.9	3.9	703.5	21.2	38.4	13.3
SACR-3	1.47	4.93	3.27	1.6	0.5	42.2	69.8	143.0	3.8	741.1	21.4	38.5	16.3
SACR-4	1.47	4.85	3.88	1.5	0.4	42.0	73.6	137.9	3.9	737.6	21.5	38.6	16.0
SIU-3	1.44	4.88	3.53	1.7	0.5	79.8	75.8	120.6	3.4	710.2	22.0	41.2	15.2
SIU-4	1.37	4.64	3.07	1.5	0.4	41.0	68.7	145.9	3.7	695.2	20.6	37.5	14.0
SIU-5	1.52	5.08	4.37	1.6	0.5	43.0	75.8	142.3	3.9	762.2	21.5	45.8	18.8
SIU-6	1.49	5.15	4.95	1.6	0.4	43.5	75.1	-	4.1	796.6	22.1	48.0	18.0
VRS-1	1.46	4.94	-	1.7	0.5	86.2	77.7	197.5	3.4	701.2	21.7	42.0	19.3
VRS-2	1.42	4.89	2.22	1.6	0.5	81.2	78.6	135.5	3.4	609.1	23.4	41.0	16.9
UNCERTAINTY #215	3%	2%	10%	3%	7%	12%	15%	15%	5%	15%	3%	12%	20%
UNCERTAINTY #328	5%	3%	15%	3%	5%	15%	10%	12%	5%	10%	3%	7%	12%
CV% INMAN A	2.7	1.2	15.6	1.9	10.5	3.0	4.3	11.8	2.4	5.1	5.3	3.0	9.7
CV% INMAN B	0.6	1.2	2.3	0.2	7.3	3.7	3.5	12.5	2.7	2.3	3.4	5.5	11.0
CV% ALL INMAN	8.7	2.2	14.3	1.8	18.0	4.9	6.9	18.3	6.3	4.9	8.2	4.8	10.7

INM - OBSIDIAN SAMPLES FROM THE INMAN CREEK SOURCE, SOUTHWESTERN WILLAMETTE VALLEY
IRB - OBSIDIAN SAMPLES FROM WILLAMETTE RIVER GRAVELS AT IRISH BEND, SOUTH-CENTRAL WILLAMETTE VALLEY
OBC - OBSIDIAN SAMPLES FROM THE OBSIDIAN CLIFFS SOURCE, CENTRAL HIGH CASCADES
SACR - OBSIDIAN SAMPLES FROM THE SALT CREEK SOURCE, CENTRAL WESTERN CASCADES
SIU - OBSIDIAN SAMPLES FROM THE MOUTH OF THE SIUSLAW RIVER, CENTRAL OREGON COAST
VRS - OBSIDIAN SAMPLES FROM VINE ROCKSHELTER (35LA304), CENTRAL WESTERN CASCADES (A.K.A. STALEY CREEK SOUR

TRACE ELEMENT ABUNDANCES ARE REPORTED IN PARTS PER MILLION (PPM)
MAJOR ELEMENT ABUNDANCES (FEO, NA2O, K2O) ARE REPORTED AS WEIGHT PERCENT OXIDES
UNCERTAINTY = RELATIVE STANDARD DEVIATION FOR ELEMENT BASED ON REPEATED COUNTS OF STANDARD; THIS FIGURE IS
CV% = COEFFICIENT OF VARIATION ((STANDARD DEVIATION/AVERAGE) x 100)

Table 2. Results of neutron activation analysis of obsidian from primary and secondary sources of obsidi
Creek, Obsidian Cliffs, the Willamette River, the Siuslaw River, Salt Creek, and Vine Rockshelter.

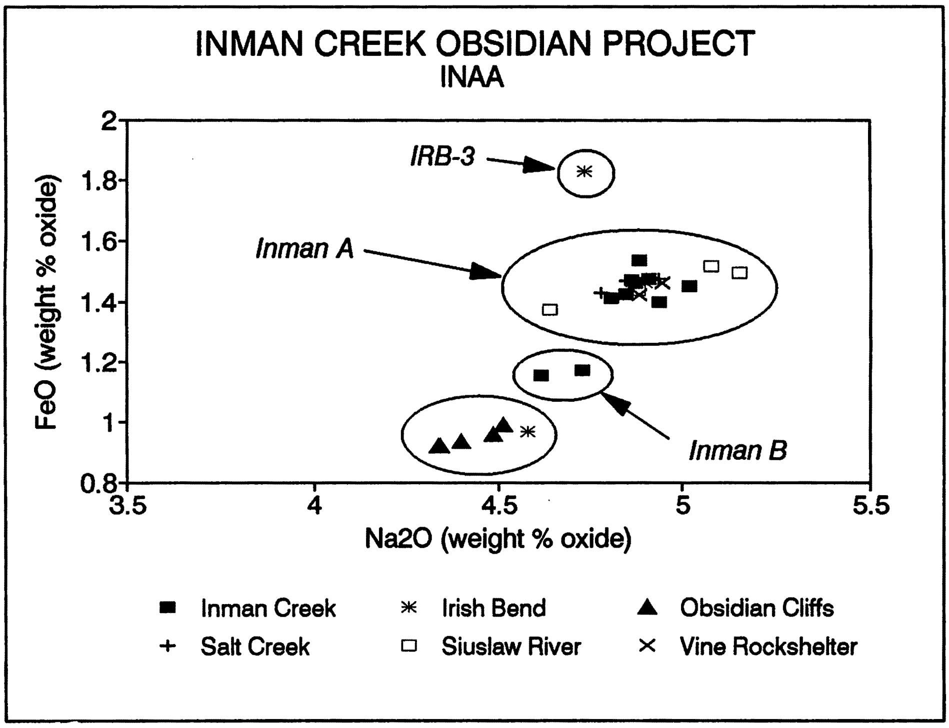
CS	BA	LA	CE	ND	SM	EU	TB	YB	LU	HF	TA	TH	U	SOURCE	PROJECT NO.
.2	662.9	19.6	40.4	15.0	3.2	0.4	0.4	2.2	0.2	2.7	0.6	7.0	3.2	INMAN B	215
.6	719.6	21.5	42.6	16.1	3.1	0.5	0.4	1.8	0.2	3.2	0.7	6.6	2.4	INMAN A	215
.7	650.7	24.3	43.2	16.7	3.4	0.5	0.4	1.9	0.1	3.1	0.7	6.7	3.4	INMAN A	215
.5	708.7	21.4	43.8	13.9	3.2	0.5	0.4	2.0	0.1	3.3	0.7	6.7	2.8	INMAN A	215
.5	632.9	23.5	40.2	12.7	3.3	0.5	0.4	1.6	0.2	3.0	0.6	6.6	2.5	INMAN A	215
.5	637.3	20.9	40.5	16.6	3.0	0.5	0.4	1.4	0.2	3.0	0.6	6.4	2.4	INMAN A	215
.7	641.2	22.9	41.1	13.6	3.4	0.5	0.4	1.2	0.2	3.1	0.7	6.7	2.8	INMAN A	215
.0	632.7	18.3	36.2	12.1	3.0	0.4	0.4	1.8	0.2	2.6	0.6	6.9	2.7	INMAN B	215
.4	656.1	23.6	41.6	16.2	3.4	0.5	0.4	1.6	0.2	3.1	0.6	6.7	2.7	INMAN A	215
.5	708.4	21.5	40.9	14.3	3.2	0.5	0.4	1.6	0.2	3.2	0.7	6.7	2.5	INMAN A	215
.3	680.3	20.7	39.4	15.3	3.1	0.6	0.4	1.1	0.2	4.8	0.8	6.4	2.8	UNKNOWN	215
.7	640.6	22.0	41.0	15.8	3.2	0.5	0.4	1.7	0.1	3.2	0.6	6.6	2.6	INMAN A	215
.6	742.9	21.5	37.6	11.3	2.5	0.4	0.4	1.8	0.2	2.9	0.7	7.2	2.3	OBS CLIFFS	215
.3	676.8	21.4	35.7	10.1	2.6	0.4	0.3	2.1	0.1	2.9	0.7	6.7	2.4	-	215
.3	715.7	20.3	37.6	15.3	2.5	0.4	0.3	1.7	0.2	2.9	0.8	6.8	2.8	-	215
.4	692.6	21.1	38.3	14.6	2.7	0.4	0.3	2.6	0.2	3.0	0.8	7.1	3.0	-	215
.6	715.6	20.9	38.8	9.1	2.5	0.4	0.4	1.4	0.1	2.8	0.8	7.1	2.5	-	215
.3	647.4	20.7	37.3	12.6	2.6	0.4	0.3	1.6	0.2	2.8	0.8	6.8	2.9	-	215
.9	703.5	21.2	38.4	13.3	3.3	0.5	0.4	1.9	0.2	3.3	0.7	6.9	2.7	-	328
.8	741.1	21.4	38.5	16.3	3.4	0.5	0.4	1.7	0.2	3.3	0.7	6.7	2.6	-	328
.9	737.6	21.5	38.6	16.0	3.4	0.5	0.4	1.9	0.2	3.3	0.6	7.7	2.7	-	328
.4	710.2	22.0	41.2	15.2	3.3	0.5	0.4	1.7	0.1	3.2	0.6	6.7	2.7	INMAN A	215
.7	695.2	20.6	37.5	14.0	3.2	0.5	0.4	1.6	0.1	3.2	0.7	6.8	2.5	INMAN A	328
.9	762.2	21.5	45.8	18.8	3.5	0.7	0.4	1.8	0.3	3.6	0.7	7.1	2.7	INMAN A	328
.1	796.6	22.1	48.0	18.0	3.6	0.7	0.5	1.9	0.3	3.5	0.7	7.3	2.8	INMAN A	328
.4	701.2	21.7	42.0	19.3	3.1	0.5	0.4	1.8	0.1	3.2	0.7	6.7	2.3	INMAN A	215
.4	609.1	23.4	41.0	16.9	3.3	0.5	0.4	1.9	0.3	3.2	0.7	6.7	2.6	INMAN A	215
5%	15%	3%	12%	20%	4%	5%	5%	7%	7%	4%	7%	3%	10%		
5%	10%	3%	7%	12%	5%	5%	5%	5%	5%	5%	5%	5%	7%		
.4	5.1	5.3	3.0	9.7	4.2	3.7	3.4	15.2	11.8	2.6	4.4	1.4	11.9		
.7	2.3	3.4	5.5	11.0	3.1	2.7	3.1	8.1	0.3	2.1	1.8	0.6	9.2		
.3	4.9	8.2	4.8	10.7	4.3	8.2	3.4	16.2	11.3	6.6	4.2	2.2	11.9		

VALLEY
NTRAL WILLAMETTE VALLEY
S

OAST
ADES (A.K.A. STALEY CREEK SOURCE)

DES
TS OF STANDARD; THIS FIGURE IS UNRELATED TO THE SAMPLE COUNTING UNCERTAINTY

nd secondary sources of obsidian at Inman
reek, and Vine Rockshelter.



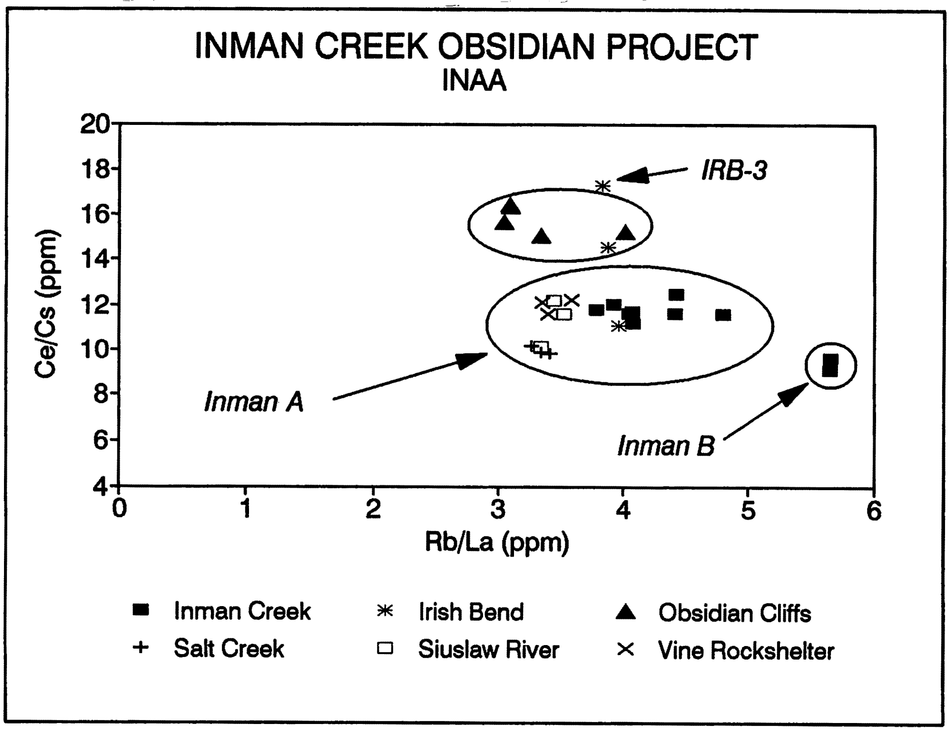


Figure 9. Scatterplots of INAA trace element data for obsidian samples from Inman Creek, the Siuslaw River mouth, and Obsidian Cliffs. **A** - FeO plotted versus Na_2O successfully distinguishes obsidian from the two Inman Creek groups and Obsidian Cliffs. **B** - Ratios of Ce/Cs and Rb/La were used to minimize the effects of inter-experiment laboratory variation.

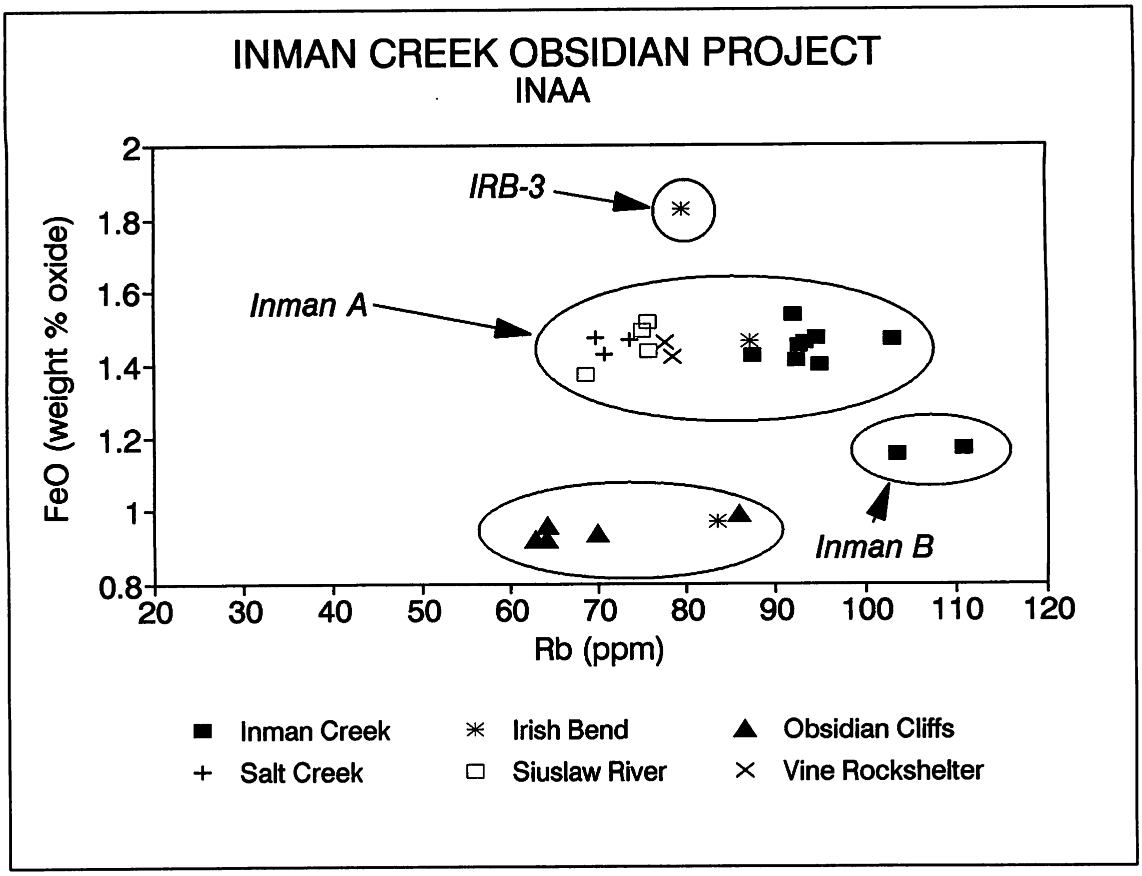


Figure 10. Scatterplot of FeO versus Rb INAA trace element data from obsidian samples collected from the Inman Creek sources, Obsidian Cliffs, Willamette River gravels at Irish Bend, and Vine Rockshelter (Staley Creek source).

elements that could be used to separate the two groups from each other and from other western Oregon obsidian sources. Obsidian pebbles from the Willamette River gravels at Irish Bend (IRB) were chosen to confirm the availability of Obsidian Cliffs glass in the mid-Willamette Valley and to see if other obsidian sources might be represented in the gravels. Two slightly modified cores of obsidian from Vine Rockshelter (35LA304) (VRS), a rockshelter site in the Upper Willamette River drainage of the Western Cascades, were picked to provide some preliminary data on a postulated Staley Creek obsidian source. The existence of this source had been predicted by Sappington (1986b), who found that a locally-utilized obsidian source (the Staley Creek source) and the Inman Creek source were chemically very similar. He reasoned that the overwhelming percentage of Staley Creek artifacts and split pebbles (94%; n=261) that he identified from four Oakridge area archaeological sites (including Vine Rockshelter) were not likely to have been transported from the Willamette Valley and had probably originated from a local source. The two obsidian cores analyzed here had been identified by Sappington as originating from the Staley Creek source. That the two sources might be one and the same was not yet suspected at that time. The Salt Creek (SACR) samples (all from secondary contexts) were added to the experiment to acquire preliminary geochemical data on this newly-recognized obsidian source and to investigate whether this may have been the Staley Creek source previously described. At the time of the sampling, the Salt Creek obsidian flow had not yet been located. Samples from Obsidian Cliffs were added to substantiate earlier XRF analyses that indicated that the Inman Creek sources were clearly distinguishable from the Obsidian Cliffs source.

DISCUSSION OF INAA RESULTS

Inman A and B Obsidian Groups

Both the Inman A and Inman B sources are distinguishable from one another using several of the major and trace elements determined by INAA analysis, substantiating the earlier XRF results that pointed to the existence of two groups. Differentiation between the two Inman Creek sources, as well as between the Obsidian Cliffs source, was accomplished by using a variety of different trace element pairs plotted on bivariate scatterplots (figures 9 and 10). FeO was particularly useful in distinguishing between the two groups.

The coefficient of variation is smaller than five percent for several of the trace elements, indicating a significant degree of intrasource homogeneity for these elements in both the Inman A and Inman B groups. The CV% is relatively small when many of the chemical data from the two groups are compared, however, suggesting that the two Inman groups might be easily confused as one when they are compared with other obsidian sources. The small sample size of the two chemical groups, however, particularly the Inman B group, makes any conclusions about their range of geochemical variation very preliminary.

Obsidian from the Inman A group appears to be considerably more common than that from the Inman B group. Of the ten samples from the Inman Creek type locality that were characterized, 80 percent were correlated with the Inman A group while 20 percent belonged to the Inman B group. INAA and XRF studies of obsidian from other locations that have been correlated with the Inman source (n=13) have found only one additional Inman B sample. Geochemical studies by Richard Hughes of artifactual materials from the central Western Cascades (see table 4-1) also indicate the dominance of the Inman A group.

Siuslaw River Obsidian

INAA characterization also confirmed the earlier XRF studies of obsidian nodules from the mouth of the Siuslaw River. All of the Siuslaw samples analyzed with INAA were correlated with the Inman A group. Greater than expected analytical variation was noted, however, for Siuslaw samples analyzed in two different INAA experiments (215 and 328 - see table 2), suggesting that some inter-experiment variation in analytical results may exist. Examination of compositional data from standards analyzed in both experiments indicates that the data should be comparable between the two experiments and suggests that the variability encountered may be due to the existence of large analytical uncertainties for several of the analyzed elements. These uncertainties could easily be reflected as larger than expected variation among samples, particularly when a small sample set is being considered. The elements that proved most useful in the XRF characterization of the glass, Sr, Rb, and Zr, all have relatively large associated analytical uncertainties. (Zr was determined only in the second experiment and is not listed in table 2).

Irish Bend Obsidian

Three samples collected from Willamette River gravels at Irish Bend were also analyzed. As was predicted by an earlier petrographic study of the obsidian (Skinner, 1986:36-40), two of the samples (IRB-7 and IRB-8) were correlated with, respectively, the Inman A and Obsidian Cliffs sources (figures 9 and 10). The third sample (IRB-3), petrographically distinct from the other two, could not be correlated with any Western Oregon source that is currently characterized with neutron activation methods. The Western Oregon source database that this sample was compared with, however, is still incomplete and characterized by few analytical data. It is not known whether the INM-3 data fall out of the range of recorded analytical variation of known sources, whether it represents a new and unrecorded obsidian source, or whether it reflects an analytical problem.

Vine Rockshelter/Staley Creek/Salt Creek Obsidian

The Vine Rockshelter/Staley Creek samples (VRS-1 and VRS-2) present a different problem. These two samples were collected from an archaeological context at Vine Rockshelter in the central Western Cascades. Independent archaeological evidence strongly suggests that they were locally procured from a source identified by Sappington as the Staley Creek source (Sappington, 1986b). Graphical correlation of the Vine Rockshelter samples with the newly-recognized Salt Creek obsidian source located 25 km to the northeast indicates that the two almost certainly share a common source, a Miocene obsidian flow located on the southern slopes of Mount David Douglas. It appears that the Staley Creek and the Salt Creek sources are one and the same. Obsidian from the Salt Creek source has been found in the gravels of Salt Creek as far as its confluence with the Middle Fork of the Willamette River and is also present in very small quantities in Middle Fork gravels. A secondary source of obsidian in volcaniclastic sediments has also been reported only about 10 km north of Vine Rockshelter and it is likely that the Salt Creek obsidian is found in several secondary outcrops in the area (Heid, 1986; Skinner, unpublished research).

These samples from Vine Rockshelter and Salt Creek are also virtually geochemically indistinguishable from the Inman A source of the Willamette Valley (figures 9 and 10). The trace element composition of the two sources is very similar and, for most elements, shares the same geochemical ranges of variation. Petrographically, the Staley Creek samples show several dissimilarities with the Inman obsidian. The Staley Creek glass contains microscopic petrographic structures (microlites and crystallites) that have not been observed at Inman Creek. Small megascopic spherulites are also very common in the Staley Creek glass and not at the Inman source. The geochemical evidence, however, is compelling, and it appears that the Salt Creek obsidian source **may** be the parent source for the Inman Creek A group found in alluvial gravels throughout central western Oregon. The degree of analytical uncertainty encountered and the small sample size analyzed preclude a definitive correlation of the Vine Rockshelter, Salt Creek, Inman Creek glass. Further geochemical studies will be necessary to confirm the common source of all these samples.

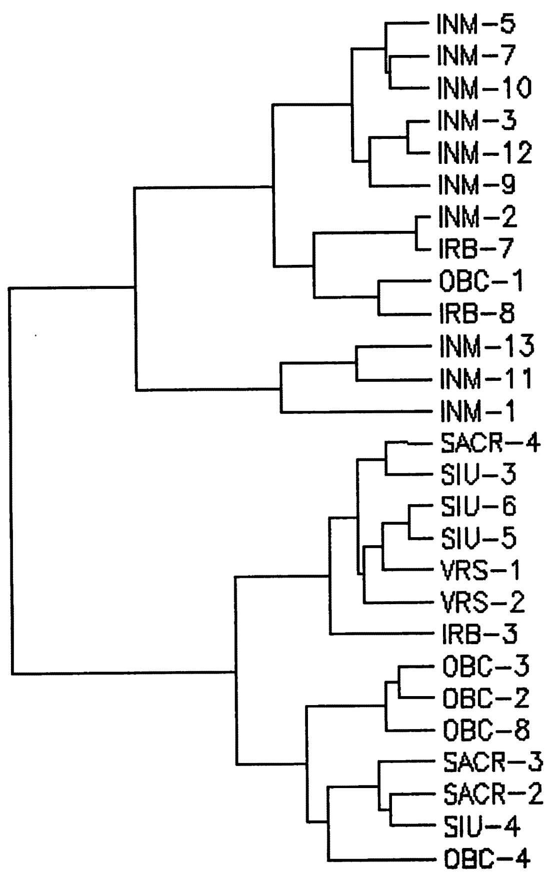


Figure 11. Dendrogram results of cluster analysis of analyzed primary and secondary obsidian source samples from Inman Creek (INM), the Siuslaw River (SIU), the Willamette River at Irish Bend (IRB), Salt Creek (SACR), Vine Rockshelter (VRS - Staley Creek), and Obsidian Cliffs (OBC)(FeO, Sc, Rb, Cs, La, Nd, Sm,and Hf).

Cluster analysis of the samples analyzed by INAA was of little help in identifying and correlating the different source groups (figure 11). While this did not resolve any problems in the current study, it did point out that statistical classification techniques are not always useful in correlating known sources with samples of unknown provenience. The degree of variation introduced by the analytical uncertainties and the two separate INAA experiments, compounded by the geochemical similarities of the Inman groups and the Obsidian Cliffs source obviated any unambiguous clustering of the different sources.

Geographic Distribution of the Obsidian

It is important to emphasize that the raw material for artifacts identified as originating from the Fern Ridge/Inman Creek obsidian source could have been procured from a widespread geographic area and not just from the Inman Creek type locality (this will be discussed in more detail in a later chapter). The results of the XRF and INAA studies reported here indicate that the glass could have been found in archaeologically-usable sizes as far west as the Pacific Ocean, as far east as upper Middle Fork of the Willamette, and possibly as far north as the Columbia River. The still limited number of obsidian artifacts correlated with the two Inman Creek geochemical groups indicate that the Inman glass was widely used throughout the central western portion of Oregon (figure 12).

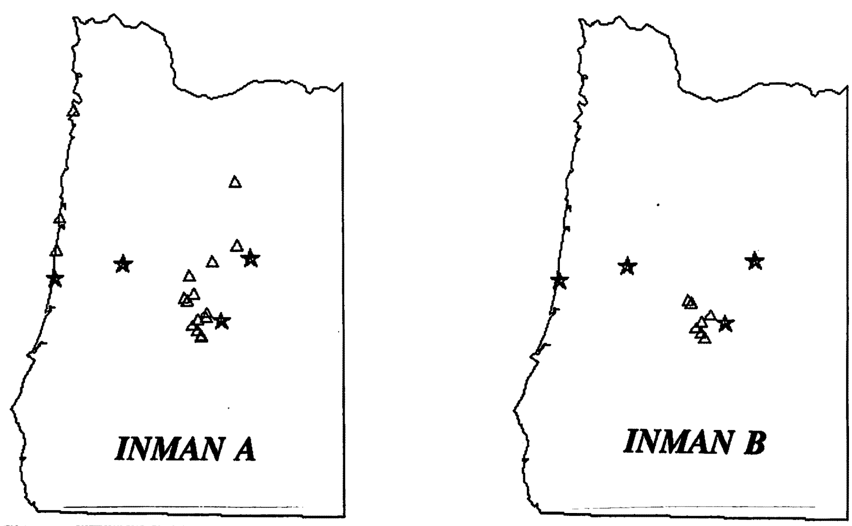


Figure 12. Distribution of Inman A and Inman B obsidian from characterized archaeological sites. The preponderance of Western Cascade sites is due to sampling bias. Earlier valley floor studies by Sappington were not included because of possible analytical problems. See figure 13 for a guide to the sources.

V. THE INMAN CREEK PRIMARY SOURCE - WHERE IS IT LOCATED?

The Search for a Primary Source of the Inman Creek Obsidian

It was initially hypothesized that the primary source of the Inman Creek obsidian was located in the Cascades to the east. Rhyolitic rocks and natural glasses have not been reported from the more proximate Coast Range. Where might the primary source of the Inman Creek obsidian have been located?

Four hypotheses were considered:

1. The obsidian might have been imported by the prehistoric occupants of the Fern Ridge area e.g. the Fern Ridge source might simply be an archaeological site.

While this would certainly account for the presence of obsidian in a geologic context where none is expected, the sheer quantity of unworked nodules, their distribution over a large area, and their presence *in situ* in alluvial deposits renders this an unlikely possibility.

2. The obsidian nodules could be exotics introduced by the flooding of Glacial Lake Missoula.

Multiple catastrophic floods resulting from the repeated failure of the Glacial Lake Missoula ice dam in Montana repeatedly inundated much of the Willamette Valley in the very late Pleistocene (Baker and Bunker, 1985). Ice-rafted glacial erratics have been reported by Allison (1935) throughout the Willamette Valley, some only 5 km east of the Inman Creek source. Allison, however, nowhere noted the presence of obsidian at any of the 249 localities he documented and it is considered highly improbable that the glass floated in from Montana.

3. The obsidian originated from sources in the High Cascades to the east of the Fern Ridge area.

Many of the alluvial deposits in the Fern Ridge area may have originated in the Cascade Range and a strong argument can be made for a Cascades origin of the Inman glass. Other researchers have, in fact, favored the Cascades as the source region of the Inman Creek glass (Minor, 1987:51; Toepel, 1985:27-29). Trace element characterization results reported in this study and earlier by Skinner (1983:304-320, and 1986:26-29) have eliminated Obsidian Cliffs as the parent source, although several other geologic sources, many of them only recently recognized, are known. INAA studies of many of these sources are currently underway by the author, although their analysis has not yet been completed. Though there are some petrographic dissimilarities between the Western Cascades obsidian and that at Inman Creek, the remarkable geochemical resemblance of the Vine Rockshelter (Staley Creek), Salt Creek, and Inman A sources strongly suggests a common primary source in the Western Cascades. If these samples were compared on the basis of the trace element analyses now available, they would be almost certainly be considered to originate from the same parent obsidian source.

If the Inman Creek obsidian had originated from the Cascades, its presence at the mouth of the Siuslaw River could be explained by changes in the drainage patterns of the Long Tom River. Baldwin and Howel (1949) found that the Long Tom River, now an eastward-draining tributary of the Willamette River, was formerly a tributary of the Siuslaw River. Alluvial deposits containing obsidian have been reported from Long Tom River terraces southwest of Inman Creek (Rick Pettigrew, personal communication, 1982; Toepel, 1985:28). If this obsidian was deposited along with other alluvium originating in the Cascades, the obsidian could have been carried westward to the Oregon Coast.

4. The obsidian originated in the Coast Range to the west of the Inman Creek source.

This conclusion, favored in earlier work by Skinner (1983:304-320, and 1986:22) is the last of the primary source possibilities to be considered here. Volcanic rocks in the Coast Range are dominated by the presence of early Cenezoic gabbroic to dioritic sills and extensive flows of submarine basalts - the appearance of rhyolitic obsidians would certainly be unexpected (MacLeod and Snavely, 1973; Snavely and Wagner, 1961; Snavely et al., 1968 and 1980; E. Baldwin, personal communication, 1982). Local geologic studies also fail to mention rhyolitic rocks or obsidian in the Coast Range adjacent to the Fern Ridge area (Frank, 1973; Gandera, 1977; Zimmerman, 1927). Why, then, would the Coast Range be seriously considered as the source of the Inman glass?

The presence of obsidian in the Siuslaw River drainage provides a major clue to a Coast Range source. Though the obsidian nodules reported from Long Tom River terraces on the lower slopes of the eastern Coast Range could conceivably have been carried there from the Cascades, their appearance would be more plausibly ascribed to the presence of a local source. The grain size frequency distribution of obsidian nodules collected near the mouth of the Siuslaw River is also consistent with a Coast Range source lying in the eastern part of the Coast Range (figure 5). Changes in the drainage patterns of the Long Tom River described by Baldwin and Howell (1949) provide a reasonable explanation to account for the appearance of obsidian both at the Oregon Coast and the southwestern Willamette Valley.

The most compelling argument for a Coast Range origin, however, lies in the size and abundance of the obsidian nodules in the Fern Ridge area. The sheer number and range in size of the glass nodules argues very strongly for a nearby source. Nowhere in the alluvial gravels exposed by the Willamette River, for example, do the number of glass nodules anywhere near approach the quantity found at Inman Creek. Toepel (1985:28) mentions that during an archaeological survey of the Fern Ridge area naturally occurring pebbles of obsidian were found in many of the surveyed sections. These abundances are simply not consistent with obsidian that has been carried over 100 km from its source and then fluvially dispersed throughout the Willamette Valley.

The maximum diameter of the nodules also points to a local source. Obsidian finding its way into the bed-load of a river can be carried long distances downstream, although the potential transport distance for glass large enough for prehistoric use is limited because of mechanical abrasion during transport (Pettijohn, 1975:45-46). A study by a group of Czechoslovakian students (reported by O'Keefe, 1976:29) of the weight loss of pluvially-transported glass as a function of the distance from their source, showed that 99% of the mass of the glass was lost in the first 40 km. Studies with other lithic materials have also demonstrated that weight loss plotted versus distance displays a lognormal relationship with a higher rate of loss taking place near the source (Pettijohn, 1975:47). The maximum size of characterized fluvially-transported obsidian pebbles collected approximately 100 km from Obsidian Cliffs, for example, is about 4 cm (Skinner, 1986). The relatively large size of the Inman Creek nodules suggests a source that is much closer than that.

And the Primary Source Is ...

And so, where did the Inman Creek obsidian originate from? While persuasive evidence can be cited for a Coast Range origin, even more convincing evidence can be cited for a Cascades origin. It appears, **based on preliminary geochemical evidence**, that at least one of the geochemical groups associated with the Inman Creek obsidian, the Inman A group, originated from an obsidian-rhyolite flow located on the southern flanks of Mount David Douglas in the Upper Willamette River drainage of the Western Cascades. This conclusion is corroborated by the presence of Inman A artifactual obsidian from several archaeological sites in this drainage (figure 12). The distribution of Inman B artifactual obsidian (figure 12) additionally suggests that the Inman B source is also likely to be found somewhere in the same area as the Inman A glass. The tentative nature of the correlation of different sources and the small sample sizes considered leave this conclusion as less than conclusive, however. The Inman Creek problem still requires a thorough geochemical study for its final resolution.

The Inman Creek Grain Size Problem: A Volcanic Debris Flow?

The grain size and relative quantity of Inman obsidian found in the Willamette Valley and along the Oregon coast is not consistent with nodules that have been fluvially transported 100 km or more. If the primary source of the obsidian lies in the Salt Creek drainage of the Western Cascades, as is suggested by the geochemical and archaeological evidence, how was the glass transported to the west? I suggest here that a possible transport mechanism may be found in debris flows, lahars, or mudflows. These three terms are often used synonymously to describe flows of water-saturated debris and sediments. These phenomena may be caused by a variety of events, including heavy rains on loose materials on slopes, release of water by the failure of a dammed lake or stream, the triggering of water-saturated materials downslope by an earthquake, and a variety of volcanic-related processes (Macdonald, 1972:171; Fisher and Schmincke, 1984:309-311). Debris flows have been reported to travel well over 100 km from their sources with a few exceeding more than 200 km from their source (Macdonald, 1972:170-181; Fisher and Schmincke, 1984:295-311). Lahars from the 1980 eruption of Mount St. Helens, for example, traveled more than 120 km from the mountain down the Toutle River channel (Janda et al., 1981). The resultant deposits are often coarse-grained, poorly-sorted, show little to no internal bedding, may contain large rock fragments, and are commonly found in valleys spreading onto flat piedmont surfaces (Fisher and Schmincke, 1984:309-310). While evidence for a debris flow origin of secondary deposits of Inman obsidian in western Oregon is still quite circumstantial, it does offer an explanation that is consonant with the size and quantity of glass in the poorly-exposed Inman Creek obsidian-bearing conglomerates.

VI. PREHISTORIC UTILIZATION OF INMAN CREEK OBSIDIAN

Previous Research

The presence of the Inman Creek obsidian, though now well-documented, eluded the notice of Oregon archaeologists for many years. Numerous archaeological sites had been reported from the Inman Creek vicinity by professional and amateur archaeologists, yet the existence of a local obsidian source went unnoticed (Collins, 1951; Frazer and Miller, 1965). Since the recognition of the source, recent archaeological work in the Fern Ridge area and the Western Cascades has added many additional sites to the list of those already identified.

The first archaeological allusion to the Inman glass was by Davis (1970:13), who mentioned the presence of a secondary source of obsidian in the Long Tom River gravels. An early neutron activation trace element study of artifactual obsidian from three Willamette Valley sites may have included glass from Inman Creek, though the geochemical data are, unfortunately, not comparable with the INAA data from the current investigation (Hansell, 1972). The first description of the Inman Creek source was in a Master's Project by Skinner (1983:304-320), who presented preliminary geochemical, petrographic, and geologic data. A later unpublished report by Skinner (1986) added further details about the source.

Ironically, the first published reference to trace element studies of artifactual obsidian from the Fern Ridge sources erroneously identified Tucker Hill in Eastern Oregon as their source (Toepel and Sappington, 1982). The Inman Creek glass had not yet been included in the source universe that the samples were compared with and this, along with the use of a statistical correlation method that required that a source be identified, led to the postulation of a long-distance procurement trade system. The identification of Tucker Hill as a source or possible source of Willamette Valley and Western Cascades artifacts persisted, however, for several years after the Inman obsidian was identified and sampled (Sappington, 1984a; 1984b; 1984c; 1985a; 1985b; 1986a). This may have been compunded by the existence of two geochemically-distinct sources in the Fern Ridge area,

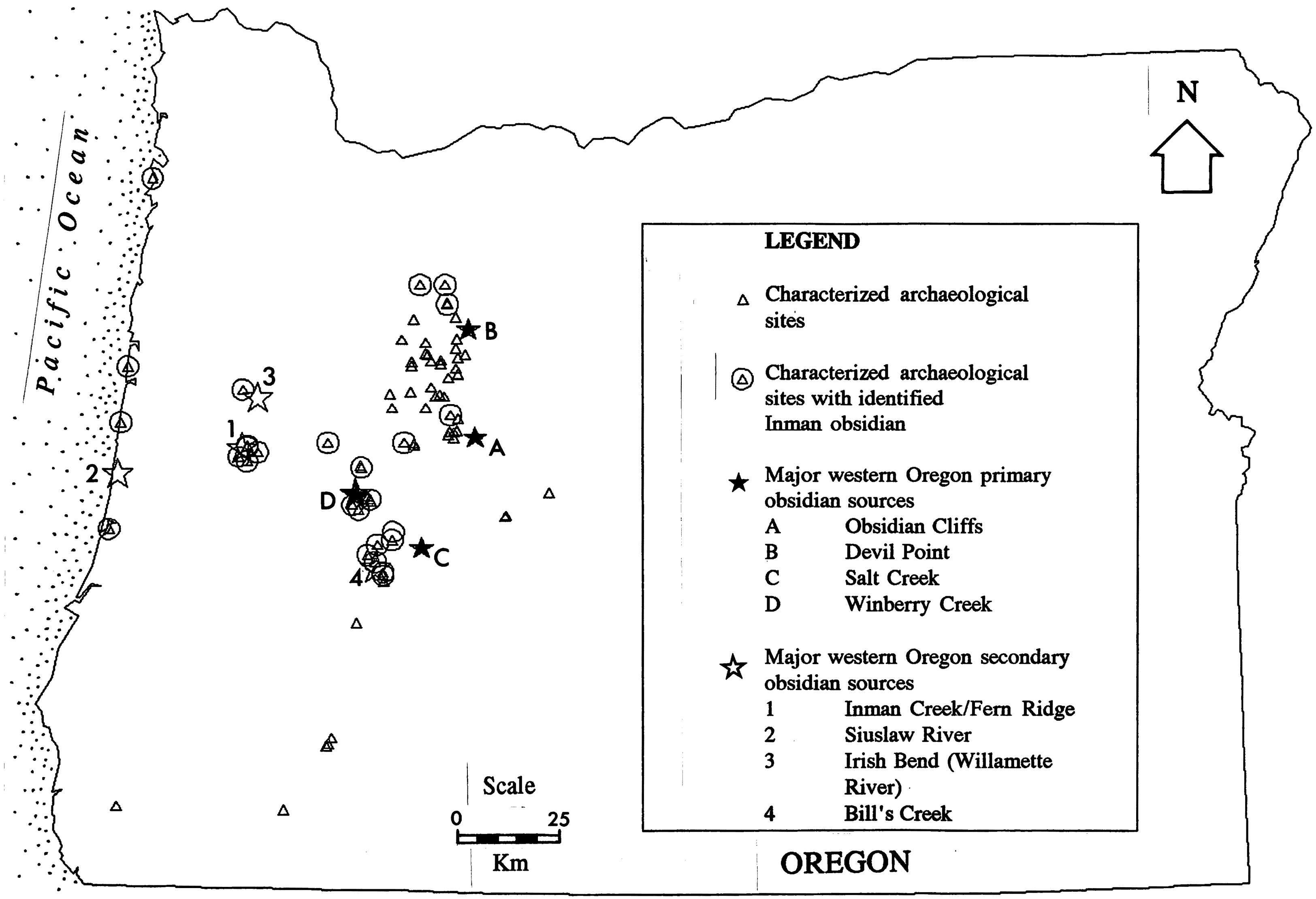


Figure 13. Obsidian sources, characterized archaeological sites, and Inman Creek obsidian in western Oregon.

only one of which had been recognized during the initial trace element studies of the Inman Creek glass. The Inman B source, occurring in lesser quantities than the Inman A source, may have been mistaken as the Tucker Hill source in these later studies. A single utilized flake from the Lava Island Rockshelter near Bend in Central Oregon has also been correlated with the Inman Creek source (Minor and Toepel, 1984), though a later restudy of obsidian at this site suggests that this identification was in error (Scott, Davis, and Flenniken, 1986). The analytical data of Sappington are not comparable to XRF obsidian studies by Skinner and Hughes and were not considered in most of the current study.

More recently, trace element studies of Western Oregon obsidian artifacts have been carried out by Richard E. Hughes of California State University at Sacramento in conjunction with contract research initiated by the Willamette National Forest. Obsidian artifacts correlated with the Inman Creek sources have been identified at several archaeological sites in the central Western Cascades of Oregon (see figure 13 and table 2-1). The results of early XRF investigations have been summarized elsewhere by Minor (1987:50-55).

Recent INAA trace element studies also indicate that the Fern Ridge obsidian, possibly the pebbles found near the mouth of the Siuslaw River, served as the source of artifacts from the Umpqua/Eden and Netarts Spit sites along the Oregon Coast (Skinner, 1987a; Skinner, 1987b; unpublished research by the author).

Artifact Material Evidence: Obsidian Debitage Percentage

Skinner (1986:52-55), in a previous study of Western Oregon obsidian, noted that the obsidian debitage percentage (total debitage / obsidian debitage) appeared to be a sensitive source-distance attribute of the archaeological collections examined. The obsidian debitage percentage was found to vary inversely as a function of the distance of the archaeological site from the geologic source of obsidian.

The obsidian debitage percentage also constitutes an independent indicator of prehistoric use of the Inman Creek site. Regression analyses of the quantities of archaeological materials and the distance from their origin have often yielded demonstrable relationships (Ericson, 1981; Findlow and Bolognese, 1982; Hodder, 1974; McBryde and Watchmen, 1981; Renfrew, 1977). If a regular relationship of obsidian debitage percentage and distance from source can be established, it is almost certain that the source in question was utilized. It also follows that if a regular relationship of source distance and obsidian debitage percentage is expected, the approximate source distance from an archaeological site and geographic location of a source may be predicted from archaeological data alone. (There is an obvious danger of circular reasoning to this argument, however, that obsidian characterization studies can circumvent). This technique, however, will clearly be most productive for **point resources**. That the Inman Creek obsidian was available over a widely distributed area is likely to render regression analysis as a less than optimal technique.

Trend surface maps of the obsidian debitage percentage were also constructed in an attempt to ascertain local prehistoric use of Inman Creek obsidian. Given that local sources of obsidian are those that are most often utilized, particularly for utilitarian artifacts such as debitage (Hughes and Bettinger, 1984), a trend surface map computed from obsidian debitage data might be used to infer both the existence of a source **and** its prehistoric use as a lithic resource. Hodder and Orton (1976:156) also address this use of trend surface maps in a somewhat different archaeological context:

> In general terms it seems that objects made in, or distributed from, one centre often maintain a concentration around that centre. When the centre is unknown, can we predict its location by finding the high point or highest frequency on the smoothed trend surface?

In an attempt to provide a more sensitive archaeological indicator for source distance fall-off studies in Western Oregon, the obsidian debitage ratio was redefined in the current study to consider only functionally-equivalent materials:

$$ODR = \frac{TDN}{ODN} \qquad (2)$$

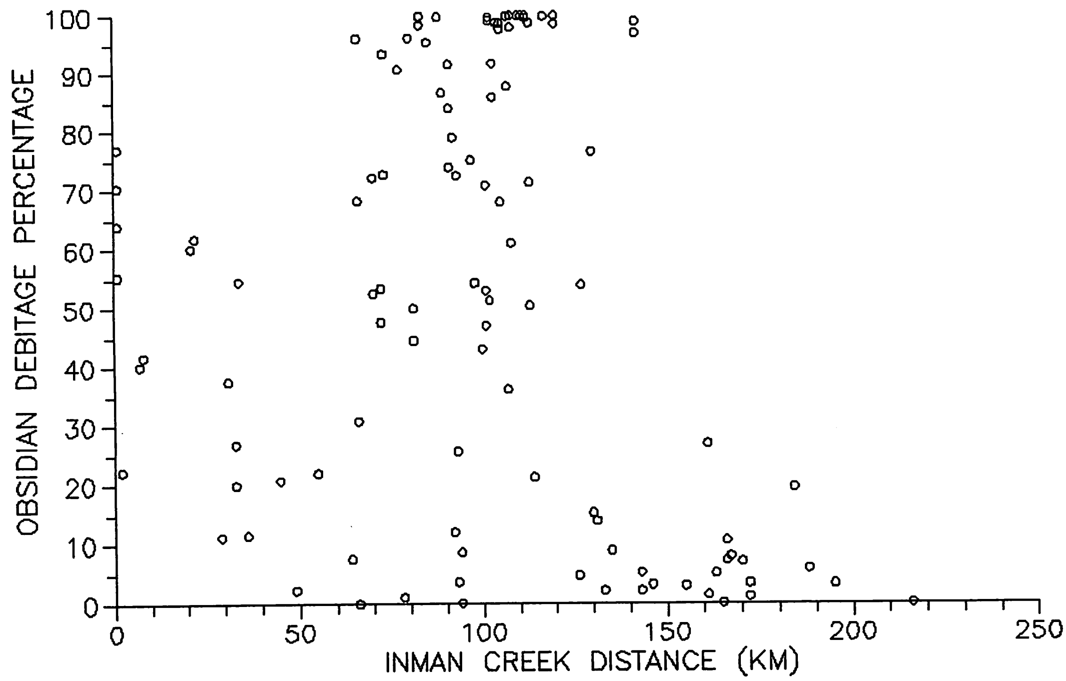
where ODR = obsidian debitage ratio (percent), TDN = total number of glassy and very fine-grained debitage items in the collection (obsidian + ccs + very fine-grained), and ODN = total number of obsidian debitage items.

The debitage count included all primary, secondary, and tertiary waste flakes, flake fragments, and fragments of angular waste. Materials typically classified by archaeologists as cryptocrystalline silicates (CCS), jasper, chert, and petrified wood were all considered to be functionally equivalent to obsidians; the lithic raw materials appeared to be used interchangeably in similar artifact tool categories. Coarser-grained materials, most notably basalts, were excluded from consideration.

No attempt was made at this point to chart changing debitage ratios over time; each site was considered as a single synchronic analytical unit.

REGRESSION ANALYSIS AND THE SOURCE DISTANCE VARIABLE

When all Western Oregon obsidian debitage data (n=144; see table 2-1) are plotted versus the distance of the site from the Inman Creek source, an unusual pattern results (figure 14A). The debitage percentage regularly decreases to a distance of about 60-70 km from the Inman Creek type locality. At this distance, however, the range of debitage values suddenly expands to nearly 100 percent. This is interpreted here to be an interference pattern resulting from a relatively sudden shift to the nearer Western Cascades obsidian sources, primarily the Obsidian Cliffs source. This interpretation is corroborated by recent trace element studies of archaeological obsidian in the Western Cascades - most



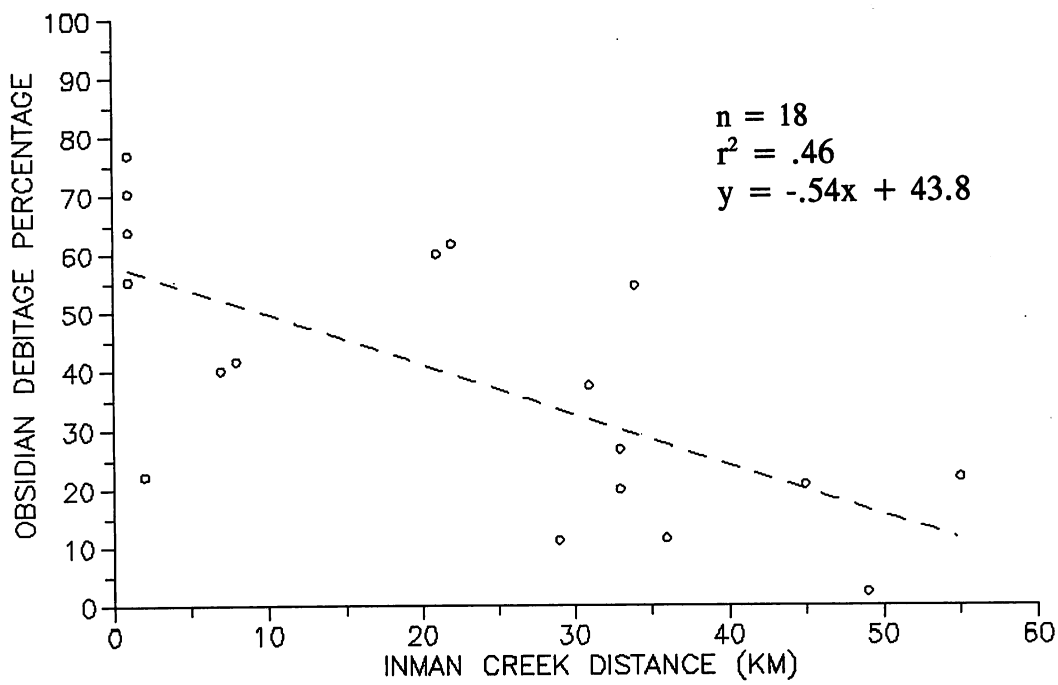


Figure 14: Obsidian debitage percentage plotted versus different site distances from the Inman Creek source. Data from 113 sites are plotted in figure 14A; in figure 14B, the distance scale has been shortened to reduce apparent interference from High Cascades obsidian sources. The linear best-fit line clearly illustrates the fall-off of the obsidian debitage percentage in relation to Inman source distance (distance-decay).

characterized obsidian from the Santiam and McKenzie drainages of the central Western Cascades have been found to originate from Obsidian Cliffs (Winkler, 1991; Winkler and Skinner, 1991). This pattern disappears when only sites lying within about 60 km of the Inman Creek source are considered (figure 14B).

The best-fit regression line of figure 14B indicates a typical distance-decay pattern when only data from archaeological sites lying within 60 km of Inman creek are considered. The correlation (r^2) between the obsidian debitage percentage and the source distance is, however, not a particularly significant one.

Using only the obsidian debitage percentage from archaeological sites, the regression equation or resultant best-fit line (as in figure 14B) could be cautiously used to **estimate** the distance of an archaeological site from a source of obsidian. The range of data points on the obsidian debitage percentage axis in figures 14A suggests, though, that source distance estimates at a distance greater than about 60 km from Inman Creek would be a risky exercise. A symmetrical pattern must also be assumed.

OBSIDIAN DEBITAGE PERCENTAGE TREND SURFACE ANALYSIS: ADDING A THIRD DIMENSION

The directionality of the debitage percentage trends are only apparent when they are viewed in more than two dimensions with the trend surface map (figure 15) and contour diagram (figure 16). The Inman Creek source appears as a data high on the western shoulder of a much more dominant data feature to the east. The debitage percentage decreases rapidly as a function of distance from the Inman source, although it appears to drop less rapidly to the west, a factor almost certainly due to the presence of Inman obsidian at the mouth of the Siuslaw River and to the lack of other competing available sources. East and southeast of the Fern Ridge area, the obsidian debitage percentage also drops, only to quickly rise again, probably the result of a shift of source preferences to the Western and High Cascades. The highest debitage percentage values on the eastern part of the perspective diagram approximately correspond to the location of the Obsidian Cliffs source. Recent trace element studies indicate that the Obsidian Cliffs glass dominates all other sources in the central Western Cascades. The obsidian debitage percentage values taper off gradually to the south and north of Obsidian Cliffs, the result of a lack of competing obsidian sources in either of these directions. Only the Devil Point source, a minor and locally-utilized obsidian quarry site north-northwest of Obsidian Cliffs, lies in Oregon to the north of the central Obsidian Cliffs source. No other sources of obsidian in western Oregon lie to the south of Obsidian Cliffs and the decreasing obsidian debitage percentage reflects a gradual shift to the procurement of more distant eastern Oregon and northern California sources (Winkler and Skinner, 1991). The very low values at the four corners of the diagram are largely attributable to a lack of archaeological data from these areas.

The approximate locations of the two major western Oregon obsidian sources, Inman Creek and Obsidian Cliffs, can be discerned strictly from the obsidian debitage percentage

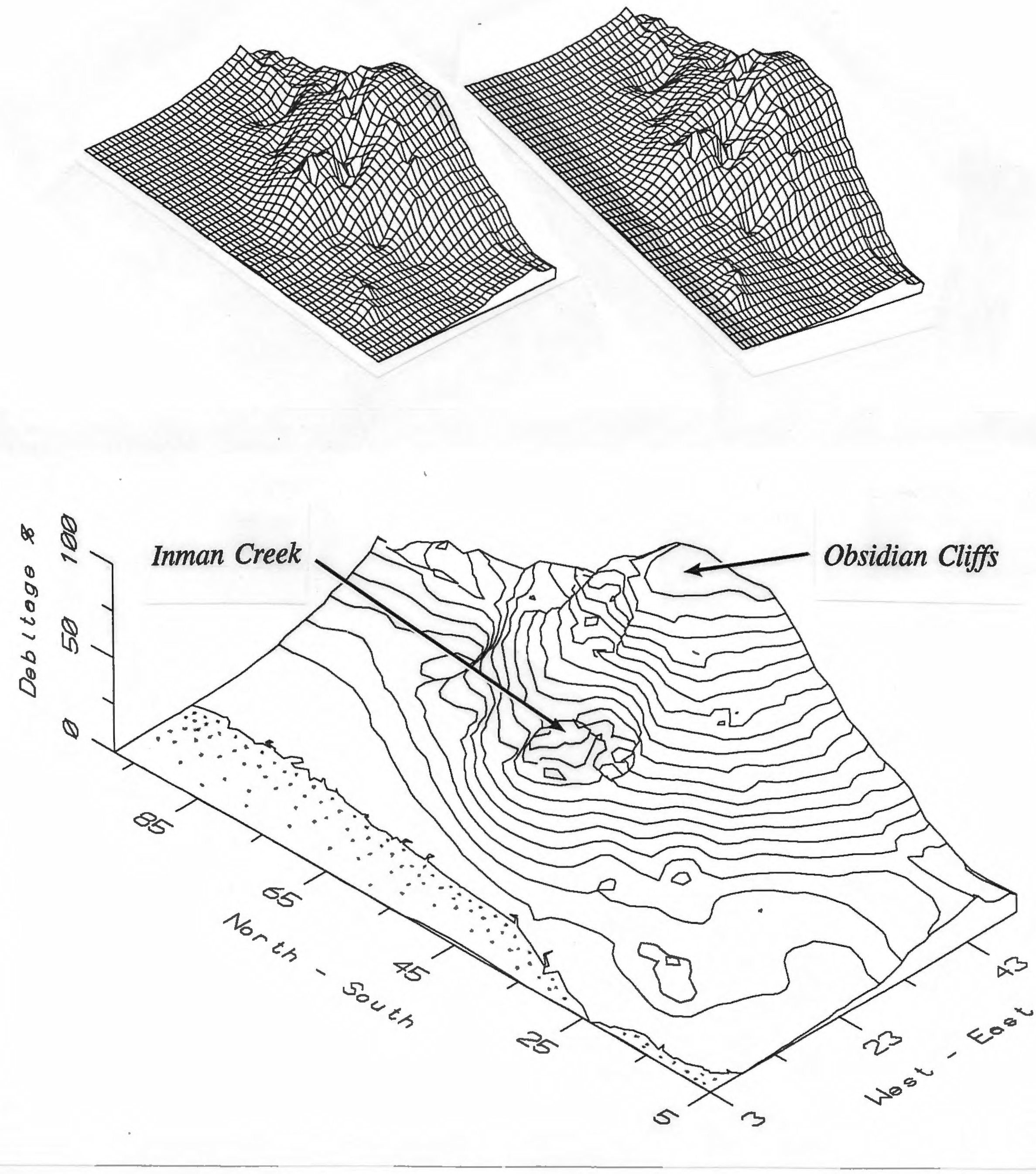


Figure 15: Trend surface map (and stereo pair) of the Western Oregon obsidian debitage percentage data surface. The northern boundary is the Oregon-Washington border while the southern boundary is the California border. The Pacific Ocean is on the west and the eastern border lies just east of the Cascade Crest. The contour interval is 5%. The numbers along the border refer to the gridding system (see table 2-1 for X-Y coordinates of specific sites).

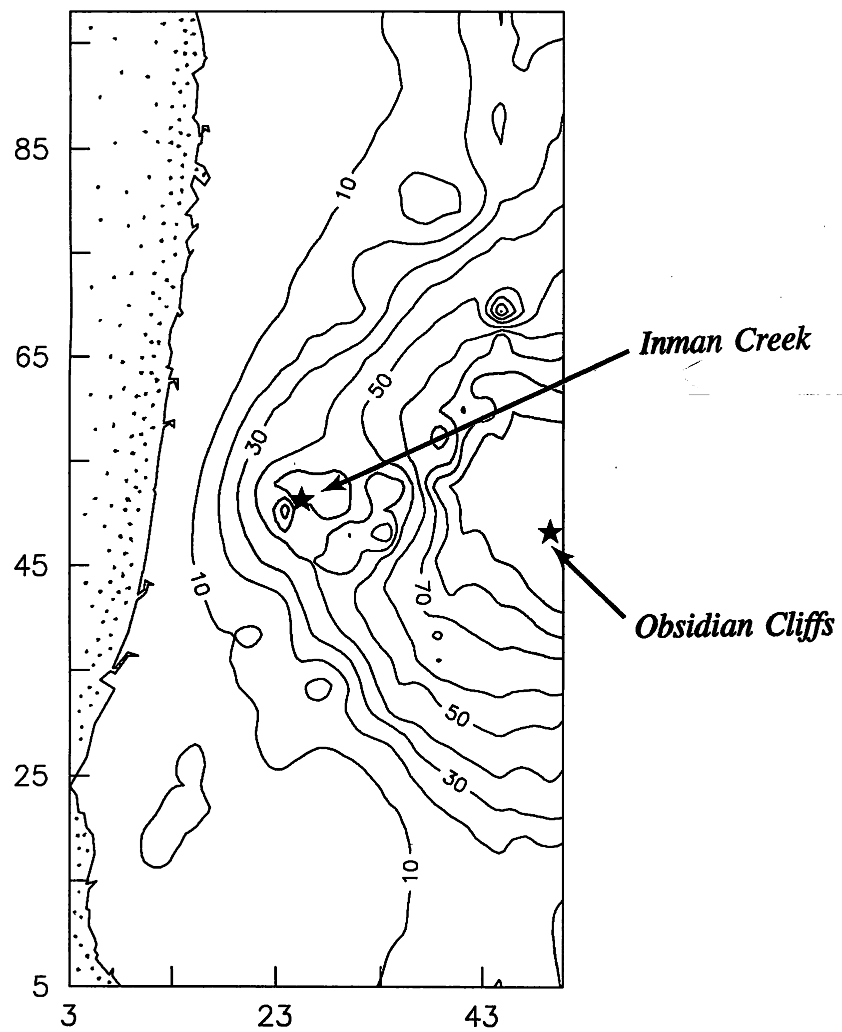


Figure 16: Contour map of the obsidian debitage percentage in western Oregon. This diagram covers the identical area as figure 15. The contour interval is 10%.

variable. The location of a trend surface high point approximately over the Inman Creek source further suggests that a large degree of the prehistoric procurement of obsidian correlated with this widely distributed secondary obsidian source may have taken place in the general area of the present Inman Creek type location.

The three-dimensional diagrams of figures 15 and 16 indicate that regional obsidian debitage percentage information can be independently used to predict the location(s) of prehistorically-utilized obsidian sources. This technique could be used not only to infer the usage of obsidian from a specific source in the absence of more reliable characterization data, but to predict the location of an unidentified source of regionally-utilized archaeological natural glass.

Trace Element Evidence: Inman Creek Source Utilization Percentage

The obsidian source utilization percentage, another obsidian-related parameter that was investigated, is defined here as the percentage of characterized artifactual obsidian at an archaeological site that was chemically correlated with the Inman Creek source. The results for Western Oregon must be considered as still very preliminary. The number of sites with adequate data is still low, though recent Willamette National Forest archaeological contract policies favoring obsidian characterization studies has led to a concentration of characterized sites in the central Western Cascades (figure 13). Data from many other areas of the state, however, ranges from sparse to absent. Sample sizes are also often very small, temporal controls are virtually absent, and no consideration of artifact types, differences in sample size among collections, or archaeological site use was taken into account. Despite these obvious caveats and limitations, the results are suggestive of both distance-dependent and directional tendencies to the prehistoric utilization of the Inman Creek obsidian.

In an attempt to reduce bias introduced by isolates and the very small sample sizes available at several sites, the source utilization data examined here includes only archaeological sites with more than five characterized obsidian artifacts. Because of methodological problems, the earlier work of Sappington has been disregarded and only characterization research by Richard Hughes or myself was considered. The resultant data are far from optimal - the sample size is small (n=12 for regression analysis) and sites are very overrepresented in the central Western Cascades.

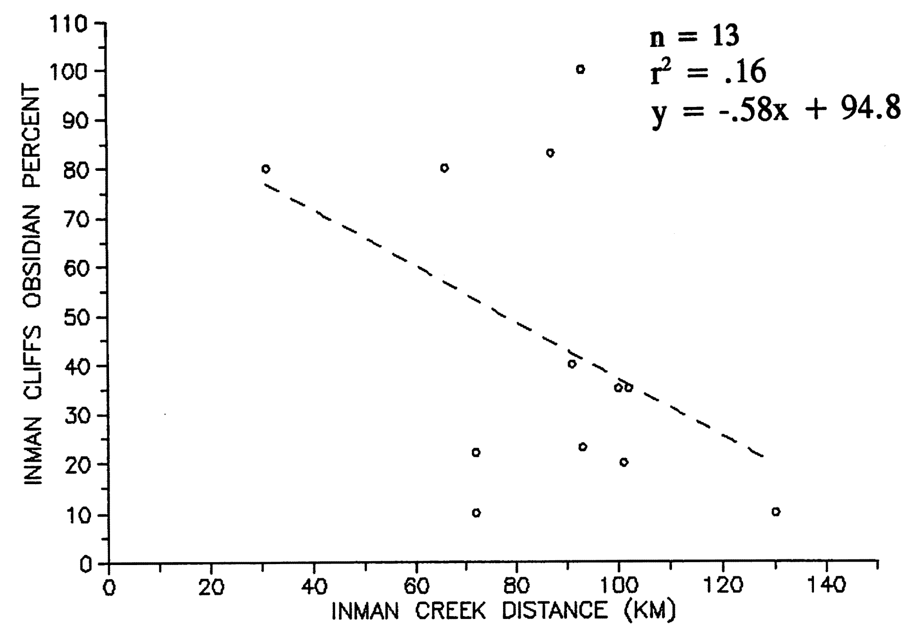


Figure 17. Inman Creek obsidian source utilization percentage plotted versus Inman source distance from the Inman Creek source. Identical data are plotted in both graphs; only the distance scale has been changed.

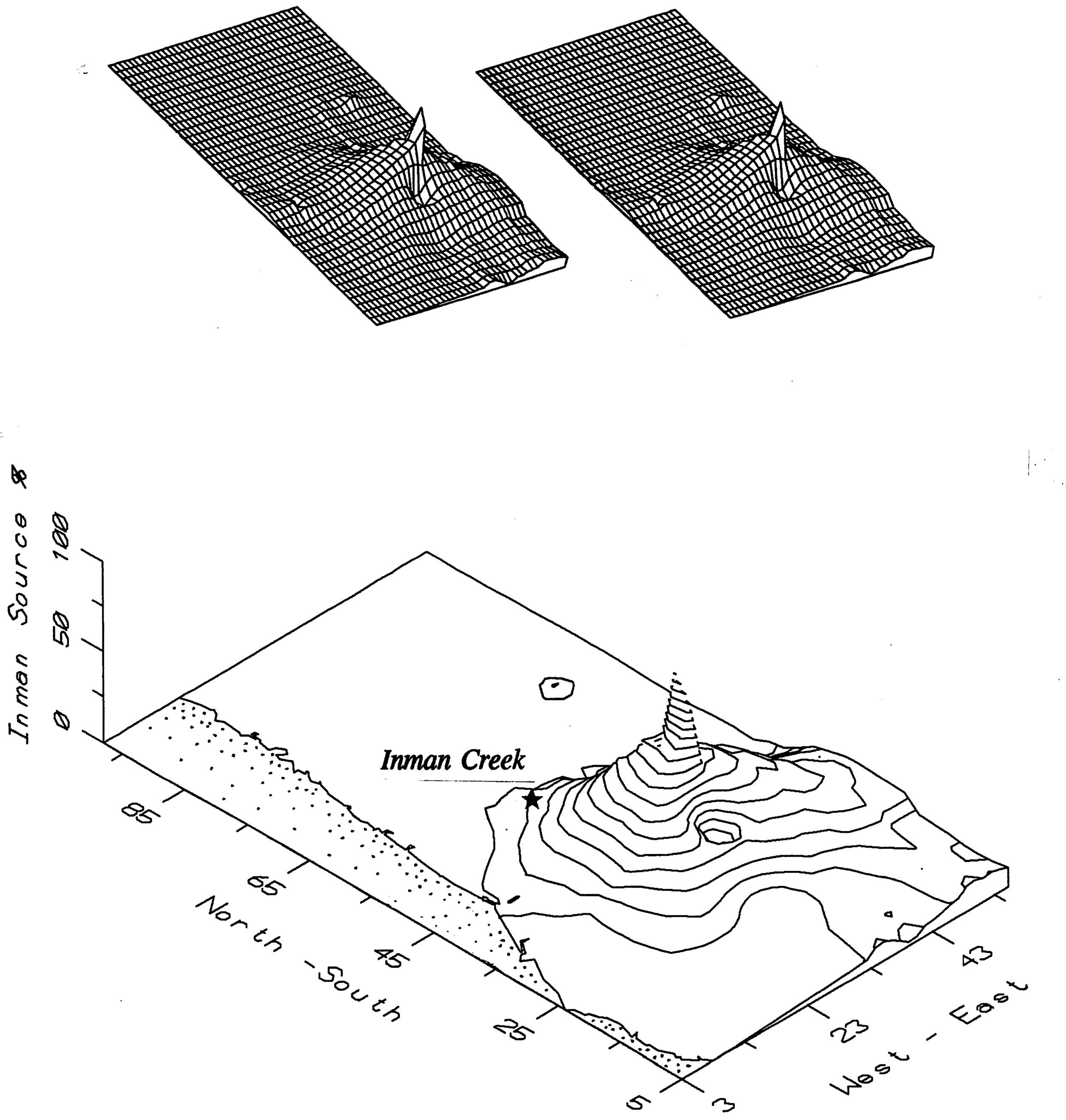


Figure 18. Trend surface map and stereograms of the western Oregon source utilization percentage data surface. The topographic high point is located southwest of the Inman Creek type locality. The contour interval is 10%.

REGRESSION ANALYSIS AND THE SOURCE UTILIZATION PERCENTAGE

Plotted against the distance of the site from the Inman source, the source utilization percentage displays only a weak pattern of decreasing source use as a function of distance (figures 18 and 19). At a position of about 70-100 km from the source, several seemingly anomalous data points (high percentage values) appear in the graph. The significance of these data are only apparent when the directionality of the source utilization trend in relation to the Inman source is considered. Distance-decay schemes such as the one employed here are **unidirectional** and are effective only when the fall-off of a variable from a point source is symmetrical in all directions. Asymmetrical or directional patterns such as those encountered here result in distance decay relationships that are not suitable for regression analysis.

The linear best-fit line does indicate the distance-decay characteristics of the source utilization percentage though the relationship of the two variables is very low ($r^2 = .16$).

TREND SURFACE ANALYSIS

The directional characteristics of the Fern Ridge source obsidian utilization patterns are more clearly pictured in the trend surface and contour diagrams in figures 18 and 19. The anomalous data points are seen to be the result of the asymmetrical utilization characteristics of the Fern Ridge obsidian. The peak of the trend surface also lies southeast of the Inman Creek type locality, though this is interpreted here to result from the low number of archaeological sites considered and their location east and southeast of Inman Creek. Any conclusions drawn from the current data set must be considered as very provisional. Source utilization drops off rapidly to the north and south but remains high into the Western Cascades.

The asymmetrical characteristics of the Inman source utilization trend surface is probably a real phenomenon and not simply the result of the inadequate sample size, though the shape of the trend surface is undoubtedly influenced by a lack of characterized sites in the Willamette Valley. The archaeological site sample size considered was considerably larger for the construction of the trend surface than for regression analysis - 46 sites with five or more artifacts were used, though only 12 sites contained identified Inman Creek obsidian. The decline to the north and south is thought to be due to the existence of competing sources of obsidian in these regions - Obsidian Cliffs and Devil Point to the north and northeast and eastern Oregon and northern California sources to the south and southeast. The extension of a high Inman source utilization into the Western Cascades, specifically the upper Willamette River drainage, is almost certainly due to the probable presence of the parent primary Salt Creek obsidian source. The trend surface simply reflects the linear nature of availability of Inman glass rather than any particular cultural obsidian procurement process. The data are too scanty to provide clues about procurement styles and there is no indication whether exchange or direct access procurement was preferred.

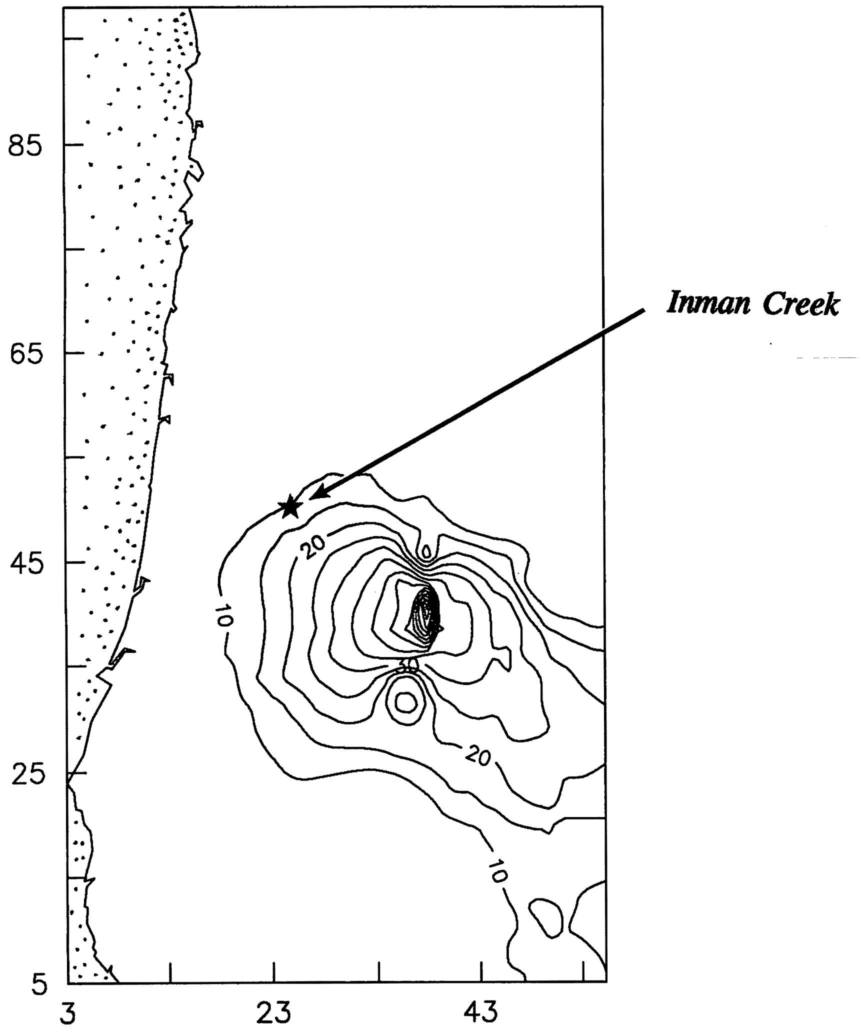


Figure 19. Contour map of the Inman Creek obsidian source utilization percentage. The map covers the same area as figure 18. The contour interval is 5%.

As was true with the obsidian debitage percentage, the location of a utilized or previously unidentified geologic source of obsidian (if it was being utilized) should be apparent using archaeological obsidian characterization information alone. Had these data and methods been in existence ten years ago, the approximate geographic location of the Inman Creek obsidian source could have been estimated with only archaeological information.

While the results of this trend surface analysis must be considered as speculative, exercises like this can provide us with tentative research hypotheses, methods, and directions in which to aim these future investigations. Further obsidian characterization studies may provide western Oregon archaeologists with the quantity and scope of data needed to more adequately investigate and reconstruct prehistoric behavioral systems related to procurement activities.

The Diachronic Dimension: Obsidian Hydration Evidence

Chronologic data from most of the characterized archaeological sites was scanty, with site chronologies based on rare radiocarbon dates, the infrequent use of volcanic tephra as a chronostratigraphic marker (Skinner and Radosevich, 1991), and most commonly, upon the cross-dating of projectile point sequences developed in adjoining regions (Minor, 1987:41-42). Chronologic information about artifacts correlated with the Inman Creek chemical groups was particularly sparse in the archaeological literature. Obsidian hydration measurements, available for many of the characterized obsidian artifacts, cannot yet be reliably converted to calendar dates but **can** be used to investigate relative intrasite and intersite chronologies and to evaluate the stratigraphic integrity of deposits at archaeological sites. Chemical composition and temperature (particularly elevated temperatures) are the two primary variables affecting the rate of hydration of obsidian and it has long been recognized that characterized obsidian must be used to control the compositional variable (Michels and Tsong, 1980; Skinner, 1983:47-51,66-71). Given that no attempt was made here to control the temperature variable, the hydration rim thickness of artifacts correlated with the two Inman Creek groups was examined to explore the question of Inman obsidian utilization over time (figures 20 and 21).

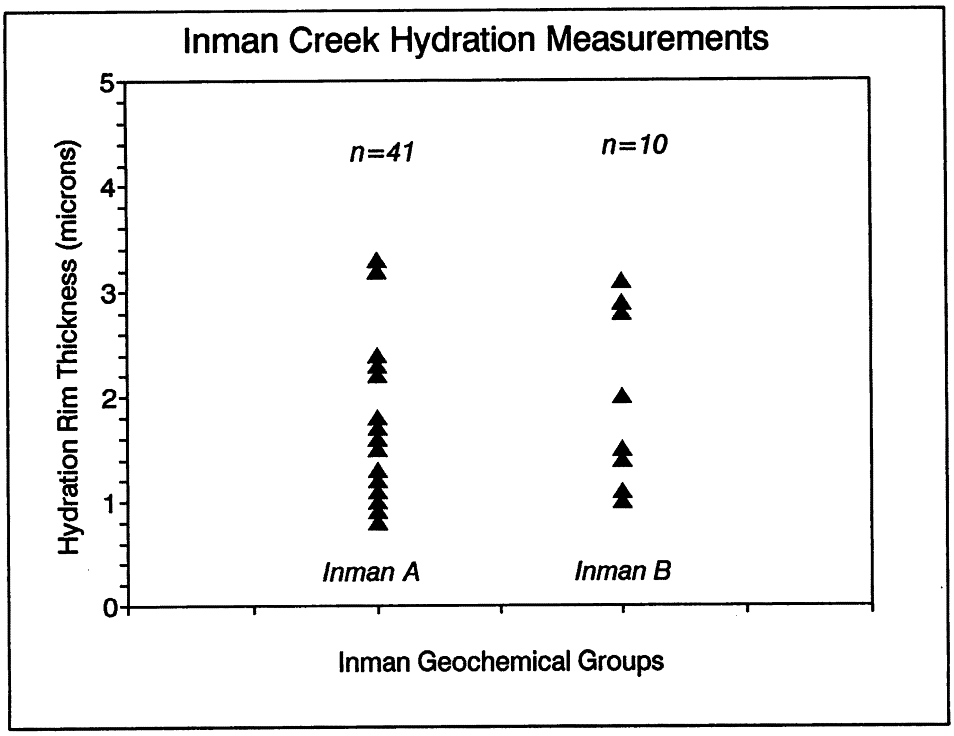


Figure 20: Range of hydration rim measurements for obsidian artifacts correlated with the Inman Creek source.

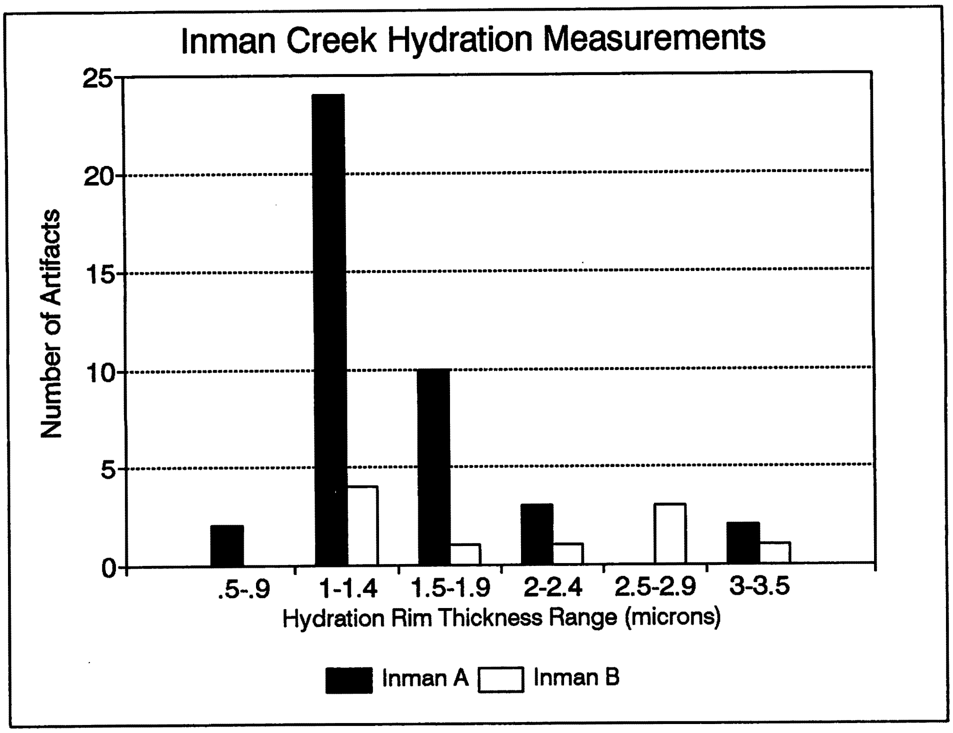


Figure 21. Frequency of different ranges of hydration rim measurements from Inman Creek obsidian artifacts.

Hydration rim measurements of Inman Creek artifacts range from less than one micron to slightly over three microns. The ranges of measurements for both the Inman A and B groups is similar and it is likely that both groups were utilized for approximately the same period of time (provided that their hydration rates were similar). At the present time, radiocarbon dates with which to calibrate rim measurements are not available, and it is not possible to estimate the calendar span of time that these measurements represent. Though the sample size of measured artifacts is still small, the predominance of rim measurements in the 1.0 to 1.4 micron range (figure 21) suggests that the peak of Inman Creek source utilization may have come fairly late in time. Whether this is a function of increased prehistoric use of the glass or the source areas or other sociocultural variables such as increasing population size is not known.

VII. CONCLUSIONS AND RECOMMENDATIONS FOR FURTHER RESEARCH

Conclusions

1. Contrary to a long-held archaeological assumption, there were several geochemically-distinct indigenous sources of obsidian available to the prehistoric inhabitants of Western Oregon.

2. An important source of natural glass, the Inman Creek obsidian, was widely distributed by fluvial and perhaps other processes and was available over a large area of Western Oregon. The best geologic exposure of the obsidian (the type locality) is in the Inman Creek area of the southwestern Willamette Valley.

3. The Inman Creek source is composed of two geochemically-distinct subgroups, here named the Inman A and Inman B sources. These two groups are easily distinguished using trace element abundances determined by XRF and INAA techniques.

4. Obsidian correlated to the Inman Creek sources using geochemical, statistical, and graphical methods has been identifed not only in the Fern Ridge area, but in the gravels of the Siuslaw River at the Oregon central Coast, the gravels of the Willamette River in the Willamette Valley, and the upper Willamette River drainage of the Western Cascades.

5. The primary source of the Inman Creek obsidian has not been positively identified, though initial geochemical INAA data point to the Salt Creek obsidian flow as the most likely source. Earlier speculations about a central Coast Range primary source were probably in error, though the depositional environment of the Inman Creek obsidian remains enigmatic.

6. Cluster analysis of Rb, Sr, and Zr abundances for major western Oregon obsidian sources clearly differentiates among the sources and suggests that this method will be effective in the future classification of samples of unknown provenience.

7. Early geochemical studies by Sappington that identified Tucker Hill obsidian from Eastern Oregon in Western Oregon archaeological assemblages were in error. The Tucker Hill source was identified due to the omission of the Inman sources from the source universe considered (and possibly because of similarities in trace element composition).

8. The limited obsidian characterization studies in Western Oregon to date (limited both in number of sites and number of samples) indicate that the Inman Creek source groups were being utilized by the aboriginal population of Western Oregon. These sources were probably extensively used by Willamette Valley and central Western Cascades inhabitants as well as by the aboriginal population along the central Oregon Coast. Dependence on Inman Creeks glass appears to decrease rapidly in the northwestern Cascades and in Southern Oregon as competing sources of obsidian become more accessible.

9. Obsidian recovered from the Vine Rockshelter in the central Western Cascades and attributed to an as yet unlocated local obsidian source (the Staley Creek source), is virtually geochemically indistinguishable from the Inman A source. Preliminary geochemical evidence suggests that the Staley Creek and Salt Creek obsidian sources may be one and the same.

10. The percentage of obsidian debitage recovered from excavated Western Oregon archaeological sites appears to be an archaeological attribute sensitive enough to independently confirm the prehistoric utilization of the Inman Creek source. Obsidian debitage percentages vary in relation to archaeological site distance from obsidian sources; preliminary data from Western Oregon archaeological sites indicate the presence of foci coincident with sources in the Fern Ridge area, the Obsidian Cliffs area, and the High Cascades immediately to the south of Obsidian Cliffs.

11. The obsidian source utilization percentage also holds some potential as an indicator of site utilization, exhibiting many of the same characteristics as the obsidian debitage percentage.

12. Regional patterns of raw material usage, as reflected by indices such as the obsidian debitage ratio, can be used to predict the existence and approximate geographic location of unrecognized natural sources.

13. Three-dimensional graphical methods of data analysis such as trend surface maps may be useful in revealing the directionality of archaeological phenomenon and in reconstructing prehistoric behavior. The obsidian debitage percentage was useful in identifying the Inman Creek obsidian source location from archaeological data alone and in confirming source use. The source utilization percentage showed promise as an aid in identifying the directionality of Inman Creek obsidian utilization in prehistoric times.

14. The closest source of a lithic material, all things being equal, is the one that gets used the most.

15. Large quantities of artifactual obsidian from Western Oregon sites no longer can be counted on to indicate the existence of exchange or long-distance procurement systems. Clues will now have to come from characterized obsidian or the presence of other exotic materials in archaeological collections.

16. Obsidian characterization studies should prove to be a particularly valuable research tool in the further investigation of Western Oregon prehistory. The relatively low number of obsidian sources in this region, if combined with adequate geologic work and adequate archaeological data could be combined to make Western Oregon a cultural laboratory in which lithic production and procurement-related behavioral hypotheses could be tested and refined.

Recommendations for Further Research

The real challenge of obsidian characterization studies in Western Oregon will ultimately lie not in the determination of the geologic sources of artifacts but in the reconstruction of the cultural processes that were responsible for the spatial distribution of these artifacts. The latter information is, after all, what we are really after when we try to identify the geologic sources of obsidian artifacts. To that end, a number of recommendations are offered:

1. Thorough geologic, geochemical, and geomorphic studies should be made of all Western Oregon obsidian sources with special attention being focused on the distribution of glass in secondary sources.

2. Statistical methods of correlation such as cluster analysis should be used only with caution and should be empirically evaluated with known obsidian sources prior to archaeological applications.

3. Archaeological sites should be excavated using methods that allow for easy comparison with other sites. The use of mixed screen sizes during site excavation, for example, introduces potentially significant problems of comparability of debitage data.

4. Debitage analysis is a valuable analytical aid in lithic procurement studies and should be seriously considered in any archaeological investigation. Flake types and abundances may be useful not only in reconstructing the lithic technology used at a site but may also be used in the identification of unidentified sources of raw materials. Sites consisting of only waste flakes (the venerable lithic scatter) must be considered as potentially valuable archaeological resources.

5. The material type for each individual artifact (except for debitage) should be recorded. Material type categories, however detailed or generalized they might be, should be reducible to commonly used categories for the purpose of comparison.

6. Comparable and conventional units should be used when obsidian characterization results are reported. Trace element abundances, for example, should be reported only in parts per million and should be accompanied by the analytical uncertainty of the analysis. Interlaboratory calibration of trace element results would also enhance the comparability of analytical results.

7. The provenience of characterized obsidian samples, a detail sometimes omitted, must be reported so that diachronic variations in utilization patterns can be identified. Any associations of characterized materials with chronologic data provided by radiocarbon dates, volcanic tephra, or temporally-sensitive artifact types should be clearly reported.

8. The type or category of characterized artifact should always be reported. Source utilization differences have been noted between different artifact classes.

9. A sampling strategy should be used when selecting artifacts for characterization purposes. A simple random sample of an entire archeological collection may not adequately reflect the sources utilized because of differential source use observed for certain artifact classes. Different categories of artifacts may reflect different procurement systems (e.g. local or long-distance) and should be selected for characterization with specific objectives in mind.

10. Additional geochemical studies of the two Inman chemical groups and the Salt Creek source are recommended for resolution of the Inman Creek primary source problem.

11. The use of quantitative measures or indices such as the obsidian debitage ratio used in this study deserves further attention. Measures such as the exchange index, the debitage index, the cortex index, the core index, and the obsidian density index may be useful in interpreting and reconstructing prehistoric cultural behavior (Ericson, 1984; Sidrys, 1977).

12. Graphical methods of three-dimensional data analysis have proved useful for this investigation and should be explored in future research, both in obsidian analysis and other research areas.

13. Lastly, for lithic procurement research to proceed at a significant rate in Western Oregon, characterization methods must accessible, reliable, comparable, and inexpensive. In the absence of real data, we have only theories to rely upon - it is my contention that theories should be tested, not used as interpretative devices. The trace element characterization of obsidian, while a powerful tool, is neither cheap nor simple. Alternative characterization techniques appropriate for the relatively small number of Western Oregon obsidian sources should be considered and investigated.

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APPENDICES

APPENDIX ONE

Glossary of Terms

APPENDIX 1: GLOSSARY OF TERMS

The first occurrence of a word in the text that appears in this glossary is italicized.

Acicular
Needle-like in form.
Acicular Trichite
A hairlike trichite.
Asteroidal Trichite
Spiderlike arrangements of trichites radiating from a central point.
Characterization
Identification of a specific source on the basis of a distinguishing characteristic; "fingerprinting"; see sourcing.
Cluster Analysis
Numerical taxonomic method sometimes used to correlate artifacts and sources.
Coefficient of Variation
A measure of intraunit variability of a set of data; (standard deviation/mean) x 100.
Crystallite
A broad term applied to a minute body of unknown mineralogical composition or a crystal form that does not polarize light.
Distance-Decay
Graph or regression analysis in which an archaeological attribute is considered as function of the distance from a source or site.
Glacial Erratic
Rock transported by ice.
Globulite
A microscopic spherical crystallite often found in volcanic glasses.
Holohyaline
Said of an igneous rock composed entirely of glass.
INAA
Instrumental neutron activation analysis.
Longulites
A cylindrical microlite structure formed by the coalescence of globulites.
Margarites
Bead-like string of small spherical structures or globulites often found in volcanic glasses.
Microlite
A microscopic crystal with determinable optical properties.
Phenocryst
A relatively large crystal set in a finer-grained or glassy groundmass.
Primary Obsidian Source
Source of obsidian found in the immediate vicinity of its vent.
Prismatic Microlite
Rod-shaped microlite
Secondary Obsidian Source
Source of obsidian transported from its original primary source by a variety of natural and cultural processes.

Skeletal Crystal
Microscopic outline of the framework of the incomplete development of a crystal.

Sourcing
Grammatically-poor but often used synonym for characterization.

Stereogram
Stereo pair of images; when viewed with a stereo viewer or a trained eye, the pair visually merge to create the illusion of a three-dimensional object.

Trace Element
Elements found in abundances of less that 1000 parts per million.

Trend Surface Analysis
Name used for methods of smoothing the values of some mapped surface; a generalized surface is derived that may be used to represent regional data trends.

XRF
X-ray fluorescence analysis.

APPENDIX TWO

Obsidian-Related Archaeological Site Data

APPENDIX 2: OBSIDIAN-RELATED ARCHAEOLOGICAL SITE DATA

All obsidian-related archaeological site data that were used in the construction of the distance-decay graphs and trend surface diagrams are shown in table 2-1 in this appendix. The data are also available as a Lotus 1-2-3 compatible worksheet (SITES.WKS) and can be found in the supplementary data disk in the pocket at the end of this report. All geochemical and hydration data used in this report can also be found in worksheet data files (XRF.WKS and INAA.WKS). To look at the data with a shareware spreadsheet (As-Easy-As 4.0) that has been included:

1. Insert the supplementary data disk.
2. Type GO, then <RETURN> - this will load a shell from which the files may be loaded.
3. Type 2 at the introduction screen to load the spreadsheet.
4. Press the backslash (/) key to activate the menu window.
5. Press F (for File) to bring up the File Menu.
6. Press R (for Retrieve) - use the cursor to move the highlighted cell to the name of the worksheet and press <RETURN>.

   For help while in the spreadsheet, use the F1 key. To exit the spreadsheet, press the backslash key (/), then E (for Exit), then Y (for Yes). This will return you to the shell - Esc to exit.

Archaeological Site Name: The most commonly-used name for the archaeological site, if one is in use. The USFS designation refers to unnamed U.S. Forest Service sites that have not yet been assigned a standard archaeological site number.

Site No.: The county abbreviation and the county site number. The prefix 35 (for Oregon) is assumed.

Geo Area: The physiographic province that the site is located in. CO = Coastal border; COR = Coast Range; HC = High Cascades; KL = Klamath Mountains; NEW = Newberry Volcano, Central Oregon; WV = Willamette Valley; WC = Western Cascades.

X and Y: The east-west/north-south coordinates used to locate geographic features for use with the trend surface analysis software. These values were combined with selected z-values such as obsidian debitage percentage to create the trend surfaces depicted in this report.

Total Debitage (N=): The total number of obsidian and CCS (cryptocrystalline) debitage items.

CCS Debitage (N=): The number of cryptocrystalline debitage items (primary flakes, secondary flakes, tertiary flakes, flake fragments, and angular waste) collected at the site. This total reflects combined surface and subsurface collections.

CCS Debitage Percentage (n=): The percentage of CCS items in the combined obsidian + CCS debitage collection.

Obsidian Debitage (N=): The number of obsidian debitage items (all flakes and angular waste) collected at the site. Combined surface and subsurface collections are included in the total.

Obsidian Debitage Percentage: The percentage of obsidian items in the combined obsidian + CCS debitage collection.

Inman Distance (km): The airline distance in kilometers from the designated archaeological site to the Inman Creek source located at Fern Ridge Reservoir. The source is treated as a point resource for the purposes of this measure.

Salt Creek Distance (km): The airline distance in kilometers from the designated archaeological site to the Salt Creek obsidian source. The source is treated as a point resource for this measure.

Obs. Cliffs Distance (km): The airline distance in kilometers to the Obsidian Cliffs obsidian source. The source is treated as a point resource for this measure.

References: Bibliographic references for site and obsidian-related information.

Identified Obsidian Sources: If obsidian characterization studies were carried out, the frequencies and percentages of sources that were identified are listed.

Characterization Studies (Y/N)?: Have characterization studies been undertaken at this site (yes or no).

Sample Size: The number of artifacts characterized at the archaeological site.

No. of Sources: The number of geologic obsidian sources identified in the characterized artifactual collection.

Obsidian Sources: The individual obsidian sources that were identified in the artifact collection. N = number of artifacts; % = percentage of total characterized artifacts.

BOF	Big Obsidian Flow, Newberry Caldera, Central Oregon
CM	Cougar Mountain, Fort Rock Basin, Central Oregon
DP	Devil Point, Western Cascades
FR	Fern Ridge/Inman Creek, Western Oregon
	FR-A Fern Ridge/Inman Creek "A" geochemical group
	FR-B Fern Ridge/Inman Creek "B" geochemical group
GF	Grasshopper Flat/Lost Iron Well/Red Switchback, Medicine Lake Highlands, Northern California
MB	McKay Butte, Newberry Volcano (western flanks), Central Oregon
MB/QM	McKay Butte/Newberry Volcano flanks, Central Oregon (these two sources are sometimes difficult to geochemically distinguish)
NV	Newberry Volcano, Central Oregon (excluding the geochemically distinct Big Obsidian Flow; many of the Newberry obsidian sources are geochemically similar and difficult to distinguish from one another)
OC	Obsidian Cliffs, High Cascades

QM	Quartz Mountain, Newberry Volcano (eastern flanks), Newberry Volcano
SL	Silver Lake/Sycan Marsh, South-central Oregon
SM	Spodue Mountain, South-central Oregon
UW	Upper Winberry Creek
OTH	Other obsidian source; the source was identified but was not shown in the data table.
UNK	Unknown source of obsidian; the geologic source of the characterized artifact could not be determined. As many as three different distinguishable unknown sources were found in western Oregon archaeological collections. **Please note**: the A,B, and C designations apply only to distinguishable sources **at each site**. For example, Unknown A source **is not** the same unknown source at different archaeological sites, it is only the first unknown source to be recorded at that particular site.

Characterization Methods: The analytical method used to characterize the obsidian. INAA = instrumental neutron activation analysis; XRF = X-ray fluorescence.

Lab: Laboratory/researcher that conducted characterization analysis. HU = Richard E. Hughes; SA = Richard L. Sappington; SK = Craig E. Skinner; OR = Thomas E. Origer.

1A

ARCHAEOLOGICAL SITE NAME	SITE NUMBER	GEO AREA	X	Y	DEBITAGE TOTAL N	CCS N	CCS %	OBS N	OBS %	INMAN CREEK DISTANCE (KM)	SALT CREE DISTAN (KM)
ANDERSON CREEK	LIN 123	HC	46.2	54.1	268	0	0.0	268	100.0	112	
ARMET ROCKSHELTER	- -	WC	35.7	44.4	439	17	3.9	422	96.1	66	
ARMITAGE BRIDGE	LA 354	WV	28.8	50.7	385	147	38.2	238	61.8	22	
BEAR	LA 391	WC	46.6	52.2	1041	3	0.3	1038	99.7	112	
BEAR SADDLE	LIN 301	WC	43.0	61.1	12151	1482	12.0	10669	87.8	107	1
BEE BEE	LIN 302	WV	43.2	61.0	54	1	2.0	53	98.0	108	1
BILLS CREEK	LA 519	WC	38.0	38.5	-	-	-	-	-	93	
BLITZ	LIN 147	WC	45.5	54.5	1745	14	0.8	1731	99.2	102	
BLOSSOM BAR	CU 143	KL	15.0	20.0	2255	2222	98.5	33	1.5	161	1
BREIGHTENBUSH LOWER	MA 51	WC	46.0	65.0	-	-	-	-	-	130	1
BRUNO 3	LIN 105	WC	46.0	61.7	-	-	-	-	-	121	
BUCK CREEK	LA 297	WC	38.2	39.5	4077	341	8.4	3736	91.6	91	
CANYON OWL CONFLUENCE	18-03-114	WC	39.7	55.3	475	238	50.0	237	50.0	81	
CAT SCRATCH	- -	WC	47.0	61.0	-	-	-	-	-	124	1
CHIMNEY PEAK ONE	LIN 312	WC	41.7	59.8	175	80	45.7	95	54.3	98	1
COLT	LA 599	WC	38.8	37.1	17756	8352	47.0	9404	53.0	101	
COLT TIMBER SALE GROUP	- -	WC	38.7	37.1	305	89	29.2	216	70.8	101	
CONDON BUTTE	- -	HC	48.0	52.5	-	-	-	-	100.0	120	
COUGAR RIDGE WAY TRAIL	LIN 116	WC	43.6	57.5	3483	9	0.3	3474	99.7	102	
CUPOLA	LA 390	WC	45.6	51.7	1546	2	0.1	1544	99.9	107	
CURTDAY ACORN	CU 149	KL	11.5	12.8	21416	21400	99.9	16	0.1	216	2
DALE BEAM	LA 793	WC	45.3	52.3	2554	4	0.1	2524	99.9	104	
DANE SADDLE	LIN 320	WC	44.9	56.5	-	-	-	-	-	107	
DEADHORSE ROCKSHELTER	LA 656	WC	37.2	39.3	1075	523	48.7	552	51.3	102	
DIAMOND LIL	LA 807	WC	36.6	48.8	12848	6734	52.4	6114	47.6	72	
DUSTY MINK	DS 502	EC	51.2	43.5	443	13	3.0	416	97.0	142	
ELK CREEK LAKE JA 27	JA 27A	WC	33.0	19.0	2245	2065	92.0	180	8.0	167	1
ELK CREEK LAKE JA 59	JA 59	WC	33.5	19.8	2070	1964	94.9	106	5.1	163	1
ELK CREEK LAKE JA 100	JA 100	WC	33.2	19.2	4921	4397	89.4	524	10.6	166	1
ELK SADDLE	LA 444	WC	37.4	45.4	442	29	6.6	413	93.4	73	
FALL CREEK	LA 33	WV	33.6	47.0	4621	4517	97.7	104	2.3	49	
FINLEY REFUGE 10	BE 10	WV	24.6	57.6	520	236	45.4	284	54.6	34	1
FINLEY REFUGE 37	BE 37	WV	24.5	57.3	4306	3154	73.2	1152	26.8	33	1
FINLEY REFUGE 39	BE 39	WV	24.8	57.6	700	554	80.0	146	20.0	33	1
FLANAGAN	LA 218	WV	26.0	50.5	14434	10189	58.3	4245	41.7	8	1
FOX BUG	MA 48	WC	45.2	66.6	-	-	-	-	-	130	1
GATE CREEK 1	LIN 373	WC	39.7	40.9	1605	442	27.5	1163	72.5	93	
GEERTZ	- -	WV	40.8	79.5	669	620	92.7	49	7.3	166	2
GLIDE RANGER STATION	DO 58	COR	27.5	32.9	3203	3087	96.4	116	3.6	93	
GOAT	70055	WC	45.6	52.5	401	0	0.0	501	100.0	108	
GOAT TWO	LA 837	HC	45.8	52.0	128	0	0.0	128	100.0	108	
GOOD FORTUNE POINT	LNC 55	CO	11.9	54.9	212	212	100.0	0	0.0	66	1
GOOD FORTUNE COVE	LNC 56	CO	11.8	54.9	35	35	100.0	0	0.0	66	1
GRAYLING SPRING	DS 381	EC	51.1	43.4	18282	182	1.0	18100	99.0	142	
HAGER'S GROVE 7	MA 7	WV	30.0	68.6	2138	1591	74.4	547	25.6	93	1
HAGER'S GROVE 9	MA 9	WV	30.0	68.7	3422	3129	91.4	293	8.6	94	1
HALVERSON	LA 261	WV	33.2	51.5	1095	867	79.2	228	20.8	45	
HANNAVAN CREEK	LA 647	WV	24.1	50.0	615	478	77.7	137	22.3	2	1
HATCHERY TRIBUTARY	LA 469	WC	35.3	51.3	249	195	78.0	54	22.0	55	
HORN RIDGE	LIN 252	WC	46.2	60.7	285	4	1.4	281	98.6	120	1
HORSEPASTURE CAVE	LA 39	WC	39.5	36.4	17094	5470	32.0	11624	68.0	105	
HUGH CREEK	CL 61	WC	42.5	68.5	930	428	46.0	502	54.0	127	1
HURD	LA 44	WV	28.6	51.1	6543	2610	39.9	3933	60.1	21	
INDIAN RIDGE	LA 194	WC	41.2	48.3	4048	187	4.6	3861	95.4	85	
IRIS	LA 798	HC	45.4	52.7	6	0	0.0	6	100.0	110	
KATZ ROCKSHELTER	LA 802	WC	36.3	44.2	269	75	27.9	194	72.1	70	
KIRK PARK 565	LA 565	WV	24.9	51.1	2341	690	29.5	1651	70.5	1	1
KIRK PARK 566	LA 566	WV	24.9	51.2	10387	4656	44.6	5781	55.4	1	1
KIRK PARK 567	LA 567	WV	25.0	51.1	704	154	23.0	550	77.0	1	1
KIRK PARK 568	LA 568	WV	25.0	51.2	3172	1142	36.0	2030	64.0	1	1
LAVA BUTTE	DS 33	NEW	55.5	46.0	-	-	-	-	-	160	
LITTLE OAK FLAT SITE	- -	WC	36.1	32.0	397	114	28.7	283	71.3	113	
LONE CEDAR	0761	WC	45.7	51.9	291	0	0.0	291	100.0	108	
LOONEY	DO 13	KL	15.5	26.0	422	363	86.0	59	14.0	131	1
LOST PRARIE	LIN 322	WC	44.4	56.7	-	-	-	-	-	104	
LOW BLOW	LIN 133	WC	43.0	62.3	-	-	-	-	-	109	1
LUPHER'S ROAD	LA 632	WC	37.3	45.6	82	32	39.0	50	61.0	108	
MALLARD	LA 820	HC	45.8	52.6	678	1	0.1	677	99.9	117	

Table 2-1. Obsidian and archaeological site-related data used in the distance-decay and trend su
presented in this report.

E		INMAN CREEK	SALT CREEK	OBS. CLIFFS	REFERENCES
OBS N	OBS %	DISTANCE <KM>	DISTANCE <KM>	DISTANCE <KM>	
268	100.0	112	73	15	CHURCHILL AND JENKINS, 1989A; HUGHES, 1989C; ORIGER, 1989I
422	96.1	66	40	73	WILLIG AND MUSIL, 1986
238	61.8	22	88	97	TOEPEL AND MINOR, 1983
1038	99.7	112	70	6	WINTHROP ET AL., 1987
10669	87.8	107	107	54	NILSSON, 1989; HUGHES, 1989E; ORIGER, 1989B
53	98.0	108	106	52	SPENCER, 1989B; HUGHES, 1989D; ORIGER, 1989B
-	-	93	24	84	MINOR, 1987; ROUNDS, 1986; HUGHES, 1986B
1731	99.2	102	74	23	MINOR AND TOEPEL, 1984; SAPPINGTON, 1984C
33	1.5	161	172	231	ROSS ET AL., 1982
-	-	130	128	68	ROUNDS, 1986; HUGHES, 1986B
-	-	121	12	52	ROUNDS, 1986; HUGHES, 1986B
3736	91.6	91	22	80	BAXTER, 1984
237	50.0	81	78	45	SPENCER, 1988; HUGHES, 1988B; ORIGER, 1988E
-	-	124	109	47	ROUNDS, 1986; HUGHES, 1986B
95	54.3	98	100	52	BERGLAND, 1987; JENKINS, 1988; HUGHES, 1988E; ORIGER, 1988D
9404	53.0	101	25	88	BAXTER, 1986; HUGHES, 1986A; ORIGER, 1986A
216	70.8	101	25	88	BAXTER, 1983
-	100.0	120	66	5	SKINNER, 1983
3474	99.7	102	88	37	FLENNIKEN AND OZBUN, 1988; HUGHES, 1988F; ORIGER, 1988A
1544	99.9	107	62	8	WINTHROP ET AL., 1987
16	0.1	216	228	288	NILSSON AND MANIERY, 1987; HUGHES, 1987B; ORIGER, 1987B
2524	99.9	104	64	14	SPENCER, 1989A; HUGHES, 1989H; ORIGER, 1989E
-	-	107	84	29	LINDBERG-MUIR, 1988; HUGHES, 1988C; ORIGER, 1988C
552	51.3	102	22	86	CHURCHILL, 1989; HUGHES, 1989A; ORIGER, 1989F
6114	47.6	72	35	70	FLENNIKEN ET AL., 1990A; HUGHES, 1990A; ORIGER, 1990C
416	97.0	142	46	48	MCFARLAND, 1989; HUGHES, 1989G; ORIGER, 1989G
180	8.0	167	117	183	PETTIGREW AND LEBOW, 1987; HUGHES, 1987A; ORIGER, 1987A
106	5.1	163	112	177	PETTIGREW AND LEBOW, 1987; HUGHES, 1987A; ORIGER, 1987A
524	10.6	166	115	181	PETTIGREW AND LEBOW, 1987; HUGHES, 1987A; ORIGER, 1987A
413	93.4	73	37	63	FLENNIKEN ET AL., 1989A; HUGHES, 1989I; ORIGER, 1989J
104	2.3	49	58	78	COLE, 1968
284	54.6	34	127	122	HAVERCROFT, 1987
1152	26.8	33	126	122	HAVERCROFT, 1987; SAPPINGTON, 1987
146	20.0	33	126	121	HAVERCROFT, 1987
4245	41.7	8	100	112	TOEPEL, 1985A; SAPPINGTON, 1985B
-	-	130	134	75	ROUNDS, 1986; HUGHES, 1986B
1163	72.5	93	15	70	FLENNIKEN ET AL., 1990B; HUGHES, 1990C; ORIGER, 1990B
49	7.3	166	200	145	WOODWARD, 1972
116	3.6	93	85	142	CHURCHILL AND JENKINS, 1985
501	100.0	108	65	8	WINTHROP ET AL., 1987
128	100.0	108	63	8	CHURCHILL AND JENKINS, 1989A; HUGHES, 1989C; ORIGER, 1989I
0	0.0	66	172	183	MINOR ET AL., 1985
0	0.0	66	172	183	MINOR ET AL., 1985
18100	99.0	142	45	48	MCFARLAND, 1989; HUGHES, 1989G; ORIGER, 1989G
547	25.6	93	158	125	PETTIGREW, 1980
293	8.6	94	158	125	PETTIGREW, 1980
228	20.8	45	75	75	MINOR AND TOEPEL, 1982; TOEPEL AND SAPPINGTON, 1982
137	22.3	2	105	120	CHEATHAM, 1984; CHEATHAM, 1987; CHEATHAM, 1988; SAPPINGTON, 1986A
54	22.0	55	67	65	SOUTHARD, 1987
281	98.6	120	106	46	LINDBERG-MUIR, 1983; ROUNDS, 1986; HUGHES, 1986B
11624	68.0	105	25	89	BAXTER ET AL., 1983
502	54.0	127	143	89	WINTHROP AND GRAY, 1984; SAPPINGTON, 1984D
3933	60.1	21	90	98	WHITE, 1975
3861	95.4	85	42	40	HENN, 1975
6	100.0	110	65	14	CHURCHILL AND JENKINS, 1989A; HUGHES, 1989C; ORIGER,1989I
194	72.1	70	38	71	CHURCHILL AND JENKINS, 1989B; HUGHES, 1989B; ORIGER, 1989G
1651	70.5	1	108	117	CHEATHAM, 1984; CHEATHAM, 1987; CHEATHAM, 1988; SAPPINGTON, 1984B
5781	55.4	1	108	117	CHEATHAM, 1984; CHEATHAM, 1987; CHEATHAM, 1988; SAPPINGTON, 1984B
550	77.0	1	108	117	CHEATHAM, 1984; CHEATHAM, 1987; CHEATHAM, 1988; SAPPINGTON, 1984B
2030	64.0	1	108	117	CHEATHAM, 1984; CHEATHAM, 1987; CHEATHAM, 1988; SAPPINGTON, 1984B
-	-	160	72	48	SCOTT ET AL., 1986
283	71.3	113	52	117	BERRYMAN, 1987; HUGHES, 1987C
291	100.0	108	63	8	WINTHROP ET AL., 1987
59	14.0	131	148	207	PETTIGREW, 1980
-	-	104	85	31	LINDBERG-MUIR, 1983; ROUNDS, 1986; HUGHES, 1986B
-	-	109	113	60	ROUNDS, 1986; HUGHES, 1986B
50	61.0	108	38	63	FLENNIKEN ET AL., 1989A; HUGHES, 1989C; ORIGER, 1989J
677	99.9	117	65	12	CHURCHILL AND JENKINS, 1989A; HUGHES, 1989C: ORIGER, 1989I

distance-decay and trend surface analyses

2A

ARCHAEOLOGICAL SITE NAME	SITE NUMBER	GEO AREA	X	Y	DEBITAGE TOTAL N	CCS N	CCS %	OBS N	OBS %	INMAN CREEK DISTANCE <KM>
MARIEL	CU 84	KL	14.5	20.5	12548	9175	73.1	3373	26.9	161
MARTHALLER	JO 16	KL	20.9	13.8	16379	15405	94.1	970	5.9	188
MARTIN CREEK	DO 147	WC	21.2	38.8	266	246	92.5	20	7.5	64
MCBEE RIDGE	- 0166	WC	44.2	46.0	24	2	8.3	22	91.7	103
MEADOWS CREEK	- -	WC	46.0	59.5	-	-	-	-	-	117
MERRIL-EXTON	LA 814	WC	37.5	45.3	88	41	46.6	47	53.4	72
MONUMENT PEAK	LIN 342	WC	40.7	62.6	304	162	53.3	142	47	101
MOOSE MOLALLA ONE	LIN 139	WC	41.5	58.0	181	29	16.0	152	84.0	91
MOSTUL VILLAGE	- -	WV	37.5	79.0	-	-	-	-	3.0	155
NARROWS	DO 153	WC	28.8	33.3	6359	5593	88.0	766	12.0	92
NEPTUNE	LA 3	CO	12.0	53.8	-	-	-	-	-	65
NETART'S SPIT	TI 1	CO	15.3	79.9	-	-	-	-	-	160
NORTH PARK HEADQUARTERS	LIN 253	WC	44.0	58.5	456	291	63.8	165	36.2	107
NORTH PARK SALVAGE	LIN 186	WC	45.3	58.5	3794	46	1.2	3748	98.8	113
OAKRIDGE SPUR ROAD	LA 633	WC	37.6	45.1	216	59	27.3	157	72.7	73
OCEAN BEACH WAYSIDE	TI 47	CO	15.2	81.0	1453	1452	99.9	1	0.1	165
OLSEN 1 ROCKSHELTER	LA 190	WC	35.7	44.7	143	99	69.2	44	30.8	66
OLSEN 2 ROCKSHELTER	LA 191	WC	35.6	44.8	66	21	31.8	45	68.2	66
PACKARD CREEK	LA 475	WC	38.2	40.4	-	-	-	-	-	87
PEPPER ROCKSHELTER	LA 801	WC	39.8	41.8	7535	1966	26.1	5569	73.9	91
PERKINS PENINSULA	LA 282	WV	24.9	49.5	2441	1462	59.9	979	40.1	7
PHILPOTT	CS 1	CO	6.6	30.1	3765	3761	99.9	4	0.1	94
POWERFUL 1	DO 187	WC	36.5	32.3	1320	655	49.6	665	50.4	113
POWERFUL 2	DO 227	WC	36.6	32.0	2537	1996	78.7	541	21.3	114
PUMP CHANCE	LIN 431	HC	46.1	52.8	6392	1	.0	6391	100.0	110
QUARTZVILLE MCQUADE	- -	WC	41.2	61.5	233	58	24.9	175	75.1	97
RIPPLE	CL 55	WC	45.0	68.5	3571	3455	96.8	116	3.2	146
ROADSIDE	- 0751	WC	46.4	52.0	148	0	0.0	148	100.0	111
SADDLE	LA 529	WC	38.8	37.4	14377	8196	57.0	6181	43.0	100
SADDLE QUARRY	MA 68	WC	45.2	66.4	94	22	23.4	72	76.6	130
SALTSGAVER	JA 21	KL	28.6	12.3	857	829	96.7	28	3.3	195
SANBURG	LA 27	WC	45.0	53.5	131	3	2.3	128	97.7	105
SARDINE CONFLUENCE	LA 539	WC	39.4	45.5	160	6	3.8	154	96.2	80
SCARRED DOE	- -	WC	43.6	60.3	-	-	-	-	-	108
SEAL ROCK	LNC 14	CO	12.7	59.8	-	-	-	-	-	183
SIMONS	LA 116	WV	30.0	46.5	1785	1579	88.5	206	11.5	36
SIUSLAW FALLS	LA 173	CR	22.5	40.5	463	411	88.8	52	11.2	29
SODA FORK I	LIN 230	WC	41.5	57.0	-	-	21.0	-	79.0	92
SOUTH UMPQUA FALLS	DO 205	WC	33.8	27.2	34736	29438	84.7	5298	15.3	130
SQUAW MT. NORTH III	18-03-217	WC	43.0	55.3	813	0	0.0	813	100.0	108
STANDLEY	DO 182	KL	17.3	27.0	149	142	86.0	7	4.7	126
STRAIGHT CREEK	LIN 201	WC	44.5	60.4	-	-	-	-	-	111
SUNTU	LIN 195	WC	45.5	55.5	31	0	0.0	31	100.0	110
SWAMP PEAK WAY TRAIL 1	LA 295	WC	41.6	60.2	877	11	1.3	866	98.7	105
TIDBITS	LIN 100	WC	40.8	53.5	657	1	0.1	656	99.9	83
TIRE CREEK	LA 320	WC	36.5	49.0	240	114	47.5	126	52.5	70
TLEGETLINTEN	CU 59	KL	11.5	17.7	24698	19850	80.4	4848	19.6	184
TOMBSTONE SUMMIT	LIN 341	WC	44.0	56.5	-	-	-	-	-	103
TULE LAKE	- -	WC	44.5	60.0	-	-	-	-	-	111
UMPQUA/EDEN	DO 83	CO	10.8	42.2	819	512	62.5	307	37.5	31
UPPER SIMMONDS CREEK	LA 744	WC	39.5	52.4	529	49	9.3	480	90.7	77
VINE ROCKSHELTER	LA 304	WC	38.9	36.4	8853	1248	14.1	7605	85.9	103
WAREHOUSE	LA 822	WC	40.9	51.5	2676	42	1.6	2634	98.4	83
WEST FRENCH	MA 62	WC	41.8	64.8	-	-	-	-	-	113
WHITE CLIFFS RS	- -	WC	40.2	43.0	310	41	13.3	269	86.7	89
WHITEWATER BEND	- -	WC	46.1	62.7	-	-	-	-	-	124
YAQUINA HEAD	LNC 62	CO	13.2	63.6	1586	1569	98.9	17	1.1	78
YUKWAH	LIN 118	WC	39.5	56.8	786	436	55.5	350	44.5	81
USFS 40087	- -	WC	-	-	-	-	-	-	-	-
USFS 40103	- -	WC	46.2	58.9	-	-	-	-	-	116
35 DO 36	DO 36	WC	28.6	24.9	5252	5137	97.8	113	2.2	133
35 DO 37	DO 37	WC	29.7	24.7	56	51	91.1	5	8.9	135
35 DO 390	DO 390	WC	30.7	23.2	228	223	97.8	5	2.2	143
35 DO 396	DO 396	WC	30.6	23.2	543	515	94.8	28	5.2	143
35 JA 85	JA 85	KL	29.7	12.2	1056	1043	98.8	13	1.2	172
35 JA 184	JA 184	WC	31.6	18.2	28	26	92.9	2	7.1	170
35 JA 185	JA 185	WC	31.6	17.6	2554	2466	96.6	88	3.4	172
35 LA 325	LA 325	WC	41.8	51.4	-	-	-	-	-	87
35 LA 857	LA 857	WC	41.9	51.2	404	1	0.2	403	99.8	88

Table 2-1 (continued). Obsidian and archaeological site-related data.

E		INMAN CREEK DISTANCE (KM)	SALT CREEK DISTANCE (KM)	OBS. CLIFFS DISTANCE (KM)	REFERENCES
OBS N	OBS %				
3373	26.9	161	172	231	SCHREINDORFER, 1985
970	5.9	188	171	236	STEELE, 1984
20	7.5	64	108	151	O'NEILL, 1989
22	91.7	103	30	35	WINTHROP ET AL., 1987
-	-	117	100	42	ROUNDS, 1986; HUGHES, 1986B
47	53.4	72	37	63	FLENNIKEN ET AL., 1989A; HUGHES, 1989C; ORIGER, 1989J
142	47	101	103	66	BERGLAND, 1987; LINDBERG-MUIR, 1988; HUGHES, 1988C; ORIGER, 1988C
152	84.0	91	90	47	WINTHROP AND GRAY, 1985
-	3.0	155	198	147	WOODWARD, 1974
766	12.0	92	77	135	O'NEILL, 1989
-	-	65	170	183	UNPUBLISHED RESEARCH (SKINNER); BARNER, 1981; ZONTEK, 1983
-	-	160	244	218	NEWMAN, 1959; SKINNER, 1987B
165	36.2	107	94	40	JENKINS AND CHURCHILL, 1987
3748	98.8	113	65	37	JENKINS AND CHURCHILL, 1987; HUGHES, 1988D; HUGHES, 1988E
157	72.7	73	36	63	FLENNIKEN ET AL., 1989A; HUGHES, 1989C; ORIGER, 1989J
1	0.1	165	222	248	ZONTEK, 1978
44	30.8	66	42	73	CHURCHILL, 1989; HUGHES, 1989A; ORIGER, 1989F
45	68.2	66	42	73	CHURCHILL, 1989; HUGHES, 1989A; ORIGER, 1989F
-	-	87	22	81	MINOR, 1987; ROUNDS, 1986; HUGHES, 1986B
5569	73.9	91	16	65	CHURCHILL AND JENKINS, 1989B; HUGHES, 1989B; ORIGER, 1989G
979	40.1	7	102	118	CHEATHAM, 1984; CHEATHAM, 1987; CHEATHAM, 1988; SAPPINGTON, 1986A
4	0.1	94	188	236	DRAPER, 1980; DRAPER, 1982
665	50.4	113	50	114	WINTHROP AND GRAY, 1987
541	21.3	114	50	115	WINTHROP AND GRAY, 1987
6391	100.0	110	67	11	CHURCHILL AND JENKINS, 1989A; HUGHES, 1989C; ORIGER, 1989I
175	75.1	97	103	57	SPENCER, 1987A
116	3.2	146	160	100	LEBOW, 1985; SAPPINGTON, 1985C
148	100.0	111	65	6	WINTHROP ET AL., 1987
6181	43.0	100	23	87	BAXTER, 1986; HUGHES, 1986A
72	76.6	130	133	75	JENKINS, 1988; HUGHES, 1988D; ORIGER, 1988B
28	3.3	195	157	223	PROUTY, 1988; HUGHES, 1988A
128	97.7	105	70	17	WINTHROP ET AL., 1987
154	96.2	80	32	55	CONNOLLY AND BAXTER, 1983
-	-	108	103	49	ROUNDS, 1986; HUGHES, 1986B
-	-	183	182	73	UNPUBLISHED RESEARCH (SKINNER); CLARK, 1988
206	11.5	36	72	95	PETTIGREW, 1975
52	11.2	29	105	133	PETTIGREW, 1975
-	79.0	92	86	43	LINDBERG-MUIR, 1983; ROUNDS, 1986; HUGHES, 1986B
5298	15.3	130	78	144	MINOR, 1987
813	100.0	108	77	32	SPENCER, 1988; HUGHES, 1988B; ORIGER, 1988E
7	4.7	126	142	198	CONNOLLY, 1986
-	-	111	104	47	ROUNDS, 1986; HUGHES, 1986B
31	100.0	110	80	22	WINTHROP ET AL., 1987
866	98.7	105	102	50	FLENNIKEN ET AL., 1990C; HUGHES, 1990B; ORIGER, 1990A
656	99.9	83	69	38	MINOR AND TOEPEL, 1982
126	52.5	70	37	72	FLENNIKEN ET AL., 1989A; HUGHES, 1989C; ORIGER, 1989J
4848	19.6	184	196	256	TISDALE, 1987
-	-	103	83	32	LINDBERG-MUIR, 1983; ROUNDS, 1986; HUGHES, 1986B
-	-	111	101	45	ROUNDS, 1986; HUGHES, 1986B
307	37.5	31	161	195	SKINNER, 1987A
480	90.7	77	65	43	WINTHROP ET AL., 1987
7605	85.9	103	26	90	BAXTER AND CONNOLLY, 1985
2634	98.4	83	60	37	FLENNIKEN ET AL., 1989B; HUGHES, 1989F; ORIGER, 1989C
-	-	113	126	73	ROUNDS, 1986; HUGHES, 1986B
269	86.7	89	19	60	WILLIG AND MUSIL, 1986
-	-	124	115	55	ROUNDS, 1986; HUGHES, 1986B
17	1.1	78	182	183	MINOR ET AL., 1987
350	44.5	81	86	51	SPENCER, 1987A; LINDBERG-MUIR, 1988; HUGHES, 1988C; ORIGER, 1988C
-	-	-	-	-	ROUNDS, 1986; HUGHES, 1986B
-	-	116	95	35	ROUNDS, 1986; HUGHES, 1986B
113	2.2	133	102	168	BAXTER AND MINOR, 1987
5	8.9	135	105	166	BAXTER AND MINOR, 1987
5	2.2	143	104	169	BAXTER AND MINOR, 1987
28	5.2	143	104	169	BAXTER AND MINOR, 1987
13	1.2	172	155	221	LEBOW, 1983
2	7.1	170	124	190	BAXTER AND MINOR, 1987
88	3.4	172	126	192	BAXTER AND MINOR, 1987
-	-	87	58	32	WINTHROP AND GRAY, 1989; ORIGER, 1989H
403	99.8	88	57	32	WINTHROP AND GRAY, 1989; ORIGER, 1989H

ARCHAEOLOGICAL SITE NAME	CHAR. STUDIES? (Y/N)	SAMPLE SIZE	NO. OF SOURCES	BOF N	%	CM N	%	DP N	%	FR N	%	FR-A N	%	FR-B N	%	GF N	%
ANDERSON CREEK	Y	11	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ARMET ROCKSHELTER	N	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ARMITAGE BRIDGE	N	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BEAR	N	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BEAR SADDLE	Y	33	3	0	0	0	0	14	42	0	0	0	0	0	0	0	0
BEE BEE	Y	10	2	0	0	0	0	3	30	0	0	0	0	0	0	0	0
BILLS CREEK	Y	5	2	0	0	0	0	0	0	5	100	4	80	1	20	0	0
BLITZ	Y	30	-	0	0	0	0	0	0	10	33	10	33	0	0	0	0
BLOSSOM BAR	N	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BREIGHTENBUSH LOWER	Y	1	1	0	0	0	0	1	100	0	0	0	0	0	0	0	0
BRUNO 3	Y	4	2	0	0	0	0	2	50	0	0	0	0	0	0	0	0
BUCK CREEK	N	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CANYON OWL CONFLUENCE	Y	10	2	0	0	0	0	1	10	0	0	0	0	0	0	0	0
CAT SCRATCH	Y	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CHIMNEY PEAK ONE	Y	20	2	0	0	0	0	9	45	0	0	0	0	0	0	0	0
COLT	Y	20	7	1	5	0	0	0	0	4	20	4	20	0	0	0	0
COLT TIMBER SALE GROUP	N	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CONDON BUTTE	Y	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
COUGAR RIDGE WAY TRAIL	Y	20	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CUPOLA	N	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CURTDAY ACORN	Y	6	3	0	0	0	0	0	0	0	0	0	0	0	0	4	67
DALE BEAM	Y	10	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DANE SADDLE	Y	12	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
DEADHORSE ROCKSHELTER	Y	26	9	0	0	1	4	0	0	9	35	8	31	1	0	0	0
DIAMOND LIL	Y	65	8	0	0	0	0	0	0	14	22	14	22	0	0	0	0
DUSTY MINK	Y	15	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ELK CREEK LAKE JA 27	Y	64	8	0	0	0	0	0	0	0	0	0	0	0	0	13	20
ELK CREEK LAKE JA 59	Y	42	3	0	0	0	0	0	0	0	0	0	0	0	0	3	7
ELK CREEK LAKE JA 100	Y	37	3	0	0	0	0	0	0	0	0	0	0	0	0	9	24
ELK SADDLE	N	10	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
FALL CREEK	N	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
FINLEY REFUGE 10	N	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
FINLEY REFUGE 37	Y	5	2	0	0	0	0	0	0	3	60	-	-	-	-	0	0
FINLEY REFUGE 39	N	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
FLANAGAN	Y	60	-	0	0	0	0	0	0	33	55	-	-	-	-	0	0
FOX BUG	Y	2	2	0	0	0	0	1	50	0	0	0	0	0	0	0	0
GATE CREEK 1	Y	30	7	0	0	1	3	0	0	7	23	7	23	0	0	0	0
GEERTZ	N	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
GLIDE RANGER STATION	N	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
GOAT	N	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
GOAT TWO	Y	10	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
GOOD FORTUNE POINT	N	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
GOOD FORTUNE COVE	N	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
GRAYLING SPRING	Y	15	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
HAGER'S GROVE 7	N	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HAGER'S GROVE 9	N	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HALVERSON	Y	98	-	0	0	0	0	0	0	52	53	-	-	-	-	0	0
HANNAVAN CREEK	Y	11	1	0	0	0	0	0	0	11	100	-	-	-	-	0	0
HATCHERY TRIBUTARY	N	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HORN RIDGE	Y	3	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
HORSEPASTURE CAVE	N	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
HUGH CREEK	Y	10	1	0	0	0	0	0	0	10	100	-	-	-	-	0	0
HURD	N	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
INDIAN RIDGE	N	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
IRIS	Y	6	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
KATZ ROCKSHELTER	Y	10	2	0	0	0	0	0	0	10	100	5	50	5	50	0	0
KIRK PARK 565	Y	15	1	0	0	0	0	0	0	15	100	-	-	-	-	0	0
KIRK PARK 566	Y	15	1	0	0	0	0	0	0	15	100	-	-	-	-	0	0
KIRK PARK 567	Y	15	1	0	0	0	0	0	0	15	100	-	-	-	-	0	0
KIRK PARK 568	Y	15	1	0	0	0	0	0	0	15	100	-	-	-	-	0	0
LAVA BUTTE	Y	42	7	0	0	1	2	0	0	0	0	0	0	0	0	0	0
LITTLE OAK FLAT SITE	Y	9	4	0	0	1	11	0	0	0	0	0	0	0	0	0	0
LONE CEDAR	N	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
LOONEY	N	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
LOST PRARIE	Y	18	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LOW BLOW	Y	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LUPHER'S ROAD	Y	10	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MALLARD	Y	14	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 2-1 (continued). Obsidian and archaeological site-related data.

	MB		MB/QM		NV		OC		QM		SL		SM		UW		OTH		UNK1		UNK2		UNK3		CHAR.	
%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	METHOD	LAB
0	0	0	0	0	0	0	11	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	XRF	HU
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
0	0	0	0	0	1	3	17	52	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	XRF	HU
0	0	0	0	0	0	0	7	70	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	XRF	HU
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	XRF	HU
0	0	0	0	0	0	0	8	27	0	0	0	0	0	0	0	0	12	40	0	0	0	0	0	0	XRF	SA
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	XRF	HU
0	0	0	0	0	0	0	2	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	XRF	HU
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
0	0	0	0	0	0	0	9	90	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	XRF	HU
0	0	0	0	0	0	0	1	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	XRF	HU
0	0	0	0	0	0	0	11	55	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	XRF	HU
0	0	0	5	25	2	10	2	10	0	0	0	0	0	0	0	0	0	0	5	25	1	5	0	0	XRF	HU
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
0	0	0	0	0	0	0	1	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	XRF	SK
0	0	0	0	0	0	0	20	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	XRF	HU
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
7	0	0	0	0	0	0	0	0	0	0	0	0	1	17	0	0	0	0	1	17	0	0	0	0	XRF	HU
0	0	0	0	0	1	10	9	90	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	XRF	HU
0	0	0	0	0	0	0	12	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	XRF	HU
0	1	4	0	0	3	12	3	12	0	0	8	31	1	4	0	0	0	0	0	0	0	0	0	0	XRF	HU
0	3	5	0	0	9	14	26	40	0	0	10	15	1	2	1	2	0	0	1	2	0	0	0	0	XRF	HU
0	0	0	2	13	9	60	2	13	0	0	1	7	0	0	0	0	0	0	1	7	0	0	0	0	XRF	HU
0	0	0	0	0	0	0	0	0	0	0	33	52	13	20	0	0	3	5	1	2	1	2	0	0	XRF	HU
7	0	0	0	0	0	0	0	0	0	0	13	31	26	62	0	0	0	0	0	0	0	0	0	0	XRF	HU
4	0	0	0	0	0	0	0	0	0	0	14	38	14	38	0	0	0	0	0	0	0	0	0	0	XRF	HU
0	0	0	0	0	0	0	10	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	XRF	HU
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
0	0	0	0	0	0	0	2	40	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	XRF	SA
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
0	0	0	0	0	0	0	15	23	0	0	0	0	0	0	0	0	6	10	6	10	0	0	0	0	XRF	SA
0	0	0	0	0	0	0	1	50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	XRF	HU
0	1	3	0	0	3	10	2	7	0	0	7	23	5	17	0	0	0	0	2	5	1	3	1	3	XRF	HU
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
0	0	0	0	0	0	0	10	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	XRF	HU
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
0	0	0	1	7	13	87	0	0	0	0	0	0	0	0	0	0	0	0	1	7	0	0	0	0	XRF	HU
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
0	0	0	0	0	0	0	36	37	0	0	0	0	0	0	0	0	0	0	10	10	0	0	0	0	XRF	SA
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	XRF	SA
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
0	0	0	0	0	0	0	3	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	XRF	HU
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	XRF	SA
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
0	0	0	0	0	0	0	6	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	XRF	HU
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	XRF	HU
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	XRF	SA
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	XRF	SA
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	XRF	SA
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	XRF	SA
0	1	2	0	0	32	76	1	2	4	10	2	5	0	0	0	0	0	0	1	2	0	0	0	0	XRF	HU
0	1	11	0	0	2	22	0	0	0	0	5	55	0	0	0	0	0	0	0	0	0	0	0	0	XRF	HU
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
0	0	0	0	0	0	0	18	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	XRF	HU
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	100	0	0	0	0	XRF	HU
0	0	0	0	0	0	0	6	60	0	0	4	40	0	0	0	0	0	0	0	0	0	0	0	0	XRF	HU
0	0	0	0	0	0	0	14	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	XRF	HU

ARCHAEOLOGICAL SITE NAME	CHAR. STUDIES? (Y/N)	SAMPLE SIZE	NO. OF SOURCES	BOF N	%	CM N	%	DP N	%	FR N	%	FR-A N	%	FR-B N	%	GF N
MARIEL	N	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MARTHALLER	N	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MARTIN CREEK	N	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MCBEE RIDGE	N	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MEADOWS CREEK	Y	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0
MERRIL-EXTON	Y	10	4	0	0	0	0	0	0	1	10	1	10	0	0	0
MONUMENT PEAK	Y	10	3	0	0	0	0	3	30	0	0	0	0	0	0	0
MOOSE MOLALLA ONE	N	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
MOSTUL VILLAGE	N	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NARROWS	N	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NEPTUNE	Y	2	1	0	0	0	0	0	0	2	100	2	100	0	0	0
NETART'S SPIT	Y	1	1	0	0	0	0	0	0	1	100	1	100	0	0	0
NORTH PARK HEADQUARTERS	N	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
NORTH PARK SALVAGE	Y	12	1	0	0	0	0	0	0	0	0	0	0	0	0	0
OAKRIDGE SPUR ROAD	Y	10	3	0	0	0	0	0	0	0	0	0	0	0	0	0
OCEAN BEACH WAYSIDE	N	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
OLSEN 1 ROCKSHELTER	Y	10	3	0	0	0	0	0	0	8	80	6	60	2	20	0
OLSEN 2 ROCKSHELTER	Y	10	2	0	0	0	0	0	0	0	0	0	0	0	0	0
PACKARD CREEK	Y	6	3	0	0	0	0	0	0	5	83	1	17	4	67	0
PEPPER ROCKSHELTER	N	10	5	0	0	0	0	0	0	4	40	3	30	1	10	0
PERKINS PENINSULA	Y	19	1	0	0	0	0	0	0	19	100	-	-	-	-	0
PHILPOTT	N	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
POWERFUL 1	N	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
POWERFUL 2	N	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PUMP CHANCE	Y	24	1	0	0	0	0	0	0	0	0	0	0	0	0	0
QUARTZVILLE MCQUADE	N	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
RIPPLE	Y	10	1	0	0	0	0	0	0	10	100	-	-	-	-	0
ROADSIDE	N	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SADDLE	Y	20	6	0	0	0	0	0	0	7	35	6	30	1	5	0
SADDLE QUARRY	Y	10	4	0	0	0	0	0	0	1	10	1	10	0	0	0
SALTSGAVER	Y	23	5	0	0	0	0	0	0	0	0	0	0	0	0	11
SANBURG	N	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SARDINE CONFLUENCE	N	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SCARRED DOE	Y	5	2	0	0	0	0	2	40	0	0	0	0	0	0	0
SEAL ROCK	Y	2	2	0	0	0	0	0	0	2	100	2	100	0	0	0
SIMONS	N	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SIUSLAW FALLS	N	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SODA FORK I	Y	10	1	0	0	0	0	0	0	0	0	0	0	0	0	0
SOUTH UMPQUA FALLS	N	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SQUAW MT. NORTH III	Y	10	2	0	0	0	0	0	0	0	0	0	0	0	0	0
STANDLEY	N	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
STRAIGHT CREEK	Y	3	2	0	0	0	0	1	33	0	0	0	0	0	0	0
SUNTU	N	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SWAMP PEAK WAY TRAIL I	Y	15	2	0	0	0	0	12	80	0	0	0	0	0	0	0
TIDBITS	N	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TIRE CREEK	Y	10	5	0	0	1	10	0	0	0	0	0	0	0	0	0
TLEGETLINTEN	N	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TOMBSTONE SUMMIT	Y	10	2	0	0	0	0	0	0	0	0	0	0	0	0	0
TULE LAKE	Y	2	1	0	0	0	0	2	100	0	0	0	0	0	0	0
UMPQUA/EDEN	Y	10	3	0	0	0	0	0	0	8	80	-	-	-	-	0
UPPER SIMMONDS CREEK	N	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
VINE ROCKSHELTER	Y	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
WAREHOUSE	Y	49	2	0	0	0	0	0	0	2	4	2	4	0	0	0
WEST FRENCH	Y	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0
WHITE CLIFFS RS	N	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
WHITEWATER BEND	Y	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0
YAQUINA HEAD	N	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
YUKWAH	Y	30	3	0	0	0	0	1	3	0	0	0	0	0	0	0
USFS 40087	Y	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0
USFS 40103	Y	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0
35 DO 36	N	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
35 DO 37	N	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
35 DO 390	N	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
35 DO 396	N	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
35 JA 85	N	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
35 JA 184	N	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
35 JA 185	N	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
35 LA 325	Y	15	1	0	0	0	0	0	0	0	0	0	0	0	0	0
35 LA 857	Y	36	1	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 2-1 (continued). Obsidian and archaeological site-related data.

O B S I D I A N   S O U R C E S

F		MB		MB/QM		NV		OC		QM		SL		SM		UW		OTH		UNK1		UNK2		UNK3		CHAR.	
N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%	METHOD	LAB
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
0	0	0	0	0	0	0	0	1	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	XRF	HU
0	0	0	0	0	0	0	0	5	50	0	0	3	30	0	0	0	0	0	0	1	10	0	0	0	0	XRF	HU
0	0	0	0	0	0	0	0	5	50	0	0	0	0	0	0	0	0	0	0	2	20	0	0	0	0	XRF	HU
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	INAA	SK
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	INAA	SK
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
0	0	0	0	0	0	0	0	12	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	XRF	HU
0	0	0	0	0	0	0	0	7	70	0	0	2	20	1	10	0	0	0	0	0	0	0	0	0	0	XRF	HU
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
0	0	0	0	0	0	0	0	2	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	XRF	HU
0	0	0	0	0	0	1	10	9	90	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	XRF	HU
0	0	0	0	0	0	0	0	0	0	1	17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	XRF	HU
0	0	1	10	0	0	1	10	0	0	0	0	1	10	3	30	0	0	0	0	0	0	0	0	0	0	XRF	HU
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	XRF	SA
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
0	0	0	0	0	0	0	0	24	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	XRF	HU
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	XRF	SA
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
0	0	1	5	0	0	4	20	3	15	0	0	0	0	0	0	0	0	0	0	4	20	1	5	0	0	XRF	HU
0	0	0	0	0	0	1	10	7	70	0	0	0	0	0	0	0	0	0	0	1	10	0	0	0	0	XRF	HU
1	48	0	0	0	0	0	0	0	0	0	0	2	9	8	35	0	0	2	9	0	0	0	0	0	0	XRF	HU
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
0	0	0	0	0	0	0	0	3	60	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	XRF	HU
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	INAA	SK
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
0	0	0	0	0	0	0	0	10	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	XRF	HU
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
0	0	0	0	0	0	0	0	9	90	0	0	0	0	0	0	0	0	0	0	1	10	0	0	0	0	XRF	HU
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
0	0	0	0	0	0	0	0	2	66	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	XRF	HU
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
0	0	0	0	0	0	0	0	2	13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	XRF	HU
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
0	0	0	0	0	0	2	20	5	50	0	0	1	10	1	10	0	0	0	0	0	0	0	0	0	0	XRF	HU
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
0	0	0	0	0	0	0	0	8	80	0	0	0	0	0	0	0	0	0	0	2	20	0	0	0	0	XRF	HU
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	XRF	HU
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	10	1	10	0	0	INAA	SK
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
0	0	0	0	0	0	0	0	47	69	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	XRF	HU
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	100	0	0	0	0	0	XRF	HU
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
0	0	0	0	0	0	0	0	2	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	XRF	HU
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
0	0	0	0	0	0	0	0	28	93	0	0	0	0	0	0	0	0	0	0	1	3	0	0	0	0	XRF	HU
0	0	0	0	0	0	0	0	1	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	XRF	HU
0	0	0	0	0	0	0	0	1	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	XRF	HU
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
0	0	0	0	0	0	0	0	15	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	VISUAL	OR
0	0	0	0	0	0	0	0	36	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	VISUAL	OR

APPENDIX THREE

Obsidian Sample Locations

APPENDIX 3: OBSIDIAN SAMPLE LOCATIONS

INM-1, INM-2, INM-3, INM-4, INM-5 INMAN CREEK
Location: Sec.8, T.15S., R.5W.; Lane County; Willamette Valley.
USGS Map: Veneta 7½' (1984)
Description: Obsidian nodules collected from the gravels of Inman Creek between the highway and the reservoir drawdown low-water line.

INM-7 INMAN CREEK
Location: Sec.8, T.15S., R.5W.; Lane County; Willamette Valley.
USGS Map: Veneta 7½' (1984)
Description: Collected from the Fern Ridge Reservoir beach immediately south of Inman Creek.

INM-9 INMAN CREEK
Location: Sec.19, T.15S., R.5W.; Lane County; Willamette Valley.
USGS Map: Veneta 7½' (1984)
Description: Nodule found *in situ* in the obsidian-bearing conglomerate exposed in the bank of the mouth of the first unnamed creek north of Hannavan Creek.

INM-10, INM-11 INMAN CREEK
Location: Sec.19, T.15S., R.5W.; Lane County; Willamette Valley.
USGS Map: Veneta 7½' (1984)
Description: Obsidian nodules collected from the gravels of Hannavan Creek below the reservoir high-water line.

INM-12, INM-13 INMAN CREEK
Location: Sec.8, T.15S., R.15W.; Lane County; Willamette Valley.
USGS Map: Veneta 7½' (1984)
Description: Obsidian nodules collected *in situ* from the obsidian-bearing conglomerate exposed at Inman Creek immediately east of the main highway.

OBC-1 OBSIDIAN CLIFFS
Location: Sec.10, T.16S., R.8E.; Lane County, High Cascades.
USGS Map: North Sister 7½' (1988)
Description: Grayish-black spherulitic glass collected at the northwestern base of Obsidian Cliffs near the Collier Cone flow.

OBC-2 OBSIDIAN CLIFFS
Location: Sec.15, T.16S., R.8E.; Lane County, High Cascades.
USGS Map: North Sister 7½' (1988)
Description: Collected at the northern margin of the flow at the lower plateau.

OBC-3 OBSIDIAN CLIFFS
Location: Sec.19, T.16S., R.8½E.; Lane County, High Cascades.
USGS Map: North Sister 7½' (1988)
Description: Collected directly above Obsidian Falls at the northern margin of the upper plateau.

OBC-4 OBSIDIAN CLIFFS
Location: Sec.19, T.16S., R.8½E.; Lane County, High Cascades.
USGS Map: North Sister 7½' (1988)
Description: Collected at the eastern margin of the flow near the main vent next to the Pacific Crest Trail.

OBC-8 OBSIDIAN CLIFFS
Location: Sec.19, T.16S., R.8½E.; Lane County, High Cascades.
USGS Map: North Sister 7½' (1988)
Description: Red and black obsidian collected near OBC-4.

SACR-2 SALT CREEK OBSIDIAN FLOW
Location: Sec.29, T.22S., R.5½E.; Lane County; Western Cascades.
USGS Map: Mt. David Douglas 7½' (1986)
Description: Collected from loosely-consolidated pyroclastic deposit exposed in a roadcut of Highway 58.

SACR-3 SALT CREEK OBSIDIAN FLOW
Location: Sec.25, T.22S., R.5½E.; Lane County; Western Cascades.
USGS Map: Mt. David Douglas 7½' (1986)
Description: Obsidian nodules from colluvial deposits exposed in a roadcut 50 m north of Salt Creek.

SACR-4 SALT CREEK OBSIDIAN FLOW
Location: Sec.25, T.22S., R.5E.; Lane County; Western Cascades.
USGS Map: McCredie Spring 7½' (1986)
Description: Grayish glassy to microcrystalline obsidian nodule collected from a stream terrace immediately above Salt Creek and directly upstream from McCredie Hot Springs.

SIU-1,SIU-2,SIU-3,SIU-4,SIU-5,SIU-6 SIUSLAW RIVER GRAVELS
Location: Sec.34, T.18S., R.12W.; Lane County; Oregon Coast.
USGS Map: Florence 7½' (1984)
Description: Obsidian nodules collected at a gravel bar along the north bank of the Siuslaw River about 1 km west of the Highway 101 bridge.

VRS-1 VINE ROCKSHELTER (35LA304)
Location: Sec.13, T.24S., R.3E; Lane County; Western Cascades
USGS Map: Staley Ridge 7½' (1986)
Description: Obsidian core of slightly porphyritic glass from stratum IIb (sample #304-F-13.1). Previously characterized by Sappington (1986b) and assigned to the Staley Creek source.

VRS-2 VINE ROCKSHELTER (35LA304)
Location: Sec.13, T.24S., R.3E.; Lane County, Western Cascades.
USGS Map: Staley Ridge 7½' (1986)
Description: Obsidian core of slightly porphyritic glass from stratum IIa (sample #304-F-5.2). Previously characterized by Sappington (1986b) and assigned to the Staley Creek source.

APPENDIX FOUR

Inman Obsidian-Related Artifact Data

APPENDIX FOUR: INMAN OBSIDIAN-RELATED ARTIFACT DATA

The data presented in table 4-1 were extracted from contract research literature initiated by the Willamette National Forest, Eugene, Oregon. All XRF trace element data are from Richard E. Hughes (California State University, Sacramento) while all obsidian hydration data area from Thomas E. Origer (Sonoma State University, Anthropological Studies Center). All older Inman Creek trace element data in which the two geochemical subgroups (A and B) were not differentiated have been reevaluated and reassigned to one of the two groups.

GeoProv

Geomorphic Province; WEC = Western Cascades

Artifact Type:

BF	Biface Fragment
D	Debitage/Flake
PP	Projectile Point
UF	Utilized Flake

Hydr. Rim (Mean)

The average value of five hydration rim readings for each artifact. All hydration readings may be found in the cited literature sources.

SITE NAME	SITE NUMBER	GEO PROV	ART. TYPE	SAMPLE NO.	GEO SOURCE	TRACE ELEMENTS					HYDR. RIM (MEAN)	REFERENCES
						RB	SR	Y	ZR	NB		
BILLS CREEK	35LA519	WEC	D	519-1	FR-A	75.5	143.1	21.4	94.1	7.9	1.2	11,16,23
BILLS CREEK	35LA519	WEC	D	519-2	FR-A	85.8	158.1	20.0	103.0	8.2	NVB	11,16,23
BILLS CREEK	35LA519	WEC	D	519-3	FR-A	85.1	151.7	20.5	111.0	5.3	1.2	11,16,23
BILLS CREEK	35LA519	WEC	-	519-4	FR-B	89.1	108.1	15.7	75.7	4.9	-	11,16,23
BILLS CREEK	35LA519	WEC	-	519-5	FR-A	78.9	150.3	22.1	106.1	6.6	-	11,16,23
COLT SITE	35LA599	WEC	D	599-1B1	FR-A	88.0	152.1	16.4	112.1	13.4	NVB	1,8
COLT SITE	35LA599	WEC	D	599-1B3	FR-A	73.9	143.4	16.4	111.5	11.7	0.9	1,8
COLT SITE	35LA599	WEC	D	599-3A3	FR-A	80.4	138.9	14.6	107.4	11.5	NVB	1,8
COLT SITE	35LA599	WEC	D	599-6A2	FR-A	84.8	151.5	11.2	117.6	13.3	1.1	1,8
DEADHORSE ROCKSHELTER	35LA656	WEC	D	656-1	FR-B	94.2	117.2	20.1	75.6	1.8	NVB	2,10,11
DEADHORSE ROCKSHELTER	35LA656	WEC	D	656-2	FR-A	81.9	150.0	21.4	105.3	10.8	1.5	2,10,11
DEADHORSE ROCKSHELTER	35LA656	WEC	D	656-5	FR-A	84.4	167.2	22.6	105.0	9.4	NVB	2,10,11
DEADHORSE ROCKSHELTER	35LA656	WEC	D?	656-7	FR-A	89.5	157.2	22.2	106.7	11.3	1.6	2,10,11
DEADHORSE ROCKSHELTER	35LA656	WEC	D	656-11	FR-A	84.6	169.9	21.9	111.6	7.2	1.8	2,10,11
DEADHORSE ROCKSHELTER	35LA656	WEC	UF	656-16	FR-A	81.7	151.9	23.9	104.2	12.6	NVB	2,10,11
DEADHORSE ROCKSHELTER	35LA656	WEC	BF	656-17	FR-A	75.3	147.6	19.6	102.5	12.2	1.8	2,10,11
DEADHORSE ROCKSHELTER	35LA656	WEC	PP	656-18	FR-A	86.8	147.0	19.9	101.0	6.9	NVB	2,10,11
DEADHORSE ROCKSHELTER	35LA656	WEC	PP	656-21	FR-A	87.0	154.3	21.0	106.2	9.2	NVB	2,10,11
DIAMOND LIL	35LA807	WEC	D	EU1.2	FR-A	84.3	155.5	19.5	105.7	7.4	1.1	6,14,21
DIAMOND LIL	35LA807	WEC	PP	EU3.1	FR-A	89.5	158.5	21.2	105.7	12.3	NVB	6,14,21
DIAMOND LIL	35LA807	WEC	D	EU3.3	FR-A	90.3	160.8	22.5	111.5	8.1	0.8	6,14,21
DIAMOND LIL	35LA807	WEC	PP	EU7.3	FR-A	92.3	168.7	24.4	115.0	11.4	1.2	6,14,21
DIAMOND LIL	35LA807	WEC	D	EU7.6	FR-A	82.7	150.8	19.4	108.7	8.4	1.2	6,14,21
DIAMOND LIL	35LA807	WEC	D	EU7.7	FR-A	88.8	163.6	23.1	113.2	4.6	1.2	6,14,21
DIAMOND LIL	35LA807	WEC	D	EU7.10	FR-A	92.4	170.6	20.2	110.1	11.9	1.2	6,14,21
DIAMOND LIL	35LA807	WEC	PP	EU15.1	FR-A	83.9	152.4	19.4	107.8	10.2	NVB	6,14,21
DIAMOND LIL	35LA807	WEC	D	EU15.3	FR-A	84.2	151.6	21.4	101.9	13.6	NVB	6,14,21
DIAMOND LIL	35LA807	WEC	D	EU15.4	FR-A	86.9	162.7	17.9	108.4	16.1	1.2	6,14,21
DIAMOND LIL	35LA807	WEC	PP	EU 2a	FR-A	86.4	158.4	20.8	107.3	9.7	1.1	6,14,21
DIAMOND LIL	35LA807	WEC	PP	EU 12a	FR-A	85.3	149.3	19.8	99.6	7.5	1.2	6,14,21
DIAMOND LIL	35LA807	WEC	PP	EU 12b	FR-A	84.1	149.6	19.9	102.2	9.3	2.2	6,14,21
DIAMOND LIL	35LA807	WEC	PP	EU 17	FR-A	82.5	146.5	20.3	96.7	7.7	1.2	6,14,21
GATE CREEK #1	35LA295	WEC	D	TU7 0-10a	FR-A	85.9	161.2	20.0	112.1	8.5	NVB	7,15,22
GATE CREEK #1	35LA295	WEC	D	TU7 40-50b	FR-A	87.6	165.9	19.3	111.1	10.3	DH	7,15,22
GATE CREEK #1	35LA295	WEC	D	TU5 10-20b	FR-A	84.0	148.9	19.7	102.6	11.1	1.3	7,15,22
GATE CREEK #1	35LA295	WEC	D	TU5 10-20c	FR-A	86.3	154.3	20.5	100.0	14.2	NVR	7,15,22
GATE CREEK #1	35LA295	WEC	D	TU5 40-50c	FR-A	89.7	158.0	21.6	105.0	9.9	1.7	7,15,22
GATE CREEK #1	35LA295	WEC	D	TU5 40-50g	FR-A	94.3	164.3	24.7	105.2	1.8	1.5	7,15,22
GATE CREEK #1	35LA295	WEC	D	TU5 40-50h	FR-A	97.6	170.3	20.5	101.9	1.8	1.8	7,15,22

Table 4-1. Inman obsidian-related artifact geochemical and hydration data.

SITE NAME	SITE NUMBER	GEO PROV	ART. TYPE	SAMPLE NO.	GEO SOURCE	TRACE ELEMENTS RB	SR	Y	ZR	NB	HYDR. RIM (MEAN)	REFERENCES
KATZ ROCKSHELTER	35LA802	WEC	SC	802-A5	FR-A	95.2	161.8	19.8	109.6	9.0	1.2	3,10,18
KATZ ROCKSHELTER	35LA802	WEC	SC	802-B1	FR-B	89.4	118.0	21.5	72.5	11.0	1.1	3,10,18
KATZ ROCKSHELTER	35LA802	WEC	SC	802-B2	FR-B	85.0	112.3	21.0	75.2	10.3	NVB	3,10,18
KATZ ROCKSHELTER	35LA802	WEC	SC	802-B3	FR-A	87.8	151.7	19.6	103.6	9.6	1.3	3,10,18
KATZ ROCKSHELTER	35LA802	WEC	UF	A-3-3	FR-B	82.7	104.9	18.3	87.0	6.4	1.5	3,10,18
KATZ ROCKSHELTER	35LA802	WEC	BF	A-3-4	FR-A	89.7	162.2	20.6	106.0	8.1	1.3	3,10,18
KATZ ROCKSHELTER	35LA802	WEC	BF	A-4-7	FR-A	86.8	151.8	23.0	99.4	12.4	NVB	3,10,18
KATZ ROCKSHELTER	35LA802	WEC	D	B-1-18	FR-B	79.6	105.1	18.2	86.6	6.4	1.4	3,10,18
KATZ ROCKSHELTER	35LA802	WEC	BF	B-2-12	FR-B	81.2	108.0	20.5	92.5	10.6	NVB	3,10,18
MERRILL-EXTON	35LA814	WEC	PP	65	FR-A	84.8	156.7	20.7	106.8	10.5	1.3	4,12,19
OLSEN 1 ROCKSHELTER	35LA190	WEC	D	190-1	FR-B	93.3	123.8	14.2	85.3	1.8	NVB	2,10,17
OLSEN 1 ROCKSHELTER	35LA190	WEC	D	190-2	FR-A	80.4	156.0	22.1	114.7	13.0	3.3	2,10,17
OLSEN 1 ROCKSHELTER	35LA190	WEC	D	190-3	FR-A	93.6	172.1	18.0	111.2	1.8	NVB	2,10,17
OLSEN 1 ROCKSHELTER	35LA190	WEC	D?	190-4	FR-B	104.4	126.5	25.4	76.0	10.6	2.0	2,10,17
OLSEN 1 ROCKSHELTER	35LA190	WEC	D?	190-6	FR-A	97.0	132.6	19.1	99.9	9.7	2.3	2,10,17
OLSEN 1 ROCKSHELTER	35LA190	WEC	D	190-8	FR-A	83.0	153.2	16.9	106.1	1.8	NVB	2,10,17
OLSEN 1 ROCKSHELTER	35LA190	WEC	D	190-9	FR-A	96.3	165.0	22.4	102.7	17.0	NVB	2,10,17
OLSEN 1 ROCKSHELTER	35LA190	WEC	PP	190-10	FR-A	84.4	152.8	20.6	103.1	9.0	1.2	2,10,17
PACKARD CREEK	35LA475	WEC	D	475-2	FR-A	85.0	156.0	19.1	107.0	12.0	1.7	9,16,23
PACKARD CREEK	35LA475	WEC	D	475-3	FR-B	87.7	110.5	20.9	98.3	10.1	1.1	9,16,23
PACKARD CREEK	35LA475	WEC	D	475-4	FR-B	78.9	111.7	20.3	87.6	8.4	2.8	9,16,23
PACKARD CREEK	35LA475	WEC	D	475-5	FR-B	75.6	98.9	20.6	92.5	8.6	2.8	9,16,23
PACKARD CREEK	35LA475	WEC	D	475-6	FR-B	79.7	108.7	17.8	97.0	9.7	2.9	9,16,23
PEPPER ROCKSHELTER	35LA801	WEC	D	801-B1	FR-B	89.8	122.8	18.0	98.6	1.8	3.1	3,11,18
PEPPER ROCKSHELTER	35LA801	WEC	D	801-B3	FR-A	82.7	148.4	23.4	104.9	7.8	2.4	3,11,18
PEPPER ROCKSHELTER	35LA801	WEC	D	801-B5	FR-A	78.6	153.5	20.2	99.4	3.9	1.8	3,11,18
PEPPER ROCKSHELTER	35LA801	WEC	BF	B-27-33	FR-A	76.7	150.4	20.2	98.3	11.6	3.2	3,11,18
SADDLE SITE	35LA529	WEC	D	529-2A1	FR-A	81.4	152.0	15.6	111.6	0.0	1.7	2,8
SADDLE SITE	35LA529	WEC	D	529-2A3	FR-A	79.5	136.9	15.4	109.6	12.5	1.1	2,8
SADDLE SITE	35LA529	WEC	D	529-2B1	FR-A	78.2	137.5	13.1	107.0	12.4	DH	2,8
SADDLE SITE	35LA529	WEC	D	529-3A1	FR-A	78.5	145.4	12.3	107.9	12.3	1.1	2,8
SADDLE SITE	35LA529	WEC	D	529-3A3	FR-A	68.8	134.7	14.2	105.9	10.2	1.0	2,8
SADDLE SITE	35LA529	WEC	D	529-4A1	FR-A	73.6	140.3	14.0	110.1	0.0	1.1	2,8
SADDLE SITE	35LA529	WEC	D	529-4A3	FR-B	72.5	133.1	10.9	101.9	11.4	1.0	2,8
SADDLE QUARRY	35MA68	WEC	D	B-1	FR-A	83.5	138.5	21.1	113.3	7.7	1.2	2,8
WAREHOUSE	35LA822	WEC	D	TU2 10-20	FR-A	69.0	146.4	20.2	127.3	16.6	1.3	5,13,20
WAREHOUSE	35LA822	WEC	D	TU2 20-30B	FR-A	82.4	143.0	18.7	120.9	4.5	NVB	5,13,20

REFERENCES:

1 BAXTER, 1986
2 CHURCHILL, 1989
3 CHURCHILL AND JENKINS, 1989B
4 FLENNIKEN ET AL., 1989A
5 FLENNIKEN ET AL., 1989B
6 FLENNIKEN ET AL., 1990A
7 FLENNIKEN ET AL., 1990B
8 HUGHES, 1986A
9 HUGHES, 1986B
10 HUGHES, 1989A
11 HUGHES, 1989B
12 HUGHES, 1989C
13 HUGHES, 1989D
14 HUGHES, 1990A
15 HUGHES, 1990B
16 MINOR, 1987
17 ORIGER, 1989A
18 ORIGER, 1989B
19 ORIGER, 1989C
20 ORIGER, 1989D
21 ORIGER, 1990A
22 ORIGER, 1990B
23 ROUNDS, 1986

Table 4-1 (continued). Inman obsidian-related artifact geochemical and hydration data.


INMAN CREEK
PROJECT
Supplementary Data Disk
Craig E. Skinner
Type GO, then <RETURN> to begin
IBM PC 720K