

CHAPTER 11

Ancient Trade Routes for Obsidian Cliffs and Newberry Volcano Toolstone in the Pacific Northwest

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Obsidian has been recognized throughout the world as an important trade commodity in societies dependent on lithic tools, in regions as diverse as the Mediterranean, Micronesia, Asia, and the Americas (Ammerman 1985; Ayres et al. 1997; Baugh and Nelson 1987; Braswell 2003; Carlson 1994; Glascock 2003; Glascock et al. 2006; Grier 2003; Kuzmin and Glascock 2007; Kuzmin et al. 2008; Santley 1984). In the Pacific Northwest of North America, obsidian and other goods were distributed via a far-reaching trade network, involving the Columbia and Fraser river systems and the intervening coastal zone from southern British Columbia to Oregon (Anastasio 1972; Carlson 1994; Hayden and Schulting 1997; Ray 1939; Stern 1998). Hayden and Schulting (1997) note commonalities in exotic materials, crafted prestige items, marine shell ornaments, and sculpted bone and stone artifacts throughout a “Plateau Interaction Sphere,” distributed between important economic centers, including principal exchange nodes at The Dalles on the lower Columbia River and at the Thompson-Fraser river confluence in southern British Columbia. Taking a coastal perspective, Ames and Maschner (1999:170) similarly note a southern Northwest Coast “obsidian exchange network” that includes lands bordering the Salish Sea (Gulf of Georgia-Strait of Juan de Fuca-Puget Sound), and extending

south to the lower Columbia River region. In addition to economic connections, they note a number of distinctive cultural traits shared throughout this region, including cranial reshaping, anthropomorphic stone bowls, common artistic motifs in carved pumice, antler, and clay, whale bone and zoomorphic clubs, and other artifacts (also see Connolly 1992; Duff 1956; Wingert 1952).

Charting the geography of exchange networks has been facilitated by the use of x-ray fluorescence and other techniques which provide inexpensive and non-destructive means of identifying diagnostic trace element profiles of both subject artifacts and their geologic sources. As a result, geochemical “fingerprinting” of artifact obsidian has become standard practice in archaeological studies, and, especially in regions where obsidian is abundant, extensive source data have been compiled.

Carlson (1994) has noted that a significant proportion of artifact obsidian from sites in southern British Columbia has been traced to Oregon sources (Figure 11-1). Artifact obsidian at these sites derive predominantly from source localities near the headwaters of Oregon’s Deschutes and John Day Rivers, including Obsidian Cliffs, Newberry Volcano, Glass Buttes, and a “John Day” source that is likely the widely distributed geochemical type most commonly

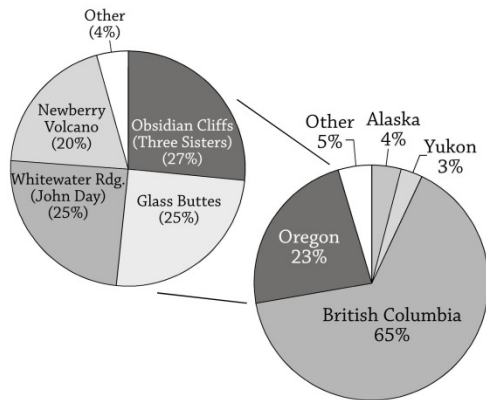


Figure 11-1. Proportion of British Columbia obsidian artifacts by source area (after Carlson 1994).

identified in Oregon as Whitewater Ridge (Skinner 2008). Hughes and Connolly (1999) have previously shown that obsidian systematically quarried from one of these sources—the Newberry Volcano obsidian flows in central Oregon—was used most extensively in the Deschutes River basin to the north, and commonly distributed in trade farther north along the spine of the Cascade Range and then throughout the region bordering the Salish Sea. The present research, similar in scope and design to the earlier Newberry Volcano study, is aimed at mapping the geographic distribution of obsidian quarried from the culturally important Obsidian Cliffs source. We find that, apart from a slightly more westerly bias, material from the Obsidian Cliffs exhibits similar geographic, and possibly temporal, distributions as the Newberry obsidian, suggesting that both were parts of the same economic network, primarily employed by consumers to the north.

The Newberry Volcano Obsidian Quarries: A Review

Newberry Caldera is at the center of the massive Newberry shield volcano. Located about 40 miles east of the Cascade Range crest, it marks the hydrologic divide between the Columbia River Plateau to the north and the Great Basin to the south. The caldera saw regular residential use in the early Holocene, most notably at the Paulina Lake site (Connolly 1999). About 7600 years ago the caldera was buried by nearly a meter of airfall tephra from the eruption of Mt. Mazama, a major

Cascade Range Volcano; this event was soon followed by extensive eruptive activity within the Newberry Caldera itself. These events dramatically changed the landscape in the caldera neighborhood, creating a biotic desert that would have significantly diminished its biotic values for hunter-gatherer communities. On the other hand, among these eruptive events were numerous obsidian flows, including the geochemically indistinguishable Interlake, Central Pumice Cone, Game Hut, and East Lake flows. These were extruded between ca. 7000 and 3000 years ago, and together make up the Newberry Volcano geochemical type (Connolly and Hughes 1999; Hughes 1988; Laidley and McKay 1971; Skinner 1983).

Other chemically distinguishable obsidian flows are present in the caldera, including the Buried Flow (exposed prior to ca. 7600 years ago but rendered largely inaccessible by subsequent volcanic activity), and the Big Obsidian Flow, which erupted about 1300 years ago (Friedman 1977; Linneman 1990; MacLeod et al. 1995; MacLeod and Sherrod 1988). Obsidian from neither of these sources commonly occurs beyond the immediate vicinity of Newberry Volcano (Hughes and Connolly 1999), which suggests that these obsidians, most accessible in early Holocene times and during the most recent millennium, respectively, experienced fundamentally different economic circumstances than the Newberry Volcano geochemical type. Many sites have been identified within the caldera, and most—particularly those of middle and late Holocene age—are quarry stations or satellite lithic workshops dominated by early and middle stages of lithic reduction and the production of large bifacial blanks (Ozbun 1991).

Although the caldera apparently saw some residential use in the early Holocene, there is no evidence for sustained occupations during middle and late Holocene times, when activities in the caldera appear to have been focused almost exclusively on toolstone procurement and the production of quarry blanks for transport away from the quarry source (Connolly 1999). The extent of lithic reduction activities in the caldera is indicated by massive quantities of lithic reduction debris, especially notable in light of a general absence of domestic features and a paucity of evidence for hunting, harvesting, food processing,

and other subsistence activities. The tool assemblage is dominated by large quarry blanks and preforms, with only modest occurrences of other tool classes (Figure 11-2). This contrast suggests that obsidian toolstone procurement in the caldera during middle Holocene and later times was not simply an activity embedded into a complex of hunter-gatherer routines, but a targeted activity on a scale that suggests a commercial enterprise.

Questions relating to the trajectory of Newberry Volcano obsidian beyond the caldera were addressed by Hughes and Connolly (1999), with the development of a contour map illustrating the distribution of Newberry Volcano obsidian (Figure 11-3). Contour values were generated by using the proportion of Newberry Volcano obsidian to all sourced specimens from each site where it was present. Ten-percent contour intervals were used, with the lower limit set at 20%, since the decreasing frequency of data points at the outer limits of the map made the contouring increasingly unreliable. Beyond the 20% contour interval, occurrences are simply represented by dots.

The results show a strongly directional distribution of Newberry obsidian to the north, traveling primarily through the Deschutes River basin. Some Newberry obsidian continued north, possibly along the spine of the Cascades, and into the Salish Sea (Puget Sound-Gulf of Georgia) region. This movement was no doubt facilitated by proximity of the Newberry source to the regional trading center at The Dalles, which provided a distribution point throughout the larger Columbia Plateau or southern Northwest Coast interaction spheres. By contrast, there is little suggestion that Newberry obsidian was conveyed in any quantity to the south.

The Obsidian Cliffs Quarry

More recently, we had the opportunity to examine a complex of sites at the northeast shore of Suttle Lake, located on the east flank of the Cascade Range about 55 miles northwest of Newberry Caldera. Like the Newberry sites, those at Suttle Lake exhibited the features of quarry-related lithic reduction workshops, with dense lithic reduction debris and a tool assemblage dominated by mid-stage bifaces (Figure 11-4). However, the obsidian reduction debris was derived exclusively from Obsidian Cliffs, an important source located on the

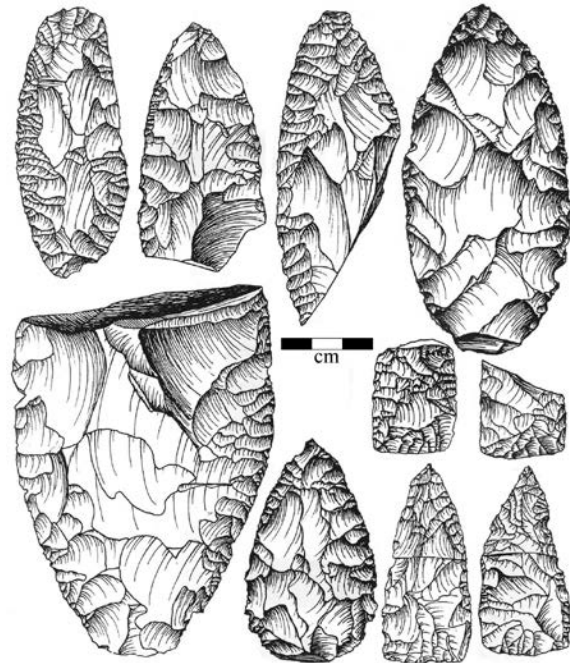


Figure 11-2. Newberry quarry bifaces from sites 35DS219 and 35DS34 (from Connolly 1999).

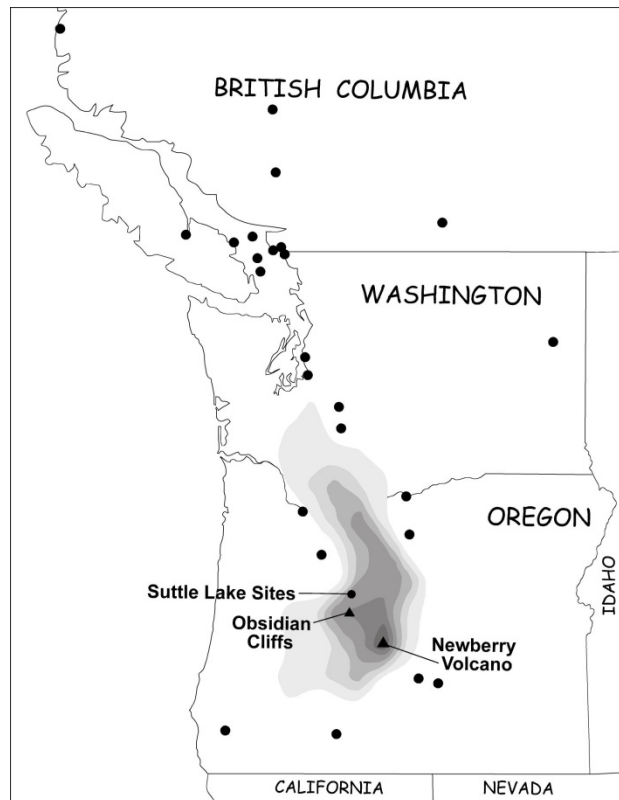


Figure 11-3. Distribution of Newberry Volcano obsidian beyond the Newberry Caldera, and the relative positions of the Obsidian Cliffs quarry and the Suttle Lake/Lake Creek site complex.



Figure 11-4. Bifaces of Obsidian Cliffs obsidian from the Suttle Lake/Lake Creek site.

west flank of the North Sister mountain peak in the High Cascades about 15 miles south of Suttle Lake.

Obsidian Cliffs obsidian has been found at many archaeological sites, particularly in western and central Oregon, and it is clear that this was a major toolstone source throughout the post-glacial period (Skinner 1995; Skinner and Winkler 1991, 1994; Musil and O'Neill 1997). It has been noted at the Paulina Lake site (within Newberry Caldera) in components dating between 11,000 and 7000 years ago (Connolly 1999), and at the 10,000 year old 45KT1362 site in central Washington (Galm and Gough 2000), and at Cascadia Cave in the South Santiam River drainage, where 96% of characterized obsidian from the nearly 9000 year-long occupation sequence is from Obsidian Cliffs (Baxter 1986, 2007). Numerous archaeological sites of the High Cascades near Obsidian Cliffs appear to be lithic reduction stations related to quarrying activity (Fagan et al. 1992; Jenkins 1988; Jenkins and Churchill 1988; Minor and Toepel 1984; Winthrop and Gray 1985).

Based on reported occurrences of Obsidian Cliffs material in the Oregon Cascades, it appears that Obsidian Cliffs material, like the Newberry Volcano obsidian, was primarily carried northward. Skinner and Winkler (1994) report that Obsidian Cliffs material represents about 85% of obsidian at sites on Willamette National Forest lands in the McKenzie River subbasin west of the Cascade crest, and 72% of obsidian in the Clackamas and Santiam sub-basins to the north (cf. Kelly 2001, 2003). This proportion decreases dramatically to

the south; although Obsidian Cliffs is located near the head of the Middle Fork Willamette subbasin, toolstone from this source is just 34% of identified obsidian in the Middle Fork basin. In the Umpqua Basin to the immediate south, just 8% of identified obsidian is from Obsidian Cliffs (Skinner and Winkler 1994).

To more systematically evaluate the distribution dynamics of this widely used obsidian, we produced a comprehensive map. For this effort, we relied primarily on the obsidian sourcing data bank of co-author Craig Skinner's Northwest Research Obsidian Studies Lab, as well as a small amount of published data from other sources. We identified a total of 550 distinct sites in Oregon, Washington, and British Columbia from which at least one artifact of Obsidian Cliffs material was identified.

As with the Newberry data, a distribution and density contour map was then generated, in a two step process, using the percentage of Obsidian Cliffs material identified in each assemblage where it was present. We elected to limit our mapping universe to sites from which 20 or more obsidian specimens had been sourced. As a result, our final sample used for contouring was reduced from 550 to 188 sites. We used Surfer mapping software to produce a contour map with 5% contour intervals, using site latitude and longitude for X and Y coordinates. The lowest contour value was set at 20%, as the decreasing frequency of data points at the outer limits of the map made the contouring increasingly unreliable. Occurrences beyond the 20% contour were simply represented by dots to indicate presence (Figure 11-5).

As expected, the Obsidian Cliffs obsidian shows a strong northerly bias, nearly matching that previously mapped for the Newberry Volcano source, and reinforcing attention to the Cascade uplands as a possible transport corridor. Apart from a small amount of Obsidian Cliffs material that travels down along the crest of the Cascade Range and into the upper North Umpqua River drainage, there is little movement south. By contrast, most Obsidian Cliffs material travels north along the spine of the Cascades, and is commonly found in the Willamette Valley to the west and northwest. In the southern and Central Willamette Valley, Obsidian Cliffs glass could also have been procured from local secondary deposits of McKenzie and Willamette river gravels. It apparently follows main river systems draining the western Cascades,

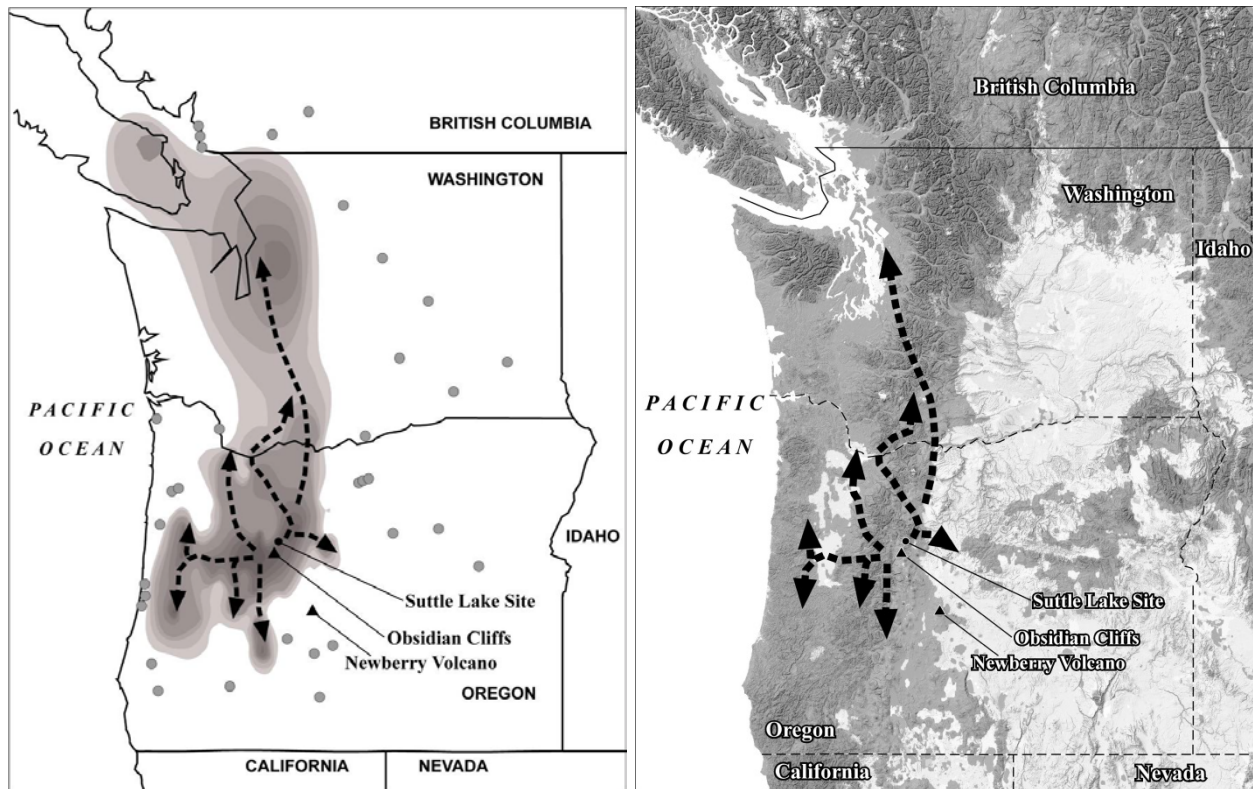


Figure 11-5. Left: Contour distribution map of Obsidian Cliffs (OC) obsidian, based on percentage of OC to all sourced specimens in 188 sites. Dots represent additional occurrences where OC obsidian accounts for less than 20% of the total sample. Right: Inferred Obsidian Cliffs distribution routes overlying a landform map (base map modified from Google maps).

probably a reflection of critical travel routes. Principal corridors include the McKenzie, Santiam, and Clackamas river systems. The appearance of Obsidian Cliffs obsidian in the northwest Umpqua Basin appears to reflect a link to the Yoncalla via their Kalapuya linguistic relatives in the Willamette Valley, rather than movement of material down the Umpqua River. Movement of material north of the Columbia River appears to follow the Cascade Range to the Puget Sound area and regions even farther north, possibly passing through trading centers at The Dalles or in the Portland Basin.

Chronology and Social Context of the Newberry and Obsidian Cliffs Quarries

Although Newberry Volcano obsidian dominates in the Deschutes Basin sites, Obsidian Cliffs material is also common, and, at a number of residential sites in the basin, is the predominant material type (Jenkins and Connolly 1994, 1996). In the western Cascades where Obsidian Cliffs obsidian is most

common, Newberry Volcano obsidian regularly co-occurs with it (Skinner and Winkler 1994). This regular co-occurrence suggests that even though these two sources served slightly different geographies, both functioned as companion elements within a larger, common economic community.

Because the obsidian flows of the Newberry Volcano geochemical type are post-Mazama in age, toolstone procurement from these quarries was necessarily an activity in the post-Mazama period (middle and late Holocene). More specifically, most intensive quarrying activity appears to have occurred after ca. 4000 years ago, and prior to ca. 1000 years ago (Connolly 1999:237; Davis and Scott 1991:53) During this time there appears to have been a specialized production of bifacial implements for export from the quarries. Numerous biface caches sourced to both Newberry Volcano and Obsidian Cliffs have been identified in central Oregon and in the Cascade Range (Bennett-Rogers 1993; Marschall 2004; Scott et al. 1986; Swift

1990; Winthrop and Gray 1985). The biface caches, which feature both high numbers of bifaces and uniform production qualities, support the interpretation of obsidian as a commoditized product that was a factor in intergroup commerce, and not simply procured for local needs (Figure 11-6).

In his review of trade and exchange in British Columbia, Carlson focused on obsidian because it is a trackable commodity. To be sure, obsidian is not terribly abundant at BC sites, and, not surprisingly, most obsidian in BC sites is from BC sources. However, Carlson found that nearly a quarter of traced obsidian in British Columbia sites is from Oregon sources. Of these, four are most prominently represented, including Newberry Volcano, Obsidian Cliffs (which Carlson identifies as the “Three Sisters” source), Glass Buttes, and one from the John Day area, almost certainly the source most commonly identified as Whitewater Ridge (refer to Figure 11-1).

We have drawn on data in this study from the Obsidian Cliffs and Newberry Volcano sources. We know that both sources are near the southern limits of the Columbia Basin, and near the northern edge of the Great Basin. The other two sources commonly found in British Columbia are similarly located near this important hydrologic and cultural boundary. Though we have yet to systematically examine the distribution of obsidian from these more easterly sources, we predict that they, too, will be found to be quarried most intensively by southern Columbia Plateau communities for distribution northward.

The emergent model suggests that a small number of prominent obsidian sources located near the Columbia Plateau-Northern Great Basin boundary were most intensively quarried by people to the north, serving as an important commodity in a regional exchange system that extended well into British Columbia.

In reviewing the use history of the Newberry Volcano obsidian quarries, Connolly (1999) found diminished use during the last millennium, indicating changes to the interaction sphere by which obsidian was earlier distributed. This change may correlate to settlement pattern changes documented on the southern Columbia Plateau; as noted by Endzweig (1994:12), “[t]he high density of archaeological sites recorded along the John Day River as contrasted with its limited treatment in



Figure 11-6. Bifaces of Obsidian Cliffs obsidian from the Paul’s Fire Cache site.

ethnographic and historic accounts supports the impression of a population reorganization” during the last millennium. Archeological surveys have documented the presence of many housepit village clusters throughout the southern Columbia Plateau, extending along the middle and upper drainages of the Deschutes and John Day rivers (Hibbs et al.1976; Polk 1976; Endzweig 1994); for example, Jenkins and Connolly (1994) found that the Paquet Gulch site, a large village with 75 to 100 housepits not far from the Deschutes River town of Maupin, was occupied as early as ca. 2500 years ago but produced little evidence for occupation within the last ca. 1300 years. Endzweig (1994) reports that housepit sites on the upper John Day were most intensively occupied between ca. 2600 and 900 years ago; many sites continued to be regularly used after this time, but probably not as residential places. This pattern varies notably from the settlement distribution documented historically, in which residential centers were arrayed along the Columbia River corridor (Murdock 1938; Rigsby 1965; Suphan 1974). When fur trade or military parties encountered southern Columbia Plateau

Sahaptins in the upper Deschutes and John Day regions during the early nineteenth century, they were generally at temporary hunting camps and accompanied by horses (Young 1899; Fremont 1887).

The apparent withdrawal from residential centers in the upper Deschutes and John Day basins during the last millennium may not have been abrupt, and may have been a response to multiple factors. Dumond and Minor (1983) see a reorientation of focus on the middle Columbia River from upstream to the downriver Chinook area after ca. 1000 BP, possibly in response to growing economic opportunities along the Columbia River corridor. Lewis and Clark marveled at the constant trade activity along the river, and Clark's remark that The Dalles vicinity was "the great mart of all this country" is well known (Thwaites 1905:4:289). The Lower Columbia area was but one important center for a region-wide Pacific Northwest/Northwest Coast exchange network. Throughout the region economic activity was controlled and managed by powerful elites, representing resource-controlling corporate households and lineages who maintained their position in part by their central role in the wide-ranging exchange economy (Ames 2006; Ames and Maschner 1999; Sobel 2006, 2012).

Another factor may have been an increasing level of hostility between southern Columbia Plateau Sahaptins and Northern Paiutes over the course of the last millennium (Kelly 1932; Murdock 1938; Ray 1938; Spier and Sapir 1930; Stewart 1938; Sutton 1986; Teit 1928) that led to the abandonment of small, isolated and vulnerable hamlets in favor of larger and more secure population centers (Endzweig 1994; Jenkins and Connolly 1994; Connolly 1999).

Whatever the motivations, it is clear that by the time of contact what had been the major Plateau obsidian sources were firmly within lands occupied by the Northern Paiutes, who had established residential centers in the upper Deschutes, John Day, and Crooked River basins (Stewart 1939; Fowler and Liljebblad 1986; Figure 11-7). Lewis and Clark reported that, in 1805, the name given for the Deschutes River by the Columbia River Indians was "the river on which the Snake Indians live" (Thwaites 1905:3:147). While there are notable exceptions (Couture et al. 1986; Hunn 1990), the documented attitude of hostility between Plateau

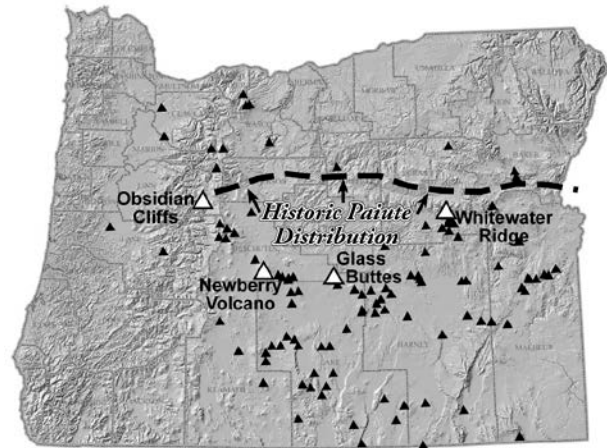


Figure 11-7. Location of the major Plateau prehistoric obsidian sources, in relation to Paiute territory at contact.

Sahaptins and their Paiute neighbors to the south must have had some impact on access to and procurement of obsidian from these sources by Plateau consumers (cf. Connolly 1999:242-243).

While access to some of the southernmost obsidian sources may have been diminished for southern Plateau folks during the last millennium, trade activity was accelerating along the Columbia River corridor (Dumond and Minor 1983; Hayden and Schulting 1997). How this change in the obsidian trade within the last millennium affected economic dynamics west of the Cascades remains largely unexplored, but one possible change is an elevated role of west-side obsidian, possibly including Obsidian Cliffs, and most notably the Inman Creek material from the Willamette Valley. Inman Creek obsidian was probably originally extruded from Western Cascades vents in the upper Middle Fork Willamette River basin, but is now widespread in Pleistocene-deposited Willamette River gravels.

A dramatic increase in the occurrence of obsidian at later Willamette Valley sites was first noted by Pettigrew (1980:66-67), who suggested that this increase may have been related to introduction of the bow and arrow, estimated to have occurred in the valley within the last ca. 2000 years. Since the Inman Creek obsidian most readily available in the Willamette River gravels occurs primarily as pebble-sized nodules, obsidian would have been of relatively limited use for the production of stone dart tips, which were typically reduced from larger bifacial preforms. The much

smaller arrow points, by contrast, were frequently made on flakes, immediately making the local obsidian a significantly more valuable raw material. A manifold increase in the occurrence of projectile points in the Willamette Valley in later sites has also been noted as evidence for an increasing concern with security (Aikens et al. 2011:308-309; Jacobs et al. 1945:191-193; Zenk 1976:5-6).

From the present study, another possibility emerges for the dramatic increase of Willamette Valley obsidian in later sites. Diminished access for consumers along the Columbia River corridor to eastern Oregon obsidian sources may have enhanced its market value. One of the larger samples of sourced obsidian from the Willamette Valley is from the cluster of sites bordering the former channel of Mill Creek, in the vicinity of the modern I-5/Oregon Highway 22 interchange near Salem. The sites represent mostly continuous use throughout the past ca. 6000 years, with intense use periods between ca. 5000 and 3500 years ago and again during the last ca. 2000 years. Of 466 tested obsidian artifacts, 98% were sourced to either Obsidian Cliffs or the local Inman Creek sources. Of this number, 92% were Inman Creek obsidian, and 8% were from Obsidian Cliffs, but they were not equally distributed through time.

A number of obsidian hydration studies have suggested that Inman Creek obsidian hydrates at a relatively slow rate on the valley floor. Minor (1977, 1985) proposed hydration rates of $1.3\mu^2/1000$ years for the Portland Basin and $1.6\mu^2/1000$ years for the upper Willamette Valley, based on small sets of paired hydration values and radiocarbon dates. Connolly and O'Neill (2004) suggest a rate of $1.9.0\mu^2/1000$ years for Inman Creek obsidian in the upper Willamette Valley, based on Inman Creek obsidian from radiocarbon-dated contexts at the Chalker site (35LA420). This rate, which we apply to the Mill Creek sites, is slightly faster than Minor's preliminary rate, but still considerably slower than other Oregon obsidians, including Obsidian Cliffs. Based on their research on hydration rates for many eastern Oregon obsidians, Pettigrew and Hodges (1995) have found that Obsidian Cliffs and Newberry Volcano obsidians hydrate at comparable rates. Adjusting the experimentally induced hydration rate for Newberry Volcano obsidian reported by Friedman and Long (1976) and Friedman and Obradovich (1981) to the effective hydration

temperature calculated for the Salem recording station, provides a hydration rate of $3.6\mu^2/1000$ years that we apply to the Obsidian Cliffs material. Calibrated ages are shown in Figure 11-8.

The use of Obsidian Cliffs material exhibits a gradual increase through time, but about 45% of obsidian from this source at Mill Creek predates ca. 1500 BP, and 55% occurs after that time. By contrast, about 84% of Inman Creek material appears to post-date ca. 1500 BP, representing a dramatic surge in the use of this local material. Looking beyond the valley, Inman Creek obsidian also appears to have assumed a position of importance in regional trade; at villages on the lower Columbia occupied only during the last millennium, the proportion of Inman Creek obsidian far exceeds that of eastern material (Sobel 2006). The implication is that Inman Creek obsidian was commoditized during the last ca. 1500 years, enhancing its value and range of distribution in the Willamette Valley/Lower Columbia region. Whether this is a function of enhanced trade opportunities in the lower Columbia Basin or of diminished access to eastern Oregon obsidians, or both, remains unresolved at present.

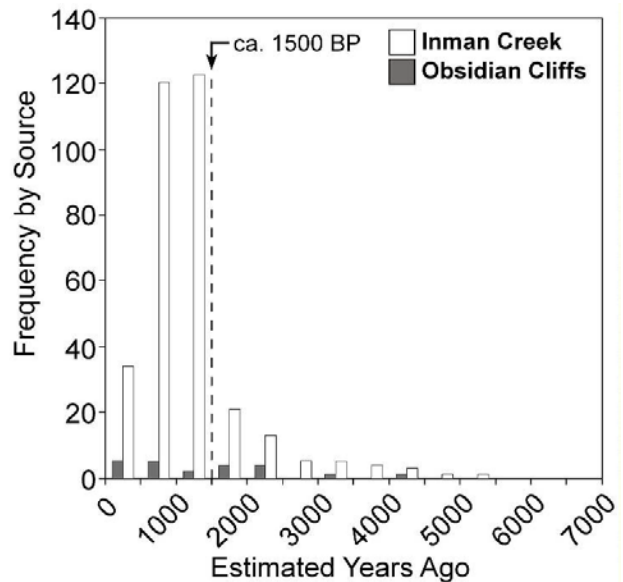


Figure 11-8. Relative proportions of Inman Creek vs. Obsidian Cliffs obsidian through time at the Mill Creek sites, central Willamette Valley.

In summary, Obsidian Cliffs, like obsidian from Newberry Volcano, was not only an important local

toolstone material, but was a commoditized product systematically quarried and shaped into uniform, transportable forms and transferred to distant consumers through a regional exchange network with centers on the lower Columbia River and the Salish Sea regions. Though systematic studies have yet to be pursued, it is likely that several other eastern Oregon obsidian sources located near the southern rim of the Columbia Plateau region (most notably Glass Buttes and Whitewater Ridge) also primarily served northern consumers who participated in this exchange network. Further, it appears that during the most recent millennium, changing social dynamics may have reduced access to these eastern sources by northern consumers, while at the same time the intensity of commerce on the lower Columbia River accelerated. These factors may have served to enhance the value of the Willamette Valley's Inman Creek obsidian.

We are still some distance from fully understanding the driving forces of these regional economic patterns, but it is clear that understanding local chronologies and social dynamics depends on placing them within a much broader regional economic context.

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References Cited

- Aikens, C. Melvin, Thomas J. Connolly, and Dennis L. Jenkins
2011 *Oregon Archaeology*. Oregon State University Press, Corvallis.
- Ames, Kenneth M.
2006 Thinking About Household Archaeology on the Northwest Coast. In *Household Archaeology on the Northwest Coast*, edited by Elizabeth A. Sobel, D. Ann Trieu Gahr, and Kenneth M. Ames, pp. 16-36. International Monographs in Prehistory, Ann Arbor, Michigan.
- Ames, Kenneth M. and Herbert D. G. Maschner
1999 *Peoples of the Northwest Coast: Their Archaeology and Prehistory*. Thames & Hudson, New York.
- Ammerman, A. J.
1985 The Acconia Survey: Neolithic Settlement and the Obsidian Trade. Distributed by Left Coast Press, Walnut Creek, California; originally published as Institute of Archaeology Paper 10, University College, London.
- Anastasio, Angelo
1972 The Southern Plateau: An Ecological Analysis of Intergroup Relations. *Northwest Anthropological Research Notes*, 6(2):109-229.
- Ayres, William C., Gordon G. Gales, and Felicia R. Beardsley
1997 Provenance Study of Lithic Materials in Micronesia. In *Prehistoric Long-Distance Interaction in Oceania: An Interdisciplinary Approach*, edited by Marshall I. Weisler, pp. 53-67. New Zealand Archaeological Association Monograph 21, Auckland.
- Baugh, Timothy G. and Fred W. Nelson
1987 New Mexico Obsidian Sources and Exchange on the Southern Plains. *Journal of Field Archaeology* 14:313-329.
- Baxter, Paul W.
1986 Archaic Upland Adaptations in the Central Oregon Cascades. Ph.D. Dissertation, Department of Anthropology, University of Oregon, Eugene.
2007 Obsidian Studies at Cascadia Cave, South Santiam Drainage, Linn County. Paper presented at the Association of Oregon Archaeologists Annual Meeting, Salem.
- Bennett-Rogers, Ann C.
1993 Paul's Fire Cache (35LIN542), A Biface Cache from the Western Slope of the Cascades, Oregon. *International Association for Obsidian Studies Bulletin* 9:3-4.
- Braswell, Geoffrey E.
2003 Obsidian Exchange Spheres of Postclassic Mesoamerica. In *The Postclassic Mesoamerican World*, edited by M. Smith and F. Berdan, pp. 131-158. University of Utah Press, Salt Lake City.
- Carlson, Roy L.
1994 Trade and Exchange in Prehistoric British Columbia. In *Prehistoric Exchange Systems in North America*, edited by Timothy G. Baugh and Jonathon E. Ericson, pp. 307-361. Plenum Press, New York.
- Connolly, Thomas J.
1992 *Human Responses to Change in Coastal Geomorphology and Fauna on the Southern*

- Northwest Coast: Archaeological Investigations at Seaside, Oregon.* University of Oregon Anthropological Papers 45, Eugene.
- 1999 *Newberry Crater: A Ten-Thousand-Year Record of Human Occupation and Environmental Change in the Basin-Plateau Borderlands.* University of Utah Anthropological Papers No. 121, Salt Lake City.
- Connolly, Thomas J. and Richard E. Hughes
1999 Geochemical Characterization of the Newberry Caldera Obsidian Flows. In *Newberry Crater: A Ten-Thousand-Year Record of Human Occupation and Environmental Change in the Basin-Plateau Borderlands*, by Thomas J. Connolly, pp. 151-156. University of Utah Anthropological Papers No. 121, Salt Lake City.
- Connolly, Thomas J. and Brian L. O'Neill
2004 Obsidian Studies. In *A Holocene Geoarchaeological Record for the Upper Willamette Valley, Oregon: The Long Tom and Chalker Sites*, by Brian L. O'Neill, Thomas J. Connolly, and Dorothy E. Freidel, pp. 203-209. University of Oregon Anthropological Papers 61, Eugene.
- Couture, Marilyn, Mary F. Ricks, and Lucile Housley
1986 Foraging Behavior of a Contemporary Northern Great Basin Population. *Journal of California and Great Basin Anthropology* 8(2):150-160.
- Davis, Carl M., and Sara Scott
1991 The Lava Butte Site Revisited. *Journal of California and Great Basin Anthropology* 13(1):40-59.
- Duff, Wilson
1956 *Prehistoric Stone Sculpture of the Fraser River and Gulf of Georgia.* Anthropology in British Columbia, No. 5. British Columbia Provincial Museum, Victoria.
- Dumond, Don E. and Rick Minor
1983 *Archaeology in the John Day Reservoir: The Wildcat Canyon Site, 35GM9.* University of Oregon Anthropological Papers No. 30, Eugene.
- Endzweig, Pamela E.
1994 Late Archaic Variability and Change on the Southern Columbia Plateau: Archaeological Investigations in the Pine Creek drainage of the Middle John Day River, Wheeler County, Oregon. Ph.D. dissertation, Department of Anthropology, University of Oregon, Eugene.
- Fagan, John L., David V. Ellis, F. Paul Rushmore, and Douglas C. Wilson
1992 Archaeological Data Recovery Investigations at the Canyon Owl Site (35LIN336), Linn County, Oregon. Archaeological Investigations Northwest Report No. 20, on file at the Oregon State Historic Preservation Office, Salem.
- Fowler, Catherine S. and Sven Liljeblad
1986 Northern Paiute. In *Great Basin: Handbook of North American Indians, Vol. 11*, edited by Warren L. d'Azevedo, pp. 435-465. Smithsonian Institution, Washington D.C.
- Friedman, Irving
1977 Hydration Dating of Volcanism at Newberry Crater, Oregon. *Journal of Research of the U.S. Geological Survey* 5:337-342.
- Friedman, Irving and William Long
1976 Hydration Rate of Obsidian. *Science* 191:347-352.
- Friedman, Irving and John Obradovich
1981 Obsidian Hydration Dating of Volcanic Events. *Quaternary Research* 16:37-47.
- Fremont, John C.
1887 *Memoirs of My Life, Including in the Narrative Five Journeys of Western Exploration, During the Years 1842, 1843-44, 1845-6-7, 1848-49, 1853-54.* Belford, Clarke & Co., Chicago.
- Galm Jerry R. and Stan Gough
2000 Site 45KT1362, A ca. 10,000 B.P. Occupation in Central Washington. *Current Research in the Pleistocene* 17:29-31.
- Glascok, Michael D. (editor)
2003 *Evidence for Long Distance Exchange.* Bergin and Garvey, Westport, CT.
- Glascok, Michael D., Vladimir K. Popov, Yaroslav V. Kuzmin, Robert J. Speakman, Andrei V. Ptashinsky, and Andrei V. Grebenniko
2006 Obsidian Sources and Prehistoric Obsidian Use on the Kamchatka Peninsula. In *Archaeology in Northeast Asia on the Pathway to Bering Strait*, Edited by Don E. Dumond and Richard L. Bland, pp. 73-88. University of Oregon Anthropological

- Papers 65, University of Oregon Museum of Natural and Cultural History, Eugene.
- Grier, Colin
2003 Dimensions of Regional Interaction in the Prehistoric Gulf of Georgia. Chapter 7 in *Emerging from the Mist: Studies in Northwest Coast Culture History*, edited by R.G. Matson, Gary Coupland, and Quentin Mackie, pp. 170-187. University of British Columbia Press, Vancouver.
- Hayden, Brian and Rick Schulting,
1997 The Plateau Interaction Sphere and Late Prehistoric Cultural Complexity. *American Antiquity* 62:51-85.
- Hibbs, Charles H. Brian L. Gannon, and C. H. Willard
1976 Lower Deschutes River Cultural Resources Survey: Warm Springs Bridge to Macks Canyon, Sherman, Wasco, and Jefferson Counties. USDI Bureau of Land Management report, on file at the Prineville District, Prineville, Oregon.
- Hughes, Richard E.
1988 X-Ray Fluorescence Spectrometry. Appendix D in *Archaeological Investigations in Newberry Crater, Deschutes National Forest, Central Oregon*, by J. J. Flenniken and T. L. Ozburn. Report on file, Fort Rock Ranger District, Deschutes National Forest, Bend, Oregon.
- Hughes, Richard E. and Thomas J. Connolly
1999 Distribution of Newberry Caldera Obsidians. In *Newberry Crater: A Ten-Thousand-Year Record of Human Occupation and Environmental Change in the Basin-Plateau Borderlands*, by Thomas J. Connolly, pp. 166-174. University of Utah Anthropological Papers No. 121, Salt Lake City, Utah.
- Hunn, Eugene S.
1990 *Nch'i-Wana: "The Big River:" Mid-Columbia Indians and Their Land*. University of Washington Press, Seattle.
- Jacobs, Melville, Albert S. Gatschet, and Leo J. Frachtenberg
1945 *Kalapuya Texts*. University of Washington Publications in Anthropology 11. Seattle.
- Jenkins, Paul Christy
1988 Archaeological Evaluation of the Saddle Quarry Site, 35MA68. Report on file at the Willamette National Forest, Eugene, Oregon.
- Jenkins, Paul Christy & Thomas E. Churchill
1988 Archaeological Data Recovery at the Chimney Peak One Site, 35LIN312. Report on file at the Willamette National Forest, Eugene, Oregon.
- Jenkins, Dennis L. and Thomas J. Connolly
1994 *Archaeological Investigations at the Paquet Gulch Bridge Site: A Pithouse Village in the Deschutes River Basin, Southwest Columbia Plateau, Oregon*. University of Oregon Anthropological Papers 49, Eugene.
- 1996 *Mid-Holocene Occupations at the Heath Cliffs Site, Warm Springs Reservation, Oregon*. University of Oregon Anthropological Papers 53, Eugene.
- Kelly, Cara M.
2001 *Prehistoric Land-Use Patterns in the North Santiam Subbasin on the Western Slopes of the Oregon Cascade Range*. Master's Thesis, Interdisciplinary Studies, Oregon State University, Corvallis.
- 2003 Prehistoric Land-use Patterns in the Northern Santiam Subbasin on the Western Slopes of the Oregon Cascade Mountains. *Current Archaeological Happenings in Oregon* 28(1/2):10-19.
- Kelly, Isabel T.
1932 Ethnography of the Surprise Valley Paiute. *University of California Publications in American Archaeology and Ethnology* 31(1):67-210. Berkeley.
- Kuzmin, Yaroslav V. and Michael D. Glascock
2007 Two Islands in the Ocean: Prehistoric Obsidian Exchange between Sakhalin and Hokkaido, Northeast Asia. *Journal of Island and Coastal Archaeology* 2(1):99-120.
- Kuzmin, Yaroslav V., Robert J. Speakman, Michael D. Glascock, Vladimir K. Popov, Andrei V. Grebennikov, Margarita A. Dikova and Andrei V. Ptashinsky
2008 Obsidian use at the Ushki Lake Complex, Kamchatka Peninsula (Northeastern Siberia): Implications for Terminal Pleistocene and Early Holocene Human Migrations in Beringia. *Journal of Archaeological Science* 35(8): 2179-2187.
- Laidley, Richard A., and David S. McKay
1971 Geochemical Examination of Obsidians from Newberry Caldera, Oregon.

- Contributions to Mineralogy and Petrology* 30(4):336-342.
- Linneman, Scott R.
1990 The Petrologic Evolution of the Holocene Magmatic System of Newberry Volcano, Central Oregon. Ph.D. dissertation, Department of Geology and Geophysics, University of Wyoming, Laramie.
- Marschall, Mary Elizabeth
2004 A Preliminary Regional Analysis of Lithic Cache Sites in Central Oregon. MA Thesis in Applied Anthropology, Oregon State University, Corvallis.
- MacLeod, Norman S., David R. Sherrod, Lawrence A. Chitwood, and Robert A. Jensen
1995 Geologic Map of Newberry Volcano, Deschutes, Klamath, and Lake Counties, Oregon. U. S. Geological Survey Miscellaneous Investigations Series I-2455
- MacLeod, Norman S., and David R. Sherrod
1988 Geologic Evidence for a Magma Chamber beneath Newberry Volcano, Oregon. *Journal of Geophysical Research* 93(B9):10,067-10,079.
- Minor, Rick
1977 An Obsidian Hydration Rate for the Lower Columbia Valley. *American Antiquity* 42(4):616-619.
1985 Hydration Analysis of Obsidian from the Flanagan Site. Appendix A in *The Flanagan Site: 6000 Years of Occupation in the Upper Willamette Valley, Oregon*, by Kathryn Anne Toepel, pp. 172-179. Ph.D. dissertation, Department of Anthropology, University of Oregon, Eugene.
- Minor, Rick and Kathryn Anne Toepel
1984 *Lava Island Rockshelter: An Early Hunting Camp in Central Oregon*. Idaho Museum of Natural History Occasional Papers No. 34. Pocatello.
- Murdock, George Peter
1938 Notes on the Tenino, Molala, and Paiute of Oregon. *American Anthropologist* 40(3):395-402.
- Musil, Robert R. and Brian O'Neill
1997 Source and Distribution of Archaeological Obsidian in the Umpqua River Basin of Southwest Oregon. In *Contributions to the Archaeology of Oregon: 1995-1996*, edited by Albert Oetting, pp. 123-162. Association of Oregon Archaeologists Occasional Papers No. 6, Eugene, Oregon.
- Ozbun, Terry L.
1991 Boulders to Bifaces: Initial Reduction of Obsidian at Newberry Crater, Oregon. *Journal of California and Great Basin Anthropology* 13(2):147-159.
- Pettigrew, Richard M.
1980 *Archaeological Investigations at Hager's Grove, Salem, Oregon*. University of Oregon Anthropological Papers 19, Eugene.
- Pettigrew, Richard M. and Charles M. Hodges
1995 Prehistoric Hunter-Gatherer Land-Use Systems: Pacific Northwest. In *Archaeological Investigations PGT-PG&E Pipeline Expansion Project Idaho, Washington, Oregon, and California*, Michael J. Moratto, General Editor. Volume IV: Synthesis of Findings, Randall F. Schalk, Volume Editor, pp. 2-1 to 2-70. Pacific Gas Transmission Company, Portland, Oregon.
- Polk, Michael R.
1976 Cultural Resource Inventory of the John Day River Canyon. USDI Bureau of Land Management report, on file at the Prineville District, Prineville, Oregon.
- Ray, Verne F.
1938 Tribal Distribution in Northeastern Oregon. *American Anthropologist* 40(3):384-395.
1939 Cultural Relations in the Plateau of Northwestern America. *Publications of the Frederick Hodge Anniversary Publication Fund*, Vol. 3. Los Angeles.
- Rigsby, Bruce J.
1965 Linguistic Relations in the Southern Plateau. Ph.D. dissertation, Department of Anthropology, University of Oregon, Eugene.
- Santley, Robert S.
1984 Obsidian Exchange, Economic Stratification, and the Evolution of Complex Society in the Basin of Mexico. In *Trade and Exchange in Early Mesoamerica*, edited by Kenneth Hirth, pp. 43-86. University of New Mexico Press, Albuquerque.
- Scott, Sara A., Carl M. Davis, and J. Jeffrey Flenniken
1986 The Pahoehoe Biface Cache: A Lanceolate Biface Cache in Central Oregon.

- Journal of California and Great Basin Anthropology* 8(1):7-23.
- Skinner, Craig E.
 1983 Obsidian Studies in Oregon: An Introduction to Obsidian and an Investigation of Selected Methods of Obsidian Characterization Utilizing Obsidian Collected at Prehistoric Quarry Sites in Oregon. M.A. Thesis in Interdisciplinary Studies, University of Oregon, Eugene.
- 1995 Obsidian Characterization Studies. In *Archaeological Investigations, PGT-PG&E Pipeline Expansion Project, Idaho, Washington, Oregon, and California, Volume V: Technical Studies*, by R. U. Bryson, C. E. Skinner, and R. M. Pettigrew, pp. 4.1-4.54. INFOTEC Research Inc., Fresno, California, and Far Western Anthropological Research Group, Davis, California, on file at the Oregon State Historic Preservation Office, Salem.
- Skinner, Craig E. and Carol J. Winkler
 1991 Prehistoric Trans-Cascade Procurement of Obsidian in Western Oregon: The Geochemical Evidence. *Current Archaeological Happenings in Oregon* 16(2):3-9.
- 1994 Prehistoric Trans-Cascade Procurement of Obsidian in Western Oregon: A Preliminary Look at the Geochemical Evidence. In *Contributions to the Archaeology of Oregon: 1989-1994*, edited by Paul W. Baxter, pp. 29-44. Association of Oregon Archaeologists Occasional Papers No. 5, Eugene, Oregon.
- Sobel, Elizabeth A.
 2006 Household Prestige and Exchange on the Northwest Coast: A Case Study of the Lower Columbia River Valley. In *Household Archaeology on the Northwest Coast*, edited by E. Sobel, A. Gahr, and K. Ames, pp. 159-199. International Monographs in Prehistory, Ann Arbor, Michigan.
- 2012 An Archaeological Test of the "Exchange Expansion Model" of Contact Era Change on the Northwest Coast. *Journal of Anthropological Archaeology* 31(2012):1-21.
- Spier, Leslie and Edward Sapir
 1930 Wishram Ethnography. *University of Washington Publications in Anthropology* 3(3):151-300. Seattle.
- Steward, Julian H.
 1938 *Basin-Plateau Aboriginal SocioPolitical Groups*. Smithsonian Institution Bureau of American Ethnology, Bulletin 120.
- Stern, Theodore
 1998 Columbia River Trade Network. In *Plateau: Handbook of North American Indians*, Vol. 12, edited by Deward E. Walker, pp. 641-652. Smithsonian Institution, Washington, D.C.
- Suphan, Robert J.
 1974 *Oregon Indians II*. Garland Series in American Indian Ethnohistory, New York.
- Sutton, Mark Q.
 1986 Warfare and Expansion: An Ethnohistoric Perspective on the Numic Spread. *Journal of California and Great Basin Anthropology* 8(1):65-82.
- Swift, Mark
 1990 Lithic Caches of Central Oregon: A Descriptive Comparison. Paper presented at the 43rd Annual Northwest Anthropological Conference, Eugene, Oregon.
- Thwaites, Reuben Gold (editor)
 1905 *Original Journals of the Lewis and Clark Expedition, 1804-1806*. Dodd, Mead and Company, New York.
- Wingert, Paul S.
 1952 *Prehistoric Stone Sculptures of the Pacific Northwest*. Portland Art Museum, Portland, Oregon.
- Winthrop, Kathryn and Dennis Gray
 1985 *Moose Molalla One Data Recovery Evacuation (35 LIN 139)*. Document on file at the Sweet Home Ranger District, Willamette National Forest, Sweet Home, Oregon.
- Young, F. G., editor
 1899 *The Correspondence and Journals of Captain Nathaniel J. Wyeth*. University Press, Eugene, Oregon.
- Zenk, Henry B. and Bruce Rigsby
 1998 Molala. In *Plateau: Handbook of North American Indians*, Vol. 12, edited by Deward E. Walker, Jr., pp. 439-445. Smithsonian Institution, Washington, D.C.