Archaeological Investigation and Technological Analysis of the Quartz Mountain Obsidian Quarry, Central Oregon.

by

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AN ABSTRACT OF THE THESIS OF

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Barbara Roth

The Quartz Mountain Obsidian Quarry is located in the Southeast corner of the Bend Fort Rock Ranger District in central Oregon, approximately forty-five miles southeast of Bend, Oregon.

The research of the Quartz Mountain Obsidian Quarry began with a literature search of other quarry sites in the area and the use of ariel photos to determine the survey area. After the survey area was established a ground survey was conducted. Following the survey several key areas were chosen for surface collections that could answer key questions: What types of core reductions were being used on Quartz Mountain?; and What types of materials were being utilized? (red/black obsidian found in rhyolite veins, red/black obsidian found in fist sized and larger nodule form, or large block black obsidian).

In order to answer these questions three collection units were established. The lithic material from the units was collected and analyzed and the information placed into a database, which was then grouped for statistical analysis, and generated into charts and tables.

The resulting data was then compared to the information found from an extensive literature search to see how the material that I collected compared to those found at other quarry sites. From this information I was able to determine that two different core reduction methods were being used on Quartz Mountain: blade core and bifacial core. Along with the different core reduction methods a mobility strategy also came into play.

In this thesis I will use the data gathered to determine the different core reduction methods and the mobility strategies that are associated with them.

Masters of Arts in Interdisciplinary Studies thesis of John B. Hatch presented presented on May , 1998

APPROVED:

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Dean of Graduate School

I understand that my thesis will become part of the permanent collection of Oregon State University libraries. My signature below authorizes release of my thesis to any reader upon request.

John B. Hatch, Author

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I. Introduction

Quartz Mountain obsidian quarry is located in Central Oregon, on the Deschutes National Forest in the southeast corner of the Bend Fort Rock Ranger District. The quarry consists of vast amounts of lithic debris left over from many generations of craftsmen. The quarry has several different types of obsidian ranging from red, to red/black to black.

Quartz Mountain has several dry drainages that show signs that water once flowed on a regular basis. The area where the red obsidian was extensively used has a drainage that still has Quaking Aspen *(Populus tremula)* growing, which indicates that water is still close to the surface. With the presence of fresh water and relatively flat ground close by, this area would have been an ideal location to camp. This area has an extensive lithic scatter, but has not been tested for buried cultural deposits. Other parts of Quartz Mountain have large outcroppings of rhyolite with veins of red, red/black, and black obsidian that show signs of mining by early craftsmen (Figure 1.1). Still other areas of the mountain have large cobbles of high grade black obsidian eroding from the hillside (Figure 1.2). These areas all show signs of quarrying over several miles of the southwest and south facing slopes. The north slope of the mountain has several drainages with rhyolite/obsidian outcrops with several small rock shelters all showing large amounts of lithic debris indicating extensive quarrying. The top of Quartz Mountain is relatively flat and has large stands of old growth Ponderosa pines *(Pinus ponderosa)*.

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The Quartz Mountain material source has been known about for many years, but very little survey work has been done on the steep slopes, as this area is considered low probability for finding sites (Claeyssens 1992). For the most part, the material from Quartz Mountain was considered as occurring in small cobbles that are dense and completely covered with cortex which require sectioning before workable flakes could be produced (Scott 1991:177). For this reason Quartz Mountain obsidian was considered of low quality and was overlooked as being a usable resource.

The major goal of this thesis is to determine if Quartz Mountain (Figure 1.3) has had any importance as an obsidian source in this region. I have been in contact with the Deschutes National Forest Service (Paul Claeyssens, Forest Archaeologist) and a cooperative agreement was developed to survey the entire mountain and do a surface collection in several key areas on Quartz Mountain. These areas were chosen because they best represent the materials used and the technology used to reduce the obsidian. The survey and collections were designed to allow me to formulate the extent to which this material source was used over time.

Prehistoric quarry workshops were an important early focal point in North America (Bamforth 1986, 1991; Binford 1979, 1980; Gould 1985; Kelly 1983, 1988a) and such sites are once again beginning to attract the attention of archaeologists concerned with the reconstruction of extinct cultural systems. The present trend toward technological, functional, and behavioral lithic analysis is well grounded in past research (e.g., Holmes 1894) but owes much of its current foundation to people like Don Crabtree

Figure 1.1 Mining Area. This area of red/black obsidian shows signs of extensive mining by early craftsman. The area at the base of these overhangs have large amounts of debitage possibly several meters deep.

Figure 1.2 Quarry Area. This area located on the south side of Quartz Mountain is covered with large cobbles, many of which have been reduced into cores or rejected for some reason.

and his many students. For the most part quarry workshops remain understudied, which could be due in part to the variety of problems they seem to present. One of these problems is the extent and vast quantity of artifacts that are present in these sites, for they can literally cover thousands of square meters. Therefore, most researchers have attempted to describe finished tools and other unique pieces at these sites, primarily for dating purposes; products manufactured; worked materials; and sometimes the manufacturing or lithic-reduction techniques represented (Singer 1984:35).

In this thesis, I investigate the technology of flake and tool production, and any evidence of material preference on Quartz Mountain. My primary emphasis will be on the technological production (specifically which reduction methodology, core or bifacial) was used. I also examine how artifacts located away from the material source can help archaeologists understand the movements of early humans in the region. By beginning my research at the source and addressing how these artifacts were made, this study will add to the understanding of cultural differences and movements through time and space.

The proposed research lasted two years, consisting of 70 days in the field doing surveys and collections. Along with the ground survey extensive time has been spent going over aerial photographs and USGS maps to get a better understanding of the ground conditions. Along with this research a literature search has been done to trace the movements of material from this source. This research has found material as far away as Mud Springs on the Crooked River National Grasslands (35JE49) located approximately 70 miles northeast , dating to around 10,000 B.P. (INFOTEC 1995).

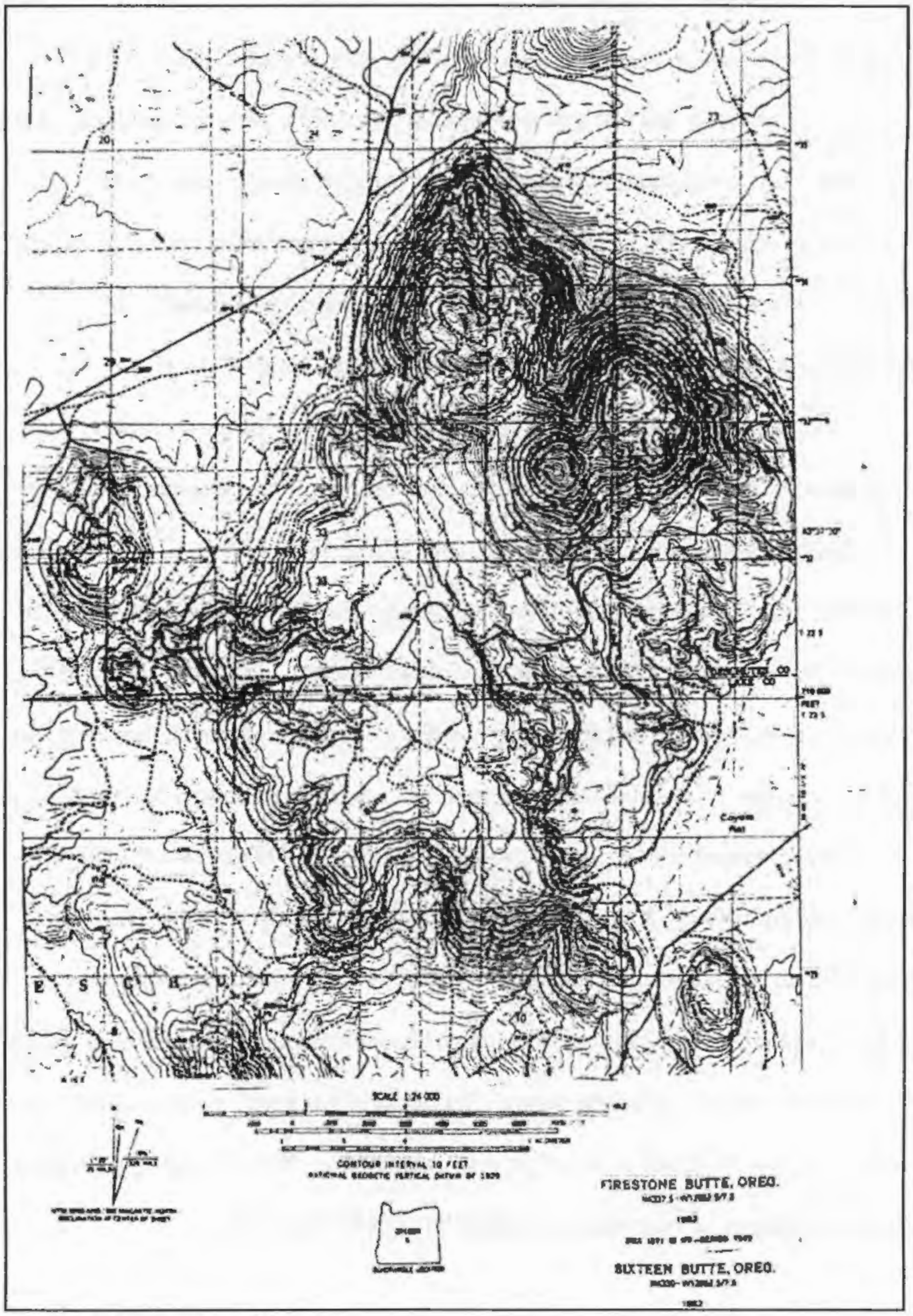


Figure 1.3 Survey Area Map

2. Prehistoric Period Overview of Central Oregon (Northern Great Basin)

The earliest inhabitants of Central Oregon were representative of the Paleo-Indian Stage in North American prehistory, which encompasses archaeological remains more than 10,000 years ago. Evidence of Paleo-Indian occupation generally occurs in environmental contexts moister than those of the present. Paleo-Indian life ways are often associated with the hunting of big game, including megafauna (mammoth, bison, etc.) which subsequently became extinct. Over-hunting by Paleo-Indian and a trend toward a warmer climate which might have reduced the carrying capacity of the land have both been suggested as explanations for the eventual extinction of these large game animals (Connolly 1995:17; Kelly 1997; Martin 1984; Willing 1989) . The origins and broader affiliations of the Paleo-Indian peoples are controversial, with opinions of archaeologists being divided into several schools of thought (Aikens 1993). One recent theory for early entry into the New World is the coastal route, with entry into the interior by the way of the major rivers (Columbia to the Deschutes) (Fladmark 1983:19-23). The more accepted theory is through the ice-free corridor and into the interior from there (Fladmark 1983:26-32, Aikens 1993:19, Cressman 1977:57-76, et al.).

It has long been assumed that the earliest cultures in the Intermountain West must have been associated with the Fluted Point Tradition. Characterized by Clovis and Folsom fluted projectile points, this tradition is widely represented in eastern and southwestern North America where it has been radiocarbon dated to the period from

11,5000 to 10,000 B.P. An alternative interpretation is that the earliest inhabitants of the Intermountain West are represented by the Stemmed Point Tradition, which is composed of various complexes of stemmed shouldered, and indented base lanceolate projectile points. These points are thought to represent a separate culture complex, the earliest aspects of which are at least as old as the Fluted Point Tradition (Minor et al. 1987: 193-194).

At this time its hard to say which interpretation is correct given the archaeological evidence currently available. Clovis points have been found at the Dietz site, but these have yet to be associated with good radiocarbon dates. Lanceolate shaped projectile points were found at Fort Rock Cave. These have been associated with radiocarbon dates of 13,000 B.P. (Bedwell and Cressman 1973). Both Forest Service and Bureau of Land Management archaeologists in Eastern and Central Oregon have found surface artifacts characteristic of each tradition (Willig 1988, Aikens 1993:23-26; Connolly 1995:17).

The later prehistoric peoples of Eastern and Central Oregon practiced lifeways fully characteristic of the Archaic Stage in North America prehistory, a period characterized by intensification of a hunting and gathering economy. The development of Archaic lifeways coincided with the onset of the Althermal interval; a period of warmer and drier climate which occurs between 8500-4000 B.P. Archaeological remains from Archaic peoples are characterized by an increasing range of special tools and utensils, especially milling tools, geared to local subsistence resources of each region. The archaeological record left behind by Archaic peoples is a complex one. In the Great basin increasing aridity had different effects on different parts of the Great Basin (Kelly 1997; Madsen 1982). As Lake Bonneville's levels dropped from 7000 to 6000 B.P., it created vast wetlands that expanded and shrank repeatedly until 3500 B.P. After this time period there was increased precipitation which caused the lake to rise. These conditions lasted until 2000 B.P. With the reforming of Lake Bonneville this region again offered a large food source to the occupants (Madsen 1982; Kelly 1997).

The northwestern Great Basin was drier than that of the Lake Bonneville area. Sites for this time period tend to cluster around dependable springs (Fagan 1974). These conditions contributed to a regionally sparse population. In Surprise Valley (Northeastern California) researchers have found large (7-m-diameter), deep (0.75-m) pithouses with substantial posts that supported a heavy roof (Kelly 1997). These have been associated with dependable springs. The faunal analysis that was done indicates a winter occupation, but the pithouses reflect a repetitive use of a particular location and possibly an overall decrease in mobility relative to the early Holocene. Water may have played a role in reducing residential mobility, this would take the form of intensive use of these areas and sites would decrease the further the distance from the water source (Bettinger 1993 ;Kelly 1997).

The central Great Basin was even drier. There were no lakes or wetlands, and there is very little evidence of a substantial population. There are a few middle Holocene dates from caves and rockshelters on the edge of the central Great Basin. It was found that South Fork Shelter (northeastern Nevada) was occupied just before the Mazama Ash fall at 6750 B.P. (Spencer *et al.,* 1987; Kelly 1997), but in the central Great Basin itself, there is little evidence of occupation after the initial Paleo Indian use to about 6000 or 5500 B.P. (Kelly 1997).

As people clustered around the established watered areas of the Great Basin, there may have been even larger regional positioning of the human population as well, with more ideal locations such as California or the Columbia Plateau absorbing what was probably a very small early Holocene Great Basin population.

After 5000 to 4500 B.P. there are many more of archaeological sites, with abundant evidence of the use of rockshelters in the central Great Basin Gatecliff series points mark the resumption or even the initial occupation of many sites and regions. After 5500 B.P., sites appear in the uplands in the eastern Great Basin (Madsen 1982; Kelly 1997). Madsen feels that these sites represent hunting rather than seed or pinyon processing (Madsen 1982). However, there are pre-5000 B.P. sites in most parts of the Great Basin, at this time its not sure if the higher numbers of late Holocene sites indicates a new settlement pattern or if they are the expected result of continuity in a settlement-subsistence pattern coupled with a slow rate of population growth.

The return of people to the central Great Basin is contributed to the increase in moisture beginning 5000 to 4500 B.P. This is based on the pollen records that show that wetlands and lakes start to return to many places (Kelly 1997). In many rockshelters that are in close proximity to wetlands, such as Hidden Cave (north-central Nevada) and Lovelock Cave (just north of Hidden Cave), the earliest evidence of occupation is asssociated with large amounts of cattail, bulrush, and other biological indicators of wetlands. The earliest use of Lovelock Cave is considered to be around 4500 B.P., but intensive occupation does not begin until 3000 B.P. Duck decoys from the site have been dated to 2200 B.P. (Kelly 1997). At Hidden Cave, the earliest occupation is 3800 B.P. In the Humboldt Sink, shallow pithouses are associated with Elko, Rosegate, and Desert side-notch series points. In the Stillwater Marsh, Elko and Rosegate series points are also associated with shallow pithouses (Larsen and Kelly 1995, 1997), but earlier Gatecliff series points are present on the valley floor as well. In neither the Carson nor the Humboldt Sink do houses contain substantial posts or well-defined interior features as in houses excavated in some other Great Basin wetlands, so these could suggest seasonal use (Kelly 1997).

A return to mesic condition (wetter/cooler temperatures) did not effect all places at the same time. While pithouse structures appear in some wetlands along the Sierra front in the early late Holocene, in Surprise Valley wickiups and shade structures replace deep pithouses.

Wetlands in the Fort Rock Basin saw an increase in population in the late Holocene (Aikens and Jenkins 1994), as suggested by the intensity of occupation along shorelines after 5000-4000 B.P. Near Lake Albert, pithouses (5 to 7 m deep) with a central hearth and sometimes a surrounding earthen berm appear at this time (Oetting 1989, 1990; Kelly 1997).

Research in the Steens Mountains area reflect changes in the middle-to-late Holocene population levels and settlement patterns in the northwestern lakes region but form upland perspective. Prior to 6000 B.P. , site frequencies are low as people are attracted to the well-watered lake basins (Kelly 1997; Pettigrew and LeBow 1989). From

6000 to 4000 B.P., upland site frequency increases as the uplands become more attractive with the return of more moist conditions, but sites are small as people disperse to exploit scattered food resources. Site frequencies peak from 4000 to 3000 B.P. and sites tend to be larger, this could be due in part to a growing population. Sites continue to grow in size from 3000 to 2500 B.P.; this may be partly a function of the growth of any archaeological record over time, but since sites decline in number, it may also reflect a continual use of a few attractive sites. Sites increase in frequency but are smaller after 2500 B.P., perhaps reflecting a logistical use of the area by lakeside dwellers (Kelly 1997; Fagan 1974; Bedwell 1973).

Linguistic evidence indicates that native peoples inhabiting Southeastern Oregon at the time of historic contact were the Northern Paiute, which had expanded into Southeastern Oregon from the south around 1000 years ago. This migration was very likely concurrent with a slight change in climate which rendered the earlier lake-marsh oriented adaptations infeasible and resulted in a retreat of the previous inhabitants. An implication of this population is that the bulk of the archaeological record in Southeastern and Central Oregon relates to prehistoric peoples who occupied the region before the arrival of the Northern Paiute in the late prehistoric times (Aikens 1993; Madsen and Berry 1974; Minor *et al.* 1987:194-196).

Two major language families were represented among the native peoples who were occupying Central Oregon at the time of historic contact. The distribution of these groups corresponded closely with the division between the Great Basin and Columbia Plateau Physiographic Provinces. The Northern Paiute who inhabited the desert country of southeastern Oregon spoke a language related to the Numic languages of the Great Basin to the south. Native peoples inhabiting the mountains and valleys of Northeastern Oregon, including the Tenino and the Umatilla, spoke Sahaptian languages which were related to those spoken by other Columbia Plateau groups (Minor *et al.* 1987:194-196).

2.1 Ethnographic Life Way of the Northern Great Basin

Research shows that the native people practiced the ancestral life way well into the 19th century. Comparison of archaeological and ethnographic evidence shows that prehistoric peoples made tools, gathered plants, and hunted animals of similar if not identical kinds. The similarity is not exact, or complete, for in thousands of years there were inevitably changes. Nevertheless, the life of the historic peoples is a guide to understanding the ancient cultures attested to by archaeological evidence, and historic and prehistoric may be interwoven to detail some of the more timeless aspects of the desert culture.

The hunter-gathering peoples of the Northern Great Basin were dependent on the free-living bounty of nature for their sustenance, habitually tracking the natural patterns and cycles of their environment. The annual round of Eastern Oregon's historic Harney Paiute was broadly typical of many Great Basin groups (Figure 2.1).

This annual cycle would start in March when the groundhogs first appeared. People at this time were still living in their winter encampments near Malheur Lake and where the modern town of Burns is located. They were eating primarily stored foods and any game that could be obtained. April would bring the first green shoots through the snow, and by late April or early May, the Indian potato month would begin. This would bring about the first major economic and social event of the new year - the spring trek to the root camp. The root camp of the Harney Valley people was traditionally not a single locality but a vast area in the barren hills around Stinking- Water Pass, on the northeastern rim of the Great Basin. There Indian potatoes, bitterroot, biscuit root, yumpa, wild onion and other species grew in great quantities. During this time period people would congregate in large groups, some having come from 50 or 100 miles away to participate in the harvest. Some would remain at the root camp as long as a month or so, building up stores for the following winter and enjoying the company of friends and relatives from miles around. The historic record shows that the gathering was intertribal, with non-Paiute groups from the Columbia Plateau region across the mountains also participating. Archaeological remains from Stinkingwater Pass suggest that this pattern probably dates back to at least 4000 B.P. (Pettigrew 1984).

Traditionally while the root camps were in full swing, the men would move to the headwaters of the Malheur River. The Malheur, a tributary of the Columbia, had spawning salmon. Women would join the men on the river when they concluded their gathering at the root fields. Together with the men the task of catching and drying salmon for winter would continue for several weeks.

By June, vast fields of blue camas (*Camassia quamash*) lilies would be blooming between Malheur Lake and the surrounding foothills. Camas was harvested in great quantity and baked in large earth ovens for winter stores. During this time period marmots were available in the rocky foothills, so special trips were made to hunt them.

People moving back toward the Harney Valley from root and salmon camps in the mountains would conduct these harvests, and store the proceeds in caches. These caches stored in rockshelters would then be retrieved for winter use.

The month of July was the month when the grass had grown high. Crickets thrived, and these were also collected, dried and pounded into a protein rich food which was also stored. During July and early August, people would disperse into small groups that would rove so they could hunt elk and small game, catch fish and gather the early currents and huckleberries of the season.

In late August and September, the seeds and berries of many other plants were ready to harvest. The Harney Valley Paiute were called the *Wadatika,* or "Wadaeaters," named for the low growing plant extremely common along the shore of Malheur Lake and other desert lakes. The wada plant would yield a seed that was tiny but available in great quantity. The Wadatika would gather into large groups to collect wada as well as the seeds of goosefoot, Indian Rice grass, Great Basin Wild Rye, mule-ear, and other desert plants. At suitable locations buckberries, huckleberries, and chokeberries were harvested.

October-November was the rutting season for deer and antelope, which was the time for deer hunts, antelope drives, and rabbit drives. Seeds of shooting star and ponderosa pine were collected. Winter encampments were established at traditional places which were near water and not too far from previously established food caches.

The cold months of the year, usually from December through April, were spent in winter encampments. People would range out for fishing, water fowling, and hunting, but the stores of dried food built up during the preceding months constituted the primary food resource during the winter season (Aikens 1993; Hunn1990) .

The day to day tasks and annual cycle exemplified by the Harney Valley Paiute year are found to be well represented in the archaeological sites of the Northern Great Basin. Gathering activities are attested to by digging sticks, carrying baskets, milling stones; hunting is represented by atlatl and dart, the bow and arrow, stone projectile points, and stone knives and scrapers; and extensive travel is symbolized by rich finds of sagebrush-bark sandals found at Fort Rock Cave and other sites. Among the thousands of known sites there are a variety of winter villages and special activity camps of various kinds. Although the match between prehistoric life ways and that of the historic Paiute people is surely not complete or exact, this evidence leaves no doubt of their basic similarity (Aikens 1993).

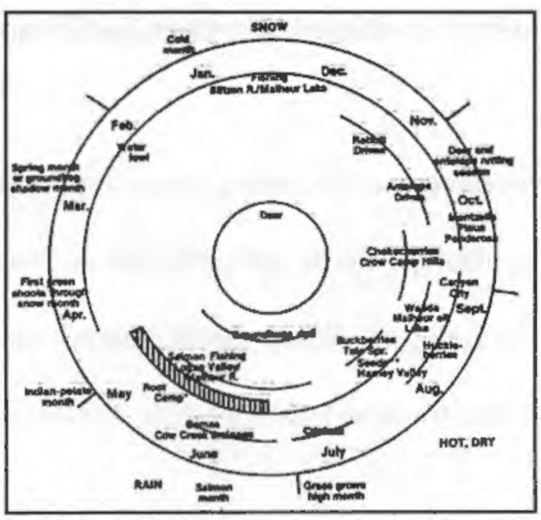


Figure 2.1 Harney Valley Paiute seasonal rounds (Aikens 1993).

2.2 *Time/Environmental Change in the Northern Great Basin*

Archaeological evidence shows that the first peoples living here started showing up near the end of the Pleistocene, when the world climate was in transition from the cold of the glacial age to the warmth of the post-glacial. Glaciers in the Cascades, Steens, and Blue mountains began to dwindle and disappear. Modern Malheur, Harney, Summer, Albert, and Warner Valley lakes became the shrunken remnants of great Pleistocene water bodies. At the same time many pluvial lakes vanished completely, as in the Catlow Valley, leaving only broad, level plains (Cressman 1940). High on hills around valley basins, three or more beach terraces can still be seen, and some run for miles. In some parts of Eastern Oregon, beach lines occur as much as 350 feet above the basin floors (Summer Lake); the lakes that made these beaches were not only of vast extent, but deep (personal observations).

Animals that went extinct at the end of the last glacial age include giant mammoth (*Mammuthus columbi)* and ground sloth (*Megalonychidae)*, giant bison (*Bison antiquus)*, camel (*Campelops)*, and the horse (*Equus)*. Species that survived to the present include antelope, deer, mountain sheep, bear, migratory and upland birds, rabbits and other small mammals, various fish, and predators such as cougar, bobcat, coyote, and wolves. Plant species of the late glacial times were essentially those seen today in the region, but boreal trees such as white pine, spruce, and fir were more abundant. Timber lines were lower, and alpine species were more broadly distributed. The sagebrush-grassland communities of lower elevations were probably richer in grass cover and more diverse than they are today (Aikens 1993; Connolly 1995: 16-17; Cressman 1977:46).

Recent pollen evidence shows that by about 9,000 B.P., cold-tolerant trees were colonizing high terrain previously covered by arctic tundra vegetation. Sagebrush, juniper, and other species followed these trees up slope as temperatures continued to rise. From about 7,000 to 4,500 years ago there was a general aridity, and many Great Basin lakes dried up completely. This aridity is revealed by extensive dune fields along modern shorelines, formed as prevailing winds carried fine sediments of dried lake beds exposed by evaporation. A Neopluvial rebirth of the lakes was beginning to take place sometime around 4,500 years ago, this was related to global cooling that also brought traces of Neoglaciation back into the Cascades and elsewhere. This somewhat cooler, moister regime has continued to the present time (Aikens 1993; Connolly 1995:15-16; Cressman 1977:46; Willig 1988).

A now classic interpretation of post-glacial climate has summarized these intervals as Anathermal (cooler, moister than today) 9,000-7,000 B.P.; Altithermal (warmer, dryer than today) 7,000-4,500 B.P.; and Medithermal (conditions as today) 4,500 B.P. to present (Antevs 1948, 1955). Detailed paleoclimatic evidence shows, however, that temperature and moisture fluctuated quite evenly within these periods. In the midst of generally dry times were marked wet phases, and just as markedly there were dry phases during generally wetter times (Mehringer 1977, 1986).

The degree to which large scale climatic changes may affect the local occurrence of particular plants and animals is of direct importance to human use of the landscape.

The topographic and biotic diversity of an area are critical variables. Global or regional shifts in temperature are less likely to wreak major changes in species availability within a topographically diverse area than in more uniform terrain. Precipitation and evaporation of moisture are greatly affected by temperature, which varies directly with altitude. A rise in temperature, through increased drying, could eliminate important plants and animals from a flatland biotic community over a large area, and might even affect species distribution much less dramatically in an altitudinally varied landscape. There, a given plant species might have to shift its range only a few hundred feet up slope to stay in a setting of sufficient moisture, and the animals that fed on it could readily follow. Thus, the extent to which climatically induced environmental change over time might affect the long term human settlement pattern, the placement of hunting, gathering, and dwelling sites over a landscape, depends critically on specific local topographic variables. Environment and its changes are manifestly of great importance to human ecology, and some of the ways in which they affected prehistoric Northern Great Basin communities (Aikens 1993; Connolly 1995:17; Cressman 1977:46).

3. Site Data

3.1 Prehistoric Overview of the Deschutes National Forest

Over the past two decades numerous archaeological surveys have been done in the Deschutes River drainage and on the high desert that is in close proximity. On the Deschutes Forest there are well over 500 sites; of these sites 12 sites have been excavated. The data have yet to be analyzed or synthesized into a prehistoric cultural chronology for central Oregon. As a result, archaeological sites are commonly interpreted within the framework of established prehistoric chronologies of the Great Basin and Columbia Plateau areas.

Great Basin Chronologies show that prehistoric people have inhabited this region for the last 13,200 years (Bedwell 1973). On the southern Columbia Plateau, a lengthy sequence of prehistoric occupation is also represented (Aikens 1993; Cressman 1977; Ross 1963). For the purpose of this thesis I will use data specific to the Deschutes National Forest and the Upper Deschutes River basin. The area's prehistory can be summarized in conjunction with a discussion of the archaeological investigations completed to date, since they are closely interrelated.

The first archaeological research on the Deschutes National Forest was conducted on the Crescent District in 1934 by Luther S. Cressman of the University of Oregon. The research involved the examination of two bifacially flaked obsidian artifacts which were found beneath Mount Mazama ash (6,700 B.P.) during a construction project near Wickiup Reservoir (Cressman 1937). Test excavations were subsequently undertaken at the location and two bifaces were found, but no other prehistoric materials were recovered. Cressman (1977) believed these tools provided evidence of the initial (pre-6,700 B.P.) human occupation of central Oregon.

Archaeological research was continued on the Crescent District by Cressman (1948) in 1946 at the Odell Lake Resort site. The site was found during a construction project which involved excavations beneath Mount Mazama ash. Cressman's subsequent archaeological excavations yielded several lanceolate-shaped obsidian bifaces, chipped stone debitage, and ground stone tools below the layer of Mount Mazama ash. Unfortunately only limited excavation work was undertaken at the site but it proved to be one of the first documented "Paleo Indian" sites in central Oregon. Cressman (1948) tentatively noted the similarities between the site assemblage and artifacts found in the Klamath Basin to the south.

In 1948, an archaeological survey of the proposed Benham Falls Reservoir was undertaken by the Smithsonian River Basin Survey crew (Osborn 1950). The project area is located 3.2 km south of Benham Falls and extended upstream for about 22.5 km. A total of 32 prehistoric sites were recorded during the survey. Nearly all were discovered on the first gravel terrace above the Deschutes River flood plain (Osborn 1950: 115). Although no test excavations were undertaken, all 32 sites were assumed to be surface manifestations. Projectile points, "knives," "blades," "choppers," ground stone tools, and lithic debitage were collected during the 1948 survey. Many of the projectile points were found to be similar to type found in the Great Basin and represent a time span of 5,550 to 230 years B.P. (Heizer and Hester 1978: 3-9). Based on the survey data, Osborn has hypothesized that prehistoric sites in the area were occupied on a seasonal and intermittent basis.

In 1961 archaeological excavations were conducted at the Lava Butte site (35DS33), located 5.6 km southeast of Benham Falls (Ice 1962). The Lava Butte excavations were undertaken in order to mitigate negative impacts caused by the construction of a Pacific Gas transmission line (first of two lines). The site proved to be archaeologically rich and yielded an extensive inventory of prehistoric tools, chipped stone flakes, and ground stone processing equipment. Data from the site indicates that the prehistoric inhabitants focused on hunting, plant processing, and the production and maintenance of stone tools. The site was originally believed to have been occupied during the last 200 to 500 years (Ice 1962: 49) but a later analysis of the artifact assemblage (Figure 3.1) indicates the site may have been used by prehistoric people as early as 4,000 years ago or earlier (Davis and Scott 1984).

During the early 1960's, a several archaeological investigations were undertaken in areas surrounding the Deschutes National Forest. Research by University of Oregon archaeologists in the Round Butte Dam Reservoir area at the confluence of the Metolius, Crooked, and the Deschutes Rivers, resulted in the location of 48 prehistoric sites (all under water at present time). Thirty-two of the sites were tested or surface collected (Ross 1963). Based on evidence from the study, Ross (1963) suggested that rock shelters along the Deschutes River were preferred by earlier prehistoric inhabitants while later aboriginal groups camped closer to the open flood plain (Ross 1963: 114-116).

The study concluded that sites on the west side of the Deschutes River were inhabited by groups affiliated with the Klamath and Great Basin areas, while on the east side of the Deschutes sites showed cultural affinities with the Columbia Plateau. At present time this hypothesis has yet to be tested in other areas along the river (Scott 1986).

By the mid-1960s and early 1970s, strengthened environmental and historic preservation legislation resulted in an increase in the number of small-scale archaeological survey and excavation projects throughout the region. One of the first-small scale excavation projects on the Deschutes National Forest was undertaken in 1976 and involved the test excavation of two sites near Sunriver, Oregon.

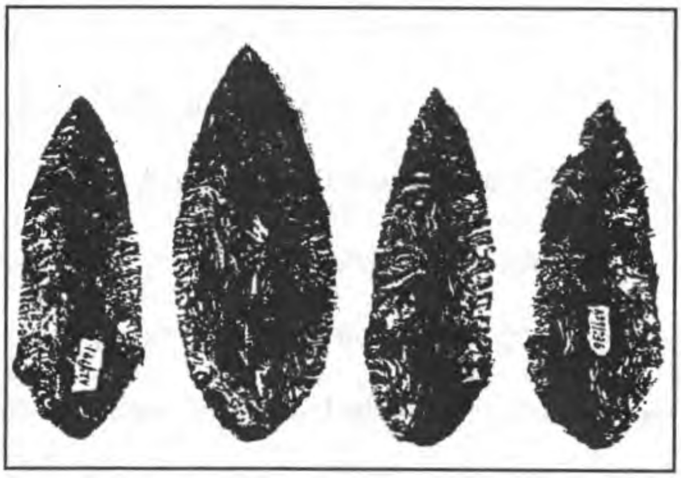


Figure 3.1 Haskett Points. Haskett style points found at Lava Butte site (Ice 1960).This point style dates from 7,240-11,200 (Beck and Jones 1997:196).

The project was conducted in advance of a land exchange project involving the Deschutes National Forest and Sunriver Properties (Cole 1977). One of the sites was found to contain very little archaeological evidence, but the other site (35DS39), which is located on a bluff adjacent to the flood plain, yielded numerous prehistoric tools and an abundance of chipped stone flakes. By cross-dating the various projectile point types, Cole has estimated that the sites were occupied prior to 600 years A.D. (Cole 1977: 19).

By 1981 a major archaeological excavation on the Deschutes Forest was undertaken at Lava Island Rockshelter (Minor and Toepal 1982,1983). Excavations were initiated because the rockshelter was in the land exchange between the Inn of the Seventh Mountain and the Deschutes National Forest. The rockshelter is situated on a steep, rocky slope above the Deschutes River approximately 8 km southwest of Bend, Oregon.

Excavations revealed a bark-lined storage pit, numerous lanceolate shaped bifaces (Figure 3.2) and thousands of chipped stone flakes. The lanceolate bifaces were suggested to be similar to Haskett projectile points which were commonly used 8,000 to 10,000 years ago on the Sank River Plain, indicating that the rockshelter (and the Deschutes River valley) were inhabited at a very early time period (Scott and Davis 1984). A more recent examination of the Lava Island bifaces, however, that suggests the points may have been of a more recent origin and lack the technological traits typical of the Haskett point type (Scott and Davis 1984). The excavations did provide reliable evidence of an Archaic "Elko" period (found above the cache of lanceolate bifaces) occupation (ca. 4000-1000 B.P.) and late prehistoric habitation (ca. A.D. 1840), presumably by Northern Paiute Indians.

In 1982 test excavations were conducted at the Sand Springs site on the southeastern edge of the Deschutes National Forest. The excavations revealed two prehistoric components separated by a thick layer of Newberry pumice deposited some 1600 years ago (Scott 1985). The artifact assemblage from the pre-Newberry component (the post-Newberry component was badly disturbed) contained few formal tools and an abundance of chipped stone obsidian bifaces (Figure 3.3 and 3.4) and debitage, suggesting that the site was used as a lithic workshop. A radiocarbon date of 2750 B.P. was obtained from this component. X-Ray Fluorescence Sourcing showed that the obsidian from the site was obtained from the nearby Quartz Mountain Quarry. Use of the Sand Springs site apparently decreased considerably after the 1600 B.P. eruption of nearby Newberry volcano (Scott 1985). The prehistoric habitation of Sand Springs spans the last 4000 years and highlights the importance of local volcanology and lithic technology for understanding regional prehistory.

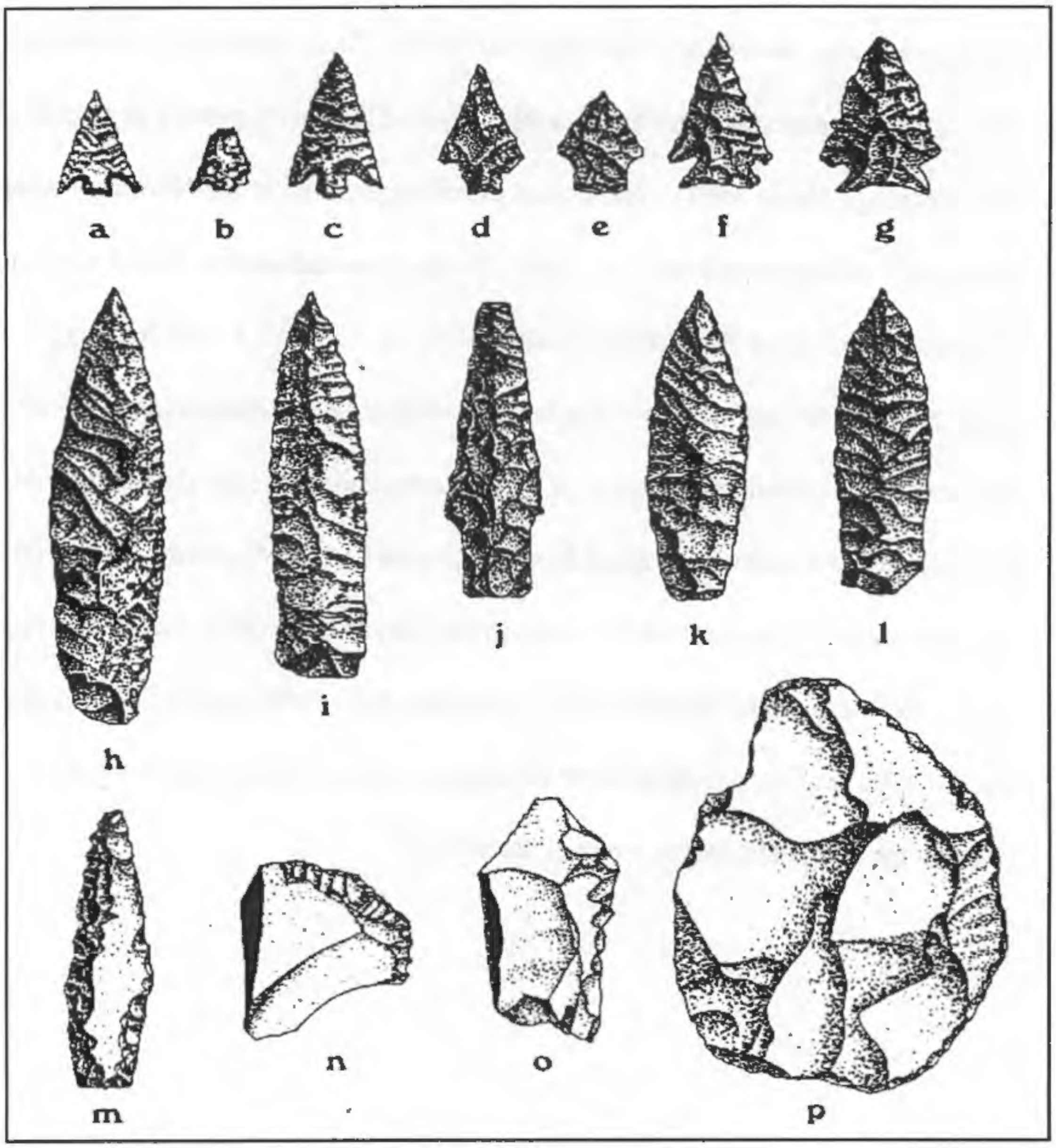


Figure 3.2 Lava Island Artifacts. Chipped stone artifacts recovered during excavations at Lava Island Rockshelter: a-d, narrow-necked projectile points; e-g, broad-neck points; h-l, lanceolate points; m, knife; n, scraper; o-p, retouched flakes (shown actual size) (Minor and Toepel 1981).

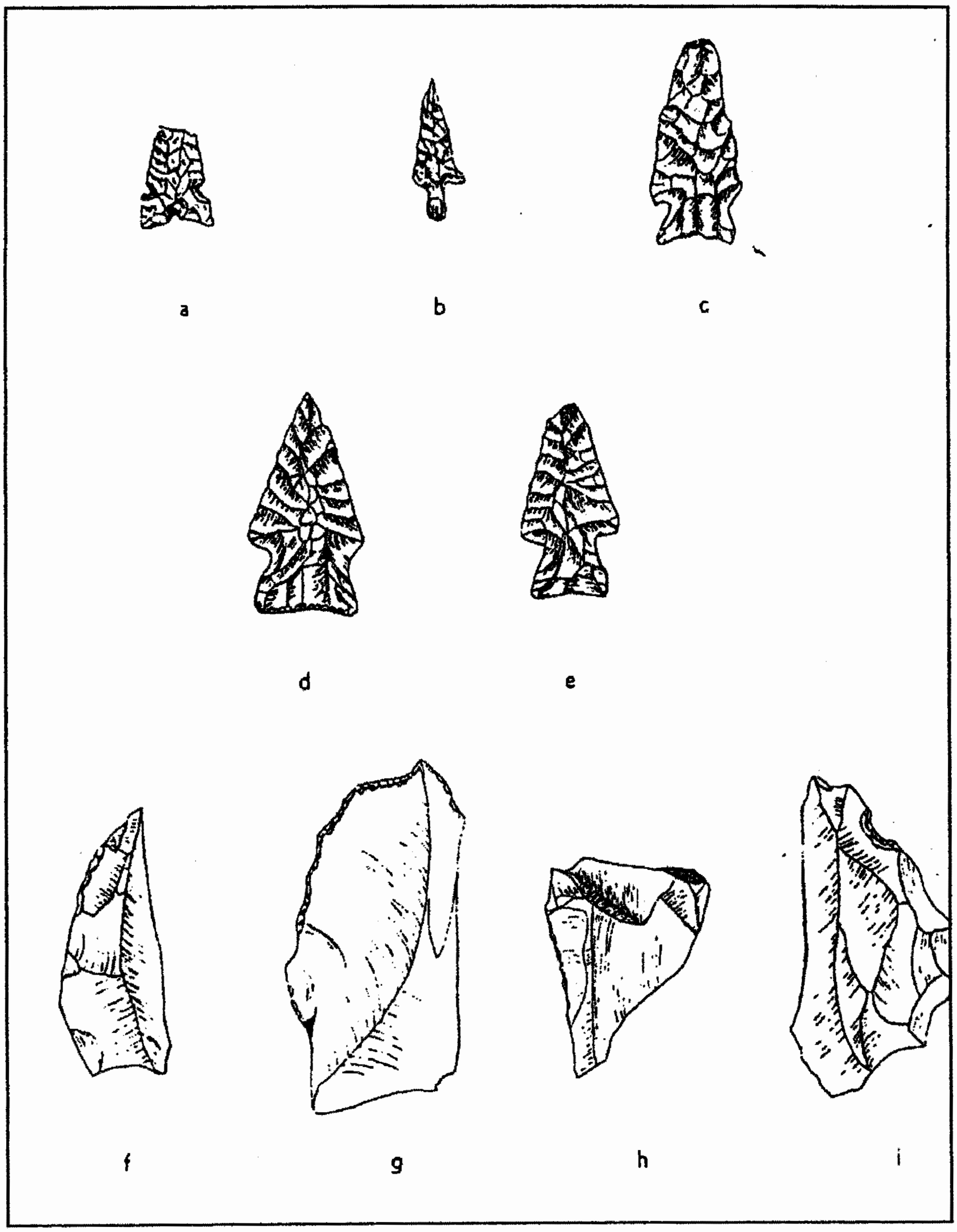


Figure 3.3 Sand Springs Artifacts: Projectile Points and Unifacial Tools. a) Desert Side-notched; b) Rose Spring; c-e) Elko; f-g) Type 3 unifaces; h) Type 2 uniface; i) Type 7 uniface. (To scale) (Scott, 1985)

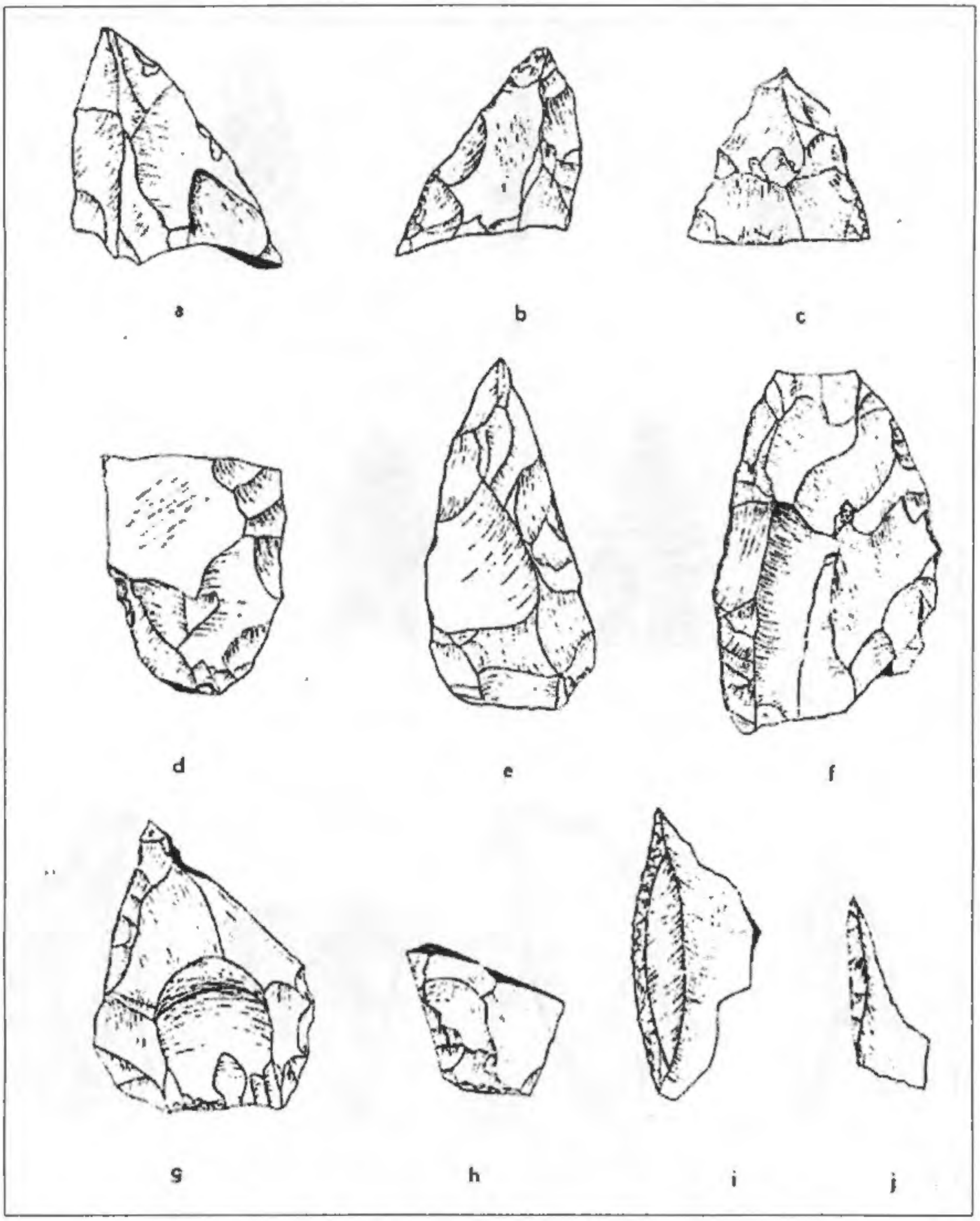


Figure 3.4 Sand Springs Artifacts: Bifacially Flaked Tools and Trimming Flakes. (a-b) biface blanks with perverse fractures; c-d) blanks with lateral snap fractures; e-f) whole biface specimens; g) base fragment; h) midsection; i-j) bifacial trimming flakes. (To scale) (Scott 1985)

In 1982, a cultural resource survey of a land exchange project involving the Deschutes National Forest and the Inn of the Seventh Mountain Resort located 12 archaeological sites on the west side of the Deschutes River near Bend (Connolly 1983). All of the sites consisted of small clusters of chipped stone flakes located above several intermittent drainages on a large broad terrace above the Deschutes River. One previously recorded archaeological site (35DS57) in the land exchange was test excavated in 1980 for a Cascade Lakes Highway project (Pettigrew and Spear 1984). Although the site revealed only minimal surface evidence, the test excavations produced more abundant subsurface archaeological deposits including flaking debris and small quantities of bone (Connolly 1983; Minor and Toepel 1983). Five projectile points, typologically similar to both Great Basin and Columbia Plateau point styles, were recovered. These points place the occupation of the sites somewhere between 6800 and 1000 B.P. On the basis of the test excavation data, the sites are believed to represent intermittently occupied hunting camps (Minor and Toepel 1983: 61). Full scale data recovery work was conducted during the summer of 1984 at four of the largest prehistoric sites in the land exchange. A detailed report is said to be forthcoming.

In 1984 two large caches of obsidian bifaces were recovered from Bend and Fort Rock Ranger Districts (Scott and Davis 1984). Both caches are excellent examples of the morphological variability inherent in a stone tool assemblage and provide insight into local stone tool technologies. Hydration dating suggests the cached bifaces date comparatively late in time, perhaps within the last 2000 to 3000 years.

From 1990 to 1992 the State Museum of Anthropology at the University of Oregon has conducted archaeological investigations in the caldera of Newberry Volcano. The research was done in connection with proposed reconstruction of the approximately 5 mile long section of highway between Paulina Lake and East Lake within the caldera. The work involved two seasons of testing at about a dozen sites, and formal data recovery excavations during the summer of 1992 at four sites.

The caldera is important because of the Early Holocene cultural record. In addition to volcanic deposits from caldera vents, Newberry Volcano is within 50 cm isopach zone of Mt. Mazama airfall pumice. Pre-Mazama age surfaces were located at a number of locations during the fieldwork in the crater, but associated cultural deposits were found to be very extensive, and closest to the modern ground surface at the Paulina Lake site (35DS34), which is crossed by the highway entrance to the crater. The bulk of the 1992 field season was focused on the excavation within the pre-Mazama component at this site. The work was limited to areas that would be directly affected by the proposed highway reconstruction project, with significant changes to the construction design which were made to minimize impacts to the site and extensive portions of this important pre-Mazama site were left intact.

Preliminary analysis of cultural patterns in the pre-Mazama component at the Paulina Lake site reveal a high degree of compatibility with subsistence settlement patterns observed regionally. Between 10,000 and 7750 radiocarbon years ago, there appears to be evidence for a broad range of extractive activities pursued from a relatively stable residential base, a function consistent with the regional pattern. This pattern shifts at the Paulina Lake site between 7750 radiocarbon years ago and the Mazama eruption to one of more focused activities pursued from a less permanent base camp (Connolly 1992).

In summary the general chronological guidelines of aboriginal cultures have long been established for the Columbia Plateau (e.g., Leonhardy and Rice 1970) and the Northern Great Basin (e.g., Bedwell 1973) for at least three decades. Dumond and Minor's (1983) cultural history for the Wildcat Canyon, located on the Columbia River upstream for the mouth of the John Day River, is considered one of the most relevant for that part of northeast Oregon. My research has found that there is no comparable archaeological record from the Deschutes River Basin (Connolly 1995: 24). This is due in part to the simple fact that scientific research has not been done on any of the rockshelters in the Deschutes Basin other than what Cressman and Bedwell have carried out in the early 40's (Cressman) and early 70's (Bedwell) at Fort Rock Cave and Cougar Mountain. At these site there was not enough data gathered to establish a good chronological record for the region. For the Fort Rock Basin, the generalized record made by Bedwell (1973) and later by Toepel (1980) still remains as the only work done on the Fort Rock Basin culture history (Connolly 1995: 24), even though evidence relating to the last 3000 years of prehistory is still lacking. In short, the existing chronological models remain elementary and generalized outlines, lacking critical detail for the immediate project vicinity.

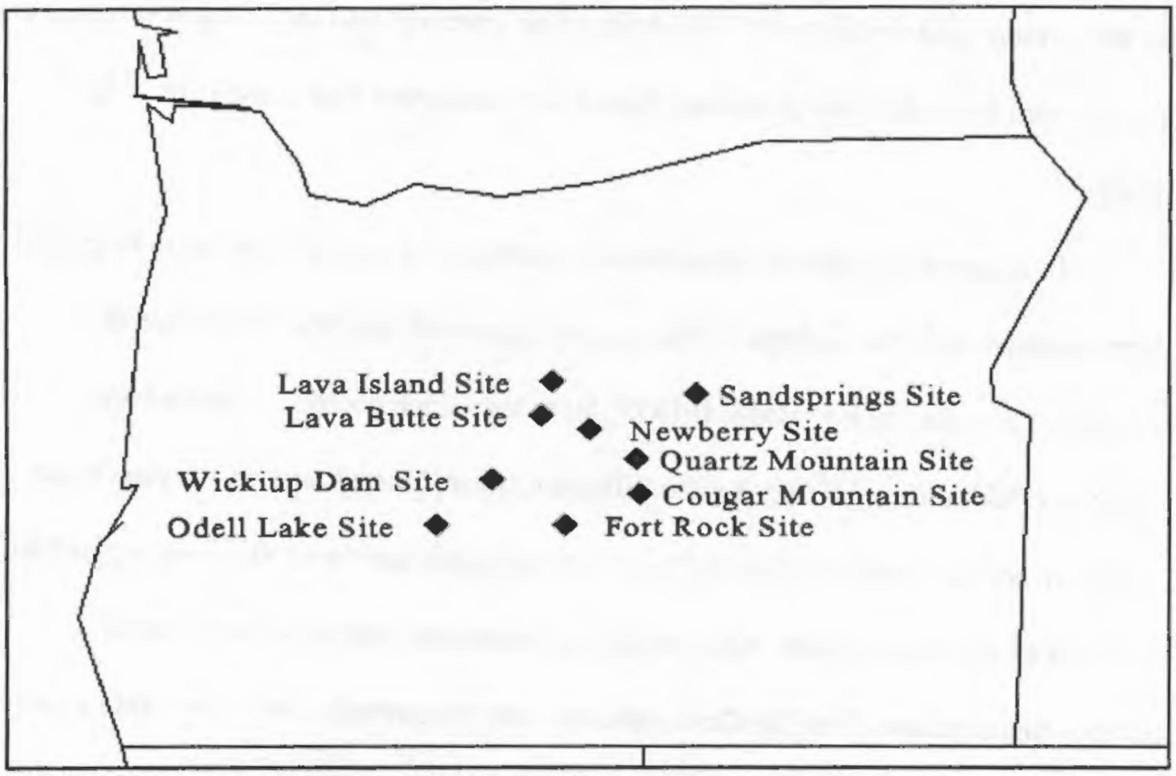


Figure 3.5 Known significant early sites in Oregon.

3.2 *Geology and Soils*

Deschutes and Lake counties contain geological features such as fault systems, cinder cones, lava flows, lava tubes and ash deposits. The High Lava Plains are described as a youthful tract of late Cenozoic lavas, ranging from 4,000 to 5,000 feet (Baldwin 1981). Extinct and dormant volcanoes are abundant throughout Deschutes and Lake Counties. Among these is Newberry Volcano, which is a primary source of obsidian raw materials in the region. The regional geologic structures have determined the soil composition, altitude, microclimate pattern, water sources, vegetation zones, and wildlife habitat. These geological and environmental features directly influence how humans have lived in the two counties during the last 12,000 years. Of great significance to human populations is the presence of numerous obsidian flows associated with past volcanic activities. Among the more significant cultural toolstone resources are: Obsidian Cliffs, Newberry Volcano (which includes McKay Butte), Glass Butte, Quartz Mountain, Cougar Mountain, and Sycan Marsh. Lava tubes were also important to prehistoric populations. They provide shelter and access to water usually in the form of perennial ice or springs. Most of the lava tubes within Deschutes county are part of the Horse Ridge and Arnold systems.

The geologic environment has also been changing over this period, requiring alterations to human settlement patterns. The most devastating geologic events were volcanic eruptions of Mt. Mazama in 6,700 B.P., Newberry Crater in 6,700, 3,500 and 1,400 B.P. and Lava Butte at 6,150 B.P. (INFOTEC 1990).

The High Lava Plains, in which most of the two counties are situated, are composed of middle-and late-Cenozoic volcanic uplands which maintain a moderate topographic relief with an elevation range between 3,000 and 8,000 feet. These High Lava Plains are marked structurally by the Brothers Fault Zone which trends west-northwest for the length of the province (Lyman 1983:5). This *en echelon* normal fault zone acts as a fundamental structural boundary between the Blue Mountains and the Great Basin's north-south faulted volcanic terrain. These uplands are overlaid by the Deschutes Formation, which is different in structure from Clarno Formation on the other side of the Crooked River. The Deschutes Formation is composed of tufaceous sedimentary rock throughout the upper-and middle-Deschutes Valleys (INFOTEC 1990: 2-39).

Soil tests conducted in the past several decades have numerous inconsistent references to soil types within the region (Lyman 1983:9). Numerous soil-type distribution maps created for land use purposes have also been produced throughout the years using various scales and resolutions. Generally soils within the counties belong to the Metolius, Houstake, Laidlaw, and Statz series: all sandy loams of similar composition. Soils in the northern part of the county are predominately of the Houstake and Statz series. The former series is a loamy sand formed in alluvium of ash materials eroded from lava, and typically found in depressions on lava plains with slopes from 0 to 5 percent (INFOTEC 1990: 2-43). These soils are taxonomically classified as course-loamy, mixed, mesic and aridic. The Statz series is composed of shallow, well-drained sandy loam soils located on the lava plains with 1 to 15 percent slopes (INFOTEC 1990:2-43). Its taxonomy is very similar to the Houstake series.

From Terrebonne to La Pine, post-glacial erosion in the small valleys has created sediments consisting primarily of: stratified diatomaceous silts, sands, and fine gravels derived from the erosion of nearby basalt shield volcanoes of the Pliocene and Pleistocene age, as well as volcanic air fall deposits of basaltic to rhyolite composition. Lacustrine and fluvial sediments of the Late Pleistocene age in the area of La Pine occupy a basin between the axis of the Cascade Range and Newberry Volcano to the east (Chitwood 1976).

4. Research Design for Quartz Mountain

Located on the Fort Rock Ranger District of the Deschutes National Forest, Quartz Mountain offers the opportunity to record a raw material source before collectors remove the undisturbed remnants of early human use of this obsidian source.

My research has found that Forest Service policy only requires that 20 percent of low probability areas be surveyed (Claeyssens 1992: 29). A review of a USGS map places most of Quartz Mountain in this category (L2, slopes greater than 20%). Having worked for the Forest Service for several years using these guidelines to set up surveys, I was well aware that much of Quartz Mountain had not been surveyed. With this in mind I set up my survey to look at those areas that I felt had not been surveyed, but had the potential to yield information on prehistoric use of the mountain's raw material source.

The survey of the mountain was conducted June 1997 through August 1997 by John Hatch, Theresa Miller, Alan Greenfield and Kim Hatch. Two or more surveyors covered the mountain using north-south transects spaced 10-20 m apart. When the topography did not permit this strategy, the transects were done according to the topography.

The survey revealed that in the area located on the NW slope (T23S, R15E , Sec. 5 NE, NE) of Dry Butte, just off the 2269 road, fist-sized nodules of red/black and black obsidian are present in large numbers. Large veins of predominately red obsidian with small amounts of black obsidian were present in the same location. These veins of red obsidian were mined out of the rhyolite to the extent that large overhangs were created, with extensive lithic debris scattered downhill from these locations. On the south side of Quartz mountain, another area of rhyolite outcrops have veins of red and red/black obsidian, but this area was not used as extensively. Lower down the south slope there is a very large area of large blocks of black obsidian that shows extensive use. On the north slope there are areas of very large boulders of black obsidian with some small areas of rhyolite with veins of red/black obsidian. This area also shows extensive use. The only area on the mountain that I found that did not have any obsidian was the northeast side. Based on the distribution of materials on Quartz Mountain, I addressed two major research questions:

1. Why was the red/black obsidian in the large veins extensively mined, whereas the same material, which can be found in nodules on the hill side in the same area, appears to have not been utilized as much or at all? I attempted to answer this question by designing a collection strategy that sampled workshop areas and by taking samples of both materials. I also used the same tools available to the early peoples and conducted lithic reduction experiments to see which material had the best physical properties. These experiments were done to determine if the nodules have structural flaws that made them less desirable over the material found in the large veins.

2. The survey of the area found that at least two different lithic reduction strategies, blade core reduction and biface reduction, were used to reduce the materials found on Quartz Mountain. In order to learn which reduction strategy was used the most, I used a collection strategy designed to obtain a good sample of both reduction methods within the same given area. The surface collection

gave me a better understanding of the lithic reduction strategies used on Quartz Mountain. This information and the survey of the area can establish the prehistoric use of the area so the U.S. Forest Service can better maintain the resource in the future.

The areas on Quartz mountain that I thought could best answer these questions are located in the NW 1/4, of the NW 1/4 of Section 4 and the NE 1/4 of the NE 1/4 of Section 5, Township 23 South, Range 15 east (see Figures 4.1 and 4.2). These areas were chosen to answer these questions, because they represent at least one or more types of obsidian (red/black obsidian found in veins with nodules or black obsidian) and both reduction methods of ore reduction were present.

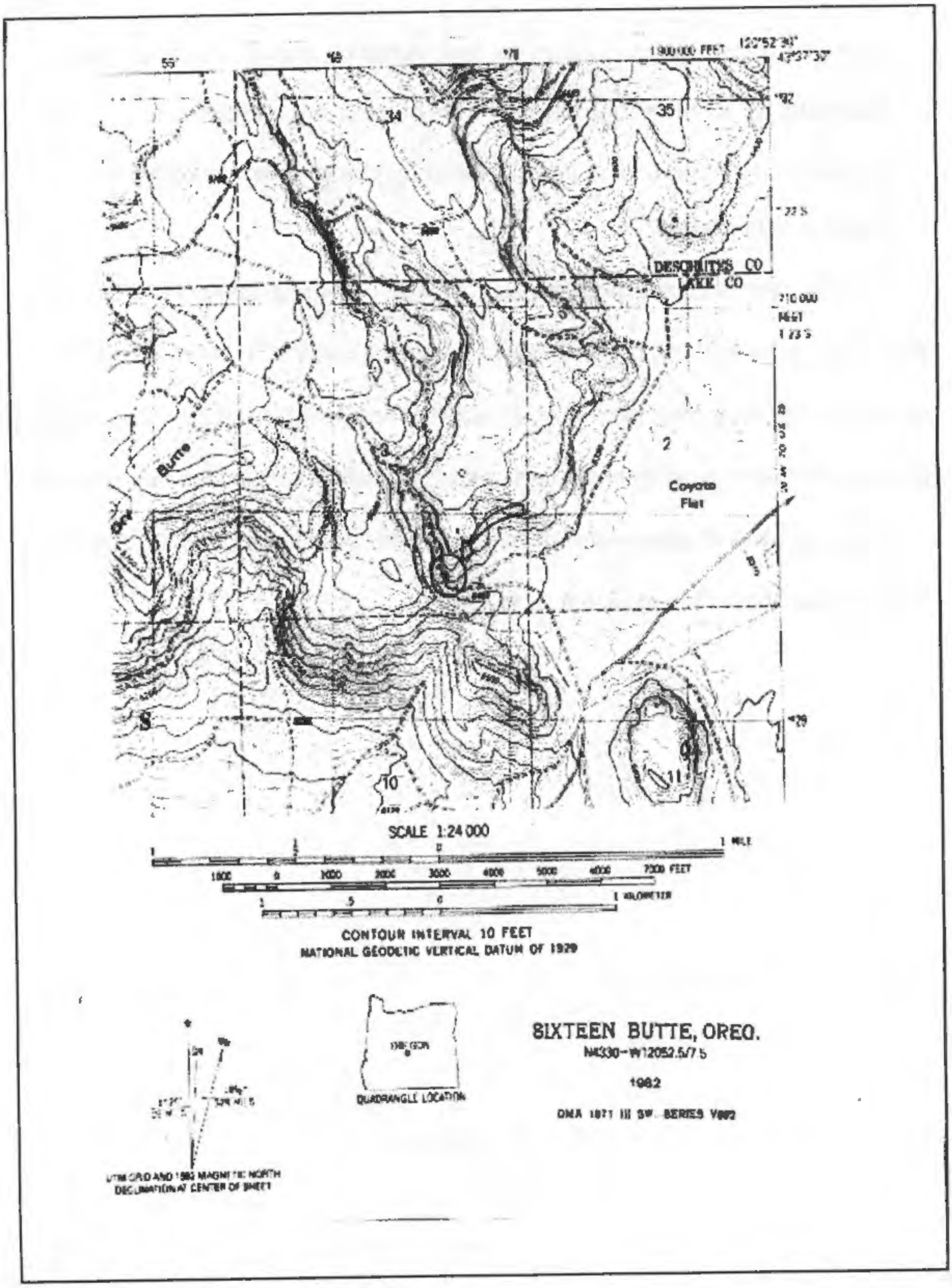


Figure 4.1 Location Map of Collection Unit A (block type obsidian).

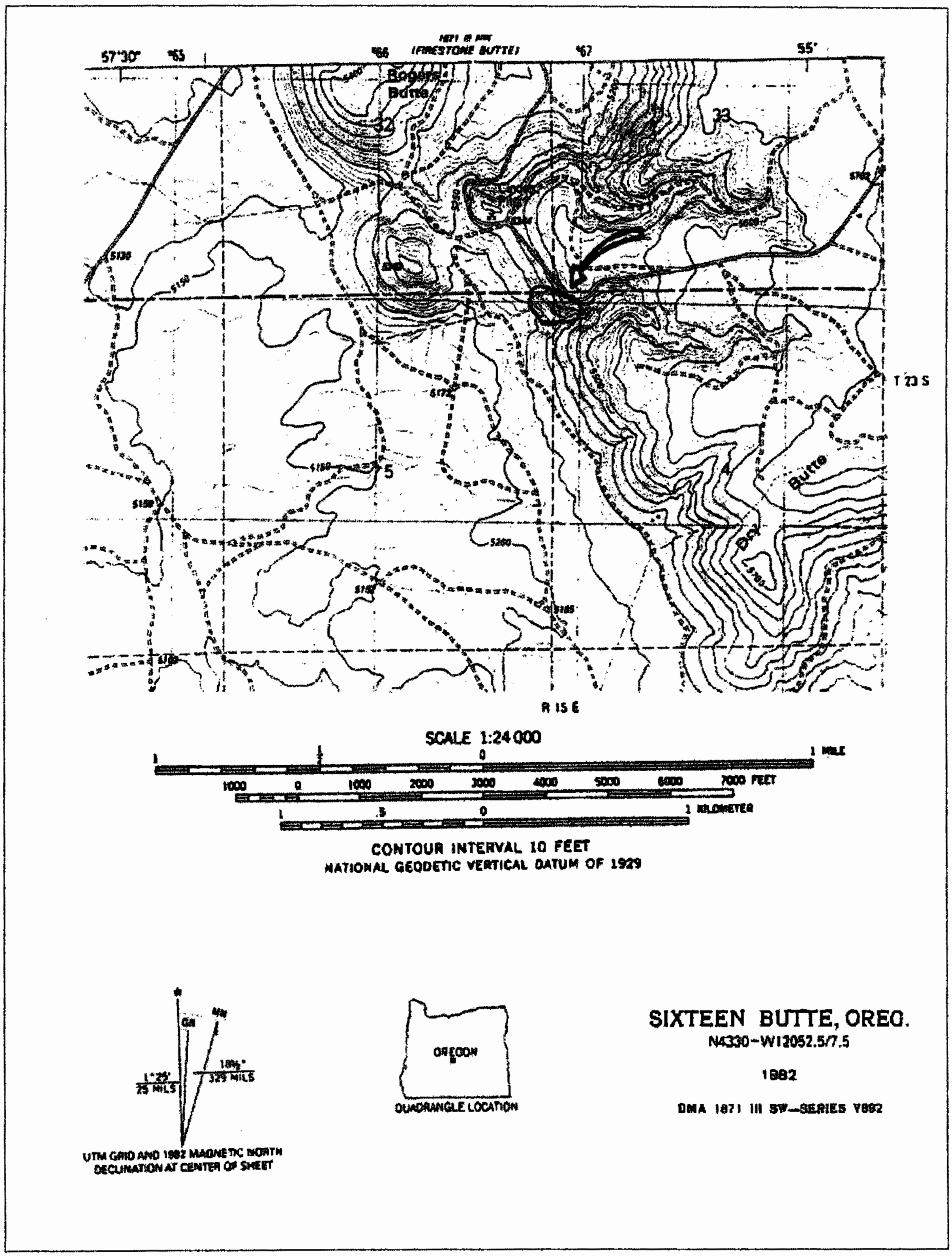


Figure 4.2 Location Map of Collection Units B and C
(red nodules and mined red obsidian)

4.1 Lithic Production Systems (The Problem)

Traditional approaches to stone tool analysis have been inadequate when it comes to considering that the structure of assemblages is related not only to the set of activities in which they are directly employed (Shott 1986:16), but also to other components of cultural systems. What is needed is an expanded view of the role of tool assemblages within cultural systems, one which takes into account how these assemblages are adapted to constraints imposed by aspects of cultural systems such as settlement mobility (Binford 1980; Kelly 1980, 1983; Shott 1986:16), the maintenance of social boundaries, and the properties of resources such as their predictability, stability, and mobility (Shott 1986:16).

For the purpose of my research a lithic production system can be defined as total synchronous activities and locations involved in the procurement and modification of a single source-specific lithic material for stone tool manufacture and use in a larger cultural system (Ericson 1982, 1984). Production is seen as a process of material modification with intent to form a particular object. During the course of many stages of production of the material, debitage will be created at the sites of production, which will be indicative of the stages of production (Crabtree 1972). Debitage analysis is a basic technique used in the reconstruction of a lithic production system.

In the context of this thesis, the reconstruction of lithic production systems is fully justified from a phenomenological point of view. The structure of a lithic production system will reveal a great deal about the investment of human energy involved in production and decision making, having economic value. The nature and internal organization of these systems are important to further our understanding of production and resource utilization in the context of procurement, exchange, technology, and social organization.

Reconstruction of a lithic production system can be achieved by adopting the techniques used in reconstructing an exchange system. Production indices are calculated and used like an exchange index to reconstruct a synchronous lithic production system in space (Ericson 1982). For this thesis, I looked at several different locations on Quartz Mountain and formulated the results in three tables (Table 7.2, 7.3, 7.4). Each index has a particular function in reconstructing the amount and location of different stages of production of a specific lithic material.

Past research has found that the morphology and the internal structure of these systems will vary a great deal. Some types of systems are immediately apparent. In some stages production will be restricted to a particular zone. More frequently, reduction is taken to a particular stage in one area and then completed in other areas of the system where the final production is completed at or near the site of consumption and use (Ericson 1984:4). Production can also be quite irregular and dispersed throughout a region. The zone of production can also vary. Some production systems will be centered and restricted to the source; a quarry-based lithic production system. Other systems will extend out into the local area surrounding the source, a local lithic production system. These differences are probably related to quarry ownership and the supply of labor involved in production. Production will frequently occur throughout the entire region, a regional lithic production system. The types of production form a continuum, from terminal to sequential to irregular. Each requiring different energy budgets and varying numbers of producers. The sites of production can occur at the quarry, within the local area, or within the region.

The quarry and its associated workshops are the most important components of a lithic production system. With this in mind, most of the remaining chapters in this thesis will demonstrate the importance of the quarry in understanding lithic production. Past research has found that a number of important activities and associated behavior patterns can be studied directly on the quarry site (Singer and Ericson 1977).

The changes in lithic technology on the quarry workshop can also be studied (Singer & Ericson, 1977). While working at the Bodie Hill quarry in eastern California, Singer and Ericson have been able to link changes in production rates with changes in reduction technology. These changes in production and technology also have been found to occur simultaneously at other quarry workshops in central and eastern California (Ericson 1981, 1982, 1984).

The analysis of the quarry and its associated workshops can provide primary data for determining extraction technology, raw material selection processes, knapping behavior, reduction technology, material products, production rates, changes in technology, and the dynamic stability of production, exchange, and technology over time (Brauner, personal communication, 1996).

4.2 *Analysis of Lithic Production Systems*

Analysis of a lithic production system cannot begin until an understanding of what is expected to be found at a material source is known. Current research reveals that certain types of artifacts can be found at quarry sites, such as hammerstones, picks, sledges, and wedges. Comparative studies of several assemblages show evidence of quarrying activities containing large amounts of primary reduction debris along with various stages of core reduction (Dibble and Roth 1998).

There will be a large number of cortical flakes, although the amounts of cortex will vary with nodule mass (Butler and May 1984). A large quantity of debris will also be found, along with "rejected" pieces such as broken tools, and thick blades (Dibble and Roth 1998). These sites may also contain worn or broken tools made from non-local materials (Gramly 1980).

With the knowledge of the artifacts that have been found at quarry sites a wide variety of categories have been employed in the analysis of the debitage presumed to have been produced by primary core reduction (Crabtree 1982; Flenniken 1993; Sullivan 1985:756). Many of these non-tool debitage categories are well defined, but they all have something in common; the three basic categories of primary, secondary, and tertiary flakes. They are also frequently accompanied by a residual category called shatter, chunks, or debris (Flenniken 1993; Sullivan 1985:756). Progressively decreasing amounts of cortex distinguish the three categories, with primary flakes having the greatest amount of cortex and tertiary flakes the least. According to some analysts, the categories reflect a very specific sequence of flake removal (Crabtree 1982; Flenniken

1993; McDonald 1985; 63; Muto 1976; Whittaker 1994): primary flakes were removed before secondary and tertiary flakes, and secondary flakes before tertiary flakes. These categories are so unquestioningly accepted that often they are not accompanied by attribute definitions (Stafford 1978:20-22; Sullivan 1985:756-757).

The assumption that these categories represent an invariant sequence of flake removal is imprecise because there is no technological dependency between them and core reduction. For example, primary flakes (flakes that have substantial cortex), may be removed at any point during the reduction sequence. Cortical variation, which is the basis for distinguishing between the non-tool debitage categories, is only indirectly related to technology. The proportion of cortical debitage in an assemblage results from: (1) raw material type and availability; (2) nodule or core size; (3) intensity of reduction; (4) the nature of regional raw material procurement and reduction systems; and (5) stylistic and functional factors (Sullivan, 1985:756). Sullivan (1985:756) and Stafford (1979:111) have come to the conclusion that "primary and secondary flakes were more similar to each other than either was to tertiary flakes" because a variety of independent technological and non-technological factors influence cortical variation. It is misleading to use cortical variation exclusively to describe prehistoric technology from what is found in workshops because we do not know exactly what was taken away and used elsewhere (Sullivan, 1985:756: Brauner, personal communications, 1997).

Debitage analysis that employ categories based on the arbitrary division of cortex are compromised by the consequences of two major operational problems. First, no currently available procedure can reliably replicate the partition of varying expressions of cortex on debitage. Second, because the proportion of cortex that defines a specific debitage category is unstandardized, primary or secondary flakes of one study would be classified as secondary or tertiary flakes in another (Sullivan 1985: 756). This lack of standardization produces a substantial lack of comparability between studies.

Research has also found that non-tool stage typologies cannot accommodate the known range of debitage variation. Their categories are restricted to complete specimens exclusively, but in the real world the majority of the material found is just the opposite. Non-cortical proximal or distal flake fragments, for example, cannot be classified as tertiary flakes because missing portions may well have been cortical. Furthermore, the three debitage categories discussed above do not incorporate criteria that allow classification of proximal flakes (flakes that are broken, but still having platforms), debris (chips or shatter, broken flakes not having platforms), and other types of debitage (Crabtree 1982:9-10).

For this reason I focused on looking at the percentage of bifaces versus cores and core fragments, the types of flakes and, the amount of debris in the analyzing the assemblages obtained during surface collections. The distinction between blade cores and flake cores (biface) was made by looking for scars on possible cores which were the result of removing blades or flakes by applying force from two directions. For bifacial reduction I looked for artifacts bearing flake scars on both faces that were not derived from blade core technology. Color of obsidian was also included in the analysis to determine if red obsidian was used over black obsidian when both were readily available in the same area.

4.3 Experimental Data: Examining Lithic Production Systems

Because production strategies involve complex motor skills easily imparted outside an apprentice-type situation, they are more diagnostic of specific cultural traditions than stylistic phenomena such as design and shape which are easily imitated and disseminated. For this reason, a classification system based on technological considerations is particularly useful to the prehistorian faced with the problem of locating people in time and space on the basis of their artifacts.

In order to bridge the gap between living craftsmen and their prehistoric counterparts, the link between the production process and the resulting artifact morphology must be established. By using controlled experiments with the same tools that were used by early flintknappers, it will be possible to specify how particular technological decisions on the part of a craftsman are recorded in the combination of individual attributes (such as flake scars) and in the sequencing of attributes on the finished experimental artifact. With this type of information I can make educated inferences concerning how prehistoric artifacts were made. Finally, it is possible to use various kinds of information derived from prehistoric artifacts and the environmental data with which they are associated to formulate hypotheses about how the artifacts were used. These inferences about how prehistoric artifacts were made and used can be tested experimentally, and this experimental data fed back into the overall interpretation of the assemblage.

4.4 Lithic Raw-Material Availability

The availability of lithic raw materials has been considered by some researchers to be the most important factor in the organization of technology (Andrefsky 1994:23). The ethnographic record has shown that the availability of lithic raw materials plays a primary role in the amount of effort expended to produce various types of tools. O'Connell's work with the central Australian aborigines has found that variations in the lithic assemblage is primarily due to the availability of lithic raw materials (O'Connell 1977:280; Andrefsky 1994:23).

The archaeological record indicates that prehistoric populations discarded formal tools made of high-quality lithic raw materials when new material sources were found (Andrefsky 1994:23). Gramly (1983) reported what appears to be "dumping" behavior at a small habitation site located just outside of Mount Jasper prehistoric quarry in New Hampshire. What he has found in this situation is that it appears that a prehistoric group traveling from a distant location retooled at the quarry and moved on. In the process, they discarded formal tools, which may have been transported from as far away as northern Maine and New Brunswick (Gramly 1983:826). At this time period it is not known what the circumstances of travel were for the prehistoric population that retooled at Mount Jasper. But, Gramly notes that there wasn't any evidence showing extended periods of habitation. The visit appears to have been primarily for the acquisition of lithic raw material from the nearby quarry (Gramly 1983:825).

One of the outstanding attributes of the ethnographically known desert Aborigines of Australia was their willingness to make long trips for the primary purpose of visiting sacred sites and meeting with members of the patrilineages controlling those sites (Berndt and Berndt 1964:107). It was noted that all-male groups made these trips. Some of these trips covered several hundred kilometers from their home areas. These special, long distance trips were called "panalipi" (translated literally: "all over the earth") and the tracks followed on such trips were a favorite theme for depiction in rock and cave art. Travelers on these trips camped together in distinct, all-male enclaves within the main concentration of campsites occupied by the locally resident population. Such trips established the introductions necessary for later use of the resources of these distinct areas by the visitors with their families, and lithic materials were often obtained and transported over long distances during the course of such trips. These trips were also important for arranging betrothals (Berndt and Berndt 1964:107; Gould and Saggers 1985:122), which in due course would mean that one was also establishing in-law relationships over these same long distances. Such in-law connections involved obligatory sharing of food and access to other resources. This relationship was considered the most strictly observed in their society.

Long-distance trips were therefore of adaptive significance, since they were instrumental in establishing social networks over wide areas of the desert. Lithic procurement occurred not only in the context of day-to-day foraging and resource procurement activities, but also in relation to these special, long-distance trips (Gould and Saggers 1985:122).

While Binford was working with the Nunamiut Eskimo's, he found just the opposite in that raw materials used in the manufacture of implements were normally obtained incidentally to the execution of basic subsistence (Binford 1979), put simply, procurement of raw materials was embedded in the basic subsistence schedules. "*Very rarely, and then only when things have gone wrong, does one go out into the environment for the express and exclusive purpose of obtaining raw material for tools*" (Binford 1979:274).

Binford gives this example:

> A fishing party moves into a camp at Natvatrauk Lake. The days are very warm and the fishing is slow, so some of the men leave the others at the lake fishing while they visit a quarry on Nassaurak Mountain, 3.75 miles to the southeast. They gather some material there and take it up on top of the mountain to reduce it to transportable cores. While making cores they watch over a vast area of the Anaktuvuk Valley for game. If no game is sighted they return to the fishing camp with the cores. If fishing remains poor, they return to the residential camp from which the party originated, carrying the cores. Regardless of the distance of Nassaurak Mountain from the residential camp, what was the procurement cost of the cores? Essentially nothing, since the party carried the lithics in lieu of the fish that they did not catch. They had transport potential, so they made the best use of it; the Eskimo say that only a fool comes home empty handed! (Binford 1979:274).

With increasing environmental changes we would expect to find increased diversity within a group's mobility strategy, such that the seasonal use of a given region could be accomplished through one form of mobility, and the use of another region through a different form (*i.e.* root gathering in the high desert and salmon fishing in the river areas) (Binford 1982: Kelly 1988:301).

Reliance upon plant resources requires not only high residential mobility, but thorough coverage of an area as well, since there is a rapid drop in the utility of commuting long distances for plant foods. Reliance upon fauna allows for a greater expenditure of energy in traveling these great distances; however, it also means that a foraging area will become rapidly depleted of resources. Consequently, residential mobility must also be high, unless storable resources are present. Reduced residential mobility can occur as a response to the need for maintaining extensive mobility or to the need for maintaining continuous observation of a resource (Kelly 1988:301). This would require small groups of individuals to be constantly on the move in order to know when these resource were ready to be harvested (Hunn 1989).

In general, among groups with high residential and low logistical mobility, consumers (family or extended family members) are brought to the location of the food resources. Thus daily food-searching forays are generalized search-and-encounter hunting and gathering forays with a simple structure, involving a limited set of activities (Kelly 1983,1988). Ethnographic data indicate that in systems of high residential and low logistical mobility (Binford 1980) there are few bifacial tools (Kelly 1988:719), and tool needs often are fulfilled expediently. This information suggests that the type and distribution of local raw material is the primary factor affecting the lithic technology of foragers. When raw material is abundant and of adequate edge holding quality there is no temporal or spatial difference in the location of raw material and the location of stone use; in effect, stone tools have no role to play, and we can expect groups living under such conditions to employ an expedient flake technology, with little use of bifaces as cores. For example, Binford (1986) found that among the Alyawara of central Australia many morphological tool types were determined by the locally available material, either chert found in cobbles from stream or outcrops of quartzite (Bedwell 1986:548).

4.5 Bifacial Core Reduction

In simple terms a biface is a large flake or core blank that has been reduced on both faces from two parallel but opposing axes through percussion and pressure flaking, and is shaped into a specific form (Crabtree 1982: 16; Kelly 1988: 718: Muto 1976: 55; Whittaker 1994:19). The relatively high-energy investment in a bifacial tool indicates that it is not to be discarded quickly and that its sharpness is important to its role. But what is the specific role of a biface? Binford (1986) found that the Australian Aborigines made almost no use of bifacially flaked implements; in fact it is difficult to find ethnographic accounts of the use of bifaces among hunter-gathers (Kelly 1988:718). The position that I am taking here is that while all bifacial tools are shaped for a deliberate reason, there may have been several different reasons to do so; in other words, bifaces can play one or more of three different organizational roles in a technology.

First, large bifaces can be used as cores as well as tools (Andrefsky 1994: Bedwell 1980; Kelly 1988:718). The flakes driven off a biface are thin and sharp, and, depending on the size of the biface, may be small but still useful. More usable flake edge can be produced from a biface than from a percussion core of similar weight because each flake from a biface has a high edge-to weight ratio (Brauner, personal communication, 1997). The use of bifaces as cores indicates that hunter-gatherers need to be prepared for a variety of tasks requiring stone tools, but can anticipate not knowing exactly how many such tasks will be conducted in the future and that raw material may not be available where the group or individual intends to go. Using large bifaces as cores maximizes the amount of tool edge carried while minimizing the amount of stone, and, by carrying all tools as one solid biface, one can assure that flakes struck from it will have sharp, undamaged edges (Brauner and D.J. Rogers, personal communication, 1997: Kelly 1988:718)

Second, biface tools may be manufactured for their long use life (Kelly 1988:718; Shott 1986). A bifacially flaked edge can have a fair amount of cutting power, the less acute angle of a biface's edge makes it more durable than a non-retouched flake. A completely flaked bifacial tool has a similar micro topography along all its edges; should the tool edge break or become dulled, it can be resharpened relatively easily and continue to be useful. Within limits set by the raw material, a bifacial form simultaneously gives a tool sharpness, durability, and potential to be resharpened. Additionally, the generalized form of a biface allows it to be modified into other tools, such as scrapers (Kelly 1988:718; D.J. Rogers, personal communication, 1997).

Lastly, a tool may become bifacial largely as a by-product of stylistic or sharping concerns, an epiphenomenon of creating a tool which is distinctive to its manufacturer or its manufacturer's social group. Such tools could include projectile points, and may be produced by specialists (Kelly 1988:718). Similarly, a stone may be worked bifacially in order to fit it to a preexisting haft (Whittaker 1994:288). Kelly (1988) notes that most hafts were made from organic materials, that were more difficult and time consuming to manufacture than the stone tools which they hold; consequently, the tool must fit to the haft rather than vice versa. Not all hafted stone tools are bifacial (Flenniken 1981, 1991: Kelly 1988), but for those stone tools which have become bifacial as a function of their having been shaped to fit a haft, bifacial flaking is not as necessary to their intrinsic function as it is for the other two types of bifaces.

4.6 Blade Core Reduction

Blade core reduction is the processes of developing a ridge system for the blades to follow. Blades made from blade cores are parallel-sided flakes that are twice as long as they are wide with one face being smooth and the other faceted with a few long surfaces. These flakes were subsequently used as knives or made into blanks from which many different specialized tools could be made Once the first blade is successfully detached, the edges of its flake scar form ridges that other blades can follow, and if the core is of good quality and the knapper is skilled, it is possible to work around and around a core, removing blades (Figure 4.3). This is a very efficient use of material; more edge per pound can be made by blades than by any other method (Brauner, personal communication, 1996; Muto 1972; Whittaker 1994).

With the blades that are produced from this technique a variety of tools can be made ranging from finished projectile points to steep end scrapers. The only drawback to this technology is that blades tend to break easier than points made from the biface methodology and they tend to dull much more easily and require re-sharpening (Brauner and D.J. Rogers, personal communication, 1997). Blade cores are usually made from flint or obsidian.

There is currently a debate going on among archaeologists concerning the relationship between mobility and technology. Bifacial tools or cores are generally associated with frequent movements between residential areas and/or lengthy logistical movements, while blade core flake tools are associated with longer residential periods and/or infrequent residential moves (Kelly 1992).

Blade core technology has been associated with early sites throughout North America. This early tool technology has been found in association with big game hunting and the use of the atlatl or spear throwers. The peoples who used this technology were likely only traveling short distances and using the tools as needed (Parry and Kelly 1987).

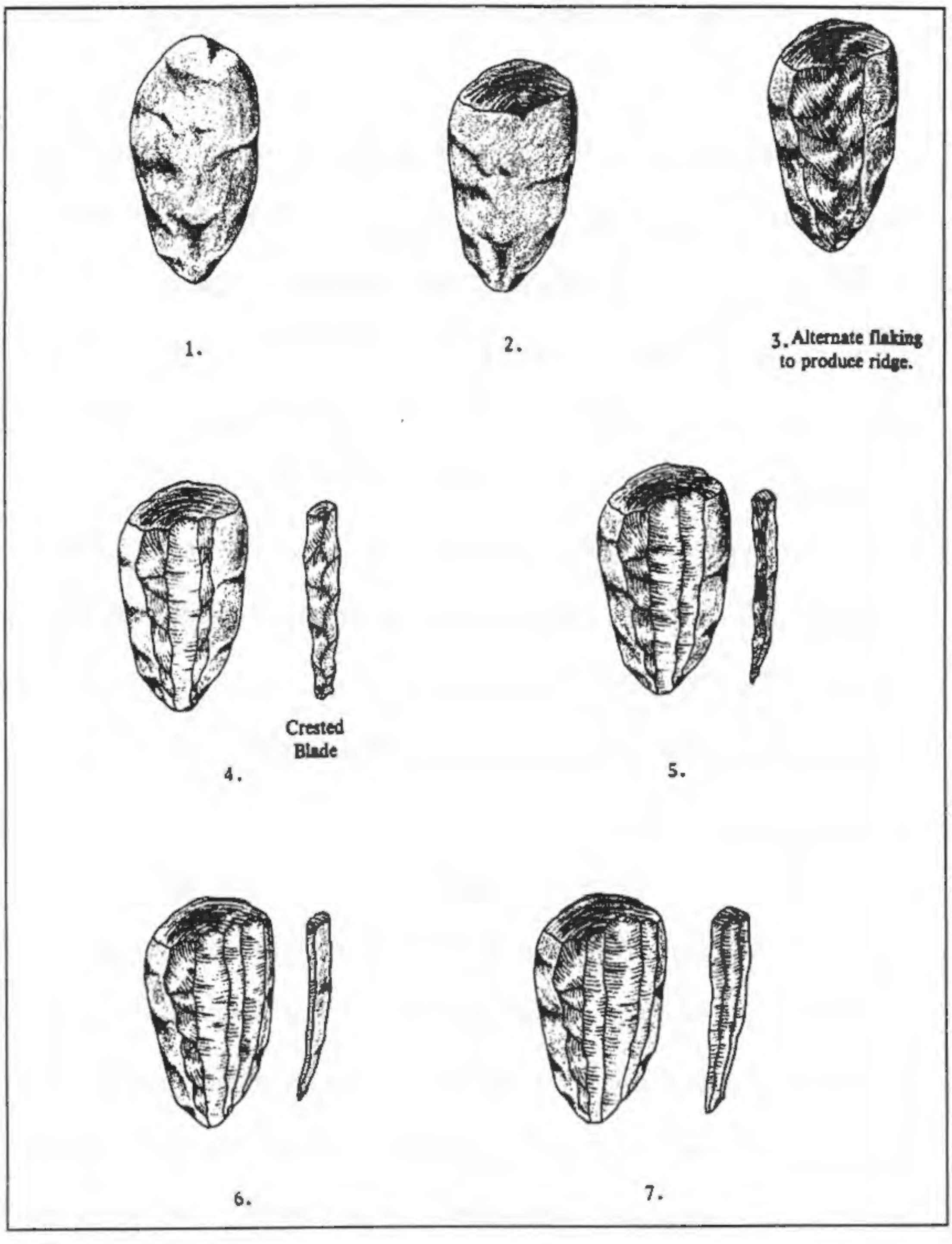


Figure 4.3 Blade Core Methodology. Blade core reduction methodology found on Quartz Mountain. Sequence of core and blade manufacture (adapted from Crabtree 1982).

5. The Regional Lithic Resource Base of the Central Oregon Area

An important factor in trying to understand procurement and production is to understand the regional lithic resource base (Figure 5.1). For the most part, researchers are only interested in the dominant lithic material at a site or those materials transported long distances as exchange items. For a stone-tool-using society it is important to understand the structure of the lithic resource base. Preliminary work done by Wright in 1974 found the need existed to consider alternative lithic materials in reconstructing prehistoric exchange systems. The location of and distance to alternative lithic resources affect the morphological characteristics of obsidian exchange systems (Ericson 1977, 1981, 1984). Reconstruction of the regional lithic resource base will allow researchers to account for this type of interaction and other processes that are involved in procurement.

Further research in lithic reduction methodology should also include variables related to technology and function. For example, different materials often appear in different categories of function and tool typology. This is particularly the case in areas where there is a great diversity of rock types. Since the physical properties of obsidian are quite variable, these properties most often play an important role in the processes of selection and tool function. Although the importance of physical properties on selection of stone tool material has been discussed (Goodman 1944, Ericson & Singer 1977, Ericson, 1984: 6), these relationships have not been adequately demonstrated. For this reason, one goal of my thesis is to sample the material mined at Quartz Mountain and try to reproduce usable tools from this material to see if the material can be worked and if differences between veins and cobbles may account for differences in use.

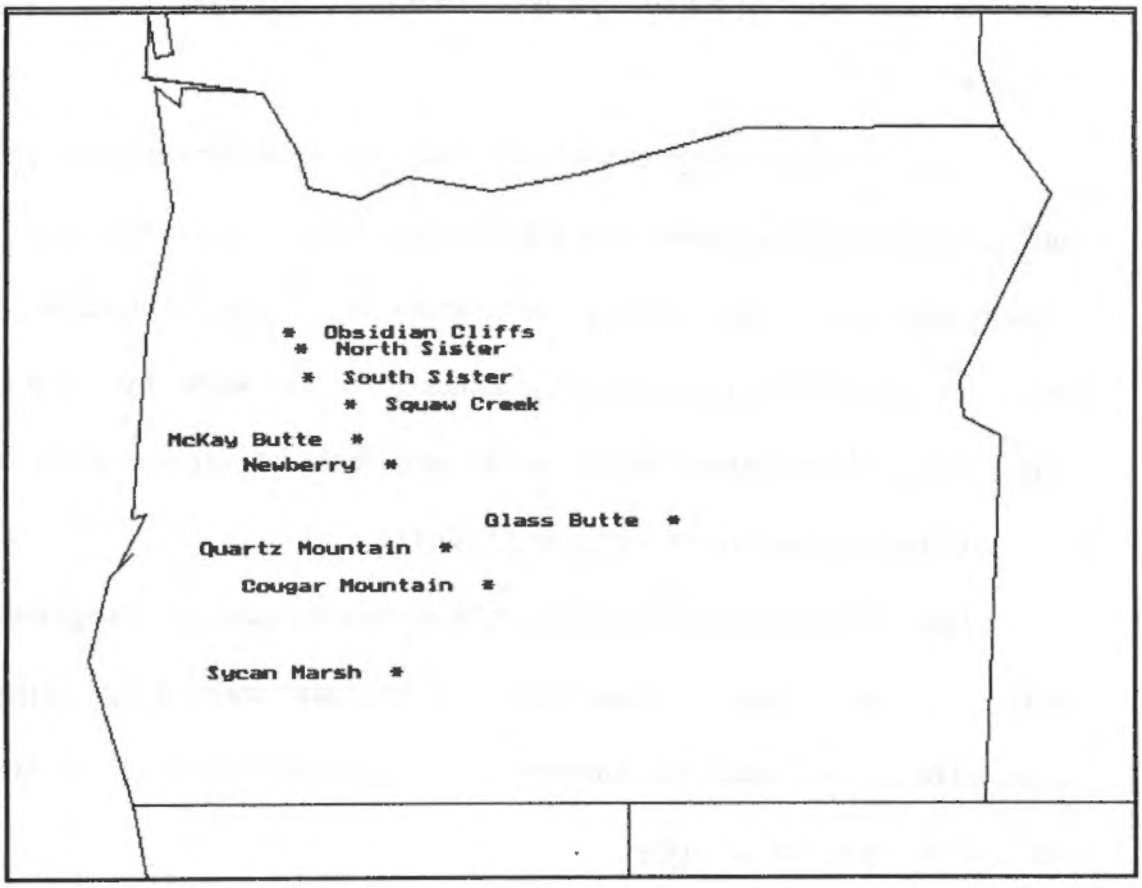


Figure 5.1 Material Sources. Map showing approximate locations of all known material sources in the Central Oregon area known by the author.

6. Research Methods

To address the production systems used on Quartz Mountain, I did surface collections and analyzed the recovered material using the indices mentioned earlier, and did an extensive literature search to see which reduction strategies applied to Quartz Mountain.

I found that archaeologists have traditionally resorted to the use of two types of analogs in classifying and interpreting flaked stone artifacts: (1) ethnographic and experimental analogs based on primary observations, and (2) analogs based on inferences made in modern and prehistoric contexts. For my research I will look at ethnographic and experimental analogs, as they provide the interpretive framework for reconstructing the prehistoric use of Quartz Mountain.

The cultural material recovered from the surface was acquired through controlled surface collection. Artifacts collected were labeled and later analyzed. The artifacts collected during the surface collection appear to be a representative sample of those observed during the initial survey.

To obtain a controlled surface collection, two metal spikes were first established as datums on one of the upper terraces of the site. This was done to establish semi-permanent reference points for the laser transit. The area surrounding these datums were then recorded, with special interest given to large debitage concentrations and the elevations of material mining areas. After the survey was completed and the resulting map was produced, two areas were selected for the surface collection. These areas were chosen after the survey was completed and all areas were examined and broken down into respective categories, (e.g. areas where obsidian was found mined out of the rhyolite with cobbles and large block cobbles eroding out the hillside). The areas were then reexamined on the ground and the collections units were then chosen by their ability to answer the research questions.

Three one-by-one meter units were collected. These collection units were randomly chosen by a lottery method (all workshop areas were given numbers and placed into a box and randomly drawn in this method). After the reduction areas were chosen, the area was broken down again into one-by-one meter collection units. All the material that was collected from the three collections units were placed into paper bags with GPS locations and site specific information on them.

Figure 6.1 Collection Unit A. This area is predominately black obsidian reduced from the large cobbles eroding out of the hillside.

Figure 6.2 Collection unit B. This site is predominately red/black obsidian.

Figure 6.3 Collection unit C. This area is primarily red/black obsidian, although some of the red/cobbles were utilized.

Collection unit A (Figure 6.1) was located in the site area 2002 A, GPS location 43 degrees 36 minutes 23 seconds north, 120 degrees 53 minutes 95 seconds west . This area I felt best represented the material (large block) and technology that was typical of the lower portion of Quartz Mountain. A datum was established and a one-by-one meter collection unit was laid out, and all the material was collected from the surface.

Collection units B and C were located in an area which contained several lithic reduction areas. Collection unit B (Figure 6.2) was located (GPS location) 43 degrees 36 minutes 90 seconds north, 120 degrees 55 minutes 94 seconds west. Collection unit C (Figure 6.3) was located (GPS location) 43 degrees 36 minutes 90 seconds north, 120 degrees 55 minutes 91 seconds west.

The raw material that was collected for the lithic reduction experiment was collected in such a matter as to not disturb the sites' integrity. The cobbles were collected from the material displaced by the construction of the 2269 road. The material that was taken from the rhyolite veins was also collected in such a manor as to not disturb the surrounding veins. The tools used were the same tools available to the Native Americans: rock hammers, antler hammers, and antler chisels. After several attempts to remove obsidian from the veins failed, another method was tried. This method involved taking a hammer stone and tapping the obsidian close to natural flaws. This method worked well, and several large pieces were removed without any damage to the surrounding obsidian.

7. Results

7.1 Survey Results

My survey of Quartz Mountain identified five extensive areas of quarrying which I have broken down into four sites (35DS2001-35DS2004). These sites cover vast amounts of surface area (Figure 7.1) and consist of large amounts of raw obsidian and extensive amounts of lithic debris. The amount of debris ranges from 500+ flakes per square meter to 10+ flakes per square meter on the fringes of the sites.

The survey also found that Quartz Mountain has been logged at least three times in the past; the most recent is ongoing. The damage to the sites is extensive and can no longer be tolerated. Skid trails made by bulldozers have caused extensive damage to several sites and large slash piles that have burned have caused the obsidian to turn frothy in some cases.

7.2 Surface Collection

The material that was collected was broken down into separate categories as follows: Blade cores (cores that were used to produce blades) blade core fragments (cores or fragments of a core, but not usable), complete tools (usable tools), proximal end flakes (flake that have the platform but is broken), complete flakes (flakes that are twice as long as they are wide), Bifaces (large flakes or long flat cobble that have flakes taken off both sides), and debris (chunks that are too badly broken to tell exactly what they were).

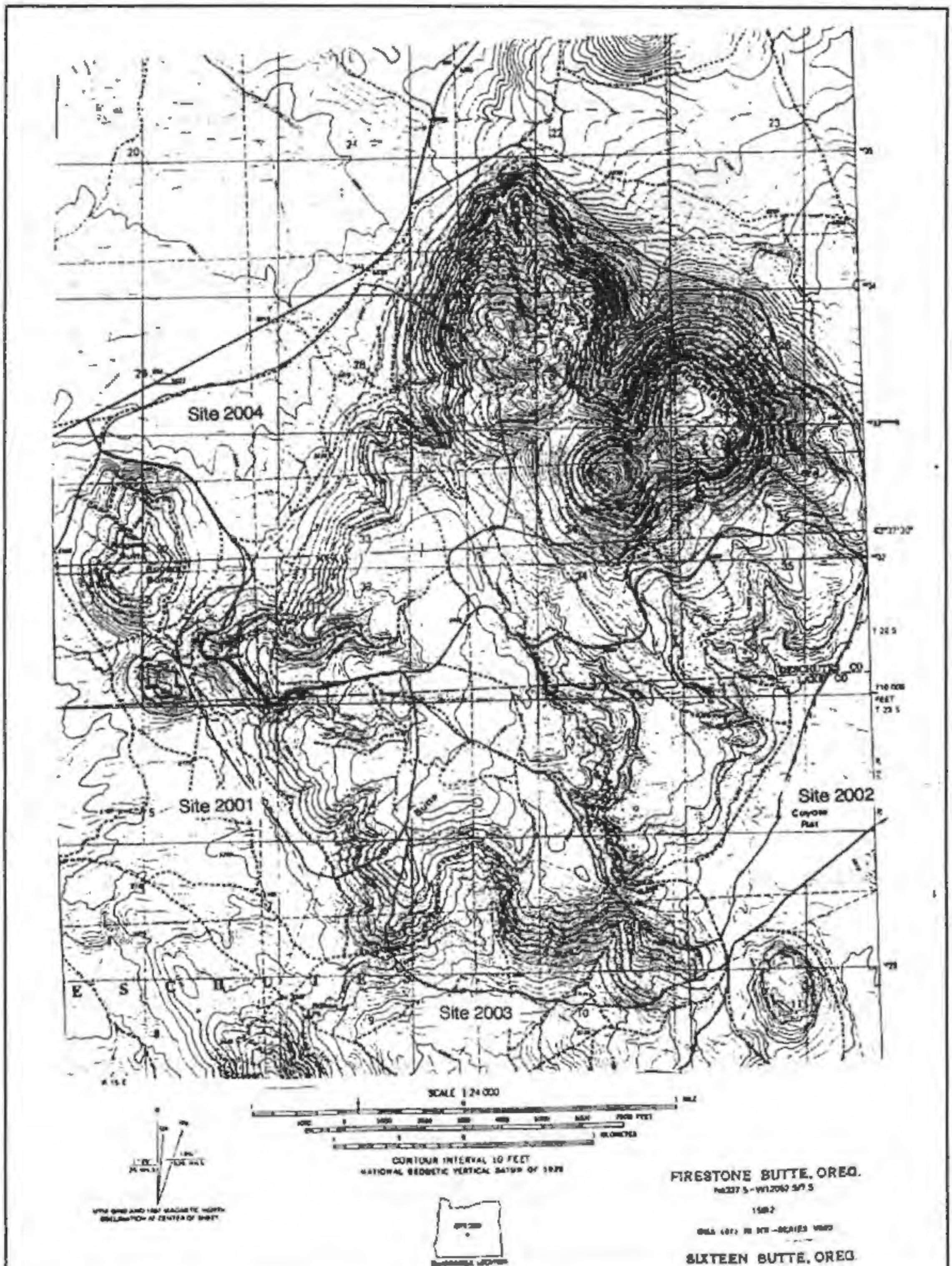
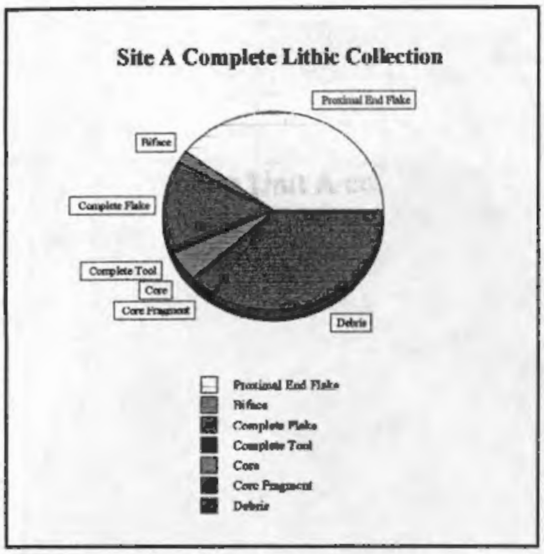


Figure 7.1 Site Map. Map showing site distribution on Quartz Mountain



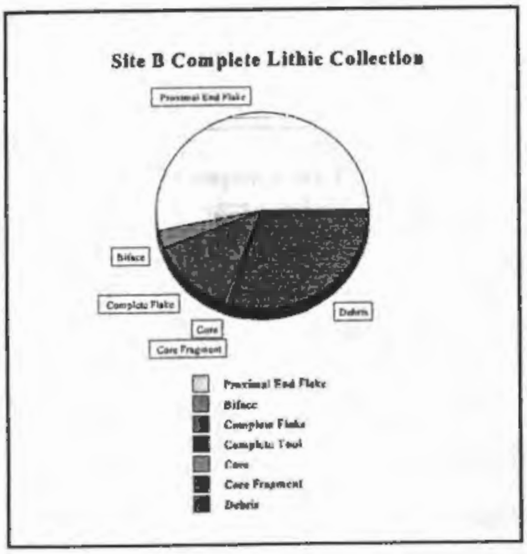
Artifacts for Site A:	No.	
Proximal End Flake	214	40%
Biface	11	2%
Complete Flake	78	15%
Complete Tool	1	.2%
Blade Core	25	5%
Blade Core Fragment	21	4%
Debris	181	34%

Figure 7.2 Quartz Mountain Site A Collection

The material collected from Collection Unit A (1 x 1m) consisted of one complete blade artifact (.2%), 11 bifaces (2%), 78 complete flakes (15%), 214 proximal end flakes (40%), 25 blade cores (5%), 21 blade core fragments (4%), and 181 pieces of debris (34%).

The material gathered at Collection Unit A indicates that two distinct tool reduction methods are taking place within this area: blade core and biface. The high percentage of proximal end flakes and complete flakes could be produced by both reduction methods. The cores and core fragments both indicate that blade core reduction was taking place as well as bifacial reduction. The debris is also a byproduct of both technologies. The presence of 25 blade cores and 21 blade core fragments compared to 11 bifaces suggest that blade core reduction was being used more extensively then bifacial reduction. However, the lower percentage of rejected bifaces and rejected biface does not mean that bifacial reduction methodology was used less. At this time we have know way of knowing what was taken away and reduced in to tools.

Collection Unit A contained predominately black (54%) and red/black (46%) obsidian. This is not surprising, as this area contains predominately black obsidian found in large blocks with some areas of red/black obsidian found in rhyolite outcrops.



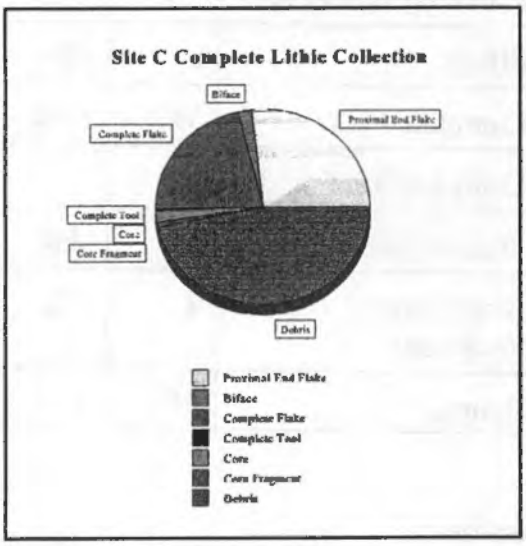
Artifacts for Site B:	No.	Percent
Proximal End Flake	**150**	**53%**
Biface	**9**	**3%**
Complete Flake	**38**	**13%**
Complete Tool	**0**	
Blade Core	**1**	**.4%**
Blade Core Fragment	**4**	**1%**
Debris	**81**	**29%**

Figure 7.3 Quartz Mountain Site B Collection

The material collected from Collection Unit B consists of no complete tools, 9 bifaces (3%), 1 blade core (.4), 4 blade core fragments (1%), 38 complete flakes (13%), 150 proximal end flakes (53%), and 81 pieces of debris (29%).

The material collected in Collection Unit B is a little different than Unit A, but with the presence of bifaces, blade cores, and blade core fragments, both technologies were being done within the same space. Here again the high percentage of proximal end flakes as well as complete flakes (53% and 13% respectively) could be produced with both technologies.

For Collection Unit B the flake evidence shows a higher percentage of red/black obsidian (88%), with less black obsidian (12%). This area also has a large amount of black obsidian that occurs in fist-sized and larger cobbles covered with cortex. The higher percent of red/black flaking debris indicates that the red/black obsidian was preferred over the black cobbles.



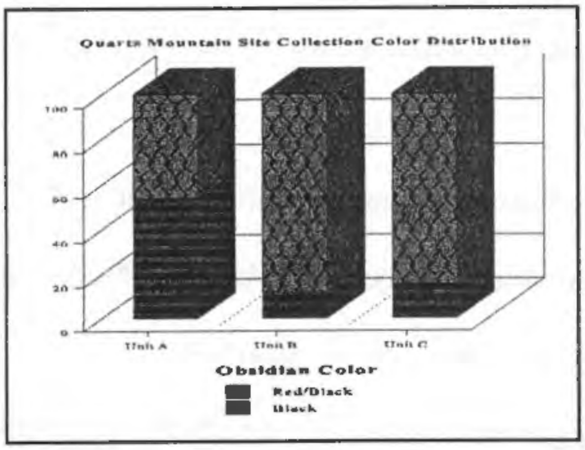
Artifacts for Site C:	No.	Percent
Proximal End Flake	69	27%
Biface	5	2%
Complete Flake	55	22%
Complete Tool	1	.4%
Blade Core	4	2%
Blade Core Fragment	2	.8%
Debris	120	47%

Figure 7.4 Quartz Mountain Site C Collection

The material collected from Collection Unit C (Figure 7.4) consisted of 1 complete tool (.4%), 5 bifaces (2%), 4 blade cores (2%), 2 blade core fragments (.8%), 55 complete flakes (22%), 69 proximal end flakes (27%), and 120 pieces of debris (47%).

The material found at collection unit C is similar to collection unit A and B in that bifaces, blade cores and blade core fragments are present indicating both technologies were again taking place in the same space.

For Collection Unit C the flake evidence shows a higher percentage of red/black obsidian (85%), with less black obsidian (15%). This area like that of Collection Unit B has a large amount of fist-sized and larger cobbles covered with cortex. The higher percent of red/black flaking debris indicates that the red/black obsidian was preferred over the black cobbles.



Site	Color	No.	Percent
A	Black	285	54%
A	Red/Black	246	46%
B	Black	34	12%
B	Red/Black	249	88%
C	Black	39	15%
C	Red/Black	217	85%

Figure 7.5 Quartz Mountain Collection Color Distribution

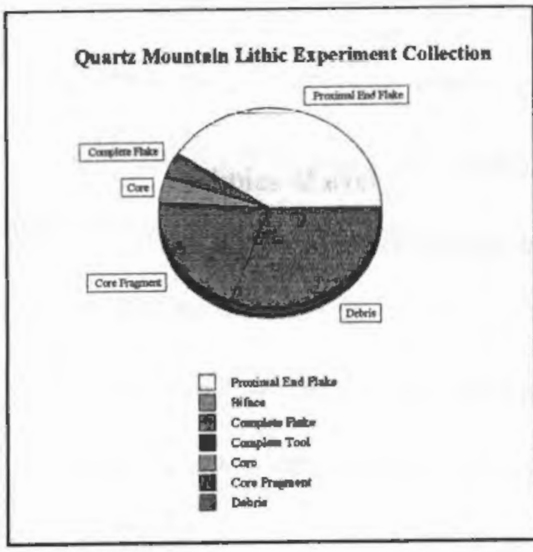
In summary, the color distribution (Figure 7.5) indicates that the material on hand is being used. The area around Collection Units B and C has a higher percentage of red/black obsidian than that of Collection Unit A, in that high grade red/black obsidian was obtainable in the rhyolite outcrops. The high amounts of mining back this up, whereas collection unit A indicates that the large black obsidian was preferred over the smaller red/black rhyolite outcrops.

7.3 Blade Core Replication Experiment

In an attempt to gain further understanding of the aboriginal blade core reduction methodology, a replication experiment was conducted. The experiment was preformed by Alan Greenfield and myself. This experiment involved the replication of a blade core and blades to see if there were differences (or if what was produced was similar) in the material that was recovered from the three collections areas. Afterwards the blades were reduced down into usable bifaces to see how they compared with the discarded bifaces found in the collection areas. This was done to determine the workability of the raw material from these locations.

The artifacts from the lithic experiment were compared to the other three collection artifacts to see if there was any correlation between what was observed at the collection sites and what was produced, during blade core reduction.

The experiment, although lacking in respect that I did not attempt to produce any bifaces or preforms from blade flakes, has several areas where similarities do exist and that is in the area of proximal end flakes and debris. Since I was only using blade core reduction methodology the numbers are similar in that respect (the percentage should be similar). But here again it must be noted that I was not trying to produce a biface or a blade preform, and we have no idea how much material was actually taken away from the source by the early craftsmen.



Artifacts from Lithic Experiment:	No.	Percent
Proximal End Flake	20	40%
Biface	0	
Complete Flake	2	.4%
Complete Tool	0	
Core	2	.4%
Core Fragment	10	20%
Debris	16	30%

Figure 7.6 Quartz Mountain Lithic Experiment Collection

7.4 Description

The objectives of the experiment was to determine (1) If the material that was recovered from the surface collection is typical of material left behind by knappers or are there stages missing?; (2) To determine if the cobbles found naturally on the hillside were utilized or was the material that was mined out of the large veins the preferred material; and (3) To determine if the amounts of cortex found on the collected material is a viable percentage.

7.5 Controlled Variables

Lithic material: Quartz Mountain obsidian, cobbles and material gathered from the veins.

Percussors: Quartzite hammer stone and deer antler billet.

Method of manufacture: Flake reduction using direct freehand percussion.

Stages of manufacture: The core reduction experiment was conducted by myself by reducing two cobbles of average size. The material was collected and analyzed using the same methodology used to analyze the material collected from the three collection units. The second part of this experiment was carried out by Alan Greenfield and myself. This involved using material gathered at the site that best represented the materials that were being utilized by the aboriginal knappers. Both cobbles and material from the veins were collected.

Two blade cores were reduced to the approximate size that were found on Quartz Mountain. A total of 20 proximal end flakes (40%), 2 complete flakes (.4%), 2 blade cores (.4%), 10 blade core fragments (20%), and 16 pieces of debris (30%) were collected after this core reduction was done. Some differences between these remains and the collection units were found, primarily in the amount of cortex. This could be explained by the fact that my experiment consisted of only the decortication process and no further reduction was conducted, whereas the aboriginal knapper was doing more than just making blades; he was reducing his material into workable preforms or blanks that would later be reduced into finished tools at another location other than the quarry (Muto 1976:136). One other possibility for the difference in the amount of cortex is that the aboriginal knapper may have taken the first blades struck from the core to reduce them into preforms or tools.

The results of the raw material experiment was that the red/black obsidian found in nodule form was workable, but had some limitations. It pressure-flaked like pie crust, meaning it was hard to make nice long pressure flakes. The material found in the veins was of somewhat better quality, but like the nodules was hard to finish and was found to not have as sharp a cutting edge. The predominant black obsidian found at other places on the mountain is a higher quality obsidian and works down into finely finished tools that have very sharp cutting edges.

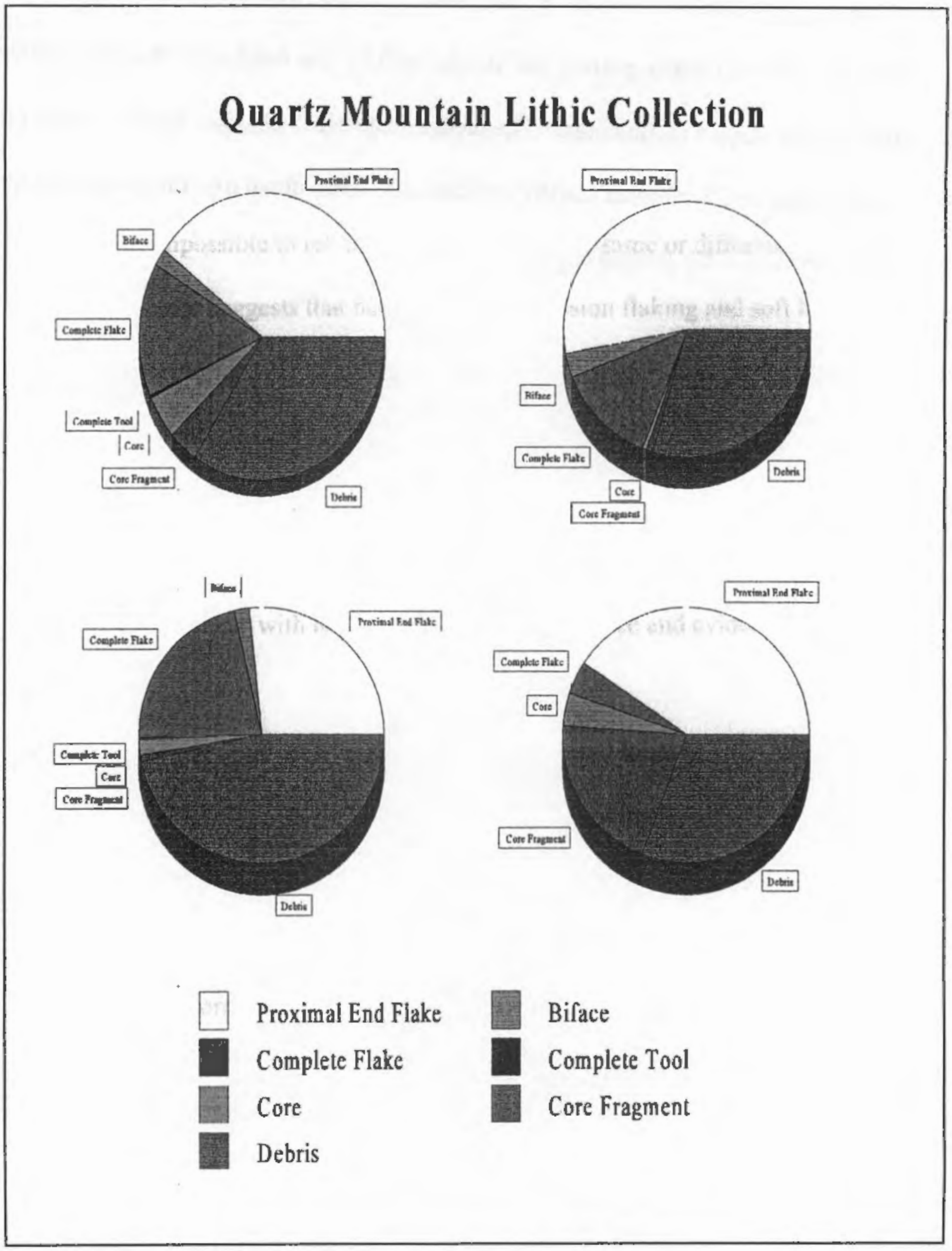


Figure 7.7 Lithic Collection Comparison Chart

7.6 Summary

The results of my surface collection indicate that there were two different reduction systems taking place on Quartz Mountain: blade core (Figure 7.2) and bifacial reduction (Figure 7.3). Both of these reduction processes were taking place in the same areas, but it is impossible to tell if they were done at the same or different time periods. The lithic evidence suggests that hard hammer percussion flaking and soft hammer billet were the only activities taking place.

The evidence for this is that a close examination of all the artifacts show pronounced bulbs and diffused force rings, both of which indicate that some degree of force was being applied. If finish work was being done at these sites, we would see smaller complete flakes with less pronounced bulbs of force and evidence of platform preparation.

None of this was found in my analysis of Quartz Mountain material, although the presence of broken bifacial preforms show that edge grinding was done to strengthen the edges for the next set of flakes. Due to the lack of finished tools or finish flakes recovered during the surface collections, the evidence suggests that the knappers were taking bifacial preforms and blades to other locations and doing finish work there as needed. This evidence has been found at occupation sites on the Deschutes and Ochoco National Forests, where finished artifacts as well as finish flakes are present.

The illustrations in this chapter (Figure 7.8 through 7.42) are typical of the reduction materials found over the Quartz Mountain complex. Certain inferences about the technological function and path position in the reduction processes can be made from this evidence. These initial inferences are combined with verbal descriptions in the second part of this chapter.

This pictorial presentation was chosen as the best form of verifiable data in a published paper form, although all of these artifacts were not collected, but all were represented in the materials that were collected. The catalog numbers and other pertinent information are included in the figure captions.

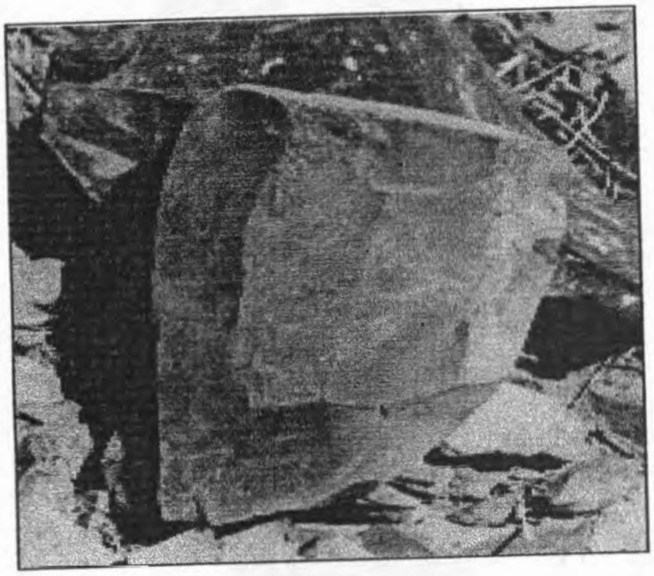


Figure 7.8 Black Obsidian Core. Blade core reduction method of reducing material on Quartz Mountain. (No scale)

Figure 7.9 Rare Large Biface. Large biface found on Quartz Mountain.

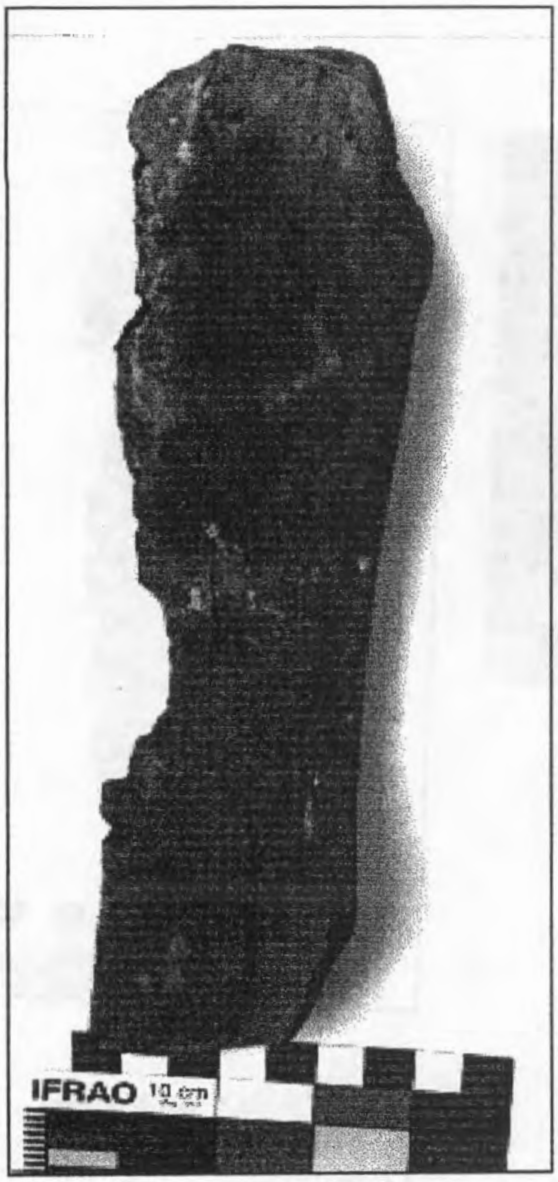


Figure 7.10 (a) Blade Flake Ventral Side. Both sides of this large blade flake are heavily weathering (Not collected).

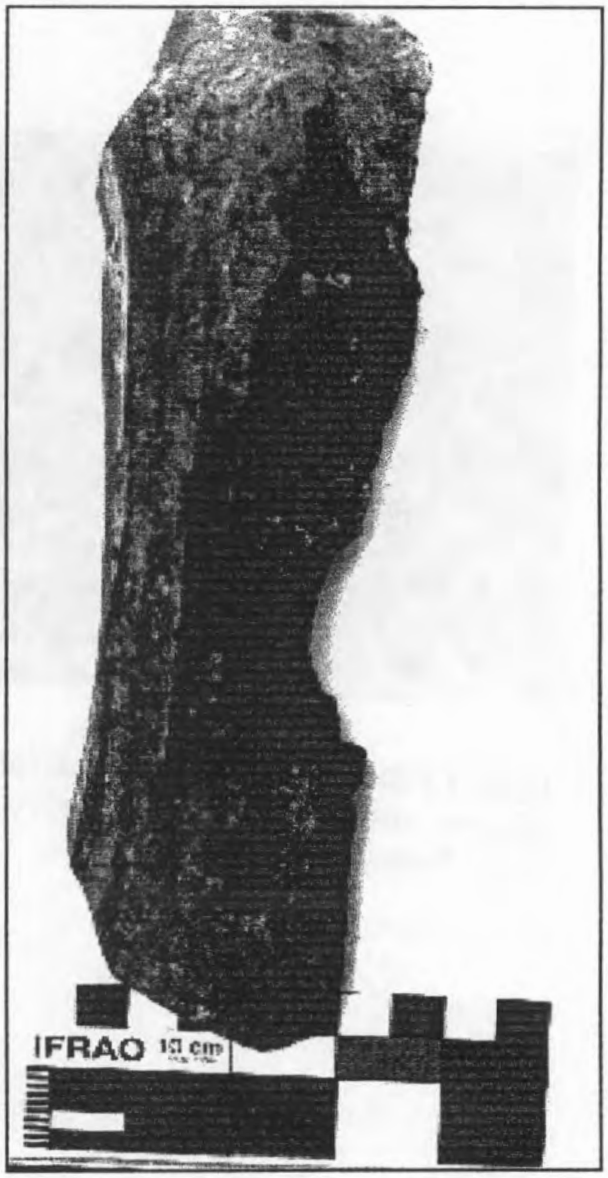


Figure 7.10 (b) Blade Flake Dorsal Side. Both sides of this large blade flake are heavily weathering (Not collected).

Figure 7.11 (a) Black Obsidian Reject. Blade biface. Dorsal side.

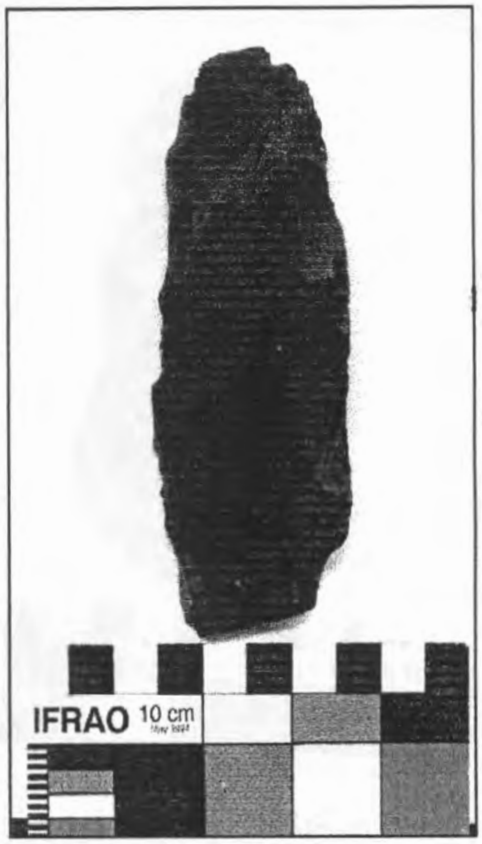


Figure 7.11 (b) Black Obsidian Reject. Blade biface. Ventral side

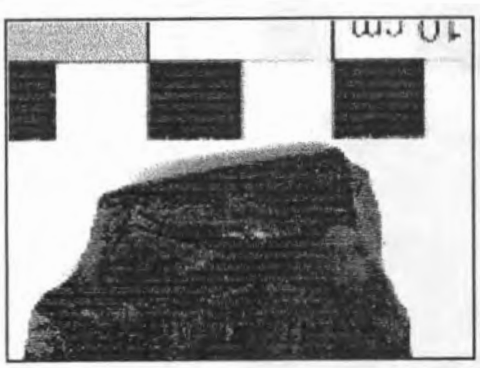


Figure 7.11 (c) Reject Platform. Platform of rejected blade flake showing several failed attempts at basal thinning.

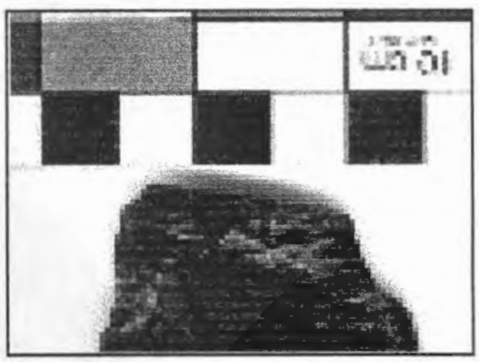


Figure 7.11 (d) Reject Platform. Platform of rejected blade biface showing edge preparation.

Figure 7.12 (a) Red Blade Flake. Dorsal side of large blade flake, with cortex.

Figure 7.12 (b) Red Blade Flake. Ventral side of large red obsidian blade flake.

Figure 7.12 (c) Red Blade Platform. Platform showing edge preparation.

Figure 7.13 (a) Black Obsidian Knife. Dorsal side of large utilized knife showing heavy hydration. Found at collection site A.

Figure 7.13 (b) Ventral side of finished knife.

Figure 7.13 (c) Black Obsidian Knife Platform. Platform shows signs of edge grinding.

Figure 7.14 (a) Blade Biface Ventral Side. Large blade style biface found at collection site A.

Figure 7.14 (b) Blade Biface Dorsal Side. Blade style biface. Note heavy hydration.

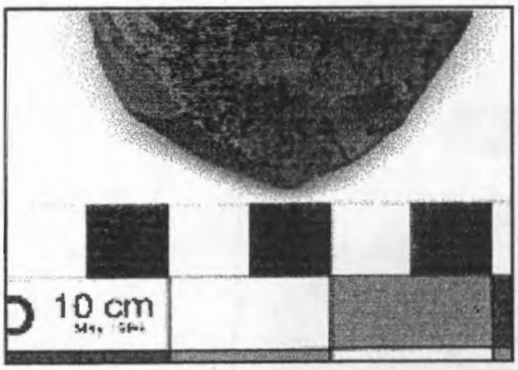


Figure 7.14 (c) Strike Off Platform. This enlarged area shows the striking platform of the blade style flake.

Figure 7.14 (d) Edge preparation.

Figure 7.15 (a) Large Black Obsidian Biface. Black obsidian biface with edge blow out resulting in the discard of the biface.

Figure 7.15 (b) Large Black Obsidian Biface. Large biface reject. Note heavy hydration and cortex.

Figure 7.15 (c) Blowout Enlargement. This enlarged area shows the point where the craftsman made a mistake; either he struck the edge at the wrong angle or he tried to take too much off, resulting in the edge to fail.

Figure 7.16 (a) Large Biface. Section one found at collection site A. Cortex on both sides indicates that a large flat block of obsidian was selected for this very large biface.

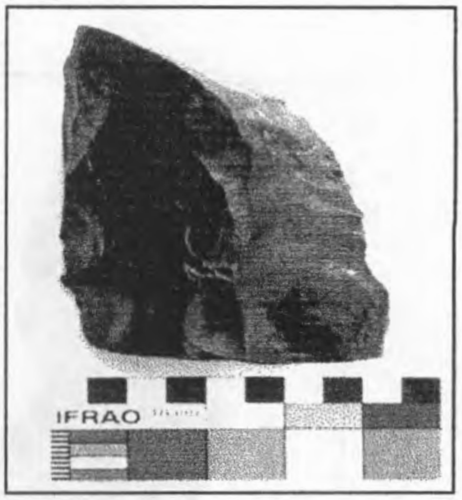


Figure 7.16 (b) Mid-section of the same large biface, found in the same 1 x 1 meter collection site.

Figure 7.16 (c) Large Biface. Section three, tip of same large biface, found in same area.

Figure 7.16 (d) Large Biface. All three pieces were found within 10 cm of each other. The area between the base and the mid-section indicates that the craftsman tried to take too much off, resulting in the biface breaking into to three sections.

Figure 7.17 (a) Red Biface. The craftsman started making this biface out of the small cortex covered nodule found in the same area as the red/black obsidian that was heavily mined.

Figure 7.17 (b) Red Biface. Reverse side of large red biface.

Figure 7.17 (c) Red Biface. This enlarged view shows the cortex exterior of the nodule. This biface indicates that nodules were being used as well as the material that was mined.

Figure 7.18 (a) Bifacial Thinning Flake. Dorsal side of large bifacial thinning flake. Found at collection site A.

Figure 7.18 (b) Bifacial Thinning Flake. Ventral side of large bifacial thinning flake

Figure 7.18 (c) Ventral side showing platform and edge grinding.

Figure 7.19 Basalt Hammerstone. This hammerstone was found at the base of the rhyolite red/black outcropping. The stone is made of water rounded basalt. This hammerstone shows extensive use. (Not collected)

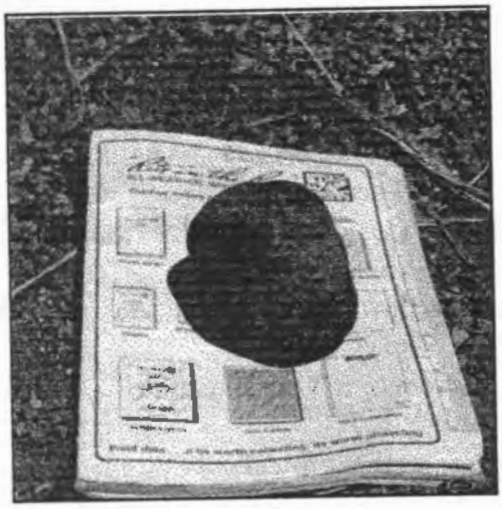


Figure 7.20 Basalt Hammerstone. This hammerstone was found in the area were the red/black obsidian was mined. The stone was made out of water rounded basalt, which is not found locally. (Not collected)

Figure 7.21 (a) Red Obsidian Hammerstone. Small red obsidian hammerstone. Both ends show signs of battering.

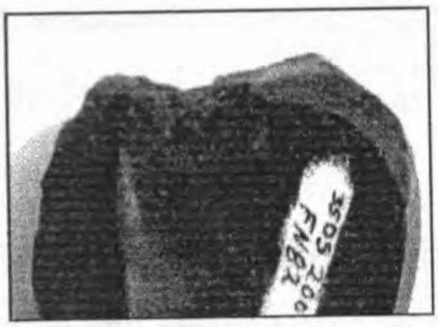


Figure 7.21 (b) Red Obsidian Hammerstone. Red obsidian hammerstone enlarged to show battering.

8 Conclusion

8.1 Discussion

Given the previously cited studies on blade cores and bifacial cores, blade cores should be associated with less residentially mobile sites, and bifacial cores should be associated with more mobile sites. Bifacial cores do not include hafted bifaces (projectile points) or bifacial drills, but all other forms of bifaces such as preforms are included in the bifacial core group.

My research has found that for many years, archaeologists have measured the size of prehistoric foraging territories and thus the degree of mobility through the distribution of stone tools relative to the geologic sources of their raw material (Kelly 1992:55). Clovis and Folsom projectile points, for example, have been found 100-300 km from their sources. Some archaeologists postulate that this indicates high residential mobility. Such information provides a rough indicator only of range, rather than mobility, since the raw material could have been acquired through residential or logistical movements or trade (Hunn 1989:224; Kelly 1992,55).

My research has also found that some archaeologists have tried to reconstruct mobility by examining the organization of stone tool technologies (Ammerman 1974; Andrefsky 1994; Bamforth 1986,1991; Binford 1979, 1980; Nelson 1991; Shott 1986; *et al.*). The organization of technology refers to the selection and integration of stages for making, using, transporting, and discarding tools and materials needed for their maintenance. Many factors affect tool production, use, and discard, but currently the relationship between availability of raw material, technology and mobility takes precedence in this research.

Among some archaeologists there is an ongoing debate on the relationship between mobility and technology. Bifacial tools or cores are generally associated with frequent and or lengthy residential or logistical movements (Kelly 1988, 1992:55), while expedient (blade core reduction) flake tools and bipolar reduction are associated with infrequent residential moves (Kelly 1992:55). However, the distribution of lithic raw material could alter these associations significantly (Andrefsky 1994; Bamforth 1986). Other researchers focus on the statistical relationship between tool assemblage size and diversity (Shott 1986). Shott suggest that collectors produce assemblages with no correlation while foragers produce assemblages with a strong positive correlation (tool designed for a specific task), and he also suggests that there should be an inverse relationship between technological diversity and residential mobility (Shott 1986). Torrence (1989) argues that technological diversity relates directly to the degree of risk involved in prey capture rather than mobility per se.

My research has found that trying to reconstruct mobility strategies from prehistoric technologies is hampered by several difficulties. One of these is that there is no simple relationship between mobility and tool manufacture. Many other variables intervene, such as tool function, raw material type, raw material workability, and distribution of sources. Another is the reconstruction of different tool manufacturing methods from debitage (which I have done with the three collection sites) which is overwhelmed with interpretive difficulties. Lastly, stone tools are not routinely used to a significant extent by any living foragers, making it difficult to test ideas relating stone tools to mobility. Analyses of ethnographic data often make the unverified assumption that as the total technology goes (including its organic parts, usually absent) so goes the stone tool component (Kelly 1992:56). What I see from my research is that at present anyway, many interpretations of stone tool assemblages as indicators of mobility are subjective, intuitive, and most of the time contradictory. What I see at Quartz Mountain and in other site reports from the Deschutes and Ochoco National Forests is that blade core technology was being used by highly mobile groups for many years, as was bifacial core reduction. Both methods were used at the same time in the same site. There is no real way to determine from the lithic evidence wether blade core reduction or bifacial core reduction was going on first or whether the same craftsman was making biface cores for himself and then producing blade preforms for trade, as was found at Lava Island (Minor and Toepel 1982) and the China Hat cache.

I feel that Binford sums it up the best with his statement:

> There is a generic relation between archaeologists' observations on living systems and the interpretative tools they use for inferring the character of past dynamics. If we bring these interpretative tools to bear in a test case, a situation in which both patterning archaeologists might see and the causes of patterning we would infer are known, then we clearly have the opportunity to test the validity of the principles standing behind our inferential arguments. This is very different from a cautionary tale, which frequently takes the form of an object lesson to archaeologists suggesting that the archaeological record is limited and not capable of yielding information about one or another form of "ethnographic reality" (Binford, 1986:555). I have suggested many times (Binford 1984b) that the testing of the validity of our interpretive principles must be made in actual situations in which the dynamic (causal) and static (derivative) effects are both observable, if our inferential techniques and conventions lead to false interpretations when applied to a test case, then we learn something of the limitations of these techniques, and concepts (Binford, 1986:555).

8.2 Summary

In order to understand what was occurring at Quartz Mountain, one must look at the Fort Rock Basin as a whole. By looking at the climatic conditions for the whole area a clearer picture comes to mind of the different lithic strategies due to different mobility strategies.

In review of the different periods, the following climatic picture is from around 13,000 to 3,000 B.P. Initially, the Fort Rock Basin contained a single lake with the shoreline elevation at 4,386 feet (Bedwell 1973:67). From all indications the lake was probably in a declining state during this time period (13,000 B.P.). The temperature was probably four to five degrees colder than present, and precipitation was much greater (present annual rainfall is sixteen inches per year). Lodgepole and western white pine were predominant in the area, existing at much lower elevations than at present. Animals were numerous in the area, and these would include now-extinct forms of herbivores, although some of these forms apparently were not as abundant in the area as in other parts of the continent (Bedwell 1973:67; Cressman 1942:17). The reason why there weren't as many large herbivores in the area is that previously the area might have been more heavily forested and provided less open grassland for grazing animals. In any event, this period was one of cool temperatures, abundant moisture, lakes, and forests.

Reduction of the Fort Rock Lake continued, and by 12,000-11,000 B.P., until some later time in that general period, the lake ceased to exist as a single body of water, having gradually reduced to a series of smaller bodies occupying the deeper depressions in the basin (Bedwell 1973:67: Cressman 1943:13). This occurred over many hundreds of years as temperatures gradually rose and more moderate temperature prevailed. Rainfall may have dropped to sixteen inches a year sometime around the middle of this period. It was during this period with its mild but warmer temperatures and numerous small lakes, marshes, and flowing streams that conditions may have been at an optimum for human hunters and gatherers. During this time period the forests was receding and open areas were increasing over the years. Occupation of the caves were more intense during this time and the butchered remains of waterfowl and many forms of land mammals (including bison) were found in large numbers (Bedwell 1973:67; Connolly 1995; Cressman 1942:144).

Because the temperature curve continued to rise over the centuries, more arid conditions appeared. This was a gradual process, which would be undetectable in any man's lifetime. Lakes and marshes very gradually become shallower and reduced in size, and rainfall lessened. These conditions were becoming more pronounced between 8000-7000 B.P., but true arid conditions did not develop until sometime after 7,000 B.P. (Bedwell 1973; Connolly 1995; Cressman 1943,1977; Willig 1988). If there is an abrupt end or lessening of occupation in the caves at 7,000 B.P., it was more likely due to the effects of the Mount Mazama eruption than any sudden shift in climate. Nonetheless, at some time in the period following the eruption, climatic conditions apparently did worsen and true arid conditions set in. During this time, the average annual temperatures probably rose to a high for the post-glacial period and precipitation was diminished (possibly to less than six inches). With the decrease in rainfall the fauna of the area was also reduced in numbers, although many forms, particularly the smaller ones, were not affected as badly. Ponds and marshes dried up and streams ceased to flow, or became intermittent. It is also quite possible that some springs still existed, but a large number dried up. With the few remaining springs the inhabitants of the area existed outside the lake bed during this warm period (almost all the springs in the basin are found in areas away from the caves). Life would have been possible for hunter gatherers even during this hot period, and some human occupation did continue, but greater mobility was required. At or some time after 5500 B.P. the climate began to improve and the area slowly returned to semi-arid conditions.

In summary of the climatic changes it can be said that the record in the Fort Rock Basin supports Bedwell's and Cressman's position over the reality of an Altithermal period. This is based on the intensity of occupation of the caves, as well as on floral and faunal evidence; there clearly were fluctuations in climate over several millennia, with one period of temperatures definitely indicated as higher than present day readings. The eruption of Mount Mazama certainly had effects on the whole region, (as well as Newberry Crater, but to an lesser extent) but these were limited in duration.

It has been shown that this area underwent environmental shifts potentially of great consequence to the human life-ways within it. From a cool, moist, forest and lake environment, the area gradually changed to lake and grassland. As the temperature curve continued upward the landscape was further modified into marshland and drying lake and, finally, to a dry lake bed and hot blowing pumice sand, punctuated only occasionally in certain places by small springs (e.g. Sand Springs). Then, with the passage of several millennia, these harsh conditions were modified. After a relatively short period of moderately renewed moisture, conditions similar to those of today's semi-desert environment were established.

My survey and analysis of the material collected from the three surface collection sites indicates that there were two lithic strategies being employed on and around Quartz Mountain. The archaeological record at nearby Fort Rock Cave and Cougar Cave show an increased population in this area when the lake would have provided all the floral and faunal needs for a fairly large population for many generations. This shows up in the lithic assemblage as a reliance on blade core technology. However, when the lake is no longer present and conditions require travel of greater distances to acquire food resources, we see in the archeological evidence a shift from blade core reduction to a bifacial reduction core methodology. This methodology shows up at Sand Springs (Scott 1982) and at Mud Springs, 35JE49 (INFOTEC 1995) This suggests that people were traveling great distances to acquire a resource for retooling or for trade items.

An alternative hypotheses is that some of the changes in technology may have come about because of changing hunting strategies as well as in changes of mobility. The changes in the large fauna would mean a reduction in the weight needed to penetrate the hide in order to reach vital organs. These changes would mean a smaller projectile point. A good example of this is when the large mammals such as the mammoth and Bison antiquus became extinct, the Clovis technology changed to a thinner and smaller Western Stemmed projectile point. This type of point style remained until a change in the environment to a warmer and drier regime. When the fauna are forced into different ecosystems (following the water), this caused a different hunting technique and still another shift in weapons. With the production of still smaller projectile points (*i.e.* Desert Side Notched and Desert Corner Notched points). The latter two are made from thick wide flakes from bifacial core reduction. Thus, it is possible that shifts in technology was in response to changes in hunting strategies.

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