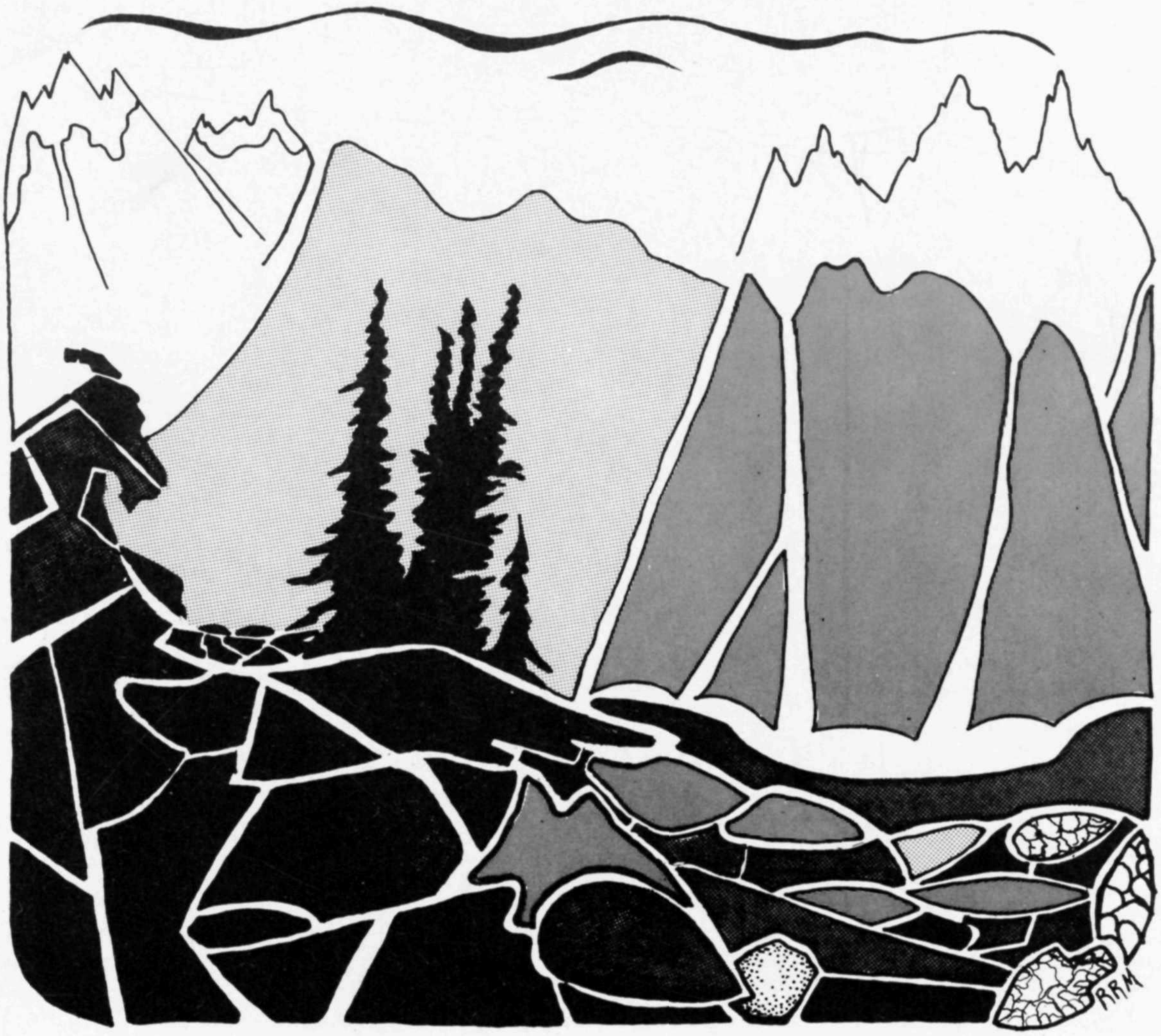
CHERT PROCUREMENT IN THE UPPER SKAGIT RIVER VALLEY OF THE NORTHERN CASCADE RANGE, ROSS LAKE NATIONAL RECREATION AREA, WASHINGTON



by

Robert R. Mierendorf
North Cascades National Park Service Complex,
U.S. Department of Interior

1993

SKAGIT ENVIRONMENTAL
ENDOWMENT COMMISSION

The Skagit Environmental Endowment Commission administers the Skagit Environmental Endowment Fund which was established by an agreement between the City of Seattle and the Province of British Columbia, settling the issue of raising Ross Dam. Its primary purposes are to conserve and protect the wilderness and wildlife habitat values and to enhance the recreational opportunities that are consistent with these values in the skagit River valley upstream from Ross Dam.

As the nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally owned public lands and natural and cultural resources. this indicates fostering wise use of our land and water resources, protecting our fish and wildlife, preserving the environmental and cultural values of our national parks and historical places, and providing for enjoyment of life through outdoor recreation.

Chert Procurement in the Upper Skagit River Valley of the Northern Cascade Range, Ross Lake National Recreation Area, Washington

Robert R. Mierendorf

Technical Report NPS/PNRNOCA/CRTR-93-001

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1. ABSTRACT

With the help of two grants provided to North Cascades National Park Service Complex by the Skagit Environmental Endowment Commission, the National Park Service (NPS) conducted an archeological survey and test excavations at a prehistoric archeological site, the Desolation Chert Quarry (45WH224), in the Ross Lake vicinity. The purpose of the test was to assess the significance of the quarry to the National Register of Historic Places.

The quarry was used by prehistoric people as the source of a locally abundant and distinctive stone, named Hozomeen chert, which is a fine-grained form of quartz. The Desolation Chert Quarry was discovered in 1987, before which time the importance of the stone to the prehistoric dwellers of this part of the northern Cascade Range was unknown to archeologists and anthropologists.

Between 1987 and 1989, twenty-two test units were excavated at the site by NPS archeology crews. A total volume of 15 m^3 was excavated and screened, resulting in the recovery of thousands of chipped stone artifacts. The majority of artifacts consist of discarded flaking debris in the form of flakes and shatter. From within the flaking debris matrix were recovered an assortment of complete and broken bifaces representing initial stages of stone tool manufacture, and the hammerstones used to shape the bifaces. From a series of 13 radiocarbon dates, the site is estimated to have been used between 7600 and 290 radiocarbon years ago, with perhaps the most intensive use being between 5000 and 3500 years ago.

A preliminary archeological survey to find if more quarry sites existed in the vicinity resulted in the recording of two more Hozomeen chert quarries, all located on steep mountain slopes. Based on evidence acquired in this study, the upper Skagit River Valley is identified as a locally important, lithic resource province to prehistoric populations adapted to hunting, gathering, and fishing in the northern Cascades.

The Desolation Chert Quarry is clearly eligible for inclusion in the National Register of Historic Places. The portion of 45WH224 above 1602 ft elevation retains integrity of location, setting, material, workmanship, and association. Information embodied within the site's artifacts and sedimentary deposits addresses questions and problems relating to Northwest prehistoric cultures, hunter-gatherer adaptations to the mountains, prehistoric trade and exchange systems, procurement of stone for tool making, correlation of artifacts with source location of stone materials, and changes in climates and natural landscapes over the last 8000 years.

Today the site is managed by NPS to maintain its unaltered, natural condition. The site is not accessible for public visitation.

2. ACKNOWLEDGMENTS

The Skagit Environmental Endowment Commission supported the study through Grants #88-06 and 89-05 to the National Park Service. Without this support, the project could not have been conducted.

During the summers of 1988 and 1989 our field crews consisted of volunteers with the Student Conservation Association (SCA) high school program. Under the supervision of National Park Service archeologists, they displayed a willingness to learn scientific archeological techniques, and excavated the bulk of the archeological deposits during the project. The SCA volunteers for both years are Michelle Acuff, David Carr, Nick Coronges, David Curtis, Stefani Eisele, Angela Herrider, Missy Ho, Terrance Huettl, Reka Koerner, Brady Lee, Lorena Martinez, Miranda Michael, Max Otterland, Pam Papish, Julie Patnode, Jorge Plata, Noah Taylor, and P. J. Winnick. It was an added pleasure to be associated with the two SCA group leaders, Doug Stephens, a professional archeologist, and Diane Boyer, who helped with field processing of samples, and professes not to be an archeologist. Finally, the support of the Student Conservation Association is appreciated.

The project benefitted from other volunteers who helped in the field. These include excavators Brent Hicks, Jim Kangas, Jim Sterling, and geologist Jon Riedel. Mike Edwards, Senior Writer, National Geographic Magazine, spent a cold and stormy day helping us screen.

Without the combined efforts of National Park Service staff, in many offices at different levels, there would be no park archeology program or projects such as this one. Jim Thomson, the Pacific Northwest Region's archeologist in Seattle found initial funding to get started, procured equipment, and helped to encourage and foster the project from the beginning. A host of staff at the North Cascades National Park Service Complex headquarters in Sedro Woolley assisted in development and administration. Park Superintendents John Reynolds, John Earnst, and William Paleck have backed phases of the project. Jon Jarvis and Bruce Freet provided encouragement and assistance. Bob Wasem made the Ling and other equipment available. Jerry Andrews, Karen Brown, Barbara Ashley, Dan Peregoy, and Margie Allen assisted in procurement and maintaining project records. Pat Blunt and Vickie Tisdel guided the project through staffing and payroll. Many staff at the Skagit District office in Marblemount lent a helpful hand throughout the project. Gerry Cook is responsible for the SCA connection, and he helped survey the site. Gary Richmeyer piloted the Mule wherever and whenever needed. Tim Oliverious, Cindy Crowle, and all the Ross Lake rangers monitored the site and helped transport people and gear, as did Ken Coss in maintenance. Jeff Harsha made equipment available and solved logistic problems. Gary Mason and Merlene Buller provided information and help on request. Bill Lester, John Dittli, and Jeff Clark worked in the darkroom to provide artifact photographs.

I am indebted to the dedicated and professional field crew, who included Kim Adams, Diane Boyer, Jim Forrest, David Harry, Dr. Jesse Kennedy, Alfred Reid, and Doug Stephens, and Linda Switzer.

I benefited greatly from discussions at the site with archeologists, including Dr. Randall Schalk, Dr. Julie Stein, Jim Thomson, Dr. Robert Whitlam, and Eric Bergland. The observations and thoughts of Dr. Richard Rutz are appreciated, also. From a distance, Dr. Ruthann Knudson shared her knowledge of prehistoric quarries. Archaeologist Brian Vivian, University of Calgary, supplied me with comparative samples of cherts from the Allenby quarries in the upper Similkameen country, and offered useful comments about prehistoric quarries.

Much of my understanding of the petrography of Hozomeen chert is due to the interest and involvement of Dr. Ned Brown, Department of Geology at Western Washington University. Dr. Andrei M. Sarna-Wojcicki, Dr. Roland Tabor, and other staff at the U.S. Geological Survey in Menlo Park, California, were most helpful for conducting the X-ray fluorescence spectrometry analysis of Hozomeen chert and providing information about the distribution of Hozomeen chert.

We have on many occasions relied on the ready assistance provided by Bill Newby, Seattle City Light's Skagit Project Manager, and his staff.

Over the years, the office of the British Columbia Provincial Archaeologist promptly honored my requests for site information to the north of the project area. I hope some day to reciprocate.

Terry Eller provided personal equipment for use at the site.

Jon Riedel generously shared his geologic knowledge and references, and contributed to the description of the Hozomeen Group of rocks. Dr. Jesse Kennedy recorded data in the field, managed the project records, designed report data tables and computer graphics, assisted with artifact analysis, and performed any number of tasks to keep the project on track. Linda Switzer cataloged and labeled all of the 45WH224 artifact collection and did the faunal analysis. Jon Riedel and David Harry drafted most of the diagrams. Jeannie Harsha compiled and proofed many of the tables. In addition, Jim Benson, Bruce Freet, David Harry, Jon Riedel, and Rob Whitlam reviewed the final manuscript draft.

It is perhaps fitting that the last words should be saved for the First People. During three different site tours, the Native People shared their beliefs, thoughts, and feelings regarding the chert quarry. These people came as representatives of the Colville Confederated Tribes, the Lummi Indian Business Council, the Nlakápamux Nation (Lower Thompson people of British Columbia), the Sauk-Suiattle Tribal Council, the Swinomish Indian Tribal Community, and the Upper Skagit Tribal Council. These

organizations today embody the tribal and ancestral knowledge handed down over a time spanning more than two hundred generations.

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6. INTRODUCTION

This report describes the results of archeological testing of the Desolation Chert Quarry (45WH224). The quarry is located along Ross Lake (a reservoir) in northeastern Whatcom County, within the Ross Lake National Recreation Area, which is administered by the North Cascades National Park Service Complex, U.S. Department of Interior (Figure 6-1). The site is the former location of extensive quarrying and collecting by Indian people of a distinctive variety of quartz rock called "chert". The evidence presented in the report will show that this Native American practice lasted for nearly eight thousand years before settlement of the continent by Euroamericans. All that remains of these activities today are many thousands of pieces of quarry debris and occasional artifacts scattered across the mountainside and buried deep within the forest soils.

This study provides, in addition, the first detailed characterization and identification of a culturally important prehistoric chert source in the Cascade Range of Washington. Although cherts and related rock types are common in archeological sites across Washington (and indeed, much of North America), rarely are their geologic and source locations known. And though archeologists have long been aware of the value of identifiable and distinctive cherts for understanding processes of cultural evolution and interaction, rarely are archeologists equipped with data sufficient to make artifact-to-source correlations from the prehistoric assemblages they study (Ives 1984). The descriptive information presented here will help remedy these problems for a mountain valley and adjacent highlands of North Cascades National Park.

The site covers portions of the steep, lower slopes of a prominent mountain forming the eastern wall of this part of the upper Skagit River Valley. In the prehistoric past the site was approachable by foot or by canoe. In 1859, while surveying the U.S.-Canada border, Henry Custer traveled past the site in a dugout canoe guided by Indian people from the lower Fraser River-Nooksack River area. No mention is made of the site by Custer as the traveling party seems to have been preoccupied with navigating the river and contending with log jams, which required numerous portages.

In prehistoric times the upper Skagit River Valley (referred to as "the valley" in this report) provided Indian people with an abundance and variety of food resources, especially deer that wintered along the valley bottom and lower slopes, where they sought refuge from deep snow and avalanches. As part of their adaptation to the valley, early people learned to use the different kinds of rocks found throughout the locality to fashion their tools. From the river gravels and glacial deposits, and from massive bedrock outcrops they collected cobbles and boulders of fine-grained cherts and metamorphic rocks for making hide scrapers, arrow and spear points, knives, drills, burins, and specialized cutting tools called "microblades." By far the most commonly used of the local rock types was the distinctively colored chert, now called "Hozomeen chert", which

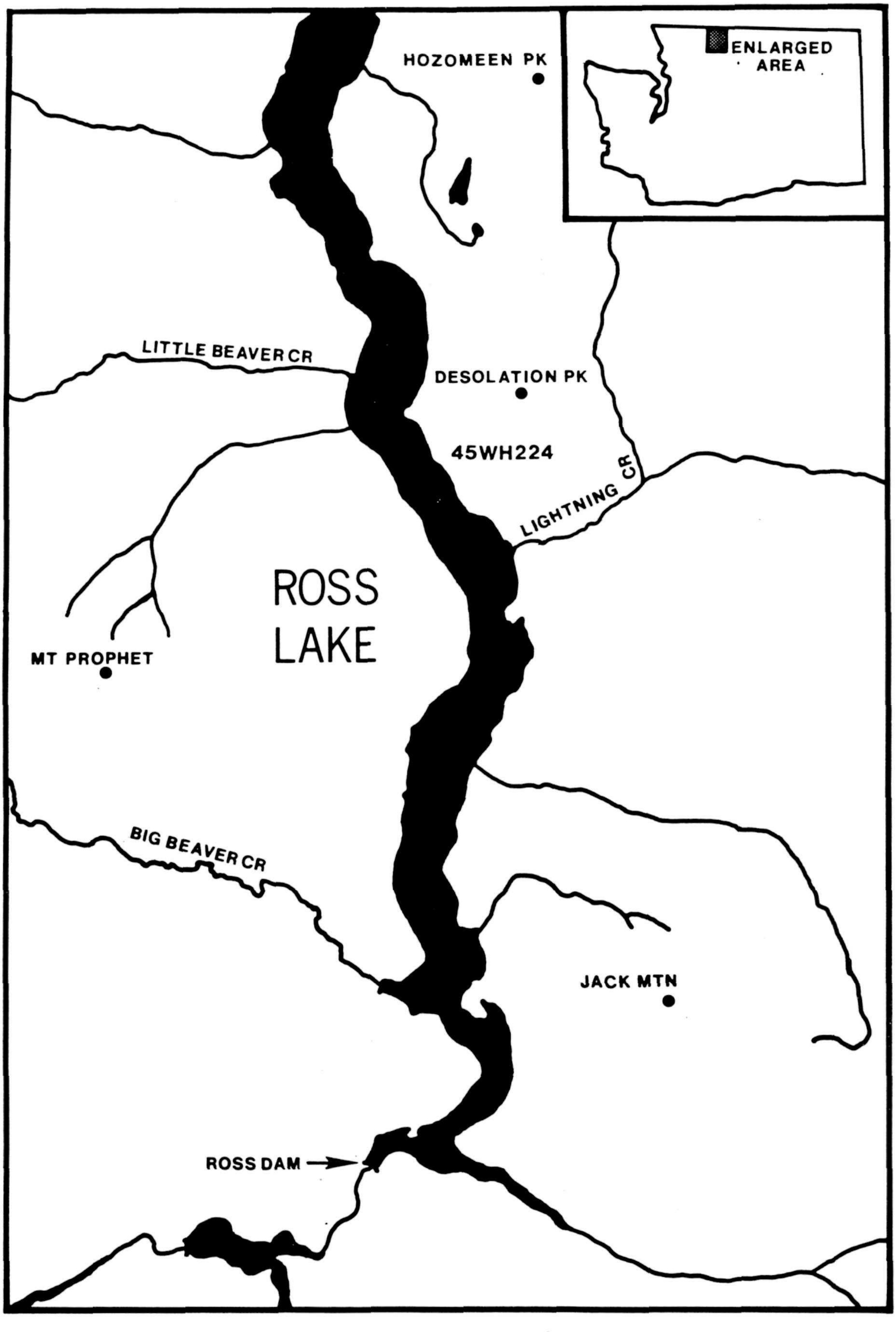


Figure 6.1. **Map of the Ross Lake vicinity and site area.**

occurs naturally in bedrock formations of the upper Skagit River Basin of Washington and adjacent British Columbia.

Although Hozomeen Chert had been noticed by archeologists working in the valley in the 1970s, it was not recognized as a distinctive and locally important stone material to the prehistoric inhabitants until the summer of 1986. At that time I began to find this stone in archeological sites from widespread areas of the NPS Complex, but nowhere more frequently than in the upper Skagit River Valley (Mierendorf 1987a and b). Then in 1987 I found a large archeological site where Indian people had quarried tons of the stone from a bedrock formation along the lower eastern valley wall. The site was recorded as the Desolation Chert Quarry (45WH224), named after the mountain on which it rests.

Although knowledge of the quarry's existence apparently was lost sometime in the past, the importance of the stone and the fact of its use persisted in the traditional knowledge of Indian people. In the late 1800s, the anthropologist James Teit was told by Nlakápamux informants (known as "Lower Thompson Indians" in anthropological literature) that stone for arrow tips was found "near the head waters of Skagit River." (Teit 1900: 241). Beyond this, few details are recorded about Nlakápamux use of the valley except that they hunted here (today's Ross Lake National Recreation Area) in winter, up to seven months at a time (Teit 1900; Smith 1988:156). The historic record is particularly mute regarding Native American presence in the valley and surrounding mountains in the nineteenth century. Although Henry Custer and his guides saw a few abandoned brush structures in the North Cascades that had been built by Indian people (Custer 1866), they encountered an unpopulated landscape devoid of inhabitants in 1859. Yet, from archeological evidence we know that for thousands of years Native people have lived at least seasonally in this valley and were as much a part of the natural landscape as were the variety of other living communities.

We can only speculate that over the span of thousands of generations, it's likely that Indian people spoke a variety of words that referred to the different kinds of stones in the valley, their color variations and qualities of use. In the old camps left by these earliest mountain inhabitants, we find tools of stone that made daily life and subsistence and survival possible. The recent finding of these archeological sites and recognition of the importance of Hozomeen chert to the early people does not constitute discovery--it is recovery of knowledge that had been lost or forgotten in the commotion of historic events of the last few hundred years. It is now from the scattered old camps, quarries, and other archeological locations that we observe the material remains of a once thriving culture and relearn what it knew.

In the following sections, prehistoric Indian use of the quarry as we have learned it is described and discussed. Although I have tried to make the text readable to a nontechnical audience, the subject matter dictates discussion of a variety of scientific and technical fields ranging from radiocarbon dating, to petrographic geology, to prehistoric stone-working techniques, to archeological method and theory, and finally to modern cultural resource management guidelines. Many of these discussions delve farther into the topic than a nontechnical treatment would require. In order to lessen this problem, I have given the technical data and analysis results as a series of appendices at the end of the report.

This report and the archeological project it describes was made possible through two grants to the National Park Service from the Skagit Environmental Endowment Commission. The purpose of the project is to assess the significance of the Desolation Chert Quarry (45WH224) and its potential for inclusion in the National Register of Historic Places.

7. ENVIRONMENT, ETHNOHISTORY, AND ARCHEOLOGY OF THE VALLEY

7.1 Environmental Setting

Northwestern Washington's climate is classified as marine with wet, mild winters and cool dry summers (National Oceanic and Atmospheric Administration 1979a). Primary factors influencing the climate of the North Cascades are latitude, proximity to the Pacific Ocean, height of the range, and semi-permanent high and low pressure cells located over the North Pacific Ocean (National Oceanic and Atmospheric Administration 1979b). Prevailing westerlies continually carry wave cyclones and moisture-laden air from the Pacific into contact with the North Cascades. The orographic effect causes increased precipitation with altitude as Pacific air cools while rising over the range. The presence of semi-permanent pressure regions over the North Pacific imparts a strong seasonal component to precipitation in the Cascades: less precipitation falls during the summers because a vast region of high pressure dominates the Pacific. Circulation around the high pressure cell causes a northwesterly flow of relatively cooler, drier air onto the continent. In late fall and winter the Aleutian low pressure dominates the Pacific, bringing a predominantly southwesterly flow of warmer, moister air into the North Cascades. Cooling and condensation as a result of the orographic effect is enhanced by the relatively cool land mass.

The upper Skagit River Valley is distinguished from other northern Cascade Range valleys for being the largest and most interior to the heart of the range, and for being the only river that cut through the crystalline core of the range. Flowing from north to south, the Skagit River splits the mountains into western and eastern subranges. To the west 18 miles (29 km) runs the north-south trending crest defined by the combined Chilliwack group of peaks and the Picket Range. To the east 14 miles (22 km) is the crest of the main Cascades, which separates waters flowing to the Columbia River from those flowing into Puget Sound. At 1500 ft elevation above sea level, the upper valley sits about 1100 feet higher than the Puget Lowlands (Figure 7.1). Other mountain valleys of comparable proportion and scale are the Nooksack to the west, the Similkameen to the east, and the Fraser to the north.

Although not highly elevated compared to many mountain ranges in North America, the Pickets' 8000-9000 ft (2440-2744 m) summits catch the brunt of Pacific storm systems. The excessive snow accumulation here has created the most heavily glaciated terrain below the 49th parallel, and has sculptured the summits and ridge-lines into vertical spires, aretes, and horns. Some of these ridge-lines descend eastwardly to the Skagit Valley, and being within a few hours hike of the valley bottom, impart a strong alpine character to the valley's ecology. The contour map (Figure 7.2) shows the topographic relief of the upper Skagit River Valley. Some of the plants characteristic of the alpine terrain include Alaska yellow-cedar, Mountain hemlock, Pacific silver fir,

Figure 7.1. Aerial Photograph of the Upper Skagit River Valley. From a 1931 photo taken by the USFS, Mt. Baker National Forest, before creation of Ross Lake.

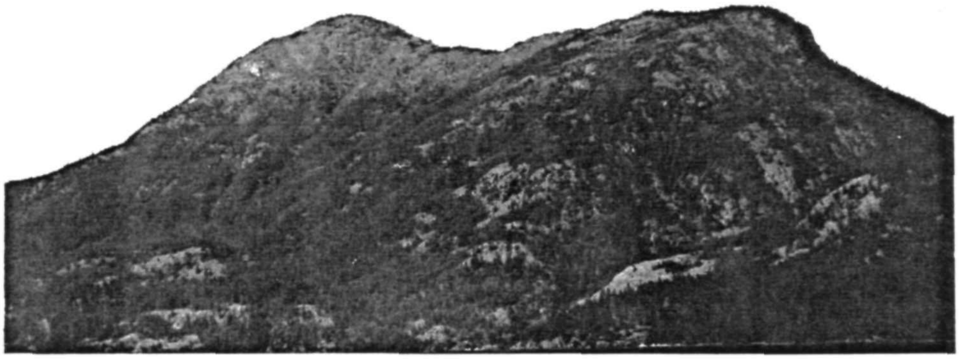


Figure 7.3. Photograph of Desolation Mtn. and the East Side of the Vall ey and Site Vicinity. Unforested patches on lower mountain slopes mark dry microenvironments; unforested area on Desolation's 6100 ft (1860 m) summit is subalpine zone; glaci al scouring has subdued and rounded the mountain's topography.

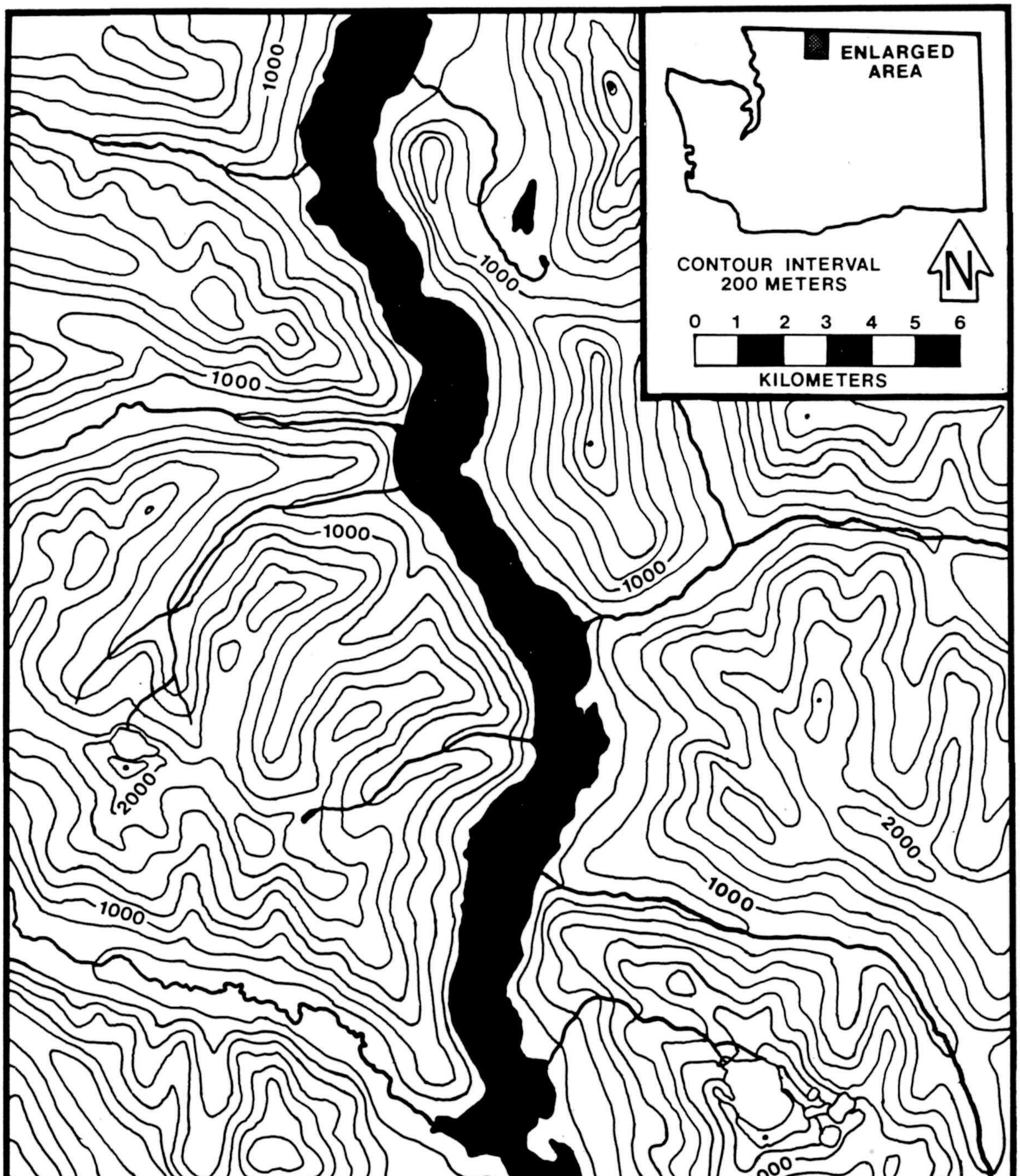


Figure 7.2 **Contour Map of the Upper Skagit River Valley in the Ross Lake Vicinity. Contour interval 200 m (656 ft).**

heather, mountain ash, and huckleberry. Alpine fauna here include mountain goats, marmots, and ptarmigan.

The moisture dropped on the Pickets is offset to the east by an area of considerably lower precipitation, the "rainshadow", along the east side of the valley (Figure 7.3). Found growing in this rainshadow, out of their accustomed place, are plant associations found only to the east in the Similkameen and Methow River drainages and to the north on the Canadian Plateau. Taking refuge on the driest microenvironments of the east valley wall can be found small communities of ponderosa pine, lodgepole pine, Rocky Mountain juniper, bunchgrass, balsamroot, and Syringa (International Joint Commission 1971; Franklin and Dyrness 1973; Ralph and Dorothy Naas 1988: personal communication).

The closest weather stations to the site are located at the north end of Ross Lake at Hozomeen campground and at Ross Dam powerhouse. The Hozomeen station collects fire weather data during the fire season (late spring to early fall). Annual precipitation is 142 cm (56 inches) at Ross powerhouse and 79 cm (31 inches) at the international boundary (International Joint Commission 1971); it is even lower at the quarry site. Mean annual temperature is 48°F at Ross Dam (Phillips 1966). Temperature extremes increase upvalley from Ross Dam, as more continental conditions begin to prevail.

7.2 Indian People of the Upper Skagit Valley

Historically, the valley is within the home range of bands of the Lower Thompson Indians whose economy was based largely on fishing salmon along the canyon of the Fraser River and hunting in the adjacent mountains. Portions of the valley also were visited by Upper Skagit people from below the Skagit River gorge at Newhalem (Smith 1987:150). Considering that it has been visited by Native populations for thousands of years, it is likely that numerous groups from both sides of the Cascade Range passed through the valley to hunt and perhaps procure other resources. A generalized map of Native American linguistic groups living in the northern Cascade Range region is shown in Figure 7.4 (data for this map is derived from Spier 1936; Swanton 1952; and Suttles and Lane 1990).

The name "Lower Thompson" is one assigned by Euroamericans to the Uta'mqtamux (also spelled Nlakápamux), "the people below Lytton". Their language is most similar to but mutually unintelligible with that spoken by the other two members of the Northern Group of Interior Salish, the Shuswap and the Lillooet (Smith 1987). The Nku'kumamux, the "people above Lytton" (the Upper Thompsons), speak the same language as the Lower Thompson but with only minor dialectic differences. Although their languages share some distant similarities, the language communities of Interior Salish are only remotely related to those of Coast Salish which is spoken by numerous groups living in Western Washington and Southwestern British Columbia (Elmendorf

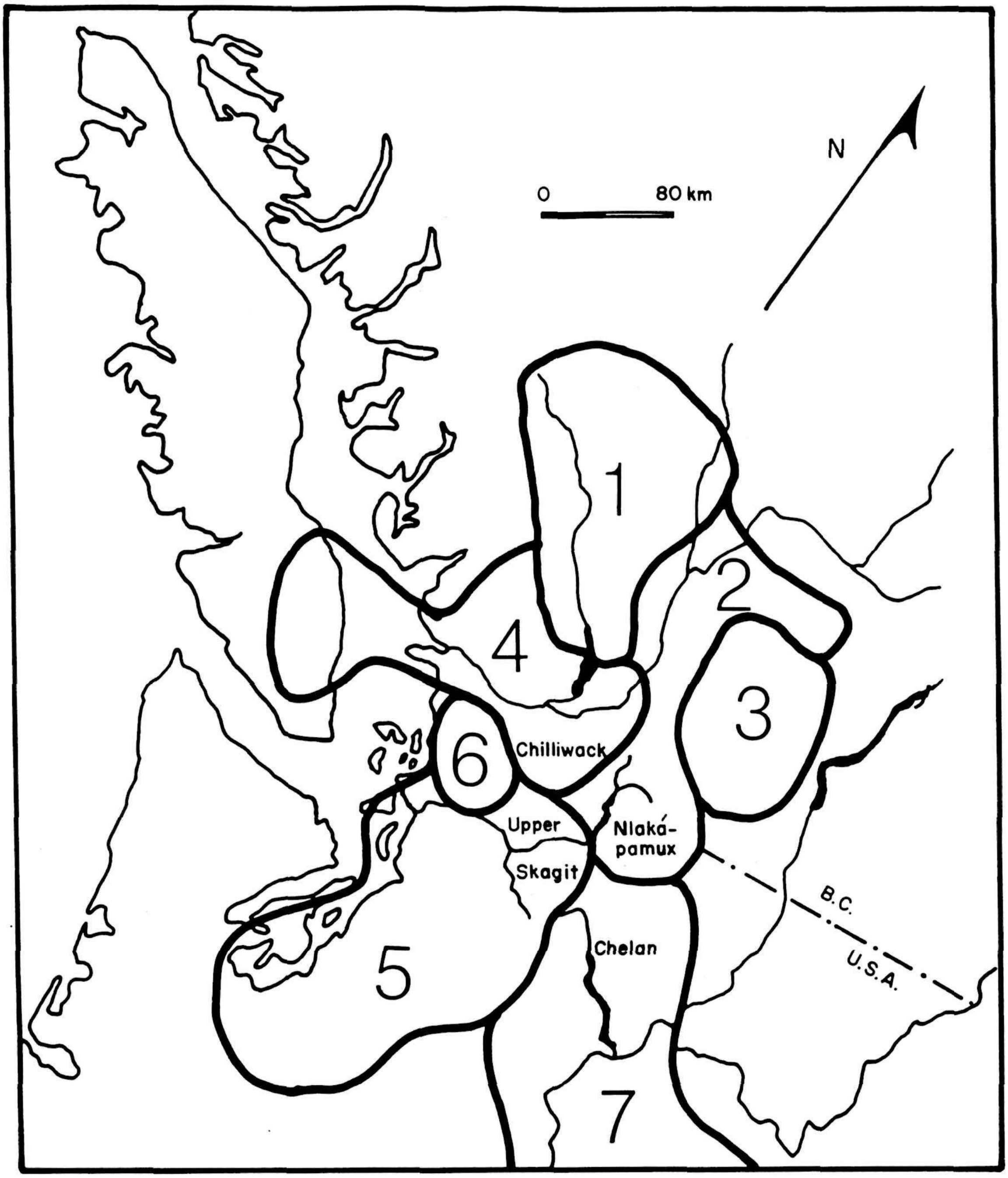


Figure 7.4 Generalized Map of Northwest Native Linguistic Groups. 1=Lillooet, 2=Nlakápamux, 3=Nicola, 4=Halkomelem, 5=Lushootseed, 6=Nooksak, 7=Columbian

1963:74). Lushootseed, one of the southern coast Salish Languages, was spoken by the various Upper Skagit bands (Suttles and Lane 1990).

Although Fraser River salmon provided their main food resource, Lower Thompson people were also hunters of the adjacent northern Cascade Mountains. Some individuals specialized in hunting. All that is known about their trips to the Skagit valley is that "Hunting-parties who visited the most southern part of their hunting-grounds were sometimes absent for seven months, returning only when the snow began to melt in the mountains." (Teit 1900:239). Based on the mapped boundaries of Lower Thompson territory and other references to the Skagit Valley, Smith (1987:156, 230) considers these hunting grounds to include the northern portion of today's Ross Lake National Recreation Area.

An intriguing and somewhat mystifying fact is the apparent disappearance of Native populations from the upper Skagit Valley in the last century. Few Indian people were seen in the northern Cascade Range, none in the upper Skagit River Valley, at the time of the first explorations by non-Indians. Some of the first such explorers were the Hudson's Bay Company trappers, who are known to have used trails established by Indian people, but who left no record of their travels through the valley. However, at the time of his 1859 travels through the valley, Henry Custer observed evidence of Native people's presence, noting that "We found an Indian trail leading through the Klesilkwa valley, faint though as all these trails are, & observed subsequently its continuance through the entire length of the Skagit valley explored by us." (Custer 1866:22). He also observed, in valleys adjacent to the Skagit, two abandoned brush structures built by Indian people. Custer's observations here agree with those of George Gibbs, who noted that many Native American trails throughout the northern Cascades appeared to have "fallen into disuse", and he attributed this to "the diminution of the tribes and the diversion of trade to the posts" (Gibbs 1877:169). Whatever the reasons, the accumulating archeological evidence suggests that Native populations at times in the prehistoric past made much more use of the valley than the historic record might suggest.

7.3 Subsistence Ecology

Most generally, the upper Skagit River Valley expresses strong seasonal differences in temperature, precipitation, and growing season. In this regard, it is transitional between the more mild and maritime conditions to the west and the more extreme continental conditions that prevail to the north and east. Compared with what many would consider more optimum environmental conditions along Puget Sound and coastal areas, the valley might be seen as a marginal environment for human occupation. The purpose of this section is to identify, in a preliminary manner, some of the ways in which prehistoric bands are expected to have adapted to the valley environment. The emphasis here is on the structure of food subsistence resources, although a host of other factors are important in defining the details of a foraging group's total subsistence base and range of settlement alternatives. Thus for example, the ways in which mountain and valley physiography constrain travel has much to do with how much energy is expended in transporting subsistence resources from the location of procurement to camps and settlements, the locations of consumption. Similarly, winter exploitation of and travel through the valley implies the knowledge of a host of winter-adapted technologies and strategies, including the ability to rapidly establish and maintain short-term bivouac camps during storms. For longer duration winter hunting camps, landforms would have been chosen that were well removed from the base of avalanche paths, which abound on the valley's mountain slopes. Finally, the brief discussion here used information drawn largely from records of the last hundred years, and it is not assumed that this time period is representative of the last 8000 years, either with respect to environment or cultural adaptation. Rather, there is good evidence to suggest that the climate and resource base of the project area, and the cultural responses to them, have experienced dramatic shifts over the last 8000 years.

The combination of environmental factors that characterize the project area offer a somewhat unique landscape in western Washington for prehistoric people based on a hunting, gathering, and fishing economy. In few places can be found this diversity of plants and animals within a day's walk from the valley bottom, the equivalent of one day's foraging radius. The biological control exerted by the environmental factors of extremely steep slopes and strong rainshadow are expressed by what has been described for other mountainous areas as "a set of biotic zones compactly arranged within small territories" (Watanabe 1968:73). Such habitat variations are considered to have an important effect on Native American subsistence patterns, and can result in different settlement patterns for different bands within the same cultural group (Watanabe 1968). It is therefore possible that a distinctive subsistence ecology developed for Indian people who lived in the upper Skagit River Valley, one that was adjusted to the environmental conditions that prevail here. This is likely to be reflected in a settlement and subsistence pattern having attributes not shared by other "culturally similar" groups and bands living in other parts of western Washington.

From the various studies conducted to assess the effects of Ross Dam and its reservoir on the upper Skagit Valley, we know that the area offered an abundance of animal food sources prior to impoundment of the river. These included bears, deer, mountain goats, elk, and many smaller mammals, such as beavers, marmots, and snowshoe hares (Taber 1971). Prior to impoundment, large trout were plentiful in the Skagit River. The valley also supports a range of plant resources that were traditionally used by Indian people throughout the Northwest for food, medicine, and utensils. Among these are wild lilies (chocolate lily, glacier lily, tiger lily), Claytonia, wild onion, berries (serviceberry, gooseberry, wild cherry, huckleberry, salmonberry, thimbleberry, raspberry, blackberry), dogbane, hazelnut, cow parsnip, bleeding heart, kinnikinnick, western red-cedar, and many others.

Of the many natural resources in the valley that served the needs of the Indian inhabitants, deer are likely to have been most abundant and of most importance to subsistence (although the cumulative abundance of other animals, such as bear, elk, and goats may have exceeded that of deer). Historically, most Lower Thompson Indians congregated in winter to live in pithouse villages along the Fraser River, some distance north of the valley. However, some groups left the Fraser and traveled south to hunt and winter in the upper Skagit Valley. This seasonal shift in residence contrasts with the settlement and subsistence pattern of the Coast Salish people further to the west and south, whose populations wintered in permanent settlements and subsisted on stored reserves and fresh supplies of freshwater and marine fish and mammals. The historic Lower Thompson pattern of winter hunting in the valley suggests that sizeable ungulate populations could have provided a predictable winter subsistence base that would have permitted at least semipermanent or intermittent occupation of the valley by prehistoric populations from adjacent areas. To such groups, the upper Skagit River Valley may have been perceived as a southern extension of the Canadian Plateau environment and resource base (Smith 1987) (except for the absence of salmon).

Studies of deer population and ecology in the valley for this century have been conducted as part of the Skagit River Project relicense effort. Although deer populations were low in the early 1900s, their numbers increased rapidly following the great fire of 1926. The main factors controlling deer population magnitude are the availability of winter shrubs and winter snow depth (Taber 1971). (In prehistoric times, it is likely that predation by Indian inhabitants may have constituted a third factor). The opening of the forest canopy following fires in this century has resulted in significant increases in deer numbers in the valley.

Intentional forest burning may have played an important role in Native American subsistence practices in the valley, as has been reported for other mountainous areas (Barrett and Arno 1982; Schalk 1984). This use of fire was mentioned as a possible explanation for the observed fire frequencies recorded in studies of wild fires on Desolation Peak and near Hozomeen (Agee et al. 1986). The only direct historical reference to this practice near to the project area comes from Custer, who noted that "Fires are very frequent during sum[m]er season in these Mountain forests and are often ignited purposely by some of the Indian[s] hunting in these Mountain regions, to clear the woods from under brush & make travel easier." (Custer 1866:20).

In this century, deer populations in the upper Skagit River Valley have been highest in winter. In this season a migratory Mule deer herd that summers in the mountains to the east joins the resident population of Black-tailed deer (a third population of deer migrates to near the head of Ross Lake in early spring of each year) (Taber 1971). Their wintering ground here was the driest portion of the valley, consisting of a three-mile long flats of well-drained glacial deposits and alluvial fans, between Devil's Cr. and Lightning Cr., that was locally called "Little Sahara." Here and on the adjacent slopes of the east valley wall were open-canopied, xeric forests and brushy expanses. Such areas correspond to the Douglas-fir/Ponderosa pine community type described by Agee et al. (1986). It is this driest portion of the valley that may have been the focus prehistorically of winter hunting activities. It would be in this area that deer herds would be concentrated or "yarded" in their winter range (Schalk and Mierendorf 1984), and where we might expect prehistoric hunters to focus their subsistence pursuits. Desolation Chert quarry is located at the northern edge of this valley segment (Figure 7.2).

Unfortunately, equivalent information from historic records regarding other ungulates and subsistence mammals is unavailable. From preliminary investigations of cooking hearths at archeological sites in the valley we have identified bones of mountain goat, elk, deer, and beaver. Although presently we can make no statements regarding the abundance of these mammals prior to the historic period at time periods in the past, it is clear that they were available in the valley to prehistoric hunters. So also were a variety of other subsistence resources, including trout and smaller fish, small mammals, upland birds, and edible plants. In the valley, the latter include Indian riceroot, other wild lilies, berries and hazelnuts. Plants also had important medicinal uses.

7.4 The Archeological Record

The thousands of years of human occupation of the northern Cascade Range before settlement of the continent by non-Indians (a time period referred to generally as "prehistory") remains one the least known subjects of the Northwest Coast. The extremely rugged and wild character of the range has traditionally served as a barrier to archeological study just as it had earlier to Euroamerican exploration and settlement.

Following the North Cascades National Park Service Complex's creation in 1968, professional archeological investigations of the valley began in the early 1970s. By 1978, three surveys to find sites had been carried out along segments of Ross Lake by archeologists from two state universities, resulting in the recording of two sites. The first of these surveys was performed to locate sites on lands that would have been inundated by the proposed High Ross Dam reservoir, from 488 m (1602 ft) up to an elevation of 526 m (1725 ft) (Rice n.d.a.). The survey strategy included examination of nearly the entire reservoir margin from a boat or on-foot. No archeological sites were found. Rice stated that factors such as the steepness of slopes and the absence of salmon and other food resources made it unlikely that Indians prehistorically used the upper Skagit River Valley. He also noted that there was small possibility that archeological sites could be found because the river banks, preferred locations of Indian habitations, had been inundated by the reservoir. Rice conducted another early survey in an area proposed for road and recreational developments at Roland Point, within the project area; no archeological sites were found (Rice n.d.b.).

In 1977 limited archeological surveys were conducted by a team from Western Washington University in widespread parts of the Park Complex, including 16 selected locations along the margin of Ross Lake. Two sites were recorded, one near the mouth of Big Beaver Cr. and the other in the vicinity of Hozomeen campground (Grabert and Pint 1978). The first of these (45WH80) was reported to contain possible housepit depressions, but subsequent test excavations recovered no evidence of any archeological remains. The latter (45WH79) is a large lithic scatter that was believed to be an early prehistoric site of some importance. Although this finding contributed new and useful information where none existed before, the significance of the valley to prehistoric Indian people remained poorly understood and underrated, as was the expected presence of additional archeological sites.

In the mid-1980s the National Park Service initiated a study of the Park Complex's prehistory and ethnography which included the valley. The main result of the study was the suggestion that the northern Cascades had been intensively used by Indian people before Euroamerican settlement (Mierendorf 1986; Smith 1987), and it predicted that many hundreds of undiscovered archeological sites were likely to exist, and that some of these were likely to be quarry sites (Mierendorf 1986:113). Subsequent archeological surveys to test these ideas were conducted by the National Park Service and resulted in the discovery of additional sites in the valley, thus lending confirming evidence to the overview's conclusions (Mierendorf 1987a).

Since 1988 the National Park Service and the City of Seattle have worked cooperatively to further record and preserve archeological sites of the upper Skagit River Valley. Within a surveyed land area covering 47.5 km^2 (11,747 acres) has been recorded 144 prehistoric archeological sites (Mierendorf 1991). In a field inventory of 7931 artifacts observed at these sites, Hozomeen chert comprised 78.6% of all lithic remains (Mierendorf 1991:101). Archeological test excavations of these sites is on-going, with 29 of them tested to date.

8. RESEARCH OBJECTIVES AND METHODOLOGY

8.1 Objectives

This archeological project has two main goals. The first is to determine the scientific importance of 45WH224 and the second is to assess the likelihood hat other chert procurement sites exist in the valley. The first of these objectives was met by collection of artifacts from the site surface, by excavation of test pits, analysis of the new information, and evaluation according to National Register Criteria. The second objective was met through limited archeological survey (a search for previously unknown sites) and recording of additional Hozomeen chert quarries. Description of the project methods are given below. The work reported here does not constitute a full-scale excavation and analysis of 45WH224 nor is the survey anything but exploratory and directed at the second stated objective.

These studies serve the added purpose of helping the National Park Service to meet its responsibility to protecting important cultural resources on its lands. The archeological work described here was done in accordance with NPS guidelines and statutory authorities, including Section 110 of the National Historic Preservation Act of 1966, and the Archeological Resources Protection Act of 1979 and its amendments. The information gained from this study aids in the management and protection of other archeological sites in the Park Complex; it also provides factual material that helps to interpret for the public the story of the first inhabitants of the northern Cascade Range.

Shortly after the site was discovered, the National Park Service developed plans to investigate it. A quarry/rockshelter like this had not been reported before in the northern Cascade Range and basic descriptive information was needed about the site. The information gathered has been used to determine if the site meets criteria for inclusion in the National Register of Historic Places. After a site has been adequately documented and studied, and its importance assessed, it can be nominated to and listed in the National Register, which is administered by the National Park Service. Cultural properties listed in the Register are afforded national recognition of their value and are insured a degree of protection and consideration in any planning that may effect them (U.S. Department of Interior 1986). A National Register assessment of the site is provided in section 12.7 of the report.

Investigations at the quarry began in fall of 1987 with a small crew of Park Service staff. Initial activities included establishment of a site datum and grid using a transit, rod, and tape. Excavation of Test Units 1 and 2 were completed and Test Unit 3 was begun but could not be completed before the end of the season.

With the benefit of funds granted by the Skagit Environmental Endowment Commission, excavations at the quarry were continued and expanded during the summers of 1988 and 1989. The excavators each season consisted of 10 high school student volunteers provided by the Student Conservation Association (SCA). The SCA student participation in the archeological project was through a cooperative arrangement with the NPS Skagit District's maintenance staff, who encouraged student involvement and who provided the logistic support to establish and maintain a field camp. The students were supervised by two adult SCA leaders and three professional archeologists. The field school lasted three weeks in 1988 and four weeks in 1989 with additional fieldwork conducted by the crew of NPS archeologists.

8.2 Methodology of Test Excavations at the Quarry (45WH224)

The gathering of basic descriptive information about the site was guided by a series of questions that are routinely considered in evaluating the significance of archeological sites. These questions are listed below. Data bearing on these questions is presented in section 10 and the answers to them are summarized in section 12.7.3.

1. What are the site's horizontal dimensions and how deep are cultural remains buried below the surface?

2. What is the range of artifacts and features preserved at the site? What was their function?

3. How old is the site? Through what methods can the age of the site be estimated (radiocarbon, volcanic ashes, cross-dating of artifacts, etc.)?

4. What kinds of organic remains are preserved at the site?

5. How many buried components or cultural layers are at the site?

6. In what ways have the original characteristics of the site been altered? What processes or events continue to affect any significant qualities of the site?

7. What kinds of analyses can be done with the artifacts and other remains that can contribute new knowledge to prehistory?

8. Is the site one member of a much larger class of sites that have already been well-studied? Are there any other sites capable of contributing the same kinds of information?

9. What are the data categories contained in the site that make it eligible according to the National Register criteria?

A north-south baseline was established across the site and was used to orient the site grid to true north. A total of 22 test units (each unit is a 1 x 1 meter square) were dug into the site using standard archeological excavation techniques. The test unit locations were selected judgementally in order to reflect the varied terrain of the steep hillside (see section 10.1 for more detailed discussion).

Test unit excavations proceeded quite slowly due to many boulders and cobbles in the soil matrix. A trowel and dustpan served as the most practical excavation tools. Deposits were excavated in 10 cm horizontal levels and sifted through 1/4" (0.63 cm) mesh screen; all cultural remains were placed in labeled level bags. Black and white and color photographs were taken of test unit walls and floors a various stages of the excavations. Prior to backfilling, test unit stratigraphy was described and a profile drawing made of the unit walls.

All test units were excavated to bedrock or to deposits devoid of artifacts. The test units varied in depth, the deepest (TU-12) being 2.1 m and the shallowest (TU-15) being 0.3 m deep.

At the end of each day, the level bags were taken to the SCA fieldcamp where they were cataloged and the artifacts washed. After drying, they were rebagged and transported to the NPS archeology office at the Skagit District Ranger Station in Marblemount. Here the artifacts were more thoroughly cleaned, sorted, given object names, measured and weighed, and assigned accession and catalog numbers. All artifacts, level bags, bulk samples, and special samples (such as charcoal) are cataloged in the NPS Automated National Catalog System. Here information about each cataloged item is maintained on a computer data base. All cataloged specimens are housed in an artifact storage facility located at the Skagit District office of the National Park Service in Marblemount.

The next step in site evaluation consisted of the analysis of artifacts recovered from the excavations. A number of specialized studies were performed, including a morphological description of artifacts, a description of site stratigraphy, the radiocarbon dating of organic remains, identification of animal bones, a description of a volcanic ash sample, and a petrographic and chemical characterization of Hozomeen chert. Results of these analyses are described in the report; the raw data has been placed in the appendices.

8.3 Methodology of Reconnaissance Survey

The second goal of the project, to assess the potential for occurrence of other Hozomeen chert procurement sites, was achieved through limited archeological reconnaissance surveys. Surveys of this type are meant to cover the ground relatively quickly but not necessarily thoroughly. The survey results thus provides a first approximation of the nature and locations of additional quarry or chert procurement sites in the mountainous terrain of the valley.

The survey was conducted on both the east and west walls of the upper Skagit River Valley within a few miles of 45WH224. More specifically, the survey tracts were along the lower Little Beaver Cr. valley and the ridgeline immediately to the north, along lower Lightning Cr., and on Desolation Peak. Survey tracts were nonsystematic and irregular, and were controlled more by an attempt to avoid hazards (including cliffs, steep gullies, loose scree, avalanche debris, and patches of impenetrable vegetation) than by any other single factor. Consequently, the survey tracts tended to follow routes offering the least resistance to a walker traveling from the valley bottom to higher elevation terrain. As might be expected, such routes are also game trails that show varying degrees of use by deer.

Only a small fraction of the mountainous landscape surrounding the chert quarry (45WH224) was examined. Most of the survey was implemented by the author alone or less frequently, a member of the field crew. Survey coverage was at a "reconnaissance" level, meaning the terrain was not examined closely and intensively, rather it was examined casually and sometimes intensively in selected locations. Occasionally, the author would combine such a reconnaissance survey with other Park duties as these permitted access to more remote terrain not previously examined for the presence of archeological sites. Generally, the surveyed terrain varied from lowland montane forests (1600 ft elevation) to subalpine forests and meadows (6000 ft).

Archeological sites found during the survey were recorded in the field on site inventory forms, photographed, and a sketch map was made of their location. These locations are plotted on U.S.G.S. topographic maps (1:24,000 scale) and vertical aerial photographs. Environmental and cultural characteristics of each site were recorded, including an initial inventory of the readily visible cultural remains observed at each site. This information was later transferred to Washington Archeological Site Inventory Forms; following submission of these forms to the State Office of Archeology and Historic Preservation in Olympia, each site was assigned a Smithsonian trinomial number. The three sites found during the survey are described in section 11 of this report.

9. THE DESOLATION CHERT QUARRY (45WH224)

9.1 Description of the Site

The site is located on the lower west slope of Desolation Peak (1860 m elevation) and consists of a massive bedrock exposure of Hozomeen chert and a rockshelter that has been formed within a large structural joint running through the rock mass. Surrounding the bedrock are scatters of Hozomeen chert flaking debris on the ground surface, and deposits of flaking debris buried beneath the forest duff layer. The tested and mapped portion of the site covers a measured area of 0.03 km^2 (7.6 acres) and extends from 489 m (1602.5 ft) above mean sea level to 535 m (1755 ft). The lowest portion of the site is inundated by reservoir waters in most years, but is known to extend to at least 455 m (1492 ft). There is also a southern segment of the site, called 45WH224B, that is much smaller than the main quarry and that is separated from it by a steep but narrow gully. This smaller segment contains much less flaking debris and few exposures of Hozomeen chert bedrock. No test units were excavated in this portion of the site.

Although not large, the rockshelter is a prominent feature of the site. The entire bedrock mass of the shelter, including its ceiling, walls, and floor are of medium to high quality Hozomeen chert. The shelter's maximum dimensions are about 32.5 m long by 4.5 m high by 4.2 m deep. In places the ceiling is horizontal and in others it is sloping, and it could afford protection from weather for a few dozen people at most. The opening faces west, toward the distant summits of the Mt. Spickard-Mt. Redoubt massif. Prior to inundation by the reservoir, the scene would have included a southerly overview of the Skagit River flood plain, a couple hundred feet lower in elevation. When discovered in 1987, the shelter opening was overgrown with small trees and the walls and ceiling was covered with moss. At a few points along the intersection of the floor and back wall, water seeps perennially through bedrock joints and percolates through the debitage deposits on the floor.

The bedrock from which the chert was quarried at the rockshelter is heavily fractured and jointed, so that the ceiling and walls of the shelter are jumbled and irregular, and in only a few places do they form smooth planes. The overall bedrock surface conformation, a result of natural weathering and human quarrying, consists of numerous corners, protrusions, gullies, open cracks, and ledges.

9.2 Bedrock Geology and Description of Hozomeen Chert

The bedrock geology of the upper Skagit Basin is complex and resulted from four main geologic events (Tabor et al. 1989). These include, (1) the accretion of terranes to the North American Continent during the pre-to-late Cretaceous period (150-70 million years before present [mybp]), (2) uplift, deformation and metamorphosis of these terranes through the late Cretaceous to Eocene (100-50 mybp), (3) crustal extension and associated faulting that broke the terranes and may have displaced parts of some terranes hundreds of kilometers during the Eocene Epoch (57-36 mybp), and (4) intrusion of magmatic rocks and their extrusive counterparts between the Oligocene Epoch and the Holocene Epoch (35 mybp).

The geology of the region was first described by Daly during a survey of the international border in 1912. The Hozomeen Group of rocks were named and described by Cairnes in 1944. McTaggart and Thompson (1967) have provided the most detailed description of the Hozomeen Group to date, although several other authors have discussed its origins (Misch 1966; Staatz et al. 1972; Haugerude 1985).

The chert at 45WH224 is part of the Hozomeen Terrane. The rocks of this terrane originated as mafic lavas, limestone and chert in an ocean basin during the mid-to-late Jurassic Period, as indicated by the presence of partially preserved radiolarian fossils in the chert. The Hozomeen Terrane was subsequently uplifted, deformed and metamorphosed into greenstone, argillite and ribbon chert. Movement along the Fraser-Straight Creek fault during the Eocene separated the Hozomeen Group of rocks from an identical suite of rocks known as the Bridge River Group (Figure 9.1). Part of the Bridge River Group known as the Carpenter Lake Assemblage contains ribbon chert with radiolarian fossils, a characteristic it shares with the Hozomeen Group (Potter 1986). Displacement along the fault system is estimated at 80-100 km (Monger 1985).

To my knowledge, the term "Hozomeen" first appears about 1860 in written documents by Henry Custer and H. Bauerman to designate the prominent pair of glacial horns that dominate the valley near the 49th parallel. Today "Hozomeen" or "Hozameen" designates a number of geographic features of the region, including the mountain, a lake, a stream, and a mountain range in southern British Columbia. Based on information provided by Dr. Dale Kinkaid of the University of British Columbia, the word appears to derive from the Salish language, almost certainly of Nlakápamux (Lower Thompson) derivation. Accordingly, "hozo" means "sharp" and "-meen" denotes "an instrument out of it". Dr. Kinkaid draws his information from Miss Annie York of Spuzzum, who gives the meaning of Hozameen as "sharp, like a sharp knife." (Akrigg and Akrigg 1986:134-135). Although a more precise meaning of the term may never be known, it is perhaps more than coincidental that it embodies within it a tradition of Native American use of this distinctive stone material extending for at least the last eight millennia.

As applied to archeology and prehistory, I have used "Hozomeen chert" to refer specifically to the subvarieties of fine-grained quartz rocks occurring naturally among the other rock types of the Hozomeen Group. Hozomeen chert occurs as banded ribbon cherts and nonbanded, irregular-shaped masses, and as detached chert fragments (pebble to boulder-sized) that originated from this group. Although most bedrock occurrences are usually as distinct chert bands interbedded with nonchert rocks, the bedrock exposure at 45WH224 consists of a heavily fractured and jointed body of massive (nonribbon) chert.

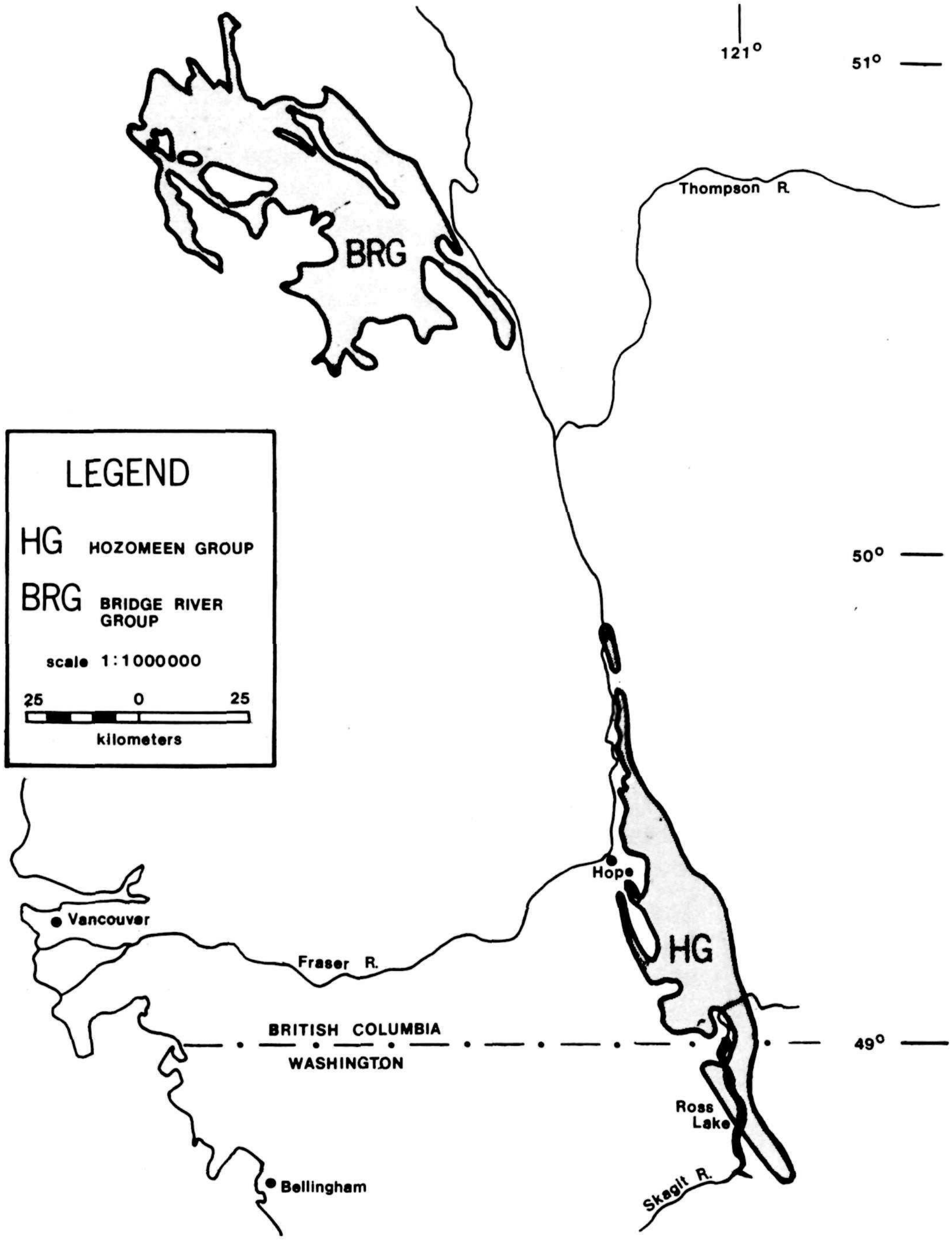


Figure 9.1. Map showing the distribution of Hozomeen and Bridge river Groups. These rock units were contiguous before they separated along the Fraser-Straight Creek Fault.

Hozomeen chert exhibits a wide range of colors and textures, and varies greatly from sample to sample in its utility for manufacturing stone tools. The different color varieties of Hozomeen chert, in order of decreasing abundance, are dark gray, black, light gray, light bluish-gray, medium gray, pink, red (jasper), pale green, white, and waxy gray (this latter variety is most similar in appearance to chalcedony). Although some specimens are uniform in color, most exhibit a mix of one or more colors in a distinctive and complex pattern of criss-crossing veins. Most varieties have a dull or earthy luster and are opaque, but become translucent on fragments thinner than a millimeter or two. Pieces of the latter type, such as thin flakes and debitage, resemble "moss agate" (long before Hozomeen chert was identified and sourced, an artifact made from it was found at a subalpine site in the North Cascades and was identified as moss agate).

The quality of Hozomeen chert varies widely in its use for flaking into stone tools, largely as a function of the crystalline texture and homogeneity of any particular sample. The great majority of chert observed in outcrops is of poor quality for flaking purposes. Such chert is coarse-grained and permeated with bands of vein quartz, which weather (chemically and physically) to form planes of weakness or empty vesicles. Consequently, this heterogeneous variety is difficult to flake in a controlled manner.

The highest quality chert constitutes only a small percentage of the total volume that is present in the valley. Such chert is fine-grained (microgranular) and homogeneous. If quartz veins are present, they tend to be thin and tightly bonded to the microgranular matrix. Chert of this quality flakes with a glassy, smooth conchoidal fracture. Thin ("feather") edges of flake margins are extremely sharp but brittle. Due to the low proportion of high quality chert, an important activity in prehistoric chert procurement was the removal and discarding of poor quality material in order to reduce workable masses of stone down to the highest quality pieces.

Samples of Hozomeen chert from the project area were petrographically and chemically characterized (Appendix B). First, samples were thin-sectioned and examined under a petrographic microscope by Dr. Edwin Brown of the Geology Department at Western Washington University. Appendix B provides detailed hand specimen descriptions and semi-quantitative petrographic descriptions of these samples. The chert consists predominately of microgranular quartz (90-95%) cross-cut by thin veins of coarse granular quartz. Mixed into the groundmass are minor percentages of other crystalline (muscovite, illite, chlorite, calcite, and carbonates) and noncrystalline materials. A distinctive characteristic observable microscopically in thin section is the presence of recrystallized radiolarian structures (see photographs in Appendix B). As part of this study, a preliminary chemical analysis using x-ray fluorescence spectrometry was performed on some of the samples. The different chemical signatures of the samples suggests that Hozomeen chert from different source locations may be separable. Chemical differences were most clear in the spectrum that contains minor trace elements.

Because it appears that accurate signatures can be achieved nondestructively, artifacts and finished tools may be analyzed using this technique.

9.3 Topography and Surficial Geology

Topographically, the site rests in an area of gently to steeply sloping mountainside at the base of Desolation Peak. Although the studied portion of the site is above the high pool level of Ross Lake, a roughly equivalent, but unmeasured portion of the site extends below the high pool level. Topographic variability of the mountainside is controlled by underlying bedrock structures, by the former effects of glacial erosion and deposition, by mass wasting deposits that have traveled down hillside gullies, and by runoff of intermittent snowmelt streams. The computer diagram in Figure 9.2 shows the site boundaries outlined on the lower slopes of Desolation Peak.

For descriptive purposes, the topographic and environmental variability within the archeological site boundaries is classified into terrain types. These terrains are widespread on hillsides throughout the valley. They include hillside colluvium and slopewash, mass wasting or earth movement deposits, flat terraces and benches, bedrock outcrops, and quarrying debris. These terrains are defined in section 10.1 of the report and are used to classify the 22 test units excavated at the site.

Soils of variable thickness have developed on the hillside since the retreat of glaciers, about 12,000 years ago. Soils vary in thickness from 0 cm (such as on exposed bedrock surfaces where no soil has formed) to greater than 2 m (6.6 ft) on steep colluvial hillsides. The parent material of the soils consists of bedrock, till, loess, colluvium and earth-movement sediments. Till is the predominant parent material at the site and consists of poorly sorted, rocky (bouldery and cobbly) silty sands, which were first transported and then deposited by the Cordilleran ice sheet as it scoured and smoothed the valley walls. Consequently, a wide range of rock types from distant sources have been mixed together in the sedimentary matrix. Such rock types include granite, gneiss, quartzite, phyllite, talc, greenstone, chert, shale, argillite, mudstone, and andesite. Some of the argillites and mudstones are fine-grained and exhibit well-developed conchoidal fractures. These stone materials also were much utilized for making tools by prehistoric populations of the valley.

9.4 Vegetation

The site lies within the broad forested zone of the western Cascade Range classified as the *Tsuga heterophylla* (Western hemlock) Zone of Franklin and Dyrness (1973). The actual site setting, within the rainshadow of the Picket Range, is more accurately described as within the more xeric Douglas-fir cover type characteristic of the dry east side of Ross Lake (Agee and Pickford 1985).

Most of the site is covered by a more or less continuous tree canopy. Trees are notably absent in two small areas of the site consisting of bare or moss-covered bedrock surfaces. The on-site tree canopy is dominated by Douglas-fir, but also includes western red-cedar, lodgepole pine, bigleaf maple, paper birch, cherry, vine maple, and ponderosa pine. The understory is dominated by shrub species, in some locations so abundant as to inhibit passage. Species observed include Oregon grape, hazel, kinnikinnick, mountain spray, serviceberry, wild rose, and boxwood. Mosses and lichens cover most rock outcrops and *Lomatium* and wild onion have been observed growing on the two moss-covered bedrock benches. The site is undisturbed by logging except for a narrow strip bordering Ross Lake; here some large diameter Douglas-fir trees were cut during logging operations conducted in preparation for impoundment of the reservoir, sometime in the late 1940s or early 1950s. Appendix A is an inventory of plants observed on the site, and includes their scientific names.

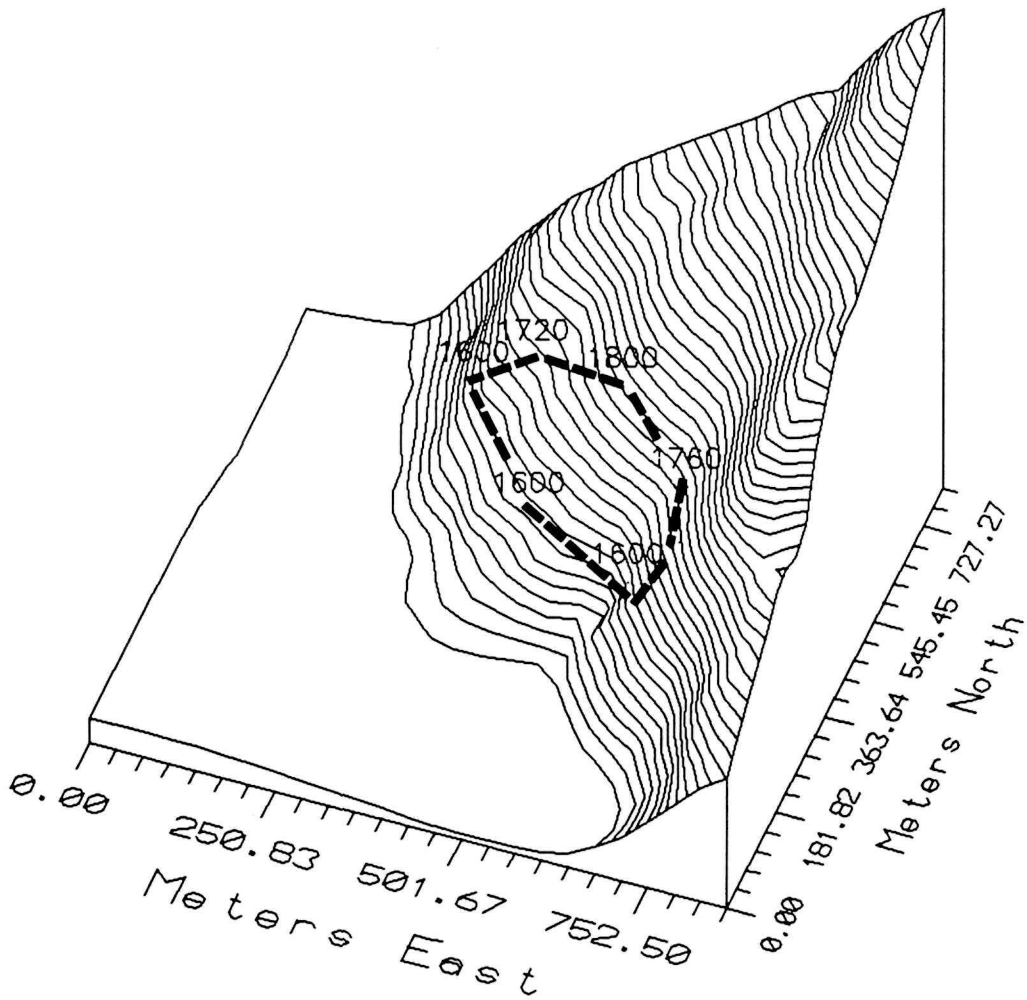


Figure 9.2. **Diagram showing 45WH224 boundaries outlined on the lower slopes of Desolation Peak.**

10. RESULTS OF SITE TESTING

10.1 Test Unit Selection

Test units (TU's) were selected that encompassed the variety of landform types and chipped stone debris scatters observed on the ground surface. TU locations were judgementally chosen for their expected ability to address project objectives and to provide answers to the questions listed in section 8.1. Certain landforms, such as the terrace/flat bench located a short distance from the rockshelter, for example, was considered important for determining if the quarry had been used as a campsite. Another area, the rockshelter floor, covers only a fraction of the total measured site area, yet the deposits here address some of the questions being asked about the site.

In order to show how the excavated TU's distributed across the hillside environment, the site area above 1602 ft elevation is classified into five different types of terrain. "Terrain" as used here in its most specific sense is defined by slope, topography, and geologic origin. The definition reflects a rather technical archeological concern with the sedimentary context of artifacts and a need to understand the evolution of the land surface over the last 8000 or more years; this sense is also similar to a microenvironmental scale of description as described by Butzer 1982:37-38.

The terrains are colluvium, earth movement, terrace/flat bench, bedrock, and quarry deposits. Photographs of site terrain are shown in Figures 10.1 to 10.5. The technical definitions of the terrain types are given next. They are described by general slope, soil development, vegetation cover, and artifact content.

1. Colluvium. The majority of the site, perhaps over 80% of the measured area, is comprised of this type. It encompasses steeply to moderately sloping hillsides on which rocks, soil, and organic debris move downslope under the force of gravity. The soils on this terrain are mixed by two processes: slope wash and rotation of small earth blocks wadded in tipped-up tree root masses. This terrain supports a closed canopy forest having generally dense brushy understory. Prehistoric flaking debris of Hozomeen chert is scattered throughout the deposits for greater than a meter in depth.

2. Earth Movement. Although this terrain type is prominent in some valley locations, it went unrecognized at the site until it was exposed in the walls of a TU. Deposits of this type were recognized a distinctive soil and sedimentary sequence. The sedimentary matrix is poorly sorted, in one place weakly sorted, and contains subangular boulders of local rock types. The ground surface is nearly level to slightly hummocky and on it rests a few boulders up to 5 m diameter. The deposit was formed by mass movement of hillside soils and rocks (the latter greater than 0.5 m. This terrain has been recognized in one restricted portion of the site at the base of a steep slope. Vegetation type is the same as colluvium. Prehistoric debitage and artifacts were found incorporated within the deposits in one TU, and in two others, a very high density of artifacts was found in a

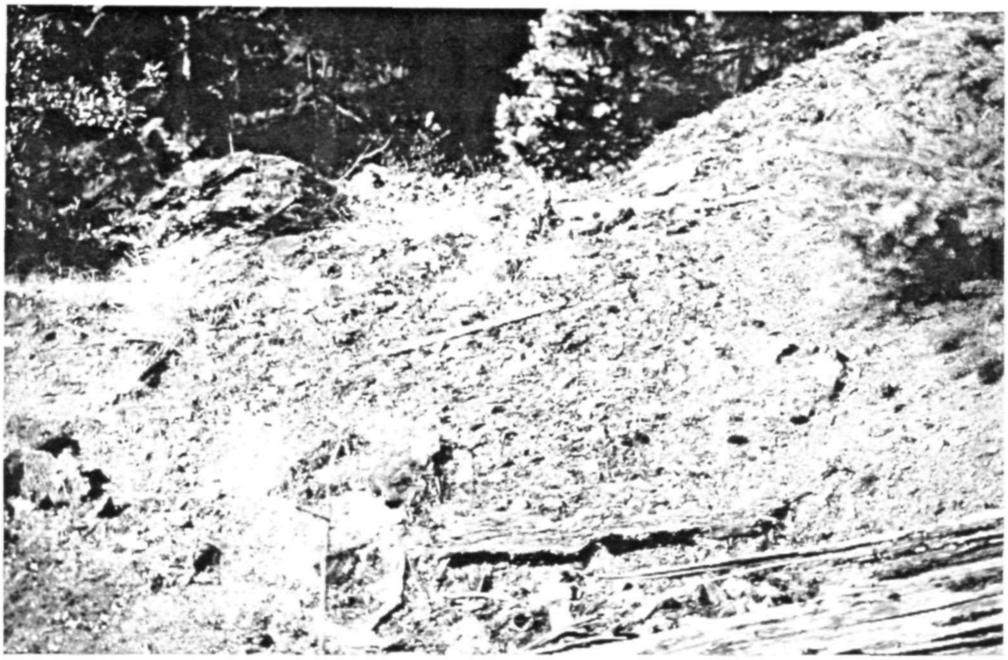


Figure 10.1. Scatter of flaking debris on bedrock bench terrain, 45WH224.

Figure 10.2. Terrace/Flat bench in foreground dropping to hillside (colluvium) in upper-right distance, 45WH224.

Figure 10.3. Distance view of 45WH224, showing bedrock bench. Rockshelter in forest left of bench.

Figure 10.4. Close-up of hammerstone marks on bedrock face in rockshelter, 45WH224.

Figure 10.5. **Panoramic view of the front of the rockshelter at 45WH224; the small trees in the foreground are growing on 1-2 m thick quarry deposits.**

well-developed soil B-horizon buried beneath these deposits.

3. Terrace/Flat Bench. Scattered about the site are a few small areas of nearly horizontal, flat ground. These were created by glacial deposition and bedrock scouring by glacier ice during the Pleistocene. These terrains consist of poorly sorted, gravelly to silty deposits from a few cm to 2 m or more in depth. They also constitute the most stable ground surfaces and exhibit a well-developed soil B-horizon (where they have not been disturbed by tree tip-up rotational blocks). Vegetation type is the same as described for the above terrains. Prehistoric debitage and artifacts are concentrated in a soil B-horizon that has developed in the top of the deposit, the underlying soil BC-horizon is devoid of artifacts.

4. Bedrock Bench. This terrain consists of glacially scoured bedrock outcrops covered with little if any soil. Outcrops are typically level to gently sloping on top and descend steeply into cliff bands on their downhill sides. These are the driest microclimates on the site, supporting a thick mat of moss, some herbs, and isolated shrubs or trees. Prehistoric debitage and artifacts occur on the bare bedrock surfaces, within the thin soil matrix, and on top of the moss mat. In addition, where bedrock faces have been hammered during prehistoric quarrying, there are distinctive fractures and quarrying scars in evidence.

5. Quarry Deposits. This is the only terrain whose origin is attributed predominately to human activity. The bulk of these deposits occur under the rockshelter ceiling and under the dripline. Other quarry deposits occur as accumulations of debitage and artifacts in shallow bedrock gullies and ledges, and in one case they fill a steep hillside gully. Quarrying is clearly indicated by numerous impact scars along corners and joints of the rockshelter ceiling, walls, and floors where the chert outcrop was hammered and fragmented. Hammerstones showing use-wear patterns are frequent occurrences within the quarry deposits. Under the rockshelter these deposits extend to 2 m in depth. The estimated volume of quarry deposits under the rockshelter exceeds 90 m^3 and its estimated weight exceeds 68.8 metric tons. Most of this volume accumulated over many years during the removal of pieces of chert bedrock, and the immediate cleaning and initial shaping of the pieces into quarry blanks. Natural processes have also added to build up of the deposits, particularly windblown fine silt, soil washed in from the hillside above, and rockfall from the bedrock formation.

In Table 10.1, all 22 Tus are listed according to terrain type and the total volume of deposits excavated. The volume of sediments excavated from all test units combined is 14.8 m^3. Locations of TUs are plotted in Figure 10.6.

10.2 Site Stratigraphy

This section describes the stratigraphy observed in the 45WH224 excavation units. The sequence diagrammed in Figure 10.7 was created by combining, in their inferred

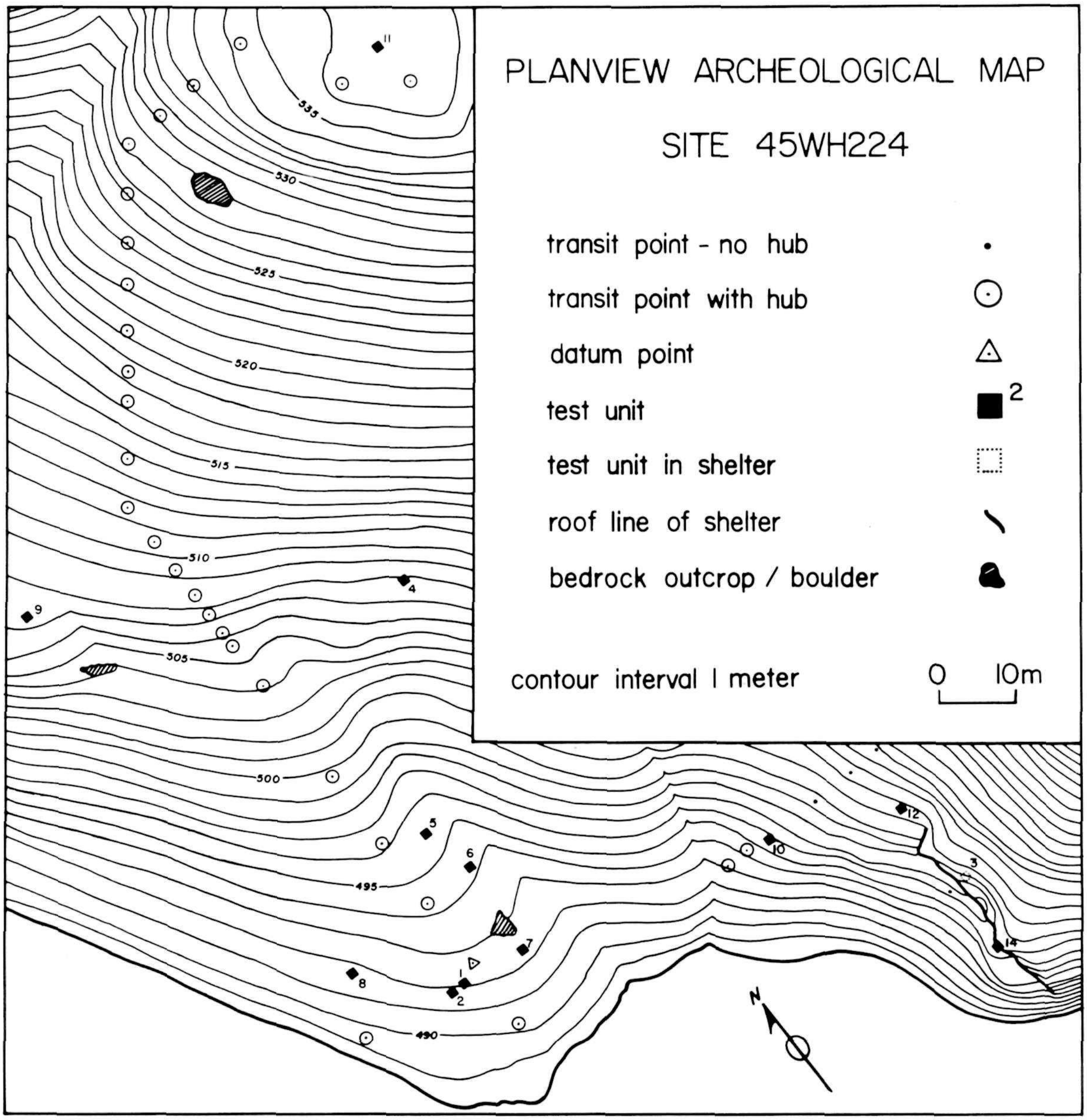


Figure 10.6. Planview archeological topographic map showing test units at 45WH224.

GENERALIZED SITE STRATIGRAPHIC SECTION

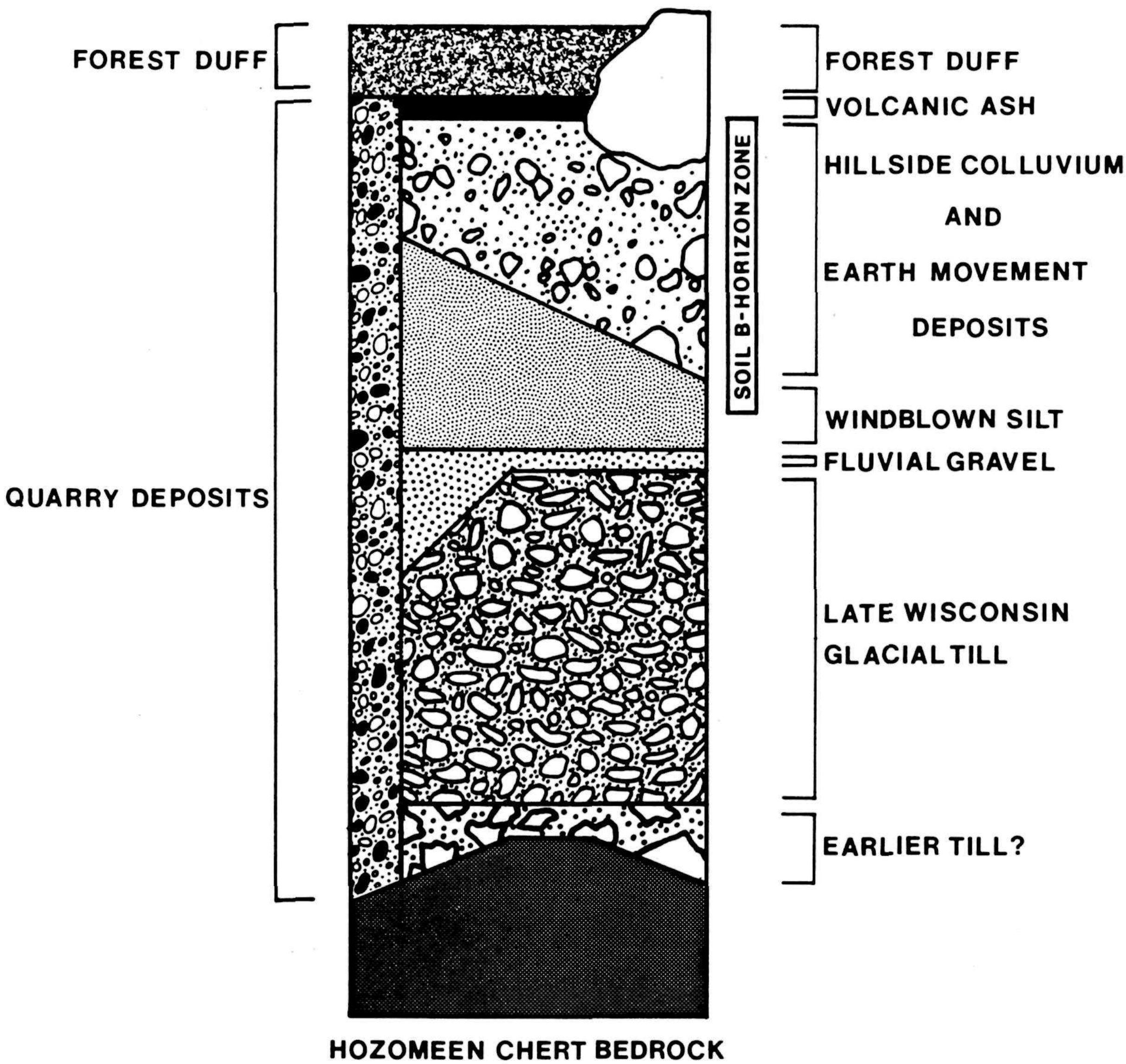


Figure 10.7. Generalized stratigraphic column at 45WH224.

Table 10.1. Test Unit Classification by Terrain Type at 45WH224. (Asterisks designate those TUs with radiocarbon dated material. Totals at bottom indicate volume of sediment excavated from each terrain class).

	Colluvium	Earth Movement	Terrace/ Flat Bench	Bedrock Bench	Quarry Deposits
	4	5*	1	15	3*
	10	6	2*	16	13
	12*		7	17	14*
			8	18	
			9	19*	
			11	20	
				21	
				22	
TOTAL:	2.8 m^3	3.0 m^3	5.2 m^3	1.2 m^3	2.6 m^3

GRAND TOTAL: 14.8 m^3

stratigraphic order, all strata observed in test units across the site. No single test unit sedimentary sequence contained all strata.

The basal stratum consists of the Hozomeen Group of rocks, consisting of either chert or greenstone. This rock group is unconformably overlain by a compact, indurated, and poorly sorted gravelly diamictite that is most probably older than late-Wisconsin. It is probably glacial till. In those test units where it was encountered, the stratum is the basal unit at which excavations were terminated. This stratum is in turn overlain by another poorly sorted gravelly till that appears to have been deposited during a late-Wisconsin glaciation, between approximately 20,000 and 12,000 years ago.

Unconformably overlying this till in TU-1 and TU-6 is a weakly laminated, moderately to poorly sorted unit of silty sand to pebbly coarse sand. In TU-1 the laminae dip downslope, and appear to have been deposited by water in a shallow gully. The predominately subangular shapes of the granule and pebble gravels suggest a short distance of transport, with the probable source being the hillside immediately above the test units.

Unconformably overlying the laminated stratum is an olive brown silt, locally mixed with small gravels supported in the silty matrix. This stratum is unstratified and appears to be aeolian in origin (i.e., dust transported by wind currents that settled out of the air). Based on one radiocarbon date from the overlying stratum (WSU-3813), the age of this deposit is greater than 4500 years old. The upper part of this unit is weathered and expresses soil B-horizon characteristics, particularly the accumulation of iron oxides.

Unconformably overlying the aeolian silt is a gravelly silty sand stratum deposited as colluvium by the accretion of silt, sand, and gravels that have washed and rolled down the steepest hillsides of the site. This colluvium forms a thick stratum in the upper half of the TU-12 profile, where a radiocarbon date of 1830 years BP (Beta-33512) was acquired from the middle of stratum. Most of the stratum has weathered to a soil B-horizon, and it contains low to high densities of chipped stone artifacts.

Intercalated with the colluvium is another deposit that was observed in one restricted portion of the site and which is inferred to be the result of mass sediment movements down the steep hillside which came to rest on top of the terrace in the area of TU's 1, 2, 5, 6, 7, and 8. As observed at TU-5, this deposit varied from massive to weakly stratified. It is characteristically very poorly sorted and contains occasional large boulders exceeding 1 m in diameter. Soil B-horizon material was dispersed throughout the deposit, but with no single prominent B-horizon expressed. A radiocarbon date of 2800 years BP (Beta-27498) was acquired from the middle of the deposit in TU-5. The stratum contained a low density of chipped stone artifacts, which are presumed to have been mixed into the stratum from the hillslope above. In TU-6, a short distance downslope from TU-5, the earth movement deposit was much thinner and was found to bury a well-developed soil B-horizon containing a high density of chipped stone artifacts. This buried horizon appears to mark the top of a stable ground surface that existed during mid-Holocene use of the site by prehistoric people.

Overlying the colluvium and earth movement deposits, in a very discontinuous layer, is a primary volcanic ash stratum. The most prominent layer of this ash was encountered in TU-6, where as sample was collected. Electron microprobe of the ash failed to identify the source volcano or the time of eruption; however, based on stratigraphic evidence it is likely to have been deposited sometime during the last 500 years (see section 10.4.1).

The uppermost stratum at the site consists of organic material, in various states of decay, derived from the forest canopy and its shrubby understory. These materials consist of conifer needles and cones, and branches and twigs from a variety of woody species.

As depicted along the left side of the stratigraphic column in Figure 10.7, test unit profiles from under the rockshelter overhang lack soil horizonation or definable strata of glacial, fluvial, or aeolian origin. These deposits built up during human quarrying activities and consist of a uniform mix of chipped stone artifacts, hammerstones, and natural rockfall from the shelter ceiling and walls. These deposits range in age from 7600 to 3600 radiocarbon years BP (Beta-33518, WSU-3814, and others in section 10.4.2).

10.3 Test Unit Stratigraphy

This section describes those characteristics of the sediments, soils, and cultural deposits observed in individual test units. This information helps us to understand what prehistoric activities occurred at the site, to estimate the site's age and the frequency of the site's use, and any cultural patterns recognizable in the artifactual remains retrieved from the site deposits.

Test unit strata are diagrammed in Figure 10.8 which shows the sequence of strata for TUs representative of each of the five terrain types (detailed geologic descriptions of strata are given in Appendix C). Figure 10.8 correlates strata between the five terrain types and the descriptions of TU stratigraphy in Appendix C. The sequence of strata is controlled by four factors: the depositional environment of the deposit (how it got there), the degree and kind of soil development (how it weathered after it got there), natural processes that alter site deposits (disturbances), and human activity. Photographs of selected TUs and the artifact-bearing deposits are shown in Figures 10.9 to 10.14.

The most meaningful deposits for understanding cultural activity at the site were observed in the terrace/flat bench and quarry debris terrains. These areas are least affected by natural disturbances and other on-going landscape changes. The majority of site deposits, especially within the colluvium and earth movement terrain types, are mixed by tree tip-ups and downslope movement of rocks and organic debris. In bedrock bench terrain, the span of prehistoric time is compressed into a thin soil cap, where artifacts are easily displaced by freeze-thaw cycles, plant root activity, and other natural processes. Consequently, it is relatively more difficult to form conclusions from excavation of test units in colluvium, earth movement, and bedrock bench terrains.

10.3.1 Soil Horizonation in Terrace/Flat Bench Terrain

The terrace/flat bench terrain shows evidence of considerable stability and in place weathering, although it too is subject to disturbances by tree tip-ups. This results when a mass of soil is lifted above ground as it is held in the root system of a wind-thrown tree. Such soil blocks eventually erode and refill the pit created by the tip-up, causing mixing of strata or soil horizons. In our excavations we encountered both undisturbed and mixed soils. The generalized soil horizon sequence in undisturbed, stable deposits, from the surface down, is O-B-BC-C-R (an approximate translation of each letter symbol is: organic debris and forest duff--weathered and oxidized subsoil--a subsoil zone transitional to unweathered sediments below--unweathered sediments--bedrock). In disturbed deposits, the order of soil horizons deviates from this sequence, with sequences such as B-O-BC-C or BC-B-O-C or some other combination. These latter two stratigraphic sequences indicate that subsurface soil material have been brought to the surface, and horizons that normally form close to the surface have been buried below the present ground surface). By recording the soil horizon sequence, therefore, we can

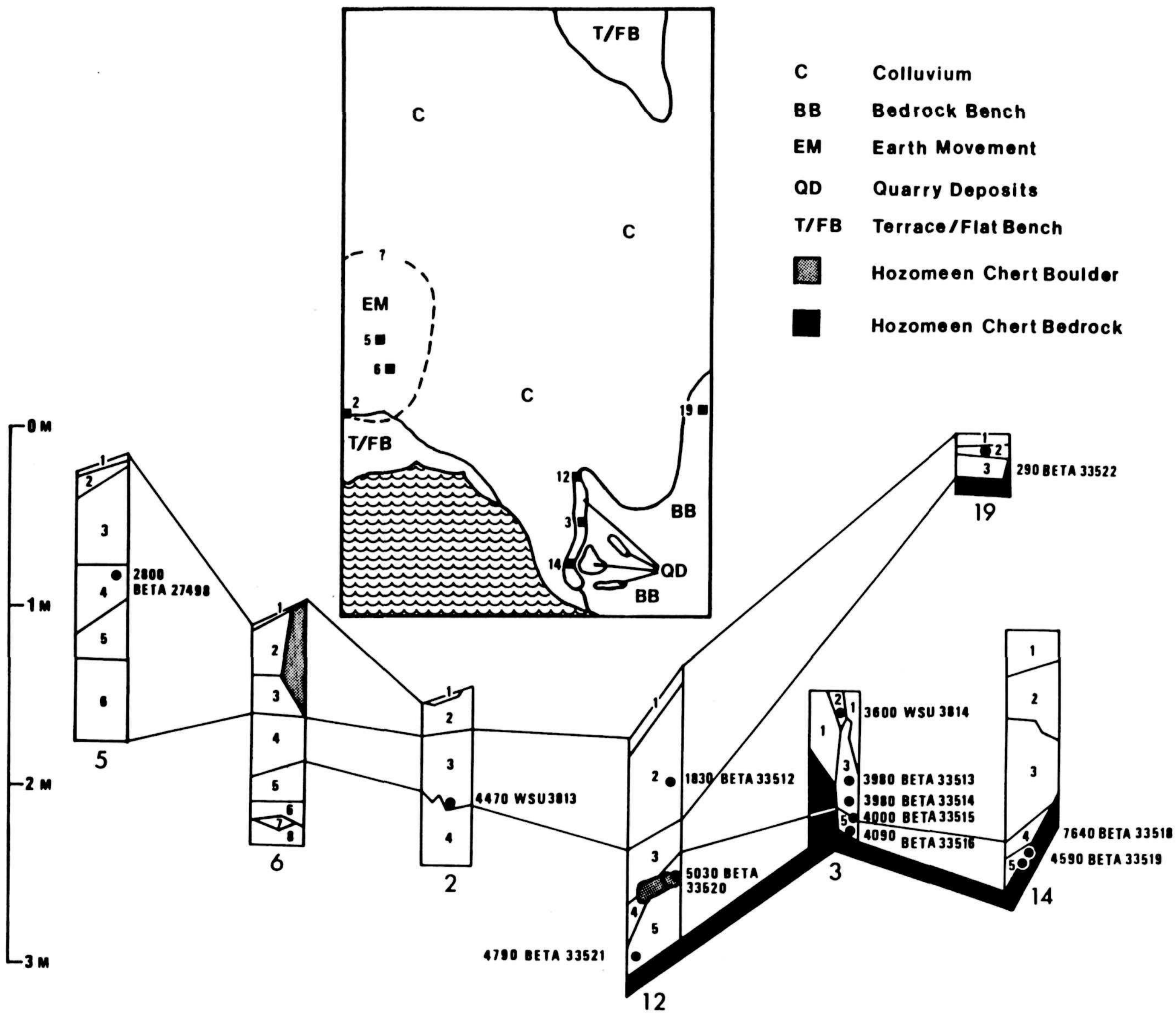


Figure 10.8. Diagram of strata for test units representative of each of the five terrain types, 45WH224.

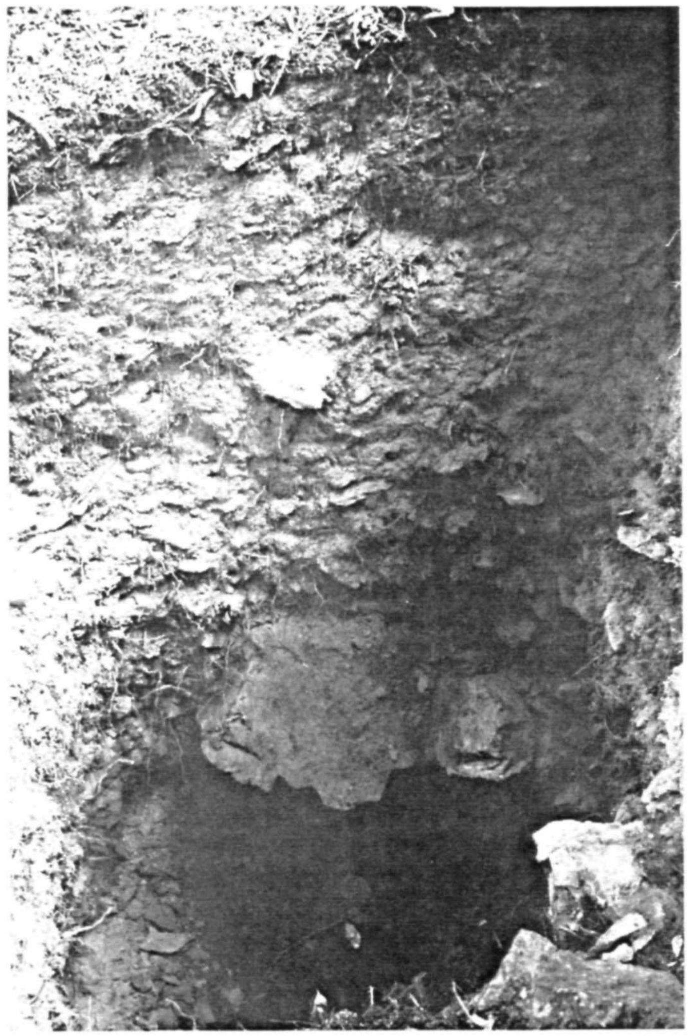


Figure 10.9. North wall of Test Unit (TU) 12, 45WH224 after excavation. The Upper half of profile is colluvium, and the lower half is quarry deposits mixed with angular Hozomeen chert rockfall from the rockshelter overhang.

Figure 10.10. **Block excavation at 45WH224 of TUs 15, 16, and 19 (from near to far) on bedrock bench. TU19 dated about 290 radiocarbon years old.**

Figure 10.11. Test unit 4, level 7 half-finished, excavated in hillside colluvium deposits at 45WH224.

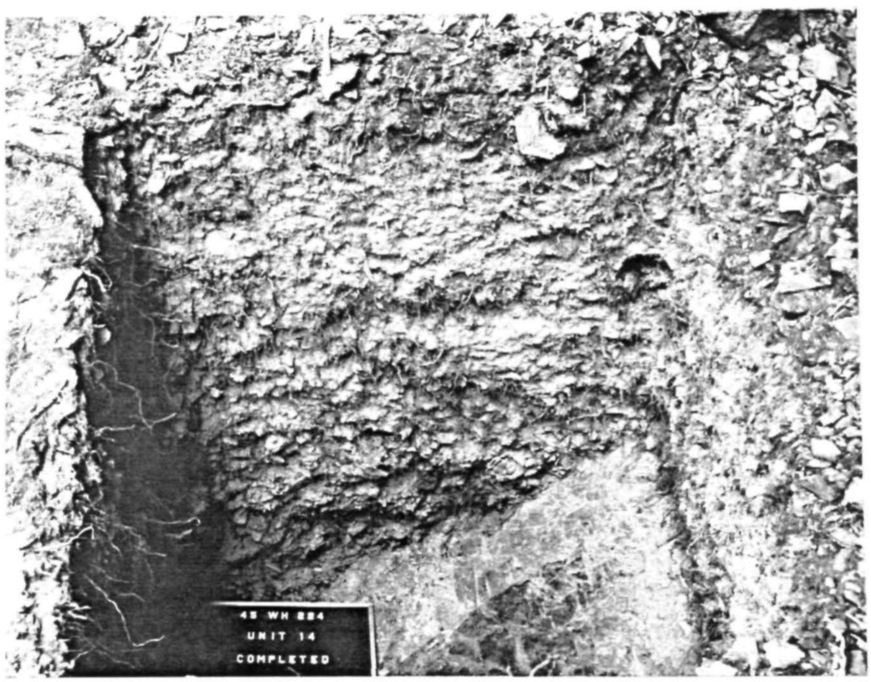


Figure 10.12. North wall of TU14 at 45WH224 after excavation. The dipping bedrock floor is Hozomeen chert overlain by quarry deposits; charcoal from just above bedrock floor dated between 4600 and 7600 radiocarbon years ago.

Figure 10.13. Bottom of level 13, TU5 excavated in earth movement deposits at 45WH224. The nails in the tag mark wall locations of a combined charcoal sample 2800 radiocarbon years old.

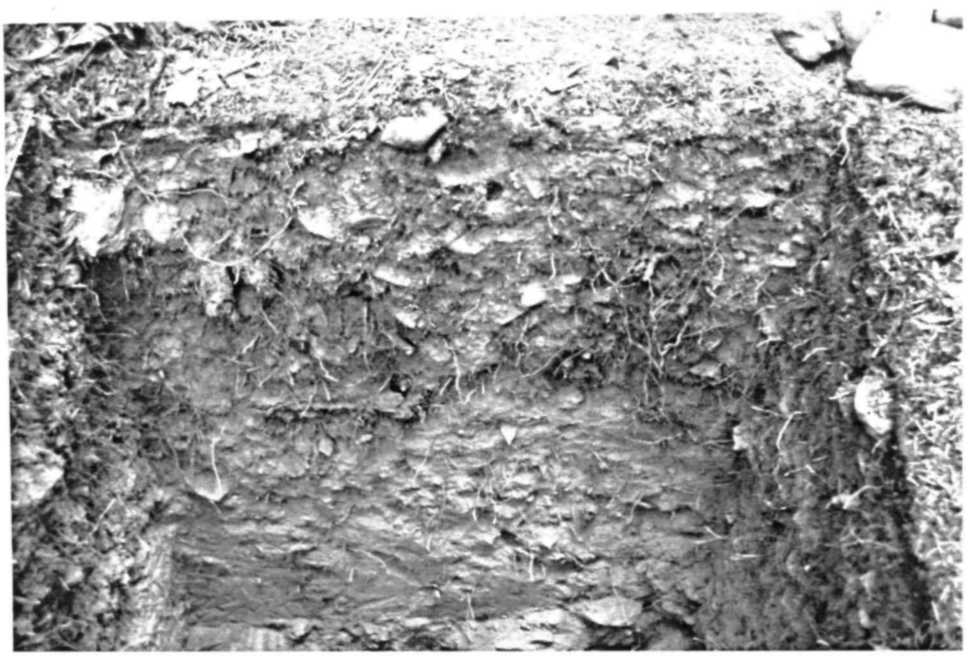


Figure 10.14. West wall of TU2 on terrace/flat bench at 45WH224, after excavation; charcoal recovered two-thirds distance down from top of ground dated 4470 radiocarbon years old.

infer the approximate degree of sediment mixing and disturbance to artifact bearing deposits.

10.3.2 Soil B-horizon Development

Soil horizons and properties are described in Appendix C according to Soil Conservation Service (1981) conventions. Soil horizons at 45WH224 are characterized by color, texture, and amount and type of organic matter. The key marker stratum at the site is the B-horizon, which if unmixed is easily distinguished by color; it is the only horizon that is described as "orange" or "red" when using informal terms. According to terminology used in the Munsell color system, the B-horizon here is more precisely described as "strong brown" to "dark brown" to "brown", on moist sediment samples. In nearly all cases this is the only horizon with a hue of 7.5YR and a chroma as strong as 6. This color is imparted by *in situ* weathering of sediments resulting in the accumulation of iron oxide coatings on individual grains in the soil matrix (see discussion of cambic horizons in Soil Conservation Service 1975:33). Iron oxide also acts as a cementing agent that welds soil particles together. Thin brown coatings of silt, resembling weathered cortex, are strongly cemented with iron oxide to many artifacts, and indicate that these artifacts have resided a considerable time in the B-horizon. Given the high degree of soil horizon mixing, it is not surprising to note that artifacts with such coatings were observed from a variety of soil horizons, including from on top of the forest duff.

There is a positive correlation at the site between well-developed B-horizons and high concentrations of chipped stone debitage. This correlation was best expressed at TUs 1, 2, 6, 7, and 11. The correlation may indicate two things: 1) that the subsurface B-horizon marks the location of a stable ground surface at some time in the past, and 2) that most quarrying and flaking of chert took place at this time as compared with later time periods. An age estimate of about 4500 radiocarbon years ago was derived from the bottom of this B-horizon in TU-2. The radiocarbon dated sample was found in place as a tight cluster of charred wood chunks at 80 cm below the ground surface (see Appendix D, sample number WSU-3813) and in direct association with the bottom of a high concentration of flaking debris. The charcoal was removed from compact B-horizon matrix, and was distinguishable from smaller, dispersed charcoal fragments outside of the B-horizon matrix. The sample is considered to be cultural in origin.

Tree-caused massive displacement of artifact-bearing soils at the site is an ongoing process that left clear stratigraphic evidence in many TU profiles. The clearest example is at TU-8, which was excavated into a prominent depression on the ground surface. Recovery of tree root segments and mixed soil horizons during the excavations showed that the depression was created by a tree that had fallen long ago. As excavations at the site continued, it became clear that not all deposits were disturbed in this manner--we found undisturbed deposits that interfingered with the disturbed ones. Over even short horizontal distances there occurred abrupt changes in degree of disturbance. After a correlation was drawn in the field between stable soil B-horizons and high artifact density, the location under the ground surface of disturbed and undisturbed became an important consideration in choosing test unit locations.

From a purely archeological perspective, envision (in three dimensions) the entire volume of the soil layer that blankets the landscape, as encompassing two different physical parts. The first is a nonsystematic mix of soil from different horizons, partially decayed tree parts, and unweathered sediments. The other part is dominated by a relatively well-developed B-horizon or other evidence of a stable, or relic soil. If the boundaries between the two soil parts could be mapped, they would appear to be extremely irregular in shape and in other places to grade into one another. Undisturbed soil parts ought to occur in stable settings (lacking erosion and deposition events), such as under or adjacent to large boulders, or under decayed logs on the forest floor. On top of relict terraces having deep soils, the distribution of soil parts is largely a consequence of the frequency of tree blow-downs and forest history. Except for the occasional presence of tree tip-up mounds and depressions, the location of disturbed deposits is difficult to predict from ground surface morphology. It is within the undisturbed soil parts where prehistoric features and artifacts in their original geological context are more likely to be found, when archeological excavations are conducted in mountain coniferous forests.

10.3.3 Stratigraphy of Rockshelter Deposits

The deposits under the rockshelter proved to be stratigraphically and artifactually distinctive. They were excavated at TU's 3, 13, and 14, and the lower half of TU-12. Each of these TUs is sheltered to some degree by the rockshelter overhang and ceiling. As a group, these test units encompass deposits of different character and origin compared with deposits of the other terrain types. The rockshelter quarry deposits for the most part lack soil horizonation and natural geologic stratification. They have accreted vertically primarily as a result of chert fragmentation by humans, and to a lesser degree from the influx of silts and fine sands transported as slopewash and loess. The locations of these TUs in relation to the rockshelter structure is shown in Figures 10.15 and 10.16.

The deposits are nearly homogeneous and are characterized by a matrix of pebble to cobble-sized clasts of chipped stone flakes and shatter (debitage) including minor amounts of biface fragments, hammerstones, and natural rockfall. At the top of the deposits, the interstitial matrix between rock fragments is filled with brown sandy silts derived from eroded and transported soil B-horizons from upslope. With increasing depth, the sandy silt decreases in proportion and the interstitial matrix becomes increasingly open and clast-supported. A visually prominent cultural stratum at the bottom of each test unit consisted of a loose open-work deposit of flaking debris mixed with finely powdered charcoal and small dispersed and concentrated pieces of solid

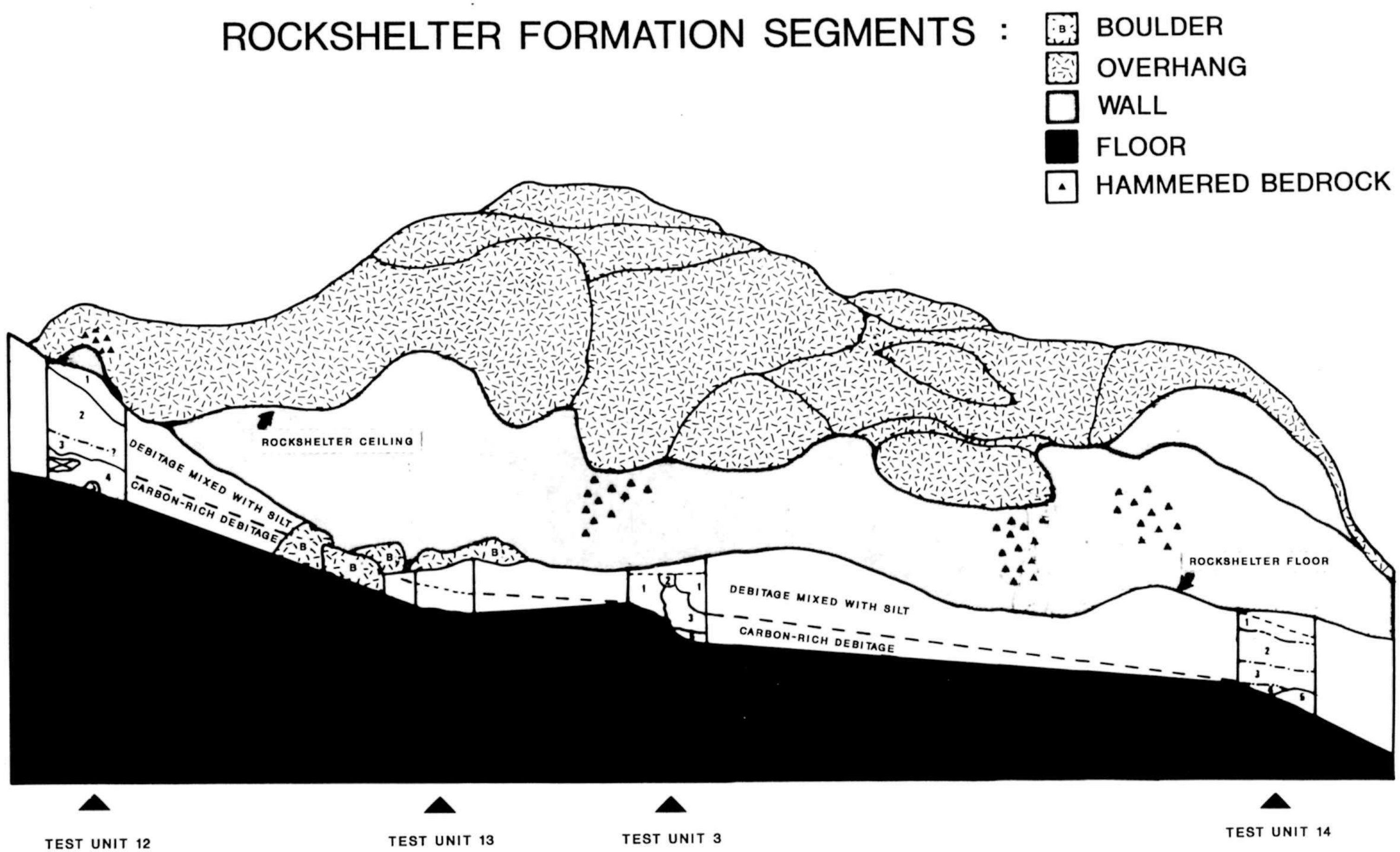


Figure 10.15. Diagram showing different segments of the rockshelter structure at 45WH224.

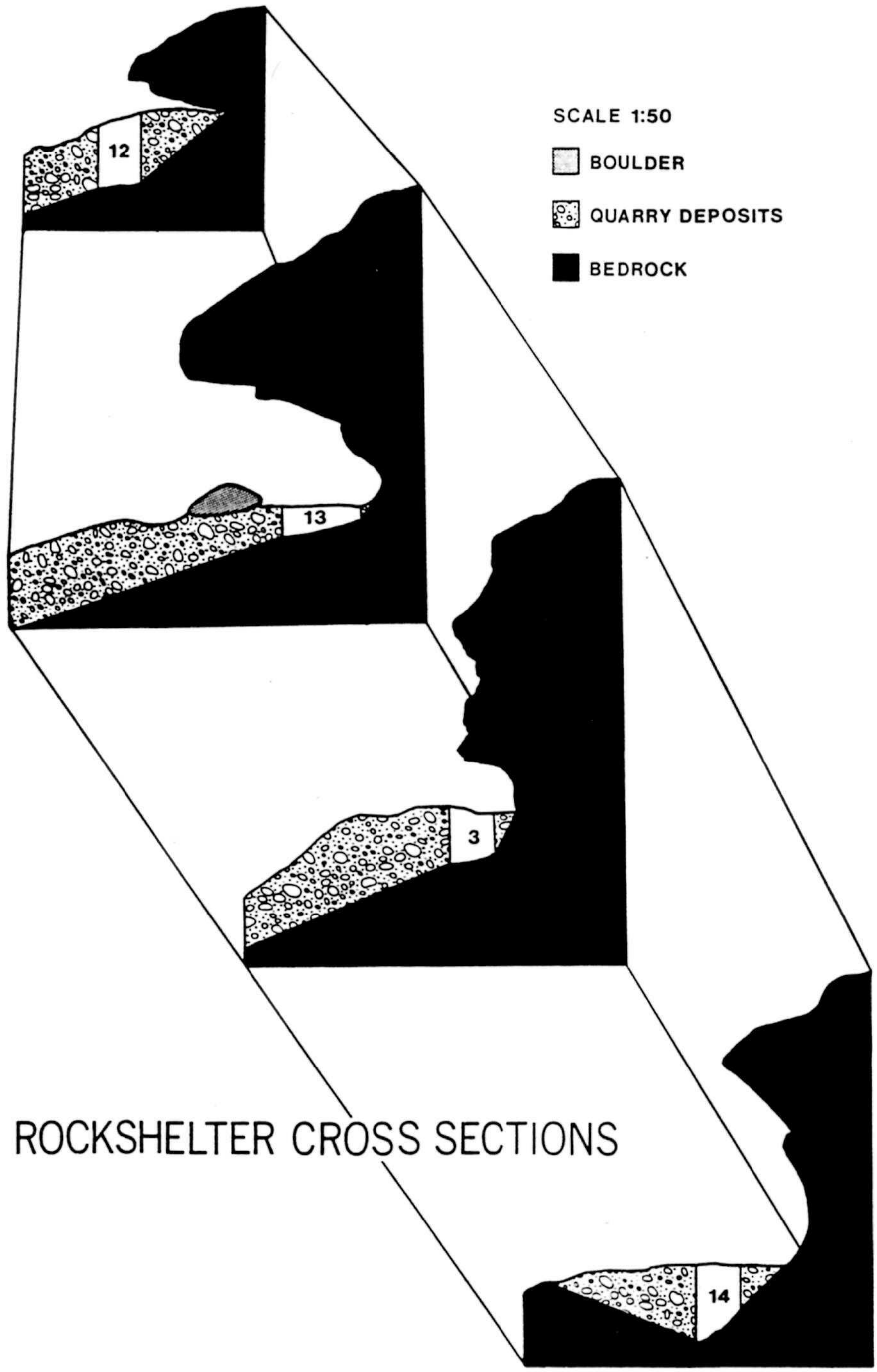


Figure 10.16. Diagram of rockshelter cross-sections and test unit locations at 45WH224.

charcoal. Some of the debitage from this stratum is coated with a fine black soot. Also, the flaking debris has different physical properties compared to the that above; these include increased brittleness, chalkiness, and an abundance of splintery fractures. These deposits rest on gently to steeply dipping, chert bedrock surfaces. In common with the bedrock exposure of chert in the rockshelter ceiling and walls, the rockshelter floor is highly jointed and fractured, and shows evidence of quarrying in the form of impact scars from hammering and prying along joints.

The rockshelter quarry deposits lack interbedded strata that indicate time intervals of nondeposition or of changing rates of debitage deposition. Absent are volcanic ash layers, stratified loess or slopewash sediments, rockfall layers, or paleosols. The uppermost radiocarbon date from these deposits, at 3600 years old (WSU-3814), was found only 6-10 cm below the top of the deposits. This may indicate that build up of most of the flaking debris under the rockshelter had occurred before about 3500 years ago.

10.4 Estimation of Site Age

The age and time periods of site use have been estimated through the use of the radiocarbon technique to date organic remains associated with artifacts. The artifacts themselves have limited value for typological dating because regional chronologies are based on formal tool types, which are nearly absent from the quarry. The one observed volcanic ash layer was also of limited value for age estimation due to its restricted distribution across the site and its undetermined origin and age.

10.4.1 Volcanic Ash Identification

In the uppermost levels of TU-6, a thin discontinuous layer of volcanic ash was found within the upper mineral soil horizon, immediately below the forest duff (the soil O horizon) and well above the more deeply buried prehistoric artifacts. A sample of the ash was collected and sent for identification to Dr. Andrei Sarna-Wojcicki at the U.S. Geological Survey, Menlo Park, California (Sample No. NOCA-88-2). The glass shards were analyzed using an electron microprobe in order to determine the proportion of trace elements present, thus allowing comparison with other volcanic ashes in the region. Unfortunately, the source and age of this ash is unknown. Until additional evidence about this ash is acquired, all that can be said is that it is possible, but uncertain, that the ash originated from an eruption of Glacier Pk., a large volcano located in the central portion of the North Cascades, approximately 85 km south of the project area. This eruption probably occurred less than 500 years ago. It also is possible that the ash originated from another Cascade volcano.

Appendix D shows the electron microprobe results of the analysis as the percentage chemical composition of the listed elements.

10.4.2 Radiocarbon Analysis of Charcoal

A total of thirteen charcoal samples from the site were submitted for radiocarbon dating. These are listed in Table 10.2 according to the uncorrected date as reported by the radiocarbon lab, and the tree-ring calibrated BP date ("Before Present" by convention means "before A.D. 1950") and calendar dates. Appendix D provides a detailed description of each sample's location and stratigraphic and cultural context. Most of the samples (9) were collected from the charcoal-rich layer of flaking debris at the bottom of the rockshelter quarry deposits. The remainder (4) were recovered from test units that sampled other deposits at the site.

All of the samples provided good dates, but as will be shown, some are more meaningful than others. Generally, these dates show that the quarry has been used at least sporadically for the last 7600 radiocarbon years, a time that spans much of the post-glacial history of the valley. The histogram in Figure 10.17 shows the number of radiocarbon dates for the site by 250-year increments. If this sample of dates is representative of when the site was used, it could mean that most of the quarrying

Table 10.2. Uncorrected and corrected radiocarbon dates from 45WH224.*

Sample Number	Uncorrected Date BP	Corrected Date BP	Corrected Calendar Date
WSU-3813	4470±200	5212(5329-4859)	3263 BC (3380-2910)
WSU-3814	3600±130	3910(4089-3809)	1961 BC (2140-1860)
Beta-27498	2800±120	2925(3059-2779)	976 BC (1110-830)
Beta-33512	1830±60	1804(1839-1703)	146 AD (55-341)
Beta-33513	3980±70	4503(4562-4402)	2554 BC (2613-2453)
Beta-33514	3980±80	4503(4564-4401)	2554 BC (2615-2452)
Beta-33515	4000±90	4513(4576-4402)	2564 BC (2627-2453)
Beta-33516	4090±90	4604(4649-4525)	2655 BC (2700-2576)
Beta-33518	7640±150	8407(8579-8319)	6458 BC (6630-6370)
Beta-33519	4590±80	5305(5330-5254)	3356 BC (3381-3305)
Beta-33520	5030±100	5851(5909-5789)	3902 BC (3960-3840)
Beta-33521	4790±70	5575(5598-5459)	3626 BC (3649-3510)
Beta-33522	290±80	311(472-286)	1639 AD (1478-1664)

*Descriptive and provenience data accompanying each radiocarbon date is provided in Appendix D.

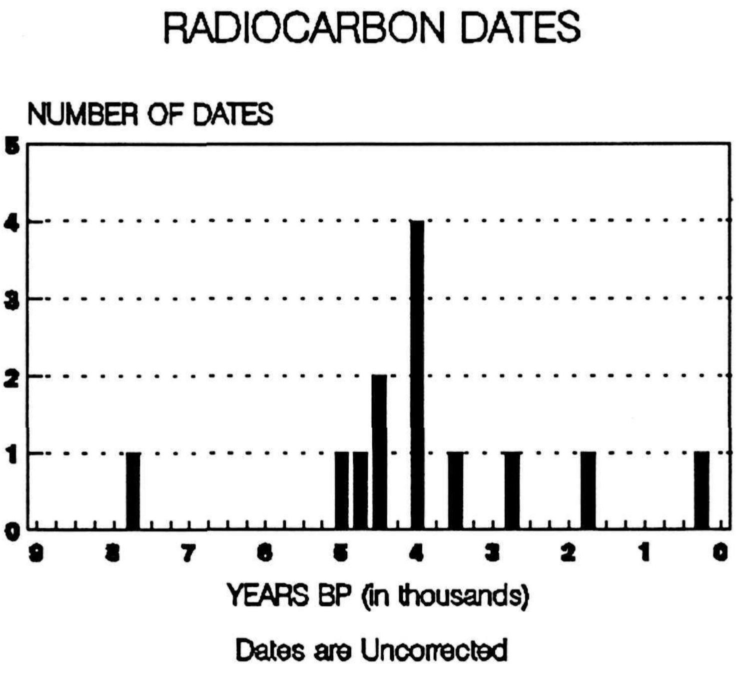


Figure 10.17. The number of radiocarbon dates from 45WH224 in 250-year increments.

occurred sometime between 5000 and 3500 years ago. Although there is no way of assuring the representativeness of the sample, the stratigraphic evidence provided in section 10.3.3 supports the inference of rapid accumulation of quarry debitage under the rockshelter over a relatively narrow timespan during the mid-Holocene. This evidence is derived from dating of the quarry deposits in TU-3, which shows that nearly all of the quarrying debris at this location had been in place by 3600 radiocarbon years ago. This is supported by the date from TU-2, which shows the highest density of flaking debris to be associated with a buried soil dated at 4470 years ago; soils formed above this buried ground surface contain a much lower density of debitage.

Two of the radiocarbon dates appear contradictory because they occur in reverse order, i.e., they are younger than the date above them. The sample numbers for these dates are Beta-33521 and Beta-33519. The cause of the reversals is attributed to mixing of charcoal from just above the steeply dipping bedrock floor of the shelter, as explained in Appendix D in each of the respective sample descriptions.

10.5 Distribution of Flaked Stone

Nearly the entire collection of artifacts from the site consists of flaked pieces of Hozomeen chert. Other cultural items are less common, including pecked hammerstones, flaked metamorphic rock, charcoal fragments, charred animal bone fragments, and five obsidian flakes. In Table 10.3 below is shown the number of flaked Hozomeen chert artifacts from the excavations, by test unit and level below the unit datum. Artifact categories counted in the table include broken and whole flakes, blades, shatter, bifaces, cores, bedrock corners, and others described in Appendix E. Not included are non-Hozomeen chert rocks and natural chert rockfall and frost-fractured fragments.

Overall the table shows very large counts of chipped stone throughout the site deposits. Such high frequencies are accounted for by the large volume of rock quarried and flaked, and the predominance of low to moderate quality stone, which easily fractures along quartz veins and other planes of weakness. The highest frequencies were encountered under the rockshelter (TU's 3, 12, & 14), where most primary reduction took place. Because of the very large number of items, the counts given for these three TU's are on a sample taken from each level, not the entire level. The actual number of artifacts from these levels is probably two to four times more than the counts shown in the table.

Artifacts occur at variable depths below the ground surface, depending on the depositional history of the terrain where the TU's were excavated (see Section 10.1 and Figure 10.8 for TU locations). Artifacts are most deeply buried where downslope movement (erosion and mass displacements) of soils has buried the deposits (TU5, 10, & partially 12) and under the rockshelter floor (TU3, the upper levels of 12, and 14). Deposits of flaking debris are thinnest on terraces/flat benches (TU1, 2, 7, 8, 9, & 11) and on bedrock benches (TU15-22).

10.6 Description of Artifacts

The range of artifact types recovered from 45WH224 reflects both the different stone reduction techniques employed by prehistoric people and the fracture properties of Hozomeen chert as a raw material. Compared to other classes of archeological sites in the Pacific Northwest, such as villages, hunting camps, and middens, the range of artifact categories at the quarry is narrow, simply reflects the cumulative effort expended over 8,000 years in the primary and secondary reduction of chert nodules, flakes, and bedrock masses into early stage bifaces (quarry blanks) and cores. No evidence has been recovered to suggest that completed tools or projectile points, including spear, dart, and arrow points were being manufactured anywhere on site. There is only the slightest evidence that a restricted portion of the site was occupied as a temporary camp, this during the last few hundred radiocarbon years.

Table 10.3. Flaked stone items per test unit and level.

Depth (cm below unit datum)**	1	2	3*	4	5	6	7	8	9	10	11
					Test Unit Number						
0-10	40	49	>10³	0–20: 6	-	-	8	-	0–20: 2	-	0–28: 64
10-20	1	75	>10³		0	0	244	0		0	
20-30	3	149	>10³	5	1	7	664	8	1	0	
30-40	0	173	>10³	18	9	19	677	4	6	0	194
40-50	94	365	1747	9	13	6	238	10	1	10	70
50-60	0	445	2848	44	35	12	103	5	1	40	25
60-70	11	294	1268	26	22	9	23	4	1	51	11
70-80	T	153	1446	26	10	11	6	5	0	49	2
80-90		55	1055	22	9	36	0	8	0	75	2
90-100		9	845	1	23	273	0	3	0	57	0
100-110		T	823	2	25	158	T	0	0	20	0
110-120			344	0	22	77		0	0	11	T
120-130			596	0	33	7		0	0	5	
130-140			B	T	2	0		0	T	3	
140-150					3	0		T		0	
150-160					2	T				T	
160-170					2						
170-180					0						
180-190					0						
190-200					T						

\- TU datum is set above ground surface
* Count is on a sample; is not a complete level inventory of artifacts
** TU's 1, 2, and 3 levels measured from highest of ground surface
T Level at which TU terminated
B TU terminated on bedrock

Table 10.3, CONTINUED

Depth (cm)	12*	13	14*	15	16	17	18	19	20	21	22
	Test Unit Number										
0-10	-	NO DEBITAGE COLLECTED	-	-	-	3 | 339 | 13	-	-	-	-	-
10-20	10 | 13 | 40		385	201	74	13 | 284 | 23	28	32	10 | 11 | 30	41	11 | 871 | 67
20-30			1493	257	472		195	559		237	
30-40			956	B	283	B	161	190	149	91	
40-50	8		533		154		12	B	23	17	
50-60	135		648		12		B		21	B	
60-70	116		406		B				B		
70-80	135		484								B
80-90	134		274								
90-100	359		389								
100-110	512		475								
110-120	303		866								
120-130	447		267								
130-140	453		694								
140-150	527		1016								
150-160	554		410								
160-170	735		267								
170-180	247		181								
180-190	460		B								
190-200	89										
210-220	76										
220-230	B										

13 | 11 | 23 — Count for a level with nonstandard depth. Upper and lower numbers indicate depth below unit datum (cm).

Appendix E provides detailed descriptions of the artifact categories observed at the quarry. The sample of artifacts in Appendix E consists of all items collected from 45WH224, including some from the surface below 1602 ft elevation, some from the surface above 1602 ft, and those excavated from *in situ* deposits in test units. For each artifact category are listed morphological attributes, the number of items, their size ranges as measured by the longest dimension, and additional notes. Table 10.4 summarizes the information contained in Appendix E. The list of 26 artifact categories spans the range of artifacts collected from the ground surface or excavated from buried site deposits. A total of 231 artifacts are described by 24 of the categories. The two remaining categories, shatter and flakes, are too numerous to count; by total number or by weight, these two categories encompass greater than 99% of all artifact observed at 45WH224. Photographs of selected artifact categories are shown in Figures 10.18 to 10.22.

The total artifact assemblage shown in Table 10.4 offers evidence that chert biface reduction represents the majority of activity conducted at 45WH224. Other reduction technologies were certainly practiced, most particularly core-and-flake production from unprepared or unshaped cores or from bipolar cores; however, the degree of reliance on these technologies was minimal based on the quantitatively small sample of core types that are arguably diagnostic of these reduction methods.

It also is noteworthy that no clearly diagnostic artifact classes, either of time period or cultural affiliation, were recovered from the site. There are two possible, but unlikely, exceptions to this statement. The first is a bipointed, lanceolate-shaped biface that in outline superficially resembles an Olcott or Cascade point. It is made from a poor quality piece of chert and lacks a controlled flake scar pattern; there is no basal grinding, and it does not appear to be a finished tool. This item (NOCA 7337) is listed as a stage III biface in Appendix E. It was recovered from level 7 of TU-12, in direct association with a charcoal sample dated 1830$\pm$60 BP (Beta-33512). This date is incompatible with the 8000-4500 time range assigned to Olcott or Cascade assemblages.

Another possible reduction technology employed at the site is represented by microblade-like cores and microblades. Although these items are listed in Appendix E as "microblade" and "microblade core" because they meet the morphological criteria of these categories, they do not indicate the intentional production of microblades or the use of that technology at the site. The three cores lack a prepared platform for blade removal, and when compared to the collection of microblade cores from other sites in North Cascades National Park and the larger region, they do not show evidence of intentional microblade production. Given the uncounted thousands of pieces of chipped stone produced at the site, the quantitatively very small sample of such microliths is not unexpected and is here considered an unintentional product of other reduction technologies.

Table 10.4. Artifact categories from 45WH224.

I	FLAKED STONE ARTIFACTS: Hozomeen Chert	
	Tested Nodules	13
	Bedrock Corners	11
	Shatter	Uncounted*
	Flakes	Uncounted*
	Bifaces - Stage II	28
	Bifaces - Stage III	15
	Biface Thinning Flakes	45
	Irregular Cores	4
	Bipolar Cores	4
	Bipolar Flakes	3
	Microblade Cores	3
	Microblades	9
	Unifacially Edge Modified Flakes	10
	Edge-Modified Tabular Shatter	4
	Heat-Modified Flake	2
	Polished Stone	4
	Subtotal:	155
II	FLAKED STONE ARTIFACTS: Non-Hozomeen Chert	
	Obsidian Pressure Flakes	5
	Other Flakes (Metasediment)	26
	Quartz Crystal Shatter	1
	Bipolar Core	2
	Subtotal:	34
III	PECKED, GROUND, AND ABRADED STONE ARTIFACTS:	
	Large Hammerstones	12
	Medium Hammerstones	12
	Small Hammerstones	12
	Hammerstone Fragments	4
	Anvil Stone	1
	Abrader	1
	Subtotal:	42
	GRAND TOTAL:	**231**

*Not counted in Subtotal or Grand total.

BEDROCK CORNER NOCA 7313

BIFACE III NOCA 7513

BIFACE III NOCA 7358

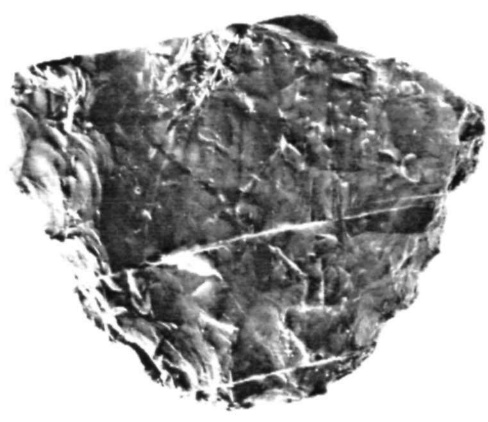
BIFACE III NOCA 6345

Figure 10.18. Photographs of 45WH224 artifacts (actual size).

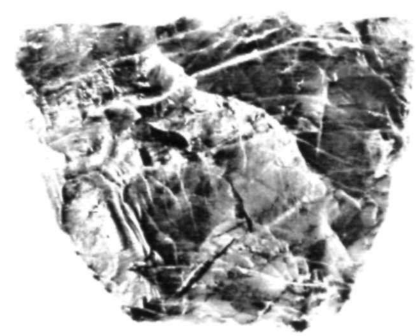
BIFACE III
NOCA 6349

BIFACE III
NOCA 6350

BIFACE III
NOCA 6351

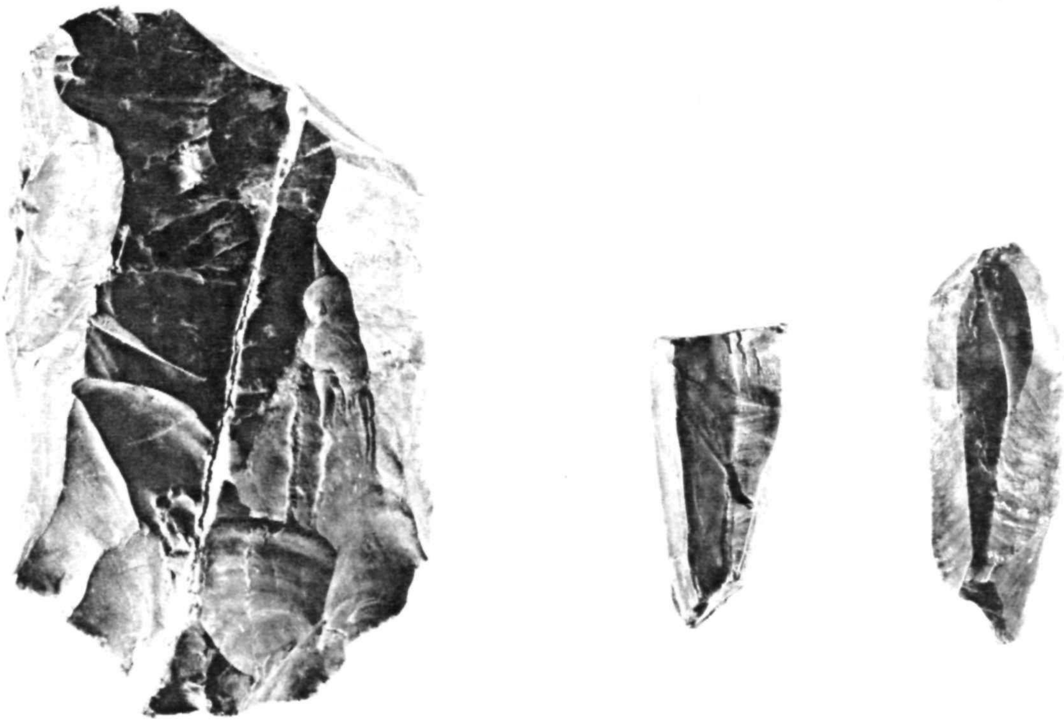


BIFACE III
NOCA 6346

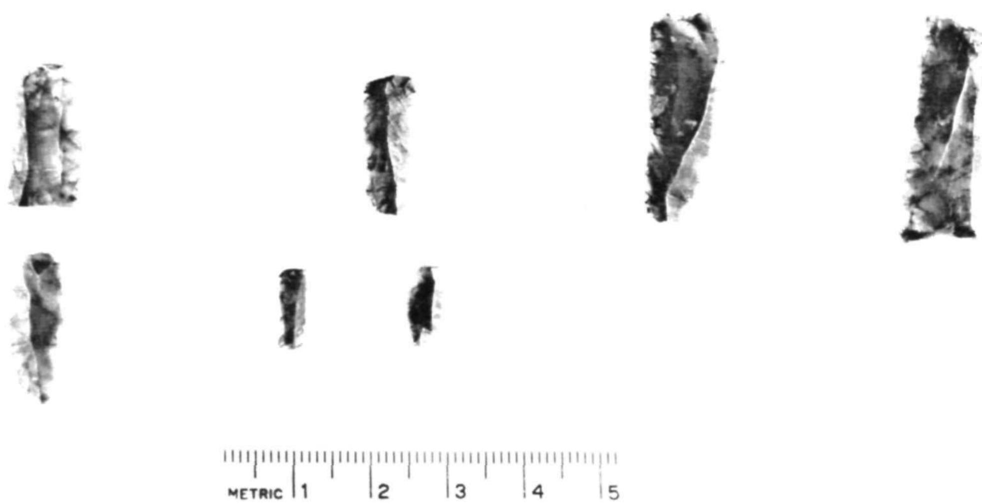


BIFACE III
NOCA 6347

Figure 10.19. Photographs of 45WH224 artifacts (actual size).



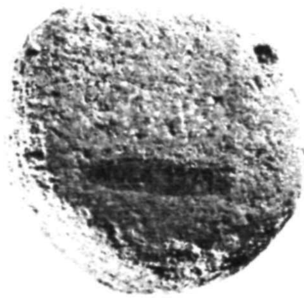
IRREGULAR CORE NOCA 6420 BIPOLAR CORES NOCA 7362 AND 7397



MICROBLADES: Top Row - NOCA 6691, 7389, 7365, 7368
Bottom Row - NOCA 7656, 7654, 7655

Figure 10.20. Photographs of 45WH224 artifacts (actual size).

EDGE-MODIFIED TABULAR SHATTER
NOCA 6401

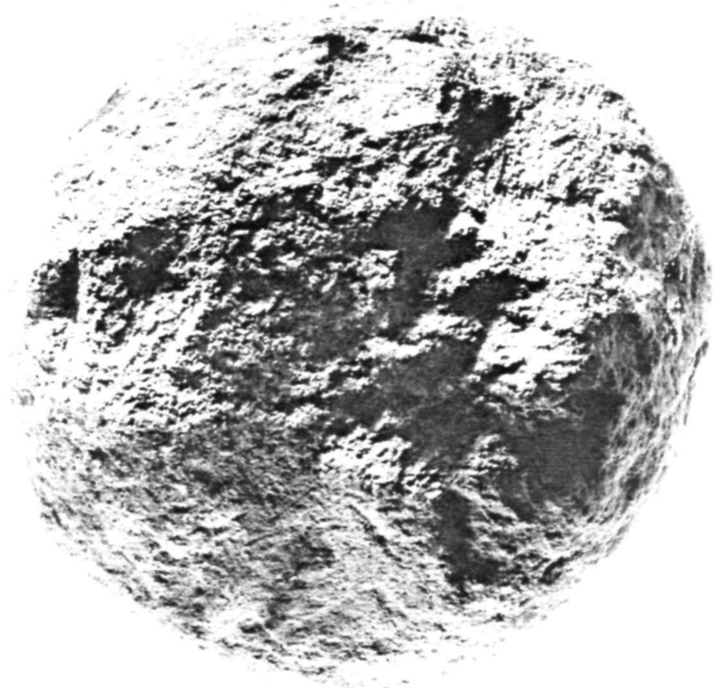


SMALL HAMMERSTONE
NOCA 7379

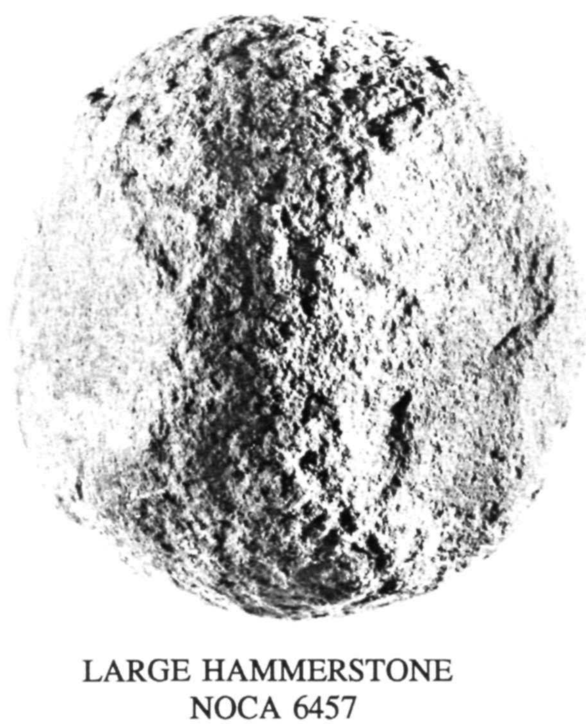
SMALL HAMMERSTONE
NOCA 7372

SMALL HAMMERSTONE
NOCA 7372

Figure 10.21. Photography of 45WH224 artifacts (actual size).



LARGE HAMMERSTONE
NOCA 6456



LARGE HAMMERSTONE
NOCA 6457

Figure 10.22. Photographs of 45WH224 artifacts (actual size).

Although no diagnostic artifacts were found at the site, it is often useful to know which formed tools were recovered in direct association with radiocarbon dates. This information is provided in Appendix D-2 under the cultural context heading. Here, the catalog number and artifact category name (as described in Appendix E) are listed for each item associated with the date. A total of 23 formed tools are listed in association with radiocarbon dates described in Appendix D.

The archeological assemblage described in Appendix E is comprised of the entire collection of artifacts from 45WH224, including those found on the surface and those recovered from excavation units. Appendix F lists only the formed tools in Appendix E that were recovered from the excavations. Appendix F gives the object name, catalog number, excavation level, and depth below surface or datum. As shown, most of the artifacts recovered from the excavations are early stage bifaces and hammerstones, and these are scattered throughout the site deposits. Table 10.5 shows the metric attributes for all bifaces from 45WH224, by reduction stage. Other artifact categories are much less frequent.

If the test units in Appendix F are grouped according to terrain types, as they are in Table 10.1, then the excavated bifaces can be totaled and their distribution by terrain type can be examined. The result is that of 31 excavated bifaces, 20 were recovered from the rockshelter quarry deposits. Of the 20, 75% (15) are stage II bifaces and 25% (5) are stage III. The other 11 bifaces were distributed uniformly among the other terrain types, except for earth movement deposits, which yielded only 1.
From this it might be inferred that most biface preparation occurred under the rockshelter overhang. However, if it is assumed that only "unsuccessful" or broken bifaces were left at the site by the people who made them, and that they removed the "successful" or completed ones, then the greater abundance of bifaces in quarry deposits does not warrant the conclusion that biface preparation was centered under the rockshelter. In the following description of flaking debris, this question is addressed.

10.7 Description of Flaking Debris

The purpose of this analysis is to characterize the kinds of flaked stone debris at the Desolation Chert quarry. Such debris or "debitage" is considered to be the unusable residue or waste resulting from the flaking process, generally lacking unbroken and finished tools. The various components of debitage reflect a number of aspects about archeological sites, including functional differences between site types such as villages, hunting camps, and lithic procurement locations. The characteristics of debitage are governed also by the physical properties of the stone raw material and the overall abundance and availability of stone in a given geographic area. As a consequence, it is useful to quantitatively characterize the debitage from 45WH224, a site which is known to have functioned as a stone quarry and reduction center for Hozomeen chert.

Table 10.5. Metric Attributes of bifaces from 45WH224

All measurements in millimeters.

Stage 2 (Complete)					Stage 2 (Incomplete)				
NOCA #	Length	Width	Thick	W/T	NOCA #	Length	Width	Thick	W/T
7280	80.85	51.70	24.70	2.1	**7304**	74.60	61.10	23.70	2.6
6631	95.25	50.70	23.75	2.1	**7507**	85.50	54.05	19.60	2.8
7324	111.90	53.65	24.80	2.2	**7506**	88.10	57.80	23.10	2.5
7513	105.75	41.40	24.45	1.7	**6425**	72.05	55.30	15.15	3.7
6351	63.80	27.30	13.40	2.0	**7398**	60.65	35.05	18.35	1.9
6511	50.50	37.20	11.20	3.3	**6453**	56.25	39.70	14.60	2.7
7375	65.70	41.05	11.95	3.4	**7649**	27.45	22.00	13.00	1.7
7457	53.65	43.10	14.10	3.1	**7441**	46.65	34.90	18.05	1.9
7390	54.55	23.30	11.40	2.0	**7537**	56.55	32.20	15.50	2.1
7295	67.90	45.20	22.80	2.0	**7432**	68.05	44.75	25.10	1.8
6450	70.30	34.30	16.40	2.1	**7388**	43.10	23.60	15.80	1.5
7433	58.45	30.60	16.75	1.8	**7439**	52.05	36.35	17.10	2.1
6598	80.50	38.40	22.10	1.7					
Count:	13				Count:	12			
Average:	73.8	39.8	18.3	2.3	Average:	57.2	41.4	18.3	2.3
Stdev:	20.0	9.3	5.6	0.6	Stdev:	21.7	13.2	3.9	0.6

Stage 3 (Complete)					Stage 3 (Incomplete)				
NOCA #	Length	Width	Thick	W/T	NOCA #	Length	Width	Thick	W/T
6350	60.90	31.95	8.50	3.8	**7383**	70.70	40.80	22.75	1.8
7337	77.75	29.15	10.75	2.7	**6345**	89.55	52.30	18.90	2.8
6348	73.15	48.90	21.80	2.2	**6346**	52.40	62.65	17.15	3.7
					6347	43.20	55.95	14.65	3.8
					7381	63.50	49.65	14.20	3.5
					7369	86.55	43.00	17.00	2.5
					7354	71.40	43.00	16.00	2.7
					6349	70.55	38.00	10.95	3.5
					7358	107.60	43.80	21.80	2.0
					6424	49.85	21.70	9.95	2.2
					7543	16.80	27.10	7.40	3.7
Count:	3				Count:	11			
Average:	70.60	36.67	13.68	2.9	Average:	65.65	43.45	15.52	2.9
Stdev:	8.71	10.69	7.12	0.8	Stdev:	24.84	11.91	4.78	0.7

Debitage from 5 of the 22 test units at the quarry were judgementally selected for analysis. These units, 2, 3, 6, 7, and 19, include terrain types corresponding respectively to terrace, quarry deposit, earth movement, terrace, and bedrock bench (see section 10.1). Of the five, only TU-3 is located at the rockshelter and the others are located on flats above or below the rockshelter, and within a few hundred feet of it.

The analysis was performed on a sample collected from each level (note that of these test units, only TU3 level collections were sampled in the field due to the excessively large number of flaked artifacts, and are therefore, not a complete and total collection of artifacts from each level). Sampling was accomplished by quartering the pile of debitage from each level. All items in one of the quarters were then classified and inventoried according to debitage categories. The results of the analysis are shown in Table 10.6 as the number of artifacts by category for each level of the test units. Artifact categories are as defined in Appendix E, with the exception that complete flakes have been separated from incomplete flakes (the latter are those that exhibit at least one clear flake attribute, but that are so fragmented that other flake attributes and much of the flake mass are missing).

Table 10.6 shows that flakes and shatter constitute the bulk of debitage categories excavated from 45WH224. The only other category that occurs to any significant degree is biface thinning flakes, although

Table 10.6. Ratio of Debitage Categories from Test Units at 45WH224

Test Unit	All Flakes: Total Debitage	Shatter: Total Debitage	Biface Thinning: All Flakes
2	0.88	0.09	0.02
3	0.51	0.48	0.001
6	0.81	0.16	0.02
7	0.93	0.05	0.01
19	0.81	0.16	0.03

these occur in very low frequencies. In order to compare differences between test units, the ratio of all flakes/debitage, and biface thinning flakes/all flakes for each test unit is shown in Table 10.6. The clear pattern exhibited in these data is that TU3 ratios differ from the others. TU3 contains a higher proportion of shatter and a lower proportion of biface thinning flakes.

The ratios show that chert reduction immediately adjacent to the bedrock source is characterized by much shatter relative to flakes and the biface thinning flakes especially are infrequent. Such a high concentration of shatter is expected where chert fragments were hammered from bedrock faces, corners, and joints, and where initial shaping and cleaning of bifaces is done. This is the locus of primary reduction. On the other hand, flat terrain located a short distance from the bedrock source is characterized less by shatter and more so by flakes, including biface thinning flakes. On this basis, flat terrain thus appears to be the location of workshop areas where chert was secondarily reduced into bifaces. Returning to the distribution of excavated bifaces as discussed in section 10.6, the higher frequency of bifaces recovered from the rockshelter quarry deposits is most probably a reflection of the greater breakage rate in early stages of manufacture. The pattern of biface distribution away from the rockshelter quarry most probably reflects a higher success rate, which results archeologically in a higher frequency of biface thinning flakes and a lower frequency of bifaces.

10.8 Description of Faunal Remains

Very few animal bones were found preserved at the site. A total of 33 fragments were recovered from 7 test units. The number of bones by test unit and level are shown in Appendix G. They have been preserved through charring but are too small for positive identification as to species. One tooth fragment was from a mountain goat or mountain sheep. Seven of the pieces were long bone. The largest number of pieces from a test unit was 11 from TU15. Five pieces were recovered from TU19, from stratigraphically below a radiocarbon date of 290$\pm$80 (Beta-33522).

The 7 test units with bone fall within three of the five terrain types that the site covers--terrace, bedrock bench, and quarry, but particularly the first two. If the bone pieces are the remains of food cooking at the site, these ought to be associated with camping or domestic areas, which would clearly select for flat landforms. The combined total of bones for flat landforms (terrace and bedrock bench) is 28; the remaining 5 came from within quarry debris under the rockshelter. None were recovered from the steep hillside (colluvium) or earth movement deposits. None of the bone was associated with any kind of a feature or found in any concentration, instead, they occur as dispersed isolated pieces in the sedimentary matrix. Although the evidence is sketchy, it is likely that the scattered animal bone fragments originated in lightly and infrequently used, prehistoric food cooking areas. These have subsequently degraded and dispersed through natural processes.

11. RESULTS OF RECONNAISSANCE SURVEY

11.1 Objectives

Early in the planning of this project, the importance was recognized of the need for information about the existence and use of other quarry or stone resource procurement sites in the upper Skagit River Valley. Whereas test excavations at 45WH224 advance our knowledge about how prehistoric populations used this extensive site, the survey results address the question of how widespread or how common this class of sites is in the local mountain landscape. Without this information, how are we to understand the geographic context of the Desolation Quarry and it's role in the subsistence of the valley's prehistoric populations? Is 45WH224 only one of many such sites representing the exploitation of Hozomeen chert, or is the site unique? The first step in answering these questions is to search for other procurement sites (see section 8.3 for a description of the survey strategy). Procurement techniques may include, for example, breaking pieces off of bedrock masses; digging pits or otherwise excavating for stone materials; or simply collecting usable fragments from the ground surface.

11.2 Results and Site Descriptions

A total of three prehistoric archeological sites were found during the survey. These are designated F.S. #'s 129, 130, and 173 ("F.S." stands for "Field Site" number; these are assigned successively to each new archeological site recorded in North Cascades National Park Service Complex). Their respective Smithsonian trinomial numbers are 45WH446, 45WH447, and 45WH449.

All three sites are open (meaning exposed to weathering and the elements) lithic scatters consisting of chipped stone flaking debris. Like at 45WH224, the debris resulted from the procurement, cleaning, and initial shaping of Hozomeen chert for eventual use in manufacturing stone tools. The sites occur, in terms of general valley physiography, on steep slopes along the sides of glacially-scoured U-shaped valley walls. In terms of more localized terrain, they are on south-facing slopes characterized by thin rocky soils. The first two sites are associated with bedrock outcrops of Hozomeen chert. Two of the sites are on small bedrock flats or "benches". (Such flats are ubiquitous on the glacially-scoured mountain slopes of the valley, where they offer momentary respite to anyone climbing upslope). The other is on a steep slope uninterrupted by any flats. The sites are described in greater detail below. At these sites, as elsewhere in the valley, rounded hammerstones for use as flakers are readily available in the veneer of glacial till that mantles the landscape.

45WH446. This site is the largest of the three. At about 2800 ft (854 m) elevation, it sits 1400 ft above the elevation of the Skagit River flood plain. It is located along the glacially-scoured ridge north of Little Beaver Cr. (Figures 11.1 and 11.2). It was found and recorded in 1989, along with site 45WH447, by the author. Vegetation on-site is dominated by a moderately closed canopy formed of Douglas-fir with some Western red-cedar, and understory of vine maple, serviceberry, mountain spray, and Oregon grape.

The inventory of observed artifacts consists of 174 flaked pieces of Hozomeen chert, mostly shatter and noncortex flakes, including a small number of cortex flakes, flake cores, and two possibly utilized or otherwise edge-modified flakes. An exhaustive and complete inventory of all artifacts exposed on the ground surface likely would exceed 1000 in number.

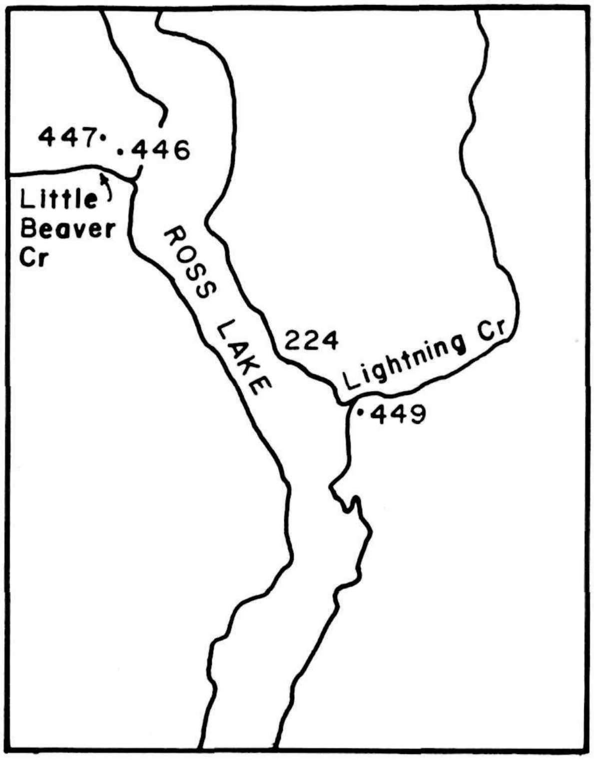


Figure 11.1. **Planview map of project area showing the locations of sites 45WH446, 45WH447 and 45WH449.**

These artifacts are scattered on a hillside with about a 100% slope (measured with a pocket clinometer to between 40° and 46° from the horizontal). The scatter's boundaries define a triangular-shaped area on the hillside, with the apex up the slope and the base downslope. There is about 200 ft (61 m) of elevation change between the top and bottom of the site. At the apex of the scatter is the source of the chert in the form of a short vertical face (1 m high) of moderate to high quality Hozomeen chert bedrock. The bedrock here was quarried by prehistoric people, and it exhibits clear impact scars

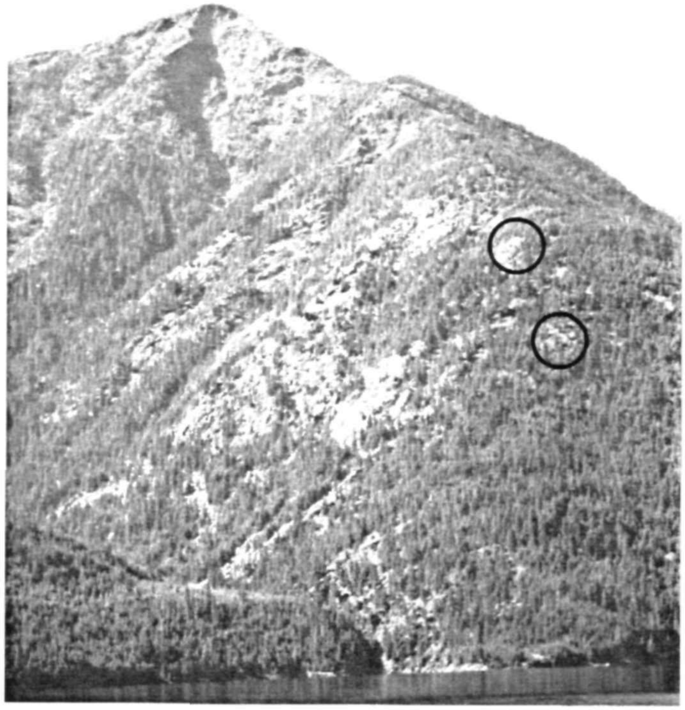


Figure 11.2. Location of chert quarries 45WH446 and 45WH447 on ridge above Ross Lake and Little Beaver Creek.

Figure 11.3. Location of chert quarry 45WH449 on rocky bench above Ross Lake and Lightning Creek.

created by prehistoric hammering of the rock face. Roughly 100 m downslope at the bottom of the site, the scatter is nearly 50 m wide.

The Hozomeen chert here is variable in flaking quality and occurs in two color varieties. One variety matches closely to one that we informally recognize as "Little Beaver Gray". A sample of this variety is described as sample no. 1 in Appendix B. The other is a dark gray variety that is not easily distinguished from most other dark gray forms of Hozomeen chert.

45WH447. This is the smallest of the three sites. It sits at about 3600 ft (1097 m) elevation, almost 2000 vertical ft (610 m) above Little Beaver Cr. It is located a few hundred meters from 45WH446 (Figure 11.1 and 11.2). On-site vegetation consists of an open canopy of Douglas-fir with an understory of vine maple, serviceberry, mountain spray, and Oregon grape.

The inventory of observed artifacts consists of 13 items, mostly shatter with a few noncortex flakes, all of Hozomeen chert. These artifacts are sparsely scattered across a narrow, nearly flat bedrock bench on the steep valley wall. Below this bench, the mountainside drops precipitously in cliff bands and talus, to the canyon of Little Beaver Cr. Above this bench, the mountainside rises moderately to the ridgecrest separating the Little Beaver Cr. drainage from the much smaller, avalanche-fed creeks draining the north-facing side of the ridge. The scatter's boundaries approximate a rectangle 20 m by 30 m. The soils are thin and rocky, with flat areas and low outcrops of Hozomeen chert bedrock. In several locations the chert outcrops show prominent impact scars (oftentimes hidden under carpet-like patches of green moss) from hammering of the rock in order to remove fragments.

The chert varieties that outcrop here, like at 45WH446, are "Little Beaver Gray", which has a smooth, fine-grained texture with relatively few quartz veins, and the more ubiquitous dark gray color variety. Unlike at 45WH224 where the chert forms a large, relatively undifferentiated mass, at this site it outcrops in the form of beds or "ribbons" 3-6 cm thick.

45WH449. This site is at about 2050 ft (625 m) elevation and is located on the rocky mountainside south of where the Lightning Cr. canyon enters the broader Skagit River Valley (Figures 11.1 and 11.3). Vegetation on-site consists of open areas between small stands of Ponderosa pine, Douglas-fir, and Lodgepole pine with an understory of bunchgrass, mountain spray, kinnikinnick, wild onion, wild lily, and yarrow. Bedrock exposures are in most places thickly covered with mosses and lichens. The site was found in 1989 by Dave Harry and was recorded by he and the author.

The inventory of observed artifacts consists of 60 items of Hozomeen chert, with equal portions of cortex flakes and cortex shatter. A more thorough and complete inventory likely would encounter a couple hundred chipped stone items.

These artifacts were scattered in small concentrations on the flattest portions of narrow bedrock benches and ramps formed on the moderately sloping (about 35° from horizontal) mountainside. The scatter's boundaries roughly define a 50 m by 20 m rectangle. Like the other two sites, the soils here are thin and rocky, and interspersed with flat exposures and rounded outcrops of bare Hozomeen chert bedrock.

The variety of Hozomeen chert that was flaked at this site is common in other sites along the eastern side of the valley, including at 45WH224. This variety is dark gray mottled with many white, criss-crossing quartz veins. It is most similar in appearance to sample nos. 3 and 4 (Appendix B). The flaking debris at this site consists of high quality, homogeneous and fine-grained chert. Thin pieces of the chert have a characteristic ring or tingle when struck lightly.

Although hammerstones with obvious wear patterns or geometric shapes were not observed, the site recorders noted the presence of numerous glacially-rounded rocks within the site boundary, many of appropriate size and shape for use as hammerstones.

11.3 Conclusions

The survey results shows that Desolation Chert Quarry (45WH224) is not unique in the upper Skagit River Valley, and that Hozomeen chert was procured from a series of quarries on both sides of the valley. Examination of the artifacts at these quarries (all artifacts were left in place) suggests they are morphologically and technologically similar to the 45WH224 assemblage, and that they also were locations of procurement and primary reduction activities.

The inventory of artifacts recorded at the three sites is shown in Table 11.1, which displays the number of items according to flaking debris categories. The categories in the table reflect quarrying and primary reduction. As shown in Figure 11.4, nearly all the artifacts consist of shatter and flakes. The cortex develops as exposed bedrock surfaces weather in place, resulting in a high frequency of cortex on flakes and shatter from reduction of bedrock fragments. As was noted at 45WH224, the Hozomeen chert at these three sites is heterogeneous due to the presence of numerous quartz laminae, fractures and weathering planes, and vacuoles. Primary reduction of such material produces numerous blocky chunks unsuitable for further reduction or use.

Like at 45WH224, few if any artifacts are present indicating that finished tools, such as knives, drills, burins, or projectile points were manufactured at the quarries. Secondary reduction and manufacturing of such tools, if they were made of chert derived from these three quarries, most likely was performed at other locations characterized by archeological assemblages with high frequencies of debitage and artifact categories reflecting the final shaping and finishing of tools.

Table 11.1. Artifacts inventoried on site forms, By flaking debris (DEBITAGE) type (All Artifacts are of Hozomeen Chert).

SITE	SHATTER		FLAKES		FLAKE CORE		EDGE MODIFIED FLAKE		TOTAL ARTIFACTS INVENTORIED
	W	W/O	W	W/O	W	W/O	W	W/O	
45WH446	100*	-	20*	50*	2	-	-	2	174
45WH447	10*	-	-	3	-	-	-	-	13
45WH449	30*		30*		-	-	-	-	60
COMBINED ASSEMBLAGE SUBTOTALS	140	-	50	53	2	-	-	2	COMBINED TOTAL 247

* = Represents only the number of artifacts inventoried.
W and W/O = With cortex and without cortex, respectively.

In contrast with 45WH224, there is a total absence of broken quarry blanks or any obvious evidence of biface reduction, such as biface thinning flakes. The presence of the two cores at 45WH446 may be evidence of a core-and-flake technology here, rather than biface reduction. It is possible that these three sites reflect a different procurement strategy than at 45WH224, where procurement seems to be unrelated to other activities. At these three sites, Hozomeen chert may have been procured on an encounter basis, in which case it was opportunistically exploited secondary to other subsistence pursuits, such as hunting and plant gathering. However, it is possible that sampling error due to small sample size has skewed the artifact assemblage observed at sites 45WH446, 447, and 449.

Considering the widespread distribution of Hozomeen chert exposures and outcrops in the upper valley, it is almost certain that many more quarries and procurement sites are scattered throughout that portion of the mountainous landscape characterized by Hozomeen chert availability (in the form of bedrock exposures, talus blocks, glacial till, and river and alluvial fan gravels). The cumulative evidence here suggests that the upper Skagit River Valley, in fact, is more accurately characterized as the setting of a complex of many Hozomeen chert quarries. The extent to which local chert exploitation is secondary to other more primary subsistence pursuits remains uncertain at this time. Related to this question, the valley here may be unique in the sense that it constitutes a lithic landscape, an area defined uniquely by the availability of Hozomeen chert and related rock types (see discussion in section 12.5.2).

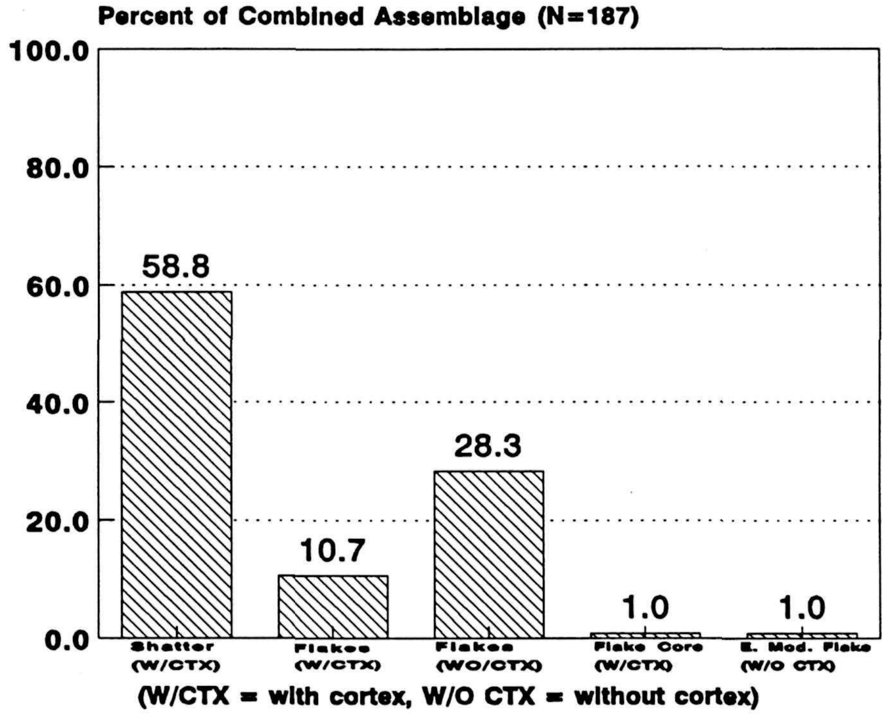


Figure 11.4. Percent flaking debris categories for sites 45WH446 and 45WH447.

This brief survey covered a small portion of the upper Skagit River Basin. Although it is not necessarily representative of larger land areas in any quantitative sense, it provides qualitative and irrefutable evidence that some interior Cascade valleys were important for the lithic raw materials they supplied to prehistoric stoneworking technologies of the first and former inhabitants of the valley. Based on the evidence acquired from the test excavations at 45WH224, these activities have been occurring for at least the last 8000 or so years.

12. DISCUSSION AND CONCLUSIONS

12.1 Introduction

The intent of this section of the report is to put the Desolation Chert quarry into the context of prehistory generally and to explore its more specific cultural role within the northern Cascades. Given the scant archeological information currently available about the prehistory of the Northwest's mountains, such a task is difficult at best. Under even the best of circumstances, only a small part of a society is preserved in the archeological record. Of the entire range of material possessions carried by people who live by hunting, gathering, and fishing, which includes artifacts made of bone, antler, hide, plant fiber, wood, all types of food, and minerals, it is only the latter that resists decay (with minor exceptions), to be preserved for thousands of years in soil or geologic strata. Our knowledge about the earliest cultures in the northern Cascades, then, is dependent on our ability to decipher this unintentional material record left in stone.

Until recently, the upper Skagit River Valley was not known to have been the focus of extensive prehistoric Native American subsistence activities, and neither was it suspected to have provided to these people vast quantities of a distinctive rock type that was relied on for the manufacture of a variety of tools. In fact, the first archeological investigations in the valley detected no substantial record of human presence here and made no attempt to find the sources of the various stone materials observed in the single archeological assemblage recorded. In this assemblage, from a large prehistoric site (45WH79) in the vicinity of Hozomeen campground, a nonspecific category of "chert" was one of a few stone materials noted, and it was found to comprise 4.8% by number of a sample collected from the site (Grabert and Pint 1978:39). Today, benefiting from the results of research of the last five years, we know that the unidentified chert referred to by Grabert and Pint is, indeed, Hozomeen chert. Recent results have also shown, based on examination of over 7000 artifacts from a sample of 123 archeological sites in the valley, that Hozomeen chert constitutes nearly 80% of all chipped stone remains. This chert was procured from throughout the valley's bedrock formations and stream, glacial, and alluvial fan gravels (Mierendorf 1991).

Hozomeen chert formed in a deep ocean basin millions of years ago and was subsequently metamorphosed through mountain uplift, deformation, and faulting. Over time it became exposed at the surface by weathering and erosion, especially during the repeated glaciations of the Pleistocene. Many of the stone's distinctive physical characteristics are a consequence of its complex geologic history. Although it ranges widely in color and texture, the most common variety is dark gray, mottled with a crisscrossing network of thin white quartz, or dark veins. In some exposures (particularly at 45WH224) the chert forms massive bedrock benches and cliffs; in other exposures it occurs as bands of ribbon chert interbedded with nonchert rock types. Much of the bedrock chert mass is of poor quality for flaking into tools, and requires cleaning, reduction, and selection for the high quality, homogeneous and glassy portions. Most failures and breakages during tool manufacture occur along quartz veins or inclusions or impurities.

Beginning in the middle time periods of Northwest Coast prehistory (5-3000 years ago), this stone material became an important source of tools for local bands of mountain dwelling Native people. The stone's prehistoric importance is clearly manifested in the recorded traditions of the Nlakápamux (historically called "Lower Thompson") people of southern British Columbia, whose ancestors would travel to the headwaters of the Skagit River to find stone to make their tools. Indeed, the word "Hozomeen" is a Salish term, probably derived from a Lower Thompson dialect, that means "sharp, like a sharp knife" (Akrigg and Akrigg 1986). A more appropriate meaning would be difficult to find.

The remainder of this chapter discusses the identification of Hozomeen chert; stone material procurement; the relationship between flakeable stone sources, particularly Hozomeen chert, and settlement and subsistence; and the significance of 45WH224 with regard to local and regional prehistory.

12.2 Identification of Hozomeen Chert

Hozomeen chert has a number of physical characteristics that give it a distinctive visual appearance, most particularly its tendency to be mottled in various shades of gray, the complex reticulate pattern of white quartz veins, and its opaqueness. Based on results of the analysis in Appendix B, on field observations of thousands of pieces of Hozomeen chert in archeological assemblages widespread in the northern Cascade Range, and in bedrock structures, my tentative conclusion is that hand specimen observation, aided with low power optical magnification, is sufficient for identification of this material.

Presently there seems to be little agreement among archeologists as to what set of techniques constitutes an adequate methodology for sourcing lithic materials. The issue is important for the study of any number of research problems that are dependent on sourcing and identification of stone. If the techniques of identification are flawed, the results of the study may be invalid. As a case in point, Perry (1992) reexamined the lithic raw material identifications from archeological site assemblages in the northern Columbia Plateau. In one instance, she found that out of a sample of 204 artifacts categorized as "black argillite", 61% consisted of non-argillite rocks, including igneous extrusives (probably basalt), quartzite, arkose, andesite, and others (Perry 1992:205). Another sample of 663 artifacts was initially reported to consist of 98.8% black argillite; a subsequent and more detailed analysis of this assemblage indicated that it consisted in actuality of 98.2% basalt (Perry 1992:205). As a result of this reanalysis, Perry questioned the reliability of the regional comparisons made on the basis of the original identifications.

Efforts to differentiate stone raw material types are widespread in contemporary archeological studies. In a study of lithic materials on Black Mesa in Arizona, Green described 38 different stone types. She used visual inspection (except for obsidian) aided by comparative samples to assign sources to archeological lithic assemblages. She believes that "Geologic source characterization can be accomplished fairly accurately through visual means for many materials other than obsidian." (Green 1985:12). She cites Luedtke's (1976) analysis of Michigan cherts, showing an 8.7% discrepancy between sources identified visually and those identified through neutron activation analysis.

Mason and Aigner (1987) used petrological description and comparison of thin sections in order to source artifacts from three archeological sites in the Aleutian Islands. From the results of their analysis they suggested that chipped stone artifacts from all three sites came from a single flow or closely related flows located 15-30 km from the sites. As discussed in section 12.4 below, Bakewell (1990 and n.d.) also used petrography to identify and infer a source for dacite artifacts from archeological sites in the Puget Sound region.

In a study of Kettle Point chert, which outcrops along Lake Huron, Janusas used macroscopic description, thin-sectioning and petrographic analysis, neutron activation analysis, and isotopic composition analysis to describe and characterize the stone. She concluded that no single method was sufficient for characterization and she recommends the use of several techniques (Janusas 1984:83). Both she and Ives (1984) question the usefulness of visual or macroscopic descriptions of chert in order to make correlations between archeological assemblages and raw material sources.

This brief review suggests that the set of appropriate techniques to be used for sourcing stone artifacts depends on factors that are controlled by regional geology and the research problem being addressed. The regional considerations include the range of lithic raw material types, their homogeneity, distinctiveness, and distribution. The research considerations include cost, accuracy, available technology, sample destruction, and the research problem being investigated.

Although I presently advocate visual inspection for identification of Hozomeen chert in site assemblages from the upper Skagit River Valley, additional studies are required before this can be done with any certainty or with assemblages far removed from the valley. Two particular questions need to be addressed in any such studies.

1. The geographic distribution of Hozomeen chert rocks needs to be established with certainty because there is evidence that this material may have much wider distribution in geologic contexts than I have demonstrated in this report. For example, included in the comparative collection of lithic material types at the North Cascades National Park Service Complex we have a rock sample (NOCA 10163 is in the form of a river or glacial gravel) from Flint Beach, Lopez Island (one of the San Juan Islands) that is

visually identical to samples of Hozomeen chert from the upper Skagit River Valley. This suggests that some Hozomeen chert gravels may have been glacially transported far beyond it's source location in the Cascades.

Other evidence is provided indirectly, and is derived from the inferred slippage and separation of the Hozomeen Group of rocks from the Bridge River Group of British Columbia along the Fraser-Straight Creek fault during the Eocene (see section 9.2). Within the Bridge River Group, the Carpenter Lake Assemblage is described as containing ribbon cherts with radiolarian fossils (Potter 1986), as does Hozomeen chert. The Bridge River Group is located in the Lillooet-Cache Creek-Hat Creek area, where chert has been noted in stream and glacial cobbles and in bedrock (Magne 1985:204-205). Before artifact-to-source correlations at a regional scale can be made for Hozomeen chert, the visual and chemical differences between the Bridge River and Hozomeen cherts should be characterized.

2. Chemical characterization needs to be performed on a larger sample of Hozomeen chert samples removed from bedrock sources in order to determine the degree of homogeneity in the chemical "fingerprint". The more homogeneous is this chemical signature, the more reliable and accurate will be the identification of the chert in archeological assemblages. The preliminary characterization reported in Appendix B only goes far enough to suggest the possibility that Hozomeen chert can be fingerprinted.

12.3 A Geographic Perspective of Stone Procurement

Throughout western North America (in fact throughout vast areas of North America) there are known to exist a variety of stone procurement localities. Some of these were well known by Native populations dispersed across wide areas, and it is surprising to some that specific stone materials were transported and traded extremely long distances. At the time of Euroamerican settlement of North America, many such quarries had been extensively worked. In order to place the Desolation Chert quarry within a larger geographic perspective, comparative information from other quarries will be selectively reviewed and discussed as these pertain to understanding 45WH224.

Within the state of Washington, few prehistoric lithic resource procurement sites and quarry sites have been recorded by archeologists. For the most part, this general category of sites has been considered by archeologists working in the state to hold little if any potential for contributing to our understanding of the past. With a few recent exceptions, there have been no research designs written nor surveys conducted explicitly to identify lithic resources and associated procurement and quarrying activities, or to explore the role of such sites within regional settlement and subsistence strategies. Nevertheless, there is a widespread oral tradition among archeologists, amateur and professional, that recognizes the existence of numerous quarrying locales where specific stone raw materials were procured. However, most of the locations of these sources remain unidentified, and many of those that are known remain unrecorded and uninvestigated. One of the main assumptions behind the present study is that there is much that could be learned about the past through an increased understanding of the prehistoric procurement, utilization, and exchange of stone materials. In the remainder of this section, the known sources of chipped stone raw materials in Washington and the Pacific Northwest will be reviewed, with emphasis placed on procurement patterns in and adjacent to the northern Cascades.

It would be easy to misjudge the degree to which Native American peoples had explored and investigated the locations, conditions, and properties of the various sources of materials for the manufacture of stone tools. Their knowledge in these regards was extensive, and they expended great effort on the acquisition of suitable stone materials. It is unfortunate that most of this traditional knowledge was lost during the rapid and oftentimes destructive transformations in Native American cultures that characterized the historic period. References in ethnohistoric records to stone procurement are rare. Other than the specific reference noted above regarding Nlakápamux acquisition of stone from the Skagit River, there are few others relating to the northern Cascades. For Indian groups of the northeastern Cascades, James Teit's informants noted stone material was found scattered over the surface of the country and that quarries were scarce (Teit 1928:111). On the western slopes, the Upper Skagit people made arrow tips out of a white stone from a rockslide along the Skagit River (Collins 1974:53). Any kind of information about traditional ways of handling and working stone materials for the project area is nonexistent.

Archeologists learned early on, beginning with one of the earliest investigations along the Columbia River, that the various forms of quartz, such as chert, chalcedony, and jasper had widespread distribution in bedrock outcrops, boulders, and river gravels of the region (Collier et al. 1942:58). Archeologists recognized eventually that other rock types, including steatite and serpentine for example, occurred throughout the state but that knowledge about Native American quarries was inadequate (Nelson 1960). Subsequently, with the benefit of comprehensive inventories of minerals, it became apparent that fine-grained varieties of quartz are more abundant than originally thought:

> Varieties of cryptocrystalline quartz are found throughout the State. Chalcedony and jasper have been carried westward by rivers that drain the Coast Range and the Cascade Mountains. They have been concentrated by wave action on islands and coastal beaches of the Juan de Fuca Strait, and along the Pacific Coast from the northern end of the Olympic Peninsula southward to the Oregon border. Agate, jasper, and other types of cryptocrystalline quartz are common in many stream gravels, especially those in the southern half of the State. Silicified wood is abundant on the Columbia Plateau. Cryptocrystalline quartz varieties are less common in the northeastern part of the State (U.S. Geological Survey 1966:212).

Notwithstanding the quotation above, archeologists for the most part know little regarding the identification of, archeological distributions, and the sources of stone raw material types found in archeological assemblages. Yet, some progress over the years has been made. Placing emphasis on chipped stone technology, let's begin by looking at what is currently known about stone sources in and around the northern Cascades.

12.4 Sources of Tool Stone in the Northern Cascades and Vicinity

It is usually the case in scientific investigations, archeology included, that the first researchers to work in an area can set the tone and direction of subsequent investigations and thereby establish a tradition of research that persists for some years. This is no less true of the northern Cascades and adjacent landscapes. The earliest archeological investigations were in northern Puget Sound, where archeologists noted the apparent absence in abundance and variety of stone tool sources and stone tools in archeological assemblages (see Bakewell 1990 for discussion). In an early archeological survey of this area, Bryan noted the occurrence in Skagit and Whatcom counties of a variety of stone materials suitable for groundstone technology, most particularly anthophyllite, serpentine, talc, slate, and graphite (Bryan 1963:9-10). Occurrences of flakeable stone, however, are much restricted by comparison, and he mentions only jasper from Vancouver Island and Point Roberts, and fine-grained basalt on beaches in the San Juan Islands. He concludes that "There are very few occurrences of cryptocrystalline minerals in northwestern Washington and adjacent British Columbia." (Bryan 1963:9) and that archeological collections from northern Puget Sound contain stone materials from eastern Washington and Oregon, including obsidian, petrified wood, chert, opal, and other cryptocrystalline minerals (p. 10). Based on information available today, flakeable stone is much more abundant in Whatcom and Skagit counties than these earliest investigations suggested.

More recently in the same area, Bakewell has performed petrological and chemical analyses of a stone material that has widespread distribution in archeological sites of northern Puget Sound. This material may be the "fine-grained basalt" referred to in the statement above attributed to Bryan. On the basis of his findings, Bakewell postulates that this material is actually a dacite that is likely to have an origin in the Cascade volcanic arc, possibly from the Mt. Garibaldi vicinity (Bakewell 1990). In a subsequent study, Bakewell determined that chemically identical materials to this San Juan Dacite occur in archeological assemblages extending from subalpine zones in the Olympic Mountains to the Gulf of Georgia (Bakewell n.d.). Finally, because Bakewell believes that San Juan Dacite may derive from Quaternary volcanics of the last 10,000 years, and because it may not be present in beach gravels along northern Puget Sound, he suggests that the stone raw material was procured near its sources and has been brought into the area by prehistoric populations (Bakewell 1990 and n.d.).

In addition to the region of Mt. Garibaldi, a number of other stone sources are known to occur north of the Cascades, in British Columbia. A source of obsidian has been reported in the Anahim Peak vicinity of west-central British Columbia (Nelson and Will 1976). The Cache Creek vicinity, directly north of the northern Cascades, is a well-known source of a fine-grained basalt that was extensively used by prehistoric populations.

Along the eastern flanks of the northern Cascades, stone raw materials occur with abundance and variety, as they do in large areas of central and eastern Washington and along the Columbia and Snake River valleys. These consist predominately of variously colored, fine-grained cherts and chalcedonies, opal, and basalt. The first three of these often form as chemical sedimentary rocks within joints and other bedrock structures of the Columbia Plateau flood basalts. Other stone types are less common but nonetheless locally important. For example, where the Columbia River flows along the eastern margin of the northern Cascade Range, between the Okanogan and Entiat Rivers, archeologists for some years now have recognized a distinctive type of obsidian that was used by the prehistoric people of that area. Based upon its localized occurrence in archeological assemblages and its distinctive appearance, they inferred the existence of quarries or source localities of this "vitrophyre" in the northern Cascades (Gunkel 1961; Grabert 1968; Mierendorf and Bobalik 1983; Galm and Masten 1985; Chatters 1986), but the sources of this particular raw material have yet to be found.

The results from recent archeological surveys in the northern Cascades of British Columbia have disclosed the presence of previously undocumented quarries and outcrops of distinctive cherts in the upper Similkameen River drainage (Vivian 1989). This material is called "Allenby chert", after the name of the rock formation in which it occurs. At the Vermillion Bluff Quarries (DiRd15) were found extensive scatters of cores, shatter, and flakes from primary reduction. This chert is highly variable in color (purple, deep red, red & white, orange, brown, black, white, and black & white), has a greasy luster, and contains many inclusions (Vivian 1989:50-51). The other quarry is the Similkameen Quarry (DiRd35) where the stone material consists of a high quality black chert (Vivian 1989:61). Both of these sources of Allenby Chert are believed to be the source of many of the stone raw materials found in archeological sites of the upper Similkameen River Valley. Based on hand specimen comparison of Allenby chert reference samples provided to Mierendorf by Vivian, a few projectile points of this material, representing early, middle, and late time periods, are reported from archeological assemblages from the upper Skagit River Valley (Mierendorf 1991).

With the increasing interest of the last few years in archeology of the interior of the Cascades has come the realization that mountainous terrain offers many exposures of usable stone materials (Mierendorf 1986). This is because the mountain environment is characterized by rock exposures, such as cliffs, ridgelines, cirque faces, talus slopes, and glacial gravels, offering access to a variety of lithic materials. Recently, reconnaissance surveys for archeological sites in subalpine zones within North Cascades National Park Service Complex have resulted in discovery of a source of a local variety of obsidian. Here, in the Hannegan volcanics, lithic reduction sites in association with outcrops and dikes of vitrophyre have been reported (Mierendorf 1987b). Although it is not homogeneous, this particular variety of obsidian dominates the high elevation archeological assemblages so far recorded in the northwestern part of the Park Complex. Further east, in the upper Skagit River Valley surrounding 45WH224, at least 9 different locally available stone materials have been recorded in addition to Hozomeen chert. These include predominately metasedimentary rocks, along with very minor occurrences of andesite, nephrite, quartz crystal, slate, chalcedony, jasper, and soapstone (Mierendorf 1991).

Further south, in the central Cascades of Washington, procurement sites have been reported of local varieties of tool-quality stone. These sites are generally found where nodules erode out of hillsides or along ridges (Zweifel and Reid 1991). Outcrops of vitrophyre, similar in macroscopic appearance to the obsidian reported by Mierendorf (1987b) have been found in the Goat Rocks Wilderness of the southern Cascades. Here at Elk Pass Quarry (45LE286), a localized source of obsidian occurs in talus and is associated with prehistoric workshops where the raw stone was initially reduced (McClure 1989). Source samples of the obsidian were characterized using X-ray fluorescence, which permitted artifact-to-source correlations to be made. Elk Pass obsidian was found to be present at six archeological sites of the upper Cowlitz River drainage, at distances up to 30 km from the source. The use of this raw material is estimated to date between 6650 and 500 years ago. Even further south, in the southern Cascades of Washington, an obsidian source has been plotted (Sappington 1981) at Brooks State Park, but little is known regarding the extent of prehistoric quarrying and use of this material.

East of the Cascade Range, across the widespread area of flood basalts of Washington, Idaho and Oregon there can be found numerous extremely localized sources of fine-grained quartz (mostly chalcedony and chert), opal, and basalt. Except for the latter, these varieties of silica form as chemical precipitates in solution cavities and joints in bedrock. Through natural weathering and fragmentation of the bedrock, these appear as weathered nodules and chunks in basalt talus, stream gravels, and eroding hillsides. In these forms they have supplied Native Americans with a source of stone tools for thousands of years. Because the source locations are scattered over thousands of square miles, and because many of the sources consist of dispersed nodules, it is difficult if not impossible in many cases to trace their origin when these materials are found in archeological assemblages.

A classic example of one such source is the Connell Quarry (45FR267). One of the first reported chipped stone quarries in the state discovered and investigated by archeologists, it was found in the Columbia Plateau of southeastern Washington. This quarry is located in the eroded basalt flows on the rim of Washtucna Coulee. Here, a fine-grained, "waxy" silica rock ranging in color from "light cream to deep red" formed within a small eroded lava blister (Brauner 1972). Apparently the site was used only to gather the stone and no tools were manufactured there. The site is described as containing an estimated 2.5-3 million pieces of quarry debris, 10-15% of which consists of flakes. The technologies used by prehistoric people to reduce the stone, however, is not described. The only formed tools recovered from the meager test excavations consisted of two unifacial flake tools, one biface, and a hammerstone. The site is undated and the occurrence of this stone material in sites in the region is unknown.

More recently, surveys of large land tracts in the Columbia Plateau have shown that quarries and other sources of quartz rock are widespread in some areas. In a systematic site survey of nearly 12,000 acres of east-central Washington, Benson and Lewarch (1989) reported finding 66 source localities where varieties of quartz, including petrified wood, chalcedony, and opal were procured and reduced in order to make tools. Fifty-one percent of the archeological sites recorded in the survey were classified as "quarry" sites. Most of these procurement sites were located in upland (nonriverine) areas and are associated with the Ellensburg Formation (Benson and Lewarch 1989).

Most recently, a source of high quality white chalcedony has been reported from Grant County (eastern Washington) in association with a quarry pit and manufacturing debris (Gramly 1991). This stone material is reported to be similar in appearance to the material that was used to manufacture the largest of the fluted Clovis bifaces recovered from the East Wenatchee Clovis site (45DO482). This possible quarry site remains to be documented.

Sources of fine-grained basalt are likely to have a similar distribution and occurrence to chert and chalcedony. One of the best documented of these is the Stockhoff Basalt Quarry (35UN52) of northeastern Oregon. This quarry covers an area larger than 400 acres where Native American people collected and initially flaked a fine-grained variety of basalt (Womack 1977). Use of the site was apparently confined to a time period between about 8000 and 4000 years ago. Analysis of tools and debitage at the site suggested that biface reduction was the predominant technique for reducing the basalt talus into early tool stages.

12.5 Lithic Resource Procurement Patterns

Desolation Chert Quarry and the other lithic source localities mentioned in the review above exhibit characteristics that have been recognized at stone procurement sites from throughout North America. At the same time, these sites may express characteristics that reflect more local conditions, environmental or cultural. In this section, patterns in the procurement of stone materials, whether local or regional, are identified and compared with the archeological evidence from the Desolation Chert Quarry. Identification of stone procurement patterns offers a basis for comparing individual procurement sites on regional basis, which is helpful for beginning to understand the role that such sites play in larger scheme of prehistoric settlement and subsistence strategies.

First and perhaps foremost for understanding procurement strategies is the realization that there are likely to exist many more quarries and stone procurement locations than first appearances would suggest. Due to the great difficulty in investigating mountainous terrain and due partially to a research tradition that denied Native American use of such terrain, only a small percentage of the mountainous interior has been studied, certainly a much lower percentage than the surrounding lowlands. This in turn suggests a sampling bias and that many more sites of stone procurement, presently unknown, are yet to be found. In light of the meager data presently available, it may be difficult to clearly separate local from regional factors of stone procurement.

One pattern reflected in the foregoing review of stone sources is the procurement of localized occurrences of lithic materials. Sources were utilized prehistorically that are relatively small, or that offer limited exposures of stone, often in rugged terrain offering limited access, or wherein the stone is not of exceedingly high quality, or all of the above. This is not to deny other procurement strategies also, such as use of high quality materials acquired from distant sources through trade. However, evidence for the latter are typically rare at localized procurement sources.

Another possible pattern is for stone procurement locations to be geographically distributed as a consequence of geologic factors, including regional rock structures and terranes. Thus, a series of related quarries may occur in a restricted area because the stone types being exploited occur in the same geologic formation, and share similar origins, ages, and geologic histories. Recognition of this pattern is helpful in searching for unknown stone procurement localities and, when considered along with cultural factors, it may be crucial for understanding the spatial distribution of procurement sites in some regions.

12.5.1 Characteristics of Large Quarry Sites

It is useful at this point to examine the characteristics frequently shared by large prehistoric stone procurement sites. In the section below, eight characteristics are discussed and compared to those observed at 45WH224.

1. Noted at quarries from across North America is a pattern of temporal variability--the changing use over time--of stone source localities. This variation can express itself as changes in the type of stone reduction techniques employed over the span of site use or changing intensity of use over this time. Singer and Ericson (1977), for example, looked at a large obsidian quarry (8 km^2) in the Sierra Nevada Range of California and found a biface and blade production technology. Using obsidian hydration dating, they inferred a fluctuating rate of biface production, with most production occurring between 4200 and 2300 BP.

   At the extensive Knife River Flint source area in North Dakota, Ahler (1986:108) noted two significant temporal changes. The first involved a change in reduction strategies, with the early period (<5000 BP) showing an emphasis on freehand core reduction and production of large thin bifaces; the later period is characterized by mostly bipolar core reduction. The second involved the spatial distribution of reduction activities. In the early period of use, cobble extraction and cleaning was spatially segregated from workshop areas where core reduction and biface thinning were concentrated. In the later period, a wide range of reduction techniques were used in both quarry and workshop areas.

In northern British Columbia is the largest known quarry complex in the province. From his archeological investigations here Fladmark (1985) has found that quarrying of the Mt. Edziza obsidian was most intensive prior to about 3000 years ago. After this time, there appears to have been decreased use of alpine and subalpine zones in this area, including the abundant local obsidian (Fladmark 1985: 199-200).

The evidence from Desolation Chert Quarry (section 10) does not indicate that different reduction strategies were emphasized in different time periods; rather, the chipped stone remains reflect uniform employment of the same reduction techniques throughout the 7600 year span of site use. However, the sequence of radiocarbon dates from the site suggests a period of more intensive use of the quarry between about 5000 and 3500 years ago. The pattern is shown clearly in the histogram of site radiocarbon dates (Figure 10.17, section 10.4.2), but this conclusion is based upon the untested assumption that the dates are representative of all periods of site use.

2. There is often spatial differentiation of activity areas within a single site. As noted above by Ahler (1986), this occurs because there is segregation of the activity that procures the stone, such as quarrying, digging or some other "extractive" technique, from the activity that shapes the stone into finished tools. At Desolation Chert Quarry, this pattern was definable from the debitage analysis, which shows relatively high ratios of flakes to shatter and higher incidences of biface thinning flakes away from the rockshelter, which reflects predominately biface thinning. At the rockshelter, on the other hand, there are low ratios of flakes to shatter and a near absence of biface thinning flakes, reflecting predominately extraction and cleaning of stone fragments.

3. Procurement areas often consist of a series of related quarries or workshop areas within a circumscribed area, sometimes referred to as a "quarry complex". For example, Ritchie and Gould (1985) describe the Massachusetts Hill Quarry Complex as a series of scattered quarries, rockshelters, and workshops among the low hills comprised of volcanic and sedimentary rocks. Any number of other lithic resource localities with an abundance of flakeable stone have been described by these or similar characteristics. Such quarry complexes provided a

concentrated lithic source and functioned culturally as a regional centers for stone procurement.

The archeological survey results described in section 11, and other surveys in the project area, have demonstrated that the Desolation Chert Quarry is only one of many Hozomeen chert procurement sites in the upper Skagit River Valley. The sites represent three extraction techniques, these being the hammering and fragmentation of bedrock formations in order to create usable pieces, the heating of bedrock masses in order to enhance breakage along natural fracture planes (45WH224 is the only example of this technique), and the collection of weathered nodules from river gravels, talus slopes, alluvial fans, and glacial drift. Cumulatively, this quarry complex constitutes an important part of the archeological record left by the prehistoric, and possibly historic, Native American inhabitants of the northern interior of the Cascades.

4. There is an abundance of chipped stone debris (also called "quarry debitage" or "quarry debris") consisting of waste rock, pieces too small to use, flakes, cores, hammerstones, and broken tools (Bryan 1950). At Desolation Chert Quarry such debitage is scattered across the site surface and in places is buried to a depth of 1.7 m (5.6 ft). As previously noted, the physical characteristics of stone such as Hozomeen chert (which has numerous fracture planes and lacks homogeneity) can promote excessive fragmentation, resulting in the accumulation of much debitage. Cultural factors are also involved, particularly in the case wherein artifacts are manufactured in sequential stages, and where the stages are spatially separated. The reduction sequence practiced by the prehistoric users of 45WH224 appears to fit this pattern also.

5. Related to item 4 above, there often is an absence of finished tools. Many stone procurement sites reflect only the need to gather or extract, clean, and roughly shape stone nodules. Further shaping and working n such cases are done elsewhere, at locations called "workshops". Quarries reflecting such "primary reduction activities" are one of the earliest site types systematically investigated by professional archeologists in North America. Based on his pioneering investigations along the Potomac River, Holmes (1890) recognized that in the process of manufacturing stone tools, there are sequential stages or developmental forms between the unmodified rock at the beginning and the final artifact form at the end. He investigated many quarries wherein only the initial developmental stages of artifacts were represented, and numerous other subsequent archeologists have verified this pattern at quarry sites (Johnson 1981). The artifact assemblage from Desolation Chert Quarry clearly fits this pattern.

6. Lastly, there is mass removal, selection, and reduction of bulk raw material. This is often manifested by the patterns already noted in items 4 and 5 above. In addition, such bulk treatment can be reflected by the presence of pits, adits,

trenches, and quarrying debris piles of tremendous size and volume, leading to use of the term "factory" to describe large scale quarrying activities (Fowke 1928; Bryan 1950). At the Harvey Mountain quarry, a high elevation source of Pritchard argillite in northern Idaho, numerous adits and trenches were excavated into the bedrock in order to procure high quality blocks of the stone (Knudson 1976). At the Obsidian Cliffs in today's Yellowstone National Park, quarry features consisting of single oval pits, multiple overlapping pits, winding linear trenches, and shallow quarries cover an expansive area of a rhyolitic lava flow (Davis et al. 1992).

At 45WH224, the rockshelter overhang constitutes a quarry feature. The present conformation of the rockshelter ceiling and back wall have been formed largely by quarrying. A significant, though uncertain, portion of the rockshelter overhang was thus enlarged by fragmentation with hammerstones and by heating of bedrock surfaces. This quarrying likely followed the natural joint system of the wall and at the time that prehistoric people first began to quarry here, the overhang was smaller and less prominent than it is today. Direct evidence for fragmentation consists of the many impact scars covering the rockshelter ceiling and walls, and the recovery of bedrock corners from the rockshelter excavations. Indirect evidence consists of the estimated volume (90 m^3) of chert debitage on the rockshelter floor, most of which is inferred to have been intentionally quarried from the immediately adjacent bedrock face, and the recovery of charcoal concentrations and strata, in association with heat-scorched debitage, from the rockshelter deposits,.

12.5.2 The Lithic Landscape

The concept of the lithic landscape is valuable for understanding patterns in stone procurement and how these relate to the conditions of settlement and subsistence. Implicit is the recognition that any particular land area embodies a distinctive and unique suite of stone material types that constitutes the stock of raw materials available to stone-working technologies practiced by prehistoric populations. Based on study of lithic source areas in the Kootenay region of southeastern British Columbia, Choquette (1981) noted the need for archeologists to recognize regional patterning in stone tool sources as an aid to understanding prehistory. By characterizing the stone material types for a portion of the northern Rocky Mountains, he showed that regions and localities can be characterized by the presence of distinctive combinations of stone sources and that such combinations do not occur elsewhere. Choquette used the term "lithic provinces" to refer to such areas (1981:24). Blanton (1984:116) employed the same concept under the term "lithic landscape". In each of their respective cases, these investigators identified three different provinces in their project areas on the basis of geologic origin, degree of metamorphism, and age of major rock units. Using similar criteria, many such lithic landscapes could be identified in the Pacific Northwest and elsewhere, but little or no research along these lines has been attempted.

Archeological investigations over the last six years have demonstrated that the northern Cascade Range in the vicinity of today's Ross Lake constitutes a previously unrecognized lithic landscape. It is characterized by the presence of bedrock and detrital sources of Hozomeen chert, metasediments, and other rock types. The Desolation Chert Quarry is only one, albeit the largest yet recorded, of nearly a dozen Hozomeen chert quarries and procurement sites in the project area (Mierendorf 1991; section 11 this report). Other abundant rock types consist of varieties of sedimentary rocks that were later subjected to varying degrees of metamorphism--hence use of the more general term "metasediments" to characterize mudstones, argillites, siltstones, and quartzites. Finally, there are present in this lithic landscape a variety of local stone materials, including chalcedony, jasper, obsidian (vitrophyre), slate, quartz crystal, soapstone, and andesite. Based on preliminary examination and identification of 7931 chipped stone items (tools and debitage) from 124 archeological sites in the project area, 10 different stone materials were recognized (Mierendorf 1991:98-99). Of these, Hozomeen chert, chalcedony, and jasper constituted >78% of the assemblage, metasediments constituted >18%, with the remaining <4% comprised of local and nonlocal stone material types (Mierendorf 1991:101).

In order to more fully characterize lithic landscapes, it is useful to identify some of their main variables or attributes. This is done next, as these variables are used to define, in a preliminary way, an upper Skagit lithic landscape.

1. The spatial (geographic) distribution of suites of stone raw materials covers a land area, that given an adequate information base, can be assigned at least approximate boundaries. In the case of the upper Skagit lithic landscape, the boundaries have yet to be determined. Although the location of bedrock structures of the Hozomeen group of rocks (including Hozomeen chert) is well-known, the distribution of detrital fragments is likely to extend far beyond the bedrock occurrence. This is due largely to the action of the Pleistocene glaciers, which transported rocks encased within the glacial ice and carried them many miles downstream in late-glacial meltwater streams. At the present state of knowledge, I believe the boundaries conform to the Skagit River valley and its adjoining mountainous slopes, including the lower ends of its tributary valleys, from British Columbia to the town of Newhalem at the lower end of the Skagit River gorge; downstream of here it appears to be confined to the river channel and glacial valley fill deposits for an unknown distance toward the Skagit River delta and adjacent Puget Sound.

2. The degree of dispersion or concentration of the source locations controls stone material availability (Blanton 1984). Within their source area, the upper Skagit lithics are concentrated in bedrock outcrops, but they have been dispersed by glacial processes and consequently their availability is more widespread. The importance of glacial till as a source of lithic raw

materials, and the resultant archeological signature, has been described by Deaver (1988) for formerly glaciated terrain in Montana.

3. Within a defined lithic landscape, the entire range of available stone materials should be detailed. This is a long-term research effort in the northern Cascades, and although much has been accomplished in this regard in the last six years, results have only begun to show. Presently, 10 different locally available lithic raw material types have been described preliminarily for the upper Skagit lithic landscape.

4. The accessibility and transportability of stone materials are variables that constrain their use by prehistoric peoples. Within the lowest elevation portions of the upper Skagit lithic landscape, an abundance of chert and other stone materials can be procured from bedrock outcrops and from gravels of the river channel, alluvial fans, and glacial terraces. However, low accessibility source locations, in this case on steep slopes and ridgelines, were used also.

In order to transport stone materials outside of the upper Skagit River Valley, they would need to be carried. There is no unimpeded canoe route leaving the valley; following the Skagit River downstream would have required detouring around a ten mile long gorge of turbulent white water. The alternative route would require ascending more than a mile vertically up to a ridgeline, then immediately descending equally steep slopes to return to the river. However, above and below this gorge, the river was navigable by canoe, which would have offered an important means of transporting stone materials (Bryan 1950:20). Because it flows at the base of Desolation Chert Quarry, we know that for at least the most recent part of the prehistoric past, the workers at the quarry would have had canoe access to the site.

12.5.3 Chronology of Quarry Use

As reported in section 10.4.2, the Desolation Chert Quarry has been used for stone procurement by prehistoric people over the last 8000 or so years. As noted at other quarries studied in North America, there are differences in stone procurement over time (e.g. Ahler 1986; Singer and Ericson 1977). Analysis of archeological assemblages from in and around the northern Cascade Range shows changes in the use of stone materials in different time periods (Mierendorf and Bobalik 1983; Chatters 1986; and others cited in Vivian 1992). In this regard, the series of 13 radiocarbon dates that forms the basis for estimating the occupation span at 45WH224 shows a strong clustering in 9 of the dates between 5000 and 3500 BP. This time period corresponds generally to a number of archeological units defined from excavated site assemblages in regions surrounding the northern Cascades. Such units include the Eayem Phase of the Fraser River Canyon to the north (Borden 1975); the late subphase of the Vantage and early Frenchmen Springs Phases of the mid-Columbia region east of the Washington Cascades

(Nelson 1969; Galm et al. 1981); the latter part of the Okanogan and early part of the Indian Dan Phases of the Okanogan region (Grabert 1970; Chatters 1986), and the recently redefined Lehman or Lochnore Phases of the Mid-Fraser-Thompson River region to the north (Stryd and Rousseau 1988). Definition of these phases is based largely on diagnostic artifacts and other material remains from site assemblages. Because no diagnostic artifacts were found at 45WH224, an assemblage comparison of the site with these units is not possible. However, local archeological sequences from a broad area of the Northwest suggest that the period between 5000 and 3500 years ago was a time of important cultural and environmental changes in Northwest prehistory. The archeological units noted above, when considered within their respective region's cultural sequence, are believed to reflect changes in material culture that, in turn, correlate with changes in the subsistence and settlement practices of prehistoric Indian populations.

Environmentally, this is a time when the climate in some localities was becoming cooler and moister than it had been during the previous few thousand years. Prior to 5 or 6000 years ago, evidence of summer droughts is common throughout the Pacific Northwest; after this time they became less intense due to lower temperatures and greater precipitation (Whitlock 1992). Such changes in vegetation pattern are correlated with advances of alpine glaciers (Heusser 1985, Whitlock 1992, and others cited in Whitlock). In some areas, environmental shifts may have contributed toward subsequent cultural responses, such as reliance on a different set of subsistence resources, an increased dependence on food storage, and increased sedentism (Kuijt 1989; Schalk and Cleveland 1983).

12.5.4 Geologic Context of Artifacts

The excavations at 45WH224 exposed a sequence of sedimentary deposits representing geologic and climatic events beginning with the last continental glaciation and ending with the deposition of a layer of volcanic ash from one of the Cascade Range volcanos, a timespan from ~18,000 to a few hundred years ago. The earliest appearance of artifacts in this geologic sequence occurs in the soil B-horizon, which has developed in a deposit of windblown silt in the middle part of the stratigraphic section. There are two aspects of this part of the geologic section that are likely to hold much significance for understanding local and regional prehistory.

The first of these is the origin of the windblown silt. Although not thick, this silt constitutes a distinctive depositional unit in terrace/flat bench terrain at 45WH224. In other terrain types silt is distributed more uniformly throughout the section and is mixed with larger grain sizes. Under the rockshelter, a fine silt is distributed uniformly throughout the angular chert debitage of the quarry deposits. The age and origin of these silt is uncertain, although we know it is younger than the glacial deposits and older than approximately 3500 radiocarbon years. It seems most probable that the silt is derived from two possible sources. The first is the Skagit River flood plain following the terminal phase of continental glaciation, at a time when the flood plain would have been occupied by a braided glacial outwash plain, which would be building deposits of glacial silt transported by meltwater from a glacier terminus positioned an uncertain distance to the north. Floodplain silt of this sort would have been available for retransport by local winds, which would have carried and deposited the silt on the adjoining lower mountain slopes, where it overlies glacial till. Loess of this origin apparently accreted on glacial throughout Skagit County (Soil Conservation Service 1989:205). A second source of wind transported silt could have been furnished during the warmer and drier climate that existed prior to 5 or 6000 years ago (Whitlock 1992), either from a more open forest canopy or from reduced vegetation cover on the flood plain, or from the greater frequency and intensity of fire on mountain slopes, resulting in accelerated slope instability or erosion. All of these factors may have contributed to the rate of deposition, including an occasional influx of tephra (silt-sized particles of volcanic glass) derived from the intermittent eruptions of Cascade Range volcanos. Detailed analyses of windblown deposits from this general time period in the upper Skagit River Valley have the potential to resolve part of the climatic history of the northern Cascade Range for the mid-Holocene, and to shed light on the character of the landscape that existed when prehistoric populations first began to use the Desolation Chert Quarry.

A second aspect of the mid-section of stratigraphy concerns the nature and origin of the soil B-horizon that has developed in the top of the windblown silt and later deposits. Across 45WH224, and other prehistoric sites throughout the project area, there is a pattern of co-occurrence of artifacts and soil B-horizon. At 45WH224 the lower (older) and unweathered (olive brown) silt deposits lack artifacts and predate human use of the landform; however, in the top (younger) portion of the windblown silt, chipped stone artifacts occur in abundance in association with the soil B-horizon, which is weathered to a strong brown color and which constitutes a visually prominent component of the stratigraphic section.

The importance of the soil B-horizon to understanding site formation and artifact patterning goes far beyond the locality of 45WH224 or the upper Skagit River Valley. It extends to a large region of coniferous forests, between the Cascades and the Rocky Mountains, and beyond. Archeologists working in the forests of western Washington and beyond have for some time recognized a physical association between archeological assemblages and well-developed soil B-horizons, especially for early time periods (see e.g. Borden 1975:54; Hedlund 1974:81, Kidd 1969:209 and 214, and Swanson 1961). However, correlation and interpretation at a regional scale has encountered difficulties, due largely to only partial understanding of the factors controlling B-horizon formation. Some of these factors were considered and explored, but remain unresolved, during an investigation of prehistoric archeological sites in northwestern Montana, in a valley possessing environmental and geological characteristics comparable to the upper Skagit River Valley (Mierendorf et al. 1987).

One of the factors influencing artifact-to-soil horizon associations is the mixing together of soil horizons that occurs when trees tip over and displace large volumes of soil adhering to their root systems (Wood and Johnson 1978). Even in second growth forests of moderate size trees, up to 48% of the ground area can be disturbed by trees, which individually can displace root mass volumes of up to 3 m^3 (Beatty and Stone 1986). In old growth forests of the Pacific Northwest, root mass volumes much larger than this are common. Awareness of the effects of such disturbance to archeological deposits is widespread, and perhaps has led some archeologists to mistakenly conclude that all prehistoric sites in heavily forested environments have been more or less destroyed by mixing, resulting in loss of integrity of association of artifacts.

At 45WH224 and other sites with developed soil B-horizons, analysis of the age and formation processes of the soil may help to understand the structure of the prehistoric materials found within them. In the upper Skagit River Valley, as in other valleys with similar geologic and climatic histories, different age landforms express different degrees of B-horizon development. To say this another way, the B-horizon at the quarry is one member of a soil chronosequence that ranges from young, weakly-developed soils to old, well-developed soils, similar to the chronosequence investigated along the Cowlitz River by Dethier (1988). Some field properties of soils are clearly age related, including lowering Ph (more acidic), clay films, rubification (development of hue and chroma), texture, and depth to unweathered material. Also, chemical properties may prove useful in understanding the origin and formation of the soil B-horizon. In attempting to understand these soil and artifact relationships, I am indebted to the thoughts of Earl Swanson published thirty years ago (1961:105-106), in which he encouraged the study of soil B-horizon formation as an avenue to understanding the antiquity and regional environment of early prehistoric cultures of the Northwest (particularly the Old Cordilleran Culture). His insights and suggestions are as appropriate today as they were then.

12.6 Role of Stone Procurement in Settlement and Subsistence

This section is an inquiry into what lithic procurement patterns tell us about the adaptations of the prehistoric populations that once lived in the upper Skagit River Valley. Although we may be interested in their cultures as a whole, lithic remains comprise only a small part of a culture's total material realm, and in turn the total of material remains constitutes only a small part of the entire culture. Because most (but certainly not all) stone objects are used for food acquisition and making utensils, they provide information about subsistence activities and settlement patterns--how people acquired and handled food and gear, and where they lived and worked. In the following subsections, these aspects of culture are explored from the perspective of stone procurement; because detailed study of archeological sites in the project area and surrounding mountains has only begun, any such attempt is preliminary.

12.6.1 Distance Decay Models

As applied by archeologists, such models seek to quantify the important relationship that with increasing distance from its source, the proportion of a particular stone raw material decreases in archeological assemblages. This idea has been labeled by rather imposing terms such as "Law of Monotonic Decrement" (Renfrew cited in Earle and Ericson 1977:7) and "Distance Decay Models" (Green 1985). By measuring the proportion of a specific raw material that: 1) has a known source locality, 2) occurs in a large number of archeological sites that are spread widely across a region, 3) and is reliably identifiable, it is possible to discern patterns in subsistence or settlement. Any particular lithic material's distribution pattern possibly is related to many factors, including the location of travel and trade routes, social boundaries, the availability of and demand for alternative raw materials, settlement hierarchies (Earle and Ericson 1977), and mountain barriers or other constraints of physiography.

As an example of the above approach, Weide (1974) used lithic raw materials as an "indicator material" to define the core area of a prehistoric band's territory. Working in the Warner valley of Oregon, she used a locally available basalt that served as "a non-perishable raw material with a point source origin within the area occupied by a group, a material widely used by that group in basic, general ways but lacking sufficient value outside the group's area to be the subject of trade or exchange." (Weide 1974:65). By tracing the distribution of this basalt, she defined a set of archeological sites as the North Warner Valley subsistence network. This network was believed to encompass the core area of a prehistoric band territory covering 485 mi^2 (1256 km^2) (p. 73) and possibly supporting up to 100-200 individuals at a time estimated to date between 3200 and 1400 years ago.

It is likely that a similar approach may reveal aspects of the home range or size of the territory habitually used by prehistoric bands of the project area, as has been suggested for an area east of the Cascade Range (Mierendorf and Bobalik 1983:617). To do this requires information about the distribution of Hozomeen chert in archeological assemblages across the region, but the present data base for this purpose is incomplete and regional distribution of sites is unknown. Currently, the known distribution of Hozomeen chert in archeological assemblages is as follows. As noted in section 12.4.2, it is abundant in sites of the upper Skagit River Valley (where it comprises >78% of all chipped stone remains) in the immediate vicinity of 45WH224. To the east, it has been found as an isolated piece of debitage near to the head of Lake Chelan, in Lake Chelan National Recreation Area; to the north it has been found in archeological sites immediately north of the international boundary, in the Skagit Valley Recreation Area of extreme southern British Columbia; to the west it has been found in a high elevation site on Forest Service Land west of Mt. Shuksan; and on the south it has been found in an archeological site near Cascade Pass in North Cascades National Park. This distribution spans an area, entirely within the core of the northern Cascade Range, covering 717 mi^2 (1857 km^2). Although not abundant, Hozomeen chert is common in assemblages from late prehistoric sites in the Newhalem vicinity of Ross Lake National Recreation Area, where its frequency in assemblages appears to fall off. I am aware presently of three widely spread locations in the northern Cascades where Hozomeen chert has been recovered from sites at or near the upper timberline. The closest of these is 16 miles (25.6 km) from the nearest known quarry and the most distant is 28 miles (44.8 km). From this information it can be concluded that Hozomeen chert was used by Native populations that traveled across a broad area of the northern Cascade Mountain interior, however; the cultural mechanisms and social context behind the use of Hozomeen chert remain to be investigated.

12.6.2 Embedded Procurement Strategies

Drawing on his ethnographic experiences with the Nunamiut of Alaska, Binford (1979) has suggested that procurement of stone resources is most often "embedded" in other more economically rewarding subsistence pursuits. Employing this concept, McClure (1989:66-67) suggested that exploitation of a local variety of obsidian from the Elk Pass quarry (45LE286) in the alpine zone of the southern Washington Cascades also fits the pattern of a procurement strategy embedded in other pursuits, particularly goat hunting. Presumably, the economic benefit of procuring the stone alone was far outweighed by the greater cost of its transport to the lowlands and its comparatively moderate utility for making tools.

Given the current level of understanding of prehistoric activity in the upper Skagit River Valley, I have been hesitant to conclude that procurement of Hozomeen chert at 45WH224 was embedded in other subsistence pursuits. Certainly, if it was known with confidence that prehistoric populations came to the valley primarily to collect subsistence resources, then a conclusion for embedded procurement would appear warranted. However, there are some inherent problems with the concept of embeddedness and its application to archeological interpretation that must be considered. First, the concept is overly simplistic in assuming that one resource is assigned priority or significantly greater value than all others. If the controlling factor ultimately is the cost/benefit ratio, than a mixed strategy, in which a variety of resources are sought, may be most beneficial. A mixed strategy has the added benefit of increasing the likelihood of acquiring resources of value, in other words, of making the pursuit worthwhile.

A second difficulty with the embedded concept is that it is applicable at widely different temporal and spacial scales, each with a different set of results. For instance, assuming that trips to the upper Skagit River Valley by prehistoric bands were profitable only because of an abundance of animal and plant resources, then the secondary procurement of stone would appear to be embedded in these other more primary pursuits. However, consider that these trips lasted up to eight months (as reported ethnographically), during which time bands occupied seasonal base camps. It is likely under these conditions that in addition to hunting and plant collecting, occasional forays by small groups or individuals were made from these camps to the quarry in order to collect, shape, and remove pieces of Hozomeen chert, independent of other pursuits. Viewed from this more restricted spacial and temporal scale, procurement would not appear to be embedded. Ultimately, the appropriate scale is determined by the scope of the research problems being addressed, so that more than one scale may need to be considered.

A final difficulty is with the degree to which prehistoric people actually made decisions and behaved according to energy optimizing or least cost strategies. It is commonly accepted that "The amount of time and energy available to a particular group exerts a strong influence on the makeup of lithic assemblages in terms of raw materials chosen for use as well as energy expended in manufacture, use, repair, and discard." (Jeske 1992:467). Recognizing here that energy budgeting is also a condition of temporal and spacial scale, it is informative to consider the quarry in the context of all other Hozomeen chert sources in the locality. There are many such sources, consisting of the abundant river gravels, alluvial fan gravels, glacial gravels, and talus deposits. Each of these offers numerous exposures of easily acquired chert cobbles and nodules. Furthermore, because many of these have survived exposure to high energy environments that fragment rocks (bedload impacts in river and alluvial fan gravels; glacial grinding in drift), such chert gravels, if they are of any appreciable size, tend to be homogeneous and free of internal weaknesses, and thus are excellent sources of tool stone. Given the abundance of such a chert source, it is difficult to explain the existence, from an economizing standpoint, of 68 metric tons of flaked debitage beneath the rockshelter portion of the quarry, not accounting for additional debitage from bedrock fragmentation in other parts of the site. It is much more costly to remove fragments of chert from the bedrock outcrop, many of which are of inferior flaking quality, than it is to select from the other available gravel sources. Clearly, considerations other than cost must be involved.

At the spacial scale of the upper Skagit River Valley in proximity to 45WH224 (about 15 mi upstream and downstream of the site) and the temporal scale of the last 8000 years, it appears that there were some time periods when quarrying was not incidental to other subsistence pursuits. This is not unexpected considering that the quarry is situated just above the Skagit River flood plain, which provided easy access from local residential base camps. Preliminary study of nearby archeological sites indicates that some were specialized workshops where Hozomeen chert was reduced into finished tools. We are thus beginning to recognize a pattern in which successive stages of artifact manufacture are performed at different locations, resulting in archeological site types that can be discriminated on the basis of manufacturing debris or debitage. Said in another way, stone procurement and primary reduction activities take place at quarries and source locations. Intermediate or secondary reduction occurs at workshops or campsites, and tool finishing is conducted at larger seasonal campsites or at residential sites. It is likely, however, that there were time periods when Hozomeen chert procurement was embedded in other pursuits. Such a pattern was suggested by Magne from the study of stone assemblages of 38 archeological sites in southern British

Columbia. He determined that lithic technology is largely embedded in settlement strategies and that lithic remains can be expected to change as the operations of settlement and subsistence systems change (Magne 1985:261).

It may be that in mountainous areas, stone was procured as a function of the *local* organization of subsistence and settlement. Thus, chert procurement is expected to be embedded in other economic pursuits in the subalpine, and in terrain beyond a day's foraging radius from residential sites on the adjoining valley floor. In other cases, as exemplified by 45WH224, it is not embedded in other subsistence pursuits because it is within an easy walk of residential sites on the flood plain. In the case of small quarries exemplified by 45WH446 and 45WH447, the restricted exposure of chert, the difficulty of access, and the low artifact densities all suggest a relatively high cost. Under these conditions, the sites are more likely to be within the logistic radius of residential camps on the flood plain, so that one might expect an embedded procurement strategy. This sort of economic zonation surrounding residential base camps, including the "foraging radius" and the "logistic radius" are discussed further in Binford (1982).

In attempts to characterize the relationship between settlement-subsistence organization, raw material distribution, and technology, Bamforth (1986) and Kelly (1988) agree that there is no direct correlation between the mobility of hunter-gatherer groups (in the sense of Binford) and the organization of technology. Although these articles do not directly address the question of embedded strategies, their insights into the cultural roles of lithic technology are relevant here. Bamforth (1986:49) notes, for example, that:

> Depending on the ways in which lithic material is procured and distributed, recycling and maintenance may vary spatially within a single society as distance to raw material sources increases, resulting in differing assemblage composition in behaviorally and ethnically identical sites. Aspects of human organization other than subsistence-settlement structure can also affect access to raw material. In ranked societies, such access may be controlled largely by social forces such as wealth or social status, and many aspects of technology may therefore vary within a single settlement.

Kelly examined the role of bifaces in hunter-gatherer societies and has suggested that they serve three different organizational roles: as cores; as resharpenable, long use-life tools; and as shaped, functionally-specific tools. The use of bifaces in these roles is related to raw material distribution and a group's mobility strategy (Kelly 1988:731). He suggests that a variety of conditions of raw material scarcity or abundance, along with alternative group mobility strategies, determines the role that bifaces play within the subsistence pattern of any particular group. In the upper Skagit River Valley, lithic resources are abundant, but the nature of group mobility and the organization of subsistence probably has not been static over the entire 8000 year period of site use. If indeed mobility and organization of subsistence has changed during the span of quarry use, we have been unable so far to detect any changes in the site's archeological assemblage indicating changes in stone technologies or subsistence activities over time. Alternatively, the fact that quarry use was sporadic and not intensive prior to 5000 years ago, and then became accelerated and intensive between 5000 and 3500 years ago, may be used to infer a shift at this time toward logistically organized groups, resulting in exploitation of Hozomeen chert by quarrying parties with the sole intent of making and removing bifaces from the site. This is akin to the situation described by Binford (1982:21) wherein with increasing permanence of residential camps, stone procurement becomes functionally more specific rather than incidental.

An important but as yet unknown factor in understanding the subsistence use of Hozomeen chert is the extent to which it was valued as a trade item or that it was sought by populations from outside the Skagit River valley. The only historic reference to such use comes from the information provided to Teit by Nlakápamux informants that stone for arrow tips was found "near the head waters of Skagit River." (Teit 1900: 241). Any factor that created demand for more stone essentially would have made it more worthwhile to procure--would have increased the benefit to cost ratio. Of possible significance in this regard is the evidence from 45WH224 indicating that a tremendous amount of energy was expended in reducing, cleaning, and shaping chert directly from the bedrock outcrop. This occurred in spite of the fact that there was available locally other chert sources more easily procured, such as those in river and glacial gravels. More information will be needed before we can identify the factors that explain the large volume of quarry debitage not just at 45WH224, but accumulated at many quarry and procurement sites throughout the upper Skagit lithic landscape.

12.6.3 Procurement and Cultural Change

As noted in the discussion of the chronology of the quarry's use, the period between 5000 and 3500 years ago was a time of cultural and environmental change. Archeologists have proposed and discussed different models to explain the possible causes for such mid-Holocene cultural changes. Some of these are discussed in the paragraphs below. For a more thorough and insightful critique of such models as they relate to the Cascade Range generally, see Burtchard (1990:6-16).

For widespread areas of the Pacific Northwest, archeologists have proposed recently that this approximate time period marks the onset of "intensification", a process involving more intensive use of the land. According to this model, Native American subsistence strategies became directed toward increasing the productivity of a finite land area or subsistence base (Binford 1982; Matson 1983; Schalk 1984a and 1984b; Thoms 1989). Intensification poses any number of questions regarding its causes and consequences for how non-agricultural societies organize socially and economically. One cultural response, for instance, is the development of greater social "complexity" within these societies. An outcome of increased social complexity could involve the appearance of craft specialization and trade networks, both of which were well-developed in historic Northwest Coast cultures. It has been suggested, in turn, that a social need or "demand" is required in order for there to be full-time craft specialization in flintknapping, and that demand is broadly a function of population density (Seeman 1984:20). Is it possible that the onset of intensive quarry use at 45WH224 5000 years ago is in some way related to region-wide population growth that stimulated greater demand for flakeable raw materials? Populations may have begun to increase at this time; however, no population estimates are available to test this idea. All that can be suggested, given our present level of knowledge, is that there may be an important relationship between lithic resource procurement and intensification.

An alternate explanation has been advanced recently by Stryd and Rousseau (1988) that may be applicable to the upper Skagit. They propose that beginning as early as 5500 years ago, people with a riverine-oriented subsistence pattern moved into the southern interior of British Columbia. Based on an inferred continuity between archeological assemblages and Native groups of the historic period, they propose that the prehistoric "Sqlelten Tradition" is manifested in the Salishan-speaking peoples of today (Stryd and Rousseau 1988). This hypothesis is consistent with Elmendorf's (1963) much earlier assertion, based on linguistic evidence, of a Salishan migration. Although archeologists are unable to clearly link prehistoric cultural-typological units with linguistic taxonomic units, mass population movements as a mechanism of culture change cannot to discounted.

Others have suspected climatic change of exerting a dominant influence on cultural change during this time. Working with archeological data from the Colorado Rockies, Benedict and Olson (1978) have suggested that severe droughts between 7000 and 5500 years ago forced foraging societies to abandon widespread areas of the dry, arid basins of the mountainous west, including the Columbia Plateau. They believe that human populations sought refuge from these conditions by migrating to areas of more effective moisture, and thus developed cultural adaptations to higher elevations in mountainous terrain.

It is intriguing that the 45WH224 excavations provide marked evidence that in the 5000-3500 year time period Hozomeen chert was more intensively quarried than at any time before or after. From a review of the proposed models for cultural change at this period, any number of explanations could be advanced to relate the role of Hozomeen chert procurement to changes in the organization of settlement and subsistence, to an influx of a new population, to increased demand on lithic resources due to increasing regional populations, or to climatic changes. Final evaluation of these alternative explanations will be possible only after completion of on-going investigations of the entire sample of archeological sites in the upper Skagit River Valley.

12.7 National Register Significance of 45WH224

One of the main objectives of the archeological project described in the report (see section 8.1) is to assess the significance and importance of Desolation Chert Quarry (45WH224). In North Cascades National Park Service Complex, as on other federal lands, this is done by judging cultural resource properties against the National Register criteria. Cultural resources listed in the National Register of Historic Places are given protection from actions that would destroy or adversely alter the values that impart significance to them. In the paragraphs that follow, the National Register significance of 45WH224 is discussed.

12.7.1 The National Register Criteria

The National Register criteria are stated as follows (U.S. Department of the Interior 1986:1):

> The quality of significance in American history, architecture, archeology, and culture is present in districts, sites, buildings, structures, and objects that possess integrity of location, design, setting, materials, workmanship, feeling, and association, and:
>
> A. that are associated with events that have made a significant contribution to the broad patterns of our history; or
>
> B. that are associated with the lives of persons significant in our past; or
>
> C. that embody the distinctive characteristics of a type, period, or method of construction or that represent the work of a master, or that possess high artistic values, or that represent a significant and distinguishable entity whose components may lack individual distinction; or
>
> D. that have yielded, or may be likely to yield, information important in prehistory or history.

As is the case with most prehistoric archeological sites, assessment of significance proceeds from criterion D above, which requires a demonstration that the site contributes important information for understanding prehistory and history. This has been partially accomplished in sections 12.1-12.6 above, where data gathered from the site were placed into broad regional contexts and were used to address issues and questions about prehistoric stone procurement and how this relates to prehistoric occupation of the mountains. The remaining sections below more directly address National Register considerations.

12.7.2 Site Integrity

The concept of integrity in National Register assessments refers to quality or state of being complete and unimpaired. In this regard the Desolation Chert Quarry retains a high degree of integrity. Following the National Register, the integrity criteria are as shown below as they are assessed for the site.

1. **Location:** the site is in its original location.

2. **Design:** not applicable because the site lacks design features.

3. **Setting:** although not usually applied to prehistoric sites, this is an important consideration in this case because of the site's location in a remote "wilderness" setting (it is outside of and a short distance from the boundaries of the Stephen T. Mather Wilderness as designated by the U.S. Congress in 1988, within North Cascades National Park Service Complex). The pristine character of the site has been altered by logging and reservoir operation. Logging occurred in the 1940s or 1950s during clearing of the area to be inundated behind Ross Dam. Below the high operating pool level of 1602 ft above sea level, all vegetation from the site has been removed and erosion by reservoir processes has been severe at some locations. Above the high pool, only a few large trees were cut from within the site boundaries and direct reservoir effects are confined to an eroding reservoir bank. This is the portion of the site that was test excavated and discussed in this report and it is the portion that today remains one of the largest known prehistoric quarries in the State of Washington, in a pristine and unaltered condition.

4. **Material:** the artifacts, archeological deposits, site stratigraphy, rockshelter, and debitage scatters are unimpaired and *in situ* above the 1602 ft elevation. Below this elevation, the integrity of material has not yet been determined.

5. **Workmanship:** is unimpaired and in original condition.

6. **Association:** cultural materials are in their original contexts and relationships to cultural levels and features, with little mixing or no mixing. The only agents of mixing are displacement by tree roots, gravity, and reservoir-induced wave action (below 1602 ft elevation).

It is concluded that the portion of the site above 1602 ft above sea level retains a high degree of integrity. The portion below this elevation currently is being evaluated as part of a cultural resources study by Seattle City Light related to application for relicense of the Skagit River Project by the Federal Energy Regulatory Commission.

12.7.3 Research Objectives

In section 8.1 of the report are listed nine questions that were addressed by this study. The excavation and survey methodology of the project were designed to answer these questions as part of the documentation that would be needed to complete National Register nomination forms for the site. These question are briefly answered below.

1. **What are the site's horizontal dimensions and how deep are cultural remains buried below the surface?** The mapped boundaries of the site above 1602 ft elevation have been determined through ground survey, but these are not provided here in order to avoid disclosure of the site's location in order to protect it from vandalism. This portion of the site covers 7.6 acres (0.03 km^2). The lowest elevation portion of the site has not yet been observed; it remains covered by the reservoir pool.

   Archeological remains at the site are buried at different depths below the ground surface, depending on the factors controlling deposition in the different terrain types in the site. There is no depth in those areas where artifacts rest on top of bedrock benches; the maximum depth was observed under the rockshelter overhang, where artifacts were recovered 1.7 m (5.6 ft) below ground surface. Between these two extremes, an approximate average depth of the site is 1 m below ground surface.

2. **What is the range of artifacts and features preserved at the site? What was their function?** The artifacts consist predominately of flaking debris of Hozomeen chert. Artifact categories include flakes, shatter, early reduction stage bifaces, hammerstones, and a few flake tools. The rockshelter, which was partially shaped by quarrying of chert from bedrock, constitutes the only site feature. The walls and ceiling of this feature retain numerous impact scars from the use of hammerstones as quarry tools. The cultural materials from the site reflect the earliest stage in a prehistoric stone manufacturing process that consists of sequential steps. The first step, clearly represented a the quarry, consisted of collecting, cleaning, and roughly shaping biface blanks to be later worked into finished forms.

3. **How old is the site? Through what methods can the age of the site be estimated (radiocarbon, volcanic ashes, cross-dating of artifacts, etc.)?** The site is datable through use of the radiocarbon technique. A series of 13 radiocarbon samples were dated, resulting in an estimate of site use spanning from 7600 to 290 radiocarbon years ago. One unidentifiable sample of volcanic ash was recovered from an upper level of the site deposits. Temporally diagnostic artifacts were not recovered from the site surface or from excavation units.

4. **What kinds of organic remains are preserved at the site?** Charcoal consisting of stratigraphic concentrations of small (~ 1 cm) fragments and dispersed, finely-divided particulates. These appear to be derived from burned woody plants.

5. **How many buried components or cultural layers are at the site?** In most test excavation units, six artifact-bearing stratigraphic layers were recognized. Except in a few cases, differentiation of discrete cultural strata or components was not possible.

6. **In what ways have the original characteristics of the site been altered? What processes or events continue to affect any significant qualities of the site?** This question is addressed in section 12.7.2.

7. **What kinds of analyses can be done with the artifacts and other remains that can contribute new knowledge to prehistory?** Artifact-to-source correlations with prehistoric site assemblages using chemical and petrological characterization of chert; debitage analysis; technological analysis of biface reduction stages; stone quarrying techniques; radiocarbon dating; possibly tephrachronology; possibly identification of charred plant remains; possibly identification of faunal remains; paleoclimatic interpretation of soils; and soil analyses to determine site formation processes and rates of weathering and soil formation.

8. **Is the site one member of a much larger class of sites that have already been well-studied? Are there any other sites capable of contributing the same kinds of information?** The site is an example, possibly the largest yet recorded in the State of Washington, of a prehistoric chert quarry. This category of archeological site is notable for being poorly studied in the state generally. This site is the first large quarry reported in northwestern Washington and the northern Cascade Range. Reconnaissance surveys in North Cascades National Park Service Complex have resulted in the finding and recording of other stone procurement sites, demonstrating that many more are likely to be exist. None of the other known procurement sites in the Park Complex or the northern Cascade Range are as large or as intensively used as 45WH224.

9. **What are the data categories contained in the site that make it eligible according to the National Register criteria?** This question is answered in the next section.

12.7.4 Historic Context and Property Types

The National Register nomination process uses historic context as the basis for demonstrating the significance of cultural properties. Historic contexts are defined on the basis of theme, time, and place. Clearly, the title of this report is a close approximation of the historic context used for evaluating the significance of 45WH224.

However, a more precise statement of historic context is "Lithic Resource Procurement in the upper Skagit River Valley Between 8000 and 100 Years Ago".

This historic context relates to a variety of archeological sites which can be classified into different property types. This report has dealt with just one of these, this one being the property type called "chert quarry". The entire range of property types illustrating this historic context can be defined by the type of material and its method of procurement. For example, chert quarries, soapstone quarries, and obsidian quarries are all separate property types that differ by the type of stone procured. Procurement methods include removing of fragments directly from bedrock, digging out of the ground, and collecting pieces laying on the ground surface. For example, chert quarries, chert excavations, and chert collection localities are also different property types.

In differentiating property types by lithic material it is important that the stone type be empirically and accurately characterized. A complete characterization includes description of physical properties, petrological analysis, and chemical analysis. This degree of characterization may not in all instances be required, such as in the case of stone material that is sufficiently distinctive in appearance and geographic occurrence that there is no doubt as to its source and recognition. However, characterization should be detailed enough to avoid the potential confusion inherent in attempting to identify and source the great variety of stone materials that are typically encountered in archeological assemblages.

In differentiating property types by method of procurement, there must be direct or indirect evidence of how the stone was procured. In the project area, for example, hammer marks, bashed bedrock corners, and flake scars on bedrock provide direct evidence of removal from the bedrock outcrop sufficient to justify the designation "quarry". In the case of "excavations", there must be evidence such as pits, trenches or adits visible on the ground surface or in subsurface stratigraphy. Collection localities usually occur where natural processes concentrate or disperse lithic raw materials on the ground surface, such as in or along river channels, talus slopes, or in glacial gravels. Such occurrences most often are associated with observable properties, such as river-rolled cortex, angular fragments with weathered or lichen-covered surfaces, or adhesions of weathered soil, which can be observed also on chipped stone debitage recorded at these property types.

Methods of procurement also are manifested in artifacts that functioned as extraction tools. Of the many hammerstones scattered across 45WH224 and buried in the quarry deposits, the "large" size category were most often used to remove fragments from bedrock and large nodules. At many large procurement sites, there are likely to be important relationships between the methods of procurement and the variety and number of extraction-related tools. Along these same lines, detailed analysis of hammerstone wear patterns and other physical attributes can potentially contribute as much to understanding reduction technologies as can debitage analysis.

Within the upper Skagit River Valley, on-going studies have demonstrated the existence of many distinctive stone types within prehistoric archeological assemblages (Mierendorf 1991). For most of these the locations where prehistoric people acquired the material are unknown, but in some cases there is good reason to believe the source exists somewhere within the drainage, and in a few instances the source has been located. Given the present level of knowledge, source locations and the different procurement sites associated with them are likely to occur at any elevation and on any landform type. Except for Hozomeen chert, an approximate distribution pattern for sources of stone materials (and the associated procurement sites) is as yet undefined. All that can be said with certainty is that there are likely to be many more prehistoric procurement sites (specific properties) than have been recorded to date, and that due to the many gaps that exist in our understanding, there is much to be learned about this historic context from continued investigations.

Property types related to lithic resource procurement in the upper Skagit River Valley between 8000 and 100 years ago have much to contribute to our understanding of local and regional prehistory. The kinds of information such properties are likely to yield and the problems they are likely to address are listed below. Many of the items on the list are drawn from sections 12.2 to 12.6.

1. What is the role of chert procurement in the organization of settlement and subsistence in hunting-gathering-fishing cultures of the northern Cascade Range? We can break this issue down into two parts:

    a. How do hunting-gathering-fishing bands organize to make lithic raw materials available to those who use them?

    b. How do we conceptualize the organization of technology and labor for the production of lithic tools?

    c. What are the conditions under which stone procurement is "embedded" in other subsistence pursuits or it is conducted as a subsistence pursuit in its own right?

2. How can artifact-to-source correlations of lithic raw materials be used to define the home range or habitually-used territory of hunting-gathering-fishing populations?

3. What does our understanding of prehistoric adaptations to the mountains tell us about the evolution of Northwest Coast and Plateau land use patterns? More detailed aspects of this question include:

a. Are adaptations to "marginal" environments sensitive monitors of cultural processes and changes occurring in the more densely populated lowlands?

b. Is there a demand placed on lithic resources in mountainous areas, such as the project area, in proportion to the size of lowland populations?; in proportion to competition between lowland populations?; due to the dispersion of populations away from overpopulated areas?

c. With the onset of intensification of land use in the middle and late Holocene, how did lithic resource procurement and use patterns change?

4. What can the geographic distribution within archeological sites of lithic materials from known sources tell us about exchange systems in the Northwest Coast and Plateau culture areas?

a. Can we trace trade routes or corridors between trading partners?

b. Which lithic raw material types in the Pacific Northwest region can serve as "indicator materials"? Is Hozomeen chert one of these?

5. What are the boundaries of, and what is the range of stone materials available within the various lithic landscapes of Washington State and the Northwest region?

a. At what spatial or geographic scales should lithic landscapes be defined and described in order to be relevant to understanding prehistoric Northwest land use systems?

b. Can distance-decay curves be constructed for stone materials of known source and what do these tell us about cultural dispersion and use of materials?

6. What are the acceptible standards for lithic raw material characterization?

a. What techniques are available for characterization of lithic raw materials?

b. What techniques of lithic raw material characterization are needed to do artifact-to-source correlations in the Northwest lithic landscapes?.

7. How do changing patterns in chert procurement relate to broad regional cultural sequences?

   a. What is the cultural significance of temporal differences in the use of procurement sites?

   b. Does it relate to cultural changes in the organization of subsistence, such as could be triggered by shifts in climate?

   c. Does the apparent intensive exploitation of 45WH224 5-3500 years ago relate to the initial phase of a new (Salishan) tradition proposed by Stryd and Rousseau 1993?

   d. Does the stratigraphic or sedimentary context of quarry debris address questions of climatic change or landscape evolution that relates to procurement strategies?

12.7.5 Management Recommendations

Desolation Chert Quarry (45WH224) appears to be eligible for inclusion in the National Register of Historic Places. The portion of the site above 1602 ft elevation is characterized by integrity of location, setting, materials, and association. Cultural remains at the site embody data categories that have contributed new information about the prehistory of the upper Skagit River Valley and the northern Cascade Range of Washington State and British Columbia. At present, the site is distinguished for being the largest known example of a prehistoric chert quarry in the region, and one of the few so far recorded in the northern Cascade Range.

Nomination of the site to the National Register of Historic Places will be on a multiple property listing, which is currently being developed by National Park Service staff at North Cascades National Park Service Complex. The importance and significance of the site has been demonstrated in relation to the historic context of lithic resource procurement in the upper Skagit River Valley between 8000 and 100 years ago, but the site has significance in relation to other historic contexts, also.

As on-going studies proceed and until final determinations of significance and effect have been made, the site (above 1602 ft elevation portion) will be managed according to the following policy:

1. The natural and unaltered character of the site, its setting, materials, and association will be preserved and unaltered. The exact location of the site is confidential, and the site is not to be used for public visitation or on-site interpretation. The thin soils and steep slopes contribute to rapid formation of

social trails, destruction of the vegetative ground cover, and hillslope erosion. This management policy is compatible with the forest setting and wilderness character of the mountainside environment specifically and of the upper Skagit River Valley generally.

2. As soon as possible, a section of eroding bank at the site should be stabilized. Due to the steep slope, incoherent sediment matrix, and exposure to high energy wave action, cultural deposits along a ~40 m section of shoreline are eroding into the reservoir, resulting in loss of integrity of location, setting, materials, and association.

The portion of the site below 1602 ft elevation will be managed along with other cultural resources in the reservoir drawdown. As part of the City of Seattle's relicense of its Skagit River Project with the Federal Energy Regulatory Commission, a cultural resources management plan is being developed for the drawdown zone.

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APPENDICES

APPENDIX A

LIST OF PLANTS GROWING ON 45WH224

COMMON NAME	SCIENTIFIC NAME
Douglas-fir	*Pseudotsuga menziesii*
Western red-cedar	*Thuja plicata*
Lodgepole pine	*Pinus contorta*
Ponderosa pine	*Pinus ponderosa*
Big-leaf maple	*Acer macrophyllum*
Paper birch	*Betula papyrifera*
Cherry	*Prunus emarginata*
Vine maple	*Acer circinatum*
Hazel	*Corylus cornuta*
Serviceberry	*Amelanchier anifolia*
Ocean-spray	*Holodiscus discolor*
Wild roses	*Rosa* spp.
Soap Berry	*Sheperdia canadensis*
Oregon-Grape	*Berberis nervosa*
Kinnickinnick	*Arctostaphylos uva-ursi*
Boxwood	*Pachistima myrsinites*
Honeysuckle	*Lonicera ciliosa*
Wild onion	*Allium* spp.
Biscuitroot	*Lomatium* spp.
Mosses	
Lichens	
Ferns	

APPENDIX B

HAND SPECIMEN, PETROGRAPHIC, AND X-RAY FLUORESCENCE SPECTROMETRY CHARACTERIZATIONS OF ROCK SAMPLES FROM THE UPPER SKAGIT RIVER VALLEY

HAND SPECIMEN AND PETROGRAPHIC DESCRIPTIONS

Five rock samples (4 of Hozomeen chert and 1 hammerstone fragment) were submitted to Dr. Edwin Brown, Department of Geology, Western Washington University, for thin-sectioning and petrographic analysis. A list of the submitted samples, their original locations, and additional notes are provided in Table B-1 below.

In Table B-2, descriptions are provided for each of the samples listed in Table B-1. These are the first detailed descriptions of a rock type that had much prehistoric importance to Indian people of the upper Skagit River Valley for at least 7600 radiocarbon years. Each sample is described twice: first is a hand specimen description of those characteristics most frequently observed and used by archeologists in classifying stone raw material types in the analysis of chipped stone assemblages. These were done on freshly fractured surfaces, which usually display observable properties unlike those displayed on the cortex and weathered exterior of the stone. The other is a semi-quantitative description of each sample based on examination of thin-sections with a petrographic microscope; this part of the analysis was performed by Dr. Brown. Table B-2 is followed by photographs of Hozomeen chert thin sections and an unmagnified sample.

Table B-1. ROCK SAMPLES SUBMITTED FOR PETROGRAPHIC ANALYSIS

Sample No.	Location	Collection Notes
1	Little Beaver Cr. Trail	A Hozomeen chert sample removed from a bedrock outcrop
2	Desolation Chert Quarry (45WH224)	A glacially transported nodule composed of green Hozomeen chalcedony and jasper; surface collection
3	Desolation Chert Quarry (45WH224)	A Hozomeen chert artifact from TU-3, L-4 (C-14 dated 3600 BP
4	Desolation Chert Quarry (45WH224)	A cobble of Hozomeen chert showing prominent banding, dk. gray, surface collection
5	Desolation Chert Quarry (45WH224)	A fragment of a hammerstone from TU-3, L-4 (C-14 dated 3600 BP)

Table B-2. HAND SPECIMEN AND MICROSCOPIC DESCRIPTION OF ROCK SAMPLES

Sample No. 1

Hand Sample Description:

Classification:	chert
Munsell color:	predominately uniform dark gray (N 4/0) weakly mottled with few very thin (<0.1 mm) criss-crossing light gray to white quartz veins.
Luster:	nonmetallic, dull to semi-glossy
Fracture:	very smooth, conchoidal
Crystalline matrix:	very fine-grained and homogeneous
Light Transmittance:	translucent along edges < 1 mm thick and opaque along edges > 1 mm thick.
Specific Gravity:	2.2

Thin-section Description:

Groundmass (>95% of rock) consists of microgranular quartz (grains 5-10 microns diameter), dusty material and sparse recrystallized radiolarian ghosts.

Vein material is 1-5% of rock. Vein width is 10-100 microns; grain diameter in veins is 5-30 microns. Vein mineralogy is quartz 80-90%, albite (twinned) 10-15%, sphene (granular to ideomorphic) 5%. Veins tend to be mono- or bi-minerallic.

Sample No. 2

Hand Sample Description:

Classification:	red jasper and green chalcedony
Munsell color:	irregularly, strongly mottled greenish gray (5G 5/1) to dark greenish gray (5G 4/1), light gray (5Y 7/1), and very dusky red (2.5YR 2.5/2).
Luster:	nonmetallic, dull to semi-glossy
Fracture:	smooth, conchoidal to hackly, conchoidal
Crystalline matrix:	fine-grained to medium-grained, contains inclusions and large quartz masses.
Light Transmittance:	translucent (green to white varieties) to opaque (red varieties).
Specific Gravity:	2.4

Thin-section Description:

Groundmass consists of microgranular quartz mixed with variable amounts of foliated phyllosilicate material (muscovite, illite, or altered chlorite) and scattered grains of calcite (10-100 microns across), sphene and opaque. Material which is red in hand specimen consists of relatively unrecrystallized chert crowded with dusty hematite inclusions which define a planar fabric. White patches in hand sample consist of relatively coarse, foliated recrystallized quartz (grains 10-100 microns across).

Veins are cross-cutting, branching, intersecting and curved. Vein quartz defines a comb-texture, growing in elongate grains oriented normal to the veins.

Sample No. 3

Hand Sample Description:

Classification:	chert
Munsell Color:	weakly mottled dark gray (N 4/) to very dark gray (N 3/) in a complex reticulate pattern composed of many thin (<0.5 mm) criss-crossing veins and many thin (<1.0 mm) parallel laminations.
Luster:	nonmetallic, dull
Fracture:	smooth, conchoidal
Crystalline matrix:	fine-grained and homogeneous, with occasional inclusions.
Light transmittance:	Translucent along edges <2.0 mm thick and opaque along edges >2.0 mm thick.
Specific Gravity:	2.5

Thin-section Description:

Groundmass is microgranular quartz (2-10 microns) with scattered, numerous, recrystallized radiolarian ghosts, (0.1-0.2 millimeters diameter) and sparse equidimensional grains of opaque (about 5 microns). A slight flattening fabric is defined by oblong radiolarian ghosts.

Veins are irregular, branching, intersecting and discontinuous. Coarse veins are 1-2 millimeters wide. Quartz grains in some veins occur in unusual radiating, wavy aggregates elongate normal to the crystallographic c-axis and the vein wall. Veins cross-cut, and therefore post-date, the flattening fabric. Minor carbonate vein material is also present.

Sample No. 4

Hand Sample Description:

Classification:	chert
Munsell color:	strongly mottled gray (N 6/) to black (N 2/) in a complex reticulate pattern of criss-crossing thin (>0.5 mm) black veins and many parallel laminations (0.5-3.0 mm thick)occurring in sets of dozens of laminations, with cross-cutting relationship between adjacent sets. Luster: nonmetallic, dull
Fracture:	smooth, conchoidal to hackly conchoidal
Crystalline matrix:	fine-grained, with small inclusions and empty vacuoles, and many thin (<0.5 mm) cross-cutting fractures.
Light transmittance:	translucent along thin edges (<2.0 mm) and opaque where thicker (>2.0 mm).
Specific Gravity:	2.5

Thin-section Description:

Groundmass matrix (90-95% of rock) is microgranular quartz with abundant, scattered, recrystallized radiolarian ghosts (0.1-0.2 mm diameter). Opaques occur as scattered grains a few microns across. A few carbonate grains are present.

Parallel laminations are defined by greater and lesser concentrations of dusty opaque material. Veins (5-10% of rock) are intersecting, branching, discontinuous and in places gradational into the groundmass.

Sample No. 5

Hand Sample Description:

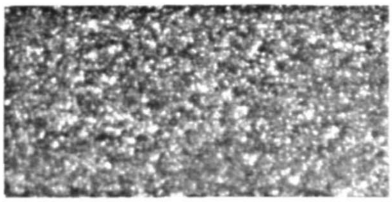
Classification:	andesite
Munsell Color:	groundmass is gray (N 5/), strongly mottled with prominent, light gray (N 7/) and black (N 2/) phenocrysts
Luster:	nonmetallic, earthy
Fracture:	rough, irregular
Crystalline matrix:	fine-grained ground mass with prominent phenocrysts (0.5-4 mm)
Light transmittance:	opaque

Thin-section Description:

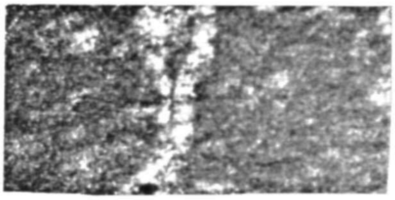
The rock is porphyritic with phenocrysts of plagioclase, augite and an altered mineral which is now chlorite, and was probably hypersthene before alteration. The phenocrysts make up about 1/3 of the rock, and are dominated by the plagioclase. The groundmass is plagioclase (50%), augite (30%) and the remainder quartz, opaque, and chloritic alteration.

The rock lacks directional fabric, either igneous or metamorphic. Vesicles are absent. Moderate chloritic and sericitic alteration is present.

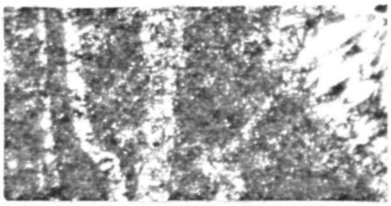
In field occurrence, this rock could have come from a shallow intrusive (dike or sill) or a lava flow. Its relative freshness suggests either a Tertiary age or an origin outside of the North Cascades metamorphic zone.



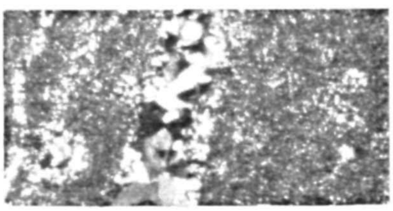
Sample No. 1:
Photomicrograph of thin-section of Hozomeen chert magnified 20X, showing microgranular quartz groundmass.



Sample No. 2:
Photomicrograph of thin-section of Hozomeen chert magnified 80X, showing quartz veins and roughly spherical radiolarian remnants in a micro- granular quartz groundmass.



Sample No. 3:
Photomicrograph of thin-section of Hozomeen chert magnified 80X showing structures of uncertain origin in a quartz vein.



Sample No. 4:
Photomicrograph of thin-section of Hozomeen chert magnified 20X showing coarse granular quartz veins and roughly spherical radiolarian ghosts in a microgranular quartz groundmass.

Sample No. 4:
Photograph at actual size of sawn and polished face of heterogeneous Hozomeen chert sample, showing quartz veins, natural fracture lines or cracks, and empty spaces.

RESULTS OF CHEMICAL ANALYSIS

As part of this study, a preliminary analysis was made of three trial samples of Hozomeen chert derived from the Hozomeen Group of rocks. These were submitted for chemical characterization to the U.S. Geological Survey. The objectives of the analysis were to determine if the chert could be chemically "fingerprinted" and if this could be done without destroying each sample. The provenience of the three samples are described below.

Sample Locations

Sample No. 1. The sample is a fragment removed directly from a bedrock outcrop exposed along the Little Beaver Cr. trail, about one mile west of the shoreline of Ross Lake. It corresponds to a sub-variety of Hozomeen chert that I have informally called "Little Beaver gray." This sample matches (and was split from a larger fragment of) Sample No. 1 listed in Table B-2.

Sample No. 2. The sample is a flake from 45WH224, Test Unit 2, Level 8 (70-80 cm below ground surface) in association with radiocarbon sample number WSU-3813, dated 4470 radiocarbon years ago (see Appendix D). In macroscopic appearance, this chert sample is representative of the bulk of the quarry debris, which is comprised of a strongly mottled, dark gray to light gray to black variety of Hozomeen chert.

Sample No. 3. This sample is a flake from 45WH224, Test Unit 3, Level 4 (43-53 cm below unit datum; about 10 cm below the top of the rockshelter floor) in association with radiocarbon sample number WSU-3814, dated 3600 radiocarbon years ago (see Appendix D). This sample matches (and was split from a larger fragment of) Sample No. 3 listed in Table B-2. Like Sample No. 2, the visual appearance of the sample is similar to the bulk of the quarry debris, which is comprised of a strongly mottled, dark gray to light gray to black variety of Hozomeen chert.

Note that none of the samples were removed from the bedrock at 45WH224. I assumed that all flaking debris found under the protecting overhang of the shelter was derived from the shelter ceiling or walls, and thus I considered a flake sample from the most protected portion of Test Unit 3 to be an acceptable representative of the adjacent chert bedrock. Subsequent to this, the evidence acquired in two field seasons of test excavations and examinations of the quarry deposits served only to support this assumption.

The results of the analysis as described below were provided by staff of the Branch of Western Regional Geology, U.S. Geological Survey, Menlo Park, California. The analyses were completed by Robert Fehr while additional aspects of the analysis and its descriptive results were provided in letters to me from Andrei M. Sarna-Wojcicki and Roland W. Tabor. Much of the information provided in this appendix has been selected directly from Dr. Sarna-Wojcicki's letter report submitted to me. The cumulative interest and assistance provided by the U.S.G.S. staff in chemical characterization of the chert has been most helpful and I am indebted to them for their efforts in this analysis.

Methodology

Samples were analyzed using a Kevex EC 7075 spectrometer coupled with a 700 X-ray excitation subsystem. Two spectral regions were measured for each sample, the 0.3 to 10.55 KeV interval and the 12.96 to 18.08 KeV interval. These two intervals cover most elements that would be expected to occur in abundance in cherts. Measurement requires placing each sample in a holder and orienting it so that a relatively flat and smooth face is struck at an angle by the primary exciting X-rays, and secondary excited X-rays are emitted from the sample and picked up by the detector. Due to the irregular shapes of the specimens and roughness of the surfaces, quantitative analysis would be difficult or impossible, but qualitative or semi-quantitative data might provide useful comparisons. Each sample was run in two different orientations in order to determine the effect of sample surface characteristics on the results.

Sample results from analysis with the Kevex energy dispersive spectrometer are machine specific and cannot be replicated with a different machine.

Results

The spectra indicate that there are larger differences between Sample No. 1 as compared with Sample Nos. 2 and 3, the latter two exhibiting smaller differences between them, regardless of orientation. These differences and similarities are more obvious in the 12.96 to 18.08 KeV spectrum that contains the minor trace elements Rb (rubidium), Sr (strontium), Y (yttrium), Zr (zirconium), and Nb (niobium) than in the lower energy spectrum containing the major and minor elements Si (silicon), Ca (calcium), Ti (titanium), and Fe (iron).

Sample No. 1 is considerably enriched in most trace and minor elements compared with Sample Nos. 2 and 3. The spectrum for Sample No. 1 shows a relatively high content of Sr, Y, Zr, and Nb, while Samples Nos. 2 and 3 contain low levels of these elements, barely above background. The latter samples contain some Rb, while Sample No. 1 does not.

After spectra were measured on intact samples, they were powdered and analyzed again, and Dr. Sarna-Wojcicki noted no significant difference in the results. He suggested that using his methods as described here, it is possible that chert artifacts, like those of obsidian, can be analyzed nondestructively.

Dr. Sarna-Wojcicki provided graphic displays of the data in order to quantify the differences between samples. Of these, only two are diagramed here. In the first of these an attempt was made to reduce scatter by normalizing the net peak heights in the lower energy spectrum to silica (assuming that the silica content, the most abundant component of chert and usually ranging from 80% to 98%, are approximately the same in all samples). Results of this attempt are shown in Figure B-1 for the two peaks of iron. He also took the net peak heights for the three most abundant minor elements (Rb, Sr, and Zr), summed these to 100%, and plotted them on a ternary diagram (Figure B-2). Again, the differences between Sample No. 1 and the artifacts (Nos. 2 and 3) is apparent, and provide evidence for the conclusion that the artifacts did not come from the chert bedrock where Sample No. 1 was collected. This conclusion matches nicely the separate provenience of Sample No. 1 as compared with the other two and the disparate macroscopic appearance of Sample No. 1 as compared with Sample No. 3 as described in Table B-2.

Conclusion

Results of the X-ray fluorescence spectrometry indicates a likelihood that Hozomeen chert can be chemically characterized or "fingerprinted" and that artifact-to-source correlations may be possible. Data from the three samples of Hozomeen Group cherts analyzed in this study suggest the possibility that samples of macroscopically different appearance, derived from separate geographical locals can be chemically differentiated. However, a sample of three is too small to be statistically meaningful. Any further investigations following the analytic techniques described here will require a much larger sample, and particularly one that represents the range of Hozomeen chert sub-varieties across the geographic extent of the Hozomeen Group or related rocks. Finally, this preliminary analysis offers the possibility that Hozomeen chert artifacts can be analyzed in a nondestructive manner.

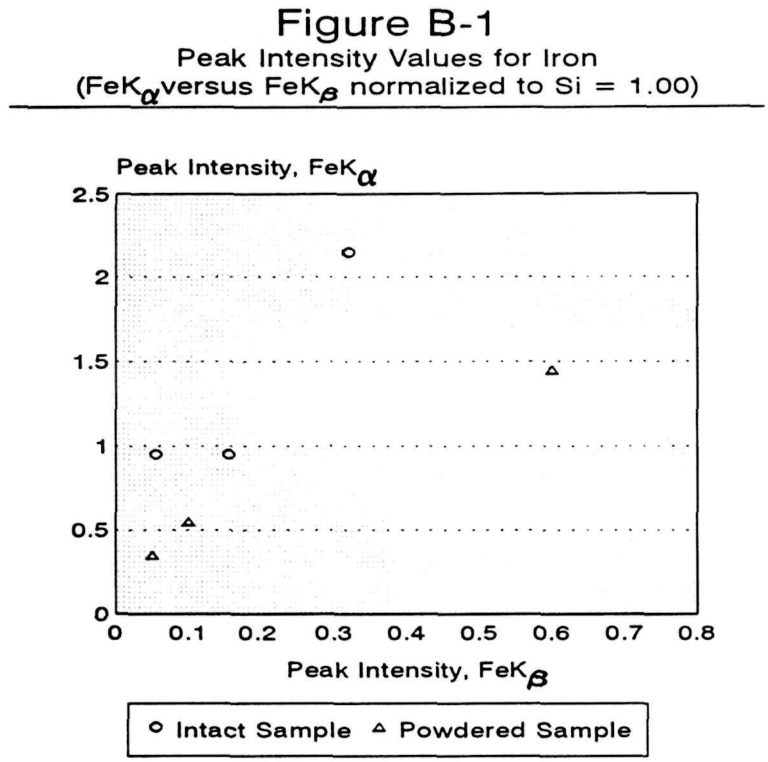


Figure B-1. **Peak Intensity Values for Iron**

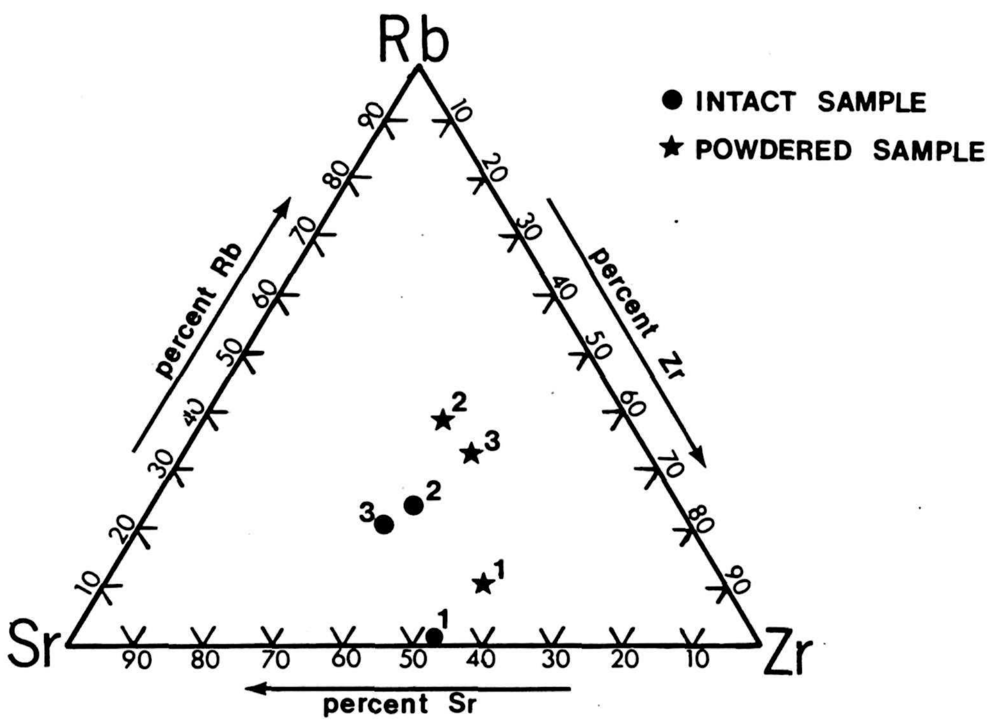


Figure B-2. **Peak Intensity Values For Three Most Abundant Minor Elements.**

APPENDIX C

FIELD DESCRIPTIONS OF TEST UNIT STRATIGRAPHY AT 45WH224

The following descriptions were recorded in the field from stratigraphic sections exposed in test unit walls. Descriptive terminology conforms in most respects to conventional procedures used to describe soil (pedological) properties as expressed in the *Soil Survey Manual* (Soil Conservation Service 1981). This descriptive format, as used here, is somewhat modified by inclusion of terminology used to describe sedimentary deposits and inclusion of nontechnical notes of observations and first order inferences about strata based on the observed field properties.

TEST UNIT 2

Stratum Number	Field Description
1	Very dark brown (10YR 2/2m); poorly sorted, gravelly silty sand; slightly sticky and nonplastic; no soil or sedimentary structures; many very fine and fine roots; clear, smooth boundary. Notes: many small charcoal flecks; stratum is a weakly developed soil A horizon.
2	Dark yellowish brown (10YR 3/4m); poorly sorted, cobbly silty sand; nonsticky and nonplastic; no soil or sedimentary structures; many very fine to large roots; clear, wavy boundary. Notes: stratum exhibits properties similar to the upper gravel strata at TU's 5, 6, and 7 and probably correlates with them; is the distal end of the earth movement deposit.
3	Dark brown (7.5YR 3.5/4m); poorly sorted, gravelly sandy silt; slightly sticky and nonplastic; many fine to large roots; clear, wavy boundary. Notes: stratum is the soil B-horizon; small boulders are supported in the matrix; near bottom of stratum, some degree of disturbance by tree roots indicated by loose matrix; a charcoal sample recovered from compact sediment in this stratum was radiocarbon dated 4470 ± 200 BP (WSU-3813).
4	Olive brown (2.5YR 4/4m); moderately sorted, silt mixed with a poorly sorted gravelly sandy silt; slightly sticky and plastic to nonsticky and plastic; no soil or sedimentary structures; many fine to large roots; Notes: stratum is the soil BC horizon; bouldery clasts are supported in a fine matrix at the bottom of the stratum.

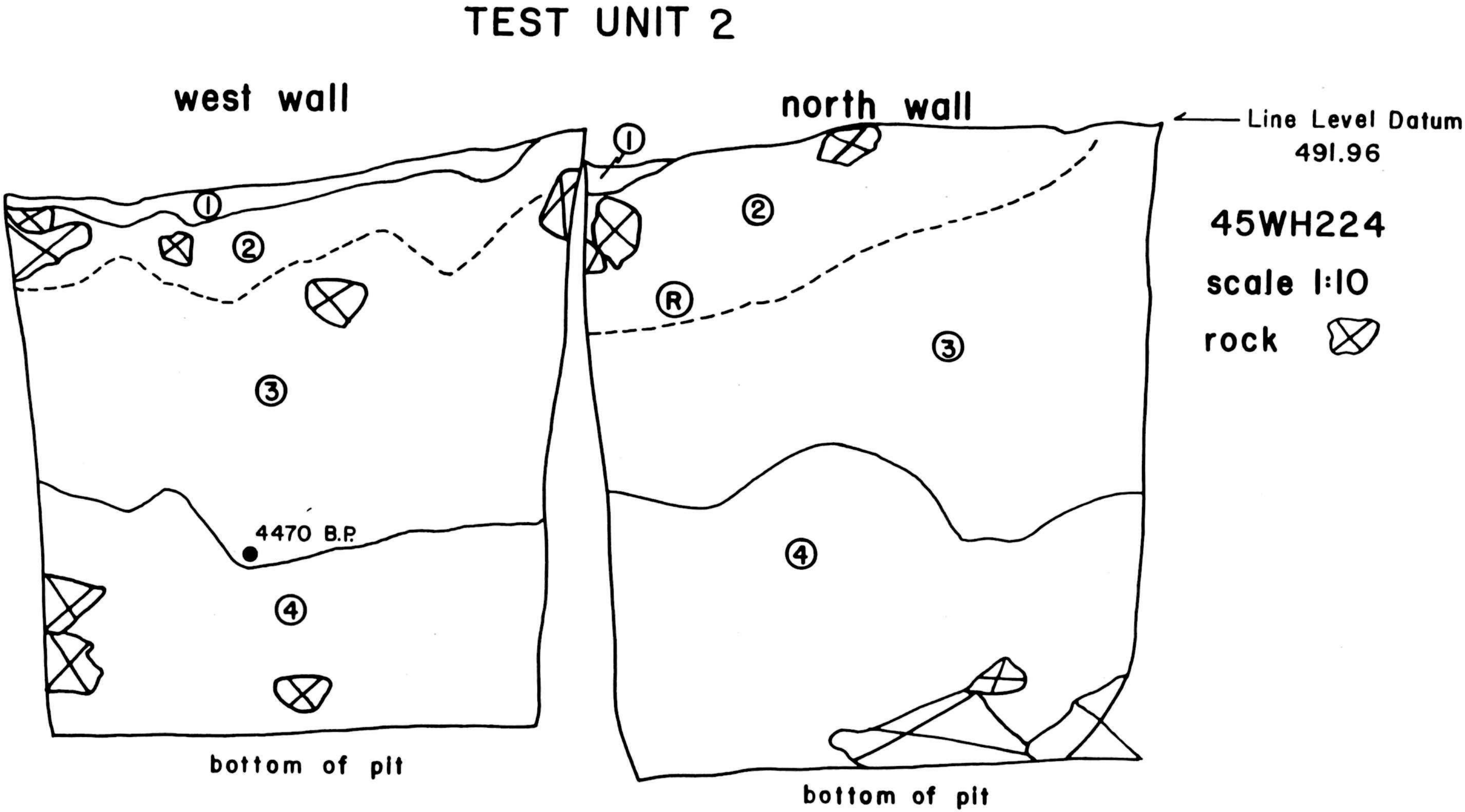


Figure C-1. Stratigraphy of TU2

TEST UNIT 3

Stratum Number	Field Description
1	Dark yellowish brown (10YR 4/6m); poorly sorted, gravelly silty sand; matrix predominately clast-supported Hozomeen chert debitage; many very fine to medium roots. Notes: loose silt in the interstitial matrix is likely aeolian in origin.
2	Black (N 2/0); poorly sorted, clast-supported Hozomeen chert debitage; many very fine to medium roots. Notes: a charcoal sample from the lower portion of this stratum is dated 3600 ± 130 BP (WSU-3814); flakes and shatter coated with charcoal powder; charcoal chunks common.
3	Black (10YR2/1m), mixed with some yellow brown sandy matrix (10YR 2/1m to N2/0); poorly sorted, clast-supported Hozomeen chert debitage; chert fragments are angular and platy (scorched or heat fractured); many very fine to medium roots; debitage coated with finely divided charcoal or soot; small (<2cm) charcoal chunks common; many cobble-size angular pieces of Hozomeen chert shatter. Notes: some portion of this debitage originated from the bedrock bench above the rockshelter and has fallen over the rockshelter dripline and built a prominent berm; two charcoal samples from this stratum dated 3980 ± 70 BP (Beta-33513) and 3980 ± 80 (Beta-33514).
4	Same as stratum 3, but without sandy brown matrix and with more charcoal fragments and finely divided charcoal. Notes: a charcoal sample from this stratum dated 4000 ± 90 (Beta-33515).
5	Black (N 2/0 m), same as stratum 4 but with a higher concentration of charcoal fragments and finely divided charcoal. Notes: a charcoal sample from this stratum dated 4090 ± 90 BP (Beta-33516).
6	Hozomeen chert bedrock of high flaking quality; bedrock formation characterized by tight joints and tight quartz veins up to 4 mm thick.

GENERAL NOTES: the entire deposit excavated in this test unit is derived from human quarrying activities; the charcoal fragments from stratum 5 appear to be branch material that rested on the bedrock floor and burned; no evidence was found indicating construction of a pit or other feature, and the charcoal distribution above stratum 5 appeared to be irregularly dispersed through the test unit matrix; this stratum correlates with TU12, stratum 5 and TU14, stratum 5.

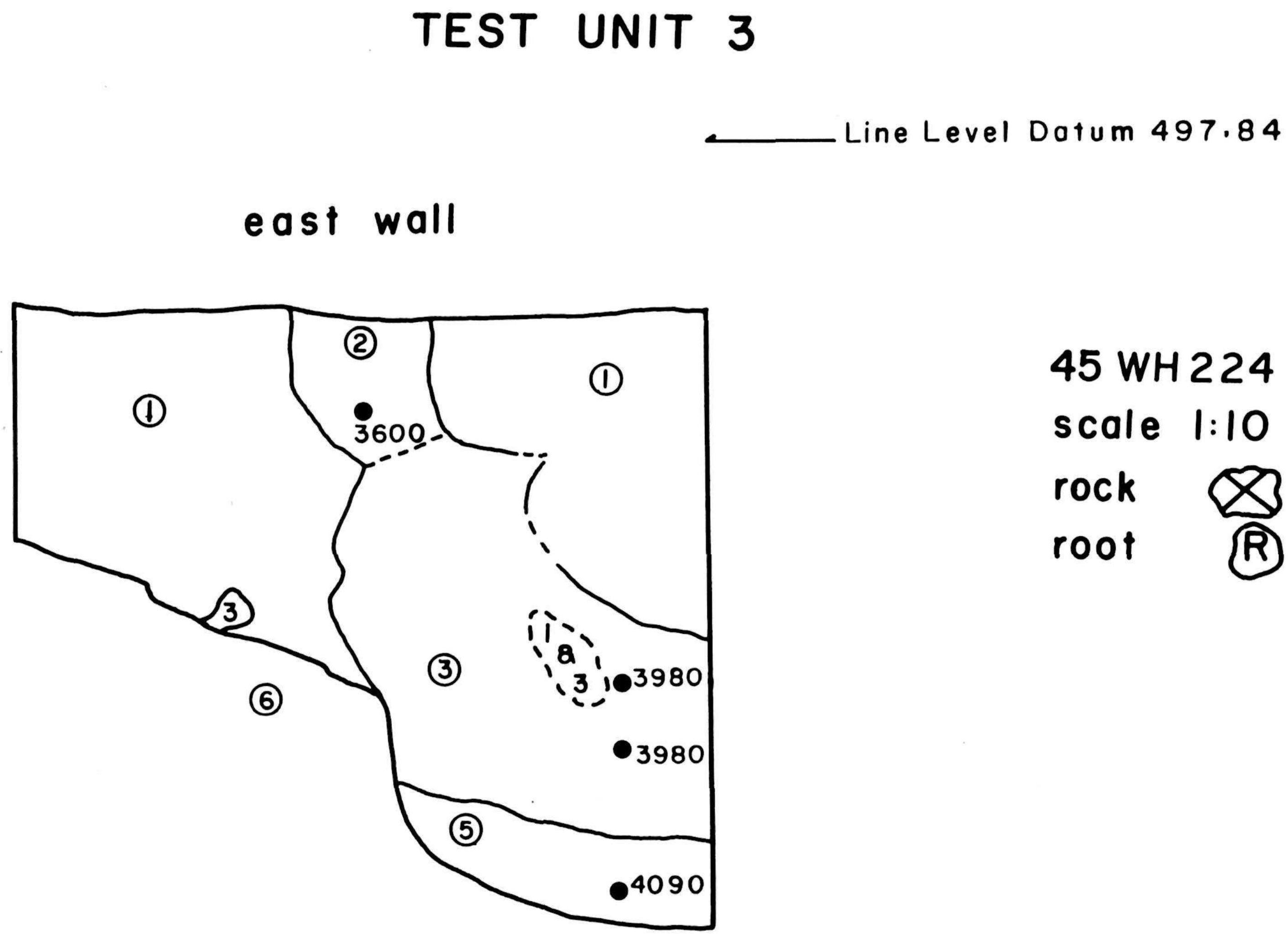


Figure C-2. **Stratigraphy of TU3.**

TEST UNIT 5

Stratum Number	Field Description
1	Soil O horizon; forest duff or conifer needles, twigs, and cones.
2	Dark yellowish brown (10YR 3/4), (10YR 5/3d); poorly sorted, gravelly silty fine sand; nonsticky and nonplastic; no soil or sedimentary structures; many very fine to medium roots; clear, wavy boundary. Notes: in dry profile is distinctly gray, may have a high content of volcanic ash; stratum is the soil E horizon; gravel fraction mostly angular to sub-angular pebbles, loose matrix.
3	Strong brown (7.5YR 3/5m), (7.5YR 5/4.5d); poorly sorted, gravelly silty sand; nonsticky and nonplastic; no soil or sedimentary structure; many very fine and few large roots; smooth, gradual boundary. Notes: gravel fraction mostly angular to subangular pebbles; this stratum is the soil B1 horizon; loose matrix.
4	Dark brown (7.5YR 3/4m), (10YR 5/6d); poorly sorted, gravelly silty sand; slightly sticky and nonplastic; no sedimentary structures; matrix fractures into fine angular soil aggregates having iron oxide stained faces (high gravel content may retard expression of what is in fact moderate angular blocky structure); many very fine roots; clear, wavy boundary. Notes: stratum is the soil 2Bt2 horizon; gravel fraction consists mostly of subangular to angular pebbles, but with a distinctly higher concentration of small cobbles and large pebbles than above stratum; very compact matrix; a charcoal sample from this stratum dated 2800 ± 120 BP (Beta-27498).
5	Dark yellowish brown (10YR 4/6m), (10YR 5/6d) moderately sorted, sandy silt; slightly sticky and nonplastic; no sedimentary structures; moderate angular blocky structure, with fragments mottled with irregular-shaped patches of strong brown iron oxide stains; many very fine roots; clear, smooth boundary. Notes: stratum is the 3Bt3 soil horizon developed in a different parent material from soil above; few gravels; very compact and hard matrix.
6	Dark yellowish brown (10YR 3/4m), (10YR 5/4.5d) poorly sorted, gravelly silty sand; nonsticky and nonplastic; no sedimentary or soil structures. Notes: stratum is a soil 4B4 horizon, very compact and hard (dry consistence); gravels are predominately angular and subangular pebbles with small cobbles common.

General notes: this deep excavation unit is characterized by multiple strata, each of which represents a separate depositional event; the combination of cobble-size gravels in a fine matrix, along with properties expressing weak soil development (which are likely soils eroded from the hillside above) and the absence of evidence for a stable land surface such as characterizes other test units in this vicinity, supports the hypothesis of episodic deposition through earth movement (mass wasting) prior to and after 2800 radiocarbon years ago.

TEST UNIT 6

Stratum Number	Field Description
1	Soil O horizon; composed of conifer needles, duff, Douglas-fir cones, bark, and roots.
2	Brown (10YR 4/3m), (10YR 7/2d); poorly sorted, gravelly silt; nonsticky and nonplastic, no soil or sedimentary structures; many very fine to medium roots; clear, wavy boundary. Notes: stratum is the soil E horizon, a mixture of primary volcanic ash in irregular pockets in a mixed matrix of volcanic ash and soil B-horizon; electron microprobe analysis of the volcanic ash (see section 10.4.1) was inconclusive as to the source volcano and the date of eruption.
3	Strong brown (7.5YR 4/6m), (10YR 5/6d); poorly sorted, gravelly silty sand; nonsticky and nonplastic; no soil or sedimentary structures; many very fine to medium roots; abrupt, smooth boundary. Notes: stratum is the soil Bw1 horizon; gravels are predominately pebbles and cobbles; enclosed within the sediment matrix of both strata 2 and 3 is a Hozomeen chert boulder 1 m in diameter, indicating that these two strata are earth movement deposits.
4	Strong brown (7.5YR 4/4m), (7.5YR 5/6d); poorly sorted, gravelly sandy silt; slightly sticky and nonplastic; no soil or sedimentary structures; many very fine to medium roots; diffuse, wavy boundary. Notes: stratum is the soil Bw2 horizon and also is the reddest and most heavily iron oxide stained B-horizon seen on site; is very hard and compact; this soil represents an old, weathered, and stable land surface that was buried by earth movement deposits; it correlates with an abrupt increase in the frequency of chipped stone debitage; a charcoal sample from this stratum contained too little carbon to date, however, the stratum correlates with stratum 3, TU2, dated 4470 BP.

TEST UNIT 5

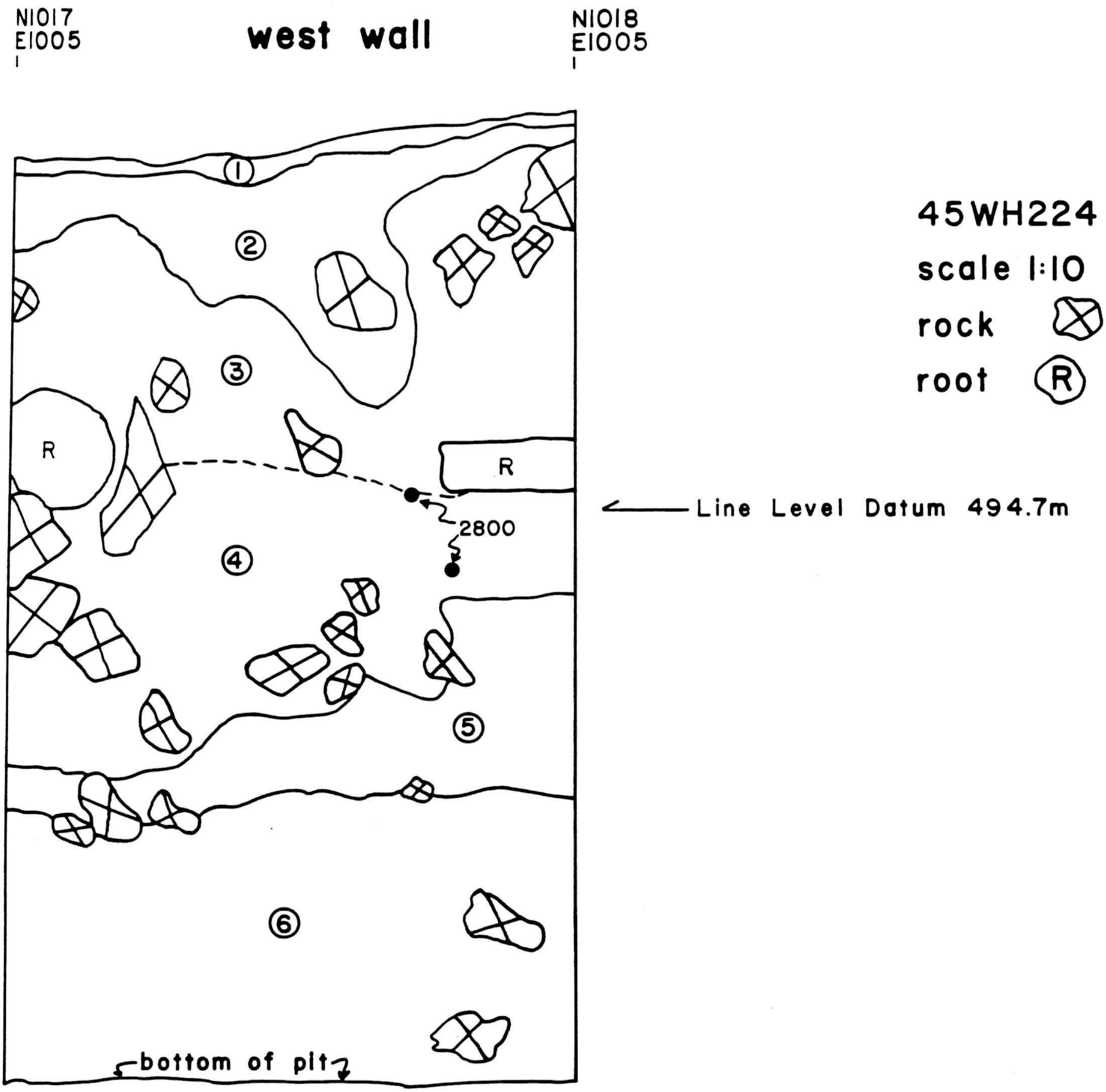


Figure C-3. Stratigraphy of TU5.

TEST UNIT 6

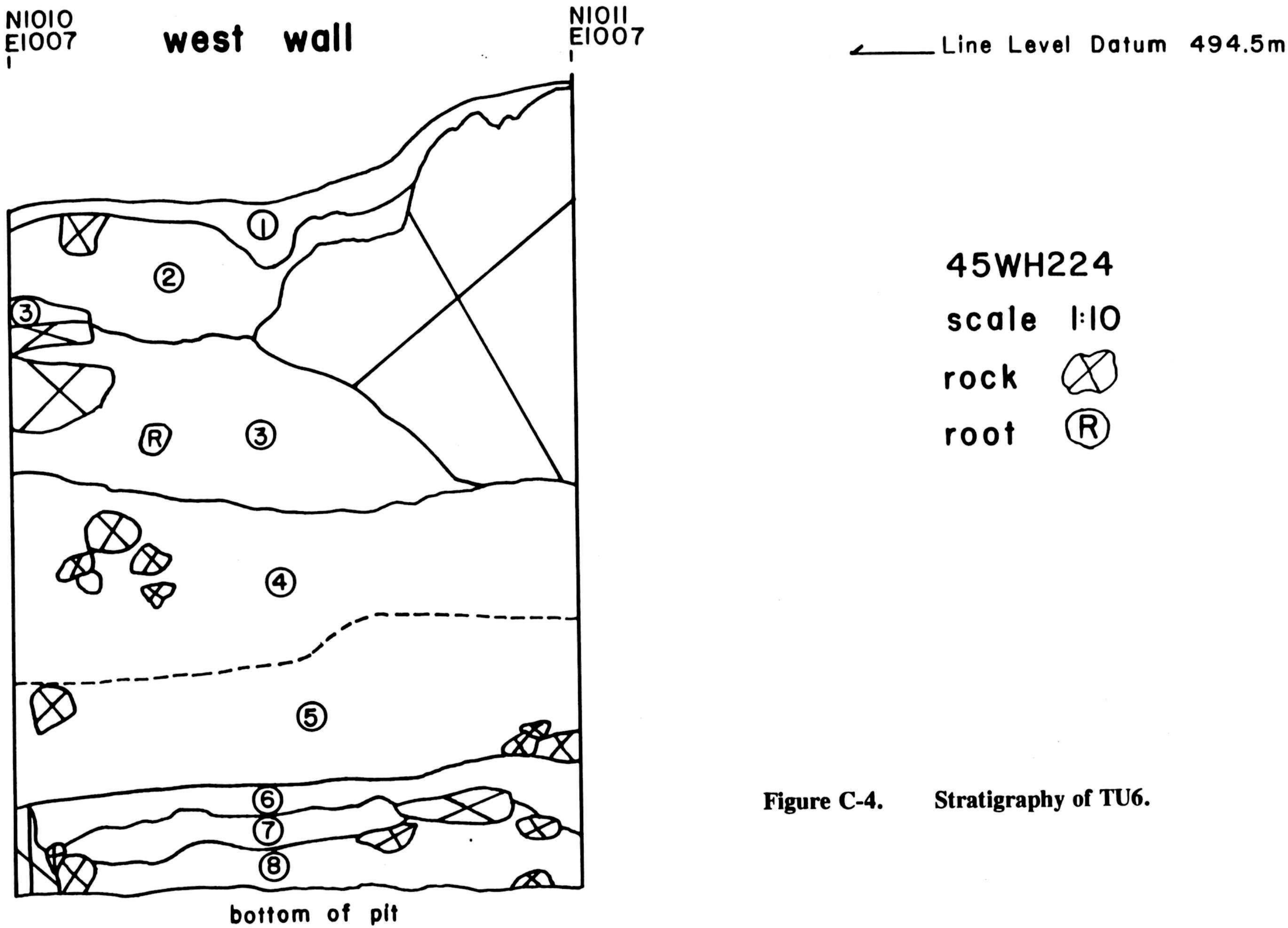


Figure C-4. **Stratigraphy of TU6.**

5	Dark yellowish brown (10YR 4/4m), (10YR 6/5d); poorly sorted gravelly silty sand; nonsticky and nonplastic; no soil or sedimentary structures; abrupt, wavy boundary. Notes: stratum is the soil BC horizon; is very hard and compact; gravels are predominately pebbles and granules welded into the matrix.
6	Dark yellowish brown (10YR 3/4m), (10YR 4/4d); poorly sorted, gravelly coarse sand; nonsticky and nonplastic; no soil or sedimentary structures; abrupt, wavy boundary. Notes: stratum is the soil C horizon; weakly cemented with iron oxide; gravels of large pebbles form a line and may be a lag deposit resulting from the effects of water erosion at some time in the past; the high iron oxide content of the stratum is likely derived from precipitation out of solution in ground water; stratum is very hard and compact.
7	Dark yellowish brown (10YR 3/6m), (10YR 4.5/6d); moderately sorted, very fine sandy silt to silty sand; nonsticky and nonplastic; no soil structure; thin (2 mm), weakly laminated by particle size (difficult to observe in test unit wall); abrupt, discontinuous boundary. Notes: is the soil 2C horizon; a clear water laid deposit; soft consistence.
8	Same properties as stratum 6. Stratum 7 appears to be interbedded within strata 6/8.

TEST UNIT 12

Stratum Number	Field Description
1	Very dark brown (10YR 2/2m); poorly sorted, loamy sand mixed with forest duff; many fine and medium roots; diffuse boundary. Notes: many fine charcoal flecks distributed throughout the matrix.
2	Strong brown (7.5YR 4/6m); poorly sorted, pebbly silty sand; many fine and medium roots; diffuse boundary. Notes: stratum is the soil B-horizon; pebbles of rounded nonchert mixed with angular Hozomeen chert; a charcoal sample from this stratum dated 1830 ± 60 BP (Beta-33512).
3	Brown (7.5YR 4/5m); poorly sorted, gravelly silty sand; gravels are matrix supported, consisting mostly of Hozomeen chert debitage (pebble to cobble sizes); the abrupt boundary is defined by two Hozomeen chert boulders that appear to have fallen from the overhang

	above. Notes: stratum is a mixture of soil B-horizon of colluvial origin on the hillside above and chert fragments from the overhang.
4	Very dark grayish brown (10YR 3/2m); poorly sorted, angular Hozomeen chert matrix supported debitage gravels. Notes: stratum contains numerous charcoal chunks with some flakes coated with finely divided charcoal; some sandy matrix between clasts; stratum is the soil BC horizon; a charcoal sample from this stratum dated 5030 ± 100 BP (Beta-33520).
5	Same as stratum 4 but with almost no sandy matrix; clast supported debitage; numerous charcoal flecks and debitage coated with finely divided charcoal; abrupt smooth boundary. Notes: stratum is the soil C horizon; this stratum accreted as a result of human quarrying of chert bedrock; a charcoal sample from this stratum dated 4750 ± 70 BP (Beta-33521).
6	Hozomeen chert bedrock, coated with finely divided charcoal.

GENERAL NOTES: Stratum 5 appears to correlate with TU3, stratum 5 and TU14, stratum 5.

TEST UNIT 14

Stratum Number	Field Description
1	Very dark grayish brown (10YR 3/2m); poorly sorted, gravelly sandy loam; matrix supported angular chert debitage; many fine and medium roots.
2	Dark yellowish brown (10YR 4/5m); poorly sorted, gravelly sandy loam; matrix supported angular chert debitage; many fine and medium roots. Notes: this stratum exhibits soil B-horizon development.
3	Dark yellowish brown (10YR 4/4m); poorly sorted, gravelly sandy loam; same as stratum 2, but clast supported in some portions due to a decrease in the sandy matrix; many fine and medium roots. Notes: stratum is the soil BC horizon.

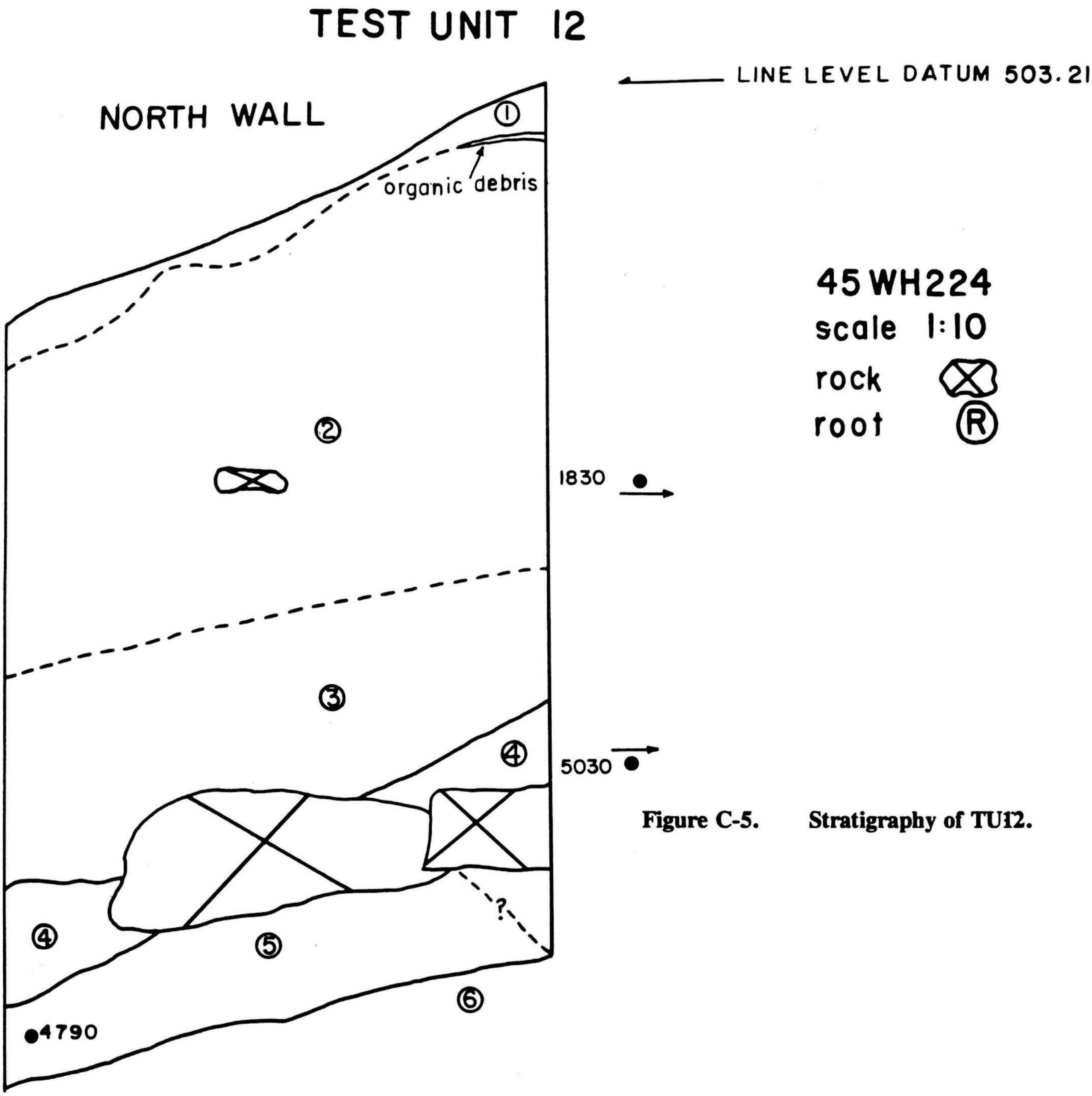


Figure C-5. Stratigraphy of TU12.

Figure C-5. Stratigraphy of TU12.

4	Same as stratum 3, but entirely clast supported with decrease in dark yellowish brown sandy matrix; many fine roots. Notes: stratum is the soil BC horizon.
5	Gray (10YR 5/1d and 6/1d); poorly sorted chert debitage; angular and platy clasts; clast supported. Notes: abundant small charcoal fragments and some debitage coated with soot and finely divided charcoal; chert debitage is brittle and appears to be scorched; two charcoal samples from this stratum date 7640 $\pm$ 150 BP (Beta-33518) and 4590 $\pm$ 80 (Beta-33519).
6	Hozomeen chert bedrock; high flaking quality; numerous tight joints and cracks, no loose pieces.

GENERAL NOTES: this stratum correlates with TU3, stratum 5 and TU12, stratum 5 based on these physical and stratigraphic properties: each stratum is rich in charcoal fragments and finely divided charcoal coatings on debitage, the debitage in each stratum is brittle and appears to have been scorched (subjected to high temperature), and each stratum lays directly on the Hozomeen chert bedrock floor of the rockshelter overhang.

TEST UNIT 19

Stratum Number	Field Description
1	Soil O horizon; forest litter, moss and sod.
2	Brown to Dark Brown, silty sand with some round to sub-round granules. Notes: stratum is the soil A horizon; a charcoal sample from this stratum dates 290 $\pm$ 80 BP (Beta-33522); slopewash colluvium and aeolian deposit.
3	Brown to Yellowish Brown, silty sand with some round to sub-round granules and small pebbles. Notes: stratum is a weakly developed soil B-horizon.
4	Hozomeen chert bedrock.

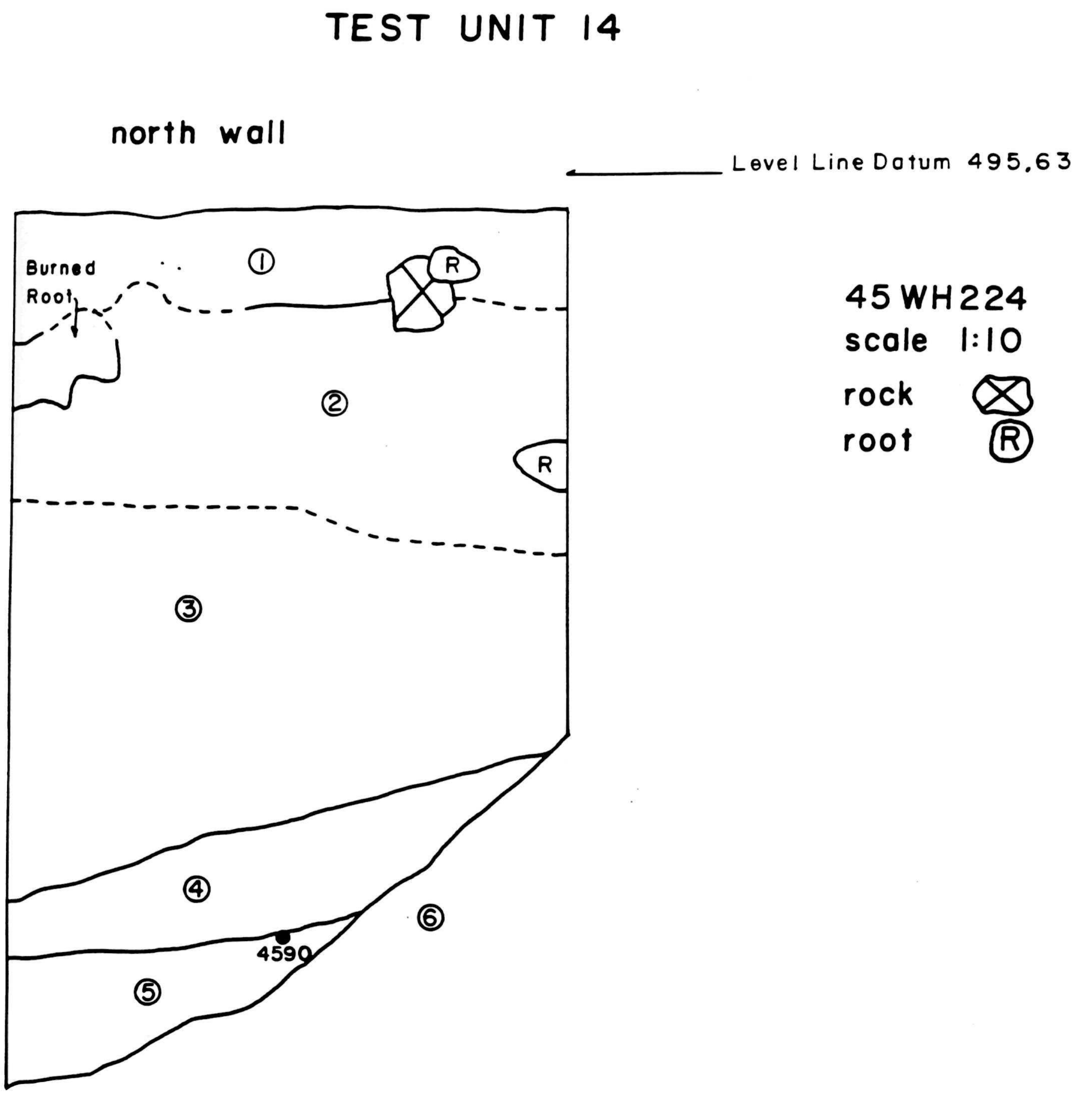


Figure C-6. Stratigraphy of TU14.

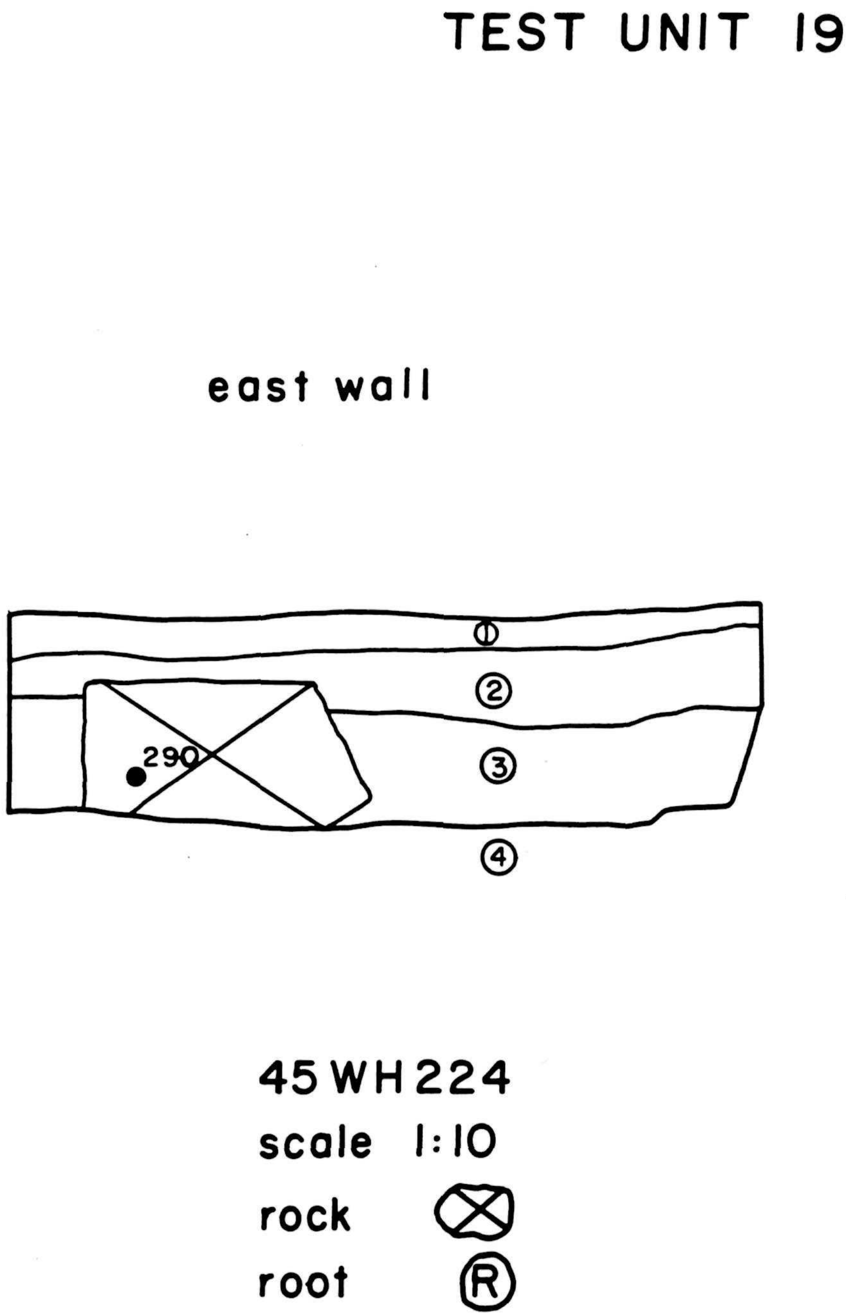


Figure C-7. **Stratigraphy of TU19.**

APPENDIX D

RESULTS OF VOLCANIC ASH ANALYSIS AND DESCRIPTION OF RADIOCARBON-DATED CHARCOAL

APPENDIX D-1

**Electron microprobe results of analysis of Sample No. NOCA-88-2. This sample was removed from Test Unit 6, Appendix D-1 Stratum 2.

RESULTS OF VOLCANIC ASH ANALYSIS

Chemical Composition of Glass Shards

Element	Oxide Value %*
SiO_2	78.38
Al_2O_3	11.95
K_2O	3.94
Na_2O	3.33
Fe_2O_3	1.06
CaO	0.95
TiO_2	0.22
MgO	0.14
MnO	0.03
TOTAL	100.00

* The oxide values are recalculated to 100% volatile-free basis with FeO recalculated to Fe_2O_3.

APPENDIX D-2

DESCRIPTION OF RADIOCARBON-DATED SAMPLES

During excavation of some of the test units, charcoal fragments were found in direct association with the prehistoric artifacts. These were collected and sent to radiocarbon labs for dating.

Radiocarbon dates are not equivalent to calendar years. The radiocarbon ages listed below have been converted into calibrated calendar years through use of software programs (CALIB and DISPLAY) developed by Stuiver and Reimer (1986). The "Uncorrected Date" category below designates the radiocarbon age as reported by the radiocarbon laboratories, which employ a half-life of 5570 years for C-14.

For each uncorrected date, CALIB may provide more than one intercept to the calibration curve; in such cases the oldest date was recorded as the "Corrected Date". Following each corrected date (BP and AD/BC) is the age range spanned by one standard deviation. The age span of one standard deviation was determined using CALIB's Method B, which calculates the probability distribution around the radiocarbon age as a function of time.

The abbreviations used below are as follows. "B.U.D." means: below the test unit datum. "B.U.S." means: below the ground surface measured from the highest elevation corner of the test unit.

Sample Number : WSU-3813

Age Estimate

Uncorrected Date: 4470±200
Corrected BP Date: 5212 (5329-4859)
Corrected Calendar Date: 3263 BC (3380-2910)

Provenience

Site: 45WH224
Test Unit: TU2
Unit Quad: SW
Level: L-8 (153 cm B.U.D.)
Depth: 80 cm B.U.S.

Stratigraphic Context

Matrix: Dark brown (7.5YR 3.5/4m); poorly sorted, gravelly sandy silt (Stratum 3)
Soil Horizon: Bottom of B (weathered subsoil), which has been buried by the distal portion of an earth movement (possibly landslide) deposit; collected from in place, where it consisted of a tight cluster of fragments encased in the B-horizon; none of this sample was collected from the screen
Depositional Environment: Mixed aeolian and earth movement
Landform Type: Terrace/Flat bench

Cultural Context

Artifacts: Hozomeen chert, chipped stone debitage (Section 10.7 of the report includes a description of debitage from this unit and level).

Sample Data

Material Type: Charred wood chunks
Collected Sample Wt: 0.8 gm
Dated Carbon Wt: 0.069 gm
Counting Time: Extended count

Interpretation and Comments

A flake of Hozomeen chert from this level was analyzed by X-ray fluorescence spectrometry, the results of which are described in Appendix B for Sample No. 2.

Sample Number : WSU-3814

Age Estimate

Uncorrected Date: 3600±130 BP
Corrected BP Date: 3910 (4089-3809)
Corrected Calendar Date: 1961 BC (2140-1860)

Provenience

Site: 45WH224
Test Unit: TU3
Unit Quad: SE
Level: L-4 (43-53 cm B.U.D.)
Depth: 6-10 cm B.U.S.

Stratigraphic Context

Matrix: Dark yellowish brown (10YR 4/6m); poorly sorted, gravely silty sand (Stratum 2)
Soil Horizon: Not a soil
Depositional Environment: Human quarrying activity
Landform Type: Interior floor of rockshelter

Cultural Context

Artifacts: Entire matrix consists of Hozomeen chert debitage (Section 10.7 of the report includes a description of debitage from this unit and level); formed tools excavated in direct association with this date are:

NOCA 6456	Andesite hammerstone (Figure 10.22)
NOCA 6457	Andesite hammerstone (Figure 10.22)
NOCA 6479	Andesite hammerstone fragment (flake)
NOCA 6481	Hozomeen chert, unifacially edge-modified shatter
NOCA 7276	Andesite hammerstone fragment
NOCA 7280	Hozomeen chert, Stage II biface

Features: Sample was located within Feature #1, defined by an irregular charcoal concentration

Sample Data

Material: Charred wood chunks
Collected Sample Wt.: 1.1 gm
Dated Carbon Wt.: 0.12 gm
Counting Time: Extended count

Interpretation and Comments

A flake of Hozomeen chert from this same level was analyzed by X-ray fluorescence spectrometry, the results of which are described in Appendix B as Sample No. 3. This sample was split, thin-sectioned, and petrographically analyzed, the results of which are described in Appendix B for Sample No. 3.

Sample Number : Beta-33513

Age Estimate

Uncorrected Date: 3980$\pm$70
Corrected BP Date: 4503 (4562-4402)
Corrected Calendar Date: 2554 BC (2613-2453)

Provenience

Site: 45WH224
Test Unit: TU3
Unit Quad: SE
Level: L-8 (83-93 cm B.U.D.)
Depth: 50-60 cm B.U.S.

Stratigraphic Context

Matrix: Black (10YR 2/1m); poorly sorted, silty sand (Stratum 3)
Soil Horizon: Not a soil
Depositional Environment: Human quarrying activity
Landform Type: Interior floor of rockshelter

Cultural Context

Artifacts: Entire matrix consists of Hozomeen chert debitage (**Section 10.7 of the report includes a description of debitage** from this unit and level); formed tools excavated in direct association with this date are:

NOCA 311 Andesite hammerstone fragment

Features: Sample was located in Feature #1, defined by an irregular charcoal stain

Sample Data

Material Type: Charred wood chunks
Collected Sample Wt: 27.4 gm
Dated Carbon Wt: 2.2 gm
Counting Time: Standard

Sample Number : Beta-33514

Age Estimate

Uncorrected Date: 3980±80
Corrected BP Date: 4503 (4564-4401)
Corrected Calendar Date: 2554 BC (2615-2452)

Provenience

Site: 45WH224
Test Unit: TU3
Unit Quad: SE
Level: L-9 (93-103 cm B.U.D.)
Depth: 63-73 cm B.U.S.

Stratigraphic Context

Matrix: Black (10YR 2/1m); poorly sorted, silty sand (Stratum 3)
Soil Horizon: Not a soil
Depositional Environment: Human quarrying activity
Landform Type: Interior floor of rockshelter

Cultural Context

Artifacts: Entire matrix consists of Hozomeen chert debitage (Section 10.7 of the report includes a description of debitage from this unit and level); formed tool excavated in direct association with this date are:

NOCA 7315 Andesite hammerstone fragment
NOCA 7316 Andesite hammerstone fragment
NOCA 7318 Hozomeen chert, bipolar flake
NOCA 7319 Hozomeen chert, microblade core

Features: Sample was located in Feature #1, defined by an irregular charcoal concentration.

Sample Data

Material Type: Charred wood chunks
Collected Sample Wt: 26.3 gm
Dated Carbon Wt: 2.3 gm
Counting Time: Standard

Sample Number : Beta-33515

Age Estimate

Uncorrected Date: 4000±90
Corrected BP Date: 4513 (4576-4402)
Corrected Calendar Date: 2564 BC (2627-2453)

Provenience

Site: 45WH224
Test Unit: TU3
Unit Quad: SW
Level: L-11 (113-123 cm B.U.D.)
Depth: 103-113 cm B.U.S.

Stratigraphic Context

Matrix: Black (10YR 2/1m); poorly sorted, silty sand (Stratum 4)
Soil Horizon: Not a soil
Depositional Environment: Human quarrying activity
Landform Type: Interior floor of rockshelter

Cultural Context

Artifacts: Entire matrix consists of Hozomeen chert debitage; (Section 10.7 of the report includes a description of debitage from this unit and level); artifacts excavated in association with this date are:

NOCA 7324 Hozomeen chert Stage II biface

Features: Sample is located in Feature #1, defined by an irregular charcoal concentration.

Sample Data

Material Type: Charred wood chunks
Collected Sample Wt: 12.8 gm
Dated Carbon Wt: 1.6 gm
Counting Time: Standard

Sample Number : Beta-33516

Age Estimate

Uncorrected Date: 4090±90
Corrected BP Date: 4604 (4649-4525)
Corrected Calendar Date: 2655 BC (2700-2576)

Provenience

Site: 45WH224
Test Unit: TU3
Unit Quad: SE
Level: L-11 (113-123 cm B.U.D.)
Depth: 83-93 cm B.U.S.

Stratigraphic Context

Matrix: Black (N 2/0); poorly sorted, silty sand (Stratum 5)
Soil Horizon: Not a soil
Depositional Environment: Human quarrying activity
Landform Type: Interior floor of rockshelter

Cultural Context

Artifacts: Same as sample number: Beta-33515
Features: Sample is located in Feature #1, defined by an irregular charcoal concentration.

Sample Data

Material Type: Charred wood chunks
Collected Sample Wt: 13.2 gm
Dated Carbon WT: 1.4 gm
Counting Time: Standard

Sample Number : Beta-27498

Age Estimate

Uncorrected Date: 2800±120
Corrected BP Date: 2925 (3059-2779)
Corrected Calendar Date: 976 BC (1110-830)

Provenience

Site: 45WH224
Test Unit: TU5
Unit Quad: NW
Level: L-10 & 11 (90-102 cm B.U.D.)
Depth: 70-82 cm B.U.S.

Stratigraphic Context

Matrix: Dark brown (10YR 3/4m); poorly sorted, gravelly silty sand (Stratum 4)
Soil Horizon: A buried, weakly developed B
Depositional Environment: Mass wasting (possibly a landslide)
Landform Type: Earth movement

Cultural Context

Artifacts: Hozomeen chert debitage; formed tools recovered from this level:

NOCA 6631 Hozomeen chert Stage II biface
NOCA 7346 Hozomeen chert edge-modified tabular shatter

Sample Data

Material Type: Charred wood chunks
Collected Sample Wt: 6.9 gm
Dated Carbon Wt: 0.3 gm
Counting Time: Extended count

Sample Number : Beta-33512

Age Estimate

Uncorrected Date: 1830±60
Corrected BP Date: 1804 (1839-1703)
Corrected Calendar Date: 146 AD (55-341)

Provenience

Site: 45WH224
Test Unit: TU12
Unit Quad: NE
Level: L-7 (90-95 cm B.U.D.)
Depth: 50-55 cm B.U.S.

Stratigraphic Context

Matrix: Strong Brown (7.5YR 4/6m); poorly sorted, pebbly silty sand (Stratum 2)
Soil Horizon: B (weathered subsoil)
Depositional Environment: Hillslope colluvium
Landform Type: Colluvial slope

Cultural Context

Artifacts: Hozomeen chert debitage; a formed tool excavated from this level is:

NOCA 7337, a Hozomeen chert Stage III biface

Sample Data

Material Type: Charred wood chunks
Collected Sample Wt: 29.6 gm
Dated Carbon Wt: 3.5 gm
Counting Time: Standard

Interpretation and Comments

This Stage III biface is bipointed and lanceolate-shaped, and although not a finished tool, it is morphologically similar to specimens that are frequently categorized as "Olcott" or "Cascade", both of which have been assigned to time periods between 9000 and 6000 years BP. On technological and chronological evidence, such an assignment in this case would be unwarranted.

Sample Number : Beta-33520

Age Estimate

Uncorrected Date: 5030±100
Corrected BP Date: 5851 (5909-5789)
Corrected Calendar Date: 3902 BC (3960-3840)

Provenience

Site: 45WH224
Test Unit: TU12
Unit Quad: SE
Level: L-12 (145 cm B.U.D.)
Depth: 134 cm B.U.S.

Stratigraphic Context

Matrix: Very dark grayish brown (10YR 3/2m); poorly sorted, matrix supported Hozomeen Chert debitage mixed with some sand (Stratum 4)
Soil Horizon: BC
Depositional Environment: Human quarrying activity
Landform Type: Floor under rockshelter overhang

Cultural Context

Artifacts: Hozomeen chert debitage; formed tool excavated from this level are:

NOCA 7349 Andesite hammerstone fragment
NOCA 7351 Andesite hammerstone

Sample Data

Material Type: Charred wood chunks
Collected Sample Wt: 6.3 gm
Dated Carbon Wt: 1.6 gm
Counting Time: Standard

Interpretation and Comments

See Interpretation and Comments for sample number: Beta-33521 on the next page.

Sample Number : Beta-33521

Age Estimate

Uncorrected: 4790±70
Corrected BP Date: 5575 (5598-5459)
Corrected Calendar Date: 3626 BC (3649-3510)

Provenience

Site: 45WH224
Test Unit: TU12
Unit Quad: W 1/2
Level: L-17 (190-200 cm B.U.D.)
Depth: 100-142 cm B.U.S.

Stratigraphic Context

Matrix: Very dark grayish brown (10YR 3/2m); poorly sorted, clast supported Hozomeen chert debitage Stratum 5)
Soil Horizon: C (zone of minimal weathering)
Depositional Environment: Human quarrying activity
Landform Type: Floor under rockshelter overhang

Cultural Context

Artifacts: Hozomeen chert debitage

Sample Data

Material Type: Charred wood chunks
Collected Sample Wt: 15.6 gm
Dated Carbon Wt: 2.9 gm
Test Type: Standard

Interpretation and Comments

The date of this sample is stratigraphically reversed as compared with Beta-33520 from the stratum above. This is likely due to the fact that Beta-33520 was removed from *in situ* deposits, while Beta-33521 was removed from the screen from just above the bedrock floor of the unit. This floor dipped steeply to the west. Because the ground surface along the west side of the test unit (where the sample was collected from) dipped steeply to the southwest, the full range of depths below the uneven ground surface is 42 cm, as indicated. The reversal of dates is most probably caused by natural or cultural mixing of charcoal fragments of different ages sliding down the steeply dipping bedrock floor from higher up near the back of the rockshelter.

Sample Number : Beta-33518

Age Estimate

Uncorrected Date: 7640±150
Corrected BP Date: 8407 (8579-8319)
Corrected Calendar Date: 6458 BC (6630-6370)

Provenience

Site: 45WH224
Test Unit: TU14
Unit Quad: SE
Level: L-11 (120 cm B.U.D.)
Depth: 95 cm B.U.S.

Stratigraphic Context

Matrix: Gray (5/1d-6/1d); poorly sorted, clast supported chert debitage (Stratum 5)
Soil Horizon: Not a soil
Depositional Environment: Human quarrying activity
Landform Type: Floor of rockshelter

Cultural Context

Artifacts: The entire matrix consists of clast supported, Hozomeen chert debitage; formed tools in direct association are:

NOCA 7378 Andesite hammerstone fragment
NOCA 7683 Andesite hammerstone fragment

Sample Data

Material Type: Charred wood chunks
Collected Sample Wt: 2.3 gm
Dated Carbon Wt: 0.41 gm
Counting Time: Extended count

Interpretation and Comments

See Interpretation and Comments for sample number: Beta-33519 on next page.

Sample Number : Beta-33519

Age Estimate

Uncorrected Date: 4590±80
Corrected BP Date: 5305 (5330-5254)
Corrected Calendar Date: 3356 BC (3381-3305)

Provenience

Site: 45WH224
Test Unit: TU14
Unit Quad: NW
Level: L-14 (142 cm B.U.D.)
Depth: 131 cm B.U.S.

Stratigraphic Context

Matrix: Gray (10YR 5/1 and 10YR 6/1); poorly sorted, clast supported chert debitage (Stratum 5)
Soil Horizon: Not a soil
Depositional Environment: Human quarrying activity
Landform Type: Floor of rockshelter

Cultural Context

Artifacts: Entire matrix consists of clast supported, Hozomeen chert debitage; tools excavated from this level in association with this date:

NOCA 7381	Hozomeen chert, Stage II biface
NOCA 7382	Hozomeen chert, unifacially edge-modified flake
NOCA 7506	Hozomeen chert, Stage III biface
NOCA 7511	Andesite hammerstone fragment

Sample Data

Material Type: Charred wood chunks
Collected Sample Wt: 17.5 gm
Dated Carbon Wt: 2.1 gm
Counting Time: Standard

Interpretation and Comments

This charcoal sample was removed from *in situ*, 22 cm below sample number: Beta-33518, also removed from *in situ*, but which is older. Both samples were within Stratum 5 matrix, and were recorded from just above the steeply dipping bedrock floor of the test unit. The reversal of the dates is most likely caused by natural or cultural mixing of charcoal fragments of different age sliding down from nearer the back of the shelter.

Sample Number : Beta-33522

Age Estimate

Uncorrected Date: 290±80
Corrected BP Date: 311 (472-286)
Corrected Calendar Date: 1639 AD (1478-1664)

Provenience

Site: 45WH224
Test Unit: TU19
Unit Quad: NE
Level: L-2 (20-30 cm B.U.D.)
Depth: 5-15 cm B.U.S.

Stratigraphic Context

Matrix: Brown to dark brown; silty sand with rounded to subrounded gravels (Stratum 2)
Soil Horizon: B (weathered subsoil)
Depositional Environment: Aeolian
Landform Type: Bedrock bench

Cultural Context

Artifacts: Hozomeen chert debitage; (Section 10.7 of the report includes a debitage from this unit and level); tools excavated in association with this date:

NOCA 7390 Hozomeen chert, Stage I biface

Sample Data

Material Type: Charred wood chunks
Collected Sample Wt: 6.4 gm
Dated Carbon Wt: 1.2 gm
Counting Time: Standard

APPENDIX E

ARTIFACT CATEGORY DESCRIPTIONS

The sample of artifacts described in this appendix were collected from 45WH224 between 1987 and 1989, during evaluation and testing of the site. Some were collected from the site surface, including the severely eroded portions of the drawdown zone below 1602.5 ft, and others from the unaltered ground surface above the high pool level of the reservoir. The surface collections have contributed the majority of hammerstones recovered from the site. From the subsurface excavations have come most of the bifaces, nearly all the quarry debitage (flakes and shatter), including a few biface-thinning flakes, along with some hammerstones. For descriptive purposes, these collections were combined to form the total artifact assemblage described below.

The artifact classification used in the appendix conforms in most respects to standard artifact categories having widespread use by prehistoric archeologists working with similar collections. A few of these categories, however, have been defined in nonstandard ways in order to address particular aspects of chert reduction technology embodied by the quarry materials. For the most part, guidance regarding definitions and terms describing lithic technological categories was provided by Callahan (1979), Crabtree (1982), Ahler (1986), and others cited within the text. For each category listed below, both a conceptual and an operational (empirical) definition are given.

I. FLAKED STONE ARTIFACTS OF HOZOMEEN CHERT

1. TESTED NODULES

General Description:

Naturally-occurring pieces of Hozomeen Chert that have been flaked in order to check for quality and homogeneity of the stone. Nodules are irregular in shape, generally varying from roughly spherical to tabular in a few instances. Alteration through flaking is minimal; not attempt was made to shape or clean nodules.

Morphological Characteristics:

a. Have all of the characteristics of shatter,
b. In addition, have one or two complete flake scars with striking platform, indicating nonsystematic, irregular flaking.

Number: 13

Size range: 6.36 to 18.0 cm

Catalog Numbers: 6352, 6449, 6460, 6630, 6917, 7288, 7307, 7357, 7385, 7396, 7454, 7523, 7529

Notes: Tested nodules are scattered about the entire site. They are particularly common in the colluvial gully and steep hillside below the rockshelter.

2. <u>BEDROCK CORNERS</u>

General Description:

A type of shatter, wherein the overall shape results from removal of a portion of an outside corner of bedrock or any other irregular-shaped protruding mass of bedrock. This morphological category reflects the irregular Hozomeen chert bedrock surfaces at 45WH224, which are separated by numerous joints and fractures, resulting in near-right angle outside corners. Abundant flake scars and battered corners on bedrock faces suggests that corners were preferred locations for removing nodules of chert from the bedrock mass.

Morphological Characteristics:

a. Roughly triangular in cross-section (3-faced),
b. One margin shows battering, which consists of multiple, overlapping, crushed platforms, proximal Hertzian cone remnants, and flake scar remnants on one or two faces,
c. Commonly one face consists of weathered, outcrop cortex or a the fracture plane along a macrocrystalline quartz vein,
d. At least one face, or a portion thereof, exhibits a perverse or irregular fracture, lacking flake attributes,
e. Some specimens resemble crude and irregular-shaped bifaces.

Number: 11

Size Range: 4.3 to 9.28 cm

Catalog Numbers: 6464, 6469, 6682, 6688, 6699, 7310, 7313, 7392, 7557, 7652, 7653

Notes: With one exception, this category of artifacts has been found only in debitage deposited under the rockshelter ceiling. The exception is a piece recovered from TP-6 (level 10, from the strongly developed soil B-horizon), which is located on a nearly-flat bench about 60 m or so from the rockshelter.

3. SHATTER

General Description:

Irregularly shaped Hozomeen chert fragments resultant from cleaning and shaping of stone nodules. Much shatter was created while removing nodules from bedrock outcrops by bashing with hammerstones (and possibly heating to enhance natural fractures along macrocrystalline quartz veins); tabular and blocky shapes common; also a product of biface and core reduction.

Morphological Characteristics:

a. Presence of flake attributes on at least one surface,
b. Absence of complete flake scars and striking platforms,
c. Overall shape irregular, tabular, or blocky with preponderance of right angle intersections between adjacent faces and absence of feather terminations,
d. Tendency of fractures to occur along macrocrystalline quartz veins,
e. Iron stained, weathered bedrock cortex common on many surfaces,

Number: Uncounted thousands; the most common artifact type in rockshelter deposits and on the talus slope below the rockshelter.

Size range: <0.6 cm to 12.0 cm

Notes: The high frequency of shatter compared to other artifact categories and the large total volume of shatter is largely due to physical properties of the chert, which is heterogenous due to numerous planes of weakness and other structural irregularities of the crystalline groundmass.

4. FLAKES

General Description:

Includes both complete and broken, thin pieces of Hozomeen chert having multiple flake attributes.

Morphological Characteristics:

a. Presence of a recognizable portion of the flake ventral surface, especially the bulb of force,
b. Presence of a recognizable portion of the dorsal surface,
c. Complete flakes exhibit a platform, bulb of force, dorsal surface, compression rings, and occasional radial striations,

Number: Uncounted thousands; after shatter, the most common artifact type at the site. In some portions of the site well-removed from the rockshelter, is the most common artifact category.

Size range: <0.5 cm to 10.0 cm

Notes: This category includes bifacial thinning flakes and those removed from prepared and unprepared cores. Nearly all flakes appear to have been detached by direct, freehand percussion. One flake (item 7531) is smudged with a thin coating of fine red ocher. The pigment extends for 3.5 cm along one margin of the dorsal surface, where it adheres to the inside corners of small step fractures and irregularities of the flake surface.

5. BIFACES--Technological Stage I

General Description:

This stage represents the first step in the sequence of biface reduction and toolmaking recognized at quarries. This step involves selecting a piece of raw material that is considered suitable (according to several cultural and technological criteria) for knapping into any of a variety of biface types. This beginning piece may consist of a flake, a spherical or irregularly-shaped nodule, or a tabular-shaped piece of bedrock.

Morphological Characteristics:

By definition, Stage I bifaces consist of unshaped or unworked stock, which may or may not have morphological attributes resultant from knapping. Accordingly, any sizeable piece of Hozomeen chert is potentially a stage I biface. The category is set apart here only to document that some stage II bifaces were made from flakes rather than nodules or tabular pieces of Hozomeen chert.

The attribute used here to recognize the Stage I form is the remnant of a ventral flake scar on each of the four stage II bifaces. Such a surface indicates that a flake was detached from a larger nodule before biface manufacture began. The term "blank" is not used here to describe a stage I form, although others do (Crabtree 1982; Ahler 1986). Because the original flake sizes were reduced during knapping into Stage II morphology, their pre-shaped size (which is a condition of the past) is not measurable. All we know is that they were larger than their Stage II forms. These four bifaces are also itemized below as biface technological stage II, where they properly belong according to morphological criteria.

Number of complete specimens: 4

Size Range: >4.4 cm to >5.7 cm

Catalog Numbers: 7295, 7375, 7390,

Number of incomplete specimens: 1

Size Range: >3.5 cm

Catalog Numbers: 7441

6. <u>BIFACES--Technological Stage II</u>

General Description:

As the object is shaped, the first crude biface form is attained; this stage is called in technological terms a "blank". The stoneworking techniques at this step in tool making begin the process that creates an acute edge all the way around the object, which serves to separate two distinct faces or sides. This process is completed in later stages. The total length of this edge is called the "margin", which in plan view begins to take a more regular form than the more irregular shapes characteristic of stage I. The overall high frequency of natural weaknesses in Hozomeen chert require much checking and cleaning in order to establish the beginnings of a margin.

Morphological Characteristics:

a. Short, broad flake scars,
b. Margins are very sinuous with some segments ground or otherwise blunted for platform preparation,
c. Some edges not yet narrowed to an acute angle and some margin segments show the removal of an adjacent series of flakes along only part of the total margin length,
d. Biface lacks bilateral and bifacial symmetry,
e. Cross-sections are thick and irregular,
f. For various lengths along margin segments, there are numerous stacked step fractures, consisting of composite step or hinge terminations at the distal flake scars,
g. Bulbous, irregular-shaped masses on both faces are common,
h. Along the sinuous margins are many prominent and thick platforms.

Number of complete bifaces: 15

Size Range: 4.2 to 10.2 cm

Catalog Numbers: 6351, 6450, 6511, 6598, 6631, 6686, 6925, 7280, 7295, 7324, 7375, 7390, 7433, 7457, 7513

Number of incomplete bifaces: 13

Size Range: 1.6 cm to 7.5 cm

Catalog Numbers: 6425, 6453, 6686, 7304, 7388, 7398, 7432, 7439, 7441, 7506, 7507, 7537, 7649

Notes: Two small biface fragments not itemized above, 7324 and 7393, are undetermined as to technological stage. Both are about 1 cm long and appear to be the distal end of what may have been small arrow points, but this is uncertain.

7. BIFACES--Technological Stage III

General Description:

Bifaces of this stage of manufacture have gone through the primary thinning process. They are more or less symmetrical in outline, defined by a continuous, acute-edged margin. Plan view outlines are oblong with rounded, pointed, straight, or indented (concave) ends.

Morphological Characteristics:

a. Flake scars travel at least to the midline of the biface,
b. Margins are nearly straight with low sinuosity,
c. Most of the total margin length is narrowed to an acute angle,
d. Cross-sections are mostly regular, lenticular, and moderately thinned,
e. Plan view outlines are nearly symmetrical,
f. Platforms and blunt margin segments are smaller and less frequent than in Stage II,
g. Composite hinge and step terminations are common, especially adjacent to irregular or protruding masses that would not detach as a flake,
h. Irregular or protruding masses of stone have been removed for the most part, but one or both faces may retain these.

Number of complete specimens: 3

Size Range: 5.0 to 6.7 cm

Catalog Numbers: 6348, 6350, 7337

Number of incomplete specimens: 12

Size Range: 0.6 to 9.6 cm

Catalog Numbers: 6344, 6345, 6346, 6347, 6349, 6424, 7354, 7358, 7369, 7381, 7383, 7543

8. BIFACE-THINNING FLAKES

General Description:

With a few exceptions, these are all noncortex, bifacial thinning flakes. All the bifacial thinning flakes inventoried here were recovered from TP-2, 6, 7, and 19. This class of artifacts occurs in lower frequencies from other test pits, but no attempt was made to sort these out from the flaking debris.

Morphological Characteristics:

a. Acute platform angle,
b. Dorsal surface covered with flake scars, some showing removal from the opposite margin of the biface,
c. Along longitudinal axis, dorsal surface is convex thus preserving a portion of one curved face of the original biface.

Number: 45

Size range: 1.12 to 5.4 cm

Catalog Numbers: 6404, 6405, 6407, 6409, 6411, 6412, 6413, 6421, 6423, 6437, 6590, 6592, 6594, 6595, 6599, 6601, 6679, 6692, 6699, 6700, 7574, 7581 (all of the above items are cataloged in lot bags, except for item 6421, which is cataloged separately)

Notes: The only items listed above not of Hozomeen chert is a broken flake from lot 6495 that was struck from a piece of green, opaque chert that is too small for positive raw material identification; the other exception is 6692, which is a biface-thinning flake of light gray, waxy, translucent Hozomeen chalcedony, excavated from TP-6, level 10. The source locations of this chalcedony, believed to be within the Hozomeen Group of rocks, is unknown.

9. IRREGULAR CORES

General Description:

Nodules of Hozomeen chert from which multiple flakes have been removed nonsystematically. Some of these objects, from a technological standpoint, may be excessively tested and cleaned nodules, or initial but failed attempts at biface reduction.

Morphological Characteristics:

a. Irregular, multidirectional, and unshaped angular pieces,
b. Multiple flake scars indicating flakes struck in an adjacent series from the same striking platform,
c. Striking platforms form an acute or 90 degree angle to the face from which flakes are removed by percussion,
d. Striking platforms lack evidence of platform preparation prior to flake removal.

Number: 4

Size Range: 4.98 to 9.6 cm

Catalog Numbers: 6420, 6687, 7335, 7502

10. <u>BIPOLAR CORE</u>

General Description:

A shatter-like piece of Hozomeen chert, generally oblong, that is fractured by applying a large force with a hammerstone while the object piece rests on an anvil stone.

Morphological Characteristics:

a. Meets the criteria of shatter,
b. There are two platforms, each at opposite ends of the core, and one or both are partially crushed,
c. The bulbs of percussion on the ventral surface is often partially or wholly sheared,
d. One or more negative flake scars on the core are spirally oriented around the long axis,
e. The orientation of compression rings on negative flake scars indicates that flakes were removed from both platforms.

Number: 4

Size: 3.0 to 4.8 cm

Catalog Number: 6407, 7362, 7397, 7399

Notes: Given the brittleness of Hozomeen chert and the abundance of quartz veins, this material has a tendency to shatter into many fragments during knapping. Partially for this reason, it is likely that the bipolar technique, when applied to Hozomeen chert, only infrequently leaves attributes sufficiently distinctive to identify with any certainty. As evidence of bipolar core technology, the number of cores inventoried here likely under-represents the extent of this technology's importance.

11. <u>BIPOLAR FLAKES</u>

General Description:

Hozomeen chert flakes removed from bipolar cores.

Morphological Characteristics:

a. Exhibit sheared bulbs of percussion and platforms,
b. Platforms often crushed,
c. Ventral flake surfaces often have spiral shape along longitudinal axis,

Number: 3

Size Range: 4.4 to 2.8 cm

Catalog Numbers: 6389, 6412, 7318

12. MICROBLADE CORES

General description:

Morphologically these are small, blocky pieces of Hozomeen Chert exhibiting multiple, adjacent microblade scars.

Morphological Characteristics:

a. Overall shape varies from cylindrical to blocky,
b. Angle between platform and face of blade removal varies from acute to obtuse,
c. Blade platforms show some evidence of preparation by removal of overhanging lip, which is removed by a series of small pressure flakes,
d. At least three adjacent microblade scars present.

Number: 3

Size Range: 3.1 to 5.2 cm

Catalog Numbers: 6661, 7319, 7657

Notes: As with the other categories, the operational definition is specified in terms of morphological attributes. However, this category does not necessarily conform to technologically true microblade cores. When compared to the collection of microblade cores from other sites in North Cascades National Park and adjacent areas, these three do not appear to reflect an intentional microblade production technology.

13. MICROBLADES

General Description:

Thin, parallel-side blades of Hozomeen chert that meet the morphological criteria of microblades.

Morphological Characteristics:

a. Thin, parallel-side flakes that have a length-to-width ratio of >2,
b. In cross section, are either triangular (4) or trapezoidal (3),
c. Dorsal surface has one or two ridges that parallel the blade margins,
d. Platform remnant at proximal end is prepared through fine pressure flaking or crushing.

Number: 9

Size Range: 1.10 to 2.99 cm

Sizes of Complete Specimens:

Cat. No.	L	W	T
7365	2.76	1.04	0.21
7366	3.25	0.92	0.40
7389	1.84	0.78	0.18

Catalog Numbers: 6691, 7365, 7366, 7368, 7389, 7522, 7654, 7655, 7656

Notes: Of the nine microblades noted above, only 3 are trapezoidal in cross-section. Also, although all nine meet the morphological criteria of microblades, it is unlikely that true microblade technology was practiced to any degree at the site. Given the millions of flakes created at the site, this small number of blades is a quantitative measure of the absence of microblade technology, if the artifact sample from the site is statistically representative.

14. UNIFACIALLY EDGE-MODIFIED FLAKES

General Description:

Hozomeen chert flakes showing intentional edge modification through use as a tool and/or through intentional sharpening of a margin by pressure or percussion flaking.

Morphological Characteristics:

a. Made on thin flakes or flake fragments,
b. All flakes lack weathered bedrock cortex on any surface,
c. Modified flake margins are convex to straight (only one is slightly concave),
d. the edge flaking pattern exhibits short pressure flake scars 1 to 3 mm long with some step fractures and occasional remnant platforms,
e. Edge angles are acute to 90 degrees.

Number: 10

Size Range: 2.1 to 5.90 cm

Catalog Numbers: 6481, 6596, 6683, 6690, 6695, 6926, 7382, 7394, 7462, 7651

Notes: NOCA 7382 is also a bipolar flake (not itemized in Category 9).

15. EDGE-MODIFIED TABULAR SHATTER

General Description:

Hozomeen chert tabular pieces exhibiting systematic edge modification through use as a tool and/or through sharpening and straightening of a margin by pressure or percussion flaking.

Morphological Characteristics:

a. Made on thick, tabular pieces of shatter,
b. Remnants of bedrock outcrop visible on some surfaces,
c. Modified margins are straight,
d. Edge flake pattern exhibits predominately percussion flake scars 5-10 mm long (exception: one piece exhibits pressure flake scars 1-2 mm long) with step fractures common,
e. Edge angles are acute.

Number: 4

Size range: 6.8 to 7.42 cm

Catalog Numbers: 6401, 6426, 7297, 7346

16. HEAT-MODIFIED FLAKE

General Description:

Hozomeen chert flake fragments that have been uniformly altered by extended exposure to high temperature.

Morphological Characteristics:

a. One fragment exhibits cortex having a dull, earthy luster,
b. Some portions of these flakes exhibit pot lids and crazing,
c. Flake scars and some surfaces (other than heat-treated cortex) exhibit high luster and a greasy feel (uncommon properties in Hozomeen chert).

Number: 2

Size: 4.5 to 1.8 cm

Catalog Number: 6681, 6699

Notes: These are the very few instances wherein flakes of Hozomeen chert exhibit criteria considered to be indicators of heat treatment (Crabtree and Butler 1964). The dull and highly oxidized exterior surface appears on one item appears to be outcrop cortex and covers about one-half of the dorsal surface. The other half of this face and the entire ventral flake surface are glossy and smooth, suggesting that the heat-treated piece was, at least partially, a fragment of unflaked bedrock.

17. POLISHED STONE

General Description:

Hozomeen chert flakes and shatter with polished surfaces.

Morphological Characteristics:

a. Faces, dorsal ridges, and margins have a smooth, greasy feel and are distinctly rounded from polishing,

b. All surfaces exhibit high luster.

Number: 4

Size Range: 2-3 cm

Catalog Number: 6396, 7283, 7356, 7434

Note: Item 6396 was recovered from level 1 of TP-2; the other three items were recovered from the surface and buried within the rockshelter deposits. Under magnification of 45X, the exterior surfaces of these objects are highly but unevenly polished to a high gloss and smoothness, even in micro-depressions and convex surfaces, although polish is greatest on edges and projections. The agent causing the polish is unknown.

II. NON-HOZOMEEN CHERT FLAKED ARTIFACT CATEGORIES

18. PRESSURE FLAKES

General Description:

Obsidian biface-thinning or sharpening flakes.

Morphological characteristics:

a. Flakes are non-cortex, of a dark gray, opaque to translucent, weakly banded obsidian, containing few macrocrystalline phenocrysts,
b. Dorsal surfaces are completely covered by flake scars,
c. Where preserved, platform angles are acute, and in one case is multi-faceted and consists of a biface margin remnant,
d. Along their longitudinal axis, dorsal surfaces are convex, thus preserving a portion of the biface lenticular cross-section.

Number: 5

Size Range: 0.94 to 1.22 cm

Catalog Numbers and Provenience:

7591 TU 20, Level 2, SE Quad
7608 TU 21, Level 2, SE Quad
7565 TU 18, Level 2, NE Quad
7387 TU 18, Level 2, NE Quad
7386 TU 18, Level 3, NE Quad

Notes: This type of glass lacks the abundant, large phenocrysts that characterize the locally available obsidian in North Cascades National Park and therefore is likely to be derived from a distant source.

19. OTHER FLAKES

General Description:

Noncortex flakes of metasedimentary rock. Most of these flakes are irregularly-shaped flakes made during reduction of cobbles rounded by rivers or glaciers; they vary from thick amorphous flakes to small, thin pressure flakes.

Morphological Characteristics:

a. Are noncortex (exception: one has a remnant of river-smoothed cortex),
b. Made of gray to brown, fine-grained to moderately fine-grained metasedimentary rock,
c. Includes pressure and percussion flakes and bifacial thinning flakes.

Number: 26

Size range: 1.4 to 12.0 cm

Catalog Numbers: 6402, 6592, 6595, 6599, 6600, 6601, 6608, 6614, 6703, 7113, 7603, 7604, 7609, 7610 (all the items above are cataloged separately, except for 6595, 6599, 6600, 6601, and 6592, which are cataloged by lot, in which case many items have the same catalog number). Item 6703 is a unifacially-modified tool fragment.

Notes: Item 7610 is a pressure flake of an opaque brown chert or jasper. All the other items are of dark gray metasediments, which occur in abundance in stream and glacial gravels throughout the upper Skagit River Valley. Item 7113 is a large unifacially-modified flake or it may be a tool or an early-stage biface; the flaking pattern is not technologically or functionally specific.

20. <u>QUARTZ CRYSTAL SHATTER</u>

General Description:

Flaked fragment of quartz crystal.

Morphological Characteristics:

a. Angular blocky shape, with sharp and in places, jagged margins,
b. All surfaces covered by remnants of flake scars and flake scar attributes,
c. Clear, transparent, brilliant luster.

Number: 1

Size: 1.4 cm

Catalog Number: 6873

Notes: Quartz crystal of any kind does not occur naturally at the site and this is the only quartz crystal recovered. Flaked quartz crystal occurs in very low frequencies in archeological sites throughout sites in North Cascades National Park. None of the original crystal facets remain on the piece.

21. BIPOLAR CORE

General Description: same as artifact category 9.

Morphological Characteristics: same as category 9.

Number: 2

Size Range: 4.6 to 5.3 cm

Catalog Number: 6595

Notes: Both cores are of metasediment, and came from level 5 of TP-7.

III. PECKED, GROUND, AND ABRADED STONE ARTIFACTS

22. LARGE HAMMERSTONES

General Description:

Medium to coarse-grained nonchert rocks that were used to hammer, fragment, and shape Hozomeen chert through direct, freehand percussion.

Morphological Characteristics:

a. Spherical to subspherical cobbles of andesite (5), granite (6), and greenstone (1),
b. Most have well-developed wear patterns consisting of roughened areas (battering due to percussion) surrounding smooth, clearly delimited patches indicative of finger placements for grasping during use,
c. Some are roughened more or less uniformly across the entire cobble surface,
d. Some exhibit smooth weathered cortex across most of the surface, but with restricted patches of battering on some portion that tend to form facets or flattened areas, creating polyhedral shapes,
d. Some are pecked around the entire circumference, in a wide, flattened "equatorial" band.

Number: 12

Size Range: 8.01 to 11.95 cm (includes fragments)

Catalog Numbers: 6456, 6457, 7279, 7285, 7287, 7316, 7347, 7351, 7352, 7364, 7370, 7373

Notes: All hammerstones are of tight-grained rocks (having a densely packed crystalline matrix) and some have a noticeably high density. Cobbles of these rock types are naturally abundant in the glacial deposits throughout the valley (such as andesite) and others outcrop within the valley (such as greenstone from the Hozomeen Group of rocks).

23. MEDIUM HAMMERSTONES

General Description:

Same as Category 20.

Morphological Characteristics:

a. Spherical to subspherical cobbles of andesite (6), granite (4), greenstone (2), and unspecified metamorphic (1),
b. Wear patterns not as well delimited on the cobble surface, and battered areas cover a smaller percentage of the cobble surface as compared with the larger hammerstones of Category 20.

Number: 12

Size Range: 6.87 to 8.45 cm (includes fragments)

Catalog Number: 6427, 6674, 7281, 7311, 7348, 7353, 7360, 7361, 7363, 7373, 7376, 7377.

24. SMALL HAMMERSTONES

General Description:

Same as Categories 20 and 21.

Morphological Characteristics:

a. Predominately spherical with some discoidal and subspherical shaped pebbles of unspecified metamorphic (4), andesite (4), granite (1),
b. Wear patterns cover a small percentage of the pebble surface, with battered areas prominent and well-delimited, either as pitting or forming a facet.

Number: 12

Size Range: 4.94 to 7.18 cm (includes fragments)

Catalog Number: 6696, 7349, 7350, 7355, 7372, 7374, 7379, 7384, 7391, 7437, 7451, 7683.

Notes: The grouping here of hammerstones into large, medium, and small size classes serves purely descriptive needs. Given the large sample of hammerstones present at the site, and the variability in observed wear patterns on hammerstone surfaces, it is possible that morphological (wear pattern) differences may reflect functional differences in hammerstone use, which are in turn may be informative of stone reduction technologies.

25. HAMMERSTONE FRAGMENTS

General Description:

Small fragments of hammerstones too small to classify by size.

Morphological Characteristics:

a. Some fragments show zones of use wear (battering).

Number: 4

Size Range: 5.5 to 3.4 cm

Catalog Number: 6479, 7276, 7315, 7511

26. ANVIL STONE

General Description:

Cobble used as an anvil in bipolar reduction.

Morphological Characteristics:

a. Irregular, somewhat disk-shaped cobble of unspecified metamorphic rock, with two flat sides.
b. In the center of one side, exhibits deep pecking and contiguous parallel striations.

Number: 1

Size: 12 cm

Catalog Number: 6607

Notes: Although this is the only example of an anvil stone that has been collected from the site, a number of others have been observed on the site surface, indicating that this class is more abundant than the data presented here suggests.

27. ABRADER

General Description:

Cobble used to abrade or file a softer material.

Morphological Characteristics:

a. Irregular-shaped cobble of fine-grained sandstone or quartzite,
b. Has been roughly percussion flaked along the margins into a discoidal-shaped stone, with a concave convex cross-section,
c. A naturally-occurring groove (1-3 cm wide and 11 cm long) along the center of one face is smoothed from abrasion against a softer material.

Number: 1

Size Range: 11.7 cm

Catalog Number: 7380

Notes: Given its small size and mass, the abrader was most likely to have been hand-held.

APPENDIX F

FORMED ARTIFACT LOCATIONS BY TEST UNIT AND LEVEL

TEST UNIT 2:

LEVEL	NOCA NUMBER	OBJECT NAME	DEPTH (cm ↓ datum)
3	6399	Biface, Stage III	81 - 106
6	7654	Microblade	108 - 135
7	6424 6425 6427	Biface, Stage III Biface, Stage II Medium Hammerstone	122 - 142

TEST UNIT 3:

LEVEL	NOCA NUMBER	OBJECT NAME	DEPTH (cm ↓ datum)
3	6450 6453	Biface, Stage II Biface, Stage II	33 - 43
4	6481 6456 7280 6479 7276 6457	Unifacially Edge-modified Flake Large Hammerstone Biface, Stage II Hammerstone Fragment Hammerstone Fragment Large Hammerstone	43 - 53
5	7282 7281 7279	Large Hammerstone Medium Hammerstone Large Hammerstone	53 - 63
6	7295	Biface, Stage II	63 - 73
7	7304	Biface, Stage II	73 - 83
8	7311	Medium Hammerstone	83 - 93
9	7315 7316 7319	Hammerstone Fragment Large Hammerstone Microblade Core	93 - 103
11	7324	Biface, Stage II	113 - 123
12	7285	Large Hammerstone	123 - 133

TEST UNIT 4:

LEVEL	NOCA NUMBER	OBJECT NAME	DEPTH (cm ↓ datum)
5	6607	Anvil Stone	50 - 60
11	6631	Biface, Stage II	110 - 120

TEST UNIT 6:

LEVEL	NOCA NUMBER	OBJECT NAME	DEPTH (cm ↓ datum)
7	6674	Medium Hammerstone (57)*	60 - 70
10	6686	Biface, Stage II	90 - 100
12	6696	Small Hammerstone (120)*	110 - 120

* Location of object in centimeters below datum.

TEST UNIT 7:

LEVEL	NOCA NUMBER	OBJECT NAME	DEPTH (cm ↓ datum)
4	6598 6596	Biface, Stage II Unifacially Edge-modified Flake	20 - 30
5	7657	Microblade Core	30 - 40

TEST UNIT 9:

LEVEL	NOCA NUMBER	OBJECT NAME	DEPTH (cm ↓ datum)
Wall	6661	Microblade Core	Wall

TEST UNIT 10:

LEVEL	NOCA NUMBER	OBJECT NAME	DEPTH (cm ↓ datum)
8	6926 6925	Unifacially Edge-modified Flake Biface, Stage II	80 - 90

TEST UNIT 12:

LEVEL	NOCA NUMBER	OBJECT NAME	DEPTH (cm ↓ datum)
7	7337	Biface, Stage III (98)*	90 - 100
10	7347	Large Hammerstone	120 - 130
11	7350	Small Hammerstone	130 - 140
12	7349 7351	Small Hammerstone Large Hammerstone	140 - 150
13	7348	Medium Hammerstone (158)*	150 - 160

* Location of object in centimeters below datum.

TEST UNIT 13:

LEVEL	NOCA NUMBER	OBJECT NAME	DEPTH (cm ↓ datum)
1	7432 7433	Biface, Stage II Biface, Stage II	8 - 20
2	7437	Small Hammerstone	20 - 30
3	7360	Medium Hammerstone	30 - 50
4	7352 7353 7354	Large Hammerstone (66)* Medium Hammerstone (66)* Biface, Stage III	50 - 70
5	7358	Biface, Stage III	70 - 90
6	7355	Small Hammerstone	90 - 110

* Location of object in centimeters below datum.

TEST UNIT 14:

LEVEL	NOCA NUMBER	OBJECT NAME	DEPTH (cm ↓ datum)
1	7441 7439 7657	Biface, Stage II Biface, Stage II Microblade Core	10 - 20
2	7451	Small Hammerstone	20 - 30
3	7364 7457	Large Hammerstone Biface, Stage II	30 - 40
7	7365 7369 7366 7372	Microblade Biface, Stage III Microblade Small Hammerstone	70 - 80
8	7373 7377 7378 7379	Medium Hammerstone Medium Hammerstone Large Hammerstone Small Hammerstone	80 - 90
10	7368 7683	Microblade Small Hammerstone	100 - 110
12	7375 7374 7522	Biface, Stage II Small Hammerstone Microblade	120 - 130
13	7376 7380 7502	Medium Hammerstone Abrader Irregular Core	130 - 140
14	7511 7506 7381	Hammerstone Fragment Biface, Stage II Biface, Stage III	140 - 150
15	7513 7383	Biface, Stage II Biface, Stage III	150 - 160
16	7507 7384	Biface, Stage II Small Hammerstone	160 - 170

TEST UNIT 16:

LEVEL	NOCA NUMBER	OBJECT NAME	DEPTH (cm ↓ datum)
3	7543	Biface, Stage III	30 - 40

TEST UNIT 18:

LEVEL	NOCA NUMBER	OBJECT NAME	DEPTH (cm ↓ datum)
2	7388	Biface, Stage II	20 - 30

TEST UNIT 19:

LEVEL	NOCA NUMBER	OBJECT NAME	DEPTH (cm ↓ datum)
2	7390	Biface, Stage II	20 - 30
3	7391	Small Hammerstone	30 - 40

TEST UNIT 22:

LEVEL	NOCA NUMBER	OBJECT NAME	DEPTH (cm ↓ datum)
1	7393 7524 7656	Biface, Stage Indeterminate Biface, Stage Indeterminate Microblade	11 - 67

APPENDIX G

FAUNAL REMAINS

identifications by
Linda L. Switzer

The bone remains recorded here were recovered from the screen during excavation; they were bagged and labeled separately, then placed in level bags. All of these bones are small (>2 cm) calcined or charred fragments, meaning that they were burned (intentionally or unintentionally) in a fire or cooking hearth. The distribution of these bone pieces by test unit and level are recorded in Table G-1.

TABLE G-1. FAUNAL REMAINS PER TEST UNIT

	TEST UNIT NUMBER						
DEPTH (cm)	3	11	14	15	16	19	21
SURFACE							
0-10							
10-20					2		
20-30	4			11	1	2	2
30-40					1	3	
40-50							
50-60		1					
60-70							
70-80		4					
80-90							
90-100							
100-110							
110-120							
120-130							
130-140							
140-150			1				
150-160							
160-170							
Wall						1	
TOTAL	4	5	1	11	4	6	2

In Table G-2 these bone fragments are listed by test unit, level, the part of the skeleton they represent, and the general size of the animal. Due to their small size, the bone fragments cannot be identified by species or genus. Only one bone, a tooth fragment from TU11, was identifiable as from either a mountain goat or a mountain sheep, the former being more likely. Nearly all of the remaining bones were unidentifiable, or were assignable only to "medium size mammal", which corresponds to mammals the size of deer, mountain goat, bear, wolf, among other possibilities.

TABLE G-2. DESCRIPTION OF FAUNAL REMAINS

<u>TEST UNIT 3</u>

LEVEL 3 (20-30)		1 small fragment with foramen- possibly skull 1 fragment long bone, medium size mammal 2 fragments non-identifiable bone

<u>TEST UNIT 11</u>

LEVEL 5 (48-60)		1 fragment hypsodont tooth, upper molar, possible mt. goat or sheep
LEVEL 7 (75CM)		4 fragments, dense bone, possibly skull, medium size mammal

<u>TEST UNIT 14</u>

LEVEL 14 (140-150)		1 small fragment non-identifiable bone

<u>TEST UNIT 15</u>

LEVEL 2 (20-30)		
	SE QUAD	4 small fragments long bone, medium size mammal
	SW QUAD	2 small fragments long bone, medium size mammal 2 small fragments non-identifiable bone
	NE QUAD	1 small fragment long bone, medium size mammal 1 small fragment non-identifiable bone
	NW QUAD	1 small fragment long bone, medium size mammal

TEST UNIT 16

LEVEL 1 (10-20)		
	SE QUAD	1 small fragment long bone, medium size mammal
		1 small fragment non-identifiable bone
LEVEL 2 (20-30)		
	NW QUAD	1 small fragment non-identifiable bone
LEVEL 3 (30-40)		
	NW QUAD	1 small fragment non-identifiable bone

TEST UNIT 19

LEVEL 2 (20-30)		
	SW QUAD	2 small fragments non-identifiable bone
LEVEL 3 (30-40)		
	NW QUAD	3 small fragments non-identifiable bone
WALL SCREENINGS		1 small fragment non-identifiable bone

TEST UNIT 21

LEVEL 2 (20-30)		
	NW QUAD	1 small fragment non-identifiable bone
	SW QUAD	1 small fragment long bone, medium size mammal