Early and Middle Holocene Archaeology of the Northern Great Basin

Edited by

Dennis L. Jenkins
Thomas J. Connolly
C. Melvin Aikens

University of Oregon Anthropological Papers 62

Published by the Museum of Natural History and Department of Anthropology
University of Oregon, Eugene
2004
# Table of Contents

## Preface ............................................................................................................................................................ iii

## Acknowledgements ........................................................................................................................................ v

## Abstracts and Contributor Affiliations ........................................................................................................ ix

## Introduction

1. Early and Middle Holocene Archaeology in the Northern Great Basin: Dynamic Natural and Cultural Ecologies • Dennis L. Jenkins, Thomas J. Connolly, and C. Melvin Aikens ......................................................... 1

## Paleoclimatic and Geoarchaeological Studies

2. Paleoecological Response to Climate Change in the Great Basin since the Last Glacial Maximum • Thomas A. Minckley, Patrick J. Bartlein, and J.J. Shinker ................................................................. 21

3. Geoarchaeology of Wetland Settings in the Fort Rock Basin, South-Central Oregon • Dennis L. Jenkins, Michael S. Droz, and Thomas J. Connolly ................................................................................. 31

4. Of Lakeshores and Dry Basin Floors: A Regional Perspective on the Early Holocene Record of Environmental Change and Human Adaptation at the Tucker Site • Arianne Oberling Pinson ........................................................................................................................................... 53

## Middle Holocene Archaeology in the Fort Rock Basin

5. Archaeological Investigations at the Bergen Site: Middle Holocene Lakeside Occupations Near Fort Rock, Oregon • Margaret M. Helzer ........................................................................................................... 77

6. DJ Ranch: A Mid- to Late Holocene Occupation Site in the Fort Rock Valley, South-Central Oregon • Jean Moessner ............................................................................................................................................. 95

7. The Grasshopper and the Ant: Middle Holocene Occupations and Storage Behavior at the Bowling Dune Site in the Fort Rock Basin, Oregon • Dennis L. Jenkins ............................................................................................................................................ 123

## Special Analyses


9. Faunal Assemblages of Four Early to Mid-Holocene Marsh-side Sites in the Fort Rock Valley, South Central Oregon • Vivien J. Singer ........................................................................................................... 167

10. Zooarchaeological Analysis of Cultural Features from Four Early to Middle Holocene Sites in the Fort Rock Basin • Patrick O’Grady ............................................................................................................ 187


13. Obsidian Use on Buffalo Flat, Christmas Lake Valley, Oregon • Albert C. Oetting ................................................................................................................................................. 233
   • Thomas J. Connolly and Pat Barker ................................................................. 241

15. Early and Middle Holocene Ornament Exchange Systems in the Fort Rock Basin of Oregon
   • Dennis L. Jenkins, Leah L. Largaespada, Tony D. Largaespada, and Mercy A. McDonald ............. 251

16. If It Ain’t Fluted Don’t Fix It: Form and Context in the Classification of Early Projectile Points in the Far West • Robert R. Musil .................................................................................................................. 271

17. Fluted or Basally-Thinned? Re-Examination of a Lanceolate Point from the Connley Caves in the Fort Rock Basin
   • Charlotte Beck, George T. Jones, Dennis L. Jenkins, Craig E. Skinner, and Jennifer J. Thatcher...... 281

References Cited ............................................................................................................................ 295
X-Rays, Artifacts, and Procurement Ranges: A Mid-Project Snapshot of Prehistoric Obsidian Procurement Patterns in the Fort Rock Basin of Oregon

by Craig E. Skinner, Jennifer J. Thatcher, Dennis L. Jenkins, and Albert C. Oetting

Introduction

Without a doubt, the most ubiquitous and highly preferred type of lithic material found throughout the archaeological assemblages of the Fort Rock Basin is obsidian glass. The region is literally surrounded by numerous obsidian sources and these sources of natural glass were intensively utilized throughout the long span of human occupation in the basin. Despite the importance of obsidian in understanding and interpreting the archaeological record, however, until very recently little was known about either the sources of natural glass that were available or the patterns of prehistoric use of those sources.

Until less than a decade ago, the number of geochemically analyzed obsidian artifacts from archaeological sites in the Fort Rock Basin was very small. Prior to 1993, only two investigations had been undertaken—an intriguing but methodologically flawed project reported by Sappington and Toepel (1981) and a small study at the Fort Rock and Connelly Caves described by Skinner (1983). In 1993, the final report for the Buffalo Flat Project was completed and the results of the first significant number of geochemically-analyzed artifacts from the Fort Rock Basin were reported (Hughes 1993; Oetting 1993). Interestingly, the results of this initial large-scale investigation revealed the presence of a significant number of unidentified obsidian sources among the analyzed artifacts.

There was clearly a need to investigate both the regional sources of obsidian and to increase the corpus of characterized artifacts available for analysis and interpretation. In 1995, the University of Oregon began to increasingly focus on identifying and understanding the prehistoric use of the sources and since then the pace of obsidian trace element provenance and hydration analysis studies has picked up dramatically. To date, more than 1,600 specimens from sites within or along the border of the Fort Rock Basin have been geochemically characterized. At the same time, in excess of 900 artifacts have been subjected to obsidian hydration analyses. Concurrently, Northwest Research Obsidian Laboratory began a systematic geochemical survey of obsidian sources in the potential Fort Rock Basin source regions of central and eastern Oregon, California, and Nevada. We have now completed the trace element analysis of several thousand geologic specimens from scores of different sources, including many of those found in or near the Fort Rock Basin region (Skinner 1999; Northwest Research Obsidian Studies Laboratory 2003a).

Prehistoric Obsidian Use Through Space and Time

The overall objectives we have developed to guide our obsidian artifact and source research to date are quite straightforward:

1. To identify and geochemically characterize the natural sources of obsidian in and adjacent to the Fort Rock Basin. In order to identify the sources of the obsidian artifacts, it is plain that we must first have found their geologic sources, a methodological step in artifact provenance studies that is often neglected in the rush for archaeological results. It is also critical that we understand and map the secondary distribution of source material in the basin. A variety of natural transport processes can distribute obsidian at considerable distances from primary source areas.

2. To geochemically characterize significant numbers of artifacts from key archaeological sites in the basin. When it comes to interpreting obsidian provenance data, size matters. A robust analysis of regional prehistoric obsidian use requires an adequate number of geographically
dispersed archaeological sites and a significant number of characterized artifacts. This is particularly true in an area such as the Fort Rock Basin in which many different sources of glass were utilized.

3. To describe the geographic and spatial distribution of the characterized obsidian artifacts. What are the measurable attributes of the Fort Rock Basin prehistoric obsidian procurement systems and what do they say about prehistoric behavior? Were some sources preferentially used and why? What was the procurement range of the prehistoric inhabitants of the basin? How do the patterns of obsidian use reflect movement, interaction, and contact both within the Fort Rock Basin and between adjacent or nearby lake basins and geographic areas?

4. To explore the temporal patterns of prehistoric source use with temporally-sensitive artifact types, obsidian hydration measurements, tephrachronologic clues, and radiocarbon dates. How did patterns of prehistoric source use change over time, and what cultural processes or environmental influences might have been responsible for these changes?

For the geochemical characterization analysis of both sources and artifacts, our preferred method has been energy-dispersive X-ray fluorescence (EDXRF) analysis. This method is nondestructive, rapid and accurate, relatively inexpensive, and perhaps most importantly, is easily accessible to us (Northwest Research Obsidian Studies Laboratory 2003a). In addition, geographic information systems (using ArcView) techniques are used to map and examine the geographic patterning of the prehistoric obsidian use that is revealed by these geochemical investigations.

In the research that is summarized here, we discuss the current state of obsidian source studies and artifact provenance and hydration research in the Fort Rock Basin. We also offer some preliminary observations that are beginning to emerge from the data about the patterns of prehistoric use, particularly those related to overall procurement ranges and directionality. However, we would like to emphasize that the data reviewed here are only a snapshot in time of a long-term project that is still actively in progress – our database of source and artifact information is rapidly expanding and we have scarcely begun with our analyses and interpretations.

Obsidian Sources in the Fort Rock Basin Region

Many different sources of obsidian have been identified within the Fort Rock Basin and in the region bordering the basin (Ambroz 1997; Hughes 1986; Northwest Research Obsidian Studies Laboratory 2003b; Sappington 1981a, 1981b; Skinner 1983, 1999; see Figure 2). Three of these – Cougar Mountain, Silver Lake/Sycan Marsh, and Hager Mountain – are found in archaeologically significant quantities within the boundaries of the old pluvial lake shoreline and were locally available in large quantities. We were somewhat surprised, then, when initial EDXRF studies of artifacts from several Fort Rock Basin sites indicated the presence of numerous additional sources that showed up as unknowns among the characterized artifacts (Skinner et al. 1995). Slightly earlier trace element investigations of artifacts associated with the Buffalo Flat Project (Skinner et al. 1995; Oetting 1993) had also pointed to the existence of many different unknown obsidian sources in the region. Because of this, a systematic search for new regional sources of obsidian was initiated and is currently underway. A concurrent study of the Silver Lake/Sycan Marsh source, one of the two most commonly utilized sources in the basin, has also been recently completed by Thatcher (2001). As obsidian source research has progressed in recent years, we have identified many of the formerly unknown obsidian sources. Several, such as Yreka Butte and Brooks Canyon, have been found in the region immediately adjacent to the basin. Others such as the multiple geochemical varieties found in association with the Glass Buttes Source Complex (Ambroz et al. 2001; Northwest Research Obsidian Studies Laboratory 2003b) have been identified from somewhat more distant areas.

Geochemically characterized nodules from the three locally available sources have been found at numerous primary (for Cougar Mountain) and secondary (Hager Mountain and Silver Lake/Sycan Marsh) localities throughout the basin. Rounded pebbles of obsidian from these sources can be found in many of the shoreline deposits in the basin (mapped by Forbes [1973] and Freidel [1993]). Nodules of glass have been reported from archaeological contexts in the Paulina Marsh-Silver Lake Subbasin (Jenkins 1994c; Jenkins and Aikens 1994; Thatcher 2001), in lake deposits in the Cougar Mountain vicinity (Forbes 1973; Allison 1979; Skinner 1983), and in tuff deposits near Cougar Mountain at Table Mountain (Heiken 1972). Obsidian pebbles collected from a borrow pit excavated in a large gravel bar situated immediately southeast of Cougar Mountain was chemically characterized and, not surprisingly,
proved to originate from the nearby Cougar Mountain source (Northwest Research Obsidian Studies Laboratory, unpublished research). In addition, small pebbles of obsidian that were too small for tool manufacture are found in the vicinity of the Bergen Site (35-LK-3175). These were analyzed and correlated with the Quartz Mountain source located not far north of the Fort Rock Basin.

Details concerning the many obsidian sources that are found represented among the characterized artifacts from Fort Rock Basin sites are beyond the scope of this current discussion. Ongoing research and references about the geology, geochemistry, and prehistoric use of the obsidian sources that are identified among Fort Rock Basin artifacts can be found on the World Wide Web (Northwest Research Obsidian Studies Laboratory 2003a, 2003b).

### Results of XRF Trace Element Studies of Obsidian Artifacts

In this section, we summarize the results of the trace element analysis of 1,674 obsidian artifacts recovered from 29 archaeological sites located in the Fort Rock Basin (Figure 1, Table 1). The vast majority of the artifacts were analyzed by Geochemical Research Laboratory (N=473) and Northwest Research Obsidian Studies Laboratory (N=1,195) using EDXRF nondestructive methods. An additional six specimens were destructively analyzed with a wavelength-dispersive X-ray fluorescence spectrometer formerly operating at the University of Oregon (Skinner 1983). We did not attempt to include the earlier XRF analyses reported by Sappington and Toepel (1981). Their significant but problematic early study used a very
Table 1. Summary of obsidian provenance and obsidian hydration-related archaeological projects in the Fort Rock Basin; additional information about many of these sites can be found in Aikens and Jenkins (1994a).

<table>
<thead>
<tr>
<th>Site Name</th>
<th>Trinomial</th>
<th>XRF N=</th>
<th>OH Sub-Basin</th>
<th>Reference(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Big M</td>
<td>35LK2737</td>
<td>15</td>
<td>14 SL</td>
<td>Jenkins 1994c; NWR 2001-23</td>
</tr>
<tr>
<td>Boulder Village</td>
<td>35LK2846</td>
<td>103</td>
<td>57 SL (BV)</td>
<td>NWR 1998-35; O’Grady 1999</td>
</tr>
<tr>
<td>Bowling Dune</td>
<td>35LK2992</td>
<td>23</td>
<td>– FR</td>
<td>Hughes 1995</td>
</tr>
<tr>
<td>Buffalo Flat</td>
<td>Several Sites</td>
<td>423</td>
<td>362 CL</td>
<td>Hughes 1993; Oetting 1993; Jones et al. 2003</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Claim A1</td>
<td>35LK3176</td>
<td>6</td>
<td>4 FR</td>
<td>NWR 1999-06</td>
</tr>
<tr>
<td>DJ Ranch</td>
<td>35LK2758</td>
<td>30</td>
<td>3 FR</td>
<td>Hughes 1995</td>
</tr>
<tr>
<td>Duncan Creek</td>
<td>NA</td>
<td>5</td>
<td>– SL</td>
<td>NWR 1998-71; O’Grady 1999</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fort Rock Cave</td>
<td>35LK1</td>
<td>1</td>
<td>– FR</td>
<td>Sappington and Toepel 1981; Skinner 1983</td>
</tr>
<tr>
<td>GP-2</td>
<td>35LK2778</td>
<td>23</td>
<td>7 FR</td>
<td>NWR 1995-53</td>
</tr>
<tr>
<td>Locality III</td>
<td>35LK3035</td>
<td>133</td>
<td>65 FR</td>
<td>NWR 1995-53, 1996-29</td>
</tr>
<tr>
<td>North Lake School</td>
<td>1136_NLS_1</td>
<td>1</td>
<td>1 FR</td>
<td>NWR 1999-06</td>
</tr>
<tr>
<td>Playa 9</td>
<td>35LK2909</td>
<td>14</td>
<td>7 FR</td>
<td>NWR 1998-71; O’Grady 1999</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ratz Nest</td>
<td>35LK2463</td>
<td>14</td>
<td>7 SL (BV)</td>
<td>NWR 1998-71; O’Grady 1999</td>
</tr>
<tr>
<td>Sage</td>
<td>35LK1003</td>
<td>1</td>
<td>1 FR</td>
<td>NWR 1995-53</td>
</tr>
<tr>
<td>Scott’s Village</td>
<td>35LK2844</td>
<td>32</td>
<td>– SL</td>
<td>NWR 1998-71; O’Grady 1999</td>
</tr>
<tr>
<td>Silver Lake</td>
<td>NA</td>
<td>50</td>
<td>50 SL</td>
<td>NWR 1998-81; Wingard 1999</td>
</tr>
<tr>
<td>Silver Lake N. Shore</td>
<td>NA</td>
<td>15</td>
<td>– SL</td>
<td>NWR 65-464</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stone Circle Site</td>
<td>NA</td>
<td>75</td>
<td>– FR</td>
<td>NWR 1999-58, 2002-52; Unpub. Research (UOXRF Lab)</td>
</tr>
<tr>
<td>Teri’s House</td>
<td>35LK2833</td>
<td>6</td>
<td>– SL (BV)</td>
<td>NWR 1998-71; O’Grady 1999</td>
</tr>
<tr>
<td>7 PC</td>
<td>35LK2837</td>
<td>3</td>
<td>– SL (BV)</td>
<td>NWR 1998-35; O’Grady 1999</td>
</tr>
<tr>
<td>10 US</td>
<td>35LK2831/32</td>
<td>18</td>
<td>– SL (BV)</td>
<td>NWR 1998-71; O’Grady 1999</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13 DJ</td>
<td>NA</td>
<td>3</td>
<td>– SL (BV)</td>
<td>NWR 1998-35; O’Grady 1999</td>
</tr>
<tr>
<td>14 DJ</td>
<td>NA</td>
<td>3</td>
<td>– SL (BV)</td>
<td>NWR 1998-35; O’Grady 1999</td>
</tr>
<tr>
<td>14 GP1</td>
<td>NA</td>
<td>4</td>
<td>– SL (BV)</td>
<td>NWR 1998-35; O’Grady 1999</td>
</tr>
<tr>
<td>14 GP2</td>
<td>NA</td>
<td>1</td>
<td>– SL (BV)</td>
<td>NWR 1998-35; O’Grady 1999</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>1,674</td>
<td>910</td>
<td></td>
</tr>
</tbody>
</table>

1Number of artifacts with measurable hydration rims.
2CL = Christmas Lake; FR = Fort Rock; SL = Silver Lake; BV = Boulder Village Complex.
3NWR = Northwest Research Obsidian Studies Laboratory Project number.
of the occurrence and geochemistry of regional obsidian sources has grown significantly. Because of this, we reviewed and updated all source assignments in our XRF data set, resolving many of the different unknowns in the process. Although published in 1993 as an appendix to the Buffalo Flat report (Hughes 1993; Oetting 1993), the trace element work for these sites was carried out in two phases in 1989 and 1993. Several of the unknown sources noted in 1989 (then comprising 29% of the total) had been subsequently characterized by Hughes in the intervening years but the source assignments of the earlier XRF analyses had not been updated. Our first step in approaching this data set was to bring the earlier 1989 XRF results up to date so that they were consistent with the new sources identified in the later 1993 analyses by Hughes. We then compared the combined results of the Buffalo Flat data set with the Northwest Research Obsidian Studies Laboratory source reference data base and updated and integrated as much of Hughes’ XRF data as possible into our current data base. During this process, we were able to identify many of the previously unknown sources, eventually reducing the number of unknown obsidian sources to about seven percent of the total. A summary of the results of the trace element analysis of all Fort Rock Basin artifacts is presented in Table 2. The locations of the identified sources are shown in Figure 2.

The sheer number of different geochemical sources of obsidian identified among the 1,674 characterized Fort Rock Basin artifacts—46 different known sources plus several as yet unidentified sources—is exceptional. A large proportion of the analyzed artifacts are formed tools, a sampling bias which undoubtedly elevated the level of overall source diversity. Formed tools are more likely to be curated (carried from place to place and reused) and often disproportionately originate from more distant sources than debitage or expedient tools. The significance of this bias to the current study is that

Figure 2. Trace element provenance studies of artifacts from Fort Rock Basin archaeological sites.
interaction with other regions should be well represented in the sample.

Almost 38% of the artifacts originated from the three sources that are available within the boundaries of the Fort Rock Basin–Cougar Mountain, Hager Mountain, and Silver Lake/Sycan Marsh (see Table 2). Nodules of glass are available at many locations in the Fort Rock Valley Subbasin (Cougar Mountain glass) and Silver Lake Subbasin (Hager Mountain and Silver Lake/Sycan Marsh obsidian). However, obsidian from the Hager Mountain source tends to be smaller in size and of somewhat poorer quality and is found less often in artifact collections than the other local sources.

Sources from areas immediately adjacent to the Fort Rock Basin make up by far the largest proportion of the characterized artifacts from nonlocal sources. The more significant of these sources (N>10 artifacts) include Quartz Mountain, Yreka Butte, Brooks Canyon, Glass Buttes, Big Stick, Bald Butte, Horse Mountain, Coglan Buttes, Tucker Hill, and Spodue Mountain.

A small proportion of the artifacts (less than one percent) were correlated with northeastern California sources located at Medicine Lake Volcano and the Warner Mountains and with sources found in northwestern Nevada. The remainder of the identified sources are located in Oregon in the High Cascades (Obsidian Cliffs and Carver Flow), the Klamath Lake Basin (Spodue Mountain, Klamath Marsh 1, Newberry Volcano (Big Obsidian Flow, Newberry Volcano, McKay Butte), the High Lava Plains, and a scattering of other southeast Oregon sources. The most distant sources in Oregon and Nevada that were identified were Obsidian Cliffs and the Carver Flow in the High Cascades (N=5), Whitewater Ridge (N=4), Venator (N=1), Gregory Creek (N=2), Beatys Butte (N=14), Massacre Lake/Guano Valley (N=6), Surveyor Spring (N=2), and Mosquito Lake (N=1).

The massive pre- and post-Mazama obsidian sources available within nearby Newberry Caldera (Newberry Volcano and Big Obsidian Flow chemical

Table 2. Subbasin summary of results of trace element provenance studies on artifacts from Fort Rock Basin sites. Figures 3A through 3D are based on these data, also see the research section of www.obsidianlab.com.

<table>
<thead>
<tr>
<th>Obsidian Sources</th>
<th>Fort Rock</th>
<th>Silver Lake</th>
<th>Christmas Valley</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N=</td>
<td>%</td>
<td>N=</td>
<td>%</td>
</tr>
<tr>
<td><strong>Local Obsidian Sources</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cougar Mountain</td>
<td>131</td>
<td>30.5</td>
<td>174</td>
<td>21.2</td>
</tr>
<tr>
<td>Hager Mountain</td>
<td>9</td>
<td>2.1</td>
<td>30</td>
<td>3.7</td>
</tr>
<tr>
<td>Silver Lake/Sycan Marsh</td>
<td>55</td>
<td>12.8</td>
<td>156</td>
<td>19.0</td>
</tr>
<tr>
<td><strong>Oregon Obsidian Sources</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bald Butte</td>
<td>13</td>
<td>3.0</td>
<td>66</td>
<td>8.0</td>
</tr>
<tr>
<td>Glass Buttes Complex</td>
<td>15</td>
<td>3.5</td>
<td>43</td>
<td>5.2</td>
</tr>
<tr>
<td>Newberry Caldera^1</td>
<td>5</td>
<td>1.2</td>
<td>7</td>
<td>0.9</td>
</tr>
<tr>
<td>Quartz Mountain</td>
<td>64</td>
<td>14.9</td>
<td>30</td>
<td>3.7</td>
</tr>
<tr>
<td>Spodue Mountain</td>
<td>32</td>
<td>7.4</td>
<td>53</td>
<td>6.5</td>
</tr>
<tr>
<td>Other Oregon Sources</td>
<td>59</td>
<td>13.7</td>
<td>129</td>
<td>15.7</td>
</tr>
<tr>
<td>Variety 5</td>
<td>6</td>
<td>1.4</td>
<td>79</td>
<td>9.6</td>
</tr>
<tr>
<td>Unknown</td>
<td>4</td>
<td>7.9</td>
<td>21</td>
<td>2.6</td>
</tr>
<tr>
<td><strong>Northern California and Nevada Sources</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Medicine Lake^2</td>
<td>2</td>
<td>0.5</td>
<td>4</td>
<td>0.5</td>
</tr>
<tr>
<td>Warner Mountains Area^3</td>
<td>5</td>
<td>1.2</td>
<td>28</td>
<td>3.4</td>
</tr>
<tr>
<td>Mosquito Lake</td>
<td>–</td>
<td>–</td>
<td>1</td>
<td>0.1</td>
</tr>
<tr>
<td>Total</td>
<td>430</td>
<td>100.1</td>
<td>821</td>
<td>100.1</td>
</tr>
</tbody>
</table>

^1Newberry Caldera = Combined Newberry Volcano and Big Obsidian Flow geochemical sources.
^2Warner Mountains Area = Blue Spring, Buck Mountain, Cowhead Lake, Rainbow Mines, Sugar Hill sources.
^3Medicine Lake = Cougar Butte, GF/LIW/RS, and East Medicine Lake sources.
sources; see MacLeod et al. 1995) accounted for only 16 of the 1,674 characterized artifacts. In contrast, nearly as many artifacts (N=14) correlated with the Beatys Butte source located at a considerable distance to the southeast in the Catlow Basin. This came as something of a surprise. Based on early trace element studies and the abundance of obsidian and water in the caldera, the senior author once suggested that “there was noticeable traffic between the [Fort Rock] valley and Newberry Caldera...” (Skinner 1983:Appendix IX-15). However, the evidence from trace element studies of obsidian found at sites in the Fort Rock Basin now suggests rather limited direct movement or interaction between the Basin and Newberry Caldera. Similarly, only a small proportion of characterized artifacts from Newberry Caldera sites have proven to originate from Fort Rock Basin sources (Hughes 1999).

Prehistoric Use of Obsidian in the Fort Rock Basin

Provenance Studies and Procurement Ranges

From small scale (household and site) to large scale (regional and interregional) levels of analysis, the spatial patterning of characterized obsidian artifacts is influenced by many cultural, environmental, sampling and analysis variables. The analysis and interpretation of spatial patterns of source use can provide critical information about the behavioral and environmental toolstone procurement variables that account for the observed distribution of the characterized artifacts.

At the site level of analysis, patterns of source use may be used to identify the presence of specific activity areas or even single tool manufacturing events. In special cases, patterns of source use may indicate differential access of goods and the existence of non-egalitarian social structures (Rice 1987).

At the intersite or regional level of investigation, the geographic patterning of characterized artifacts may provide information about seasonal procurement ranges, acquisition strategies, territorial or ethnic boundaries, the locations of prehistoric trails and travel routes, the curation value of particular sources or formal artifact types, cultural preferences regarding glass quality and color, the presence of trade and exchange systems, the existence of intergroup interaction, and the exchange of prestige items between elites of different groups (Hughes 1978, 1990; Binford 1979; Ericson 1981; Skinner 1983, 1995b; Hughes and Bettinger 1984, Bamforth 1986; Peterson et al. 1997; Dillian 2002).

In addition, the effects of environmental influences such as the geographic distribution of obsidian sources, the distance to the sources, the relative location of alternative or competing sources of lithic materials, raw material quality and abundance, toolstone size, the distribution of raw materials in secondary deposits, or the presence of potential barriers such as bodies of water or mountain ranges, must all be considered (Renfrew 1977; Skinner 1983; Beck and Jones 1990; Andrefsky 1994; Jones et al. 2003). Of particular importance can be the precision of our knowledge of obsidian source boundaries. Obsidian associated with fluvial or pluvial systems or ash-flow tuffs may be widely distributed over large geographic areas and it is critical to be able to distinguish between long distance procurement of a source and local procurement of a widely-distributed secondary source outcrop (Reid 1997).

Bias may be introduced during sampling by certain recovery methods, minimum physical sizes of analyzed artifacts, uneven geographic distribution of sites, and the use of small numbers of samples (Eerkens et al. 2002). Lastly, the tools used to analyze the spatial data (e.g., trend surface modeling algorithms) may affect the interpretation of the geographic patterns of obsidian use.

In the current investigation, we make the working assumption that the obsidian sources found at a given site or area in the Fort Rock Basin provide what is essentially a map of the prehistoric territory or range that was used by the prehistoric inhabitants of the basin. The processes involved in the cultural distribution of raw material from its geologic source may be simple or complex—trade and exchange, residential, logistical, or territorial mobility, or direct procurement, perhaps involving long distances. The activities that led to the archaeological distribution of obsidian over a landscape may be poorly known or even unknowable, but provenance studies provide us with a relatively clear map of the procurement territory that was involved. This range is known by a number of different terms including “procurement range,” “procurement sphere,” “procurement system,” “subsistence range,” and “foraging territory” (Shackley 1990, 1996; Kelly 1992; Roth 2000; Jones et al. 2003). All are relatively synonymous. These terms are also approximately equivalent to the concept of “interactional sphere” (Struver and Houart 1972) or “exchange network” (Plog 1977) with the important distinction that the presence of trade and exchange relationships is not implicitly implied.

Although trade and exchange are often invoked as explanations of the processes responsible for the long-distance procurement of nonlocal raw materials, long-distance direct access or embedded collection of materials over long distances are well documented and are probably a more common means of material
acquisition (Myer 1928; Heizer 1942; Layton 1981; Kelly 1983; Goodyear 1989; Meltzer 1989; Carlson 1994; Malville 2001). As Meighan (1992:2) succinctly points out: “Recognition of ‘alien’ obsidian is not necessary discovery of an ‘exchange system’ . . . . Other evidence has to be brought forward before an ‘exchange system’ can be postulated, and in most of the papers utilizing this somewhat jargonistic term, the ‘exchange system’ is assumed rather than documented.” In practice, the archaeological traces left by exchange and by direct procurement are usually identical and attempts to distinguish among the two processes are most often speculative or futile (Goodyear 1989; Meltzer 1989). Forays may be occasionally made to gather very specific resources (see Titiev 1937, and Fowler 1989, for examples) but it seems likely that in most areas the bulk of lithic resource procurement was embedded in routine seasonal food and resource-gathering activities (Goodyear 1989; Walsh 1998; Daniel 2001). The procurement range documented by the distribution of characterized obsidian artifacts, then, is probably very similar to the one that was utilized for other activities.

Once adequate data are available (as they are for the Fort Rock Basin), specific attributes and characteristics of these ranges or systems can be described and quantified. Following the initial suggestions of Plog (1977), these include content (in this case, obsidian), diversity of sources (or other items included in the procurement system), magnitude, size, boundaries, directionality, shape, symmetry, and temporal characteristics and duration, all determinable characteristics that reflect prehistoric behavior. In this early look at the prehistoric procurement characteristics of the Fort Rock Basin inhabitants, we focus specifically on the source diversity, procurement range size and boundaries, and directionality. We examine the patterns that are evident for the three major subbasins—Fort Rock, Silver Lake (and Paulina Marsh), and Christmas Valley (Hampton 1964; Freidel 1993, 1994).

Source Diversity

Although the specific artifact sources that were identified in each subbasin are very similar, the relative

Figure 3. a. Histogram of all Fort Rock Basin artifact sources; b. Fort Rock subbasin artifact sources; c. Silver Lake subbasin artifact sources; d. Christmas Valley subbasin artifact sources.
proportions of obsidian vary considerably (Figure 3). Obsidian from the local sources (Cougar Mountain, Hager Mountain, and Silver Lake/Sycan Marsh) makes up approximately 38 percent of the basin-wide total but varies substantially among the subbasins. For instance, the Cougar Mountain source occurs in considerably larger frequencies in the Fort Rock Valley Subbasin, almost certainly due to the proximity of obsidian from that source that is widely available in primary and secondary deposits. Similarly, the largest percentage of Silver Lake/Sycan Marsh and Hager Mountain obsidian artifacts are found in the Silver Lake Subbasin that lays adjacent to those two sources. In the Christmas Valley Subbasin, the most commonly used known obsidian sources are those found in association with the Glass Buttes Source Complex situated northeast of the basin.

The number of unknown sources is greatest in the Christmas Valley Subbasin. However, it is likely that this is due at least in part to the data set that was used for the analysis and not solely to the presence of unknown sources in the region surrounding this basin. All of the characterized Christmas Valley artifacts are associated with the Buffalo Flat Project whose artifacts were analyzed by Geochemical Research. Due to inter-laboratory differences in the reporting of trace elements, we were unable to thoroughly reassign known sources to all of the previously analyzed artifacts, leading to a larger number of unassigned artifacts in this basin.

**Directionality of Source Use**

The directionality of nonlocal source use is strongly linked to the direction and distance of the sources in relation to the different subbasins (Figure 4). In the Fort Rock Valley Subbasin, in the northwestern portion of the Fort Rock Basin, the largest number of nonlocal artifacts comes from the massive Quartz Mountain source that is located a short distance northwest from the basin. To the south, in the Silver Lake Subbasin, directionality of source use shifts dramatically to those sources south and southeast of this subbasin. Farther east, source use in the Christmas Valley again is quite different from the other subbasins and is dominated by northeastern sources.
It is also likely that the directionality of source use is influenced by procurement ranges that varied over time, the result of environmental change, shifting contact and exchange relationships, or changes in population movements or density. In a study of temporally-sensitive characterized artifacts from the Drews Valley area (located in Oregon to the south of the Fort Rock Basin), Connolly and Jenkins (1997) observe that the directionality of source use changed over time, perhaps the result of shifting settlement patterns.

In all cases, the directionality of nonlocal source use appears to be strongly and straightforwardly influenced by the direction and distance to nearby sources of high-quality obsidian glass. Given that the Fort Rock Basin is nearly surrounded by these sources, there seems to have been little incentive to intensively exploit those sources that lay elsewhere.

**Prehistoric Procurement Range**

The prehistoric procurement range may be inferred from examining the geographic distribution of obsidian sources that were utilized in the Fort Rock Basin (Figure 5). The identified obsidian sources are widely scattered throughout the entire southcentral and southeast portion of Oregon, northeast California, and northwest Nevada. However, the vast majority of these sources are found in southcentral Oregon and it is evident that the most significant part of the Fort Rock Basin procurement range is focused in the region immediately surrounding the basin and in particular, in the areas to the south and east. If we assume that the procurement of obsidian is most often embedded within seasonal subsistence activities, then the distribution map of obsidian source use (particularly those sources that most frequently appear in the archaeological record) should be largely coincident with the overall Holocene subsistence range of the inhabitants of the Fort Rock Basin.

Given the paucity of obsidian from High Cascades and Newberry Volcano sources, there is little evidence that this range extended very far to the northwest. The large amounts of obsidian from southern sources such as Spodue Mountain suggest that there may have been interaction with the people of the Klamath Basin or at least shared subsistence ranges in the area that lies between the Klamath and Fort Rock basins. The relatively small amounts of obsidian from other major Oregon lake basins (Summer-Abert Lake, Warner, Harney-Malheur, and Catlow), indicates that there was much less substantial interaction with those basins. However, the widespread distribution of locally available obsidian in all three Fort Rock subbasins strongly suggests a high degree of internal interaction and movement throughout the basin.

**The Elusive Variety 5**

The location of Variety 5, a significant source of obsidian identified at numerous southern Fort Rock Basin sites, has remained unknown since its initial recognition by Hughes (1993, 1995). During the field work conducted for her thesis research, Thatcher (2001)
searched for this source but was successful only in locating a single small nodule (from a drainage immediately south of Silver Lake) that correlated with the unknown source. However, the geographic distribution of sites where Variety 5 is found (Figure 6) provides us with clues to its approximate position. Artifacts from the Variety 5 source are found exclusively at sites in the southern portion of the Fort Rock Basin, and increase greatly in number at sites in the immediate vicinity of Silver Lake (the largest number of Variety 5 artifacts has been found at Carlon Village, on the south shore of the lake). Although differences in the size of analyzed collections among the different sites where Variety 5 obsidian has been found are not taken into account here, it seems likely—from its distribution and frequency—that the Variety 5 source will eventually be found somewhere very close to Silver Lake. The identification of this unknown and elusive source remains one of our top priorities in the ongoing obsidian source research being carried out in the basin.

An Early Diachronic View

The analysis of our current and rapidly-expanding dataset of characterized obsidian artifacts is far from complete and we have only just begun to carefully examine the data for clues about temporal patterns of obsidian use. However, an earlier critique of 566 chronologically diagnostic projectile points provides us with some indications as to the changing patterns of source use through time in the Fort Rock Basin (Jenkins, Skinner, Thatcher, and Hoar 1999). In this study, all arrowpoints were combined to form a single category (N=256) and all large corner-notch points were combined as an Elko category (N=180). The remainder of the artifacts were represented by 62 Northern Side-notch specimens and 68 Cascade points. Directionality of source use was examined in quadrants relative to a point in the center of the basin. The basic chronologic order of these points was verified by comparison with 104 radiocarbon dates and our obsidian hydration analysis results. All dates were converted to dendrochronologically-calibrated calendrical ages.

**Cascade Points.** The results indicate substantial variation in directionality of source use through time. Cascade points, generally representing Early and Middle Holocene occupations between 11,000 and 7000 cal. BP, were manufactured from local obsidian only 30% of the time. Populations using Cascade points came to the Fort Rock Basin from all directions and, based on the relatively low frequency of local obsidian, were extremely mobile.

**Northern Side-Notch Points.** Northern Side-notch points, predominantly made between 7300 and 4000 cal. BP, were made of local obsidian a surprising 64% of the time. Northern Side-notch points were apparently made and used locally in the Fort Rock Basin, suggesting that mobility was substantially reduced during the peak production period of these points.

**Elko Points.** As evidenced by their extreme range in obsidian hydration values, Elko points are relatively poor chronologic indicators in the Fort Rock Basin sample. Although large corner-notch points may have first appeared more than 9000 years ago in the Fort Rock Basin, they did not occur in the large Pre-Mazama Paulina Lake assemblages nearby and their antiquity is still not known. However, these points commonly occur in very Late Holocene contexts and approximately 77% of the Elko sample were made between 6400 and 1750 cal. BP. The directionality of source use of Elko points is similar to both Northern Side-notch and the later arrowpoints. Elko points were made of local sources 54% of the time. However, the use of nonlocal sources from the southeastern and southwestern sources increased, suggesting an influx of populations or resource exploitation in the Klamath-Modoc, Lake Abert-Chewaucan Marsh, and Warner Lakes regions.

![Figure 6. Site locations in the Fort Rock Basin (outline at the 1400 m elevation contour) where the unknown Variety 5 source has been found.](image-url)
**Arrowpoints.** Arrowpoints are good chronologic indicators with 79% made after about 1900 cal. BP. While in most assemblages arrowpoints generally reflect predominantly local tool stone sources because they are small, easily produced, and less easily resharpened, in the Fort Rock Basin sample they comprise only 41 percent of the specimens. A marked shift in source use direction to the northeast in the direction of the Harney-Malheur Basin and the Ochoco Mountains is accompanied by a reduction in the use of local sources and sources from the southeast. It is clear that in Late Holocene times people came to the Fort Rock Basin from the north and east in record numbers. While the southwest Klamath-Modoc sources remain fairly well-represented, those of the Lake Abert-Chewaucan and Warner Valley sources to the southeast fell dramatically.

**Conclusions**

Our initial trace element characterization studies of obsidian artifacts from sites located throughout the Fort Rock Basin indicate that an extraordinary variety of local and nonlocal sources were used. The distribution of these sources is used to map and define the overall prehistoric procurement range of the people that inhabited the Fort Rock Basin during the very late Pleistocene and throughout the Holocene Period. An intrabasin look at the geographic distribution of utilized obsidian sources demonstrates significant differences in directionality and intensity of use among the three sub-basins. This is likely the result of the straightforward influence of distance to high-quality sources of obsidian.

Looking back at the four research objectives outlined at the beginning of this chapter, it’s clear that we have now made significant progress on three of the four—source identification, artifact characterization, and the identification of basin-wide patterns of obsidian use. Continued studies of regional obsidian sources - their geochemistry, occurrence, and boundaries - and the identification of unknown sources (particularly Variety 5) are still warranted and are in progress. Also required are further trace element investigations of artifacts from a larger collection of geographically diverse sites within the basin. These increased numbers of analyzed artifacts will also allow us to look at other related issues such as those of source diversity and sample size. We can also expand the database of interbasin procurement and contact information to include archaeological sites outside the basin in which local Fort Rock Basin sources of obsidian have been found. For example, characterized artifacts from Cougar Mountain have been found at many sites outside the Fort Rock Basin (Skinner and Winkler 1991, 1994; Musil and O’Neill 1997) and will provide clues about the procurement ranges and interaction of prehistoric people from the Fort Rock Basin and surrounding regions.

This large dataset will also provide us with the necessary information with which to examine other more general methodological aspects of obsidian studies. The effect of sample size on diversity in archaeological assemblages is a topic that has received previous attention in the archaeological literature (Leonard and Jones 1989). What is the relationship of the number of analyzed samples and the number of different obsidian sources identified in a characterized assemblage (source diversity)? How many artifacts do we need to analyze in order to be confident that we have identified all significant sources? How does the geographic proximity (distance and direction) of sources relate to obsidian use and source diversity? How does the selection of categories of artifacts for analysis influence the results of provenance studies? For example, it is evident that a greater number of obsidian sources as well as more distant sources are usually found among formed tools such as projectile points and bifaces. How can we strategically select different categories of artifacts to look at different facets of procurement systems? The results of the trace element and hydration analysis of large numbers of Fort Rock Basin artifacts hold the potential to not only reveal details about the prehistory of the basin but also contain the promise of understanding more far-reaching issues related to provenance studies.

Regarding the identification of temporal patterns of obsidian use, we are well under way with the collection of the necessary typological, radiocarbon, and obsidian hydration data needed to clarify our early impressions. When completed and compiled, the chronologic information will allow considerable further refinement of the temporal issues of source use. The early look at Fort Rock Basin obsidian studies presented here clearly points the direction for future related research in the basin. Stay tuned.

**Acknowledgements**

The majority of specimens included in these studies were collected by the UO Archaeological Field School (Northern Great Basin Prehistory Project). Principal funding for the analyses was provided by the Lakeview District, Bureau of Land Management. Dr. Harold Bergen paid for the analysis of the Bergen site artifacts and the Oil Dri Corporation paid for the analysis of the DJ Ranch, Bowling Dune, and Locality III artifacts.
References Cited


Amick, Daniel S.

Andersen, M. E. and J. E. Deacon

Anderson, D. G., L. D. O’Steen, and K. E. Sassaman

1986 Perishable Industries from Dirty Shame Rockshelter, Malheur County, Oregon. Issued jointly as Ethnology Monographs No. 9, Department of Anthropology, University of Pittsburgh and University of Oregon Anthropological Papers No. 34. Pittsburgh and Eugene.

Antevs, Ernst


Atherton, John H.

Babcock, Michael
1996 Fort Rock Basin Archaeology: DJ Ranch Stratigraphic and Lithic Analysis of the Upper Excavation Block, Trench 1. Ms.in University of Oregon archaeological field school files.

Bacon, C. R.

Baker, R. G.

Baldwin, Ewart M.

Bamforth, Douglas B.

Barrett, Samuel A.

Barry, R. G., and R. J. Chorley


Basgall, Mark E.

Batchelder, G. L.

Baxter, Paul W.

Beaton, John M.

Beck, Charlotte and George T. Jones


2003 Were There People in the Great Basin before 12,000 years ago? In On Being First: Cultural Innovation and Environmental Consequences of First Peopling, edited by Jason Gillespie, Susan Tapakka, and Christy de Mille, pp 453-469. Proceedings of the 31th Chacmool Conference,
References Cited

2001. The Archaeological Association of the University of Calgary.


Beckham, Stephen Dow

Bedwell, Stephen F.


Behrensmeyer, Anna K.

Bennhoff, James A. and Richard E. Hughes


Benson, L., and R. S. Thompson

Bergen, Harold G.
1992 Personal Field Notes from Artifact Collecting Trips to the Fort Rock and Christmas Valley Region. On file at the Thomas Burke Memorial Washington State Museum, University of Washington, Seattle.

Berger, A.


Bettinger, Robert L.


Bевill, Russell, Michael S. Kelly, and Elena Nilsson
1994 Archaeological Data Recovery at 35DO37, A Pre-Mazama Site on the South Umpqua River, Douglas County, Oregon. Report to the Umpqua National Forest by Mountain Anthropological Research, Chico, California.

Billings, W. D.

Binford, Lewis R.


Birks, H. J. B. and H. H. Birks

Bocek, Barbara


Bohrer, Vorsilla L.

1977 Ethnobotanical Techniques and Approaches at Salmon Ruin, New Mexico. San Juan Valley Archaeological Project Technical Series 2: Eastern New Mexico Contributions in Anthropology 8(1).

Boldurian, Anthony T.

Carlson, Roy L.


Charnov, E. L.

Carter, J. and D. Dugas

Cheatham, Richard D.

Clark, D. H., and A. R. Gillespie

Cliewlow, C. William

COHMAP Members

Connolly, Thomas J.


Connolly, Thomas J. and William S. Cannon


Connolly, Thomas J., Catherine S. Folwer, and William S. Cannon

Connolly, Thomas J. and Dennis L. Jenkins


Connolly, Thomas J., Dennis L. Jenkins, and Jane Benjamin

Cope, E. D.

Corbet, G. B. and J. E. Hill
1991 *A World List of Mammalian Species*. Oxford University, New York.

Couture, Marilyn

Couture, Marilyn, Mary F. Ricks, and Lucile Housley

Cowles, John

Crabtree, Don E.

Cressman, Luther S.


Cressman, Luther S. and Howel Williams

Cressman, Luther S., Howel Williams, and Alex D. Krieger

Culin, Stewart

Currey, D. R.

Dance, S. P., editor

Daniel, I. Randolph, Jr.

Davis, Emma L. and Richard Shutter, Jr.

Davis, O. K.


1999 Pollen Analysis of a Late-glacial and Holocene Sediment Core from Mono Lake, Mono County, California. *Quaternary Research* 52:243-249.

Deller, D. B., and C. J. Ellis

DeQuille, Dan (William Wright)

Dillian, Carolyn D.

Douglas, M. W., R. A. Maddox, K. Howard, and S. Reyes

Draper, John A.

Droz, Michael S.

Droz, Michael S. and Dennis L. Jenkins

Earle, Timothy K.

Eerkens, Jelmer, Jay King, and Michael D. Glascock

Eiselt, B. Sunday

Ericson, Jonathan E.

Erlandson, Jon M.

Erlandson, Jon M., Rene L. Vellanoweth, Annie and Caruso

Fagan, John L.


References Cited


Fagan, John L. and Gary L. Sage

Ferguson, G. J. and F. W. Libby

Ferring, C. R.

Flenkjen, J. Jeffrey

Forbes, Charles F.

Ford, Richard I.


Fowler, Catherine S.


Fowler, Catherine S. and William J. Cannon

Fowler, Catherine S. and Sven Liljeblad

Fowler, Don D. and Catherine S. Fowler

Franklin, Jerry F. and C. T. Dynnres

Freidel, Dorothy E.


1998 Lake Level Oscillation at Paleolake Chewaucan, Oregon during the Pleistocene-Holocene
References Cited

Freidel, Dorothy E. and Brian L. O'Neill
2001 Pleistocene Lake Chewaucan: Two Short Pieces on
Hydrological Connections and Lake-level
Oscillations. In Quaternary Studies near Summer
Lake, Oregon: Friends of the Pleistocene Ninth
Annual Pacific Northwest Cell Field Trip
September 28-30, 2001, edited by Rob Negrini,
Silvio Pezzopane, and Tom Badger, pp. DF.1-DF.3.

Freidel, Dorothy E., Lynn Peterson, Patricia F. McDowell,
and Thomas J. Connolly
1989 Alluvial Stratigraphy and Human Prehistory of the
Veneta Area, Long Tom River Valley, Oregon:
The Final Report of the Country Fair/Veneta
Archaeological Project. Report to the National
Park Service and the Oregon State Historic
Preservation Office by Oregon State Museum of
Anthropology and Department of Geography,
University of Oregon, Eugene, Oregon.

Friedman, Irving
1968 Hydration Rind Dates Rhyolite Flows. Science
159:878-880.
1977 Hydration Dating of Volcanism at Newberry
Crater, Oregon. U.S. Geological Survey Journal of

Friedman, Irving and William Long

Friedman, Irving and Robert L. Smith
1960 A New Dating Method Using Obsidian, Part I: The
Development of the Method. American Antiquity

Friedman, Irving and Fred Trembour
1983 Obsidian Hydration Dating Update. American
Antiquity 48:544-547.

Friedman, Janet
1978 Wood Identification by Microscopic Examination:
A Guide for the Archaeologist on the Northwest
Coast of North America. British Columbia
Provincial Museum Heritage Record No. 5. British
Columbia, Canada.

Frison, George C.
1993 North American High Plains Paleo-Indian Hunting
Strategies and Weaponry Assemblages. In From
Kostenki to Clovis. Upper Paleolithic-Paleo-
Indian Adaptations, edited by O. Soffer and N. D.

Frison, George C. and B. Bradley
Horse Land and Culture Company, Santa Fe.

Fry, G. F.
1976 Analysis of Prehistoric Coprolites from Utah.
University of Utah Anthropological Papers No. 97.
Salt Lake City.

Gabrielson, Ira N. and Stanley G. Jewett

Galm, Jerry R.
1994 Prehistoric Trade and Exchange in the Interior
Plateau of Northwestern North America. In Prehis-
toric Exchange Systems in North America, edited
by Timothy G. Baugh and Jonathan E. Ericson, pp.

Gasser, Robert E., and E. Charles Adams
1981 Aspects of Deterioration of Plant Remains in
Archaeological Sites: The Walpi Archaeological

Geib, Phil R.
2000 Sandal Types and Archaic Prehistory on the
Colorado Plateau. American Antiquity
63(3):509-524.

Gifford, E.W.
1946 Californian Bone Artifacts. University of
California Publications in Anthropological
Records, Vol. 3. University of California Press,
Berkeley.

Gleason, Henry A. and Arthur Cronquist
1964 The Natural Geography of Plants. New York:
Columbia University Press.

Goodyear, Albert C.
1982 The Chronological Position of the Dalton Horizon
in the Southeastern United States. American
Antiquity 47:382-95.
1989 A Hypothesis for the Use of Cryptocrystalline Raw
Materials Among Paleoindian Groups of North
America. In Eastern Paleoindian Lithic Resource

Gray, Dennis
1993 Analysis of the Fish Lake Artifact Collection, Site
35JA163, Jackson County, Oregon. Report to the
Rogue River National Forest by Cascade Research,
Ashland, Oregon.

Grayson, Donald K.
1979 Mount Mazama, Climatic Change, and Fort Rock
Basin Archaeofaunas. In Volcanic Activity and
Human Ecology, edited by Payson D. Sheets and
1984 Quantitative Zooarchaeology. Academic Press,
New York.
1993 The Desert’s Past. A Natural Prehistory of the
Great Basin. Smithsonian Institution Press,
Washington, D.C.

Grayson, Donald K. and Michael D. Cannon
1999 Human Paleoecology and Foraging Theory in the
Great Basin. In Models for the Millennium: Great
Basin Anthropology Today, edited by Charlotte
Beck, pp. 141-151. University of Utah Press. Salt
Lake City.

Greenspan, Ruth L.
1990 Prehistoric Fishing in the Northern Great Basin. In
Wetlands Adaptations in the Great Basin, edited by
Joel Janetski and David B. Madsen, pp. 207-232.
Museum of Peoples and Cultures Occasional
Papers No. 1.
1993 Analysis of the Buffalo Flat vertebrate faunal
remains. In The Archaeology of Buffalo Flat:
Cultural Resources Investigations for the Conus
References Cited


Hall, E. R. and K. R. Kelson

Hampton, E. R.

Hanes, Richard C.

Harris, Jack S.

Hastorf, Christine, and Virginia S. Popper

Hattori, Eugene M., Catherine S. Fowler, and Pat Barker

Haynes, Gary

Haynes, C. Vance, Jr.


Heiken, Grant H.

Heizer, Robert F.


Heizer, Robert F. and Alex D. Krieger

Heizer, Robert F. and Lewis K. Napton

Helzer, Margaret M.


Hemphill, Brian E.

Hemphill, Brian E. and Clark S. Larsen

Hemphill, Claudia B.

Hibbs, Charles H., Brian L. Gannon, and C. H. Willard

Hirschboeck, K. K.

Hitchcock, C. Leo and Arthur Cronquist

Hodder, Ian

Hoffman, C. C.
1996 Testing the Western Pluvial Lakes Tradition

Hofman, Jack L.

Hofman, Jack L., Daniel S. Amick, and Richard O. Rose

Hofman, Jack L., and Don G. Wycoff

Holliday, V.T.

Holmer, Richard N.

Hostetler, S. W., and F. Giorgi

Hostetler, S. W., F. Giorgi, G. T. Bates, and P. J. Bartlein

Houghton, J. G.

Howard, C. D.

Howe, Carrol B.
1968 *Ancient Tribes of the Klamath Country*. Binfords and Mort, Portland, Oregon.

Hubbs C. L., and R. R. Miller


Hughes, Richard E.

1986 *Diachronic Variability in Obsidian Procurement Patterns in Northeastern California and Southcentral Oregon*. University of California Publications in Anthropology 17, Berkeley, California.


Hughes, Richard E. and R. L. Bettinger

Hughes, Richard E. and James A. Bennyhoff

Hunn, Eugene S.

Hunn, Eugene S. and David H. French

Hutchinson, Phillip W.

Jenkins, Paul C. and Thomas E. Churchill
References Cited

Jenkins, Dennis L.

Jenkins, Dennis L. and C. Melvin Aikens

Jenkins, Dennis L. and Ann Brashear

Jenkins, Dennis L. and Thomas J. Connolly

Jenkins, Dennis L. and Jon M. Erlandson

Jenkins, Dennis L., Margaret M. Helzer, Leah L. Largaespada, and Patrick O’Grady

Jenkins, Dennis L., Guy Prouty, Patricia McDowell, and Vivien Singer

Jenkins, Dennis L., Craig E. Skinner, Jennifer J. Thatcher, and Keenan Hoar

Jenkins, Dennis L. and Nina Wimmers

Jennings, Jesse D.


Kaj, Paul A. 1989 A Perspective on Great Basin Paleoclimates. In Kay, Paul A.


Leney, Lawrence and Richard W. Casteel 1975 Simplified Procedure for Examining Charcoal
References Cited


McDowell, Patricia F. and Harrison, S. P. 1993 Environmental Controls on the Distribution of Lunettes in the Western U.S.A. Manuscript in possession of authors.


Mensing, S. A.

Minnis, Paul E.

Minor, Rick

Minor, Rick and Lee Spencer

Minor, Rick, Stephen D. Beckham, and Kathryn A. Toepel

Minor, Rick and Kathryn A. Toepel

Mitchell, V. L.

Mix, A. C., D. C. Lund, N. G. Pisias, P. Boden, Lbornmalm, M. Lyle, and J. Pike

Mock, C. J.
1994  Modern Climate Analogues of Late-Quaternary Paleoclimates for the Western United States. Ph.D. dissertation, Department of Geography, University of Oregon, Eugene.

Moessner, Jean

Moreman, Daniel E.

Morris, Percy A.

Morrison, R. B.

Moyle, Peter B.

Mueller, Emily J.
2001  A Jackrabbit Dinner Mystery: Zooarchaeological Analysis of a Middle Holocene Site from Southcentral Oregon. Senior Research Paper, Department of Anthropology, University of Oregon, Eugene.

Musil, Robert R.

Musil, Robert R. and Brian L. O’Neill

Myer, William E.

Napton, L. K. and R. F. Heizer
References Cited

Contributions of the University of California Archaeological Research Facility, Berkeley.

Newman, Thomas M.
1965  Cascadia Cave.  Report to the National Park Service by the Department of Anthropology, Portland State College, Portland, Oregon.

Nials, Fred L.

Northwest Research Obsidian Laboratory (NROL)
2003a  Northwest Research Obsidian Studies Laboratory website (www.obsidianlab.com).
2003b  United States Obsidian Source Catalog website (www.sourcecatalog.com).

Nowak, C. L., R. S. Nowak, R. J. Tausch, P. E. Wigand

Oetting, Albert C.
O'Grady, Patrick
1999  Human Occupation Patterns in the Uplands: An Analysis of Sourced Obsidian Projectile Points from Playa Villages in the Fort Rock Uplands, Lake County, Oregon. M. S. Thesis, Department of Anthropology, University of Oregon.
O'Grady, Patrick
1999  Human Occupation Patterns in the Uplands: An Analysis of Sourced Obsidian Projectile Points from Playa Villages in the Fort Rock Uplands, Lake County, Oregon. M. S. Thesis, Department of Anthropology, University of Oregon.
O'Neill, Brian L.
References Cited

O’Neill, Brian L. and Gary Bowyer

O’Neill, Brian L., Thomas J. Connolly, and Dorothy Freidel

O’Neill, Brian L., Vivien Singer, Melissa Cole-Darby, and Laura C. White

O’Neill, Brian L. and Laura C. White

O’Neill, Brian L., Laura C. White, and Mike Droz

Osborn, G., and K. Bevis

Oviatt, C. G.

Ozbun, Terry L. and John L. Fagan

Paul-Mann, Teri

Pavesic, Max G.


Pearsall, Deborah M.


Personius, Stephen F.

Peterson, Roger T.

Peterson, Jane, Douglas R. Mitchell, and M. Steven Shackley

Pettigrew, Richard M.


Pettigrew, Richard M., and Charles M. Hodges

Pinson, Arianne O.


Plog, Fred T.
References Cited

Popper, Virginia S.

Porter, S. C., K. L. Pierce, and T. D. Hamilton

Price, T. Douglas and James A. Brown

Price, T. Douglas and Gary M. Feinman

Prouty, Guy L.


Purdom, William B.

Pyke, C. B.

Quade, J., R. M. Forester, W. L. Pratt, and C. Carter

Raab, Mark L. and William J. Howard

Raven, Christopher and Robert G. Elston

Ray, Verne F.

Rehder, Harald A.


Reid, Kenneth C.

Renfrew, Colin


Rice, David G.

Rice, Prudence M.

Ricks, Mary F. and William J. Cannon

Ridings, Rosanna
References Cited

Ross, Richard E.
Ross, Richard E.
Roth, Barbara J.
Roaizare, Charles E.
Russell, Israel C.
Sampson, C. Garth
Sappington, Robert L.
Sappington, Robert L. and Kathryn A. Toepel
Schalk, Randal, R. G. Atwell, W. R. Hildebrandt, C. G. Lebow, P. Mikkelsen, and R. M. Pettigrew
Schmitz, J. T., and S. L. Mullen
Schneider, J. K.
Schreindorfer, Crystal S.
Schulting, Rick J.
Scott-Cummings, Linda
Scott-Cummings, Linda and Kathryn Puseman
Sea, D. S. and Cathy Whitlock
Shackley, M. Steven
Shipman, Pat, Giraud Foster, and Margaret Schoeninger
Shott, M. J.
Shutler, Richard Jr.
Simms, Steven R.
Simms, Cookie E., Gina Harris, and Malinda Wells
2000 The Bergen Main House Unit 3 Faunal Remains. Notes in possession of the authors.
Singer, Vivien J. and Guy L. Tasa
1999 Faunal Remains from the Paulina Lake Site. In Newberry Crater: A Ten-Thousand-Year Record of Human Occupation and Environmental Change in

Skinner, Craig E.


Skinner, Craig E., M. Kathleen Davis, and Thomas M. Origer

Skinner, Craig E. and Jennifer J. Thatcher
2003 Results of XRF and Obsidian Hydration Studies: Paisley Fivemile Point Cave (35-LK-3400), Lake County, Oregon. Northwest Research Obsidian Studies Laboratory, Corvallis, Oregon.

Skinner, Craig E. and Carol J. Winkler


Smiley, T. L.

Smith, G. L., and F. A. Street-Perrott

Snyder, Sandra L.
1981a Medicine Creek. Report to the Umpqua National Forest by the Department of Anthropology, Oregon State University, Corvallis.


Spaulding, W. Geoffrey
1990 Vegetation Dynamics during the Last Deglaciation, Southeastern Great Basin, USA. Quaternary Research 33:188-203.


Spaulding, W. Geoffrey, and L. J. Graumlich

Spaulding, W. Geoffrey, E. B. Leopold, and T. R. Van Devender

Spier, Leslie

Sprague, Roderick

Stenholm, Nancy

<table>
<thead>
<tr>
<th>Year</th>
<th>Author(s)</th>
<th>Title and Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>1982</td>
<td>Thompson, R. S.</td>
<td>Late Quaternary Environments and Biogeography in the Great Basin. <em>Quaternary Research</em> 17:39-55.</td>
</tr>
</tbody>
</table>
References Cited

Toepel, Kathryn A. and Stephen D. Beckham

Toepel, Kathryn A. and Ruth L. Greenspan

Toepel, Kathryn A., Rick Minor, and William F. Willingham

Toll, Mollie S.

Train, P., J. R. Heinrichs, and W. A. Archer

Tuohy, Donald R.

Turner, R. M.

Van Devender, T. R., R. S. Thompson, and J. L. Betancourt

Van Dyke, W. A., A. Sands, J. Yoakum, A. Polenz, and J. Blaisdell

Vellanoweth, René L.


Villa, P. and J. Courtin

Voegelin, Erminie W.

Von Post, L.

Walker, G. W. and N. S. MacLeod

Walsh, Michael R.

Warren, Claude N., and C. Phagan

Wells, P. V.

Wheat, Margaret M.
1967 *Survival Arts of the Primitive Paiutes.* University of Nevada Press, Reno.

Whiting, Beatrice B.

Whitlock, Catherine and Patrick J. Bartlein

Wigand, Peter E.

Wigand, Peter E. and David Rhode

Wilkins, D. E., and D. R. Currey

Williams, Shirley B. and John L. Fagan
References Cited


Willig, Judith A.


Willig, Judith A. and C. Melvin Aikens


Wingard, George F.


Winthrop, Kathryn

Womack, Bruce R.

Wright, Jessie L.

Yohe, R. M., M. E. Newman, and J. S. Schneider

Zalunardo, R. A.

Zenk, Henry B. and Bruce Rigsby

Zielinski , G. A., and W. D. McCoy