LATE HOLOCENE OCCUPATION OF THE BIRCH CREEK SITE (35ML181), SOUTHEASTERN OREGON

By

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A thesis submitted in partial fulfillment of
the requirements for the degree of

MASTER OF ARTS IN ANTHROPOLOGY

WASHINGTON STATE UNIVERSITY
Department of Anthropology

May 2009

To the Faculty of Washington State University:

The members of the Committee appointed to examine the thesis of Christopher Douglas Noll find it satisfactory and recommend that it be accepted.

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ACKNOWLEDGMENTS

This thesis is the result of a lot of hard work and the help of a number of people. I first must thank Dr. William Andrefsky, Jr., who invited me to work along the Owyhee River. His guidance and patience with me as I worked through this project is deeply appreciated. I also thank Dr. Andrew Duff for his thorough and thoughtful critique of my work. And I also appreciate Dr. Karen Lupo's perspective on my project. My committee has helped me fashion this large work into something I can be proud of.

Several other people at Washington State University provided assistance with particular aspects of the analysis. I thank Dr. John G. Jones for helping me in the palynonolgy laboratory. His insight and expertise has been tremendously beneficial for this project and my future in archaeology. I thank Caitlin Wichlacz for her help examining the ceramic remains from the site, and Dr. Neil Endacott for thoughts on the faunal remains.

I am very grateful for the help of Greg Hodgins and the University of Arizona AMS Laboratory. He generously allowed me to come to the Physics Department and process charcoal for site dates, and provided those dates at no cost. I also thank Craig Skinner and Northwest Research Obsidian Studies Laboratory for providing obsidian XRF analysis.

I would like to thank Natalie Sudman and the Bureau of Land Management, Vail District for granting WSU access to work at this amazing site. And I am grateful for the hospitality of Paul and Rita Krause at the Birch Creek Ranch.

Thanks to my fellow graduate students. In particular I want to acknowledge the support and encouragement given to me by Jennifer Ferris, Maia Clay, and Courtney Helfrecht.

I also thank the staff of the 2006 Field School, Jennifer Keeling-Wilson, Colin Quinn, and Stephanie Vandal for their help in the field. I would also like to acknowledge the work of the students of the 2006 Field School, Paige Diamant, Chad Hansen, Stephen Holt, Lindsay Marshall, Cori McClarran, Meghan Ekno, Jonathan Weiner, and Nick Zylstra.

Finally I owe an enormous debt to Michelle Hannum, who has put up with my many late nights and missed meals while I have worked toward my Master's degree. She has been more patient and understanding though this process than I ever could have hoped for. Without Michelle's support I could not have finished this project.

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Abstract

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Recent studies of the Late Archaic period in the Great Basin have identified major changes in settlement, subsistence, and technology compared to those seen during the Middle Archaic. The concern of this study is whether the Late Archaic at the Birch Creek Site (35ML181) is marked by a significant change in adaptive strategy, as it appears to be in much of the Great Basin. This thesis uses the sediments encountered and material recovered from the 2006 excavations of the Birch Creek Site, including datable samples, ancient pollen, ground stone tools, chipped stone tools and debitage, faunal remains, and evidence of ceramic technology as evidence of the adaptive strategy of Late Archaic people at the Birch Creek Site. The Late Archaic component was expected to be structured very differently from earlier materials if it were created by a new group of people practicing a new adaptive strategy beginning during the Late Archaic. Comparisons of Late Archaic artifact assemblages to previously studied materials from the Middle Archaic component of the Birch Creek Site were used to determine if a discontinuity in adaptive strategy exists. Material evidence of settlement, subsistence, and technological organization do not reflect direct continuity, nor do they indicate

an abrupt shift, in adaptive strategies. The adaptive strategy during Late Archaic occupation of the Birch Creek Site appears to be a product of relatively local conditions related to subsistence and tool raw material resources, with some indications of wider regional interactions.

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CHAPTER ONE

INTRODUCTION

The Birch Creek Site (35ML181) in southeastern Oregon is comprised of several occupation components which represent the Middle and Late Archaic periods. The Middle Archaic occupations were excavated from 1998 to 2003 and studied through several Master's thesis projects. The Late Archaic occupation was excavated in 2006 and this project represents the first analysis of that material. The central issue of this analysis is whether the Late Archaic at the Birch Creek Site is marked by a significant change in adaptive strategy, as it appears to be in much of the Great Basin.

Recent studies of the Late Archaic period in the Great Basin have identified major changes in settlement, subsistence, and technology from those seen during the Middle Archaic (e.g., Madsen and Rhode 1994). The discontinuity may be a result of a replacement of Middle Archaic cultural groups by a different population, ancestral to the ethnographic Numic speaking groups of the Great Basin. The adaptive strategy of Numic speakers appears to be very different than that practiced by Middle Archaic people in some parts of the region.

Previous studies of the multiple Middle Archaic occupations at the Birch Creek Site have found remarkable continuity in resource use (Cole 2001; Van Galder 2002) and technological organization (Centola 2004; Cowan 2006) during that period. These studies and others provide a means of testing whether or not a change in subsistence, settlement, and technological organization is a regional phenomenon for the Great Basin. The following study uses the site sediments and materials recovered including datable samples, ancient pollen, ground-stone tools, chipped stone tools and debitage, faunal remains, and evidence of ceramic technology. The Late

Archaic component contains a rich and diverse artifact assemblage which should appear to be structured very differently from earlier materials if it were created by a new group of people practicing a new adaptive strategy.

This thesis is organized into eleven chapters which cover the physical, archaeological and ethnographic setting of the study of the region, as well as the materials recovered. The remainder of Chapter One provides a broad background for the study in terms of physical setting, the ethnographically studied peoples of the Northern Great Basin, and a summary of archaeological studies related to Late Archaic occupations in the region. Chapter Two details the activities of the 2006 excavation season. Chapter Three discusses the relative age markers recovered and the results of carbon dating from the Late Archaic component. Chapter Four provides a detailed geologic setting for the Late Archaic occupation including a discussion of the bedrock geology of the Owyhee Uplands as well as an analysis of the site sediments and features. Chapter Five deals with the pollen recovered from sediment samples and ground stone artifacts. Chapter Six discusses the composition and use of the ground stone artifact assemblage during the Late Archaic. Chapters Seven and Eight are devoted to analysis of the chipped stone assemblage. Chapter Seven analyses the tool and debitage morphology while Chapter Eight looks at the differential use of obsidian sources during the Late Archaic. Chapter Nine looks at the faunal assemblage and the implications for diet breadth and possible subsistence strategies. Chapter Ten presents the single ceramic sherd recovered from the site and discusses possible implications for links to Late Archaic ceramic producers in the region. Chapter Eleven brings together all of the material presented in the preceding ten chapters and discusses the Late Archaic occupation as whole.

Regional Setting

The Birch Creek Site (35ML181) lies in the southeast corner of Oregon in the Owyhee Uplands physiographic province along the Owyhee River (Figure 1-1). The Owyhee Uplands is bordered to the south and southwest by the Basin-and-Range physiographic province, the High Lava Plains to the east, Blue Mountains to the north (Baldwin 1976) and the Snake River Plain to the east and northeast (Alt and Hyndman 1989). Together these provinces comprise much of the arid land located between the Cascade Mountains in Oregon and the Rocky Mountains in southern Idaho.

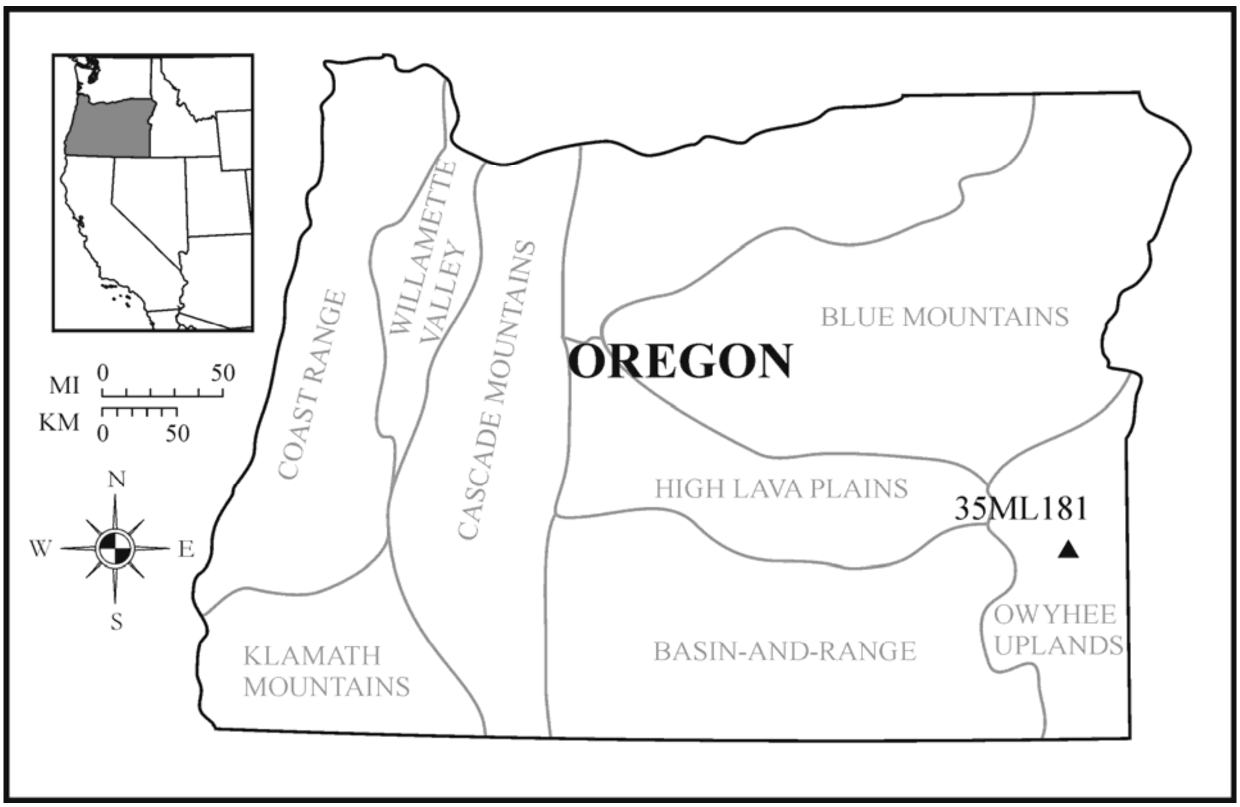

Figure 1-1. Site location relative to Oregon physiographic provinces.

The Basin-and-Range province is an extension of that terrain comprised of north-south trending fault block mountains and internally drained basins that cover Nevada, eastern California, western Utah, parts of Arizona, New Mexico, and Idaho (Baldwin 1976). Steens Mountain, located approximately 50 kilometers (km) west of the Birch Creek Site, is the nearest example of a fault-block range and reaches a maximum elevation of 3,172.6 meters (m). The surrounding high basins lie above 1,312 m in elevation.

The High Lava Plains is a relatively narrow strip of low relief volcanic terrain which extends west from the Owyhee Uplands to the Cascade Foothills near Bend, Oregon (Baldwin 1976). The area is comprised of low marshes and evaporite basins with sporadic buttes. In the eastern portion of the High Lava Plains, streams from the Blue Mountains flow into the Harney Basin and Malheur Drainage.

The Blue Mountains are a group of mountain ranges with numerous summits over 2,132 m in elevation. The province is made up of a diverse array of rocks ranging from Paleozoic and Mesozoic fossil-bearing sedimentary rocks and Miocene basalts in the west, to Permian metamorphic rocks, Late Triassic sedimentary rocks, and Mio-Pliocene volcanics in the east (Alt and Hyndman 1978; Baldwin 1976). The area is well drained by numerous rivers which feed the High Lava Plains to the south, the Columbia River to the north, and Snake River to the east.

The Snake River Plain extends east-northeast from the eastern edge of the Owyhee Uplands across southern Idaho to the borders of Montana and Wyoming at Yellowstone National Park (Alt and Hyndman 1989). The Snake River Plain is a relatively low-lying expanse of basalt which began forming roughly 13 million years ago as the Yellowstone Hotspot tracked from southeast Oregon to its present location below Yellowstone National Park. The major topographical features of the Plain are the Snake River Canyon and the canyons of its tributaries. The Snake River Canyon was heavily scoured by the Bonneville Flood 15,000 years ago which left behind giant gravel bars and bare bedrock in many places.

The Owyhee Uplands area is drained by the Owyhee River and Malheur River to the Snake River. The region is a mixture of high plateau and deep river canyons shaped into their current form by volcanism and faulting, more than erosion (Kittleman 1973). The province ranges in elevation from a little more than 640 m at the river mouths to 1,981 m at the summit of Mahogany Mountain. The region experiences hot, dry summers and cold, dry winters with much of the annual precipitation falling as winter snow and spring rain (Franklin and Dyrness 1973). For example, during 2006 (the year of field investigations for the current project) the mean annual temperature was 66.9º Fahrenheit (F) with a high of 110º F in July and low of 9º F in February (National Oceanic and Atmospheric Administration[NOAA] 2008). The total annual precipitation that year was 9.19 in. (0.81" below average) and 5.87 in. of that fell between March and June (NOAA 2008).

The Owyhee Uplands support a sage-steppe vegetation community (Franklin and Dyrness 1973). Sagebrush (*Artemisia* sp.) and rabbitbush (*Chrysothamnus* sp.) are among the most abundant shrubs while common grasses include Idaho fescue (*Festuca idahoensis*) and wheatgrass (*Agropyron* sp.). Cheatgrass (*Bromus tectorum*) has been introduced through historic era grazing and now out-competes most other grasses in rangeland areas, however, other grasses including Indian Ricegrass *(Oryzopsis hymenoides)* were likely more abundant prior to the invasion of this species. Herbaceuos species are generally diffuse but include biscuitroot (*Lomatium* sp.), Arrowleaf Balsamroot (*Balsamorhiza sagittata*), and lupine (*Lupinus* sp.). Arborial species occur in riparian zones and near the Birch Creek Site include willow (*Salix* sp.) and hackberry (*Celtis* sp.).

Patches of Desert Shrub vegetation communities occur in the Owyhee Uplands as well (Franklin and Dyrness 1973). These areas are dominated by saline soils and comprise a small portion of the Owyhee Uplands today. Sagebrush is found in and around these areas though

Black greasewood (*Sarcobatus vermiculatus*) and shadscale (*Atriplex confertifolia*) are dominant.

The Owyhee Uplands support a variety of large and small game animals. The most common large animals today are Mountain sheep (*Ovis Canadensis*), Pronghorn (*Antilocapra americana*), and mule deer (*Odocoileus hemionus*) (Csuti et al. 1997). Mountain sheep favor steep mountain slopes which occur in a few isolated pockets within the Owyhee Uplands. Antelope are widely dispersed and favor sagebrush stands. Mule deer have ranged across most of eastern Oregon's habitats, though today are found in mountainous areas, open woodland, or along valley floors in winter. All of these animals are somewhat gregarious and form small groups. Carnivores include the bobcat (*Lynx rufus*), mountain lion (*Felis concolor*), and coyote (*Canis latrans*) (Csuti et al. 1997). Small fauna of southeast Oregon include Ord's kangaroo rat (*Dipodomys ordii*), deer mouse (*Peromyscus maniculatus*), canyon mouse (*P. crinitus*), desert woodrat (*Neotoma lepida*), bushy-tailed woodrat (*N. cinerea*), Belding's ground squirrel (*Spermophilus beldingi*), Townsend's ground squirrel (*S. townsendii*), black-tailed jackrabbit (*Lepus californicus*), white-tailed jackrabbit (*L. townsendii*), and mountain cottontail rabbit (*Sylvilagus nuttallii*) (Csuti et al. 1997). Native fowl to the Owyhee Uplands include Canada goose (*Branta canadensis*), several types of teal (*Anas* sp.), turkey vulture (*Cathartes aura*), red-tailed hawk (*Buteo jamaicensis*), and sage grouse (*Centrocercus urophasianus*) (Csuti et al. 1997). Southeast Oregon reptiles and amphibians include the short-horned lizard (*Phrynosoma douglassii*), western fence lizard (*Sceloporus occidentalis*), western skink (*Eumeces skilonianus*), racer (*Coluber constrictor*), gopher snake (*Pituophis melanoleucus*), western rattlesnake (*Crotalus viridis*), western toad (*Bufo boreas*), and Great Basin spadefoot (*Scaphiopus intermontanus*) (Csuti et al. 1997). Indigenous fishes of the region include the speckled dace

(*Rhinichthy osculus*), Tui chub (*Gila bicolor*), and golden shiner (*Notemigonus crysoleucas*) (MacMahon 1985). Evidence of anadromous fish is scant though the potential for a salmonid presence in the Owyhee drainage should be expected given the salmon runs of the Snake River, which reached upstream of the mouth of the Owyhee River. Steward (1938:168) reports that people would travel up the Owyhee River for salmon. Preserved remains of the anadromous steelhead trout (*Salmo giarderii*) have been found at Nahas Cave, along one of the upper tributaries of the Owyhee River (Plew 1980a, 1986).

Ethnographic Background

Wallace (2004) completed a study of the Birch Creek Site materials and found some continuity with the ethnographic native people who occupied the Northern Great Basin. The Wallace (2004) study used artifacts dated no younger than 2,400 BP. The current study uses material from the Birch Creek Site dated to a time gap between the ethnographic period and the youngest materials used for the Wallace (2004) study. The following section serves to contextualize the ethnographically documented adaptive strategy of Northern Great Basin peoples, not to use ethnographic documents for simple analogical explanation throughout the study. Ethnography as an explanatory tool can easily be abused if applied uncritically (Stahl 1993). Ethnographic and historic documentation can provide meaningful points for comparison in addressing particular research questions, including the impact of colonial contact among Native American groups (Lightfoot 1995).

The native peoples of the Owyhee Uplands belonged to the Northern Paiute, Bannock, or Northern Shoshone (sometimes called the Snakes) group of tribes (Arkush 1990; Lowie 1909; Steward 1938). These people generally practiced a seasonally mobile foraging life way. The population density of Great Basin groups varied considerably. In Idaho, estimates ranged from one person per 4 mi^2 in southwest Idaho south of the Salmon River, to one person for every 34 mi^2 in southeast Idaho (Steward 1938). The calculated population densities represent a minimum density estimate. During the late nineteenth and early twentieth centuries, ethnographers were aware that European disease had diminished native populations and accurate censuses of the native populations were not always available (Lowie 1909; Steward 1938). Nevertheless, these estimates still represent the variation in capacity of the environment to sustain human populations because disease severely affected all native populations.

The northern Paiute and Shoshone groups occupying this region ranged within loosely recognized territories in "semi-nomadic independent family groups, subsisting on a hunting, gathering, and fishing economy"(Fowler and Liljeblad 1986:436). Band names were generally derived from the food that group was known for eating (Lowie 1909; Steward and Wheeler-Voegelin 1974; Stewart 1941). The people of the Owyhee Valley were known as Tagutika (root eaters), the people to the west in the Malheur drainage were known as Wadatika (wada-seed eaters), and those on Snake River Plain northeast of the Owyhee Uplands, were the Koa'agai Duka, and named for the abundant salmon of their area (Steward and Wheeler-Voegelin 1974:197-198; Stewart 1941:361-365). These designations referred to the major food available in a location more than the principal diet of the areas inhabitants and people would move into neighboring territories for the collection of different resources (Steward 1938). Family groups would typically move every few weeks into new territories to fish, gather roots, seeds, and berries, or trade and socialize. One of the most important trading centers in this region was the Camas Prairie near the present-day city of Grangeville, Idaho. Plateau groups such as the Nez Perce and Flathead, Plains groups such as the Bannock and Cheyenne, and Great Basin groups gathered to harvest camas roots in the late spring and early summer while participating in trade, ceremony, gaming, and marriage (Anastasio 1972).

During the spring and fall, groups moved to major rivers such as the Snake River to take advantage of anadromous fish runs (Steward 1943: 268-270). During the summer and fall people would collect seeds such as sunflower (*Helianthus* sp.), lambs quarter (*Chenopodium* sp.), and Indian rice grass (*Oryzopsis hymenoides)*, berries such as wild cherries (*Prunus* sp.), raspberries (*Rubus* sp.), currants and gooseberries (*Ribes* sp.), and serviceberries (*Amelanchier* sp.), and roots such as wild onion (*Allium* sp.), camas (*Camassia* sp.), Arrowleaf Balsamroot (*Balsamorhiza sagittata*), and bitterroot (*Lewisia rediviva*) (Fowler and Lilijeblad 1986, Stewart 1939). Seeds were harvested using conical baskets and beaters, while camas and other roots were harvested with specially made digging sticks and baked in earthen ovens, boiled, and ground using hopper mortars, or dried (Stewart 1939). In the winter months some group members left to join hunting parties traveling the plains for bison (Lowie 1909; Steward 1938). Those who remained in their home band territories occupied camps located in valley bottoms in groups of 2-15 families, and consumed cached fish, roots, and seeds in addition to both large and small game (Steward 1938:166-167). The bow-and-arrow, snares, nets, traps, and fences or blinds were used throughout the year to hunt large animals including bison, antelope, mountain sheep, and deer, as well as smaller birds and animals including rabbits (Lowie 1909).

The Northern Paiute winter dwelling was a small round shelter constructed of grass, reeds, or brush attached to a frame of branches tied together (Lowie 1909; Stewart 1941). The Shoshone constructed conical pole structures covered with grass or brush. In the summer brush wikiups were constructed for shade with materials similar to those used for winter dwellings and caves and rockshelters were also periodically utilized for brief temporary shelter (Steward 1943).

Two other types of structures were also periodically used; the sweathouse was used by shamans as well as for bathing, and the menstrual hut, used to isolate menstruating or pregnant women (Stewart 1939).

Numic Migration Hypothesis

The Northern Paiute, Bannock, and Northern Shoshone are all speakers of dialects of an Uto-Aztecan language known generally as Numic. The Numic language dialects were spoken by peoples covering all of the physiographic Great Basin and into Idaho as far north as the Salmon River, into Oregon east of the Cascade Mountains and as far north as the John Day River, and across the Rocky Mountains in Wyoming and Colorado (Miller 1986). The Numic language dialects appear to form sectors around a central hub in the area of Owens Valley, California (Figure 1-2). The degree of language difference between the dialects and geographic patterning has been used to postulate that all Numic language speakers were related to an ancestral group from the area of the Owens Valley (Lamb 1958). Lamb (1958) also hypothesized that the various Numic languages began to separate from one another approximately 1,000 years ago. Some have interpreted Lamb's hypothesis to mean that Numic speaking bands moved across the Great Basin during late prehistoric times and have looked for evidence of a population movement at around 1,000 BP (e.g., Bettinger and Baumhoff 1982; Madsen 1975).

The prehistoric migration of Numic speakers throughout the Great Basin northeast from western Nevada was first proposed in the 1940s by Julian Steward (Sutton and Rhode 1994:7). Steward was building on extensive ethnographic data (e.g., Lowie 1909; Steward 1938) which documented the contact period manifestations of Great Basin cultures. His hypothesis did not differ greatly from that of Sydney Lamb yet was not widely accepted. This may be in large part due to the aspects of Steward's hypothesis regarding timing of the migration (Sutton and Rhode

Figure 1-2. The ethnographic distribution of Numic dialects and peoples across western North America.

1994:8). Steward followed his hypothesis with an attempted explanation of the ancestral origins of several Great Basin and Southwestern groups. The general developmental chronology that Steward proposed did not fit with subsequent radiocarbon ages of site components he was incorporating at sites in south-central Oregon and at Lovelock Cave, Nevada.

The idea that Numic speaking people were relative newcomers to much of the Great Basin was reintroduced by Lamb in 1958. Lamb relied heavily on linguistic data and glottochronology to support his claim that the modern Numic speakers had originated in the southern portion of Nevada and that they had recently migrated into their ethnographic territory (Lamb 1958). The timing of linguistic divergence was the subject of the 1958 Lamb paper and has been used by archaeologists as an indication of a human migration (see Sutton and Rhode 1994). Contemporary linguistic modeling of prehistoric population movements is quite complex and involves multivariate analyses to make meaningful testable statements about those processes (Nichols 1997). Lamb's 1958 paper has provided a general chronological framework for archaeological inquiry. Linguistic data indicate that Great Basin Numic dialects were becoming distinct by probably no more than 5,000 years ago, and that the great similarity of the dialects indicates that their speakers could only have been separated and occupying their current territory between 500 to 1,000 years ago (Lamb 1958:99-100). These dates represent a range estimate for the timing of linguistic diversification which some archaeologists view as firm estimates (Thomas 1994).

Some archaeological models of the migration correlate the Numic speakers to a shift in adaptive strategies which were essentially a response to late Holocene environmental changes. Paleoclimatic data from sites along the margins of the Great Basin indicate that a region-wide decline in effective moisture occurred between 1500 to 500 BP (Aikens 1994). Hydrologic, geologic, and paleofloral and faunal evidence throughout the Basin corroborates the conclusion that there was in fact a brief warming and drying trend from 2000 BP to 500 BP though the general pattern for the late Holocene has been for relatively mild conditions approaching those of modern times (Mehringer 1986).

Bettinger and Baumhoff (1982, 1983) have argued that there was a direct replacement of pre-Numic peoples by the Numic speakers based on subsistence strategies. They view the Numic subsistence strategy as more diverse and therefore better capable of sustaining a population during an environmental shift in late prehistoric times. In this scenario the Great Basin was occupied for a considerable period prior to 1000 BP by peoples who subsisted on high yield, low technological investment foods such as big game and plants which required relatively little processing before consumption. As a consequence of relying on this potentially narrow resource base these people were marginalized by resource limitation as changes in the environment resulted in reduced abundance of their primary food sources. Conversely, Numic speaking peoples who relied on a broad spectrum of resources were at a selective advantage in the late Holocene Great Basin environment. Their strategy emphasized plant and game resources which required higher investments of time and labor to collect and process but were more readily available across the landscape. The result of collecting and processing expensive resources may have led to population growth and changes in the social structure of Great Basin cultures (Bettinger 1999).

An alternative hypotesis questions the timing of the movments of Numic speakers in the Great Basin. Aikens and Witherspoon (1986) have suggested that Numic speaking peoples may have occupied the central Great Basin for as much as 5,000 years. They argue that their subsistence strategy was uniquely adapted to arid conditions and at times they were able to expand out from their central location to occupy a much wider area. Their neighbors, in this scenario, were moisture dependent wetland adapted peoples to the west, and farmers to the east. When periods of elevated aridity occurred, the Numic speakers moved into their neighboring territories as the wetland based people and farmers abandoned them. These population shifts could have occurred more than once in prehistory with increases in effective moisture reversing the movement and outside people pushing the Numic speakers back into the central Great Basin. This hypothesis presents a potential explanation for the shape of the Numic branch distributions during contact. The Western and Southern branches would have been derived from the Central branch as Numic populations moved away from it, which would account for the overall similarity of the dialects.

The oral traditions of Native populations recorded in the Great Basin do not strongly support a recent population migration. The Northern Shoshone lack migration or origin myths altogether (Lowie 1909; Sutton 1993). Limited migration myths occur among the Northern Paiute and Western Shoshone (Sutton 1993). But the migration and origin myths which do occur among Great Basin groups are consistent with the proposed direction of movement found in the Lamb (1958) hypothesis.

The potential that a population movement occurred which resulted in the ethnographic distribution of Numic speakers is difficult to test archaeologically. The material remains associated with Numic speaking foragers are often perishable in nature and are not recovered from every excavated site. Ethnographic records show the use of basketry, seed beaters, nets for game hunting and fishing, and root-digging sticks (Fowler 1986). Seeds were ground using a mano and metate (Fowler and Lijeblad 1986). Prior to European contact arrows were tipped with Desert Side-Notched and Cottonwood Triangular points, though Rosegate points were still produced at some sites. The Paiute-Shoshone pottery type appears late in Great Basin prehistory and has been linked to the Numic expansion across the region. The pottery is a highly variable coarse gray to brown earthenware (Madsen 1986).

Fremont

Fremont refers to a range of adaptations indicative of links to horticulture/agriculture reflected in a suite of material remains. Fremont sites were occupied from approximately 2000 to 500 BP in a limited area of Utah and portions of the surrounding states (Jennings 1978; Madsen and Simms 1998; Marwitt 1986). The sites have been used to define five regional variants on the basis of material culture elements and include the Parowan, San Rafael, Sevier, Uinta, and Great Salt Lake (though some have moved away from the variant concept)(Figure 1-3). Some of the Fremont appear to have been influenced by various groups of Anasazi who were their immediate neighbors to the south during this period (Marwitt 1986). The broad elements of Fremont culture include a horticultural subsistence base with domesticates adopted from the south that included maize, pottery production, substantial residential and storage structures, and a unique artistic tradition (Marwitt 1986). The variants of Fremont include some or all of these cultural elements.

Sites assigned to Fremont are dated to as early as 2000 BP in the San Rafael area and appear in the Great Salt Lake area before 1500 BP (Madsen and Simms 1998; Marwitt 1973). Between 1500 and 1000 BP Fremont sites were occupied representing all five regional variants. After 1000 BP some areas such as the Uinta were largely abandoned (Madsen and Simms 1998; Marwitt 1973, 1986). The Fremont appear to have shrunk into the northeastern portion of their territory by about 700 BP though some believe people with ties to the Great Salt Lake area may have moved north across the Snake River Plain into the Rocky Mountains (Madsen and Simms 1998; Marwitt 1986).

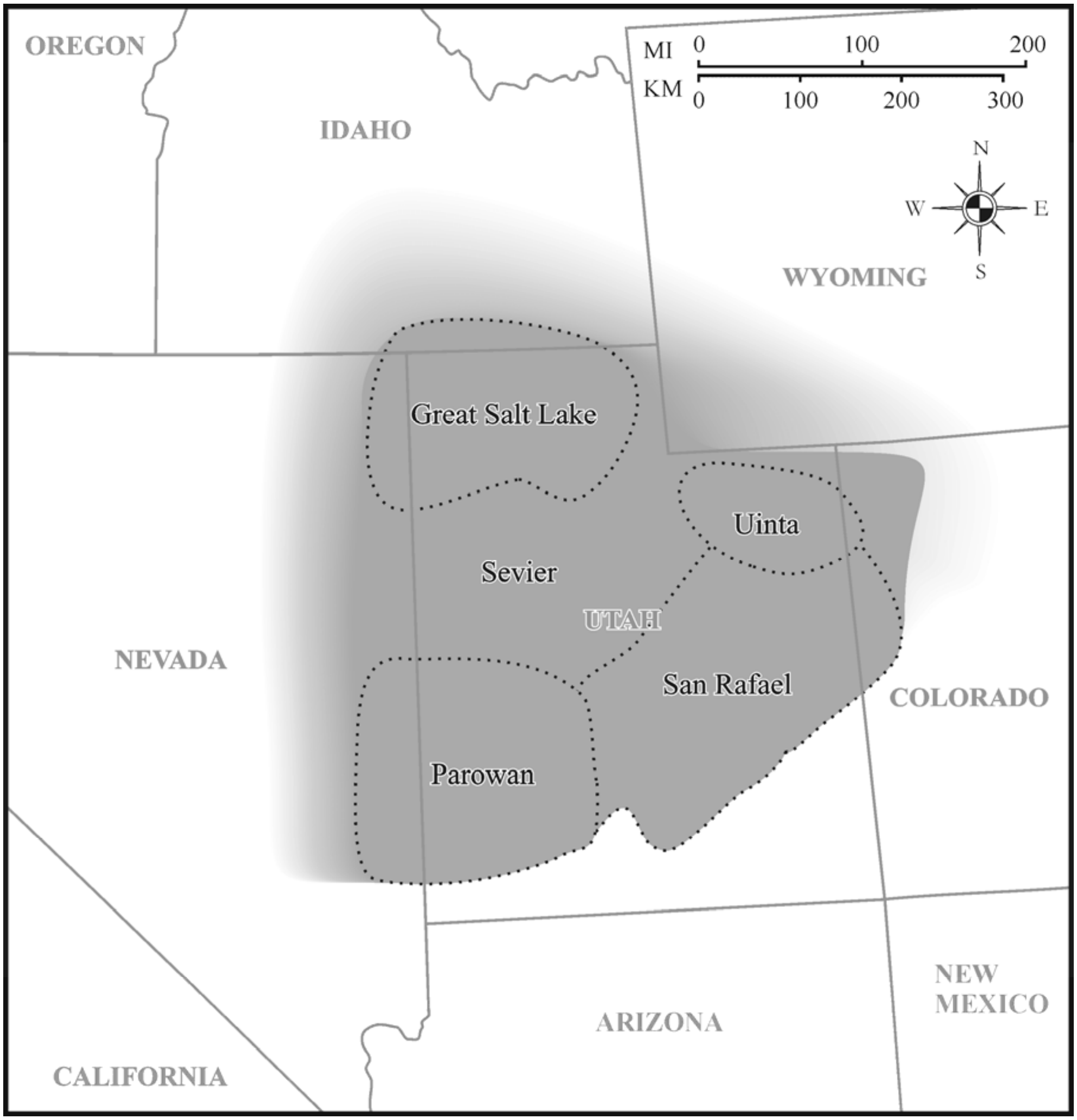

Figure 1-3. The overall distribution of Fremont Sites and the approximate ranges of the five major Fremont variants, Parowan, San Rafael, Sevier, Uinta, and Great Salt Lake.

The actual distribution of Fremont peoples is debated because there is a large amount of variation among Fremont sites depending on local circumstances (Madsen and Simms 1998; Marwitt 1986). The core areas of the defined variants fade into each other and the surrounding forager territories. In terms of material culture the Parowan possessed many elements that contribute to a recognition of a Fremont occupation, including horticulture, the trough metate with a shelf, adobe structures, and both decorated and undecorated pottery (Marwitt 1973, 1986). The Sevier and San Rafael areas are very similar, though have unique pottery styles and settlement structures such as unique pithouse forms and storage arrangements (Marwitt 1973, 1986). The northern areas lack some of the important defining elements of the south. In the north there are no major signs of horticulture in the Great Salt Lake and Uinta areas, and the trough metate with a shelf is absent in the Uinta area (Marwitt 1973, 1986). Foraging appears to have been an important part of the life way of all Fremont peoples including those practicing horticulture, though in the Great Salt Lake and Uinta areas foraging was the dominant form of subsistence (Madsen and Simms 1998; Marwitt 1986). The lack of clear boundaries demarcating the Fremont territory leaves open the possibility that they had contact with groups well outside their recognized areas.

Regional Chronological Sequences

The prehistory of the Owyhee Uplands has been divided into periods by several researchers (Fagan 1974; Hanes 1988; Plew 1979) (Figure 1-4). None of the individual sequences contains a complete and detailed record of human occupation of southeast Oregon and southwest Idaho, but they have identified key patterns of different periods of time. These periods are associated with major technological attributes such as projectile technology, ground stone, and type of dwelling. Two cultural sequences are derived from sites in the Owyhee Uplands. The Late Archaic is began 1,500 to 1,400 years ago in this province. The preceding Middle Archaic period in the Camas Creek sequence is represented by dart tips and hunting features (Plew 1979). Some ground stone is present and sites are located in open valley bottoms near water. At the Birch Creek Site during the Middle Archaic, people constructed pit houses and used a diverse array of chipped stone tools (Andrefsky et al. 2003).

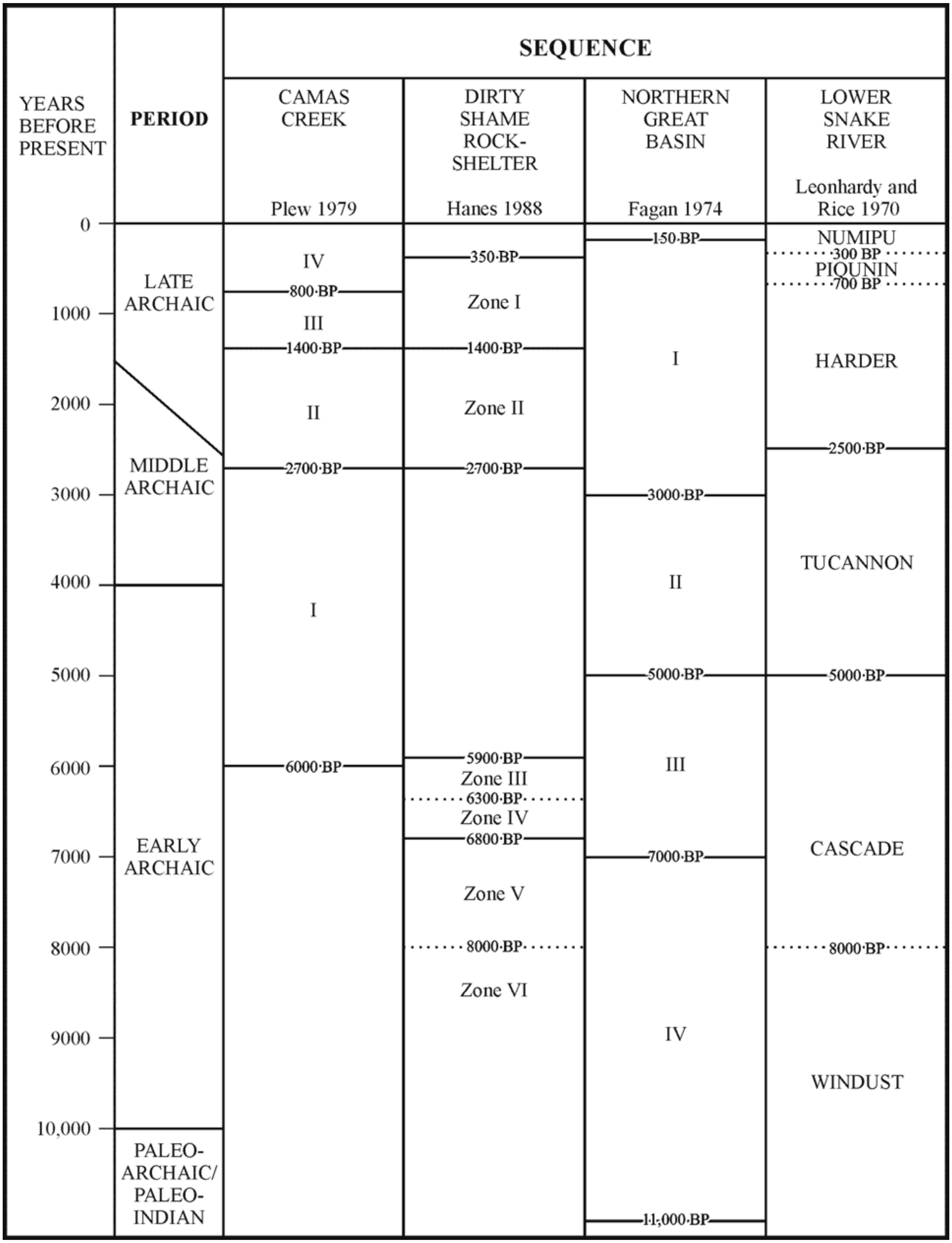

Figure 1-4. Culture chronologies of the Northern Great Basin and Southern Plateau.

The early Late Archaic of the Owyhee Uplands is represented by the Camas Creek III phase (1400-800 BP). At this time people appear to be focused on seasonal resource gathering along the small tributaries (Plew 1979). The projectile points associated with this time include Rosegate varieties, indicating a probable shift to bow-and-arrow technology. Chipped stone appears to favor biface production and tool diversity is higher than the previous period with various scrapers, drills, and flake tools. Pottery also appears during this period and ground stone is abundant. At Dirty Shame Rockshelter (DSR) the Late Archaic began 2700 years ago preceded by a 3200 year occupational hiatus (Hanes 1988). The DSR record contains evidence of heavily used flake tools and projectile points indicative of the appearance of the bow-and arrow, while ground stone use is reduced in abundance relative to the Middle Archaic assemblage. The Zone II phase of occupation contains Humboldt and Elko style projectile points while Zone I is dominated by Rosegate forms with Desert Side-notched points near the late end of the occupation. Zone II also contains evidence of pole-and-thatch shelter use and is associated with a low occupation intensity during this time. The Camas Creek IV phase of the Owyhee Uplands is a continuation of much of the patterns developed during Camas Creek III phase (Plew 1979). The major artifact difference is in the projectile points which shift to Desert Side-notched and Cottonwood Triangular forms. Occupations during this phase appear to be ephemeral, and correspond to seasonal movements for food gathering.

The broad patterns of the Late Archaic of the Northern Great Basin are comparable to the local artifact manifestations of the Owyhee Valley. The projectile point styles are generally small for the past 3,000 years and include Desert Side-notched, Cottonwood triangular, and Eastgate types (Fagan 1974). Occupations of this time are heaviest at lower elevations (below

1,640 m amsl). An abundance of ground stone appears to indicate an emphasis on seed harvesting and processing (Fagan 1974:102).

The chronology of the Lower Snake River, in close proximity to the Owyhee Uplands, provides additional context. The Late Archaic of the Owyhee Uplands matches the timeing of the late Harder and Piqunin Phases on the Lower Snake River. The artifact assemblages of the phases are generally comprised of small projectile points, abundant flake tools, ground stone, and net weights (Leonhardy and Rice 1970). The fauna suggest an apparent emphasis on salmon and large game hunting. This period is also marked by the use of semi-subterranean pit houses constructed in clusters. These patterns extend upstream on the Snake River to the Lower Salmon River as well where house-pits, small arrow sized projectile points, and abundant ground-stone have been identified dating to the period from 2000-600 BP (Davis 2001). The appearance of net weights and certain bone tools has been suggested to be an indicator of increased utilization of salmon (Davis 2001:239).

Late Holocene Archaeological Background

Extensive archaeological work has been carried out in the Northern Great Basin and Snake River Plain. While numerous sites are known for the area of southeast Oregon and southwest Idaho, only a small handful have been extensively excavated and reported on through articles or stand-alone volumes (Figure 1-5). These sites range from uplands, to large river bottoms, to marsh settings and provide pieces of data unique to those environments. A brief summary of the excavated sites located within 200 km of Birch Creek is provided below.

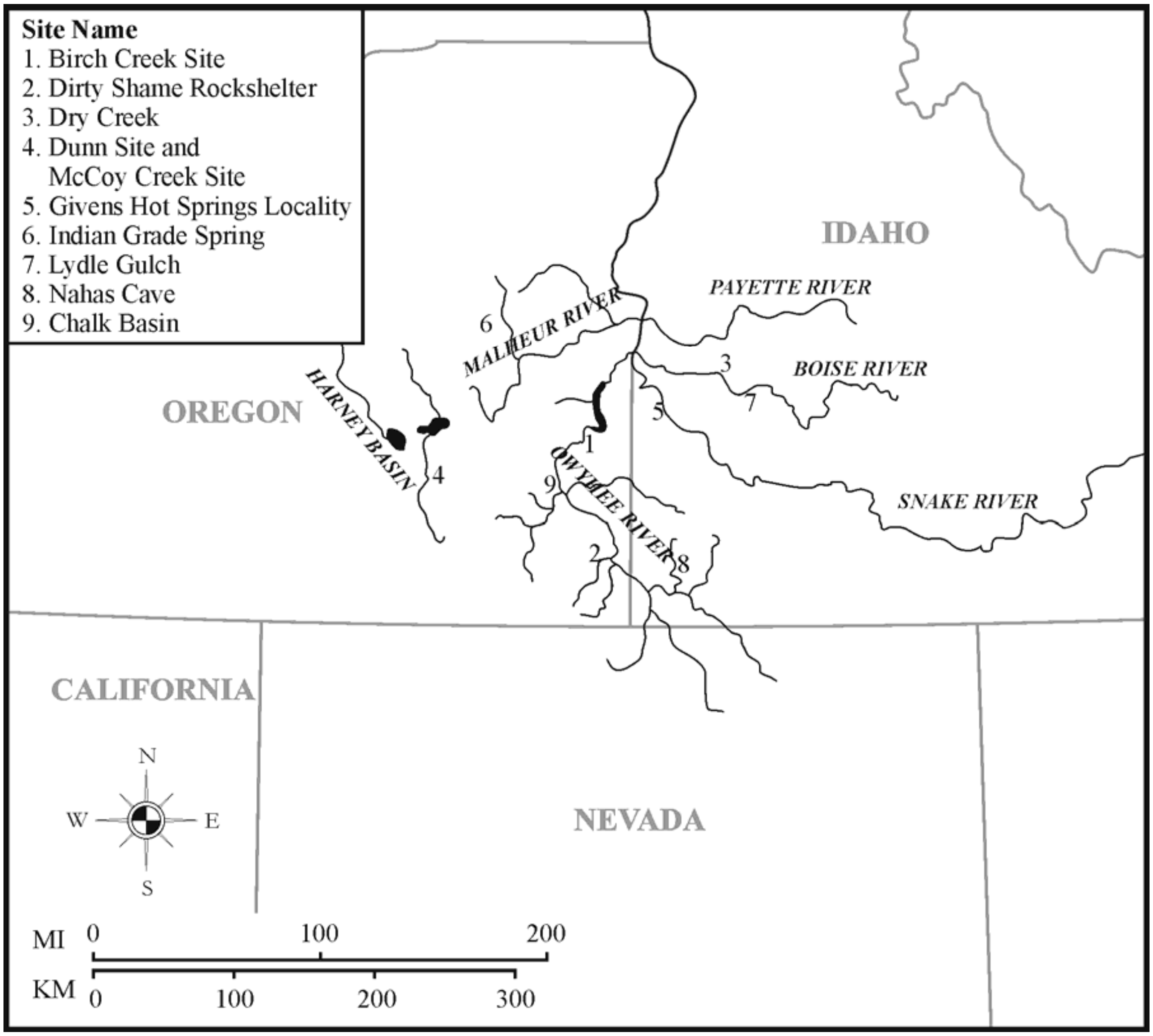

Figure 1-5. Locations of excavated and reported sites surrounding the Birch Creek Site.

Dirty Shame Rockshelter

Dirty Shame Rockshelter (DSR) is located along Antelope Creek in the Owyhee River Drainage in southeast Oregon (Andrews et al. 1986; Hanes 1988). The site was excavated to a maximum depth of 4.8 m and six cultural zones were identified within the deposits. The lowest four units represent the time from 5900 BP to approximately 9500 BP, and are separated by a 3,200 year occupational hiatus from the Late Archaic occupation of Zones I and II which cover the period from 2700 to 400 BP (Hanes 1988). The hiatus coincides with a relatively dry period in the Northern Great Basin. A return to relatively mesic conditions, evident in pollen records of the region, began around the time of re-occupation of DSR. Effective moisture during this time was variable but generally comparable to modern conditions. However, the period from 2000 to 600 BP, which covers much of the DSR Late Archaic period, is considered relatively dry.

The Late Archaic artifact remains at DSR consist of a high frequency of flake tools, projectile points, and a relatively limited ground-stone assemblage compared to earlier periods (Hanes 1988). The projectile point assemblage is comprised of Humboldt and Elko types that persist until approximately 1100 BP. Rosegate points appear as early as 2545 BP while Desert Side-notched points were introduced to the site after 1100 BP. The faunal assemblage is dominated by small mammals such as marmot and rabbit, but remains of antelope, deer, sheep, and bison are present as well.

The perishable fibers at DSR provide a lengthy and diverse sample of woven goods for the Northern Great Basin. Basketry, nets, sandals, cordage, and other materials made from plant fibers have been recovered from all six zones of the site (Andrews et al. 1986). The remains represent three distinct stages of perishable manufacturing. Zones V and VI fall into an early stage when all materials appear to be utilitarian and lack decorative elements. Zones II, III, and IV perishables continue the forms seen in the earlier period but decorative elements are added to basketry. Zone I is marked by new forms of twining and new artifact forms appear in the perishable assemblage. The raw materials used are relatively continuous through time and represent locally abundant plants such as sagebrush (*Artemisia* sp.), willow (*Salix* sp.), cattail (*Typha* sp.), and grasses (Poacea). It is interesting to note that the cumulative degree of similarity of all perishable artifact classes places Zone I as distinctly different from earlier classes (Andrews et al. 1986). This may be evidence for occupation of the site by a population during the Late Archaic that is unrelated to earlier site inhabitants (Andrews et al. 1986:218-219).

Dry Creek Rockshelter

The Dry Creek Rockshelter is a 4 m deep sandstone overhang located along Dry Creek, which is a tributary of the Boise River (Webster 1978) (see Figure 1-5). The site contains 13 stratigraphic levels developed between 4,100 years ago and the present. The youngest date and latest cultural materials are in Level 3, and date to 1410 ± 70 BP. The remaining four other dates were returned from Levels 9, 10, 12, and 13 and fall in stratigraphically superposed order from 1,710 to 4,150 years ago. Artifacts recovered include an extensive chipped stone assemblage along with a limited quantity of ground stone, modified bone, and a single clay figurine (Webster 1978:9). Faunal materials represent big game hunting though some smaller animals including rabbit and marmot are represented in the assemblage. Rose Spring and Eastgate projectile forms were recovered from nearly all cultural levels of the site (3, 5, 7, 9, 10, 11, and 12) spanning the period from 1300 to 3300 BP, however, the majority of these are concentrated in Levels 3, 5, and 7.

The deposits of the Dry Creek Rockshelter provide a stratigraphic and chronometric sequence of Middle Archaic to Late Archaic projectile technology. The appearance of several specimens that are typically interpreted as representing arrow technology at levels dating to as early as 2400 BP has been argued to represent an early adoption of this technology in the area of the Boise River (Webster 1978:29). The styles of the projectile points of all periods appear Great Basin-like which makes the early occurrence of the “arrow” tips interesting. No evidence of Plateau influence was found among the materials from the site.

Dunn Site and McCoy Creek Site

The Dunn Site and McCoy Creek Site are discussed together because of their geographic and temporal proximity. These sites lie in the Northern Great Basin at the foot of Steens Mountain along the perimeter of Diamond Swamp and were excavated in the late 1980's following testing projects which revealed extensive stratified deposits (Musil et al. 1995). Data recovery excavations at the Dunn Site identified three components. Component I is undated but contains a low density cultural deposit associated with a stemmed point. Component II is a pithouse occupation radiocarbon dated to 3255±65 BP. The housepit is associated with evidence of stored foods, large ground stone tools, and Elko points. This period of occupation is interpreted as indicative of a long-term residence focused on game and plants available at or near Diamond Swamp (Musil et al. 1995:76). Component III is undated but appears to be Late Archaic based on projectile point styles. The deposits above the housepit component contain three Rosegate points which are stratigraphically above an Elko point and large side-notched point. The late component is interpreted as a task oriented camp deposit, focused on plant processing and hunting (Musil et al. 1995:76).

The McCoy Creek Site also contains three distinct occupations. Component I is comprised of abundant chert debitage and a limited quantity of obsidian debitage, four chert bifaces, and one obsidian biface (Musil et al. 1995). No temporally diagnostic artifacts or datable charcoal was recovered; however, Component I is believed to be considerably older than the overlying occupations. A limited faunal assemblage of fish, large and small mammals, and birds along with a plummet-like object indicate that marsh/pond resources were important to people at the site during the occupation of the site at this time. Component II is an extensive deposit radiocarbon dated to a period from 1900 to 900 BP (Musil et al. 1995). Projectile point styles include abundant Rosegate specimens and a large proportion of Elko styles as well; however, the deposit may have been occupied for a longer period based on the presence of a few Gatecliff Split Stem, Northern Side-notched, Humboldt, and Cottonwood Triangular points. The diverse artifact assemblage also contains ground stone including slab metates, and aquatic and terrestrial faunal remains. Botanical remains include juniper seeds, bunchgrass, willow, sage, and seeds of goosefoot and grasses along with evidence of plant processing. Overall, the Component II deposits reflect intensive use of local game and plants during a period of marsh expansion. Component III immediately overlies Component II and in the location of a wickiup feature is intrusive into Component II (Musil et al. 1995). The occupation is radiocarbon dated to 480 BP and likely represents occupation beginning by 900 BP. In addition to the pole wickiup, the component also contains a number of small projectile points including Desert Side-notched and Small Stemmed points. Ground stone specimens are smaller and less diverse than those of Component II. The faunal and botanical assemblages are also not as diverse as in the preceding period, and reflect an emphasis on large mammals, and plants as fuels. Generally Component III appears to reflect short term winter season occupation.

Givens Hot Springs Locality

The Givens Hot Springs Locality is a Middle-to-Late Archaic village located along the Snake River, near the town of Marsing Idaho (Plew 2000) (see Figure 1-5). The site provides an important record of residential structures on the western Snake River Plain during the Middle and Late Archaic. Pithouses and two types of pole structures were identified at the site. The majority of the excavated structures fall within a period of occupation from 4620 to 3000 BP though some materials are dated to as late as 1100 BP. The site has been interpreted as a fall and winter encampment based on the presence of storage pits, activity areas, and refuse middens.

Indian Grade Spring

Indian Grade Spring is located on Stinkingwater Mountain, between the Malheur River drainage and the Harney Basin (Jenkins and Connolly 1990) (see Figure 1-5). The site is located adjacent to, and named for, a natural freshwater spring near the top of the mountain. It was excavated as mitigation for impacts of highway construction along US 20.

Three cultural components were identified at the site radiocarbon dated to 2000 to 1400 BP for Component III; 1150 BP for Component II; and 530 BP for Component I (Jenkins and Connolly 1990). A high diversity of tool forms was recovered from Components III and I. The artifacts included ground stone, formed scrapers, and a number of bifaces. Component II is dominated by flake tools and debitage indicative of later-stage tool production and tool maintenance. The three components appear to represent shifting site functions. The time between 2,000 and 1,400 years ago appears to be a hunting camp. During the period from 1,400 to 1,100 years ago, the site apparently served as a specialized task camp for the production of perishable goods like baskets and digging sticks. The site was once again used as a general hunting camp after 1,100 years ago.

The projectile technology reflects the use of bow-and-arrow in each component. Rose-Spring and Elko points appear in all three components though the smaller points are more abundant in Components I and II where larger dart-sized points including Gatecliff and Humboldt points dominate the projectile point assemblage of Component III (Jenkins and Connolly 1990). Though Component I has signs of surface deflation and component mixing, the presence of these styles throughout the occupation span suggests simultaneous use of bow-and-arrow and atlatl technology during the Late Archaic at this site.

Raw material use at the site indicates that people were using stone that could be found at or near the site. The Indian Grade Spring Site along with a group of other sites located along the US 20 corridor show a pattern of local basalt and obsidian use with no apparent long-distance transport reflected in the assemblage (Jenkins and Connolly 1990). The proportions of tool stone appear to reflect the distance to the material source, with chert naturally and culturally appearing more on the east side of the mountain, and basalt and obsidian more common in both respects to the west. The general abundance of high quality knappable stone apparently did not require extensive tool curation in the area.

Lydle Gulch

Lydle Gulch is located along the Boise River eight miles east of Boise, Idaho (see Figure 1-5). The site was extensively excavated in 1977 by archaeologists from the University of Idaho (Sappington 1981). Lydle Gulch is in an open site that developed within alluvial and colluvial sediments. An extensive assemblage of chipped stone tools and debitage along with faunal remains and ground stone were recovered. Three pieces of pottery and one clay figurine were also recovered from the site.

The site contains six total stratigraphic units, but only the top three contain radiocarbon dated cultural materials (Sappington 1981). Stratum III is the lowest and was dated to 1010 ± 90 BP, Stratum II is roughly contemporary at 1170 ± 90 BP, and the youngest deposit (Stratum I) is dated to 790 ± 100 BP and represents a steady development of an A Horizon over a period of 800 years. As a result of the age determinations of the site and temporally diagnostic artifacts the strata are grouped into two occupation components. The lower component is undated and is comprised of Strata IV, V, and VI while the upper is dated and comprised of Strata I, II, and III

The general interpretation of the site is that it functioned as a game processing station throughout its use (Sappington 1981). The faunal remains are predominantly of deer, elk, antelope, and mountain sheep. The presence of most elements of deer and elk, with limited part representation from antelope and sheep, was taken as an indicator that deer and elk were the focus of activity near the site while the other species were encountered at a greater distance from the site and partially processed elsewhere.

The chipped stone assemblage contains predominantly dart associated points in the lower component including Northern Side-Notched, Humboldt, and Elko varieties (Sappington 1981). The upper component is comprised of Elko, Rosegate, and Desert Side-Notched types and several large stemmed points which may have been used as knives. The majority of the projectile points in both components were made from obsidian. The sources of obsidian represent 14 locations widely scattered around the site and indicate the site was used by people with ties to the Northern Great Basin and Snake River Plain.

Nahas Cave

This site is located in the central Owyhee Uplands of southwest Idaho along a tributary of the Owyhee River called Pole Creek (Plew 1986) (see Figure 1-5). The site is described as occupying a "small lava bubble" that has been exposed approximately three meters above the channel of Pole Creek. The opening is no more than three meters high and cultural deposits extend to a maximum depth of two meters. Roof rock-fall was mixed with aeoloian, fluvial, and cultural deposits. Four distinct occupation zones were identified dating to 7000-3900 BP (Zone

1), 3900-2900 BP (Zone 2), 2900-400 BP (Zone 3), and 350 BP to Present (Zone 4) (Plew 1986:30-32).

The site appears to be a camp that was used sporadically throughout the four zones of the occupation. The tools and faunal remains include bifacial tools and debitage along with mammal remains that indicate the camp was used during hunting activites. Several specimens of steelhead trout (*Salmo giardnerii*) and sucker fish (Catostomidae) were recovered which indicate some fishing was practiced by the site occupants as well (Plew 1980a). The steelhead trout remains returned two radiocarbon dates from Zone 3 and two from Zone 4. These later zones also contain Elko, Rosegate (Zone 3), Desert Side-Notched, Cottowood Triangular, and Bliss projectile points, and three ceramic sherds (Zone 4).

Chalk Basin Site

The Chalk Basin Site is located along the main stem of the Owyhee River downstream of Antelope Creek, at a large chert deposit (Keeling-Wilson 2007). The site consists of a camp located along the river and a chert extraction area located on a high terrace/bench above the camp. The artifact assemblage from the site consists of abundant chipped stone debitage, chipped stone tools, ground stone, and a limited quantity of bone and shell. Much of the chipped stone raw materials are cherts, and a large proportion are likely local to the site. Obsidian was also recovered from the site and results of source analysis show an overall connection with this site to locations to the north and west (Keeling-Wilson 2007). The age of site use was determined through relative dating of temporally diagnostic projectile point styles. Six points were identified representing the Middle Archaic (Elko and Humboldt styles) and Late Archaic (Rose Spring) periods. It appears that during the Middle and Late Archaic foraging peoples were exploiting the chert at Chalk Basin for the purposes of replenishing mobile toolkits that also included obsidian tools from a wide area of the middle Owyhee Basin as far west as the edge of the Harney Basin.

Additional Archaeological Studies and Summary

The excavations discussed above represent a significant portion of the work in the region, but smaller excavations and surveys have been carried out as well, and are also important to our understanding of the regions prehistory. Among the first archaeological investigation in the region were Louis Schelback's excavation of Cave #1 (Schelback 1967) and Charlton Laird's initial investigation of Pence-Duering Cave (Gruhn 1961a), which initiated research in this area and defined the loci for future archaeological investigations on the Owyhee uplands. Earl Swanson followed with a 1958-1959 survey of the Snake River corridor for the Idaho State College Museum of Anthropology (Swanson et al. 1959; Swanson et al. 1964). Donald Tuohy carried out research at Guffey-Swan Falls (Tuohy 1958) which began three decades of research in the Owyhee Uplands region and adjoining areas. Subsequent work in the region was conducted by the Idaho State University Museum and largely focused along the Snake River and its tributary mouths (see Gruhn 1960, 1961b, 1964). In the 1960s archaeologists began to look at the regional cultural patterns and Swanson's survey of the Snake River corridor began to identify the Snake River as the boundary between the Great Basin and Columbia Plateau culture areas (Swanson 1965). During the 1970s archaeological projects began in areas away from the major drainages along Snake River tributaries and include the work in and around the Bruneau River Canyon (Bucy 1971; Pavesic and Hill 1973), survey of the Owyhee River (Pullen 1976) which first documented the Birch Creek Site, surveys of the Brown and Castle Creek drainages

(Metzler 1976, 1977), surveys in the Camas and Pole Creek Drainages (Plew 1979), excavations at Bigfoot Bar on the Snake River (Plew 1980b, 1980c), survey of the Hagermon National Fish Hatchery (Pavesic and Meatte 1980). Studies away from watercourses included a survey of high elevation spring sites (Fagan 1974), and investigations of two buffalo jumps on the Owyhee Uplands (Agenbroad 1976).

The Late Archaic archaeological record is difficult to broadly characterize in terms of patterns of human activity. The excavated sites contain evidence of people who produced Rosegate point types occupying task-oriented camps in both upland settings, such as Nahas Cave (Plew 1986) and Indian Grade Spring (Jenkins and Connolly 1990), as well as low riverine locations such as Chalk Basin (Keeling-Wilson 2007) and Lydle Gulch (Sappington 1981). A greater diversity of activity is indicated at sites like Dirty Shame Rockshelter (Hanes 1988) but it represents an apparent short term task-oriented occupation none the less. The sites at Diamond Swamp (Musil et al. 1995) and Givens Hot Springs Locality (Plew 2000) are examples of longer duration occupations that likely spanned winter seasons or longer. These sites indicate that the producers of Rosegate points in this area were also apparently practicing a logistical mobility pattern which included task camps in a wide variety of settings as well as bases in places of resource abundance.

Site Setting and Description

The Birch Creek Site (35ML181) lies on an inside bend of the main stem of the Owyhee River in southeast Oregon (Figure 1-6). The Owyhee River at this location is a third order stream with much of the drainage located to the south. As a third order stream, the tributaries feeding into it lie upstream, have few branches, and all flow toward this one channel (Leopold et al. 1964). One of these tributaries enters the Owyhee River roughly 500 m south of the site and is the source of the site name, Birch Creek. The Owyhee River retains some water year-around though, during very dry summers it can be quite low. In contrast the tributaries near the site drain small upland areas and are dry during the summer and early fall. The Owyhee River flows north to the Snake River which joins the Columbia River and drains to the Pacific Ocean.

The site lies on a river terrace at the bottom of the Owyhee Canyon at the edge of the river's full-stage channel. Portions of the site extend north onto a wide alluvial plain though the intact portion of the Late Archaic component is confined to a narrow strip of flat terrace bordered to the west by a steep colluvial slope and to the east by the Owyhee River (see Figure 1-6). The terrace and larger plain to the north were used during historic times for agriculture. Alfalfa plants still grow on the landform but are not maintained and cattle have been allowed to graze in the area. Dirt roads connect the Pinnacles Ranch at the mouth of Birch Creek to the northern end of the fields. Ground cover on the site is limited to mixed grasses, tumble mustard, and alfalfa. Several hackberry trees (*Celtis* sp.) grow near the base of the slope away from the river. Shrubs including sagebrush and rabbitbush grow on the canyon slopes and banks opposite the site and historic ranch.

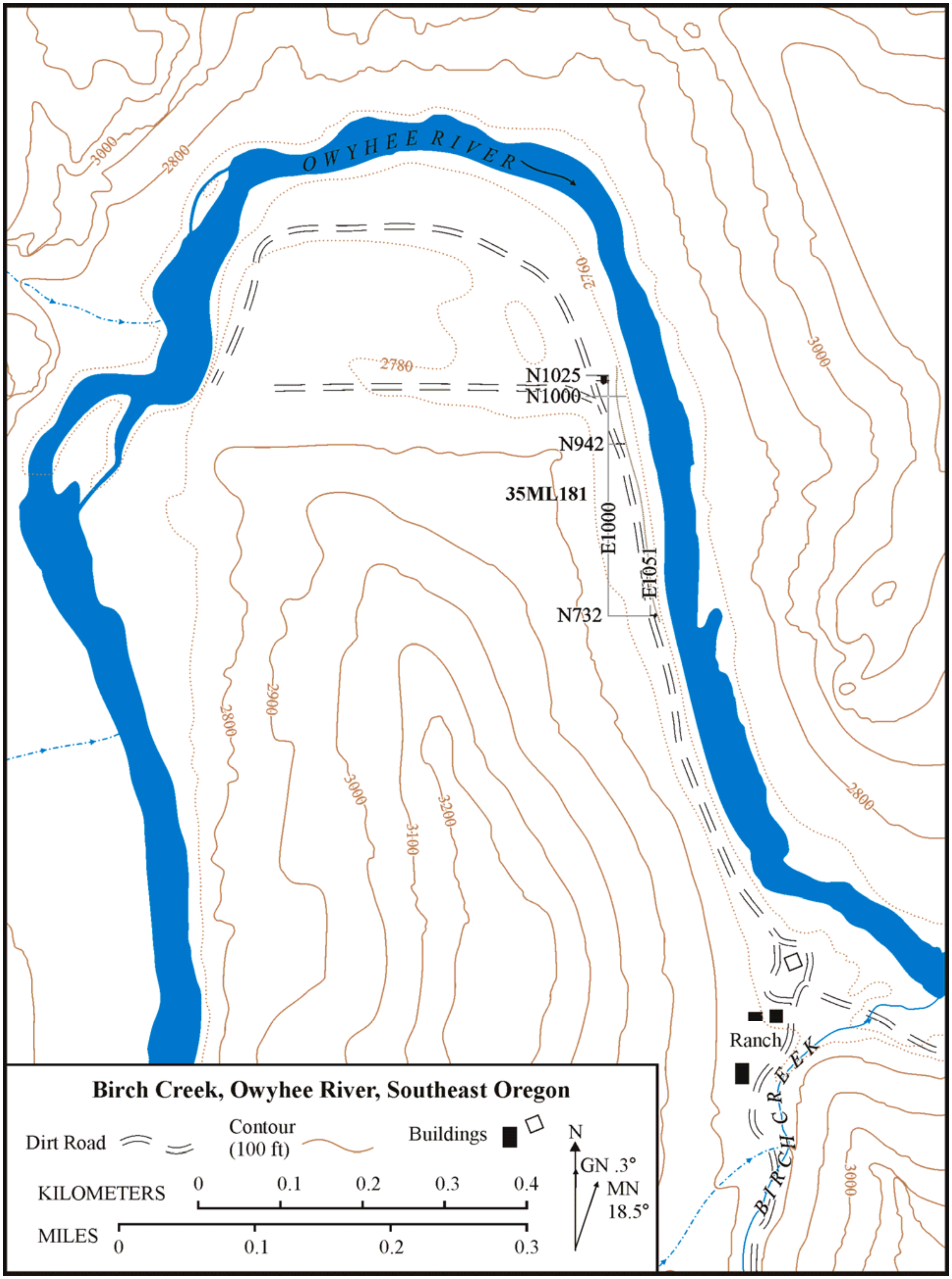

Figure 1-6. Topographic map of the Birch Creek Site area.

Birch Creek Project Overview

The Birch Creek Site was recorded during an archaeological survey of the Lower Owyhee Canyon (Pullen 1976). The survey identified archaeological sites and potential threats to site integrity from recreational activity, cattle grazing, and natural erosion. The Birch Creek Site was identified on the basis of an extensive chipped stone and ground stone scatter in the alfalfa field north of the confluence of the Owyhee River and Birch Creek. The site was on privately held land at the time it was first recorded. The only threat to the site that was identified was from plowing of the surface sediments of the field and a road through the site. Collecting of artifacts from the site was not listed as a major problem despite the proximity of this site to the raft takeout less than two miles downstream. The site and the historic Pinnacles Ranch buildings at the mouth of Birch Creek were later acquired by the Bureau of Land Management and included in archaeological site monitoring projects by that agency (Sudman 2003). In the early 1990s flooding of the Owyhee River resulted in horizontal erosion of riverbank sediments at the Birch Creek Site. A 25-30 m wide area stretching the length of the site was eroded leaving a loose sandy surface littered in chipped stone and ground stone artifacts. Charcoal stains in the cutbank formed by the flood indicated that intact deposits remained at the site. In 1998 Washington State University began a testing and excavation program at the site in the northern area (see Figure 1-6) (Andrefsky et al. 2003). Six years of excavation at the site identified two intact components consisting of an open camp immediately post-dating the Mazama ashfall (6800 BP) and a Middle Archaic Pithouse occupation.

The chipped stone assemblages of the Mazama component and the Pithouse component were compared by (Centola 2004). Aspects of the toolkits of each component relating to portability, use, maintenance, and reliability were analyzed. The lithic assemblages were found to be very similar along all dimensions despite the assumption that the two components represent different settlement strategies. The natural abundance of high quality chert available at the site was offered as a probable explanation for this unexpected result. The possibility that the settlement strategies were not very different but simply utilized different habitation structure types was offered as well.

The previous investigations at the Birch Creek Site have yielded two Master's theses which dealt specifically with chipped stone raw material sources. The first study looked at raw material variability during the period of occupation spanning 4400 BP to 2400 BP, both in proportions of obsidian and chert used and the way different obsidian sources were used (Cole 2001). A large quantity of chert is available in the gravels of the Owyhee in the vicinity of the Birch Creek Site, and as a result provided the raw material for the vast majority of the tools recovered. Obsidian was used in more limited quantities and was an important raw material for hafted bifaces. The obsidian sources identified for Birch Creek Site artifacts demonstrate that locations appear to have been used with greater intensity when they occur close to the river and proportionally decrease in use away from the Owyhee corridor, regardless of absolute distance to the site. Obsidian from Sourdough Mountain appears particularly important during the Middle Archaic period.

The second study using obsidian source data looked at the exploitation of different sources over time (Wallace 2004). Obsidian hafted bifaces were used and their source distributions were analyzed. The hafted bifaces were classified into known projectile point types with specific age ranges of use. The Birch Creek Site points were recovered from stratigraphic positions that corresponded with the relative ages of the points through time (i.e., the oldest points were the deepest and the youngest points were the shallowest). The obsidian sources were all within 48 km of the Birch Creek Site. Based on these data Wallace (2004) concluded that the occupants of the Birch Creek Site followed a mobility pattern consistent with that documented by Steward (1938) for at least the past 6,600 years. The implication is that foragers living in small family groups moved seasonally to collect seeds, roots, and game within a 20-30 mile radius of a winter village and only rarely congregated in larger groups when the limited resources of the Great Basin would allow the event.

The Birch Creek Site ground stone has been the subject of two Master's thesis projects. The first study attempted to generate a classification system for ground stone that would be clear and standardized, as well as limit functional implications in classes by focusing on morphology (Sager 2001). The Birch Creek assemblage contained four distinct ground stone types based on key size and wear attributes.

A second study of the Birch Creek Site ground stone focused on a comparison of the ground stone assemblages of the Mazama component and the Pithouse component (Cowan 2006). Several aspects of the assemblages were analyzed including the diversity of types, degree of tool production, and degree of tool use. In all of the areas of the assemblage tested no significant differences in the assemblages were found.

The site sediments have been studied for Master's thesis projects from the perspective of sedimentological processes along the river and geological structure within the site. Vandal (2007) recorded Holocene flood processes and the development of flood terraces within and downstream of the Birch Creek Site. Walker (2001) focused on the Middle Holocene excavation area and the landform development processes. These studies describe an extensive record of erosion and sedimentation at the Birch Creek Site which has produced a complicated vertical and horizontal alluvial stratigraphy.

The faunal remains from the Middle Archaic occupations of the site were analyzed to determine if changes in subsistence practices occurred over this time period (Van Galder 2002). The sample of bone represented large and small mammals as well as fish and birds. Only a small proportion of the specimens were identifiable to species level but many mammal specimens were identifiable to a size class. The analysis showed an increase in the diversity of animals used over time. Evidence of bone grease extraction was also found associated with the later end of the Middle Archaic occupation.

The work at the Birch Creek Site has been focused on the extensive Middle Archaic deposits. The study of the Middle Archaic may continue but other periods of occupation in the Owyhee Valley are worthy of attention. The Late Archaic period is underrepresented in this area and the remainder of this study is focused on adding to archaeological knowledge of this period in the Owyhee Valley.

CHAPTER TWO

2006 EXCAVATIONS

This chapter reviews the methods and techniques used to excavate and inventory materials from site 35ML181 during the summer of 2006. The site area was initially recorded by the location of chipped stone and ground stone artifacts found on the ground surface and along the edge of the Owyhee River (Andrefsky et al. 2003). The surface scatter of artifacts extends from the current edge of the Owyhee River towards the upland about 60 m. This approximate 60 m area from the river's edge towards the upland contains an artifact scatter that stretches for over 300 m without interruption along the river's edge. Conservatively, the site measures approximately 14,000 m^2 in spatial extent. Figure 2-1 shows the location of the site along the Owyhee River and excavation unit locations.

Field Procedures

The 2006 investigations used a datum and grid system to record the provenience of all materials and contexts at the site. The grid system for the site is oriented to true north. It contains a north-to-south baseline located at E1000 and an east to west base line located at N1000. Bothbase lines cross each other at N1000 E1000 (site datum location).

The 2006 excavations were initially intended to explore anomalies identified in a 2000 magnetometer survey (Carr et al. 2000) along the N942 line of the site grid (see Figure 2-1). Six 1x1 m excavation units were opened to explore subsurface cultural material that could account for the anomalies. Four of the six units were placed adjacent to and within an existing dirt road. These units recovered few artifacts and the sediments were comprised of interbedded colluvium

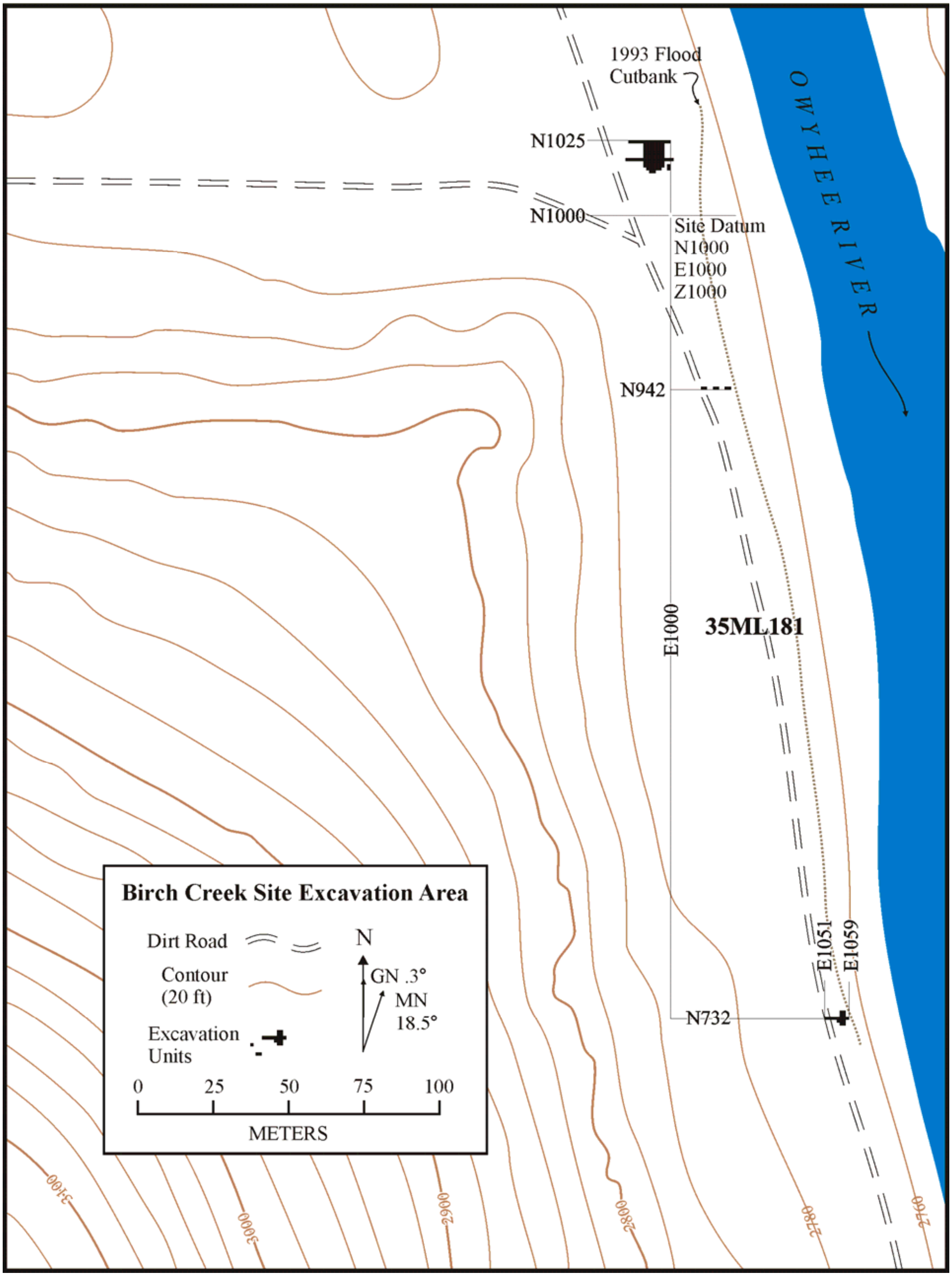

Figure 2-1. Site plan showing the locations of excavation areas.

and alluvium. As a result, the western four units were abandoned before intact cultural deposits were uncovered. The units located at E1058 and E1059 did not contain dense colluvium and were excavated using arbitrary 10 centimeter (cm) levels, beginning with the second level, to a maximum depth of 125 cm below ground surface (grid elevation 998.072) in unit N942 E1019. The Middle Holocene component of the Birch Creek site was encountered at an elevation of 998.3. Despite the identification of intact cultural material no explanation for the magnetic anomaly centered near the grid point N942 E1019 could be found. A total of 825 artifacts representing Middle Holocene activities were recovered along the N942 gridline. Excavations along the N942 line were discontinued following the identification of the Middle Holocene cultural materials and work was shifted to an area of the site further south.

The majority of the 2006 excavations concentrated on an area nearly 300 m south of all the previous excavations at the Birch Creek Site (see Figure 2-1). This location was selected because a non-systematic inspection of the river cutbank in this area resulted in the identification of partially exposed artifacts in a relatively shallow burial context. These artifacts were believed, upon first inspection, to represent an intact Late Archaic component to the site. A total of 17 1x1 m units were opened between the cutbank and existing dirt road to expose a wide surface area and determine the nature and extent of the deposits. The units were placed within the framework of the existing Birch Creek Site excavation grid and named for the grid coordinate of the southwest corner of unit (Figure 2-2). The Late Archaic component was exposed as a dense artifact concentration of dark grayish brown (Munsell colors 10YR3/2, 10YR4/2) sediment at the grid elevation 998.700 and recognized by a Rosegate series projectile point recovered at this elevation.

The formal excavation of the Late Archaic component proceeded with the excavation of eleven of the units arranged in two intersecting trenches comprised of the east-west units along the N732 gridline except for unit N732 E1058, and north-south along the E1057 gridline (see Figure 2-2). The excavation resulted in the removal of a total of volume 10.9 m^3, 5.51 m^3 of which were primary cultural deposits (Appendix A). These excavations recovered a total of 5,550 artifacts and samples. The majority of these were recovered from within the primary cultural strata of the site (n=4,487) while fewer than twenty percent (n=1,063) came from levels above. The density of prehistoric artifacts is 814.34 per m^3 within the cultural strata, and 197 per m^3 above. The artifact density is variable for each unit, however (see Appendix A).

Excavation blocks were removed in contiguous 1x1 m squares. This means that the largest unit of collection was a 1x1m square. This also means the grossest level of spatial information from the site is within 1 m. Within each excavation square artifacts and samples were collected from natural or cultural strata. If a natural or cultural stratum was thicker than 5 cm an arbitrary level or levels were designated within the natural or cultural stratum. In other words, all squares were excavated in levels less than or equal to 5 cm in thickness. Levels less than 5 cm in thickness were defined by natural or cultural contacts.

All artifacts and associated cultural materials (such as subsistence remains) were minimally collected and placed in a field bag that contained provenience information identifying the site number, 1x1 m square, the level, the depth below datum, date of excavation, and excavators. Some artifacts and samples were collected with three point provenience recorded, and bagged separately. Three point provenience records the location of the artifact or sample to within a half cm in three dimensions (north to south, east to west, depth below datum). Artifacts such as diagnostic tools and samples such as radiocarbon specimens were collected

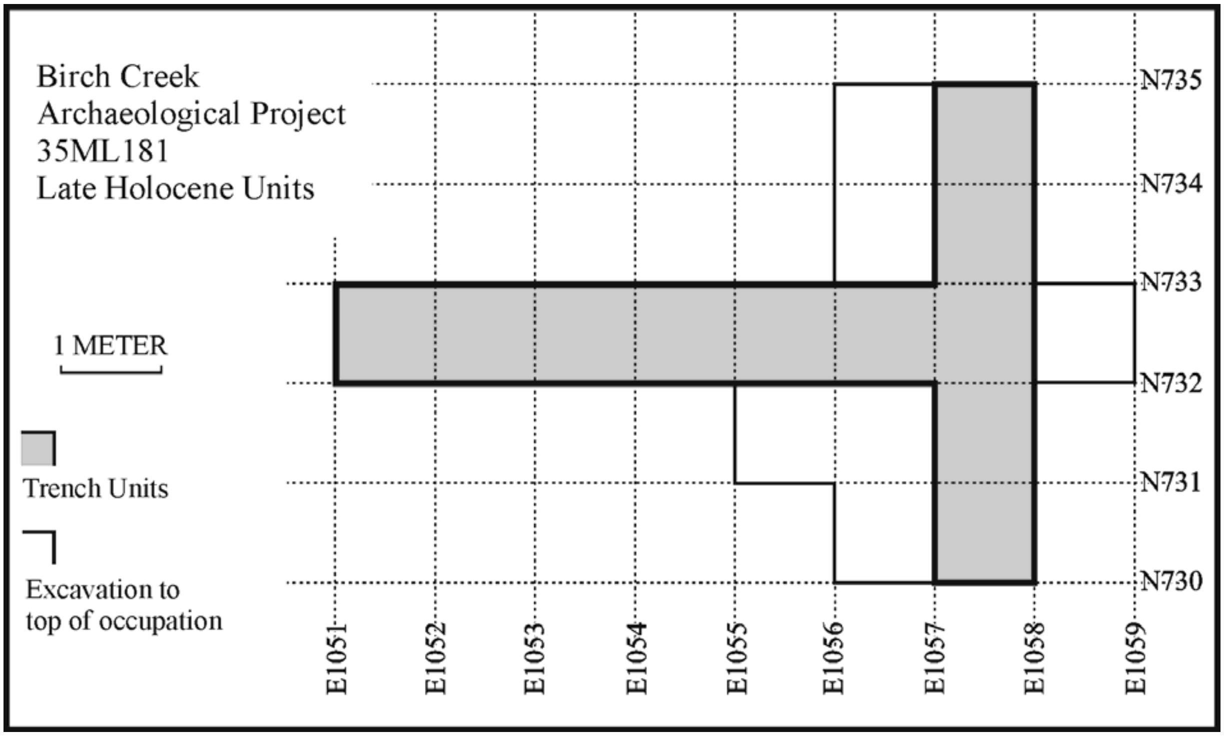

Figure 2-2. Unit excavation plan for the 2006 Birch Creek Site Late Holocene component.

with point provenience information. In addition to the collection of all artifacts and subsistence remains from each level, various samples were also recovered including sediment and charcoal. A constant volume sample of sediment was collected from the northwest corner of each level within each square. This sample provided a record of the sediment type and, potentially a record of pollen from every level. The constant volume sample is 500 cubic centimeters (cc) in size. Whenever encountered, radiocarbon samples, flotation samples, and soil samples were taken to record changes in site context and content.

Artifacts and samples identified in the ground during the excavation of each level were collected in situ. All sediments removed during excavations were sifted through a 1/8 inch mesh to ensure that no artifacts or other cultural remains were missed during excavation of the level. Artifacts found during sifting of sediments were placed within level bag along with separately marked three-point provenience bags containing artifacts discovered in situ.

Each level from each square was recorded in a field notebook and on a level form. The level form records information about the materials encountered during excavation and the context of the investigation. For instance, a list of all three-point provenienced items was included on the form as are the beginning and ending elevations in all parts of the square. The soil/sediment color was recorded using a Munsell color chart. In addition, each level form contains an area to record a plan view map of the 1x1 m square. This plan view map is a sketch of the floor of the excavation square drawn to scale. Items like rocks, stains, artifacts, disturbances, and features were recorded on the plan view map.

At least one wall profile from each excavation unit was also recorded. Typically, such profiles record the locations of different natural and cultural strata and any inclusions within the strata. Wall profiles from the 2006 investigations generally identified sediment composition, color, compaction, and location, as well as sample locations and partially exposed artifacts.

Laboratory Procedures

The laboratory procedures used for artifacts and samples recovered from the 2006 investigations are consistent with those used for inventory of artifacts recovered during previous excavations at the Birch Creek Site (Andrefsky et al. 1998, 2003; Andrefsky and Pressler 2000; Andrefsky and Satterwhite 2002). A more elaborate explanation of the procedures used for chipped stone artifact inventory can be found in a recent publication (Andrefsky 2005); a summary of that system is included below. The artifact inventory initially recognizes 13 data fields. These fields and the data included in each are:

(1) the Smithsonian site number designation

(2) the inventory number, which is a unique number assigned during the course of this project that runs consecutively beginning with the first artifact inventoried during the first season;

(3) the existing catalog number, which may include entries that are present on an artifact itself, or in site records;

(4) the unit, or horizontal provenience determined by the grid coordinate designation of the southwest corner of the excavation unit;

(5) the level or stratum, including specific datum elevation;

(6) the object group, which currently includes nine categories of objects commonly produced at archaeological sites;

(7) the object type, which is a coding designation that represents a sub-classification of a specific object group;

(8) the raw material, which may be relatively specific in the case of stone artifacts, or general in the case of most material types;

(9) a count of the number of items associated with the inventory number;

(10) the box number, which is a number assigned to boxes consecutively throughout the project beginning with one in which objects are stored;

(11) the location, which is the room, cabinet and drawer, or shelf section and tier where the box or objects are stored;

(12) the burial association, which indicates whether materials are human remains (designated H), burial goods (G), items of possible cultural patrimony (C), or have no burial association (N);

(13) additional comments, which include any relevant information found with the artifacts.

Many of the fields included within the inventory need no additional explanation. However, some fields such as object group and object type are hierarchical, in the sense that coding for object types is dependent on their object group. The coding for object group and object type are based upon morphological classification and are intended to make it possible to group similar items. Appendix B lists the codes for the 13 fields and for the object groups and the object type codes used in the sorting, as well as the codes for raw material types.

The procedures described above represent the first phase of artifact sorting, cataloging, and initial analysis. The information coded in these fields can provide preliminary frequencies and distributional information such as number of artifacts types found by unit and level, and the various type and count of artifacts found in various proveniences. In addition to this level of analysis, some artifact classes were subjected to additional analysis. The following chapters, which deal with specific object group assemblages from the 2006 excavations, provide detailed information regarding additional information collected for specific artifact analyses addressing particular questions.

CHAPTER THREE

SITE AGE

The Birch Creek Site (35ML181) is a multicomponent occupation with materials dated to before the eruption of Mount Mazama roughly 6,800 years ago (Andrefsky et al. 2003). The complex geology of the Owyhee River Canyon and human land use during the twentieth century has produced a site which has both vertically and horizontally isolated intact components. The relative ages of different site areas are not a simple matter of determining the stratigraphic position of cultural material. The age of the materials recovered during the 2006 field season can only be determined by the artifact evidence within the deposits and cannot rely on the age of previously excavated materials alone for site age estimates.

The age of the Birch Creek Site materials excavated in 2006 have been determined through multiple lines of evidence. Four projectile points and 48 charcoal samples were among the 5,550 artifacts and samples recovered. These materials provide a means of determining the age of the site with a high degree of precision. In this chapter the age-related data for the site is presented and the implications of that data are explored. The chapter begins with the relative age data and covers some of the problems with applying relative age markers to this occupation.

Relative Age Indicators

During the course of excavation five hafted bifaces were recovered. Four of these bifaces fit metrically replicable projectile point types (Figure 3-1). In the northern Great Basin projectile point types or styles provide a means of relative age determination for archaeological sites. The types have been well documented for the region as a whole (Justice 2002). These types are

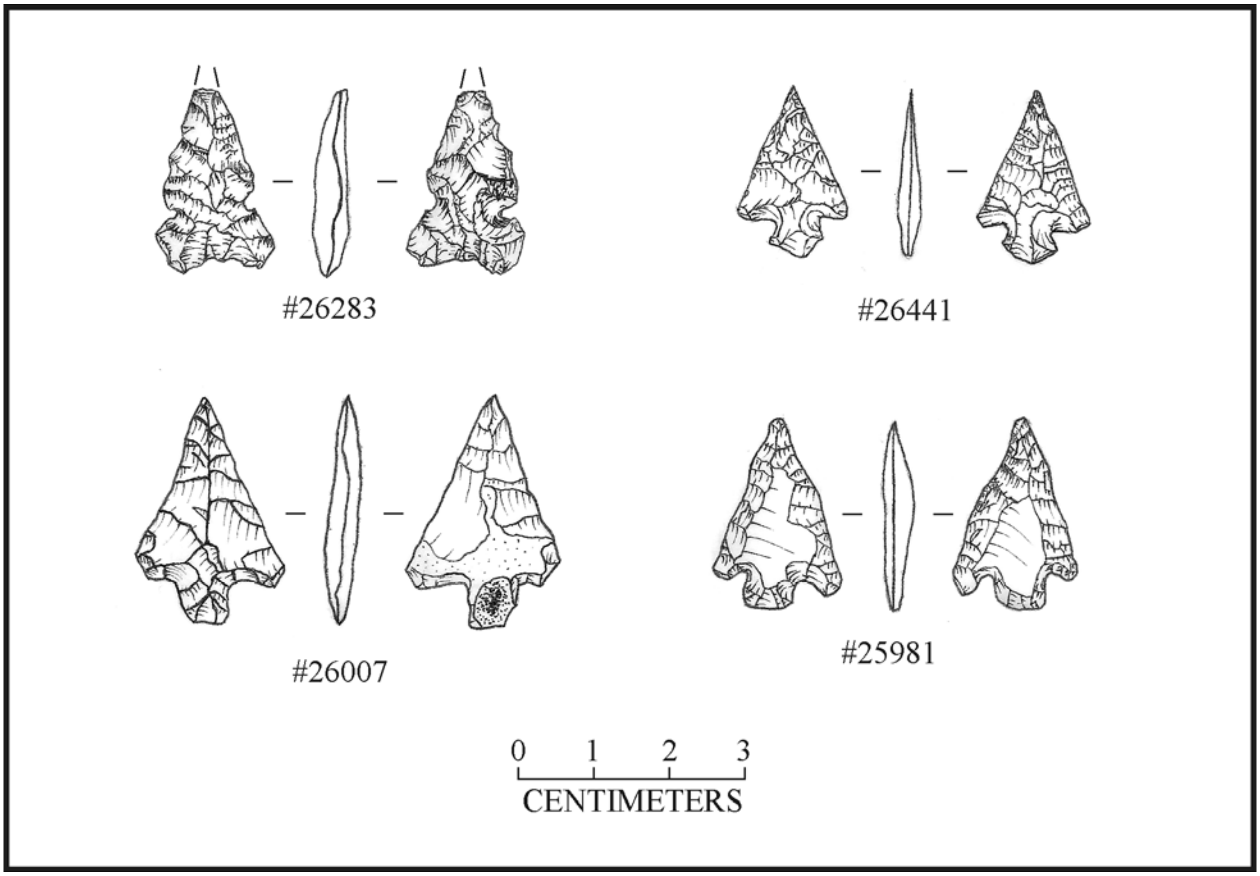

Figure 3-1. Projectile points recovered in the Late Archaic component of the Birch Creek Site. Side-Notched type (#26283), Corner Notched type (#26441, #26007, #25981).

central to descriptions of the various periods of the regional prehistory (see Jennings 1986). The significance of these artifacts for dating is great, especially in the Owyhee Canyon where organic preservation in open-air contexts is not always good. At the Chalk Basin quarry upstream of the Birch Creek Site, organic preservation was very poor and six projectile points provided the only means of dating the site (Keeling-Wilson 2007:68-71).

The projectile technology found in the Great Basin is highly variable in form and distribution. The breadth of information on these types is well covered in books (e.g., Justice 2002), however a brief review of some information regarding the types identified at the Birch Creek Site is useful here. The two projectile forms identified do not represent the same time period. The relatively more common form in the assemblage is the Rosegate series arrow point. Three of these points were recovered from the site. These include the Rose Spring Corner-notched and Eastgate Expanding Stem variants though, for the purposes of this study, they are discussed in terms of the generalized Rosegate characteristics. These points are small triangular bifaces with corner or basal notching which produces an expanding stem (Hanes 1988:24). These points were produced from approximately 1800 to 500 years ago (Jennings 1986; Justice 2002). The second type is a small side-notched point- triangular in plan with parallel-sided notches that are potential characteristics of Northern Side-Notched type points and Desert Side-Notched points. The notches of Northern Side-Notched points have been described as placed "well above the basal edge" (Hanes 1988:22). These date to roughly 8000-4000 BP (Hanes 1988:22-23; Jennings 1986) for the Great Basin in general and to roughly 5400 to 4000 BP in the Northern Great Basin (Largaespada 2006).

The side-notched point is a potential issue for dating. The Rosegate series points were recovered first and as a result conditioned our expectation that Late Archaic arrow-points would continue to be found. The neck width of each point was measured and points with necks narrower than ten millimeters were considered arrow-points while those ten millimeters or greater were considered darts (Andrefsky personal communication 2006). The side-notched point has a neck width of 9.0 mm and was initially considered an arrow-point, possibly of the Desert Side-Notched type. The use of single metric attributes of projectile tips to determine projectile type has been shown to be inaccurate even when the attribute is logically dependent on the projectile shaft diameter (Shott 1997). Multivariate analyses have also proven inaccurate in the nearby Lower Snake River area where some known dart and arrow points have failed to be segregated by haft measurements (Ames et al. 2007). Armed with the initial assessment that the point was a side-notched arrow tip the potential age of occupation was relatively late. The only side-notched arrow in the region is the Desert Side-notched type which Hanes (1988) describes as a triangular point with parallel sided notches well above the (concave) base, much like a Northern Side-notched point. The Desert Side-notched points are no older than 700 BP (Largaespada 2006). Largaespada (2006) provides detailed metric typologies for the Northern Side-notched and Desert Side-notched types based on multiple Northern Great Basin assemblages. Chapter Seven provides a comparison of the Birch Creek Site specimen to Largaespada's (2006) work. These data indicate that the initial arrow assignment made in the field was inaccurate and that the point falls within the population parameters of the Northern Side-notched point type. The possible conclusions that can be drawn from this are that the Northern Side-notched point has a much wider temporal range than is generally accepted, the site has mixed stratigraphy, or the point was collected and reused. The type definitions and age ranges for the Great Basin have been well researched and documented (Jennings 1986; Justice 2002; Largaespada 2006). It is unlikely that the Owyhee Canyon contains an example of exceptionally late production of the Northern Side-notched point. The sediments are also not likely to be the source of the problem. The stratum containing this artifact (presented in Chapter Four) is relatively undisturbed and minimal mixing within or between sedimentary units is evident. The probable source of the point is from recycling during the later period. Reuse has been documented elsewhere in the Northern Great Basin (Largaespada 2006) and may have occurred here because the small dart point was suitable for use on an arrow or for some other task. This apparent practice of material recycling further highlights the need for radiometric dating at this site, in order to avoid inaccurate statements regarding the period of occupation.

Radiometric Age

Charcoal samples used for dating were selected to determine the overall age of the occupation and detect any possible occupational hiatuses. Three of the four projectile points recovered during excavation were recognized as bow-and-arrow types and the fourth could have functioned as an arrow tip as well. As stated above, these only provided the general time period for the occupation and could have been produced/used at any time between 1,800 to 500 BP based on regional point typologies (Justice 2002). Accelerated mass spectrometry (AMS) of artifact charcoal was used to further define the period of occupation.

Charcoal specimens were recovered in situ from features and general stratigraphic contexts including unit profiles. A sub-sample of these charcoal specimens was selected to provide dates for as many cultural strata as possible while minimizing unnecessary duplication of results. Samples which could be assigned with certainty to a stratigraphic unit and, when possible, were located close to a unique and significant artifact, such as a point or grinding stone, were specifically selected.

The processing of the selected charcoal specimens was completed by the author at the AMS facility in the Physics Department at the University of Arizona in Tucson following their protocol. Specifically, I was responsible for preparing the carbon samples for measurement. The first step involved neutralization of the sample chemistry by removing carbonates with hydrochloric acid, removal of humates with sodium hydroxide, and a final base neutralization using hydrochloric acid. The final acid step is necessary to ensure that the sample is neutral or acidic because an alkaline sample will absorb atmospheric carbon dioxide and add carbon isotopes to the sample. A sediment sample was prepared in addition to the charcoal specimens. This sample underwent all of the neutralization steps described above, in addition to a concentration of the charcoal powder by dissolving the silica sediments with potassium hydroxide.

The neutralized carbon samples were sub-sampled and precisely measured along with a commensurate proportion of copper oxide, which provides oxygen when heated to allow the formation of carbon dioxide (with the artifact carbon), and placed in glass combustion tubes. The samples were individually processed on a vacuum pressurized combustion line in which carbon dioxide was captured and measured. The carbon dioxide gas was placed in specimen tubes which are subsequently processed on a graphitization line which uses iron powder as a catalyst in the reaction between the CO_2 and H_2 which produced graphite powder. The graphite powder is the substance that is placed in the accelerator for isotope measurement.

The 2006 excavations at the Birch Creek Site recovered 48 charcoal specimens. Of these, 12 were selected for AMS dating. These samples were selected to determine the age of as many of the cultural strata as possible and provide close determinations of ages of several artifacts including arrow points and ground stone objects. Ten of the 12 processed samples have radiocarbon ages which fall into a time span of roughly 200 years (Table 3-1).

The expected Late Holocene time period was returned by ten of the samples and isolated the component age to a period from 1118 to 1310 BP. In addition to the overall site component age, these dates also indicate a relatively continuous occupation (Figure 3-2). The standard deviations are generally small (32 to 46 years) and, when used to evaluate the continuity of occupation at Birch Creek during this period, reveal no gaps in occupation given the sample age ranges (Figure 3-2).

Table 3-1. Uncalibrated AMS Sample Ages Reported by University of Arizona.

AA #	Sample ID	Stratum	$d^{13}C$	F			^{14}C age BP		
AA75306	25299	XII Feature	-22.6	0.688*	±	0.028*	3,000*	±	330*
AA75307	25820	XII	-12.3	0.851	±	0.004	1,294	±	32
AA75308	25822	--	-20.6	0.976	±	0.01	198	±	85
AA75309	25303	VI	-25.6	0.854	±	0.005	1,268	±	46
AA75311	25305	VII	-24.3	0.853	±	0.004	1,271	±	33
AA75312	26488	XVI	-23.6	0.87	±	0.004	1,118	±	32
AA75313	26395	VII	-10.9	0.85	±	0.004	1,299	±	32
AA75314	27503	XVII	-11.4	0.862	±	0.004	1,191	±	33
AA75315	26449	VI	-10.5	0.859	±	0.004	1,215	±	32
AA75316	26108	IV	-22.9	0.867	±	0.004	1,139	±	32
AA75317	25980	VI	-24.3	0.849	±	0.003	1,310	±	33
AA75318	25949	IV	-23.9	0.862	±	0.004	1,189	±	32

*charcoal sample concentrated charcoal dust from bulk sediment sample.

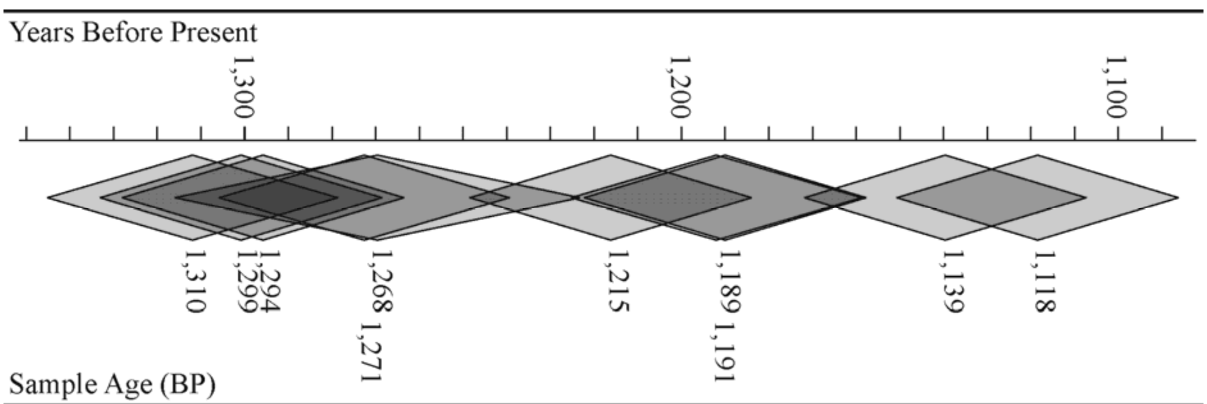

Figure 3-2. Distribution of Late Holocene AMS dates shown with one standard deviation.

The results of radiometric dating are informative, but leave some lingering questions about the nature of this apparent continuous occupation. Several explanations for the age distribution exist, including that the site was a seasonal residence occupied during only one time of the year but over two centuries, or this may have been a near permanent activity center from which all other seasonal activities where based. The dates alone are not capable of providing the resolution needed to address this issue.

There are two samples which fall outside the 200 year range that need to be addressed. The 2006 excavations focused on the Late Holocene occupations, however, a feature appeared in the eastern portion of the excavation which was dated to approximately 3,000 BP. This date was derrived from charcoal-rich sediment from the spaces between fire-cracked rocks that were arranged in a closely-fitted layer along the base of the feature. The remains from this procedure were mostly charcoal dust with a small quantity of insoluble minerals. The resulting carbon sample did yield carbon dioxide and provided a date of 3,000 ± 330 BP. The large standard deviation is likely a result of the averaging of the carbon contents of thousands of small charcoal fragments and the finding is significant though weak (F 0.688, *p* 0.028). Ultimately this date demonstrates that the base of the Late Holocene component was reached in some, if not all, of the excavation. The 3,000 year old feature is interesting but anomalous; other information on it is reported in other chapters as it relates to Late Archaic component materials. However it does not appear to have been utilized during the Late Archaic for its constructed purpose.

The second AMS date which does not correspond to the group of 10 is sample AA75308 (198 ± 85 BP). This sample represents a potentially modern source though it is one of the deepest samples of the group. There is no simple explanation for this date based on any of the associated recovered data. The $d^{13}C$ value is one potential clue as to the source of the charcoal date. Most of the plants in the world have carbon structures that fall into the two main groups of C3 or C4. The significance of these types is outside the scope of this project but the quantity of the ^{13}C isotope varies with each group an has implications for this study. The typical observed $d^{13}C$ value for C3 plants ranges from -25 to -29 while a typical observation for a C4 plant is -12 to -16 (O'Leary 1988). The $d^{13}C$ for this very young sample is -20.6, outside of the range of either plant group. The only organisms which have recorded $d^{13}C$ values in this range are algae and lichens (Smith 1972) which are unlikely sources for this sample. Water from the Owyhee River was used daily to keep the site sediments moist and avoid drying and hardening of the excavation area. Algae was probably introduced to the site area from this water and could have persisted alive within a moist sample pouch. The possible and likely scenario for this recent date is that a sample of ancient carbon was collected but contaminated by some live microorganism which affected both the age and $d^{13}C$ value of the sample.

Summary

The objective of this project was to collect and analyze data that could contribute to our understanding of the Late Archaic occupation of the Birch Creek Site (35ML181). A central requirement of this objective is a demonstration that the period of occupation dates to the Late Archaic. The 2006 excavations recovered temporally diagnostic artifacts as well as radiometrically datable organic samples that indicate a Late Archaic occupation.

The temporally diagnostic projectile points tell us something about the age of the component as well as the behavior of the occupants. Use of old artifacts apparently happened at the Birch Creek Site, the Northern Side-Notched point recovered in 2006 may have been brought to the site from far away or picked up from the banks of the Owyhee River after eroding from an earlier component. The other projectile points reflect bow-and-arrow use. The dates on the charcoal recovered from the site place the occupation firmly in the Late Holocene and combined with the projectile points define this component as Late Archaic. The sample also does not reveal any gaps in the occupation.

CHAPTER FOUR

BIRCH CREEK GEOLOGY:

REGIONAL BEDROCK AND SITE SEDIMENTS

The area of the Owyhee River Valley surrounding the Birch Creek Site is a unique and diverse landscape with a geologic history that is rich and complex. The geologic forces and structures that shape the Owyhee River Valley also influence the local geology of the Birch Creek Site, from the lithic materials available to prehistoric peoples to the landforms they lived on. This chapter describes the regional geology of the Owyhee Valley as it relates to the archaeological deposits of the Birch Creek Site and describes the sedimentary units that comprise the Late Archaic component. The purpose of this chapter is to provide the basis for the physical context of the occupation, background that will be important to discussions of lithic artifactual materials in chapters Six, Seven, and Eight, and analysis of the site sediments which relates Late Archaic settlement to that of the Middle Archaic.

Regional Geology

The Owyhee River Valley began to form during the Middle Miocene approximately 15.5 to 14.5 million years ago (mya) (Bishop 2003). During this period the area that is today eastern Oregon was the site of active volcanism with numerous basaltic and rhyolitic vents. Much of the basalt is believed to have vented from a common magma chamber located beneath east-central Oregon and southwest Idaho. The loss of magma from this chamber resulted in a subsidence of the overlying rock along numerous faults and the formation of the Oregon-Idaho Graben, which the Owyhee River flows north through today (Figure 4-1). The formation of the Oregon-Idaho Graben is the foundation for the current geology of the Owyhee Canyon and subsequent Miocene

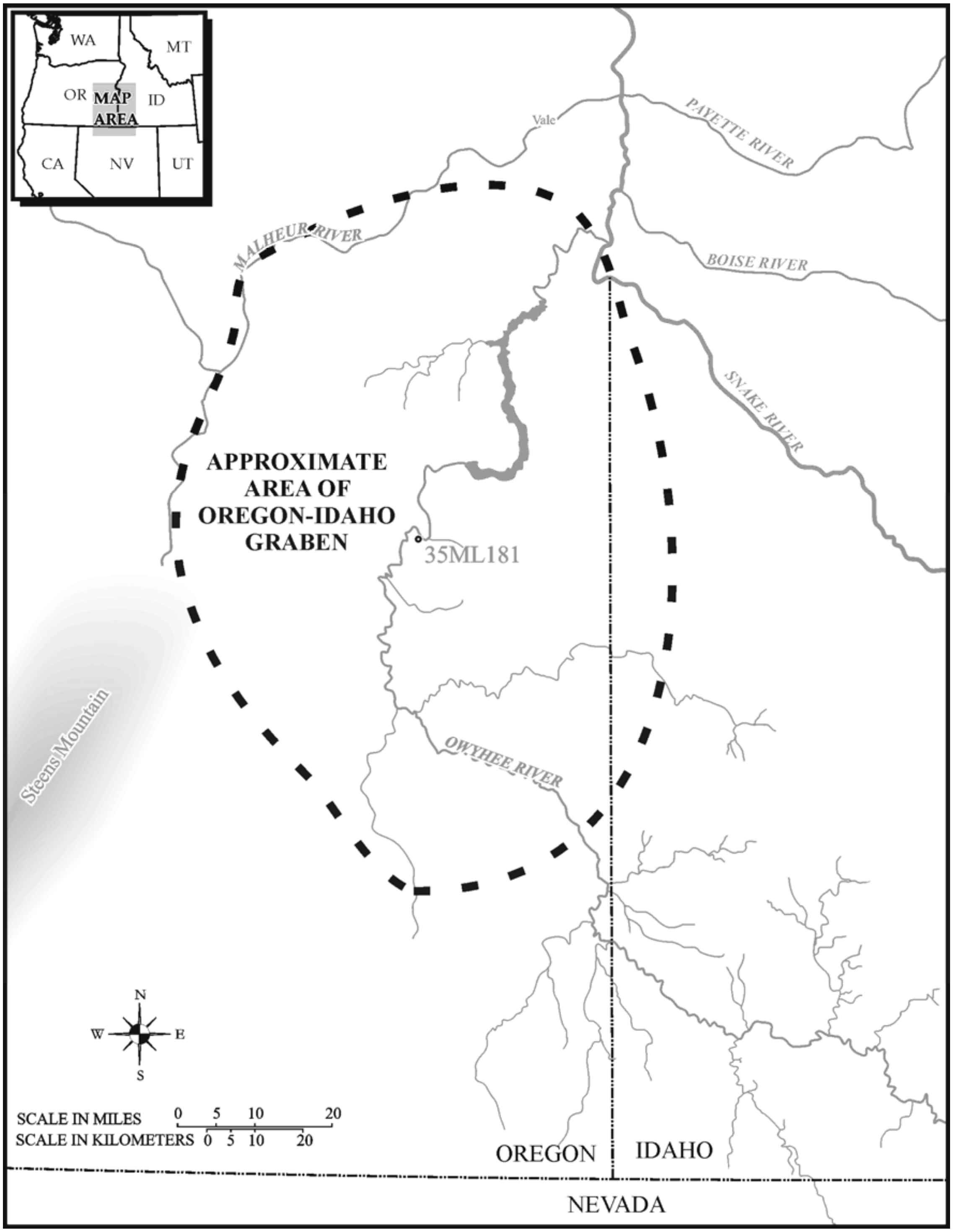

Figure 4-1. The Oregon-Idaho Graben and Owyhee River Valley, southeast Oregon (Oregon Department of Geology and Mineral Industries 2008).

and Pliocene volcanic and sedimentary formations comprise the current geologic formations of the area.

The lowest rocks exposed in the canyon along the main stem of the Owyhee River are part of the Sucker Creek Formation (Baldwin 1976:129-130). These rock are primarily siliceous tuffs and rhyolites. The Sucker Creek Formation is overlain by Owyhee Basalt and may be related to Steens Basalt to the west. The Owyhee Basalt is capped by a series of sedimentary beds known as the Deer Butte Formation (Baldwin 1976: 132-133). The Deer Butte Formation is composed of siltstone, conglomerate, and sandstone that varies from friable to so highly cemented by silica that it fractures through its grains rather than around them. The sedimentary beds of the Deer Butte Formation were deposited during the Late Miocene to Early Pliocene (ca 10 to 13 mya).

The Pliocene age rocks are primarily sedimentary in composition but do include some volcanic beds (Baldwin 1976:133). The Chalk Buttes Formation is a friable sedimentary deposit that is exposed in places along the Owyhee River canyon. A more massive sedimentary deposit is found in the "Rome Beds," which are a nearly horizontal series of deposits measuring 130-165 m thick (Baldwin 1976:133). Contained within these early-to-middle Pliocene rocks are both potential and known chert sources such as those of the Chalk Basin Quarry (Pullen 1976), which is probably part of the Chalk Buttes Formation. During the late Pliocene and early Pleistocene localized basaltic volcanic flows erupted in the uplands of the Owyhee Valley and filled some of the tributaries with small basalt flows. Jordan Craters located approximately 10 km southeast is the closest of these late basalt vents to the Birch Creek Site. The major geologic features of the Pleistocene and Holocene are largely alluvial. The margins of the Owyhee River are alluvium derived from the complex bedrock of the Owyhee Canyon which has been deposited in terraces and gravel bars.

Site Stratigraphy

The Owyhee Valley is made up of a deep winding canyon within the larger trough of the Oregon-Idaho Graben. The canyon contains a narrow band of alluvium at its base which is reworked and pushed toward the Snake River by the Owyhee River. The limited area for meandering created by the canyon walls and bedrock floor restricts the activity of the Owyhee River to pulses of sediment mobilization during periods of high water flow (floods). The result has been the formation of numerous terraces and cut-bank sequences which abut and overlap one another.

The geoarchaeological context of the occupations dating to between 6800 and 2400 BP were evaluated for a Master's thesis project completed by Walker in 2001. The soils and sediments studied are approximately 300 m north of the current study area, though part of the same site and landform. The landform is a continuous alluvial terrace sequence which is comprised of a wide point-bar in the north and terraces which narrow downstream across the length of the site. Walker (2001) characterized three terraces which have formed throughout the course of the Holocene. The Middle Holocene occupations are located on the second or middle terrace. The occupation sediments are indicative of flood sand deposits. The third and highest terrace is armored by large gravels and does not contain subsurface archaeological deposits. Intact deposits were also not identified within the sediments of Terrace 1 immediately adjacent to the Owyhee River. The loose sandy deposits and lack of soil development indicated that Terrace 1 is very young or is still aggrading during modern floods.

The geologically recent flood history of the Owyhee River was studied as part of the 2006 Birch Creek Archaeological Project field season and resulted in a Master's thesis project

(Vandal 2007). The banks of the Owyhee River were profiled in several locations including two sites adjacent to the archaeological excavation units. Vandal (2007) identified four separate flood deposits which bracket the Late Archaic component of the site. These flood deposits are comprised of a massive sandy unit below the cultural strata and three separate floods above the cultural strata, including the 1993 flood. The results of the flood study indicate that the Owyhee River has experienced numerous floods during the Holocene which deposited fine sand to silt sized sediment which developed multiple alluvial terraces in the Birch Creek Site area.

Methods

The analysis of site sediments was completed using standardized descriptive terminology for all stratigraphic units and features. In addition to the sediment recording during excavation the sediments were also described in profile at the completion of the excavation with the sediment matrix composition, structure, color, reactivity to hydrochloric acid (HCl), and inclusions noted for each stratigraphic unit. The profiles of the extant completed unit walls were drawn to scale and sediment units assigned Roman numeral designations. In some cases upper profile sections are missing because those sediments were excavated prior to profiling.

Matrix composition was determined through comparisons with texture cards containing the geologic standard sizes of sand grains. Colors were determined through dry sediment comparisons with Munsell Soil Color chart tiles and labeled with the name and numeric designation for each color. Inclusions were assessed by their type (i.e., roots, krotovina, rocks), size and density.

Stratigraphic units were analyzed in the field for sequencing and correlation. The discontinuous sediments were assessed for relative position and composition to determine possible relationships between units. Discontinuous units that did not correlate with any other units and contained stains of charcoal dust or oxidation were considered features. Features were evaluated during excavation and during profiling (if present in a unit wall). Only those features which could be recognized with clear intact boundaries were given unique designations during excavation. All stains were noted and described on level forms regardless of unique designation number assignment.

Stratigraphic Summary

A total of 19 stratigraphic deposits encompassing the Late Archaic sediments were recorded. Figures 4-2a through 4-2d show the profile drawings of these stratigraphic units from both sides of each trench formed by unit excavation and Table 4-1 provides descriptions of each stratigraphic unit as recorded in the field. These profiles show the geological and the cultural strata evident at the completion of excavations in 2006. The profiles are drawn with solid lines depicting clear recognizable boundaries and dashed lines to indicate approximate midpoints of diffuse or unclear boundaries between stratigraphic units.

Table 4-1. Descriptions of Stratigraphic Units.

Unit	**Martix**	**Color**	**Boundary**	**Inclusions**	**Additional Remarks**
Duff	Medium sand	Grayish Brown (10YR 5/2)	Clear and smooth	Very many fine roots	
I	Very fine to fine sand, inversely graded	Grayish Brown (10YR 5/2)	Clear and smooth	Very few fine roots	
II	Medium sand	Dark Grayish Brown (10YR 4/2)	Clear and wavy	Very few very fine roots, krotovina	
III	Very fine sand	Grayish Brown (10YR 5/2)	Clear and irregular		Discontinuous; Slightly effervescent
IV	Very fine to medium sand	Brown (10YR 5/3)	Clear and wavy	Charcoal flecking; Charcoal stains 1 and 2 Very Dark Gray (10YR 3/1) and 3 Black (10YR 2/1)	Very effervescent; Dated 1139 ±32 BP (AA75316) 1189 ±32 BP (AA75318)
V	Very fine sand	Light Brownish Gray (10YR 6/2)	Clear and irregular		Discontinuous; Very effervescent

Table 4-1 continued

Unit	Martix	Color	Boundary	Inclusions	Additional Remarks
VI	Very fine to medium sand	Dark Gray (10YR 4/1)	Very clear and wavy	Charcoal flecking	Slightly effervescent; Dated 1215 ±32 BP (AA75315) 1268 ±46 BP (AA75309) 1310 ±33 BP (AA75317)
VII	Silt	Dark Brown (10YR 3/3)	Not excavated	Charcoal stain 4 Black (10YR 2/1)	Slightly effervescent; Dated 1271 ±33 BP (AA75311) 1299±32 BP (AA75313)
VIII	Very fine to medium sand	Grayish Brown (10YR 5/2)	Clear and smooth	Very few very fine roots, krotovina	
IX	Medium sand with shell	Dark Grayish Brown (10YR 4/2)	Clear and smooth	Very few very fine roots	
X	Medium sand	Very Dark Grayish Brown (10YR 3/2)	Clear and smooth		
XI	Fine to coarse sand	Dark Grayish Brown (10YR 4/2)	Clear and smooth	Very few very fine roots	Strongly effervescent
XII	Very fine sand	Dark Brown (10YR 3/3)	Clear and smooth		Very effervescent; Dated 1294 ±32 BP (AA75307), Feature Fill 3000±330 BP (AA75306)
XIII	Fine to medium sand	Grayish Brown (10YR 5/2)	Clear and wavy		Slightly effervescent
XIV	Fine to medium sand with dense colluvial clasts	Brown (10YR 5/3)	Clear and smooth		Very effervescent
XV	Fine to medium sand	Brown (10YR 5/3)	Irregular		Heavily bioturbated
XVI	Fine sand with charcoal flecking	Grayish Brown (10YR 5/2)	Clear and smooth	Very few very fine roots; krotovina	
XVII	Silt	Dark Brown (10YR 3/3)	Clear and smooth	Burned sediment, Dark Yellowish Brown (10YR3/4)Charcoal Stain, Black (10YR2/1)	Dated 1191 ±33 BP (AA75314)
XVIII	Fine to medium sand with dense colluvial clasts	Grayish Brown (10YR 5/2)	Clear and wavy		
XIX	Fine to medium sand	Dark Grayish Brown (10YR 4/2)	Clear and smooth	Many fine to very fine roots	

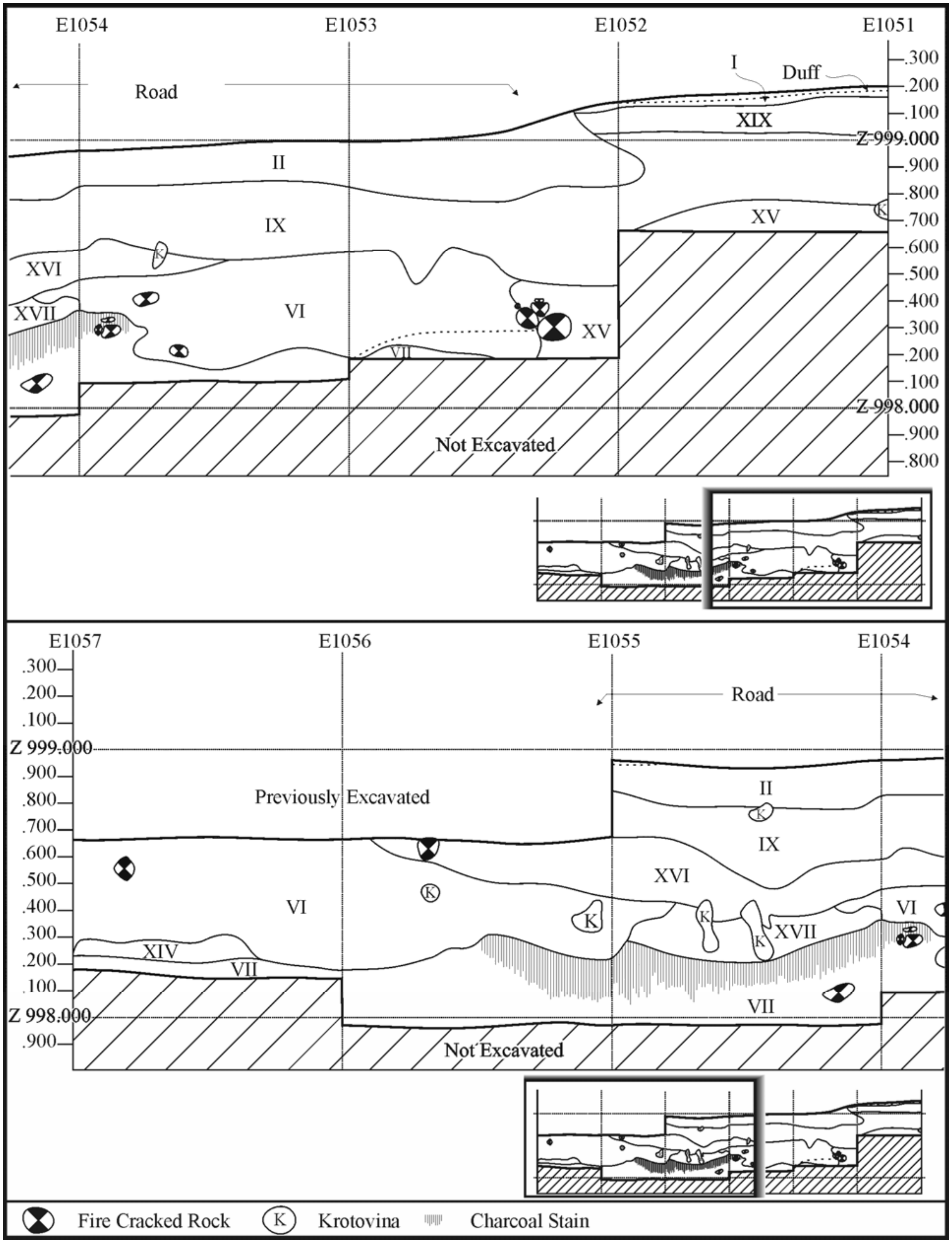

Figure 4-2a. Profile of units along gridline N732.

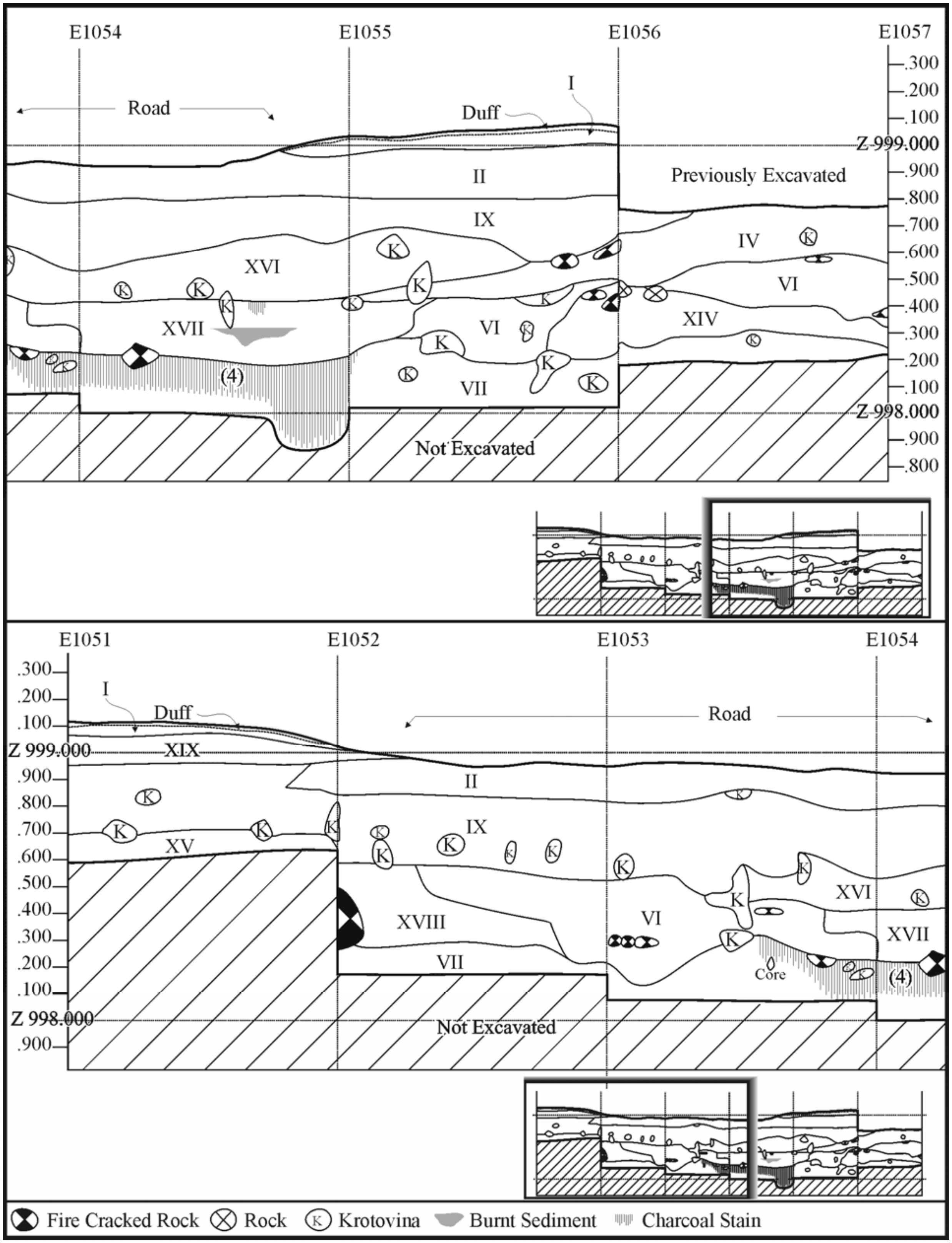

Figure 4-2b. Profile of units along gridline N733.

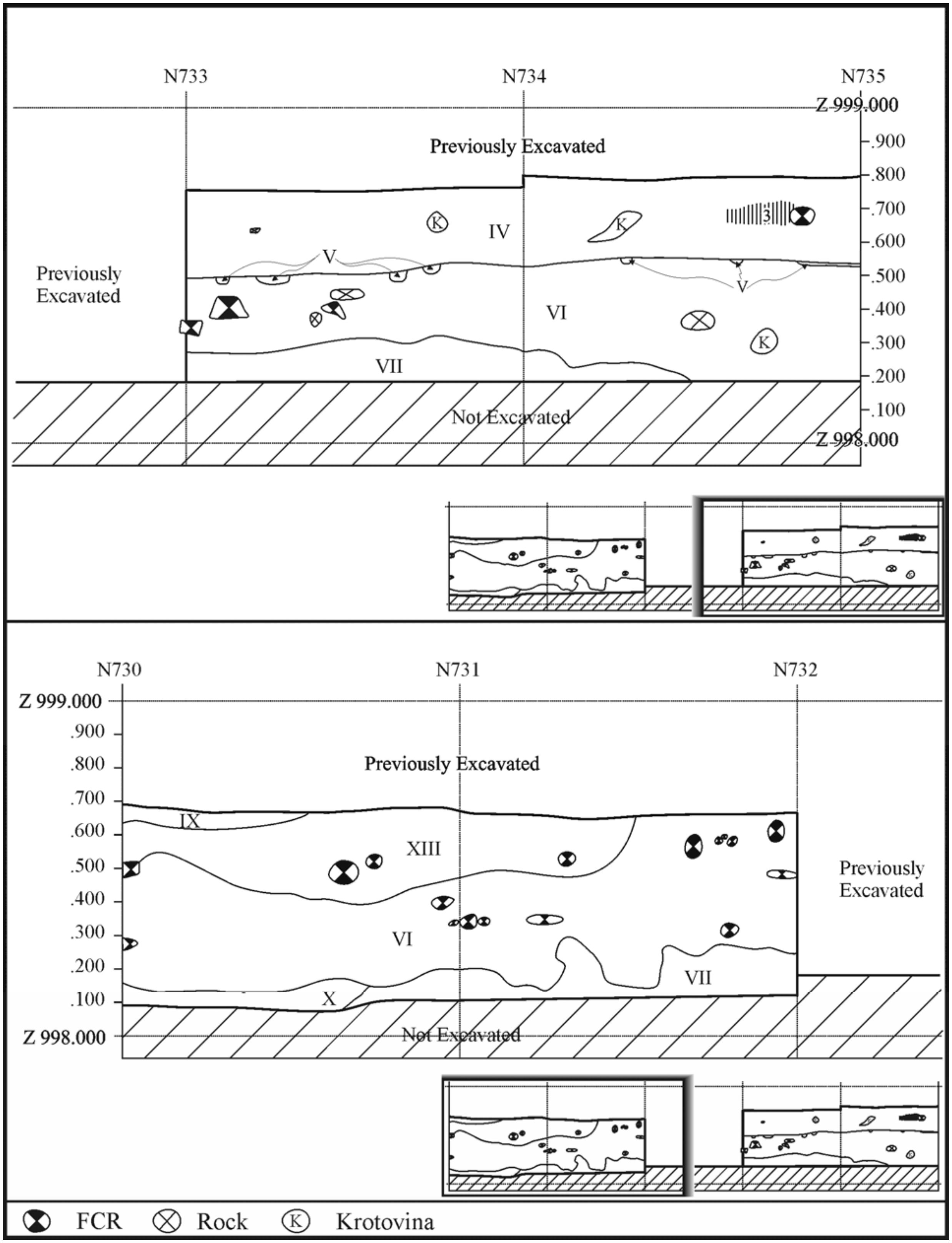

Figure 4-2c. Profile of units along gridline E1057.

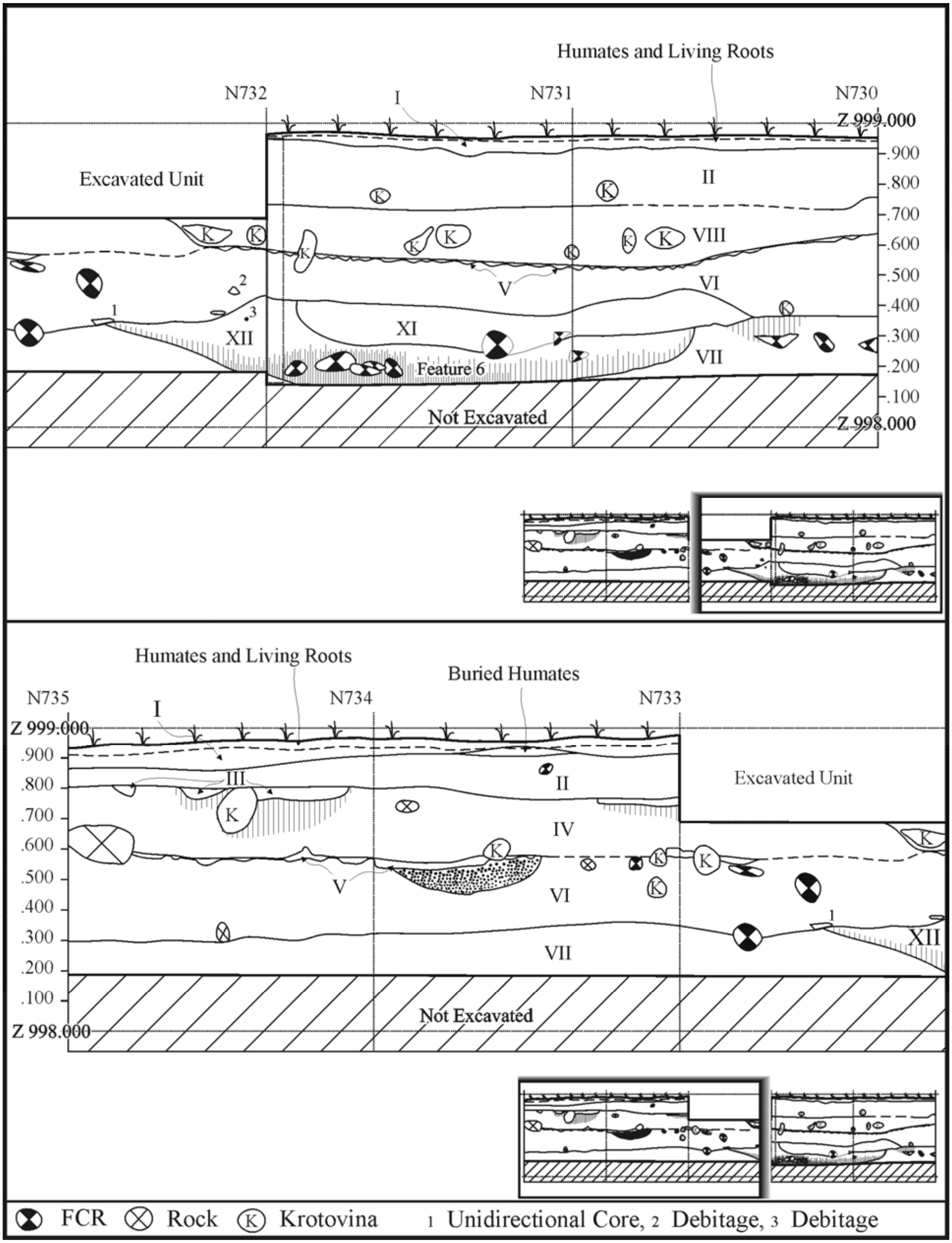

Figure 4-2d. Profile of units along gridline E1058.

The Natural Strata

Stratum VII is the basal sediment unit in most of the excavated units. This stratum is a dark brown silt which reacts slightly to HCl. Artifacts are present within the sediment matirix. One large charcoal stain extends down from the top of Stratum VII, concentrated in unit N732 E1054 but partially covering the surface if Stratum VII in the units bordering it to the east and west. This feature has a variable depth and the portion with the greatest depth contained reddish oxidized staining in addition to the charcoal. The stain extended from elevation 998.250 to a depth of approximately 997.900 and formed a basin shape in the wall and excavated floor. No indication of a surface below this stain was identified. Fine material such as charcoal and ash may be transported down through the sediment column by rainwater or biogenic agents (Butzer 1982:120-122). Thus it is likely that the stain is a result of deep percolation of charcoal and ash below a probable hearth feature with scattered lower density charcoal surrounding the feature percolating to a shallower depth. A smaller charcoal stain extends down from the surface of Stratum VII in unit N730 E1057. This stain is not associated with oxidized sediment and is a few cm south of another large feature (designated Feature 6) which sits atop Stratum VII. Feature 6 is discussed below under the cultural strata and Stratum XII.

There are two additional lower natural strata that occur in isolated locations of the excavation. Stratum X is a medium sand which appears to overlay the Stratum VII silts in unit N730 E1057. The base of this stratum was not revealed through excavation, however the overhanging contact between the two units indicates that Stratum VII would expand southward with depth based on the angle of the contact. The relatively coarse nature of this unit over a fine layer may be a product of terrace aggradation. As river bedloads and suspended loads are carried downstream, deposition of those deposits occurs differentially across the flood surface due to variations in water velocity (Leopold et al. 1964). In some circumstances during the same event silts are deposited when in other locations sands and gravels are mobilized. The stratum X sand therefore is likely related to the flood event(s) which deposited Stratum VII and was deposited under conditions different from those resulting in silt deposition.

The remaining lower-level unit is likely older than any of the others in the excavation. This unit is Stratum XV and appears to be related to the middle terrace landform within the Birch Creek Site area. Walker (2001) identified terrace sequence development that followed a pattern of vertical agradation for a period of time followed by horizontal erosion by the river. This fill-and-cut formation sequence results in horizontal beds which are not continuous across the landform, but rather have vertical divisions. Subsequent deposition results in a buried terrace step. The abrupt transition from Stratum XV to the cultural strata may be explained as a terrace step which had not been filled at the time of site occupation.

Three strata cap the occupation sediments. Strata I, II, and IX all extend across most of the excavation area. Stratum I is a thin fine sandy deposit which comprises the present ground surface. A weak humic layer is developed in this stratum. The sand thins out away from the river and patches of buried humates are present along its boundary. Vandal (2007) attributed this sand to the 1993 flood of the Owyhee River. Strata II and IX are massive medium sand deposits. Stratum IX is the basal unit and is composed of both medium sand and a large proportion of mollusk shells. The shell includes fragmentary large bivalves, numerous whole small valves (<1.0 cm), and whole gastropods measuring less than 1.0 cm in length. Stratum IX appears to fill a low area created by cultural strata to the east and the Terrace 2 edge to the west. Stratum II sits atop stratum IX and is similar in color and composition though lacks the shell component. It is possible that these two units are part of the same flood event and the shell dropped out of suspension faster than the sand resulting in a fractionated deposit. The depression in the site probably created a low bed velocity resulting in a dropout of larger materials during the filling of this depression.

Stratum XIX bridges the natural and cultural distinction. It lies below the 1993 flood deposit and above Stratum II, west of a dirt road which runs along the east side of the floodplain. Historically the area west of the road was an alfalfa field. Stratum XIX has a maximum thickness of approximately 10 cm. The 1993 flood probably did not heavily scour this unit as pre-flood surface organics (buried humates) were found on top of Stratum II closer to the river. Thus it is likely that the original thickness of Stratum XIX was roughly 10 cm. The use of this area for agriculture indicates the potential for this stratum to be a shallow plow zone. Disk plows are commonly used in fields with rooty and/or stony soils (Smith and Wilkes 1976). These plows use disks which range in diameter from 20-38 inches with a variable depth. The depth of the plow cut is dependent on several factors including the weight of the plow, soil characteristics, and angle the disks are oriented relative to the direction of pull. These plows typically operate shallower than a comparable sized chisel or moldboard plow because they rely heavily on weighting where the other types reach their depth through "suction" from the soil. The location of this field at the base of a colluvial slope and containing large gravels on the Terrace 3 surface would make it an ideal landform for the use of a disk plow or disk harrow; Stratum XIX is an apparent plow zone.

The Cultural Strata

The culturally derived strata in the Late Archaic component are recognized by either unconformable relationships, the relatively high density of the cultural material present within their matrices, or both. The unconformable units simply lie on top of or adjacent to one another in a way which makes the development sequence of these strata unclear based on principals of superposition. Artifacts were recovered from nearly every unit level of excavation but the cultural units have a high density relative to the non-cultural strata. A total of 12 stratigraphic units comprise the cultural strata of the excavation. These are primarily units formed through human activity, though some are likely related to secondary formation processes following the development of cultural sediments.

Strata XIV and XVIII are similar deposits lying immediately atop the Stratum VII flood silts which contain sedimentary rock colluvium. The colluvium is recognized by the irregular angular shape of the particles, and their size, that reach a maximum length of 7 cm and 3 cm respectively. The sedimentary rock is similar in appearance to the material which covers the slopes of the canyon as close as 50 m west of the excavation. This rocky colluvium covers the side of the canyon from the base of the rim-rock over 100 m above down to the alluvial terraces at the bottom of the canyon. The possibility that the material was derived from a colluvium bed that native peoples had excavated into was explored. This explanation is unlikely given that Stratum VII covers nearly the entire excavation and no evidence in the form of sediment color or texture changes which could indicate excavation into this sediment below the unit floors was observed. It appears that the sedimentary rock colluvium was brought in from the nearby slope and deposited in piles or ridges. The full horizontal extent of these deposits was not revealed and the purpose of these deposits remains unknown.

There are two strata which overly Stratum VII centered on unit N731 E1057. Stratum XII fills Feature 6 and Stratum XI nearly covers all of XII. Both units appear related to Feature 6. Feature 6 is a shallow basin which appears to have been excavated into Stratum VII. Charcoal staining is heaviest along the bottom of the feature and diffuses upward. Feature 6 remains extend from N732.5 to N730.6 and from E1057.6 to the eastern limit of excavation. The profile indicates that the feature extends into the wall. The plan suggests a circular shape which could be up to 2.5 m wide based on the curvature of the feature margin. A single layer of fire-cracked rock was uncovered in the northwest portion of the feature. Sediment drawn from this feature was dated to 3000 ± 330 BP and pollen was recovered from between the FCR (discussed in Chapter Five). Stratum XII contains heavy charcoal staining associated with the Feature 6 surface. This stratum is composed of very fine sand which could be wind-blown. If a slow accumulation of eolian sand did gradually fill this depression then human feet walking through the feature could account for upward mixing of charcoal dust. A fraction of the charcoal dust could also have blown in with the sand and this could account for the 3000 year old age measurement and wide standard deviation. Stratum XI is only moderately sorted and appears limited to the area above Feature 6. The charcoal staining does not extend into this unit. This sand is likely a fill deposited after the abandonment of Feature 6.

A large stratigraphic unit extends across the eastern units in a mid-profile elevation position. Stratum VI covers all of the sediments overlying Stratum VII east of the E1056 line and appears in an isolated section between E1052 and E1054. The unit appears thickest along the E1057 gridline and gradually tapers west while tapering somewhat more abruptly east. Two units appear to fill a hole excavated into this unit (discussed below) which resulted in an isolated section of Stratum VI. This stratum generally lacks features but contains abundant charcoal flecking and artifacts.

Stratum VI is interrupted in unit N732 E1054 (extending to the adjacent east and west units as well) by two small stratigraphic units. Strata XVI and XVII cut-off the western portion of Stratum VI from the main body of the unit. They also combine to inter-finger with Stratum

IV (discussed further below.) Stratum XVII occupies the space of the apparent pit witin Stratum VI. The matrix of this stratum contains charcoal, artifacts, and a burnt sediment lens. The burnt sediment lies nearly directly above the deepest portion of the large charcoal stain extending down into Stratum VII in this unit (discussed above). There is no continuation of dense charcoal staining between the two features and the burnt sediment is concentrated indicating a lack of major sediment disturbance. A direct relationship between the stain in Stratum VII and the burnt sediment in Stratum XVII is not likely. However, the presence of these two features in nearly vertical alignment may indicate a continuity of activity and stability of site structure. A hiatus in deposition over these features occurred which allowed Stratum IV materials to trail west over Stratum XVII. Following the accumulation of Stratum IV an horizontally concentrated unit (Stratum XVI) was deposited. This unit lacks preserved features and is the youngest dated unit of the site.

Three strata comprise the upper cultural strata. Stratum IV covers the northeast portion of the excavation, Stratum VIII covers the southeast corner of the excavation, and Stratum XIII covers the south-central portion of the excavation. Stratum IV was the unit first identified as an intact cultural deposit. The artifact density is high and the matrix is charcoal rich. Three charcoal stains are present in this stratum, two of which extend from the top of the unit downward, and one in the vertical center of the unit. The upper features are roughly capped by a sediment unit termed Stratum III. This unit is almost entirely limited to areas immediately above features and may represent intentional deposition of sand on top of hearth-like features for some reason. The western side of Stratum IV tapers down and forms the eastern slope of a shallow depression (at the time of deposition). The eastern portion of the unit is topographically higher than the west and appears to form a ridge or berm running parallel to the Owyhee River. Stratum

VIII extends the berm-like feature south in units N730 E1057, N731 E1057, and N732 E1057. Stratum XIII fills an irregular surface of Stratum VI. This unit is similar in composition to Stratum VI but slightly lighter in color indicating a probable lower density of charcoal and organics. The build-up of Stratum XIII material extends the apparent berm of Stratum IV to the southwest. Stratum IV is one of the youngest dated units, and Stratum XIII stratigaphically superior or contemporary with Stratum IV. Stratum VIII overhangs Stratum IV indicating it post-dates most or all of the other cultural strata. Stratum VIII does not have the high density of artifacts that Stratum IV does, but does not appear to be a wholly natural deposit. The berm created by Strata IV and XIII may have held back sub-bankfull river flow that otherwise would have covered the site. Non-size sorted cultural material including chipped stone, fire-cracked rock, and ground stone within this unit indicates continued use of this area during its developmment.

The nineteenth stratum is naturally formed deposit that is a product of human activity. Stratum V is a thin irregular deposit of very fine sand and carbonates along the top of Stratum VI on the E1058 line. This deposit roughly corresponds to the river side of the berm formed by Stratum IV and Stratum XIII. The carbonates are soluble and could have percolated to the surface of Stratum VI during periods of bank saturation. The movement of soluble carbonates up the sediment profile through induration could account for the diminished carbonate content in Stratum VI with a very high carbonate level represented by Stratum V. A water table rise accounting for the carbonate variation also aligns with the timing of berm development along the riverbank if the berm construction was intentional.

Summary

The Owyhee Canyon is a rugged landscape composed of volcanic and sedimentary rocks. Many of these rocks are good raw materials for chipped stone and ground stone tool production. The rocks have weathered and many of the different rock types formed over the past 15 million years have accumulated in mixed deposits along the bottom of the Owyhee Canyon. These rocks have been and continue to be broken down by mechanical weathering in the Owyhee River. The modern riverbed is composed of silt, sand, cobble, and boulder size fragments of basalt, rhyolite, obsidian, chert, and sandstone. These sedimentary materials are transported by the river during floods and deposited during low water in flood terraces and gravel bars. The result of this activity is a riverside environment that is periodically unstable and complex.

The Late Archaic Period component of the Birch Creek Site was formed on the first terrace of the Owyhee River. The river eroded into the second terrace and left behind a silty plain which was occupied approximately 1,300 years ago. The subsequent 200 years witnessed the development of several thick deposits which contained numerous broken artifacts. The berm formed along the E1057 units may have been a deliberate structure which was developed in response to increased effective moisture and higher spring river levels during the terminal portion of the occupation. The occupation was ultimately capped by flood sands which filled depressions in the site and covered the area with several tens of centimeters of alluvium. The last of these floods was in 1993 and deposited a thin layer of sand over the site while cutting away the riverbank.

The location occupied during the Late Archaic Period offered abundant lithic resources and a wide surface made of fine silty sediment. The riverside location was geologically stable for much of the occupation. It is difficult to know what purpose the cultural lenses may have served. Some of the earliest culturally derived deposits are mounds of rocky colluvium. The horizontal extent of these deposits is unknown but knowledge of their shape would shed some light on their function. They may have held down the sides of a shelter or stabilized an area of soft silt. What is clear is that the low area between the rocky deposits was maintained over time as other sediments were added to the site. The location was finally abandoned after 20-30 cm of sediments was deposited. Abandonment could have come as the river level rose above the elevation of the occupation. There is no evidence of a flood over the site during the Late Archaic occupation and this may be a sign that the valley sediments were stable or fluvially inactive during the occupation. Effective moisture increases could have brought floods which disrupted the occupation of the site by 1,100 years ago. There is no indication that people returned to this location after the floods which deposited the capping sands sometime after 1100 BP.

CHAPTER FIVE

POLLEN REMAINS

Pollen preserved in prehistoric contexts has the potential to provide valuable insights into past environments and diets. Soils capture pollen grains that have naturally precipitated out of the atmosphere or been inadvertently dropped from flowers by animals. Pollen becomes a dietary indicator when it is collected intentionally, by people for food, or secondarily, along with the flowering or fruiting bodies of plants to be eaten. In the region surrounding the Birch Creek Site researchers have interpreted various datasets reflecting environmental conditions of the region throughout the Holocene and ethnographers have documented a wide variety of plant foods used by Great Basin tribes (e.g., Mehringer 1985, 1986; Moerman 1998).

Environmental reconstruction is a complicated endeavor and should utilize multiple lines of evidence when possible. Pollen data are often used because many pollen taxa represent plants which are sensitive to changes in both average temperature and effective moisture. The interpretation of pollen fluctuations is challenging and leads to occasional inconsistencies; one problem is simply the scale of study. The Holocene paleoenvironmental record of the intermountain west has been divided into smaller units based on generalized environmental conditions beginning with the Anathermal or period of relative warmth and high effective moisture following the last glacial maximum from roughly 10,000 to 8500 BP, followed by the Altithermal between 8500 and 4500 BP when cool dry conditions prevailed, and the Medithermal from 4500 BP to present (Mehringer 1985, 1986; Plew 2000). These divisions mark gross trends in climate and evidence of large variations in Great Basin environmental conditions within these periods does exist (Mehringer 1986). These fluctuations are important factors in understanding the environment at the scale of a site during an occupation period. The climatic microenvironments shaping the local geology, hydrology, and biota may have dramatic impacts on the people occupying that environment (Butzer 1982).

The purpose of this chapter is to report the analysis of pollen preserved at the Birch Creek Site. The pollen remains provide information about the environmental conditions of the Late Archaic occupation, and some insight into how people exploited that environment. Pollen samples from sediments and ground stone are used to infer climatic conditions and plant use.

Background

It may not be possible, or necessary, to fully review the various studies which relate to Great Basin and Columbia Plateau climate and human plant use. A small sample of studies from the Northern Great Basin and southern Columbia Plateau provides adequate background. The background presented here provides a brief summary of climate and human plant-use research relevant to the current project, with the caveat that only a fraction of the existing literature is reviewed in this chapter.

As stated in Chapter One, paleo-climatic data from Great Basin sites indicate that a region-wide decline in effective moisture occurred between 1500 to 500 BP (Aikens 1994). The character of the climate during the Late Holocene has been described as generally approaching modern conditions (Mehringer 1985,1986). Proxy data for climate conditions including pollen, faunal remains, and macrobotanical remains can be helpful in interpreting a sometimes confusing environmental history. The climate history of the Intermountain West is quite complex and changing conditions appear to be the norm rather than the exception (Mehringer 1996).

The Great Basin as a whole has been relatively moist and near modern temperatures for the past 4,400 years (Grayson 1993). Fluctuations in floral communities through time show that variation in seasonal moisture patterns have occurred but in general it was not until plants such as Pinyon Pine (*Pinus monophylla*) spread north after 1,500 years ago that modern plant communities were established. The advances of these plants into new communities may have occurred in pulses shaped by small fluctuations in effective moisture. Changes in lake levels and relative abundance of grass to sagebrush reveal dry episodes at Diamond Swamp in the Northern Great Basin at 2900, 700, and 500 BP, with periods of greater than modern effective moisture in between (Grayson 1993:222).

The range occupied by arboreal species is significant for both climatic reconstruction and diet of prehistoric peoples. Pinyon Pine seeds were an important food for some Great Basin groups where ever the species was available (Fowler 1986). The modern extent of pinyon does not include all of the Great Basin and there is no evidence to suggest it ever has during human occupation of North America (Grayson 1993). White Pine (*Pinus strobiformis*) seeds took the place of Pinyon Pine seeds in the northern portion of Northern Shoshone territory as a staple food (Lowie 1909; Moerman 1998). White Pine also did not fill its modern territory until the Late Holocene (Minckley et al. 2007).

The place of plant species in the diet of native peoples can be difficult to reconstruct from archaeological datasets alone. Most plant materials decompose shortly after death. In rare cases partially charred remains of food plants are recovered from sites and can be identified to species level. The pollen carried along with the portions of plants collected for food offers another source of preserved dietary information when it is recovered in the context of food preparation. These special preservation situations are not directly representative of the level of importance of each species or dietary prominence. Preserved charred remains are a product of chance and pollen preservation is dependent on the durability of the individual grains, quantity of pollen produced, and method of dispersion. One area to begin to make inferences about plant foods exploited at a site based on remains is with recorded ethnographic sources of information on plant use. Some studies of Great Basin plants document the variety of uses for the region's plants (Ebeling 1986; Moerman 1998) and model the importance of individual species (Stoffle et al. 1990). The ethnographic peoples of the Great Basin used a subsistence strategy which employed a diverse array of seeds, roots, and berries, and various means of collection and processing for storage and consumption.

Methods

The samples for the present study where collected from the profile of the completed unit N731 E1057 into unit N731 E1058. A 10x10 cm wide column was excavated from the profile using arbitrary 5 cm levels. A total of 16 sediment samples were collected from the excavation area and a pinch sample was collected from the ground surface surrounding the sample column.

The sediment samples selected for the present study are a subset of the sample column (Figure 5-1). At least one sample from each stratigraphic unit was selected for analysis. Two samples were processed from Strata II and VI and three were processed from strata XII to detect any variation within large depositional units. Samples which overlap stratigraphic boundaries were avoided to prevent mixing temporal units. The ground stone selected for pollen washes are those specimens which were likely to have been used for plant processing and have no evidence of direct exposure to fire (such as radial fractures or sooting). These included large specimens with a weight in excess of one kilogram, and are interpreted to be stationary grinding stones with evidence of grinding on at least one surface.

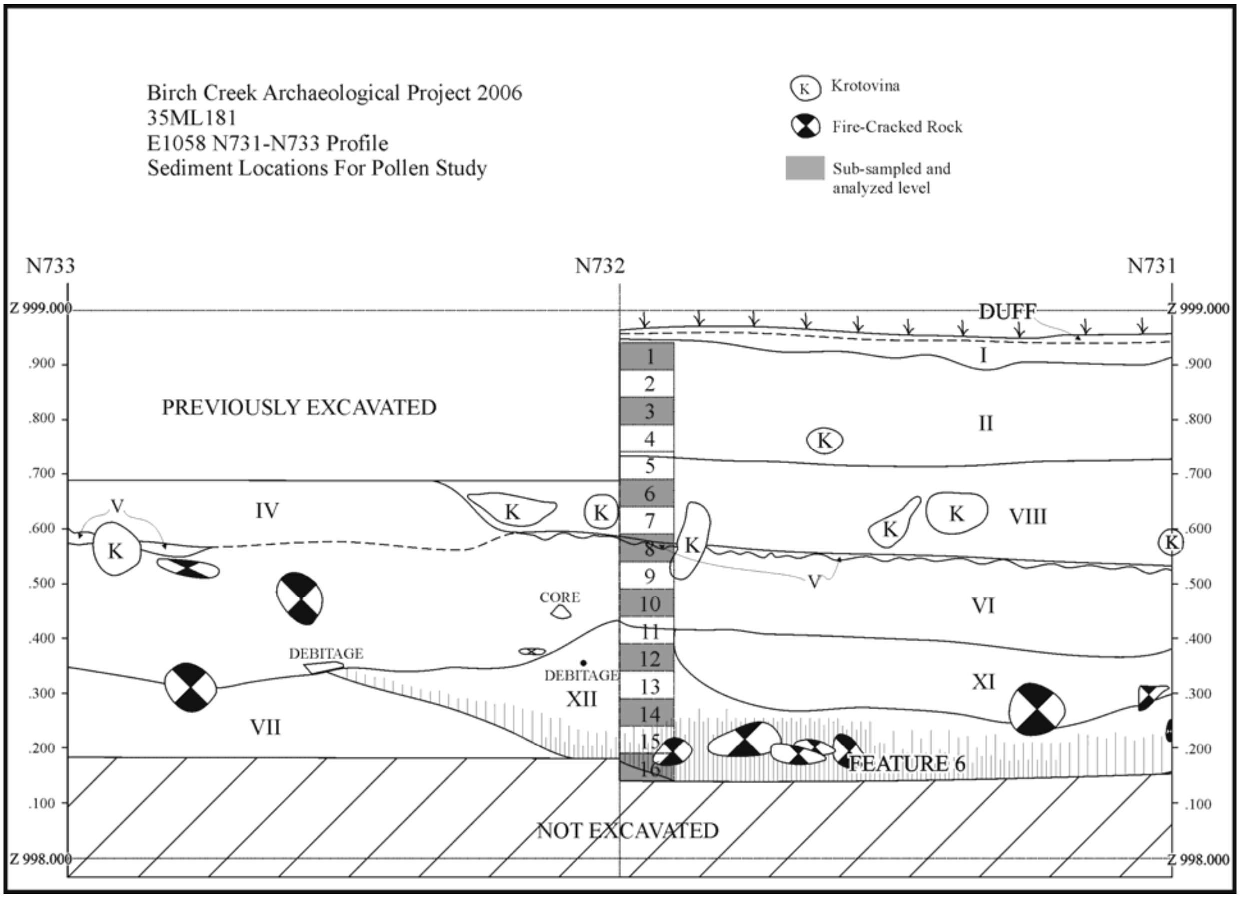

Figure 5-1. Locations of sediment samples used in pollen analysis.

The eight profile sediment samples and one surface sample were processed as four milliliter sub-samples with two tablets containing 12,542 ± 416 *Lycopodium* spores added for concentration value calculation. The samples were each treated with hydrochloric acid, rinsed, and screened though 200 µm hardware cloth before treatment in hydrofluoric acid to remove silica from the sample. The samples were removed from hydrofluoric acid after approximately eighteen hours and acetylated. Following acetolysis the samples were treated with 1 percent potassium hydroxide, and finally, subjected to heavy density separation in zinc chloride. The extracted pollen was then placed in glycerin for curation. Slides were prepared using a glycerin mounting medium. The sample slides were counted using a Nikon compound light microscope at 400x magnification. A minimum of 200 identifiable grains were counted per sample to ensure adequate statistical representation (Barkley 1934).

Ground stone pollen washes were conducted on the only four stones from the 2006 assemblage which did not show evidence of burning (BCAP inventory numbers 27931, 27536, 27694, and 26807). Because fire destroys pollen, the ground stone that was recovered as fire-cracked rock (FCR) would be unusable as a source of pollen remains. The washes were prepared by rinsing a 20-25 cm^2 area with 3 percent hydrochloric acid (HCl) and jets of distilled water. Three rinses with HCl were performed on each stone to thoroughly liberate all pollen adhering to the stones in the sample area. *Lycopodium* spore tablet fragments were then added to the samples. Tablet fragments were used because, unlike the sediment pollen samples the sample volume is unknown and therefore pollen concentration cannot be determined, though the *Lycopodium* spores do serve as markers during the treatment process. If the samples are fully processed and contain *Lycopodium* spores but no artifact pollen then none was present to be recovered, however if the *Lycopodium* were not present at the end of the treatment procedure then a mistake was made and the treatment would need to be repeated. The remainder of the pollen preparation is identical to the sediment processing procedure described above.

Results

Pollen preservation at Birch Creek is much better than expected considering the abundance of carbonate deposits in the Owyhee River drainage. The limestone bedrock upstream of the site combined with the arid climate resulted in a high calcium carbonate (CaCO3) content in the site sediments which typically results in an alkaline soil pH (Rapp and Hill 1998). High soil pH levels were determined by the reactions of sediment units to hydrochloric acid, which were strong in several cases (Chapter Four). Soils with alkaline pH levels have been found to be highly destructive to pollen grains (Bryant et al. 1994). The sediments representing the cultural occupation of the site varied from slightly to strongly reactive to hydrochloric acid indicating CaCO3 concentrations and an alkaline pH.

Environmental Data

The sediment samples contained a total of 18 identified pollen types, and of those 14 types were identified within the prehistoric cultural contexts of the excavation (Table 5-1). Concentration values ranged from 49,239 to 4,709. Many of the pollen taxa represent plants which held economic value to the ethnographically studied native peoples of the intermountain west. A brief description of the ethnographic uses of each plant group is found below.

Table 5-1. Count of Observed Pollen Types in Sediment Samples.

	Sample Provinience								
Stratum	I	II	II	VIII	V/VI	VI	XII	XII	XII/ Feat. 6
Sample Depth (cmbs)	0	0-5	10-15	25-30	35-40	45-50	55-60	65-70	75-80
Cheno-Am	123	105	117	100	135	111	142	141	62
Sarcobatus	8	8	7	11	14	11	32	40	10
Artemisia	34	27	40	70	38	50	24	13	56
TCT (*Juniperus*)	17	12	6	15	3	6	1	4	15
Picea	0	3	4	2	0	3	1	2	0
Pinus	9	47	39	12	7	3	6	14	11
Alnus	0	1	0	0	0	0	0	2	2
Asteraceae high-spine	1	4	8	6	6	2	10	12	12
Asteraceae low-spine	2	5	13	8	10	6	0	8	31
Liguliflorae	1	0	0	1	1	0	0	0	1
Poaceae	9	12	7	5	3	5	1	6	9
Acer	0	1	0	0	0	0	0	0	0
Fabaceae	1	0	0	0	0	0	0	0	0
Polemoniaceae	1	0	0	0	0	0	0	0	0
Brassicaceae	5	0	0	0	0	7	0	0	0
Caryophyllaceae	1	0	0	0	0	0	0	0	0
Rhus	0	0	0	0	0	0	0	0	1
Ephedra nevadensis	0	0	0	0	0	0	0	0	1
Unknown 1	0	11	0	0	0	0	0	0	0
Indeterminate	0	5	2	4	12	6	0	4	9
Total	212	241	243	234	229	210	217	246	220

Artemisia (Sagebrush)

Sagebrush in abundant in the site area today. The species *Artemisia tridentata* had several important uses for native peoples. The seeds are edible if parched, the bark was split into strips for basketry, and the stems were made into foreshafts for composite weapons (Ebeling 1986). The Northern Paiute used sagebrush as fuel for fires and for ceremonial purposes in addition to medicine to treat ailments ranging from colds and fevers to diarrhea and as an anti-imflamatory (Moerman 1998).

Asteraceae (Sunflower family)

This family is represented in the pollen record by three distinct forms within the Birch Creek samples; the High Spine, Low Spine and Liguliflorae-type. Together these pollens represent a wide variety of non-arboreal composite flowering plants. The roots and stems of many members of this family were consumed as food (Ebeling 1986), as well as taken medicinally for colds and digestive disorders, and combined with steam in the sweat bath (Moerman 1998). The flowers were also used to produce dyes.

Brassicaceae (Mustard family)

The few members of this family which grow in the intermountain west were eaten. The leaves were prepared through repeated boiling to remove salts and the bitter flavor (Ebeling 1986). Economic members of this family include tansy mustard (*Descurainia* sp.) and peppergrass (*Lepidium* sp.).

Chenopodiaceae-*Amaranthus* (Cheno-Am) (Goosefoot family and *Amaranthus* sp.)

Cheno-Ams are a group of plants which thrive in disturbed sediments. They may mark human activity such as agriculture because they rapidly colonizes loose, open soil. Several members of the Goosefoot family have edible seeds which could be collected in large quantities and stored while the stems of the plant were used in basketry (Ebeling 1986). The ethnographic peoples of the northern Great Basin used *Chenopodium album* for medicinal purposes (Moerman 1998). The uses of *Amaranthus* sp. in the northern Great Basin are not well documented, but in the American Southwest and Mexico it is valued as food and for medicinal uses (Ebeling 1986; Moerman 1998).

Chenopodiaceae *Sarcobatus*-type (Greasewood)

Greasewood is abundant in the northern Great Basin today. The plant is known to have been important to composite tool technology because of it's sticky sap which was used as a fastener for stone tool tips (Ebeling 1986). The stems of the plant were used for arrow shafts and needles (Moerman 1998). The seeds and new growth of the plant can be eaten though their nutritional value is unknown and the practice is not known for the northern Great Basin specifically (Moerman 1998:518). In those areas where greasewood was eaten it is considered a starvation food.

Ephedra (Jointfir, Mormon Tea)

The Paiute and Shoshoni found use for *Ephedra* sp. as a medicine (Ebeling 1986, Moerman 1998). The twigs of several different species were incorporated into treatments for burns and venereal disease. *Ephedra viridis* was especially beneficial and could also be used as an anti-inflammatory, anti-diarrheal, cold remedy, gastrointestinal aid, and as a blood putifier. The leafless needles of several species of *Ephedra* were used in a tea.

Poaceae (Grass family)

The grasses of the Great Basin were very important to native peoples. Ricegrass *(Oryzopsis hymenoides)* is often cited as an important source of food (Ebeling 1986; Fowler 1986). The seeds of ricegrass, as well as other genera including dropseed (*Sporobolus*) and wild barley (*Hordeum*), formed a staple food and were collected in large quantities to be ground into a flour. Other genera of grasses were also used. The common reed (*Phragmites australis*) was also an important food source as a supply of sugar for native peoples (Ebeling 1986). Grasses also are an abundantly available supply of fiber for mats, baskets, and sandals (Moerman 1998).

Alnus (Alder)

Alder trees are not common in the Owyhee River basin today but Great Basin peoples were known to use them. The bark produces an orange extract used as a dye and the wood was used for preserving meat without giving the meat a smoky flavor (Moerman 1998). The cambium layer and sap of this tree are also edible.

Juniperus (Juniper)

Juniper trees dot the modern Owyhee uplands. Ethnographic peoples made use of the berries for food and the berries and twigs were employed in medicinal treatments (Moerman 1998). Smoke from the twigs was used to treat headaches while whole branches were used in sweat baths for severe colds (Moerman 1998:286). The plant fibers were used in making cordage, branches were used in building structures, and the wood was used as fuel for fires (Ebeling 1986; Moerman 1998).

Picea (Spruce)

Spruce is not common in the Owyhee Valley but Paiute peoples were familiar with the tree. The Paiute made use of *Picea engelmannii* (Engelmann's Spruce) boughs to line the floors of sweat houses and as bedding in ephemeral camps (Moerman 1998).

Pinus (Pine)

Pinyon pine (*Pinus edulis*) was a staple in the diet of several Great Basin peoples. It grows intermixed in stands with juniper southeast of the Owyhee Valley in Nevada. In the northern mountains of the Great Basin White Pine (*Pinus strobiformis*) was harvested instead of Pinyon (Lowie 1909). The "nuts" of the Pinyon and White Pine were mass harvested roasted and ground (Ebeling 1986; Fowler 1986). Other species of pine were also used by ethnographic peoples in the Great Basin where Pinyon was unavailable (Steward 1938).

<u>*Rhus* (Sumac)</u>

There are few non-toxic species of *Rhus* found in the Owyhee Drainage. The principal species utilized by native peoples was Squaw Bush (*Rhus trilobata anisophylla*) which was used as food and in basketry (Ebeling 1986). The berries were eaten whole or ground and dried for storage. The stems of the bush are very flexible and were often used as the foundation of woven baskets.

Discussion

The pollen signatures from the Birch Creek profile are readily divisible into four distinct zones (Figure 5-2). Three zones align with cultural deposits while the fourth is a set of massive alluvial deposits. The basal zone is unique because it likely provides more information about human activity at the site than either of the overlying cultural zones.

The basal zone (Zone 4) contains more pollen types than either of the other occupation zones despite having the lowest concentration value. The poor preservation of grains may, in part, be attributed to thermal destruction. The basal sample was collected from arc shaped feature (designated Feature 6) which is believed to be the edge of a circle measuring roughly 2.75 meters in diameter. Feature 6 is basin shaped with dark charcoal staining and lined with a single layer of tightly fitted fire-cracked rock (Figure 5-3). The fire-cracked rock is believed to be in primary depositional context and pollen deposited in the feature would have been subjected to very high temperatures while the feature was in use.

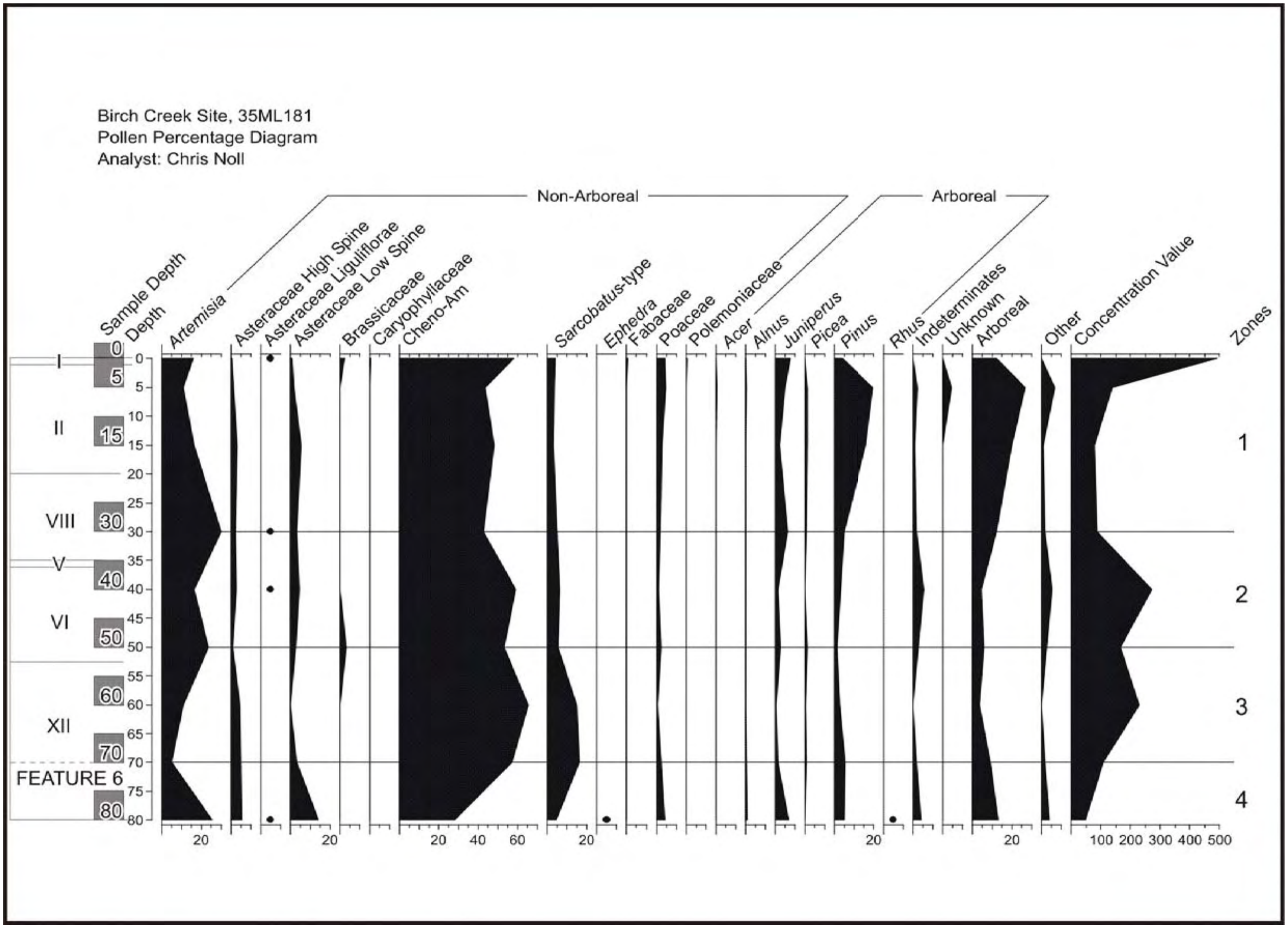

Figure 5-2. Pollen Diagram

Figure 5-3. Feature 6 fire-cracked rock cluster.

Figure 5-3. Feature 6 fire-cracked rock cluster.

The initial interpretation of Feature 6 is that it is a sweat lodge/steam bath location. These types of features have been described ethnographically from throughout western North America (Lopatin 1960). The basic arrangement involves a small structure with a bed of rock that has been heated by fire and used to produce steam by dripping water on them (Lopatin 1960:983). Fragrant plants were often placed on the hot stones as well. The pollen recovered from this feature is also consistent with a steam bath if plants are used over the hot stones. Major spikes in *Artemisia*, Asteraceae, and *Juniperus* along with the only occurrences of *Ephedra* and *Rhus* are consistent with activities such as sweat bath use. Each of the five pollen types represent plant species which have ceremonial importance to ethnographic native groups (Ebeling 1986; Moerman 1998).

In a study of contemporary Great Basin peoples the significance of 76 native plant species was ranked based on information gathered from tribal members (Stoffle et al. 1990). The significance model is dependent on the species locally available in the southern Great Basin but many if not most of the species are found throughout the region. The five plant groups all appear on the list of significant plant with *Artemisia*, *Juniperus,* and *Rhus* appearing in the top 10 and *Ephedra nevadensis* ranking 18. The single grain occurrences of *Rhus* and *Ephedra* are intriguing, but the limited representation of these taxa does not signify direct evidence of use. The spikes in the *Artemisia*, *Juniperus* and Asteraceae, however, are notable. The surface of a hot-rock feature such as the one uncovered at the Birch Creek site would have been highly destructive to pollen during its use due to the heat levels of the rock needed to produce steam or smoke. The pollen spikes observed in the feature are probably indicative of numbers of plants selected for use that were so high, and therefore cumulatively rich in pollen, that it was preserved in this feature despite the destructive conditions for pollen. These pollen levels may indicate that local species of *Artemisia*, *Juniperus* and Asteraceae were important to the culture of the Late Archaic occupants of this site based on the prominent appearance of their pollen within this feature.

The remaining zones (Zones 3, 2, and 1 from lowest to highest) are indicative of the environment at Birch Creek from the Late Archaic period to the present. The climate appears to have been dry during the human occupation and was followed by a moist period with rapid deposition of river sediments.

The climate may be gauged by several representative relationships which serve as climatic indicators. One such indicator appears in Zone 3, the cultural occupation designated Stratum XII from 52-70 centimeters below ground surface (cmbs). The genus *Artemisia* is represented in the site area predominantly by Big Sagebrush, and the *Sarcobatus*-type pollen is probably exclusively derived from Greasewood. These two plants serve as strong indicators of effective moisture in a desert environment (Rickard 1964, 1967). Greasewood has been found to be more tolerant to dry conditions because of it's ability to retain soil moisture over comparable sagebrush stands. This is due to the lack of winter foliage in greasewood (sagebrush is evergreen) which limits moisture loss during the driest months of the year for soil due to transpiration (Rickard 1967).

The sagebrush and greasewood are inversely proportional to each other in abundance throughout Zone 3. When the sagebrush pollen increases, it is most likely due to the relative abundance of the plant. This pattern disappears in Zone 2 during which time the *Sarcobatus*-type pollen drops to between five and ten percent and remains at that level into modern times. The *Artemisia* is much less regular in its representation with peaks at the beginning and end of Zone 2 and a marked decline in the middle of the zone. This pattern is a reflection of the high concentration of pollen during the occupation of Zone 2. Cheno-Am and the overall concentration value of the samples peak in conjunction with the decline in *Artemisia* indicating that it is probably relatively unchanged while other species increased in abundance.

The concentration of pollen within the cultural and non-cultural sediments is indicative of the sedimentation rate at the site and by extension the level of effective moisture. During the period of human occupation outside of Feature 6 pollen concentrations are high relative to the Zone 1 fluvial sands. It is likely that people occupied this site for short intensive periods while alluvial sedimentation was limited and built up Strata VI and XII through occupation activities such as habitation maintenance and refuse disposal. During this period of culturally derived sedimentation numerous ground surfaces would have been available to collect and preserve pollen. The Zone 1 sands could only have been deposited by a high energy overbank flood (Brown 1997:75; Vandal 2007) of the Owyhee River. The sediments, including pollen, were mobilized and redeposited by the river over a period of a few days or weeks as the stream's energy peaked and fell. The majority of the pollen in the sediments does not represent the year of the flood deposit but rather potentially ancient pollen liberated from the riverbank upstream. The alluvial sample should not be taken as a simple distribution of the surface pinch sample concentration over a forty centimeter deep alluvium. The concentration of pollen in Zone 1 is a baseline concentration for comparison of redeposited pollen accumulations within a sediment matrix.

Dietary Data

Pollen grains were recovered from the surfaces of four ground stone artifacts. The pollen remains are generally representative of the types found in the site environment (above) with the exception of a single oak (*Quercus* sp.) grain. Table 5-2 is a summary of the pollen types identified on ground stone. The majority of the pollen found on each stone represents plants which were of dietary and/or medicinal importance to ethnographically studied peoples of the Great Basin (Moreman 1998) and are a similar suite of types found in the sediment of the site. The anther clusters are particularly interesting because they are rare in the sediment but occur on three of four ground stone surfaces and are generally representative of economic plant species, including the sunflowers (Asteraceae), and the small-seed-bearing Goosefoot and Amaranths represented by the Cheno-Am type.

The remains recovered from the ground stone are potentially direct indicators of foods processed by people at the Birch Creek Site though they could also be indicative of the sediment matrix they were recovered from. The potential that the remains on the stones is related to the general pollen rain deposited during the occupation was evaluated by comparing the diversity of pollen types recovered from the stones and the sediment matrix each stone was recovered from. The Shannon-Wiener Diversity Index was calculated for each stone and Stratum VI which contained all four ground stone specimens (Table 5-3). The diversity of pollen found on surface of a ground stone artifact may be lower if it was used for processing a limited suite of plants.

Table 5-2. Pollen Types and Amounts Observed From Ground Stone Use Surfaces.

Type	**Stratum VI**		**GS1 (#27931)**		**GS2 (#27536)**		**GS3 (#27694)**		**GS4 (#26807)**	
	Count	Percent	Count	Percent	Count	Percent	Count	Percent	Count	Percent
Cheno-Am	111	(52.9)	160	(79.6)	133	(66.5)	97	(48.5)	125	(60.1)
Cheno-Am Anther	-		-		5	(2.5)	8	(4)	3	(1.3)
Sarcobatus	11	(5.2)	4	(2)	21	(10.5)	17	(8.5)	13	(6.2)
Asteraceae HS	2	(0.9)	9	(4.5)	5	(2.5)	14	(7)	20	(9.6)
Asteraceae HS Anther	-		-		-		1	(0.5)	1	(1)
Asteraceae LS	6	(2.9)	-		-		1	(0.5)	-	
Artemisia	50	(23.8)	14	(7)	22	(11)	31	(15.5)	34	(16.3)
Artemisia Anther	-		-		1	(0.5)	-		-	
Poaceae	5	(2.3)	3	(1.5)	-		5	(2.5)	-	
Pinus	3	(1.4)	1	(0.4)	4	(2)	8	(4)	4	(1.9)
Picea	3	(1.4)	4	(2)	1	(0.5)	3	(1.5)	-	
TCT (*Juniperus*)	6	(2.9)	-		2	(1)	1	(0.5)	3	(1.3)
Quercus	-		-		-		1	(0.5)	-	
Betula	-		-		-		1	(0.5)	-	
Brassicaceae	7	(3.3)	-		-		-		-	
Indeterminate	6	(2.9)	6	(3)	6	(3)	12	(6)	5	(2.3)
Total	210	(100)	201	(100)	200	(100)	200	(100)	208	(100)

The diversity values of the ground stone and sediment pollen are somewhat different but the values obtained for each stone appear as variable from one another as they do from the sediment pollen (Table 5-3). Three of the stones do show lower diversity values than the sediment matrix they were recovered from though the differences are slight. Lower diversity is to be expected if the plants (and their pollen) contacting the stone were brought together by human agency rather than through natural pollen dispersion (Faegri and Iversen 1989:193-198). Two of the stones, GS1 and GS4, with lower pollen diversity are large and could be considered

Type 3 (stationary) ground stone tools, while the remaining stones are smaller and are similar to potentially portable stones under the system developed by Sager (2001) for the Birch Creek Site. Stone GS1 pollen was composed of nearly 80 percent Cheno-Am, though lacked anthers. The remaining three stones held Cheno-Am grains which were closer to the numbers observed in Stratum VI, but they also held anthers of Cheno-Am, which Stratum IV did not. The abundance of Cheno-Am, *Artemisia*, and Asteraceae grains should be viewed cautiously, however, as these types are among the most durable and abundant forms encountered in the Birch Creek area, and their abundance may simply be a product of the preservation conditions at the site and on the ground-stone artifacts.

Table 5-3. Shannon-Wiener Index Values and Individual Measures of Richness and Evenness of Pollen Taxa On and Surrounding Studied Ground-Stone.

	Diversity Value	Richness	Evenness
Stratum VI	1.506	11	0.63
GS1	0.856	8	0.41
GS2	1.218	10	0.53
GS3	1.749	14	0.66
GS4	1.314	9	0.60

The one stone that shows a higher diversity of types also contains a higher richness value than that of the sediment matrix. The artifact referred to as GS3 is among the smallest grinding stones examined for pollen; though it is fractured it appears to have originally been a small lenticular cobble. This kind of tool would be considered a Type 4 grinding stone by Sager (2001) for the Birch Creek Site and may have been a portable tool. An examination of the taxa represented on this stone reveals that anther clusters of Cheno-Am and sunflower are large contributors to the elevated diversity value. Cheno-Am is the most abundant pollen type represented on this stone. Again, however, abundance of this pollen type may be a product of poor preservation of other taxa.

While some of the pollen recovered from the ground stone of the Late Archaic component could have been derived from pollen rain it is also possible that some portion of the pollen is a result of ground stone use. In the case of plants represented by pollen clumps (possible anthers) in this sample, sunflower, Cheno-am, and sagebrush, the flowering portions of the plants were used by ethnographic groups in the Great Basin for medicinal purposes. Much of the other pollen recovered as single grains could have been shaken loose and collected unintentionally from plants during harvesting of seeds, or simply fallen on the stones during periods of non-use. The locally abundant goosefoot and amaranths would be expected to have grains represented on the stones whether seeds from those plants were processed or not. Unfortunately the distinction between locally abundant pollen and pollen from locally abundant wild food plants is difficult to make when they are produced by the same species. Goosefoot, amaranthus, and sunflowers played an important role in the diet of ethnographic people in the Great Basin but the processing of these seeds is, at best, tentatively plausible, based on the results of ground stone pollen washes from the Late Archaic period.

Summary

The Late Holocene environmental history of the Great Basin is full of minor fluctuations in temperature and effective moisture (Mehringer 1985, 1986). The frequency and magnitude of environmental shifts can be difficult to identify with archaeological studies, and at times major net changes in climate are better preserved than small ones. Our understanding of general Holocene climate conditions is important to understanding and modeling human behavior over long time periods. Small changes in the environment may be equally important on the scale of a single or several generations though are not always preserved.

The Birch Creek Site contains a preserved pollen record spanning the 200 year long Late Archaic occupation of the site. The pollen reveals a plant community shaped by dry conditions with a relative abundance of greasewood to sagebrush. The dry conditions appear to have ameliorated somewhat near the end of the occupation and sagebrush became relatively more abundant. An increase in effective moisture late in the occupation is also indicated by the massive flood deposits which cap the occupation.

The local site environment appears to have had ample edible plants as well. Goosefoot and amaranths are abundant, comprising 50-60 percent of the pollen deposited at the site during the occupation. Human harvesting of seeds would have also resulted in the collection of pollen grains and the possible influence of people on this result should not be forgotten. Humans can shape their local plant community in many ways including burning and clearing which will favor the growth of some species (Faegri and Iversen 1989).

People living at the Birch Creek Site during the Late Archaic could have encouraged the growth of some wild plants but they do not appear to have been horticultural. There has been no evidence of domesticated plants found in the pollen record at the site thus far. If a connection to horticultural or agricultural people existed at the site, it does not appear to have included trade or growth of domesticated plants. Speculative evidence of plant consumption is limited to locally abundant wild plants such as goosefoot and amaranth seeds. The diet probably included other plants but, either because they create less durable pollen or the roots and shoots were consumed and pollen evidence of the plant was lacking from the time of collection, no conclusive evidence of those resources remains.

CHAPTER SIX

GROUND STONE

Great Basin researchers have called ground stone tools understudied and/or underutilized by archaeologists (Kolvet and Eisele 2000). The notion that ground stone has not been used to a great enough extent is steadily being dissolved as more studies focused on ground stone emerge. The description of ground stone artifacts is now a starting point for analyses of site function and mobility based on assemblage attributes (Kolvet and Eisele 2000). At the Birch Creek Site, ground stone has been used to identify continuity and potential stability in human land use over several thousand years (Cowan 2006). As an artifact class ground stone is bulky and costly to curate, but the information potential from these objects is great.

The ground stone from the Late Archaic component of the Birch Creek Site is incorporated in the current study in two ways; the netherstones (explained below) had pollen recovered from their grinding surfaces indicating utilized plant resources (Chapter Five), and in this chapter the composition of this assemblage is compared to earlier components studied by Cowan (2006) to determine if changes occurred between the Middle and Late Archaic Periods. The two Middle Archaic components were found not to be significantly different from each other by Cowan (2006). Wallace (2004) also found that aspects of the chipped stone assemblages indicated continuity from the ethnographic settlement and mobility pattern back more than 6000 years. Based on these two earlier studies the Late Archaic ground stone should appear relatively similar to the Middle Archaic assemblages if continuity between the Late Archaic and Middle Archaic exists.

Ground stone tools are frequently correlated with food processing activities, including plant parts and animal flesh and bone. The final forms of these tools are influenced by a range of variables which begins with available (and desired) raw materials and includes the intensity and range of activities conducted, and desired products (Adams 1999; Kolvet and Eisele 2000; Nelson and Lippmeier 1993). The stone selected for a grinding tool has implications for the life of the tool and the product achieved through use of the tool. Durable stone such as basalt has several advantages including greater longevity and lower volume of rock mixed into the food. Durable rock types are positively correlated with long-term use sites in the Southwest (Nelson and Lippmeier 1993). Nelson and Lippmeier (1993) looked at rockshelters and sites with architectural structures, and found that both site types contain locally available raw materials, though only the materials that were durable and difficult to acquire were used at architectural sites. The study indicates that expected long-term use of grinding stones favors the use of durable raw materials while other, less durable materials are used in ephemeral occupations when investment in material selection and tool maintenance has little or no long-term benefit.

Raw material also plays an important role in the type of food product and effectiveness of processing certain types of plant remains. The durability and texture of grinding stone materials has been shown to influence the texture of ground food and efficiency in the production of the material (Adams 1999). The dietary needs of a people may have influenced the composition of their grinding tool assemblages by whether they desired a course meal or fine flour from the plants harvested. Adams (1999) found through experimental grinding of wild seeds that vesicular basalt yielded the most ground material for unit of time when compared to either sandstone or granite and the least amount of rock was incorporated into the final product.

Additionally, the morphology of the grinding surface is important, for containing the seeds as they are processed.

Ground Stone Tool Definitions

Ground stone tools are a broad class of tools which show modification through use or design by means of abrasive wear (grinding) or removal of small amorphous chunks through percussive impact (pecking) (Adams 2002). Abrasive wear is recognized by the smoothing and polishing of a stone surface resulting in flat-topped grains, viewed at the microscopic level, and a relatively smooth surface that is distinctly different from the remainder of the stone. Abrasively worn surfaces may be flat facets, concave, or convex and have striations from wear or be smooth, depending on how the tool was used. Pecked stones typically have at least one surface area that has been made relatively rough through the removal of surface material during impact with another hard object.

A classification system has been developed for ground stone based on specimens from the Birch Creek Site and the surrounding region (Sager 2001). The system utilizes morphological attributes which segregate specimens into four unique types. The types include two handheld varieties; Type 1, a tall thin cylindrical or conical variety, and Type 2, a short wide flat, rectangular, or ovate form. The other two varieties are stationary; Type 3 is very large, tall tool, and Type 4 is a small and short tool. The system highlights the important consideration that ground stone tools are often multifunctional and that functionally embedded types such as pestle and metate may not accurately reflect the full breadth of the actual use of the tool. With the understanding that types with embedded function are limiting in some ways the present analysis will employ function based terms for tools (defined below). Employing a functionally embedded nomenclature serves several purposes including allowing comparability to earlier components studied by Cowan (2006), and demonstrating the diversity of the assemblage that could be lost in a four type system.

Pestles

These tools are recognized as variable in size and shape but are frequently elongated and handheld during use (Adams 2002; Kolvet and Eisele 2000). Pestles are known to be derived from both cobble sources and quarried from bedrock exposures. Wear patterns are typically concentrated at an end and comprised of abrasion, pecking, or both depending on the nature of use. Intentional shaping of the tool is possible. The shape, raw material, and degree of fragmentation was recorded for each pestle.

Netherstones

This is an intentionally broad category which includes any stationary stone upon which work is performed. Mortars, metates, grinding slabs, and anvils are included within this category though other less formal tools may be included as well (Adams 2002; Kolvet and Eisele 2000). Wear occurs against a broad face of the stone and may include grinding, pecking, and fracturing. The distinction between the various types of netherstones can be based on the type of material worked on (Kolvet and Eisele 2000). Metates and mortars are used almost exclusively for food preparation while grinding slabs are used for multiple materials including food and dye production. These objects are often used for plant processing but bone reduction is also carried out in mortars and on anvils. The unique attributes of each stone are described for analysis including nature and shape of wear, and raw material.

Hammerstones

These tools are used in the hand and somewhat variable in size and shape depending on the type of use though not overly elongated. These tools are generally formed on cobbles utilizing existing edges or prominences and seldom display intentional shaping (Adams 2002; Kolvet and Eisele 2000). Wear is exhibited as some degree of concentrated pecking/dimpling of the cobble surface. The weight, raw material, and degree of use was recorded for each hammerstone. Degree of use was measured by area of damage and coarseness as a comparison of raw material grain versus dimple size.

Abraders

These stones are hand-held for use and consist of one or more areas that have been modified by contact with another object (Adams 2002; Kolvet and Eisele 2000). These tools are used to grind and polish a variety of organic and inorganic substances. The attributes recorded for these tools include raw material, shape of use area and overall shape of object.

Other ground stone

This category includes ground stone that cannot be classified in simple or single use terms. Function of the objects is generally unknown but modification to a stone is evident. These objects are evaluated for nature of modification, degree of modification, and raw material.

Ground stone fire-cracked rock

These artifacts have some preserved evidence of use as a ground stone tool but have been fragmented by thermal shock. The fractures are generally recognized as thermal ("fire-cracked") because of the fracture angle at nearly ninety degrees to the cortical surface, oxidation reddening of the stone, and frequently, spalling of the cobble surface. The raw material and weight of these specimens was recorded for analysis.

Late Archaic Ground Stone

The 2006 excavations recovered 22 ground stone tools and 41 ground stone fragments that were fractured by fire. The ground stone tools fall into five object type categories with the ground stone fire-cracked rock (FCR) representing a sixth. Each of the categories is addressed in detail below.

Pestles

A total of three pestle fragments were recovered and are shown in Figure 6-1. These objects are all basalt and are comprised of a heavily pecked base, a pecked and ground base, and a midsection which appears to have two ground sides. The fragmentary nature of the three specimens makes an estimation of tool size difficult but the bases do appear to have fit very different sized tools. The smaller base is only pecked and measures 17.4 x 17 mm. It is worn heavily along the bottom and 10 to 15 mm up the sides. The second base displays both pecking and grinding and measures 30.73 x 47.34 mm. The wear is confined almost entirely to the bottom of the pestle. The relative size difference and differences in type and extent indicate that even the limited sample of pestles likely had somewhat differing uses such as crushing and grinding/pulverizing (Adams 2002). The pestle midsection is also informative in that grinding on the side of the object may indicate that of some plant materials used at the site may have required a two-step process involving crushing with a vertical motion as well as grinding in which the pestle was employed on its side with a back-and-forth stroke against a grinding slab (Adams 2002).

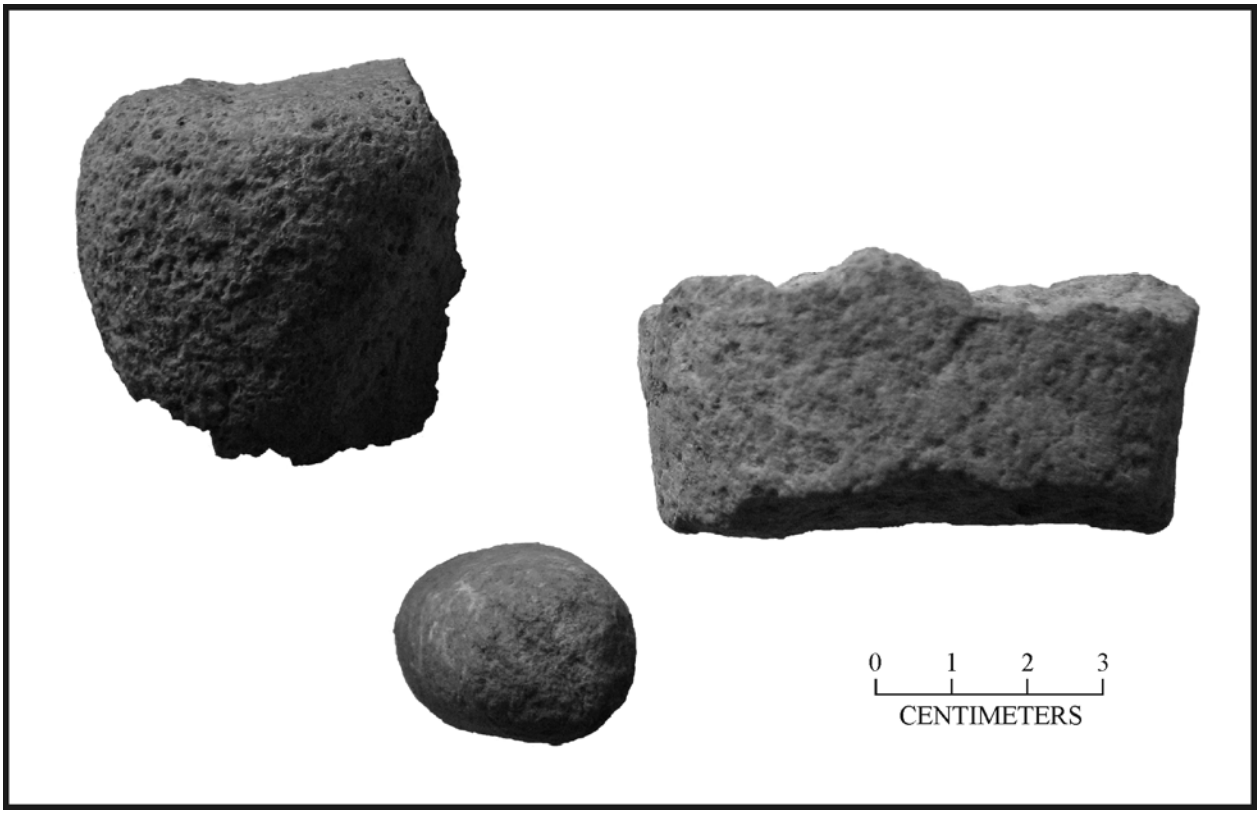

Figure 6-1. Pestles from the Birch Creek Site Late Archaic component.

Netherstones

A total of four stationary grinding stones were recovered in 2006 (Figure 6-2a-d). These are interpreted as stationary due to their size and wear patterns. All four stones are basalt and weigh from 1144 to 4300 grams (the only ground stone artifacts exceeding one kilogram). Each of these items is has unique qualities as well (discussed below).

The smallest stone (#27536) is complete and has a flat use surface on one side only, measuring 108 cm^2. It is formed on a rounded river cobble with on ovate to circular plan. Given the relatively small work area and overall shape of the stone it is likely that this was a small metate or portable multi-use netherstone. It could also have functioned as a hopper-mortar base for root processing. Hopper-mortars were used in conjunction with a basket or similar container which could hold processed materials while the stone was in use. These types of mortars have been found elsewhere at the Birch Creek site from earlier periods of occupation (Cowan 2006).

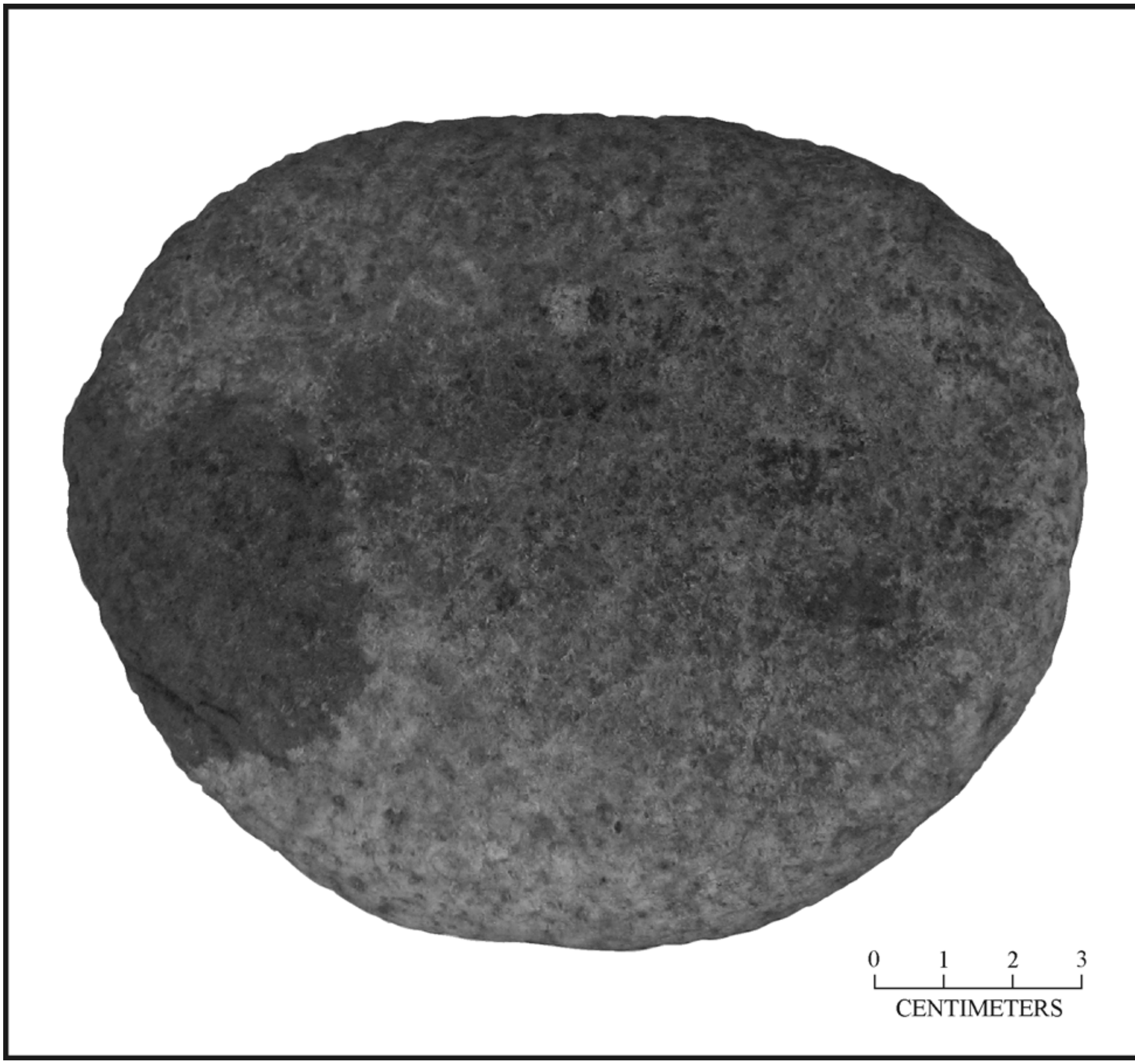

Figure 6-2a. Artifact 27536, small netherstone.

The use-wear is visible though has not dramatically altered the overall shape of the stone beyond smoothing of the use surface.

The other complete stone (#27931) is the largest in the assemblage with a slightly concave use area measuring 195 cm^2 and 1 to 2 mm in depth. It is also formed on a rounded river cobble with an ovate plan though roughly four times larger than the previously described stone. The wear pattern is ground and heavily pecked. This stone has likely been used as a hopper-mortar as well.

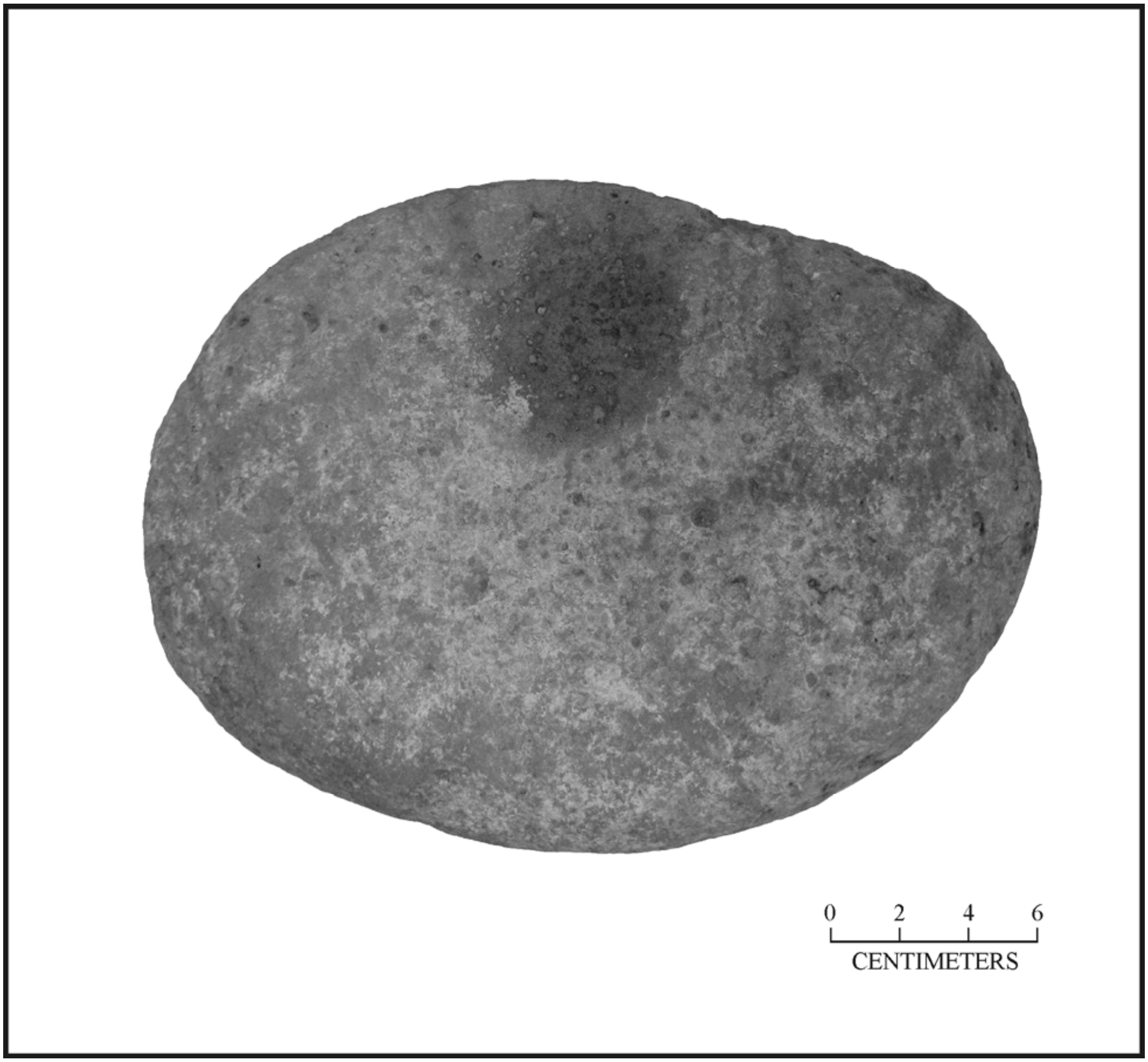

Figure 6-2b. Artifact 27931, Hopper mortar

The remaining two netherstones are incomplete and an overall use area cannot be measured. The first of these stones encountered has a flat grinding surface that covers one side of the stone to within one centimeter of the original tool edge. Three of the four sides of the stone are rough and angular, and were created after the stone was utilized for grinding. The fourth side of the stone is rounded and indicates that this grinding stone was made from a rounded boulder as well. The wear appears to be related to grinding only. The fracturing of this stone is difficult to explain with certainty however the scalloped appearance of the fracture margin may indicate the application of percussive force. The shape of the edge may have been produced through wedging fractures of the basalt if it had been used as an anvil stone for breaking very hard materials such as bone. The absence of pecking on the stone does not support this explanation but the stone may also have failed after very few impacts. The lack of reddening and charring as well as the good preservation of pollen on the stone suggest that thermal fracturing is probably not responsible for the fractures.

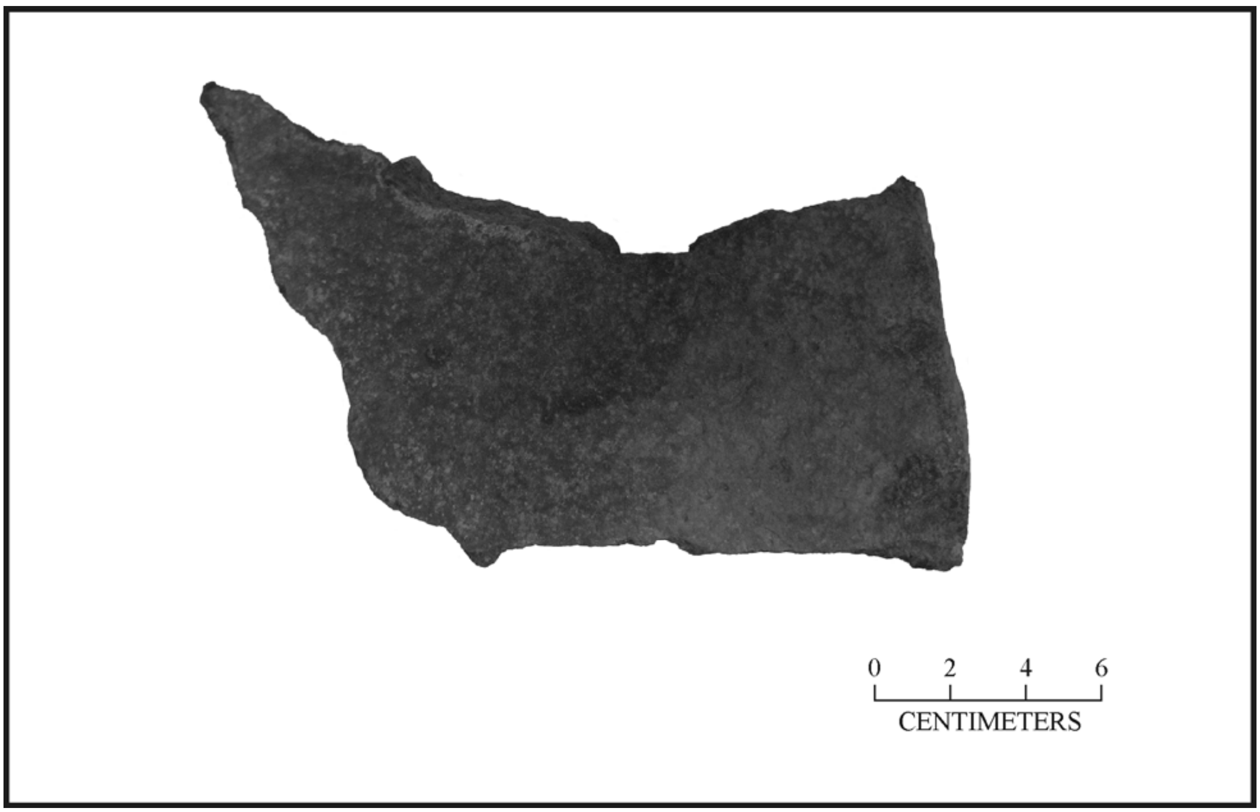

Figure 6-2c. Artifact 27694, metate fragment.

The fourth stone appears to be the most heavily worn. It is fractured but still the second largest of the stationary grinding stones recovered. The ground area extends to within one centimeter of the original boulder margin and is worn 3-4 mm below the stone rim. The stone was used with a linear stroke and shows clear striations. The deep striations and concave work surface are indications that this stone was extensively used in one task (Adams 2002). The non-fractured margin of the stone is water rounded and transitions to a gently convex base. The margin of this is stone similar to the previous grinding stone in that it has a roughly scalloped angular margin. The stone lacks evidence of heat damage and this stone may have been broken while functioning as an anvil for heavy crushing/cracking activities though the wear indicates it had a primary use as a metate or grinding slab.

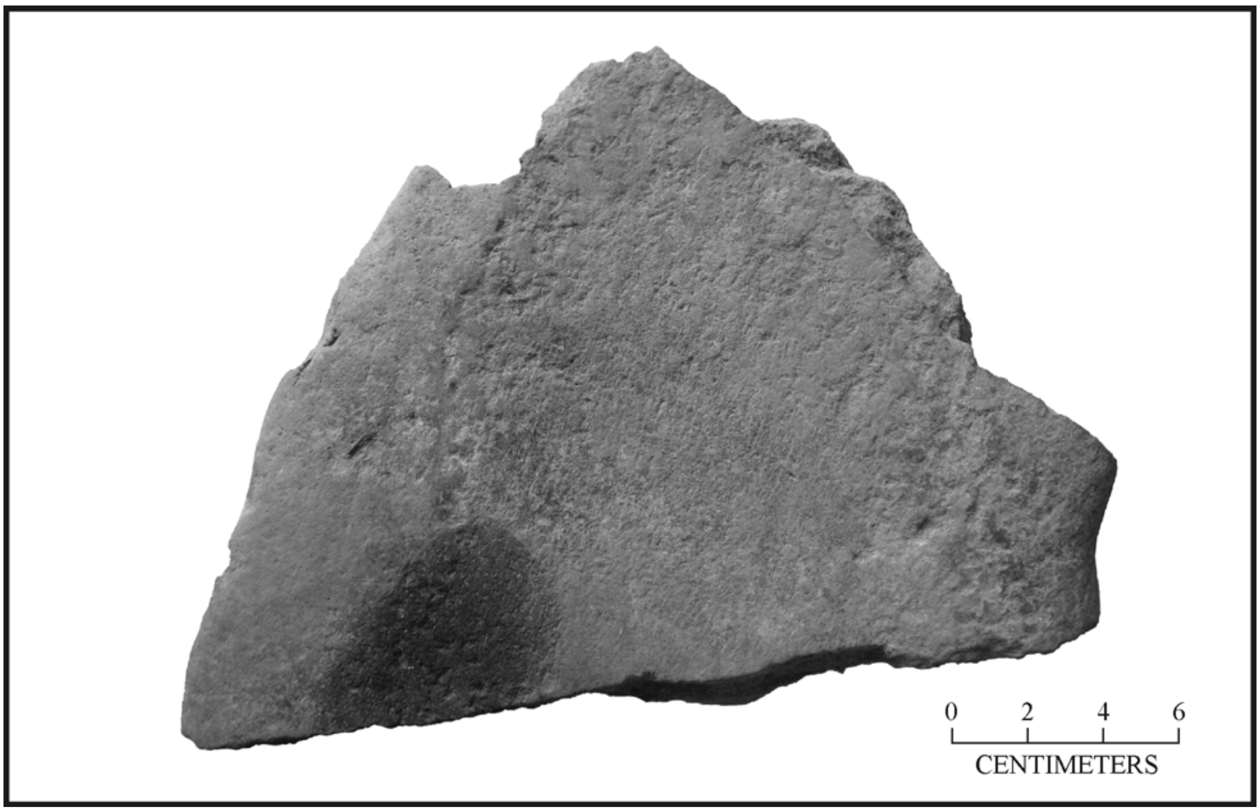

Figure 6-2d. Artifact 26807, fractured metate.

Hammerstones

The Late Holocene assemblage contains six artifacts that are recognizable hammerstones (Figure 6-3). Five of the six are whole and none display evidence of fire-cracking or burning. They vary in raw material and are composed of basalt (n=3), quartzite (n=2), and an unidentified raw material (n=1). They are also variable in size. The weight of these artifacts serves as a clear measure of the variation and ranges from 62.9g to 649.5g with a coefficient of variation of 0.865. These hammerstones are a small sample which may account for the apparent high variability. Functional differences among the different stones may account for the variation such as percussion flaking for chipped stone tool manufacture, bone crushing, and seed pulverizing which require a range of stone masses. The damage patterns on these types of artifacts may vary considerably depending on the type of activity and force used (Adams 2002). The only evidence of the different applications of these tools is in the use areas which are pecked at one end only (n=4), or at two opposite ends (n=2). They also vary in degree of battering which is qualitative for the purposes of this study but ranges from heavy (n=2) with many contiguous pits larger than the grains of the stone, moderate (n=2) with many contiguous pits roughly as large as the grains of the stone, to light (n=2) with pits smaller than the grains of the stone. The varying condition may also be related to the raw material of the tool given that the two hammers with heavy battering are also the only quartzite hammers. Despite the small sample of these artifacts it is likely that they are representative of a wide variety of percussion tasks.

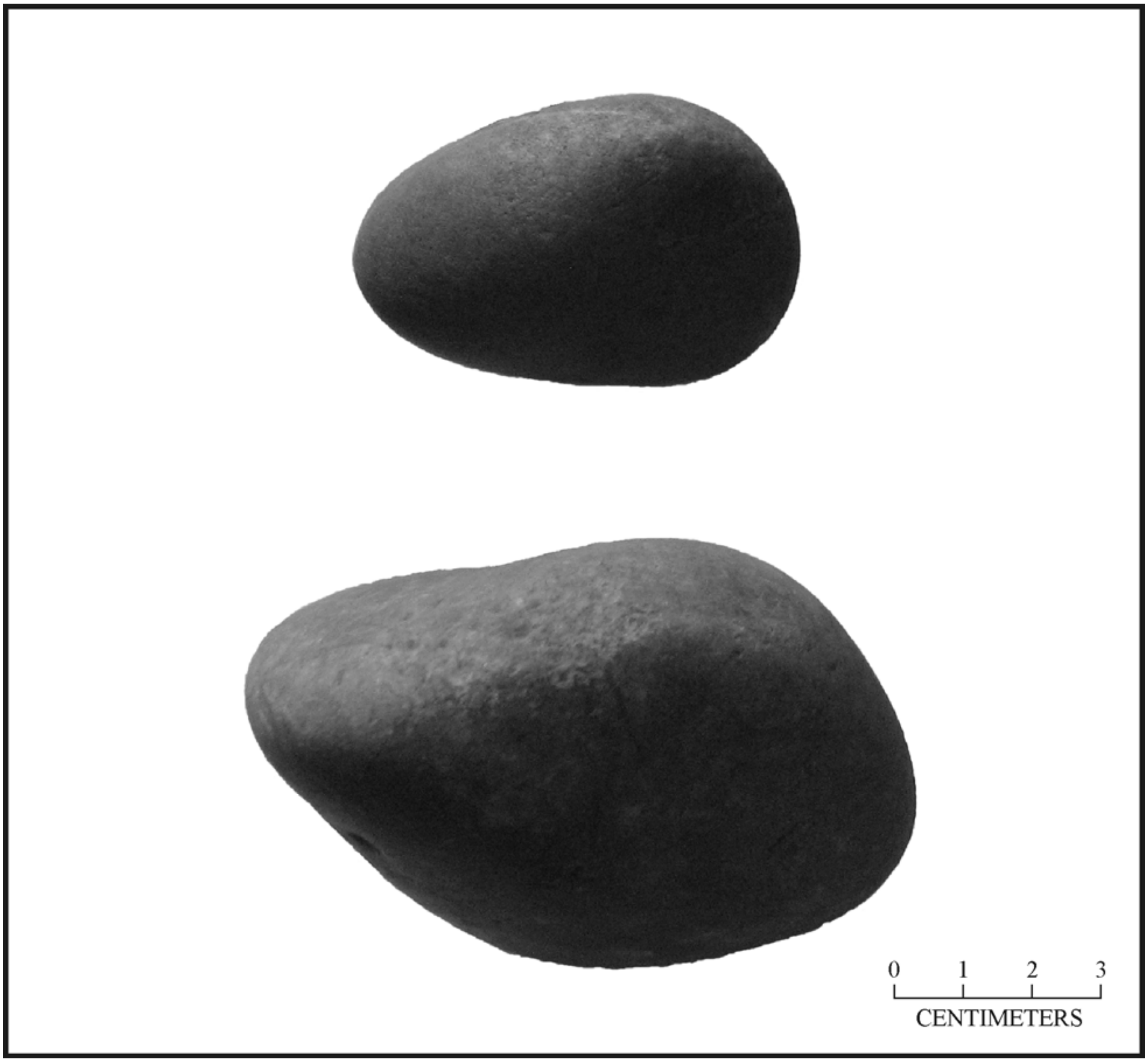

Figure 6-3. Typical hammer stone from the Birch Creek Site Late Archaic component.

Abraders

Two of the artifacts recovered in 2006 are exclusively abraders (Figure 6-4). These two artifacts are very different in appearance though have some similarity in raw material. Both are primarily silica based though have very different textures. The larger abrader is made of a very fine grained siliceous sedimentary material. One surface is flat and has a transverse line bisecting the ground surface. The smaller abrader is made of a welded tuff and the ground surface is limited to a small section measuring approximately 4 cm^2 at one end of the concave face of the stone. This object is probably shaped and appears to be a rounded river pebble in overall shape but the surface is covered in the angular clasts of the parent raw material.

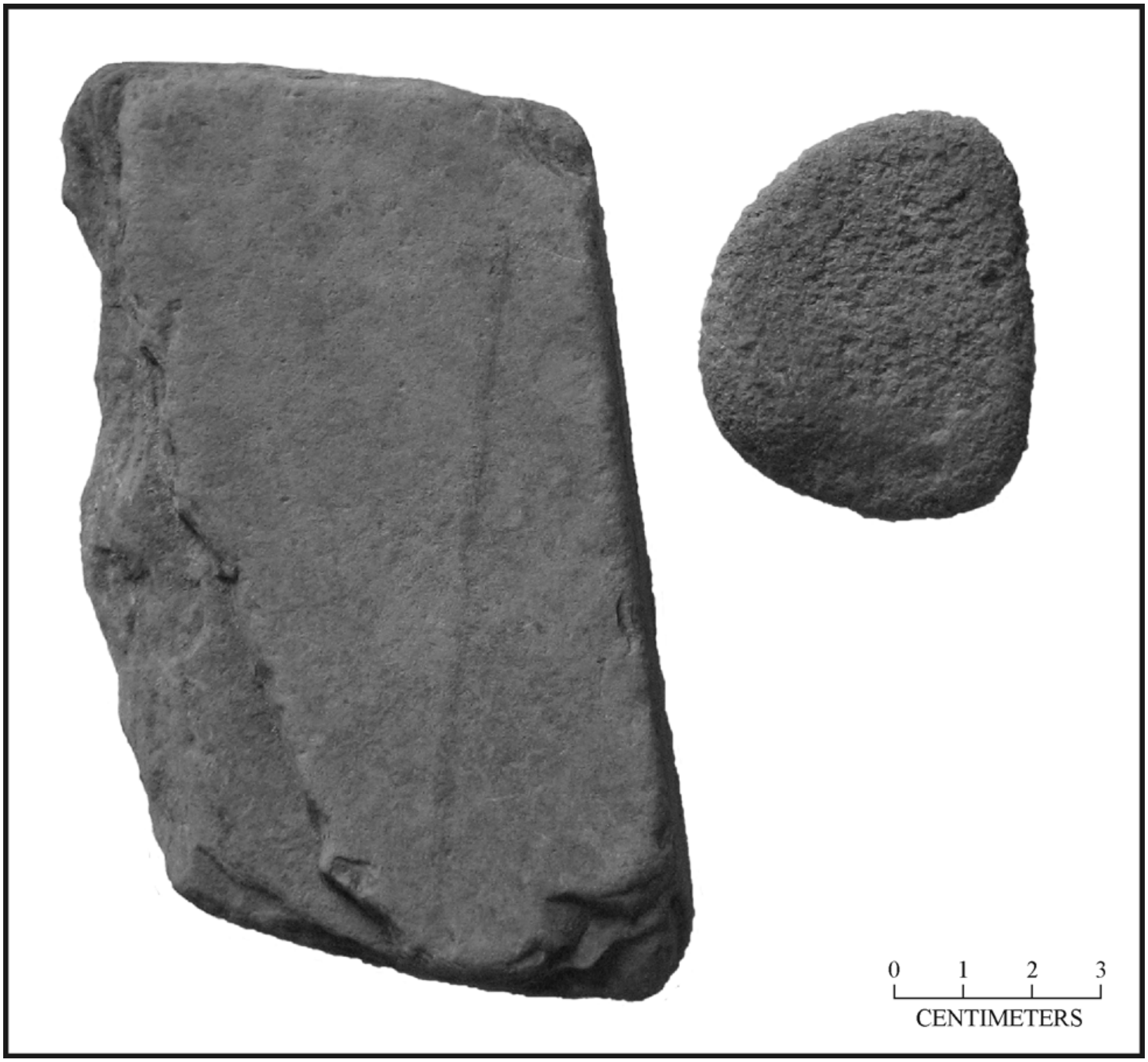

Figure 6-4. Abraders from the Birch Creek Site Late Archaic component.

Other Ground Stone

The other ground stone includes seven artifacts that either do not fit exclusively into one category or do not fit any other category at all. These include hand-stones which appear both ground and abraded (n=2), stones with wear from percussion that is not consistent with use as a hammer (n=3), and stones with wear that is so minimal it is difficult to classify (n=2).

The first subset of this group is two hand-stones that are formed on similar water-rounded ovate basalt river cobbles. One has roughly 63 cm^2 flat ground surface covering a full side of the stone and a 2 cm wide ground strip on the other. The second stone has two ground faces measuring roughly 70 cm^2 each. These appear to be the complementary tools to flat surfaced netherstones/grinding slabs though a direction/pattern of use is only preserved in the abraded strip on one of the stones.

The collection has three stones that are marked by percussion damage that is not consistent with conventional hammering or pecking. The first of these stones is an elongate basalt cobble weighing roughly 260g with battering and some grinding. The battering is intermittent across the entire object and grinding is very light. This object may have been multifunctional or discarded in the process of shaping. The second stone is a small cobble with a battered margin. The battering is concentrated though in a location that would make controlled strikes difficult due to the projecting ends. This may also have been a stone that was discarded during shaping. The third stone is an irregular quartzite cobble with a concentration of impact marks in the center of one face. The marks are ambiguous and imply some application of force to the stone. One possibility is that an attempt to split this stone was attempted and abandoned after several failed strikes. Alternatively this stone could have been used as a hammer to split very hard items (stone nodules, hard seeds/nuts, etc.) against an anvil.

The final group of stones in this category is simply difficult to identify. Two stones exhibit such light wear that they cannot be placed in any category with certainty though do appear modified. They may be hammer stones that were used very gently.

Ground Stone Fire-Cracked Rock

A total of 41 pieces of fire-cracked rock (FCR) were identified as ground stone fragments. The evidence of use as a ground stone tool appears as a faceted or smooth worn surface typically interrupted on one or more sides by a radiating fracture typical of FCR. The grinding predates the fracturing in all cases. These artifacts are fractured to such a degree that assigning them to one of the object types listed above would be an unreliable classification but based on the artifacts that have been recovered they may represent netherstones, hand-stones, abraders, or pestles. Even though they cannot provide precise technological information these items can be used to estimate the how many additional grinding stones may have been in use during the occupation. The weight of the ground stone FCR can be used to calculate the approximate number of grinding stones represented with a comparison to the relevant non-fire-damaged ground stone. The comparative sample is comprised of stones which are basalt, ground, and whole specimens. The assemblage contains five grinding stones which meet the criteria. These five stones range from 4,300g to 215.8g and average 1,249.8g. Based on these weights the 8,415.4g of ground stone FCR may represent as few as 2 additional stones based on the largest whole grinding stone in the assemblage, as many as 39 additional hand-stones based on the smallest specimen, or seven additional stones based on the average weight of whole basalt grinding stones in the assemblage. This sample is probably too small for the average of seven additional stones to be accurate but it is the best estimate given the present data-set.

Comparison to Earlier Components

The relative diversity of ground stone can provide some indication of the range of activities that occurred at a site (Kolvet and Eisele 2000). Specifically the diversity of artifacts should be higher at places like base camps and villages than at task camps because the range of materials people are using should be higher at longer-term occupations while the costs of transporting items is reduced by increased occupation duration (Shott 1986). The Birch Creek Site offers a single location but the way it was used over time may have changed depending on how people were utilizing the Owyhee Valley. The Middle Archaic Housepit component and Pre-housepit component have already been compared and found to be similar despite differing habitation types (Cowan 2006). The construction of pithouses does not appear to have been associated with a change in site use intensity. The Late Archaic component does not contain clear evidence of pithouse construction and its ground stone assemblage may be compared to earlier components to determine if changes in use occurred between the Middle Archaic and Late Archaic. If the occupation of the Birch Creek Site became more ephemeral later in time ground stone tools will show the lower intensity of use and a narrower variety of activities reflecting the decreased diversity of ground stone in the Late Archaic assemblage.

The categorization of tools presented above provides the basis for artifact types assignments used for comparison. The broad categories used above for data presentation groups stones with common attributes but also defines artifact types for each specimen in specific terms. While the information about specific artifact types is found above it is summarized here for the purposes of clarity. Handstones are Other Ground Stone which has size and shape attribute of Type 1 or Type 2 (Sager 2001) tools but do not have a well defined shape or wear pattern. Mano type tools were not recovered from the Late Archaic component. Pestles are defined as an exclusive category above and there are three specimens which could not be fragments of the same tool. Abraders are also a unique category defined above and there are two whole abraders in the assemblage. Netherstones are a broad category defined above and tools remain under the broad label of netherstone when their use appears more varied than that of a metate or mortar. Metates are clearly patterned grinding stones within the netherstone category and one was recovered from the Late Archaic component. Mortars are also clearly patterned from their use and have a pecked and ground depression in their center. One mortar was recovered from the Late Archaic component. Hammerstones have concentrated pecking in at least one area on their surface from impacting hard objects such as other stones. Six hammerstones were recovered from the Late Archaic component. The Unidentified artifact type is a catch-all for the remaining ground stone in the assemblage. The Unidentified artifacts are the Other Ground Stone not included in the Handstone artifact type, and includes the Ground Stone FCR. Ground stone FCR was not counted as individual specimens recovered but rather the estimate of seven stones based on the average mass of basalt ground stone explained above.

Table 6-1. Frequencies and Proportions of Ground Stone Artifacts in the Pre-Housepit, Housepit, and Late Archaic Components.

	Component					
	Pre-housepit		**Housepit**		**Late Archaic**	
Artifact Type	Count	%	Count	%	Count	%
Handstone	5	10.9	2	2.6	2	6.9
Mano	17	37.0	35	45.5	0	0.0
Pestle	2	4.4	3	3.9	3	10.4
Abrader	1	2.2	0	0.0	2	6.9
Netherstone	1	2.2	3	3.9	2	6.9
Metate	7	15.2	5	6.5	1	3.4
Mortar	0	0.0	2	2.6	1	3.4
Hammerstone	10	21.7	13	16.9	6	20.7
Unidentified	3	6.5	14	18.2	12	41.4
Total	**46**	**100.0**	**77**	**100.0**	**29**	**100.0**

The Shannon-Wiener Index was calculated for the Pre-housepit, Housepit, and Late Archaic components of the site to compare the assemblages in a manner similar to the Cowan (2006) study. The Shannon-Wiener index accounts for the number of categories or artifact types represented in the assemblage (the richness) and the number of artifacts within each category (the evenness) and provides a single value that can be used for comparison between assemblages. The analysis of Pre-housepit and Housepit assemblages did not find significant differences in the assemblages and therefore inferred similar suites of occupation activities over similar duration visits. The Late Archaic may have been marked by shorter and less intensive site visits, and if this were the case the diversity of ground stone should be lower than earlier occupations with relatively fewer types of stone (lower richness).

The Shannon-Wiener Index was recalculated for each of the previous components and a new index was calculated for the Late Archaic assemblage. The diversity indices for the Pre-housepit component is 1.708 and Late Archaic assemblages is nearly identical at 1.71 while the Pithouse component is 1.589. The assemblages are very similar with the Housepit assemblage slightly less diverse than the Late Archaic and Pre-housepit. The richness values of all three assemblages are the same with eight artifact categories represented though the quantity of ground stone in the Late Archaic assemblage is roughly half or less of that in either of the earlier components.

The significance of the frequency of individual types is difficult to test statistically due to the zero values of some types in some components and not others. An additional problem lies in the unidentified ground stone which accounts for over 40 percent of the Late Archaic assemblage. If the unidentified fragments could be assigned to a type it may change the diversity index for this component substantially.

The Pre-housepit and Housepit occupations were compared on several other dimensions beyond quantity and diversity of ground stone. Cowan (2006) also compared the percentages of multi-functional tools, level of maintenance, degree of use, and number of used surfaces of specimens in each of the two assemblages. These additional tests are not compared to the Late Archaic materials in the current study. While these other tests did incorporate quantitative values, the values are not easily replicable. The determination of attributes such as level of maintenance and use level is quantifiable but requires the analyst to judge where a stone fits within an arbitrarily divided continuum. Ways to stabilize the effect of personal judgment would be to have the same person determine the attribute levels for all of the stones or clearly define in measurable ways the attribute condition ranges. It is outside the scope of this project to reanalyze earlier components of the Birch Creek Site and/or create a new analysis methodology for ground stone wear. The frequency of multifunctional tools and number of used surfaces may be skewed by fragmentary tools in the assemblage which have lost use surfaces and therefore do not reflect their full suite of attributes. While many of the ground stone specimens do show signs of multi-functionality they are an unknown proportion of the assemblage.

The differential use of various raw materials is an important aspect of ground stone toolkit provisioning. As discussed above, durable stone is positively correlated with long-term or expected site use and reuse (Nelson and Lippmeier 1993). The diversity indices presented above indicate a relatively stable site use pattern during the Middle Archaic and Late Archaic. A comparison of the raw materials utilized in grinding tool applications provides another means of assessing site use over time. The tool types included under the heading of ground stone actually include tools used for plant food processing and tools used for manufacturing other tools or processing animal remains. The Nelson and Lippmeier (1993) study emphasizes tools used to process plant materials for consumption and it is those tool forms that are discussed here.

The tools included in the raw material comparison include netherstones (including metates and mortars), handstones (including manos and pestles), and other ground stone with faceted abrasive wear. The two Middle Archaic components are lumped together because the focus of the comparison is on patterns of major occupation divisions. The distribution of raw materials in each component is remarkably similar (Table 6-2). The overwhelming majority of tools are made from basalt. The remaining raw material types represent a small proportion of either assemblage but are generally also very durable materials such as quartzite. The netherstones are exclusively made from basalt during the Late Archaic and 83.3 percent of the Middle Archaic assemblage netherstones are basalt. The use of basalt may be reflection of the functional merits of the rock type, discussed above, but is abundant in the Owyhee Valley, as bedrock and in river gravel. Therefore, the use of basalt over time is probably stable because it is a suitable material available with little or no acquisition cost.

Table 6-2. Distribution of Raw Materials in the Grinding Stone Assemblages of the Middle Archaic and Late Archaic Periods. (Percentages of Component in Parentheses)

		Raw Material				
		Basalt	Other	Quartzite	Granite	Chert
Period	Late Archaic	18 (85.7)	1 (4.7)	1 (4.7)	0 (0.0)	1 (4.7)
	Middle Archaic	103 (83.7)	9 (7.3)	7 (5.7)	1 (0.8)	3 (2.4)

Summary

The prehistoric use of ground stone tools in the Great Basin is a growing area of research. The various attributes of ground stone have been used to develop typologies using strictly morphological characteristics (Sager 2001) and activity embedded types (Kolvet and Eisele 2000). At the Birch Creek Site a record of ground stone use exists for at least the past 6,500 years. Several distinct occupations have been recognized at the Birch Creek Site including an early (Middle Archaic) Pre-housepit occupation, a Housepit occupation (later Middle Archaic), and a Late Archaic occupation. These components share elements of their ground stone assemblage and demonstrate relative continuity in site use for much of the past 7,000 years.

The Pre-housepit, Housepit, and Late Archaic ground stone assemblages vary in their absolute numbers of artifacts. The diversity indices of each assemblage certainly could have been impacted by the different sample sizes of the components. The diversity indices are remarkably similar for all three components with a near exact match between the Pre-housepit and Late Archaic occupations. The Middle Archaic and Late Archaic also appear quite similar in their raw material use. Basalt and quartzite along with a few cases of other durable stone comprise the raw materials of the assemblage. These are materials that contribute to efficient processing of seeds/grains and contribute little fragmentary rock to the finished product (Adams 1999).

Though it is only one facet of a very complex site, the ground stone diversity and composition indicates that a variety of activities occurred at the site during the Late Archaic. It is difficult to know the range of activities carried out at the site because of the proportion of tools that may have been used for multiple tasks and the fact that many of the specimens are nontyped fragments. In addition to the traditional plant processing tasks carried out on mortars and metates there are also indications of hammer and anvil reduction of materials such as bone and chippable stone, shaping tools, and evidence for use that cannot be defined at this time. In summary the Late Archaic ground stone assemblage appears to plausibly represent a continuation of the site use pattern followed by earlier site inhabitants.

CHAPTER SEVEN

CHIPPED STONE

The chipped stone artifacts, including the various tool forms and debitage, represent the single largest artifact class recovered from the Late Archaic component of the Birch Creek Site (Andrefsky and Noll 2008:36-37). The composition of the assemblage reveals important aspects of the lifeways of prehistoric inhabitants of the site, including the diversity of activities carried out and mobility patterns. Human mobility indicated through obsidian source locations is discussed in Chapter Eight. This chapter presents the organization of the chipped stone artifact assemblage from the Late Archaic Period of the Birch Creek Site collected in 2006. The entire collected chipped stone assemblage totaling 5,400 tools and pieces of debitage is included in the analysis. The amount of information covered varies depending on the particular artifact class and question addressed by the data, and by no means is the description of the assemblage exhaustive, though enough data are provided to be useful to the present study and, hopefully, to future northern Great Basin researchers.

The Late Archaic is marked by a change in projectile technology from throwing board (atl-atl) and dart to bow-and-arrow. One question that may be addressed with the Late Archaic data is whether the change in projectile technology accompanied a shift in lithic technological organization. This can be detected through a comparison with the earlier occupations of the site. The aim of the chapter is to objectively present the assemblage and to then provide an analysis which focuses on the organization of Late Archaic chipped stone tool production. Finally, the Late Archaic component is quantitatively compared to the Middle Archaic components studied by Lisa Centola (2004).

Summary of The Middle Archaic Lithic Assemblages

This summary of Middle Archaic assemblages is derived from Centola (2004) who focused her analysis on material recovered from the N1047 trench, away from the major concentration of housepits. Centola (2004) used two radiocarbon dated occupations exposed in the northern portion of the site. The earlier component lies immediately above a layer of Mazama tephra and is termed the Mazama Component. The eruption of Mount Mazama occurred approximately 6,700 years ago and deposited an ash layer across much of northwestern North America east of the Cascade Mountains/Coast Range. A feature within the component was radiocarbon dated to 6640 ± 40 BP. The later component is associated with a housepit depression and termed the Pithouse Component. A charcoal feature from the pithouse floor was radiocarbon dated to 3980 ± 50 BP.

The Mazama Component sample from the N1047 trench is comprised of 859 chipped stone artifacts. The majority of the assemblage is comprised of debitage, while tools account for only 2.6 percent (n=23) of the specimens. Raw materials consist of local chert (available in the bed gravels of the site) which account for 75.2 percent of the assemblage, while obsidian and non-local chert represent 12.5 percent and 12.1 percent of the assemblage respectively. Other raw materials account for only 0.2 percent of the Mazama Component specimens. A total of 14 of the 23 tools are made from local chert, non-local chert was used for six tools, and three bifaces made of obsidian represent the only tools made from that material. The debitage assemblage is also dominated by local chert and angular shatter is underrepresented among the non-local chert and obsidian. Local chert debitage is also larger on average than non-local chert or obsidian debitage.

The Pithouse Component sample from the N1047 trench is comprised of 3,407 chipped stone artifacts. The majority of the assemblage is debitage, while tools account for only 0.4 percent (n=13) of the specimens. Raw materials consist of local chert which account for 94.8 percent of the assemblage, while obsidian and non-local chert represent 4.4 percent and 0.5 percent of the assemblage respectively. Other raw materials account for only 0.2 percent of the Pithouse Component specimens. A total of 11 of the 13 tools are made from local chert, non-local chert was used for one tool, and one biface made of obsidian represents the only tool made from that material. The debitage assemblage is also dominated by local chert and angular shatter is underrepresented among the non-local chert and obsidian. Local chert debitage is also larger on average than obsidian debitage while non-local chert debitage is represented by a very small sample and appears slightly larger on average than local chert.

The two components were presumed to be related to groups practicing two different residence patterns, and as such, variables of the toolkit designs were tested for differences. These variables included accommodation for portability, multifunctionality, maintainability, and reliability. The structure of the analysis of Middle Archaic deposits impacts the kinds of tests that can be conducted with the Late Archaic and some information on that analysis follow.

Portability relies on the recognition that there is a cost to transport and unnecessary mass will not be carried any significant distance (Beck et al. 2002; Kelly 1988; Kuhn 1994). At the Birch Creek Site local chert would not face portability requirements because it could be acquired and utilized without the need to transport it off site. However, non-local materials should have evidence of the consideration of portability in their design, including reduced mass (e.g., relatively thinner bifaces and flake tools), and cortex should be absent because it is a portion of a raw material altered through weathering that is undesirable for tool making (and use) (Crabtree

1972; Whittaker 1994), making it excess weight. The assumption that the Mazama Component represents more mobile people than the Pithouse Component is not strongly supported following the expectation that portable flake tools are smaller. While Mazama Component flake tools made from non-local materials are smaller than Pithouse Component flake tools made of non-local material, the size of the sample is too small to conclusively state that the expectations were met. Mazama Component local chert flake tools are actually significantly larger than those of the Pithouse Component and appear less portable. Cortex presence within the two assemblages was equally inconclusive, with the Mazama Component containing relatively fewer tools with cortex than the Pithouse Component, but with little difference between the assemblages in regards to cortex presence on debitage specimens. Both assemblages contained relatively little cortical debitage and most of the debitage with cortex in each assemblage is local chert.

Multifunctionality refers to the structure of lithic toolkits and how tasks are carried out using those kits. There are two major types of multifunctional tools, flexible tools and versatile tools (Nelson 1991; Shott 1986). A flexible tool changes form to perform different tasks, while a versatile tool is able to perform in multiple tasks as a generalized form. Research has been done to study the traces of individual tool uses left by different materials in different tasks (e.g., Hayden 1979; Keeley 1980), however an assemblage-based approach was taken instead. The tools of an assemblage may be used to represent degrees of multifuncionality, through number of modified edges on a flake tool, and overall tool diversity. A multifunctional toolkit would include higher average use areas on flake tools and fewer overall tool types. The flake tools from the Mazama Component indicate proportionally more multifunctional use than those of the Pithouse Component. Non-local raw materials are limited in both components but do follow expectations with 4 of 5 (80 percent) flake tools in the Mazama Component having multiple modified edges while the single flake non-local tool in the Pithouse Component only has one modified edge. Local raw materials were expected to reflect local use and lower degrees of multifunctionality within each component. The expectation was met among the Mazama Component flake tool with 5 of 11 (45 percent) local chert specimens displaying multiple areas of use. The results of the local chert flake tool analysis also indicated that the two periods were practicing different use strategies with 17 percent of Pithouse Component flake tools having multiple modified edges, opposed to 45 percent in the Mazama Assemblage. Analysis of the tool assemblage diversity found the Pithouse Component was slightly more diverse than the Mazama Component. A diversity index was calculated for each component and revealed the Mazama Component (H'= 1.44) to be lower than the Pithouse Component (H'=1.55) though richness was the same for each component and evenness was just slightly higher among Pithouse Component tools.

Maintainability refers to the capacity of a tool to experience an extended use-life, through activities such as resharpening or reshaping. Activities such as cutting and scraping wear down a sharp edge making them less effective, and impacts or shock loads to a tool can cause fracture. Tools that are maintainable are able to have dull edges sharpened and broken edges/tips reformed through retouch flaking. Tool maintenance behavior is a means of conserving tool-stone. The costs of acquiring new tool raw materials can outweigh the cost of rejuvenating a broken tool, especially when suitable raw materials are not locally available (Andrefsky 1994a, 1994b, 2008; Bamforth 1986; Odell 1996).

The maintainability of tools in the Middle Archaic assemblages was assessed through the relative frequency of retouch on flake tools, and through an examination of the size of the debitage recovered. The expectation was that more mobile groups would produce assemblages with higher proportions of retouched flake tools, especially visible in the non-local raw material. Mobility would also produce debitage that would reflect tool maintenance rather than production, through a predominance of small, cortex free proximal flakes, with a noticeable under representation of large cortical flakes and angular shatter.

The comparison of the two assemblages found that the two assemblages did not fit the expectations. The Mazama Component flake tools contained 25 percent that were retouched, and only one made from non-local raw material. The Pithouse Component flake tools contained 8 percent that were retouched, and only one made of non-local raw material. The flake tools made from non-local raw materials directly contradict expectations with a greater percentage of the edge of the exotic flake tool from the Pithouse Component containing retouch than the one from the Mazama Component. The debitage size analysis revealed comparable treatment of non-local raw materials in both assemblages, with very small debitage dominating both. In addition, non-local angular shatter was significantly underrepresented in the two components and the pieces that were recovered were very small. Local chert debitage, from both assemblages, was comprised of a wider range of flake sizes and included proportionally more angular shatter. The presence of a diverse size range of debitage indicates that in addition to tool maintenance, new tools were being produced as well.

The final dimension of tool design assessed for the Middle Archaic assemblages involves reliability, which is the aspect of design which allows it to dependably perform an intended task when put into use (Nelson 1991). Reliable tools are frequently composite implements which have been designed and constructed to exceed the minimum strength and durability requirements of a task, with components that fit securely and allow component replacement (Bleed 1986;

Nelson 1991). The assessment of reliability in the Middle Archaic components of the Birch Creek Site was made through the presence and frequency of hafted tools.

The two assemblage samples studied by Centola (2004) contained a limited quantity of hafted tools. A single side-notched projectile point within the Mazama Component was the only hafted tool in either assemblage. The lack of hafted tools was interpreted as potentially indicating little effort was placed in designing reliable tools in the Middle Archaic. These results are tentative however, as numerous hafted bifaces are known from the Middle Archaic assemblages at other locations on the site, and have been well documented and studied (Andrefsky 2008; Wallace 2004).

An alternative assessment of reliability was completed using an analysis of the frequency of exotic raw materials in the assemblages. High quality exotic materials such as obsidian are frequently considered to be superior because their brittle glassy composition provides a predicable flake fracture with reliability and confidence in the production and use of tools made from it (Whittaker 1994). The use of obsidian at the Birch Creek Site appears to indicate that Mazama Component people were practicing a more reliable tool production strategy than Pithouse Component people. Nearly 40 percent of Mazama Component tools were obsidian, compared to 11 percent of the Pithouse Component tools.

Overall the two Middle Archaic assemblages appear to represent similar technological strategies. The local abundance of high quality chert was cited as a possible factor in shaping the Birch Creek assemblages. Non-local materials were treated in a similar manner. The comparison of the Mazama and Pithouse Components indicates that occupants of the Birch Creek Site may have utilized similar chipped stone technological strategies, and despite apparently having different habitation structures, may have practiced similar degrees of residential mobility.

The Late Archaic Chipped Stone Assemblage

Chipped Stone Tools

The excavations of the Late Archaic component of the site yielded 5,400 chipped stone specimens, and of those 270 (roughly 5 percent) are tools of some kind (see Table 7-1 for summary). The assemblage has been inventoried in a manner which organizes the tools based on morphology. In this system the functionally embedded terms recognizable in chipped stone literature are generally avoided. Some classes of artifacts are labeled with potentially functional terms such as "point" though these are not necessarily projectiles but rather hafted bifaces and "point" simply recognizes that the tool has a proximal and distal end. Non-hafted bifaces are placed in the Other Biface category. Twelve distinct chipped stone tool types were recovered and these include the Point (Hafted Biface), Point Tip or Midsection (Non-hafted Biface), Other Biface (Non-hafted Biface), Flake Drill, End Scraper, Unimarginal Flake Tool, Bimarginal Flake Tool, Unimarginal and Bimarginal Flake Tool, Unidirectional Core, Cobble Core without a cutting/scraping edge, Other Core, and Other Core with a cutting/scraping edge. The definitions of these tool classes follows Andrefsky (2005:77-82) and will be briefly summarized.

Point (Hafted Biface): an objective piece with flake removals from two opposing sides separated by a single continuous margin, and with an end/segment shaped to be connected to a composite implement.

Point Tip or Midsection (Non-hafted Biface): a fragment of a biface exhibiting a fine flaking and margins consistent with a completed hafted biface but which has been detached from its haft section.

Other Biface (Non-hafted Biface): an objective piece with flake removals from two opposing sides separated by a single continuous margin and lacking a shaped section for attachment to composite implement.

Flake Drill (Unimarginal Flake Tool [formed]): a piece of debitage that has been shaped though retouch or use to have a section with parallel or nearly parallel margins, and whose modification produces complementary beveled edges.

End Scraper (Unimarginal Flake Tool [formed]): a flake which as been modified through retouch across its distal end on the dorsal face to produce a steep (>60 degrees) face.

Unimarginal Flake Tool (unformed): a piece of debitage which has been modified through use or retouch with modification to a single side of a flake margin. Multiple sections of modification may occur without changing the definition.

Bimarginal Flake Tool (unformed): a piece of debitage which has been modified through use or retouch with modification to both sides of a flake margin. Multiple sections of modification may occur without changing the definition.

Unimarginal and Bimarginal Flake Tool (unformed): a piece of debitage which has been modified through use or retouch in multiple sections with modification to both a single side of a flake margin and both sides of another flake margin area. Multiple sections of modification may occur without changing the definition.

Unidirectional Core: an objective piece with flake removals from a single common surface.

Cobble Core without a cutting/scraping edge: an objective piece with few flake removals and retaining cortex and much of the shape of the original cobble, and without evidence of direct use to perform a task (i.e., edge crushing, retouch, etc.)

Other Core: and objective piece with little or no flake patterning (flakes are removed from multiple surfaces in multiple directions) and little or no evidence of the shape and size of the original cobble. The core also has no evidence of direct use to perform a task (i.e., edge crushing, retouch, etc.)

Other Core with a cutting/scraping edge: and objective piece with little or no flake patterning (flakes are removed from multiple surfaces in multiple directions) and little or no evidence of the shape and size of the original cobble. The core has evidence of direct use to perform a task (i.e., edge crushing, retouch, etc.).

Table 7-1. Summary of Chipped Stone Artifacts Recovered From the Late Archaic Component of the Birch Creek Site.

Artifact Type	Obsidian	Chert	Basalt	Total
Point	1	4		**5**
Flake Drill	1			**1**
Point Tip or Midsection	2			**2**
Other Biface	4	8		**12**
End Scraper		1		**1**
Unimarginal Flake Tool	8	178		**186**
Bimarginal Flake Tool		13		**13**
Uni/Bimarginal Flake Tool	1	5		**6**
Unidirectional Core		7		**7**
Cobble Core w/o Cutting/Scraping Edge		1		**1**
Other Core		31		**31**
Other Core with Cutting/Scraping Edge		3		**3**
Flake Debitage with Cortex	9	112	1	**121**
Flake Debitage without Cortex	242	1393		**1646**
Cobble Spall		1		**1**
Flake Shatter	393	2187		**2581**
Angular Shatter	3	780		**783**
Total	**664**	**4725**	**1**	**5400**

Bifaces

Nineteen bifaces and biface fragments were recovered from the Birch Creek Late Archaic component. These include five relatively complete hafted bifaces, two relatively complete non-hafted bifaces, two point tips, three probable haft elements from hafted bifaces, three large biface fragments, and four small biface fragments. The bifaces are made primarily of chert and the obsidian specimens are generally smaller than the chert specimens.

Hafted Bifaces

The hafted biface group is made up of three chert points, one chert knife, and one obsidian point (Figure 7-1). These specimens are a special class that has implications for the age of the site as well as toolkit organization and each is discussed briefly.

The chert knife (#25947) is incomplete and lacks much of its haft portion. A small section of one margin of the neck is preserved which makes recognition of the hafting of this tool possible. This specimen measures 60.22 x 21.48 x 6.19 mm and weighs 4.8g. The use of this tool as a knife rather than as a projectile is apparent from the bend in the margins near the base and the retouch along the entire length of the blade distal to the bend in the margin.

The obsidian projectile point (#26283) is relatively complete though shows tip damage and extensive retouch to the blade. The specimen is 23.71 mm long with a maximum width of 15.25 mm, a neck width of 8.21 mm, and thickness of 3.73 mm. This point appears similar to the Northern Great Basin types Northern Side-Notched (NSN) and Desert Side-Notched (DSN), which fall within production periods of 5310 ± 45 to 4280 ± 220 BP and post-700 BP respectively (Largaespada 2006). The important measure in distinguishing the two is the height of the base (bottom of the side-notch to the proximal end). The NSN points have a base height greater than 6 mm while the DSN points have a base height of 3.5-6 mm (Largaespada 2006:78-79). The Birch Creek Site specimen has a base height of 7.19 on one side and 7.13 on the other. The specimen falls within the population parameters for the NSN points in the Northern Great Basin. NSN points are noted by Largaespada (2006) to have an overall length greater than 29 mm. While the Birch Creek Site specimen is shorter than 29 mm it is also heavily retouched and its original length could have been greater than 29 mm. The point type predates the radiocarbon age of the component by at least 3000 years and was likely collected from Middle Archaic deposits by people during the Late Archaic time period.

The smallest hafted biface is artifact #26441. It measures 22.13 mm long, 14.49 mm wide, with a neck width of 5.26 mm, and maximum thickness of 2.55 mm. It is a triangular corner-notched point with a slightly expanding stem. The small corner notched or expanding stem points documented in the Northern Great Basin include the Rose Spring and Eastgate forms. These are small points typically associated with the use of bow-and-arrow technology.

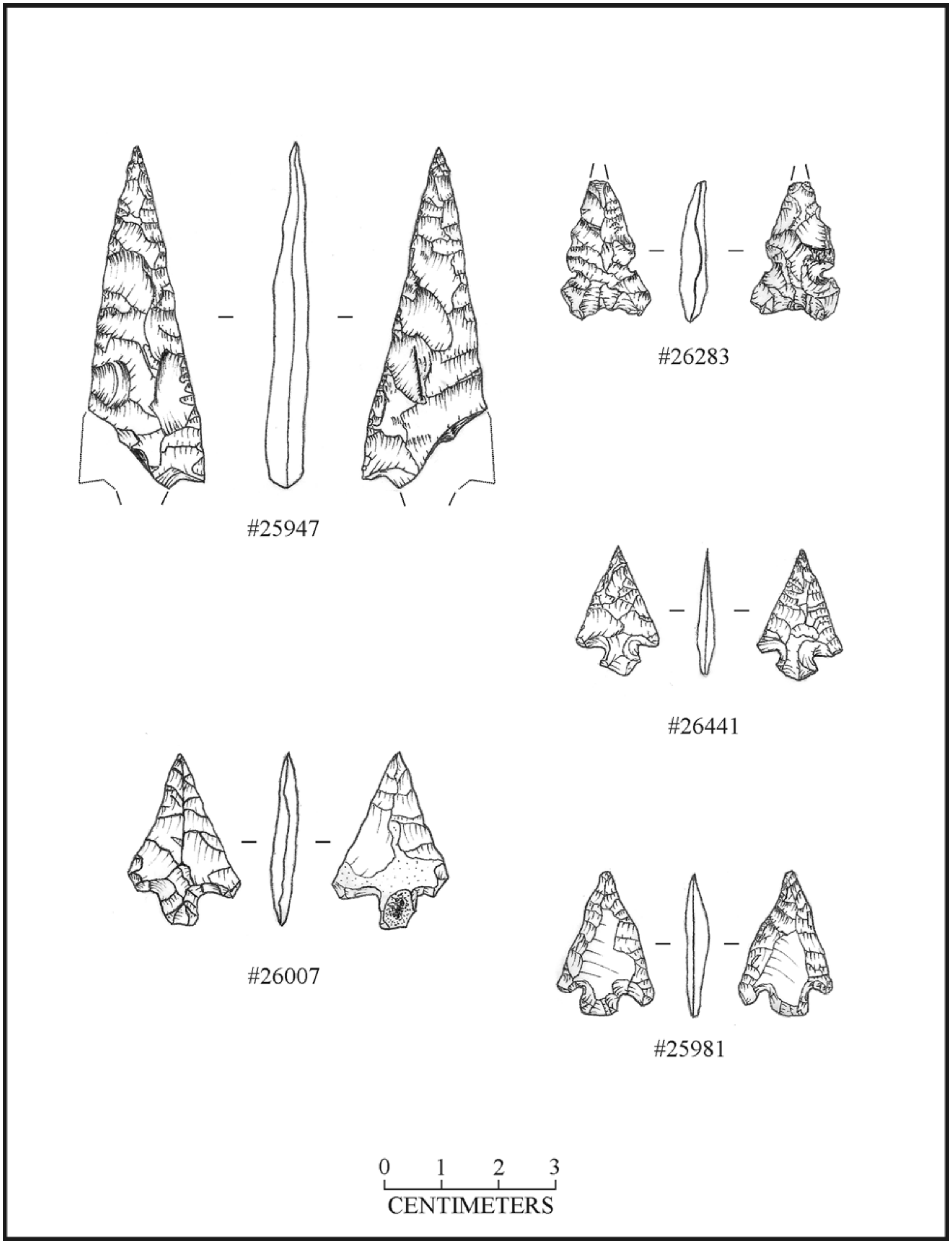

Figure 7-1. Hafted bifaces recovered from the Birch Creek Site Late Archaic component.

There are few metric attributes that distinguish the two varieties and they are often grouped within the inclusive term Rosegate. These points fall within the time span of 1780 ± 70 to 200 ± 50 BP in the Northern Great Basin (Largaespada 2006). This point appears to have been sharpened at its tip through retouch along one margin.

Specimen #26007 is a triangular corner notched point which displays potlid scars indicative of exposure to fire. The point is 30.06 mm long, 20.19 mm wide, with a neck width of 6.26 mm, and maximum thickness of 3.73 mm. This specimen is a corner notched point and falls within the population parameters of the Rosegate group. This point differs from the Rosegate point discussed above in that is has a preserved portion of the ventral flake surface of the initial flake blank.

The fifth hafted biface is specimen #25981. This point measures 25.15 mm long, 16.10 mm wide, with a neck width of 6.22 mm, and maximum thickness of 3.20 mm. The point appears corner notched though one barb projects basally far enough to suggest it was basally notched. If so this would distinguish the point as an Eastgate form. For the purposes of simplicity in this small sample the inclusive Rosegate type will be used. The point retains portions of the dorsal and ventral surfaces of the original flake blank.

Non-hafted Bifaces

There are two relatively complete non-hafted bifaces in the assemblage (Figure 7-2). Each is made of chert and each displays some evidence of water wear near in the center of its faces. They are comparable in size at roughly 60 mm in length, 34 mm in width, and 10-12 mm in thickness. The wear is isolated to the center of each specimen by margin retouch with sharp flake scars. The chert used for each biface is different and artifact #27153 is a siliceous sedimentary material while #25394 is a fine grained homogeneous green chert.

The small biface fragments take on a variety of forms including some which are recognizable as parts of formed tools while others are unrecognizable beyond the level of gross tool class (Figure 7-3). There are two artifacts which appear to be fragments from the distal ends of points. Artifact #27359 is a triangular obsidian fragment 7.45 mm long, 5.71 mm wide, and 2.04 mm thick. The other fragment is a midsection which appears to be from near the distal end of a small point. It is made from obsidian and measures 4.01 mm long, 7.02 mm wide, and 2.07 mm thick. The two fragments do not refit to one another. These fragments are relatively thin and are likely representative of two additional arrow size points.

Artifact #25414 is a relatively square chert fragment measuring 5.25 mm in length, 6.67 mm in width, and 2.04 mm in thickness. It closely resembles artifact #25948 which is also a square chert fragment measuring 4.93 mm in length, 6.76 mm in width, and 2.16 mm in thickness (see Figure 7-3). These appear to be the bases of small hafted bifaces. The whole arrow points in the assemblage have neck widths ranging from 5.26 to 6.26 mm with similar shapes to those of these two fragments. Based on the similar morphology these two pieces likely represent two arrow size points, and probably of the Rosegate type.

Artifact #27425 is an obsidian fragment measuring 6.58 mm in length, 10.98 mm in width and 4.13 mm in thickness (see Figure 7-3). The margins of this specimen appear to flare just at the fracture. This may also have been a base of a hafted biface though is appears different in plan view than any other tool in the assemblage. Without the distal portion it is impossible to determine if this was a knife or a projectile of some type.

The remaining four small biface fragments are too fragmentary to know if they are portions of finished tools or broken during production. Three of the fragments are made of chert and the fourth (#25984) is made from obsidian (see Figure 7-3). The fragments are all very

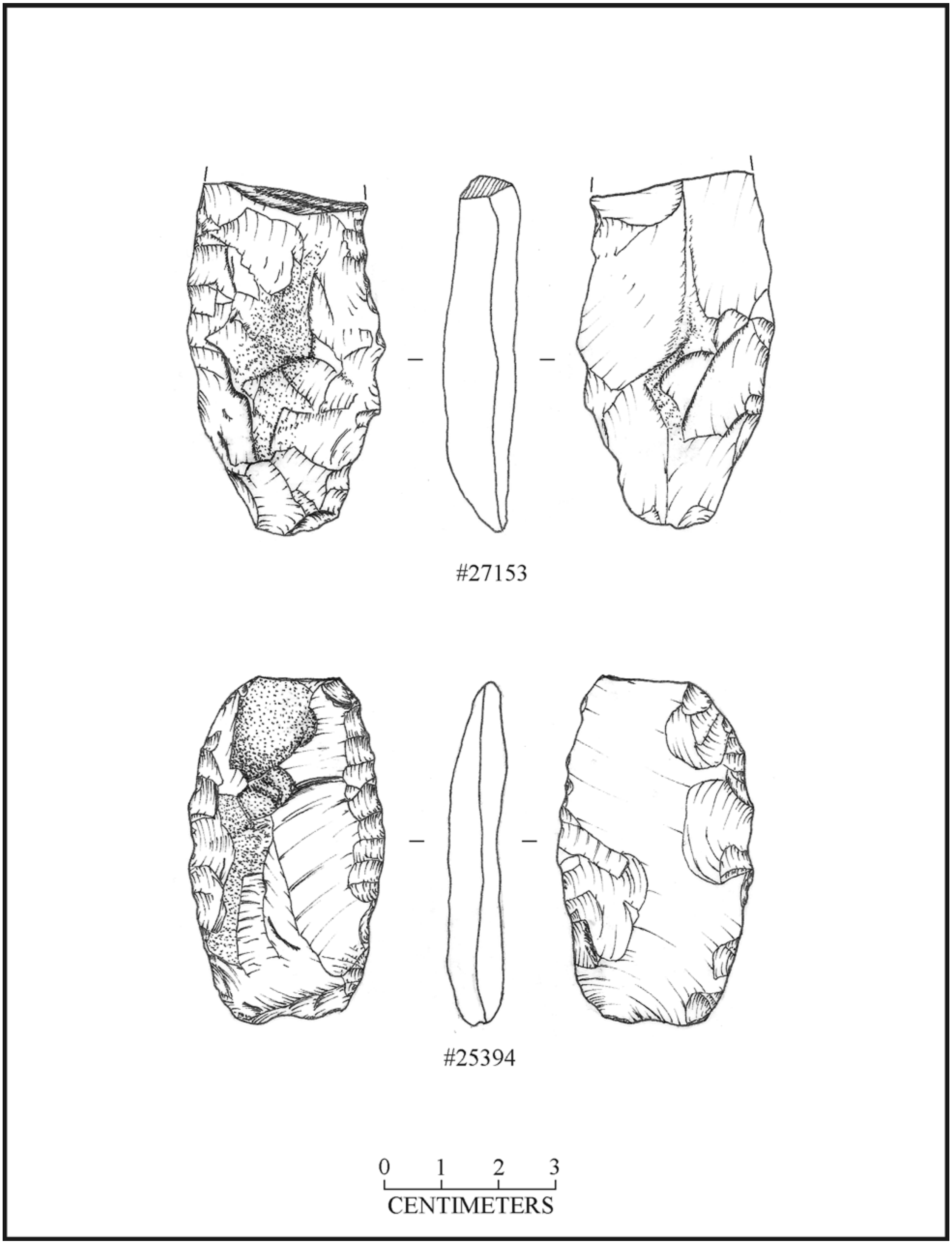

Figure 7-2. Non-hafted roughly shaped bifaces recovered from the Birch Creek Site Late Archaic component.

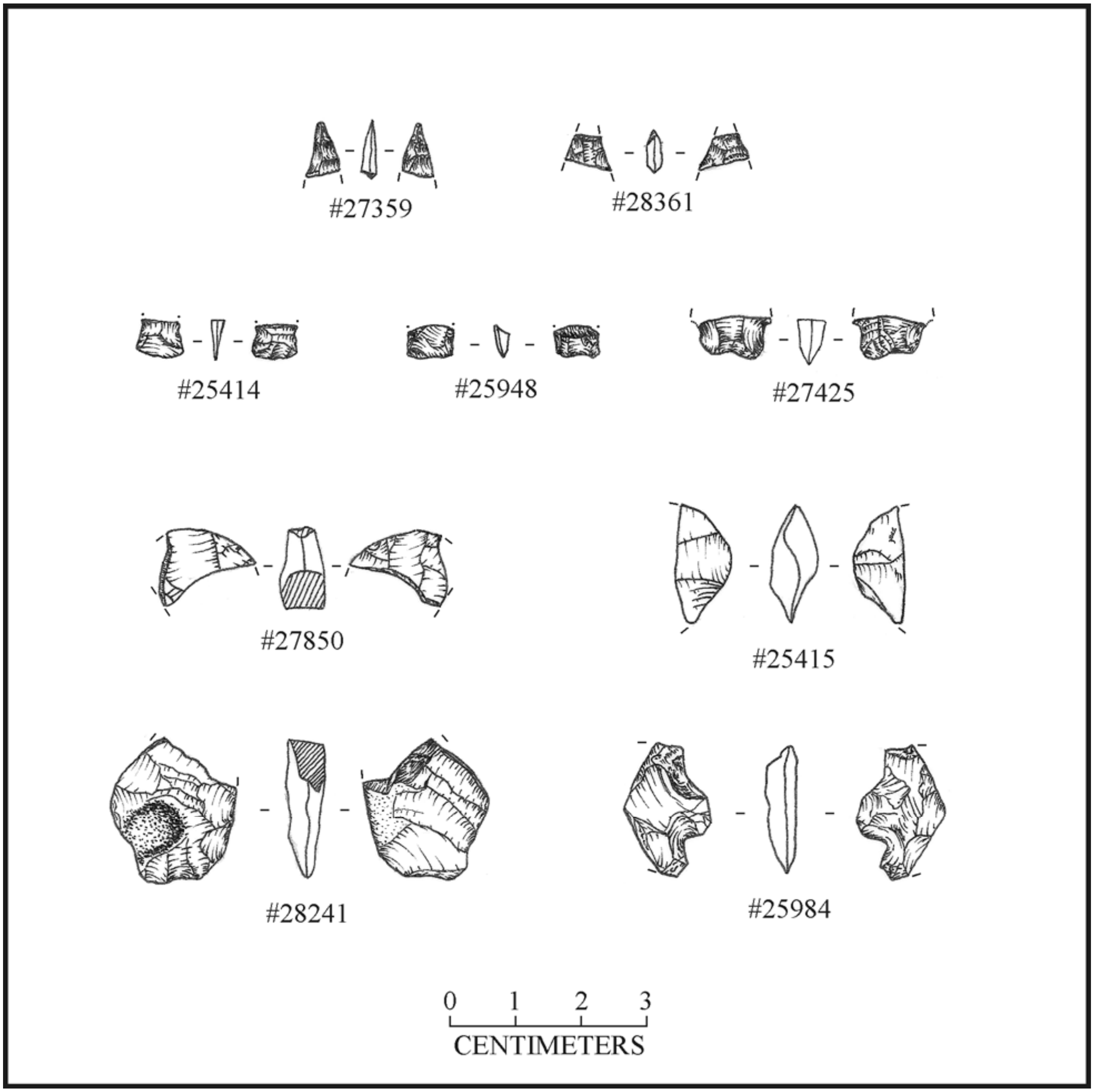

Figure 7-3. Biface fragments recovered from the Birch Creek Site Late Archaic component.

small with the chert pieces averaging in maximum linear dimension 18.20 mm and the obsidian measuring 20.74 mm across it's maximum length. The obsidian specimen has substantially more flake scars (27 scars) than the most heavily scarred chert specimen (14 scars). The chert specimen is also slightly bigger than the obsidian as well, weighing 2g, and measuring 20.84 x 18.55 x 5.54 mm while the obsidian specimen is 1g, and measures 20.74 x 13.53 x 4.33 mm.

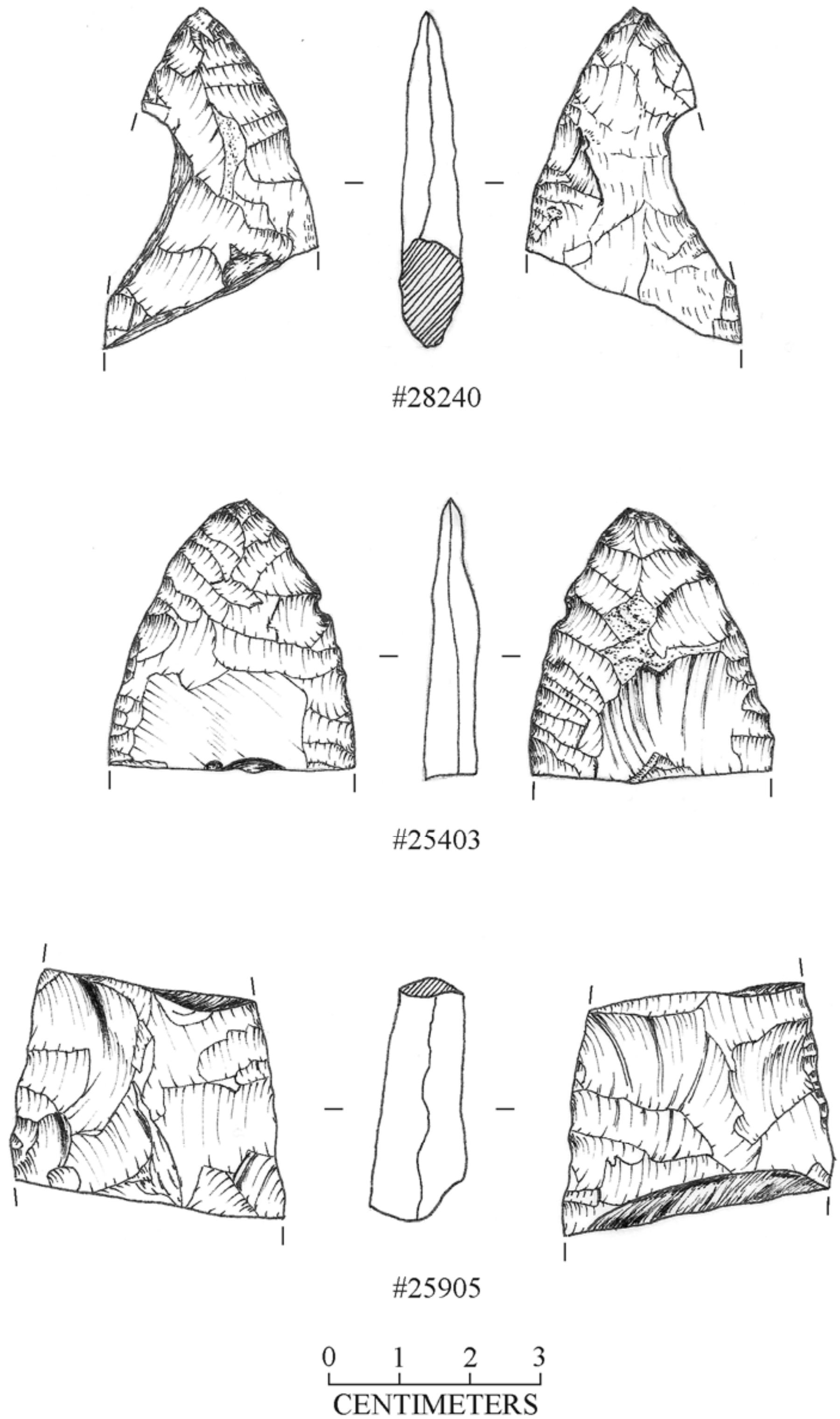

Figure 7-4. Non-hafted finely shaped biface fragments recovered from the Birch Creek Site Late Archaic component.

Three relatively large biface fragments were recovered from the Late Archaic deposits (Figure 7-4). These objects are all made from chert and appear to be well formed though broken during production. These larger biface fragments average 40.93 mm in maximum linear dimension with an average thickness of 8.51 mm. None of these pieces refit each other and they appear to all be from separate raw material cobbles based on macroscopic stone attributes.

Formed Unimarginal Flake Tools

There are two unifacial tools in the Late Archaic component that could be considered formally designed (Figure 7-5). Both are made from flake blanks and large portions of the tools retain flake attributes. In both cases however, the used edge(s) of the tool meet specific shape requirements.

One of the tools is a small flake drill made from obsidian. The drill has an overall length of 23.88 mm, maximum width of 13.13 mm, thickness of 2.93 mm, and bit width of 5.08. The only modified area of the flake is along the bit margins which are shaped with small overlapping flakes with feathered terminations. The resulting bit from the retouch is diamond shaped in cross section. The proximal end of the flake drill is irregular and the tool was likely used without a haft.

The other unifacial tool is a large end scraper made from chert. The scraper is 58.53 mm in length, 47.47 mm in maximum width, 35.09 mm wide along the distal edge, and 19.09 mm thick. Shaping of the distal end involved the probable contact edge but also along the distal lateral margins. Many of the flakes shaping the distal edge terminated in a step. The step may have prevented resharpening of the tool resulting in its discard at such a large size.

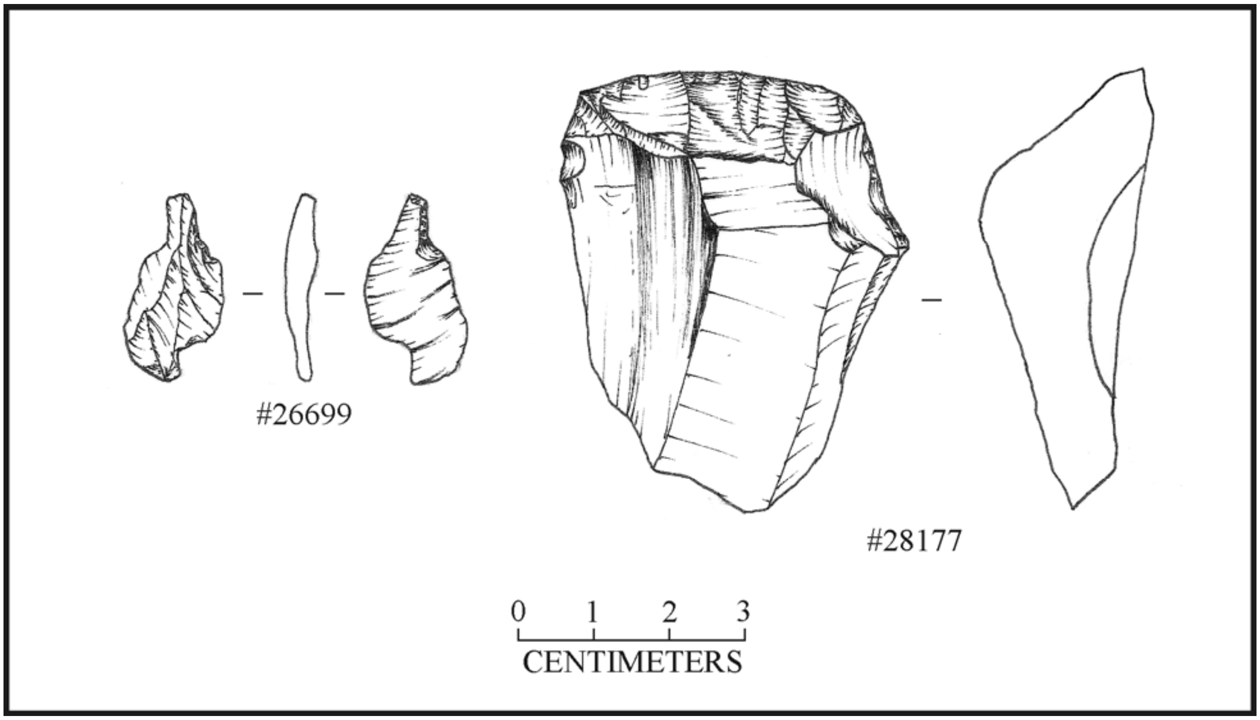

Figure 7-5. Unifacial shaped tools recovered from the Birch Creek Site Late Archaic component.

Cores

There are 42 cores included in the Late Archaic assemblage from the Birch Creek Site. These are divided into four core types, and include six unidirectional cores, one cobble core, thirty-two multidirectional cores without evidence of direct use and three multidirectional cores with evidence of use. All of the cores recovered are made from chert. The waterwear on flakescar arises of 22 percent of the total core assemblage indicates that nearly a quarter of the cores were exposed to moving water (likely the Owyhee River). The exposure probably occurred prior to the deposition in the recovery location based on the sedimentary context of the site described in Chapter Four. This also means that Late Archaic people likely collected discarded cores from prior occupations along the river. Due to this fact the distinction made by Centola (2004) between local and non-local chert will not be made for the Late Archaic assemblages because non-local chert may have been collected in a local secondary deposit.

The core specimens are highly variable in size, however, the different core types appear to overlap in their size ranges (Table 7-2). When the core types are segregated by gross morphology and unidirectional cores are left as one group and cobble cores, multidirectional cores, and utilized multidirectional cores are put together, and the attributes compared using a Unpaired t-test the cores appear very similar. The two groups are not significantly different in weight (t=.0068, df=40, p=0.9946), or maximum linear dimension (MLD) (, t=.5772, df=40, p=0.5670).

The presence or absence of cortex on each core was noted during artifact analysis. A total of 36 (83 percent) of the cores retained some amount of cortex on their surfaces. In some cases this was a small area accounting for no more than 5 percent of the surface, and in others it was considerably more. An exact measure of the cortex surface area of each core was not taken however.

Table 7-2. Size Estimates of Core Attributes by Type.

Core Type	Count	Mean Size Estimates				% w/ Cortex	% water worn
		Weight (g)	MLD (mm)	Width (mm)	Thickness (mm)		
Unidirectional Core	6	99.60 *(45.6)*	66.79 *(12.79)*	53.40 *(14.03)*	26.56 *(5.72)*	83	17
Cobble Core	1	114.30	75.58	44.07	35.61	100	100
Milti-directional Core	32	94.00 *(196.8)*	57.48 *(23.26)*	44.00 *(20.51)*	25.47 *(10.47)*	81	16
Multi-directional Core - utilized	3	148.20 *(95.18)*	88.22 *(31.23)*	63.52 *(28.63)*	26.72 *(7.24)*	100	67

Standard deviations listed in italicized parentheses.

Flake Tools

A total of 205 informal flake tools were recovered from the Late Archaic component of the Birch Creek Site. Of these 196 (95.6 percent) were made of chert while obsidian was used for the remaining 9 (4.4 percent) specimens. The informal flake tools fall into two distinct classes based on type of modification and include those with evidence of intentional retouch (Retouched) and those with evidence of use only (Utilized). The distinction is made on the basis of the macroscopic character of the modification. Following Keeley (1980) Retouched flakes have continuous adjoining or overlapping flake scars along the modified edge greater than 2 mm in width while utilized flakes have continuous or overlapping flake scars 2 mm or smaller along the use margin. Some flakes possess multiple modified margins and include both retouched and utilized edges. These flakes were recorded as having both types of modification but are included in the Retouched category for the purposes of analysis.

The sizes of the two flake tool classes differ somewhat in weight but are not remarkably different in linear measures (Table 7-3). The retouched flakes are, on average, slightly longer and relatively more thick than the utilized specimens. Major size differences are apparent between raw materials within the flake tool types with chert tools being consistently heavier, longer, and proportionally thicker than the obsidian tools.

In addition to being smaller, the obsidian tools appear to be used more heavily than the chert tools. The number of modified edges was counted for each flake. The method for this calculation deviates from Centola’s (2004) approach. With the Late Archaic tools the total number of sections was counted rather than counting the number of quadrants with modified sections as the previous study had done. Section breaks were determined by the end of continuous retouch/ “nibbling” use damage, or when abrupt changes in the flake margin separated sections. In this way, for example, two adjacent crescent shaped edges would be counted as two modifications even if they fall within a single quadrant of the tool. The obsidian stands out among both flake tool types as averaging more modification per tool, though the difference is not significant at the 0.05 level for either (Table 7-4). These numbers should be viewed cautiously however, given the small sample of obsidian flake tools in the assemblage.

Table 7-3. Size Estimates of Flake Tools From the Late Archaic Assemblage of the Birch Creek Site.

		Mean Size Estimates		
Flake Tool Type	**n**	**Weight (g)**	**MLD (mm)**	**Width: Thickness (mm)**
Retouched	76	14.0 (21.8)	41.19 (15.17)	3.07 (1.5)
Chert	*74*	*14.2 (22.0)*	*41.41 (15.3)*	*3.05 (1.52)*
Obsidian	*2*	*3.9 (2.3)*	*33.0 (5.5)*	*3.72 (0.47)*
Utilized	129	7.7 (13.34)	38.14 (13.57)	4.31 (1.89)
Chert	*122*	*8.11 (13.63)*	*38.57 (13.67)*	*4.29 (1.92)*
Obsidian	*7*	*1.4 (0.7)*	*30.63 (8.91)*	*4.63 (1.37)*

Standard deviations listed in italicized parentheses.

Table 7-4. Mean Number of Modified Edge Sections of Birch Creek Site Late Archaic Flake Tools By Raw Material.

	Flake Tool Type	
Raw Material	Retouched	Utilized
Chert	1.82 *(0.92)*	1.59 *(0.86)*
Obsidian	3.0 *(2.0)*	2.0 *(1.31)*
	t=1.7464 df=74 p=0.0849	t=1.1901, df=127, p=0.2362

Standard deviations listed in italicized parentheses. Unpaired t-test results listed for differences of raw material use for each flake tool type.

Debitage

The majority of chipped stone artifacts recovered from the Late Archaic component of the Birch Creek Site is debitage. The debitage assemblage accounts for 95.0 percent of the total chipped stone inventory. Flake shatter accounts for 50.3 percent (n=2,580) of the debitage.

These are the fragments of stone defined as pieces of flakes which retain a recognizable ventral and dorsal surface, but lack a proximal end or point of applied force. Proximal flakes, which have a single dorsal and ventral surface, as well as evidence of a point of applied force, account for 34.5 percent (n=1,768) of the debitage specimens. The remainder of the debitage is comprised of angular shatter, simply defined as debris lacking identifiable flake attributes, and accounts for 15.3 percent (n=783) of the debitage specimens.

The major debitage classes are represented by three stone raw material categories. The majority of all debitage is chert. Unlike the earlier Centola (2004) study, no attempt was made to distinguish local and non-local chert. This is due to the same reasons given for not separating local and non-local chert among the tools, which is that water-wear over tool surfaces indicates that many chert nodules were acquired from a secondary context along the river which may have been relatively local. Obsidian accounts for only 12.6 percent of the total debitage assemblage though this is almost entirely in the form of proximal flakes and flake shatter, while obsidian angular shatter is underrepresented in the assemblage (Table 7-5).

Chert is locally available in the Owyhee River bed gravels at the Birch Creek Site, and water-worn chert artifacts were available to Late Archaic inhabitants of the site as indicated above. The surfaces of chert nodules recovered from the Owyhee River have a characteristic and recognizable cortex from river transport and abrasion with sediments along the riverbed. Interestingly cortical surfaces are relatively rare among chert debitage specimens in the Late Archaic component, and are only found on 7.5 percent of chert proximal flake specimens (Table 7-6). Cortex on obsidian is less common than on chert, and is found on only 3.6 percent of proximal flake specimens.

The size of the Late Archaic component debitage is represented simply by the weight in grams of debitage specimens. Shott (1994) suggests that weight covaries with length of flake debitage. Given that the use of a standard laboratory scale is simple and reliable, making results easily comparable, the debitage sizes are described through weight only. The debitage sizes overall are generally small, though noticeably smaller for obsidian debitage which averages less than 0.2 g, compared to chert which is on average three times heavier (Table 7-7).

Table 7-5. Raw Material Types Represented in the Birch Creek Site Late Archaic Component.

	Raw Material		
Debitage Type	**Obsidian**	**Chert**	**Basalt**
Proximal Flakes	252 *(38.9)*	1515 *(33.8)*	1
Flake Shatter	393 *(60.7)*	2187 *(48.8)*	0
Angular Shatter	3 *(0.4)*	780 *(17.4)*	0
Total	648 *(100)*	4482 *(100)*	1

Relative frequencies calculated within raw material category and presented in italicized parentheses.

Table 7-6. Presence of Cortex on Proximal Flakes of the Birch Creek Site Late Archaic Component.

	Raw Material		
Cortex	**Obsidian**	**Chert**	**Basalt**
Absent	243 *(96.4)*	1401 *(92.5)*	0
Present	9 *(3.6)*	114 *(7.5)*	1
Total	252 *(100)*	1515 *(100)*	1

Relative frequencies calculated within raw material and presented in italicized parentheses.

Table 7-7. Mean Weight Estimates of Birch Creek Site Late Archaic Debitage.

	Mean Weight Estimates in Grams		
Debitage Type	**Obsidian**	**Chert**	**Basalt**
Proximal Flakes	0.18 *(0.52)*	1.12 *(3.45)*	0.05
Flake Shatter	0.11 *(0.14)*	0.35 *(0.52)*	---
Angular Shatter	0.07 *(0.02)*	0.75 *(1.18)*	---

Standard deviations listed in italicized parentheses.

Analysis

The Middle Archaic assemblages were analyzed to detect variations in the assemblage derived from residence patterns (Centola 2004). The differences in habitation types used at different times in the past at the site were not found to reflect differences in the organization of chipped stone technology between the Pithouse occupation component and the pre-Pithouse, Mazama eruption age component. The Late Archaic component already appears to reflect continuity in residence pattern based on the ground stone assemblage, presented in Chapter Six. Assumptions based on the hypothesis that change occurred in the adaptive strategy during the Late Archaic need to be tested as well. The shift in projectile technology from the throwing board and dart to bow-and-arrow is a major indicator of a potential reorganization in the lithic technology. Assemblage formality, tool use intensity, and size (of tools and debitage), should vary by component if subsistence-based acquisition and processing technology changed between the Middle Archaic and Late Archaic periods. The Late Archaic technology could rely on smaller raw material packages for the projectile points, and the use of smaller cores and production of smaller debitage overall is expected if the technological shift did precipitated an overall change in the organization of tool production.

Assemblage Formality

The tool and core form favored by a group of people may be shaped by several factors, including availability of raw materials, intended use of the tool, and use-life of the tool (Andrefsky 1994a, 1994b; Beck 2003; Christenson 1997; Nelson 1997; Shott and Sillitoe 2005). It has been argued that formal core tools such as bifaces are portable and multifunctional, making them better suited to use by more mobile people (Parry and Kelly 1987). Formal tools are contrasted with informal flake tools and multidirectional cores which have a limited production cost, and supply sharp working edges, but are more costly to transport. While bifaces may be better suited to cutting transportation costs of portable tools, use of informal tools is common among peoples practicing various levels of mobility. It has been demonstrated that tool production effort and tool form are also influenced by the abundance, size, shape, and quality of raw material (Andrefsky 1994a, 1994b). Alternatively, formal tools could be a derivative of activity intensity (Tomka 2001). Formal tools may be more durable in extended use activates than informal flake tools.

Developing expectations of the Late Archaic assemblage can be accomplished through review of other well studied assemblages in the region. The Late Archaic assemblage of the Dirty Shame Rockshelter is marked by, among other things, a relatively high proportion of flake tools (Hanes 1988). If this pattern were to appear at the Birch Creek Site it would be reflected in the assemblage diversity, with differences noted along evenness values with flake tools standing out as highly abundant.

The Shannon-Wiener Diversity Index is a statistical measure originally developed to quantify biodiversity. The index uses mutually exclusive categories and the number of specimens in each category to derive a single value describing a population. Chipped stone tool assemblages can be categorically summarized and have been for the Late Archaic, Pithouse, and Mazama Components, using the same criteria for type definitions. The diversity (H') of each assemblage is based on the richness of the assemblage, or number of categories present, and evenness, or relative number of specimens in each category. Larger H' values indicate greater diversity while larger evenness values (range from 0-1.0) indicate more similar relative frequencies of specimens in each category.

The diversity indices for the three components reveal a slightly lower tool diversity for the Late Archaic Component, while the Pithouse Component is highest and Mazama Component slightly lower than the Pithouse (Table 7-8). The difference in richness between the assemblages is accounted for by the presence of a wider array of core types in the Late Archaic than in earlier time periods. Unidirectional Cores and Multidirectional (Other) Cores are present in all periods though only the Late Archaic assemblage contains Cobble Cores (n=1) and Cores with a cutting/scraping edge (n=3).

The evenness values range from a relatively low 0.65 for the Late Archaic assemblage, to 0.91 for the Pithouse assemblage (Table 7-8). Flake tools appear to account for much of the difference in evenness between the assemblages. The utilized and retouched flake tools together account for 77.2 percent (n=207) of the Late Archaic tools while the Pithouse Component tools are comprised of 48.2 (n=11) percent flake tools. The Mazama Component is intermediate in evenness and proportion of flake tools with 69.6 percent (n=11). The number of flake tools does appear to have been greater during the Late Archaic. This conclusion should be viewed cautiously, however, due to the small sample size of the Middle Archaic Components.

Table 7-8. Shannon-Wiener Diversity Index of Tool Types in Each Component.

	Component		
	Late Archaic	**Pithouse**	**Mazama**
H'	1.36	1.47	1.44
Evenness	0.65	0.91	0.80
Richness	8	5	6
Abundance	268	27	23

A few observations on the hafted tools of the Late Archaic Component are useful for understanding the role of formality in the Late Archaic assemblage. A large hafted biface with lateral retouch, three complete arrow points along with two probable arrow hafts and one small recycled dart point were recovered from the Late Archaic deposits. These represent approximately 2.6 percent of the chipped stone tool assemblage and number substantially more than the hafted bifaces sampled from earlier components. This observation is complementary to one noted regarding the Late Archaic deposits at Dirty Shame Rockshelter where projectile point numbers were higher relative to earlier components (Hanes 1988). The projectile points at Birch Creek are interesting with regards to formality, however, in that they do not appear heavily designed. All the projectile tips do fit metrically defined styles though two of the three complete arrow points retain some portion of the flake blank surfaces. One could argue that the two points with flake blank surfaces are more like flake tools than formal hafted bifaces. The practice of minimally retouching a flake to create a hafted tool appears contrary to the notion that hafted tools would be over designed to generate reliability.

Tool Use Intensity

The intensity of tool use may be conditioned by the mobility of a group and/or the availability of raw materials. This assumption is based on the idea that mobile groups will not only use a limited toolkit but they will use it to complete multiple tasks (Shott 1986), and chipped stone tool makers will maintain tools longer as they become further from raw material sources (Andrefsky 2008). These conditions may manifest themselves archaeologically through behaviors which reflected conservation of raw materials. The conceptual framework that has provided tools for assessing these behaviors is commonly referred to as curation, which relates to the amount of potential use extracted from a tool (Shott 1996). Indices for measuring curation through tool retouch have been developed for several tool types, including bifaces, scrapers, and informal flake tools (Andrefsky 2006; Clarkson 2002; Kuhn 1990). Unfortunately utilizing indices of retouch among the different components would require new work with the Middle

Archaic assemblages and is outside the scope of this project. There are existing data that allow assessing relative tool use intensity between the Late Archaic assemblage and earlier components.

Individual flake tool specimens are sometimes found to have multiple areas of retouch or wear damage along their margins, and often these edges have different shape characteristics indicating they were used in more than one type of task (Keeley 1980). Research has been conducted into identifying the potential uses of stone tools through types of damage and residues left on the tools (Hayden 1979; Keeley 1980). These types of analysis are costly and do not directly address the organization of the chipped stone assemblage so much as specific site activity. The number of modified edges on flake tools, however, does say something about the organization of the lithic toolkit.

The Late Archaic flake tools were examined for several attributes, including the number of modified edges. Centola (2004) performed a similar examination of the Middle Archaic flake tools. Minor differences between the tool examinations fall along the structure of the determinations set by the two projects. Centola (2004) divided the flake tool surface into arbitrary quadrants and counted the number of quadrants with modified edges, with a maximum possible of four. The Late Archaic flake tools were not viewed with the same arbitrary framework, but rather, with a recognition of the unique modification area. This means that flake tools were inspected and edges modified through use or retouch were identified and breaks between those areas were used to define numbers of used edges (if more than one was present). A break is defined as an abrupt change in the character of the modified edge. These changes include a transition from a modified edge, recognized by patterned flaking, to an unmodified edge which has a uniform and unscarred margin (Figure 7-6). Changes in edge shape produced by flaking also constitute a break, and include points or “kinks” in the margin that divide two modified areas. The open-ended counting of modified edges found a maximum of five use areas, though specimens with five used edges were uncommon and account for only 1.5 percent of Late Archaic flake tools.

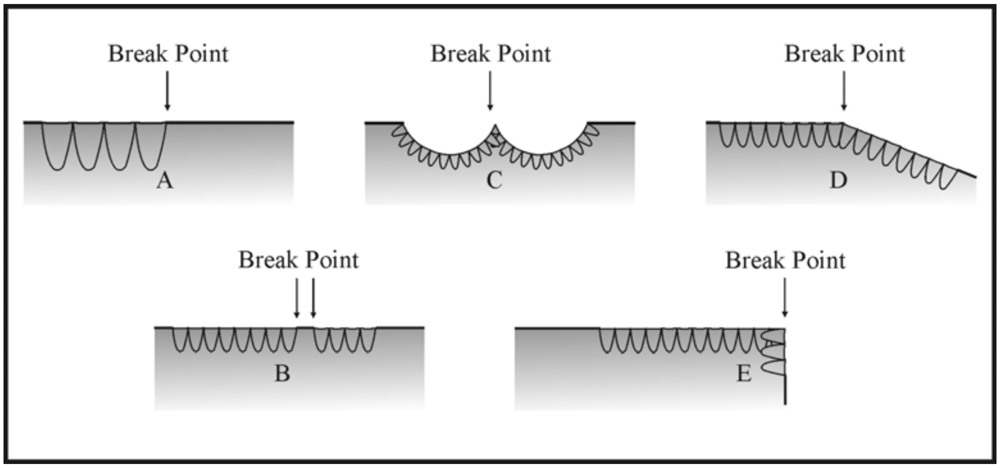

Figure 7-6. Schematic examples of typical “breaks” in use along flake tool edges. A and B- discontinuation, C, D, and E- adjoining abrupt change in margin.

The high relative abundance of flake tools during the Late Archaic at the Birch Creek Site could lead one to expect that flake tools were produced for single tasks and discarded after a short use life. In fact 44.8 percent of the overall Late Archaic flake tools assemblage shows evidence of multi-use. The proportion of multi-use tools is highest among tools made from non-local raw materials (Table 7-8). Half of the non-local Late Archaic flake tools are multi-use, which is somewhat lower than the proportion found among Mazama Component non-local flake tools, but contrasts with the Pithouse Component which contained only one non-local flake tool which did not show signs of multi-use.

The multi-use flake tools made on local raw material are similar in proportion for the Late Archaic and Mazama Components, at roughly 45 percent (Table 7-9). The Pithouse

Component is substantially lower with 16.7 percent of flake tools showing multiple uses. The abundance of local high quality raw materials would have been a constant condition for all three occupations. One possible explanation for the differences in local raw material use could actually be explained by site structure (Centola 2004). The Pithouse Component artifacts are derived from an interior residential context, unlike the Late Archaic deposits which appear to be discard lenses along the margin of the occupation (see Chapter Four). Archaeological materials may represent varying states of use depending on how they were deposited (Schiffer 1972, 1987). The Pithouse Component tools may actually reflect tools that entered an archaeological context before their users were ready to discard them, while the Late Archaic materials are more likely to represent tools that were intentionally discarded and replaced. Unfortunately the very small sample size of these tools from the Pithouse Component largely limits the explanation of the distribution and use of non-local flake tool to speculation.

Table 7-9. Multi-Use Tools Relative to Total Flake Tools of Local and Non-Local Raw Material by Component.

	Component		
Raw Material	Late Archaic	Pithouse	Mazama
Local	85:192 *(44.3%)*	2:12 *(16.7%)*	5:11 *(45.5%)*
Non-local	5:10 *(50.0%)*	0	4:5 *(80.0%)*

The proportion of retouched flake tools in the assemblage also indicates an effort to extend the use life of the tools. Used edges become damaged through contact with worked materials and sharp edges become dull and ineffective over time. Retouch of tools could also be seen as an effort to conserve resources. In this regard, one should expect retouch to be infrequent on local tools at the site during any of the occupation periods, though high quality non-local raw materials should frequently retouched.

The presence of retouch on flake tools a the Birch Creek Site does not fit the expectation that local raw materials should be maintained less frequently that non-local raw materials (Table 7-10). The same observation was made by Centola (2004:71) for the Middle Archaic components. There may be a functional explanation in the occurrence of retouch. Some describe chert as tougher than obsidian (Whittaker 1994) which simply means it is more difficult to flake or break. The local material is exclusively chert and the retouch of flake tools made of chert may be a product of a necessity for durable tools. In other words, obsidian may be retouched as a means of conserving material, while retouching chert flakes may be an attempt to generate tools with specific properties. The size of debitage at the site may reflect these differences and is addressed in the following section.

Table 7-10. Retouched Flake Tools Relative to All Flake Tools of Local and Non-Local Raw Material by Component..

	Component		
Raw Material	Late Archaic	Pithouse	Mazama
Local	75:192 *(39.1%)*	1:12 *(8.3%)*	4:11 *(23.5%)*
Non-local	3:10 *(30.0%)*	1:1 *(100.0%)*	1:5 *(20.0%)*

Size

Size may be measured in a variety of ways and different measures may be more or less important depending on the type of object involved. The measures of size should relate to the properties of the artifact that may vary in relation to a specific question. In the case of flake tools, size may vary along several dimensions including weight, maximum length, and width-to-thickness ratios, due to specific requirements of the task they were used for or potential use life. Cores and debitage may be highly variable in shape and reduction strategies affect attributes such as weight and maximum linear dimension (MLD). The examination of Middle Archaic occupations at the Birch Creek Site found broad similarities in the Pithouse and Mazama assemblages, which was partially attributed to the local abundance of high quality chert (Centola

2004). If the locally available chert is a strong influence on chipped stone toolkit formation, as theoretical and archaeological research suggests (Andrefsky 1994a, 1994b; Bamforth 1986; Centola 2004), then similar size ranges of objects made of local raw materials should be found, while differences may be present in the non-local raw materials.

The flake tools can be compared along several measures of size, including dimensional ratios which offer an indication of tool shape. The flake tools from all three assemblages have been individually weighed and measured for length (MLD), width (maximum linear dimension perpendicular to length), and thickness (maximum linear dimension perpendicular to length and width). The size estimates of retouched and non-retouched flake tools for the samples collected from each component are listed in Table 7-11. Unpaired t-tests rather than ANOVA were conducted for the purposes of component comparison because the difference between the Late Archaic component and either of the earlier components was the major concern. Unfortunately, despite the fact that the Middle Archaic components have been studied and found to have limited differences those data sets cannot be easily combined because the information presented by Centola (2004) is limited to sample means, standard deviations, and sample sizes. It is beyond the scope of this study to incorporate large amounts of raw measurements from other studies.

The retouched flake tools are not represented by many specimens in either of the Middle Archaic components and the presence of only a single specimen in the Pithouse assemblage limits statistical comparison. Comparison with the Mazama Component retouched tools finds that the Late Archaic tools are significantly lighter and shorter than Mazama Component specimens but do not significantly vary in width to thickness ratio. Conversely the nonretouched flake tools from both the Pithouse and Mazama assemblages are not significantly different in weight or length, but are wider relative to thickness than Late Archaic specimens. Overall it appears that flake tools used during the Late Archaic were smaller and less robust than those used during earlier periods.

Table 7-11. Size Estimates of Flake Tool Types and Significance Results of Differences Between the Late Archaic Component and the Middle Archaic Components.

Flake Tool Type			
Retouched		**Component**	
	Late Archaic	Pithouse	Mazama
n	76	1	5
Mean Weight (g)	14.0	5.4	54.1
SD	21.8	---	42.7
		NA	*t=3.7256 df=79 p=0.0004*
Mean MLD (mm)	41.2	40.0	74.3
SD	15.2	---	21.2
		NA	*t=4.6077 df=79 p=<0.0001*
Mean W:T (mm)	3.1	2.5	3.5
SD	1.5	---	1.0
		NA	*t=0.5859 df=79 p=0.5596*
Nonretouched		**Component**	
	Late Archaic	Pithouse	Mazama
n	129	9	11
Mean Weight (g)	7.7	4.0	14.9
SD	13.3	3.4	37.8
		t=0.8301 df=136 p=0.4080	t=1.4012 df=138 p=0.1634
Mean MLD (mm)	38.1	34.1	42.9
SD	13.6	11.8	23.0
		t=0.8594 df=136 p=0.3917	*t=1.0548 df=138 p=0.2934*
Mean W:T (mm)	4.3	6.4	6.2
SD	1.9	2.6	7.4
		t=3.1266 df=136 p=0.0022	t=2.2363 df=138 p=0.0269

Unpaired t-test results of comparisons with Late Archaic debitage listed below the statistics for each Middle Archaic component.

The cores represented at the Birch Creek Site vary by component with the greatest variety occurring in the Late Archaic. Two core types, the multidirectional and unidirectional appear in all three assemblages and can be compared. The multidirectional and unidirectional cores of all three components are made from chert. The Pithouse Component contains cores of both local and non-local chert, though they are not segregated for the purposes of the present analysis.

The cores are expected to directly reflect size differences based on the demands of different technological strategies within each component. The cores would have supplied maximum flake blank sizes for use as flake tools and formal tools. As stated above, the stone tips for arrows are generally smaller than those used for darts. If the overall tool size demands during the Late Archaic were smaller then cores could have been reduced to smaller specimens during the later period.

The determination of size of cores is derived from two attributes of the core assemblages, weight and maximum linear dimension. The weight serves as a proxy for volume as all specimen densities are expected to be roughly the same given that they are all relatively high quality chert. Maximum linear dimension gives an additional measure of size which may vary in different ways than mass could indicate, due to the potential variability in raw material package shape. The size estimates (mean and standard deviation) of multidirectional and unidirectional cores from the Late Archaic, Pithouse, and Mazama components, along with results of Unpaired t-test comparisons between the Late Archaic and each of the Middle Archaic components is provided in Table 7-12.

The results of the comparisons between the Late Archaic and Middle Archaic cores only partially meet expectations. The multidirectional cores are represented by 32 specimens from the Late Archaic assemblage, but are limited to three in the Pithouse and one in the Mazama. The numbers for unidirectional cores are slightly more even, but generally low. The Late Archaic cores (both types) are significantly shorter along their maximum linear dimension, but surprisingly no significant differences in weight were found at the $p<.05$ level.

Table 7-12. Size Estimates of Core Types and Significance Results of Differences Between the Late Archaic Component and the Middle Archaic Components.

Multidirectional	Component		
	Late Archaic	Pithouse	Mazama
n	32	3	1
Mean Weight (g)	94.0	168.9	104.2
SD	196.8	82.6	---
		t=0.6389 df=33 p=0.5273	*NA*
Mean MLD (mm)	57.5	94.4	80.2
SD	23.3	12.4	---
		t=2.6817 df=33 p=0.0113	*NA*

Unidirectional	Component		
	Late Archaic	Pithouse	Mazama
n	6	4	2
Mean Weight (g)	99.6	213.5	90.8
SD	45.6	118.6	81.4
		t=2.1762 df=8 p=0.0612	*t=0.2023 df=6 p=0.8463*
Mean MLD (mm)	66.8	96.0	84.1
SD	12.8	26.7	27.2
		t=2.3526 df=8 p=0.0465	*t=1.3144 df=6 p=0.2367*

Unpaired t-test results of comparisons with Late Archaic debitage listed below the statistics for each Middle Archaic component.

Another area that should reflect differences in the treatment of local and non-local materials is the debitage. Research has suggested that mean debitage size, which is maximally bounded by the dimensions of the objective piece (Andrefsky 2005:98), becomes progressively smaller with distance from the raw material source (Newman 1994). There are several measures of debitage size but among the most replicable and reliable is individual flake weight. Additionally, flake weight is an accurate measure of size because it co-varies with the linear dimensions of the flake (Odell 2003:126).

The examination of differences in debitage size by raw material begins with the Late Archaic materials alone. The weight estimates of proximal flakes, flake shatter, and angular shatter of chert and obsidian were calculated and are shown in Table 7-13. Comparisons of the various debitage types using Unpaired t-tests finds that chert proximal flakes and flake shatter are significantly larger than those of obsidian. This observation is not surprising given the expectations for differences in size between local and nonlocal raw materials.

Table 7-13. Weight Estimates and Significance Results of Differences Between Debitage Raw Material Types Within the Late Archaic Component.

Debitage Type		Chert	Obsidian
Proximal Flakes	n	1515	252
	Mean	1.12	0.18
	SD	3.45	0.52
	t=4.3161 df=1765 p=<0.0001		
Flake Shatter	n	2187	393
	Mean	0.35	0.11
	SD	0.52	0.14
	t=9.0893 df=2578 p=<0.0001		
Angular Shatter	n	780	3
	Mean	0.75	0.07
	SD	1.18	0.02
	t=0.9975 df=781 p=0.3188		

Unpaired t-test results of comparisons listed below the statistics for each flake type component.

The comparisons of debitage by component utilized the data for obsidian and local chert from the Middle Archaic assemblages studied by Centola (2004). The nonlocal chert is not included because it may significantly affect the distributions of flake attributes depending on how it is combined (i.e., with non-local raw material or with chert). Only local chert and obsidian are compared because they represent comparable groups for all three assemblages. The weight estimates of proximal flakes, flake shatter, and angular shatter of both local chert and obsidian from the Late Archaic, Pithouse, and Mazama assemblages are listed in Table 7-14.

The differences in debitage size between the Late Archaic and Middle Archaic components do not reflect a general reduction in mean debitage size. Among chert debitage the Mazama Component, proximal flakes and angular shatter are not significantly different than Late

Archaic specimens, however, flake shatter is larger (Table 7-15). Comparisons with the Pithouse Component find that Late Archaic proximal flakes and flake shatter are larger, though there is no difference in size between samples of angular shatter (Table 7-15). Obsidian sizes are contrary to expectations with the only significant size difference falling among flake shatter specimens which are smaller for both Middle Archaic components than the Late Archaic (Table 7-16).

Table 7-14. Weight Estimates for Debitage Within Each of the Birch Creek Site Components.

Debitage Type		**n**	**Weight (g)**
Proximal Flakes			
Late Archaic	Chert	1515	1.12 *(3.45)*
	Obsidian	252	0.18 *(0.52)*
Pithouse	Chert	676	0.3 *(0.9)*
	Obsidian	58	0.2 *(0.6)*
Mazama	Chert	202	1.4 *(5.0)*
	Obsidian	50	0.1 *(0.2)*
Flake Shatter			
Late Archaic	Chert	2187	0.35 *(0.52)*
	Obsidian	393	0.11 *(0.14)*
Pithouse	Chert	1401	0.2 *(1.0)*
	Obsidian	86	0.05 *(0.09)*
Mazama	Chert	277	0.5 *(1.7)*
	Obsidian	54	0.7 *(2.9)*
Angular Shatter			
Late Archaic	Chert	780	0.75 *(1.18)*
	Obsidian	3	0.07 *(0.02)*
Pithouse	Chert	1142	0.1 *(0.7)*
	Obsidian	6	0.1 *(0.08)*
Mazama	Chert	159	0.5 *(1.0)*
	Obsidian	0	---

Standard deviations listed in italicized parentheses.

Table 7-15. Weight Estimates and Significance Results of Differences Between Chert Debitage by Component.

Debitage Type	n	Weight (g)
Proximal Flakes		
Late Archaic	1515	1.12 *(3.45)*
Pithouse	676	0.3 *(0.9)*
	t=6.0873 df=2189 p=<0.0001	
Mazama	202	1.4 *(5.0)*
	t=1.0198 df=1715 p=0.3080	
Flake Shatter		
Late Archaic	2187	0.35 *(0.52)*
Pithouse	1401	0.2 *(1.0)*
	t=5.8826 df=3586 p=<0.0001	
Mazama	277	0.5 *(1.7)*
	t=3.1316 df=2462 p=0.0018	
Angular Shatter		
Late Archaic	780	0.75 *(1.18)*
Pithouse	1142	0.1 *(0.7)*
	t=1.4246 df=1920 p=0.1544	
Mazama	159	0.5 *(1.0)*
	t=2.4948 df=937 p=0.0128	

Unpaired t-test results of comparisons with Late Archaic debitage listed below the statistics for each Middle Archaic component.

Table 7-16. Weight Estimates and Significance Results of Differences Between Obsidian Debitage by Component.

Debitage Type	n	Weight (g)
Proximal Flakes		
Late Archaic	252	0.18 *(0.52)*
Pithouse	58	0.2 *(0.6)*
	t=0.2564 df=308 p=0.7979	
Mazama	50	0.1 *(0.2)*
	t=1.0711 df=300 p=0.2850	
Flake Shatter		
Late Archaic	393	0.11 *(0.14)*
Pithouse	86	0.05 *(0.09)*
	t=3.8044 df=477 p=0.0002	
Mazama	54	0.7 *(2.9)*
	t=4.0274 df=445 p=<0.0001	
Angular Shatter		
Late Archaic	3	0.07 *(0.02)*
Pithouse	6	0.1 *(0.08)*
	t=0.6198 df=7 p=0.5550	
Mazama	0	---

Unpaired t-test results of comparisons with Late Archaic debitage listed below the statistics for each Middle Archaic component.

The debitage from the Late Archaic assemblage is not overwhelmingly different than that from the Middle Archaic components. Some of the significant differences are contrary to expectations that the Late Archaic should reflect reduction of smaller objective pieces. Middle Archaic obsidian flake shatter is smaller than Late Archaic which may be a product of the technology used during the times. Research has found the Middle Archaic people maintained or finished the production of obsidian bifaces at the Birch Creek Site (Noll and Andrefsky 2007; Wallace 2004). Obsidian bifaces are not as large a proportion of the Late Archaic assemblage though there are a number of obsidian flake tools (Andrefsky and Noll 2008). These differing reduction trajectories may have influenced the size ranges of the debitage in the assemblages. The general small relative size of the Pithouse component debitage may also be influenced by the location of the assemblage on a structure floor. Cleaning and/or the lack of major tool maintenance or production activity within the pithouse structure may have resulted in a limited and small assemblage. Because of the location of the sample, the results of actual production, maintenance, and use of chipped stone tools may not be accurately reflected by the Pithouse assemblage.

Summary

The organization of the Birch Creek Site lithic assemblages does not appear static over an extended period of time, nor does it reflect drastic differences in the approach of tool makers and users. Differences are rare and small, though they are meaningful with regard to how people interacted with the Owyhee Uplands geography over time.

From the perspective of tool production, patterned differences are difficult to identify between the Late Archaic and earlier occupations. During the Late Archaic, flake tools appear to have been smaller and less robust than those made during earlier periods. Small arrow points are present during the Late Archaic period as well, potentially indicating a general reduction in the working size of the chipped stone industry later in time. The debitage does not support this suggestion however, with chert debitage more-or-less the same size at 6700 BP as it was at 1100 BP. Obsidian debitage is contradictory to the size assumption as well, with larger flake shatter specimens dating to the Late Archaic than the Middle Archaic components.

The shift to the bow-and-arrow occurred between the end of the Pithouse occupation and the beginning to the Late Archaic occupation. Some have argued that the adoption of the bow-and-arrow was a slow transition and darts were gradually phased out during the Late Archaic which masked the reduction in size of components of lithic toolkits (Yohe 1998). At Birch Creek little evidence of the persistence of the dart exists in the Late Archaic beyond the presence of a single, apparently recycled, Northern Side-Notched point. If anything the significant shift in lithic production was away from well formed hafted bifaces all together.

The bifaces from the Late Archaic contain more hafted specimens than either of the Middle Archaic components. Two of the three projectile points from the Late Archaic do not have flake scars shaping one or both faces. An argument could be made that these are more like hafted flake tools than formal tools. In fact the flake tools are so dominant during the Late Archaic they skew the diversity index to reflect less diversity during the later period despite having a greater tool richness than either Middle Archaic component.

The dominance of chert in the assemblage is an important factor in shaping the Late Archaic assemblage. Chert is locally abundant at the Birch Creek Site and it plays a major role in supplying every chipped stone tool class with raw material. Obsidian accounts for 12 percent of the overall assemblage, making it slightly higher than the Pithouse (11 percent) but substantially lower than the Mazama (40 percent). It is telling that obsidian is not the dominant raw material for any of the tool types during the Late Archaic, unlike earlier periods where is contributed substantially to the biface assemblages (Wallace 2004).

The structure of the Late Archaic chipped stone toolkit appears to be focused on exploitation of chert, as evidenced by the majority of all tools and debitage made of chert. The chert was locally abundant, durable, and high quality, making it suitable for a variety of tool forms and tasks. What little obsidian that was used may have been incorporated into the toolkit circumstantially. There is evidence to suggest that some artifact recycling was taking place during the Late Archaic, which certainly could have included much of the obsidian. It is possible that human movements around the site were not structured in such a way that permitted regular acquisition of new obsidian, though the chert would have supplied adequate flakes for tool production.

The expectation that Late Archaic lithic technological organization could have been based on a reduction in tool and core sizes is not supported by the Late Archaic data from the Birch Creek Site. The raw material available at the site may have been a significant factor in the lack of segregation between the Late Archaic and earlier occupations. While tools do appear smaller by some measures, the raw material available was apparently not a limiting factor in tool production. If the reduction in tool sizes from the Middle Archaic to the Late Archaic observed in these data is an accurate reflection of tool production efforts then what factors were responsible? Potentially, the tools could be a reflection of a raw material utilization strategy designed to take advantage of very small packages, or the "worst case scenario" for people moving widely, frequently, and predictably scheduled, through raw material poor areas.

CHAPTER EIGHT

OBSIDIAN SOURCE ANALYSIS

The raw materials available to and used by prehistoric people hold qualitative value that was known to prehistoric tool makers and inferred by archaeologists. Archaeologists identify high quality raw materials based on a few key attributes, including a small to microscopic grain size, smooth texture, and homogeneous composition free of fracture plains or faults (Andrefsky 2005:41). When these attributes occur in a relatively hard rock like those comprised of quartz (i.e., chert and obsidian) such a stone can be predictably fractured to produce a sharp and durable edge. In some cases sources of raw material are located at a considerable distance from a site, and prehistoric use of those sources carried a cost which can imply value (or need).

Chert is locally available and abundant throughout the bed gravels of the Owyhee River and its tributaries. Most chipped stone tools were made from the various cherts available in the Owyhee Canyon, but some were manufactured from obsidian. The quality of raw material affects the potential sharpness and durability of stone tools, and availability of those materials has implications for the kinds of tools people choose to produce in order to complete various tasks (Andrefsky 1994a, 1994b). How and when those sources were used can inform archaeologists about prehistoric mobility patterns and provisioning choices.

The Late Archaic Period may have been a time when Northern Great Basin connections to the Birch Creek Site were prominent and these people utilized obsidian for toolkit provisioning differently than earlier site inhabitants due to raw material availability. This chapter deals specifically with the information provided by the source locations of obsidian recovered at the Birch Creek Site. An introduction to relevant raw material sourcing studies is provided including both techniques used to identify sources and applications of source studies. The location and structure of obsidian sources used during the Late Archaic are analyzed. The types and proportions of various sources used in the Late Archaic at the Birch Creek Site are reviewed, and finally, the variability of raw material sources is discussed.

Raw Material Studies

Obsidian and chert are common raw materials composed primarily of quartz (silicon dioxide [SiO_2]) used in the manufacture of chipped stone tools. They are highly variable in visual attributes from source to source but can usually be distinguished from one another without difficulty as obsidian is glassy (lacking in a crystal or particle groundmass) while chert is composed of a very fine sediment grain or microcrystalline. Individual source locations of either rock type are hard to distinguish based on visual attributes. However, limited success at visual sourcing of obsidian has been reported when sources are relatively few in number and have unique internally homogeneous characteristics such as coloring, unique flow banding, or phenocrysts (Bettinger et al. 1984). Chert sources have been identified in a similar manner with varying success. The appearance of cherts on both macroscopic and microscopic scales can vary due to formation processes, weathering, and human activity (with artifact chert) to such a degree that visual attributes are frequently incapable of providing reliable source assignments (Hess 1996; Luedtke 1979). Much of the scientific source studies of lithic raw material deal with the glassy igneous material, obsidian. As the number of known unique obsidian sources has increased with time so has the need for rigorous scientific procedures which measure the elemental composition of obsidian to connect an artifact to a raw material source location. Obsidian is comprised predominantly of SiO_2 but along with it are quantities of other major and minor element compounds (Al_2O_3, NaO_2, K_2O, Fe_2O_3), and various trace elements that individually comprise a fraction to a few percent of the stone (Glascock et al. 1998). These elements vary from one location to another and obsidian erupted from the same magma chamber will also have varying composition throughout the life of a volcanic vent (Godfrey-Smith et al. 1993). The relative proportions of the included compounds make it possible to determine where artifact obsidian was acquired. Due to the number of elements that must be incorporated into a source identification the discrimination of sources requires the use of multivariate statistical analyses for accurate source assignments (Glascock et al. 1998).

The characterization of obsidian for source assignments may be handled in a number of qualitative and quantitative ways (Skinner 1983). Some researchers have been able to define obsidian sources on the basis of a simple ratio of major elements or ratios of a few trace elements (Skinner 1983:80). Not many sources may be characterized easily, and frequently the inclusion of multiple elements is required for a source characterization. A discriminant function analysis of the obsidian components can determine which elements provide a unique chemical signature of a flow within a region. Matching artifact obsidian to a source location requires measuring the significant compounds for the regional obsidian in the specimen and comparing it to known signatures. Multivariate statistical analyses such as multilinear regression must be used to calculate these complex comparisons. It should be noted that all assignments are based on strength of associations to samples of the known universe of obsidian sources (Skinner 1983). Because the known sources represent some fraction of all sources, unknown sources do appear in artifact form.

The discrimination of unique sources is a complex procedure made even more difficult by internal source variability. To an archaeologist a source is best thought of as a geographic location where obsidian was available to prehistoric tool makers. This is different than the geologic source of obsidian which can be traced back to a specific volcanic vent. Understanding the physical circumstances of discovery by tool makers makes it possible to consider the archaeological repercussions of prehistoric behavior. Obsidian may display internal source variability for two key reasons, the trace elements were not homogeneous at the time of rock formation or two or more sources have been physically brought together by post-lithification mass wasting/landform erosion events (Shackley 1998). This is an important consideration to the source lab because unknown sources may be contained within known sources and to archaeologists because the degree to which people are moving around the landscape is inferred from the locations of sources.

The Great Basin and adjacent areas contain a large number of known obsidian sources. On the northwestern margin of the Great Basin, obsidian has been used to identify a variable settlement pattern between the Middle and Late Archaic (Connolly and Jenkins 1997). Three periods of occupation were evaluated for Drews Valley in south-central Oregon, 5500-3000 BP, 3500-1000 BP, and post 1300 BP. The earlier occupation of Drews Valley indicates a settlement strategy with strong connections to the northern Great Basin having a probable focus on marsh resources (Connolly and Jenkins 1997). The disappearance of these marsh habitats in the Late Holocene resulted in a settlement shift deemphasizing the northern Great Basin and concentrating on the higher elevation areas of the southeast Oregon and northern California where food resources were more sustainable.

The Blitzen Valley in Harney County, Oregon contains two sites which have been studied using obsidian geochemical sourcing. The Lost Dune and McCoy Creek sites have components which span the past 3500 years (Lyons et al. 2001). These components are divided into an early (3500-2000 BP) occupation from Lost Dune, middle (2000-500 BP) represented at both sites, and late (post 500 BP) documented at Lost Dune. The middle period of the Blitzen Valley study covers the Late Archaic occupation period at the Birch Creek Site. During this period the Blitzen Valley sites show a pattern of relatively localized obsidian use with all sources located within 100 km of the recovery site and approximately 74 percent of sourced obsidian from within 60 km of the recovery site.

Each of these previous studies relies on aggregate source use within the periods studied. Variation in source use was analyzed between periods over centuries or millennia. The present study does not compare site components but instead analyses a single occupation span. The stratification within this component allows for an analysis of the use of obsidian during the Late Archaic at the Birch Creek Site that is different from much of the earlier work in the region. The site is in such a condition that the beginning of the Late Archaic occupation is not obscured by post-depositional processes and changes in mobility may be inferred from the use of obsidian in unique ways.

Several studies of obsidian use at the Birch Creek Site have been completed (Andrefsky 2008; Cole 2001; Wallace 2004). During the Middle Holocene the production of hafted bifaces was frequently completed using obsidian from sources near to the Owyhee River including one major source accessible via the river corridor 48 km from the site (Cole 2001) (Figure 8-1). The use of obsidian in the Owyhee Canyon and neighboring Malheur River drainage appear to have followed a consistent pattern for as much as 6600 years (Wallace 2004). This appears to reflect a stable settlement strategy with relatively close seasonal moves centered on a primary village similar to the ethnographic pattern, however Late Archaic data (younger than 2200 years) has not been included in these studies. This strategy incorporated the use of the same obsidian sources for the same tool types in stable proportions for generations.

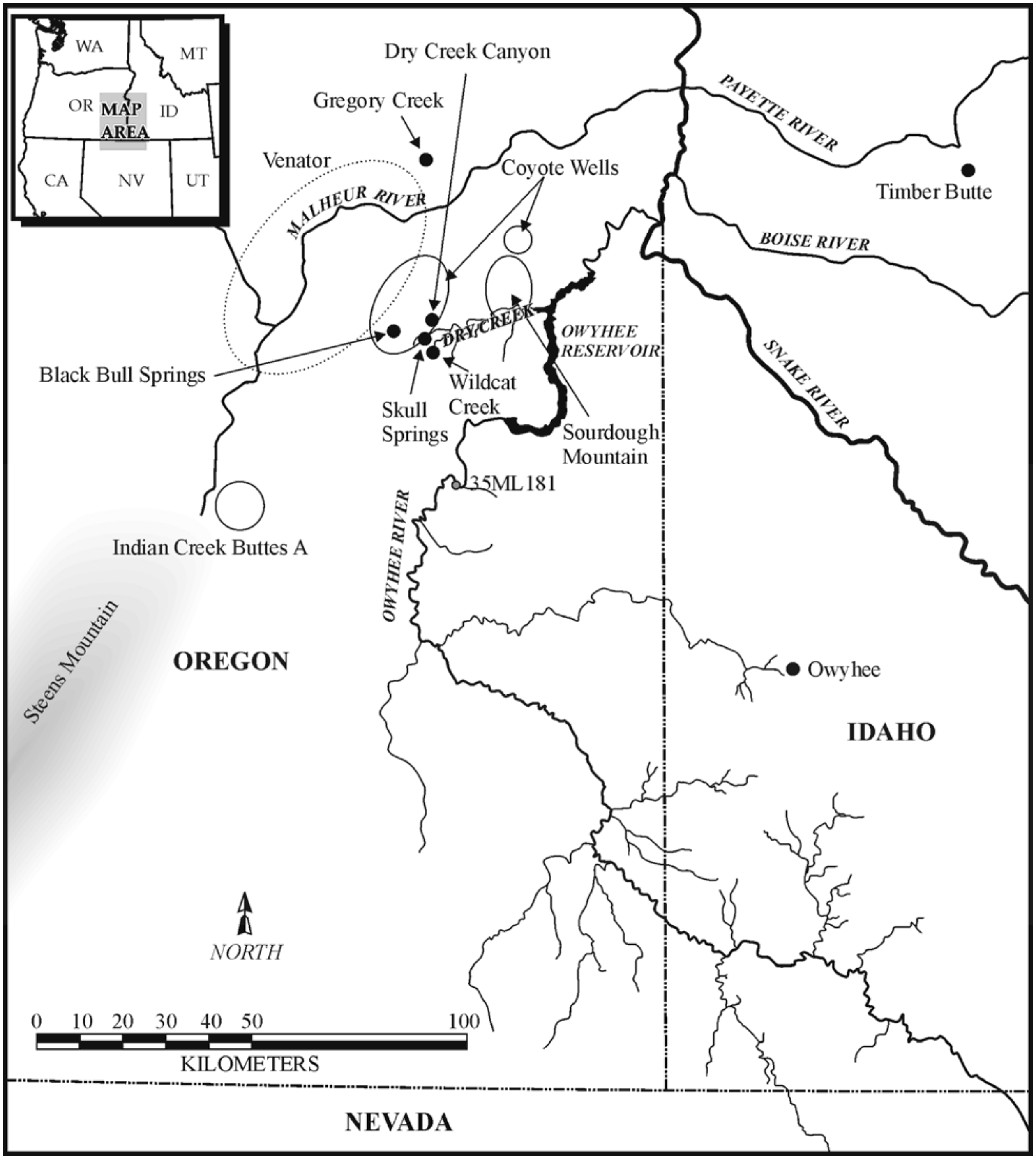

Figure 8-1. Locations of Birch Creek Site Middle Archaic obsidian sources.

Late Archaic Obsidian Geochemical Sources

In 2006, 665 obsidian artifacts were recovered from the Late Archaic component of the Birch Creek site. The majority of these artifacts are too small to meet the size requirements of the Northwest Research Obsidian Studies Laboratory x-ray fluorescence (XRF) procedure. The minimum dimensions for a sample are 10 mm in diameter and 1.5 mm in thickness (Northwest Research Obsidian Studies Laboratory 2007). Twenty-nine artifacts were selected for geochemical source characterization through XRF. The artifacts chosen for sourcing include one hafted biface, one flake drill, four unimarginal flake tools, six flakes with cortex, thirteen flakes without cortex, and four pieces of flake shatter.

The obsidian artifacts represented seven different chemical sources (Skinner 2007). Five of the sources have been previously documented and are found in the region north and west of the Birch Creek site (Figure 8-2). These sources are the Indian Creek Buttes A, Coyote Wells, Coyote Wells East, Sourdough Mountain, and Venator. In addition to these five known sources two additional unknown chemical signatures were identified. Source Unknown 1 is an apparently recycled Northern Side-Notched point and Unknown 2 is a proximal flake with cortex. Some of the known sources traced from the Birch Creek Site specimens do not have well defined boundaries or point source locations and in some cases multiple sources naturally co-occur due to secondary depositional processes.

Previous studies of Birch Creek Site obsidian have addressed source attributes based on the nature of the assemblage. Cole (2001) found that the Venator, Coyote Wells, and Coyote Wells East as a group provide the source material for larger bifaces, and cortical flakes from these sources are limited in the assemblage. The inference from these data is that those sources are comprised of relatively large nodules that are free of flaws and inclusions. The Sourdough

Mountain obsidian was observed to have cortex in more cases despite being roughly the same distance from the Birch Creek Site. It is possible that the Sourdough Mountain source is composed of smaller nodules that were transported back to the site with little or no modification (Cole 2001). Limited Indian Creek Buttes A has been recovered from earlier components but previous studies have not discussed it in detail.

The Indian Creek Buttes A (ICB-A) source stands out against the other Late Archaic Birch Creek Site sources because it is located away from the river canyon, while the others including the Coyote Wells, Coyote Wells East, Sourdough Mountain, and Venator are found in the Dry Creek drainage (Figure 8-2). The sources in the Dry Creek Drainage appear to overlap and could potentially be recovered from a mixed source deposit or at least during the same material collection foray. The prominence of this source in the assemblage is surprising given its distance from the site (minimum 50 km). The majority of the ICB-A specimens are debitage that do not hold cortex (Table 8-1). A flake drill is also made from this obsidian possibly indicating that the raw material was highly valued and much of the ICB-A stone brought to the site was utilized and perhaps formal tools were curated heavily.

The distribution of artifact morphotypes across the different sources is not very informative given the small sample size. The majority of sourced artifacts are debitage and the numbers of specimens for each type of debitage appears to be a reflection of the size of the sample from each source (Table 8-1). The tools are equally undifferentiated with flake tools dominating the assemblage and the only formal tool is a recycled projectile point from an earlier period and unknown location.

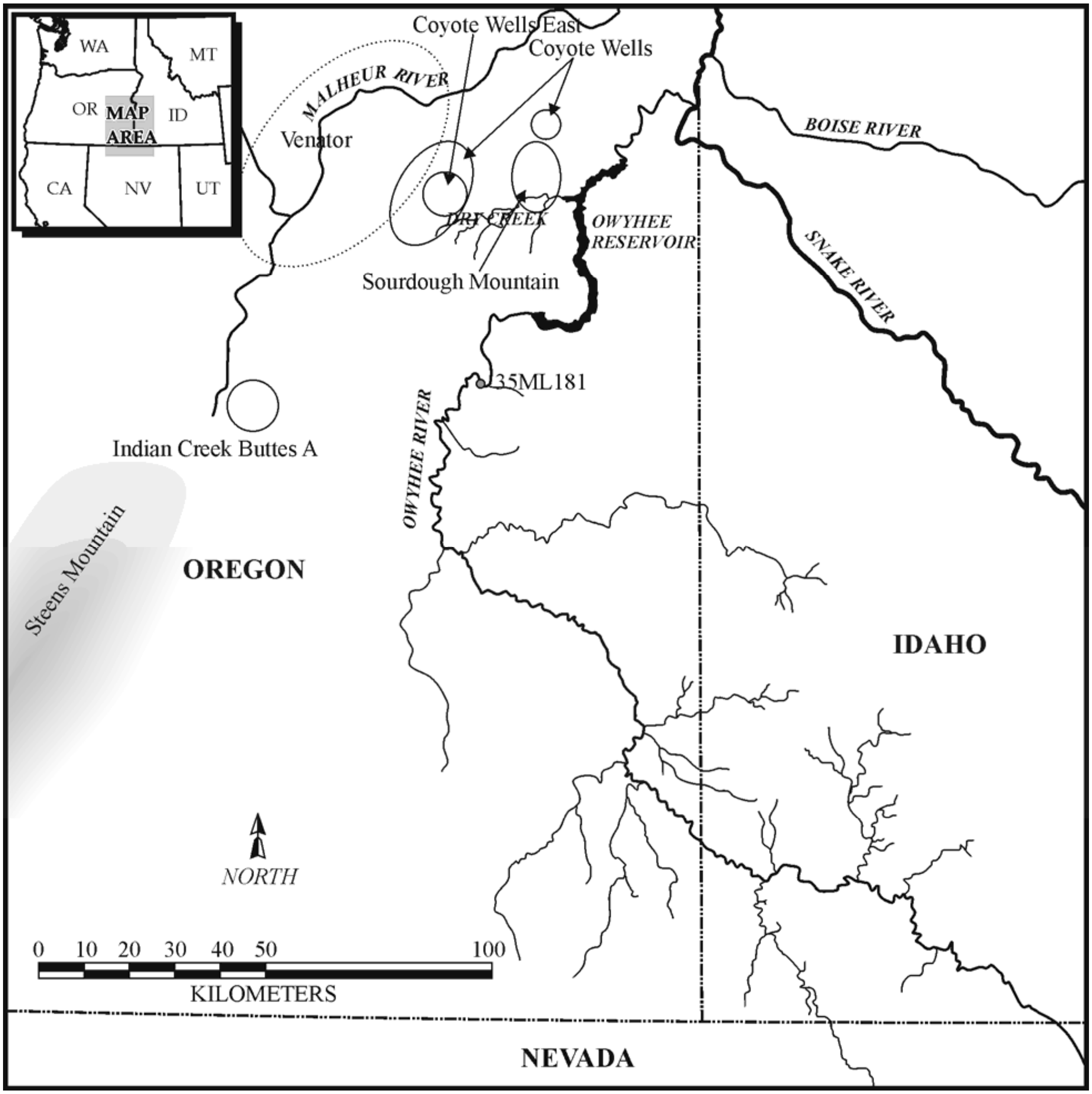

Figure 8-2. Locations of artifact obsidian sources from the Late Holocene component of the Birch Creek Site (35ML181).

Table 8-1. Obsidian Artifact Type Distributions for Each Source Area.

Source		Tools			Debitage		
		Projectile Point	**Drill**	**Flake Tool**	**Flake w/ Cortex**	**Flake w/o Cortex**	**Flake Shatter**
Indian Creek Buttes A	27.6%		1		1	6	
Coyote Wells	24.1%				2	4	1
Coyote Wells East	6.9%			1		1	
Sourdough Mountain	20.7%			1	1	2	2
Venator	13.8%			2	1		1
Unknown 1	3.4%	1					
Unknown 2	3.4%				1		

Late Archaic Resource Areas

The obsidian sources used during the Late Archaic at 35ML181 are a sub-set of all the sources that have been identified from obsidian artifacts at the site. They all lie west of the main stem of the Owyhee River and all occur at a comparable 40-50 km strait-line distance from the Birch Creek Site (Figure 8-3). The five source areas can be divided into two distinct clusters based on the direction from the site and route of access. The largest single source by percentage, source Indian Creek Buttes - A (ICB-A) is outside the Owyhee Canyon located approximately 50 km west of the site. The terrain between the site and this source is arid upland plain with shallow basins that are predominantly dry during modern times. The Coyote Wells, Coyote Wells East, Sourdough Mountain, and Venator sources (the Dry Creek Cluster) are all found within or near the Dry Creek tributary valley of the Owyhee River. These sources can all be accessed by following the Owyhee River and Dry Creek along the bottom of the canyon. The obsidian used during the Late Archaic period at the site may be analyzed based on the differences in when and how the two clusters were exploited.

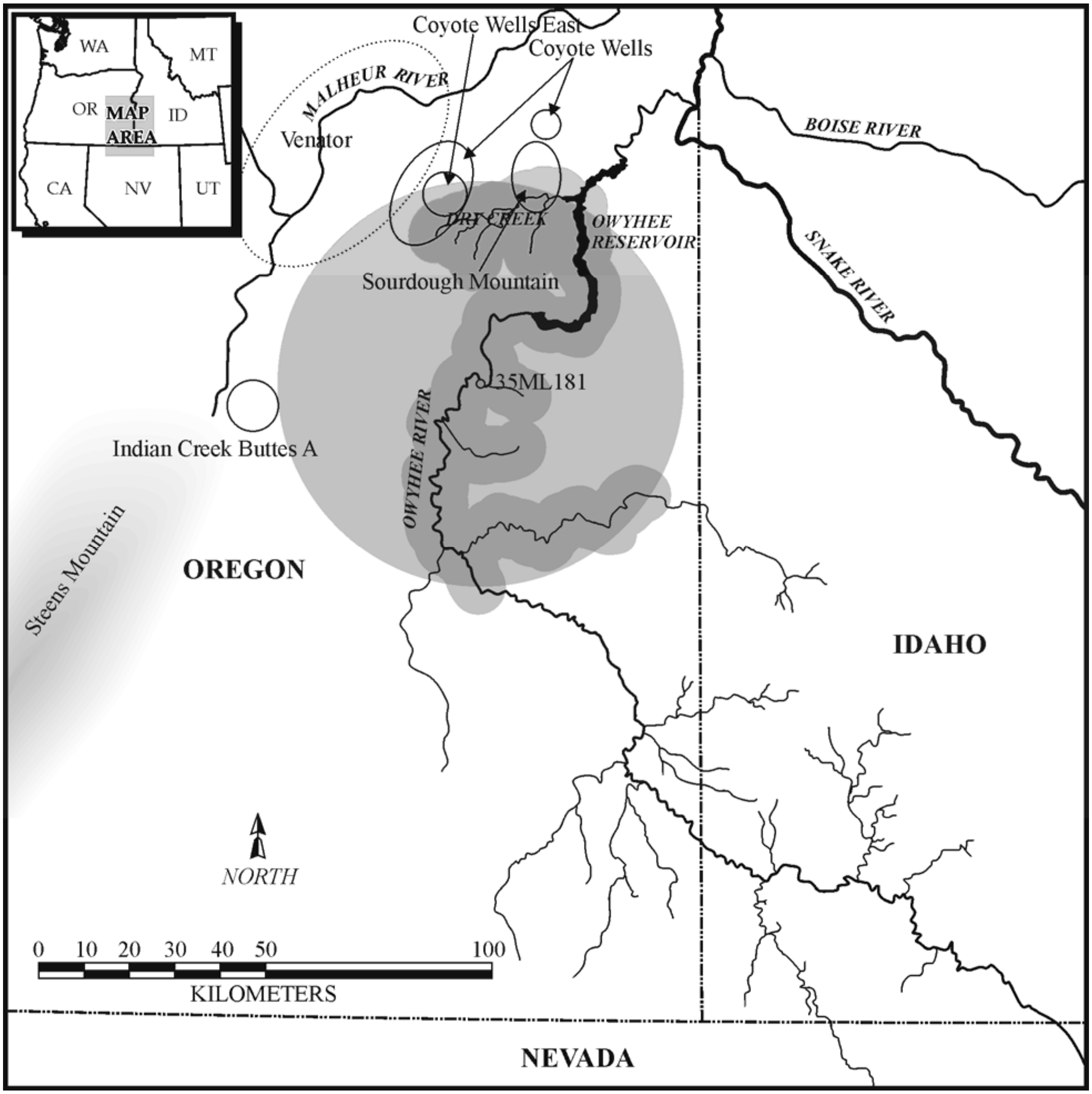

Figure 8-3. Late Archaic obsidian sources and access ranges. Minimum direct distance from site to all sources 50 km (light grey circle), river corridor buffer (dark grey) shown is 6 km.

Some simple expectations can be formulated about how the two clusters may have been utilized based on the travel patterns that would have allowed access to them. If people changed the manner in which they encountered obsidian they may have also changed the way in which they were using the material. The tools should differ in formal tool curation and relative uses of formal and informal forms. Proximal flakes can preserve signs of core type and may reflect differing reduction strategies. Also, even though a relatively continuous occupation is apparent during this time, the differing source areas may represent a change in movement around the site during the occupation. The stratigraphic units and associated dates provide a means of identifying the timing of source use within the occupation when the artifacts are matched to a stratigraphic unit.

The obsidian collected from each source area is essentially the same in physical properties (glass). If the same material type is used in different ways then one question that needs to be addressed regarding these sources is when they appear. If people were moving throughout the local area without preference for the landscape, specifically the Owyhee River canyon corridor then both source areas could have been encountered throughout the occupation. The sources are not represented in equal proportions which indicates a movement pattern that was affected by the landscape in some way which increased encounter rates at some sources. People passing Steens Mountian on their way from the Northern Great Basin could have produced and carried ICB-A cores with them when they initially moved into the Birch Creek Site. If this is the case then ICB-A artifacts should be associated with the basal strata of the occupation while the other sources would be associated with overlying strata developed during the occupation. As discussed in Chapter Four, stratum VII represents the surface sediments available for occupation at the beginning of the Late Archaic component. All other strata are culturally derived or are later fluvial sediments. The association of the two source areas with stratigraphic units was evaluated using a Fishers Exact test utilizing the counts of source specimens within each straigraphic unit (Table 8-2). The two major source areas were found to

Table 8-2. Artifacts by Source in Basal Stratum VII and All Other Strata.

		Stratigraphic Unit/Group		
		VII	Above VII	
Source	Indian Creek Buttes-A	4	4	8
	Dry Creek Cluster	2	17	19
		6	21	27

be correlated with the stratigraphy (2-Tailed p=.0441), with Stratum VII associated with Indian Creek Buttes A and the overlying strata are associated with the Dry Creek Cluster.

Additional information was collected for each of the sourced artifacts including weight, overall length, width perpendicular to length, and thickness perpendicular to length and width. The artifact types are based on the chipped-stone object types used in the inventory of the assemblage. Modifications follow the system for classification described by Andrefsky (2005) and use subtype to allow grouping of similar tool types within distinct artifact types while preserving unique information in subtype. Artifact types included in the obsidian source analysis are hafted biface, drill, flake tool, proximal flake (PF) with cortex, proximal flake (PF) w/o cortex, and flake shatter. The subtypes are unique for each artifact type and include hafted biface type names, flake or bifacial drill, unimarginal or bimarginal flake tool, proximal flake and flake shatter core source (based on dorsal flake patterns, platform faceting and platform complexity) i.e., bifacial (biface trimming) multidirectional (core reduction). Only those subtypes identified in the assemblage are discussed here. The tools consisted of a hafted biface (Northern Side-notched type), a drill (flake), proximal flakes with cortex from biface trimming, proximal flakes with cortex from core reduction, proximal flakes without cortex from biface trimming, proximal flakes without cortex from core reduction, and flake shatter that could not be assigned to a reduction strategy.

The distance to the source areas is relatively similar and should reflect comparable reductions in the size of the artifacts. Simple modeling of lithic object size reduction with increased distance from the source predicts that the size of transported tools will become smaller with distance through production (Beck et al. 2002) and/or by use (Schiffer 1983). The distance from the two source areas is roughly similar at approximately 50 km to the ICB –A source and 45 km to the Dry Creek Cluster vicinity. The results of Unpaired t-tests of the size attributes of artifacts from each source area are not statistically significant at the .05 level in the categories of weight ($t=1.431$ $df= 25$ $p=0.1648$), length ($t=1.4501$ $df=25$ $p=0.1595$), and width ($t= 1.3391$ $df=25$ $p= 0.1926$). The attribute of artifact thickness is significantly different between the two source areas ($t= 2.1367$ $df=25$ $p=0.0426$). The difference in sample thicknesses is likely due to the reduction technology reflected in the sampled artifacts. The ICB-A sample is 75 percent biface trimming flakes while only 32 percent of the Dry Creek Cluster sources reflect bifaces (Table 8-3). The remainder of the Dry Creek Cluster is in the form of flake tools (21 percent), core reduction debitage (26 percent), and flake shatter (21 percent).

Table 8-3. Summary of Reduction Strategies Indicated by Debitage Platform Attributes.

	Core Indicated			
	Bifacial	Multidirectional	Flake Shatter	
ICB-A	6 (75%)	0 (0%)	2 (25%)	8 (100%)
Dry Creek Cluster	6 (32%)	8 (42%)	5 (26%)	19 (100%)

To summarize, the size and morphology of the sourced obsidian artifacts reflects similar transport distances from the two sources areas but different reduction strategies at the Birch Creek Site. These data suggest that the Late Archaic settlers of the Birch Creek site carried bifaces made from ICB-A obsidian with them to the site but used both bifaces and multidirectional cores once they centered their movements around Birch Creek.

Summary

The way people utilized chippable stone in the past may have been influenced by multiple factors including availability of the material and the potential functionality of the material. At the Birch Creek Site there is a shift in the use of obsidian with bifacial technology in the early strata of the Late Archaic component toward multidirectional forms later in the occupation. Obsidian bifaces were common in the Middle Archaic components of the site (Wallace 2004). Biface technology does not disappear during the Late Archaic period, though chert is much more common (see Chapter Seven). Multidirectional cores and flake tools appear to dominate the sourced obsidian assemblage by the latter half of the Late Archaic.

The Late Archaic peoples that established the occupation appear to have changed the direction from which they acquired much of the obsidian during their occupation of the Birch Creek Site, from Indian Creek Buttes-A, to the obsidian that was available within the Owyhee Canyon. The obsidian assemblage is a small proportion of the chipped stone at the site and it is largely comprised of small debitage. It is possible that the shift in sources and reduction trajectories is an indication of material recycling from the earlier components of the site. A reduction strategy that maximized the obsidian available from Middle Archaic deposits at the site could result in very small debitage and the utilization of the larger flakes. Some obsidian recycling is evident with the presence of a heavily retouched obsidian Northern Side-Notched point in the assemblage and further evidence of the practice is also found on water-worn chert bifaces that were subsequently retouched.

CHAPTER NINE

FAUNAL REMAINS

The faunal remains recovered from the Late Archaic component of the Birch Creek Site comprise nearly 20 percent of the total Late Archaic assemblage. The Late Archaic faunal assemblage includes 1,186 pieces of bone and 53 shell specimens. The faunal remains provide information about the environment at the site during and after occupation, as well as indications of the diet relating to game resources.

The Birch Creek Late Archaic faunal assemblage is relatively small, both in terms of numbers of specimens and size of individual specimens. These factors limit the breadth of analysis that is possible at this time. The specimens recovered from the site are also helpful in some ways for assessing the environmental history of the site. The shell has been discussed in Chapter Four, as it relates to evidence of water discharge of the Owyhee River, and will be not be revisited here.

The evidence for diet comes largely from the mammal and fish remains recovered from the site (large bivalves were poorly preserved and only a limited sample was collected). This project is not intended to be an exhaustive analysis of the Late Archaic Birch Creek Site fauna. Instead, the analysis of subsistence remains will look at the fauna represented in an attempt to determine what kinds of animals were targeted (i.e., large or small game). Because of this approach, the differences or similarities in the ways that various animals are acquired is an important consideration for prey and diet.

Looking at the Birch Creek Site faunal assemblage from the perspective of game acquisition strategy provides important clues into how people were organizing themselves, and how they may be related to earlier and later Northern Great Basin peoples. Do the fauna suggest big game specialization or emphasis on small animals? What role do fish appear to play at the site? Is communal game hunting and fishing possible given the nature of the fauna recovered at the Birch Creek Site?

Background

The organization of hunting and fishing has long been an important aspect of Great Basin archaeological studies. The Great Basin contains a wide variety of animal species though their distribution is patchy and species representation is variable for different locations (Fowler 1986). Capture tactics varied and large mammals such as Mountain sheep (*Ovis canadensis*), were generally killed individually, while smaller game, including rabbits and hares, could be trapped with snares and deadfalls, or could be hunted with drives into nets, capturing many animals at once. Larger mammals, such as Pronghorn were also occasionally killed in large numbers by driving them into confined areas where they could be killed easily (Steward 1943).

The Northern Great Basin and Snake River contain numerous fish species, which were exploited by native groups (Fowler 1986). Resident fish include Bridgelip sucker (*Catostomus columbianus*), Largescale sucker (*C. macroheilus*), Chiselmouth (*Acrocheilus alutaceus*), Tui chub (*Gila Bicolor*), Alvord Chub (*G. alvordensis*), and Northern squawfish (*Ptychocheilus oregonensis*). Anadromous species available in the Snake River below Shoshone Falls, and some of its tributaries include Coho salmon (*Oncorhynchus kisutch*), Chinook salmon (*O. tshawytscha*), Rainbow/Steelhead trout (*Salmo gairdneri*), and Pacific Lamprey (*Lampetra tridentata*). The presence of anadromous fish in the Owyhee River basin is not widely reported but Steelhead Trout remains were recovered at Nahas Cave, along Pole Creek in the upper Owyhee River drainage (Plew 1980a, 1986).

In the Northern Great Basin, Bridgelip Sucker (*Catostomus columbianus*) remains have been recovered from Nahas Cave (Plew 1980), and marsh sites in the Fort Rock Basin contain abundant evidence of Tui Chub (*Gila bicolor*) exploitation (Greenspan 1994). These are members of the sucker and minnow family respectively. The Bridgelip Sucker reaches a maximum length of 30 cm while Tui Chub can grow to 45 cm long (Page and Burr 1991). Other common minnows in the region such as Speckled Dace (*Rhinichthys osculus*) and Redside shiner (*Richardsonius balteatus*) typically do not grow past 15 cm long. Among Northern Great Basin groups, spears and harpoons were used to capture larger fish while nets and weirs were often used to harvest smaller species including trout and minnows (Janetski 1986; Steward 1943).

An argument for the development of resource intensification in the Great Basin during the late Holocene has been made using a variety of subsistence remains and associated technology (Bettinger 1999). The bow-and-arrow, nets, and traps would have made hunting a variety of large and small mammals both possible and efficient. It is worth noting, however, that direct evidence of some technologies may be lacking from earlier periods due to a preservation bias in the archaeological record toward younger perishables (Bettinger 1999:68).

The importance of game resources in the Great Basin is not a simple matter of assessing what species are present in a site and how many specimens of each are present. A number of factors are important to the formation of a faunal assemblage, including how the animals were hunted, transported, processed, and collected archaeologically (Davis 1987; Grayson and Cannon 1999; Lyman 1994). Once accumulated at a site, bones are further altered by actions such human processing for fat, burning as fuel, trampling and bone savaging by dogs and other animals (Lyman 1994).

Great Basin ethnographic groups were known to eat individually caught small game almost immediately following capture, while small game captured in mass or large game would be processed for transport (Steward 1941). Large game was sometimes processed away from camp by cutting the meat into strips and hanging it to dry. Fish were also dried for storage.

The fauna of the Middle Archaic occupations of the Birch Creek Site were analyzed by Van Galder (2002) to determine if the range of fauna exploited changed over time. Three housepit fills were analyzed, with an expectation that the range of animal species exploited by Birch Creek Site occupants would become greater over time. Positive identifications of remains to the genus or species level were limited to 99 (0.45 percent) of the 22,046 specimens studied (Van Galder 2002:24). Large mammals identified include Mountain sheep (*Ovis canadensis*) and mule deer (*Odocoileus hemionus*), while small economic mammals species include rabbits and hares (Leporidae). General taxonomic classification identified 1,419 (6.4 percent) fish, 30 (13.6 percent) bird, and six (<0.01 percent) reptile. Additional mammal bone positively identified to mammal size class includes 3,023 (13.7 percent) specimens.

Mammal size classes refer to an arbitrary grouping of animals into classes based on live mass of the animals (Thomas 1969). The size classes are standard divisions of North American terrestrial mammals used by zooarchaeologists and have been applied to Birch Creek assemblages by Van Galder (2002). The size classes are not as precise as taxonomic classification but provide some idea of the types of animals that may be represented when reliable species identification is not possible due to fragmentation or modification of the bone specimens. Some possible Owyhee Canyon fauna could include Pronghorn (*Antilocapra americana*), mountain sheep (*Ovis canadensis*), and deer (*Odocoileus* sp.) in the class 5 category, dog (*Canis familiaris*) or coyote (*Canis latrans*) in the class 4 group, rabbits and cottotails (Syvilagus sp.) and hares and jackrabbits (*Lepus* sp.) in the class 3 group, and size classes 1 and 2 (which have been lumped together here) contain mouse (*Peromyscus* sp), squirrel (*Spermophilis* sp) and other small rodents.

The three Middle Archaic housepit fills range in age from 4480 BP (Fill 3) to 2400 BP (Fill 2) (Van Galder 2002:30). Fill 1 is undated but overlies the other fills and is therefore younger than the other fills. All of the fill samples are dominated by fish remains among identified specimens (Van Galder 2002:36). Unidentified mammal bone is abundant in all of the samples as well.

The analysis of fauna recovered from the fills found that the use of identified small mammals and fish was higher during the later fills (Fills 1 and 2) than the oldest (Fill 3) suggesting an increase in diet breadth over time, though a preservation bias could not be ruled out as the reason for the distributions of remains (Van Galder 2002). The change over time from a larger proportion of large game early in the occupation, to more small game in the later assemblage is evident in the distribution of size class NISP (Table 9-1). Table 9-1 was complied from Van Galder's (2002:34-36) study with specimens identified to genus and species combined with the appropriate size class, to show the positively identified size class NISP of each assemblage. Size classes 1 and 2 are combined to follow the data presentation format of the present study. The minimum size class specimens are not included.

Table 9-1. Fauna Size Class NISP By Fill From The Sample Of The Middle Archaic At The Birch Creek Site.

Size Class	Fill 1		Fill2		Fill 3	
	NISP	%NISP	NISP	%NISP	NISP	%NISP
1/2	17	14.1	22	22.2	4	6.1
3	60	49.6	38	38.4	24	36.4
4	7	5.8	6	6.1	3	4.5
5	37	30.5	33	33.3	35	53.0
Total	121	100	99	100	66	100

%NISP reflects the percentage contribution of the positively identified size class to the total NISP positively identified to size class of the given fill (after Van Galder 2002).

The fragmentation of mammal bone through processing activities was one potential reason for the high number of non-identifiable specimens in the Middle Archaic assemblages (Van Galder 2002). Several areas of the site, including the three housepit fills, a hearth, and a non-feature surface area, were analyzed to determine how bones were treated at the site. The study found that mammal bone recovered at the Birch Creek Site is generally highly fragmented. The hearth area contained smaller fragments than either the housepit fills or non-feature area. The distribution of varying sizes of bone fragments and different elements indicates that the hearth area was probably used for bone grease processing while the other areas are primary and secondary refuse locations.

Methods

The faunal assemblage analyzed in the present study was initially sorted by gross category, which includes mammal bone, fish bone, shell, and modified bone. These materials were bagged separately for each unit (when present). Further segregation was conducted for each object type bag by unique attribute. These attributes included separating size classes of mammal bones and defining the unique character of modified bone. Precise species identifications were not attempted because of the highly fragmented condition of nearly all the mammal specimens.

The modified bone was sorted into functional categories such as awl (pointed needle-like bone with evidence of shaping), or simply into a category called other and described, when identification was not certain. Other forms of modification, such as reduction for subsistence purposes are noted as well. Mammal remains were examined for evidence of impact fractures and bone flakes were noted when present.

Fish remains recovered from the Birch Creek Site include vertebra and mandible fragments. The vertebra centrums were measured to determine the size at death of the fish represented. Vertebra of fish have a relatively uniform centrum size along their spine and diameter of the centrum is correlated to the size of the fish (Casteel 1976).

Results and Analysis

Most of the recovered remains (98 percent) represent mammals. A mere 53 shell specimens were collected along with 20 fish bones, two bone tools and one object that appears to be an incised long bone segment from a rabbit-sized animal. The assemblage of mammal remains has been further divided by size class (Table 9-2).

Table 9-2. Summary Of Recovered Vertebrate Fauna By Class.

	Late Archaic	**Middle Archaic**
Faunal Remain Type	**NISP**	**NISP**
Other Modified Bone	1	
Awl/Needle	2	
Fish Remains	20	
Mammal Remains	1156	
Size Class 1/2	*233*	43
Size Class 3	*204*	122
Size Class 4	*5*	16
Size Class 5	*167*	105
Unidentified	*547*	
TOTAL	**1178**	

Some interesting observations about the mammal remains can be made from this simple assemblage description. The number of specimens that remain unidentifiable, even to size class is high (47 percent) due to the fragmentation of bones in the assemblage. But of the bones that are identifiable to size class and represent possible food species, there is not one clear leader. The size class 5 bones comprise 14.4 percent of the assemblage while the class 3 bones are only slightly higher at 17.5 percent.

Mammals

Much of the mammal bone consists of splintered remains less than three cm in length. Fragmentation generally appears to be a product of weathering and decay. Signs of extended exposure to weathering agents include surface flaking, penetrating cracks, and longitudinal fractures resulting in bone splintering (Lyman 1994:355). Weathering indicates an extended time of surface exposure of bone. The exact exposure period is difficult to know because local environmental variables significantly affect the rate of decay. Under some conditions bone may decompose over several months while other conditions produce decay at a much slower rate such as several years.

In addition to fragmentation indicating post-depositional weathering some specimens have evidence of green bone fracture. The fracture of fresh, or "green", bone may be indicated by a fracture surface that is smooth and spirally shaped (Lyman 1994:319) so called spiral fracture. Occasionally fresh bone that is fractured by a dynamic load application (i.e. hammering) will chip (produce a bone flake) as well as spiral fracture, and dynamic loading is known to be associated with human processing. The Late Archaic mammal assemblage contains 104 specimens with spiral fractures typical of fresh bone, and eight bone flakes.

The Late Archaic assemblage was not collected from a wide surface area. The remains presented are from a pair of trenches that sample small features and apparent refuse deposits (see Chapter Four). The above review of the condition of the mammal remains serves to qualitatively highlight some of the indications of depositional and post-depositional conditions. Much of the bone was deposited in an area that was exposed to weathering agents for a considerable time. The net effect of long term surface exposure is that the assemblage is dominated by small slivers of unidentifiable bone. This also serves as a warning that the bone recovered may be significantly biased by weathering agents against smaller, fragile bones. Because humans represented the only agents of sedimentation, the assemblage was likely exposed to scavengers for a significant length of time during the occupation as well. The effect that scavengers had on the assemblage, especially in the loss of large mammal long bone is unknown.

The mammal bone recovered and identified to size class includes 233 (38.3 percent) Size Class 1/2, 204 (33.5 percent) Size Class 3, 5 (0.8 percent) Size Class 4, and 167 (27.4 percent) Size Class 5. The small, rat and mouse size, animals are most abundant, but cannot necessarily be taken as a sign that preservation of bone is good at the site, especially considering the evidence of weathering presented above. An unknown number of these very small mammal remains could be intrusive and date to a much younger period than the human occupation. The rabbit size mammals are slightly more abundant than the larger, Mountain sheep size animals.

Comparison to the Middle Archaic

The Middle Archaic assemblage from the Birch Creek Site is used for the majority of analytical comparison. The Middle Archaic materials were collected using the same methods as the Late Archaic materials and have been exposed to similar environmental conditions, making them suitably comparable (Klein and Cruz-Uribe 1984). However, the effect of differences in time of exposure to the environment is uncontrolled.

The adoption of the bow-and-arrow and the use of other mass collecting strategies may have changed between the Middle and Late Archaic. Size classes can provide a simple way of drawing inferences regarding the subsistence strategies of different people at different times in the past. It has been argued that prey body size is a significant factor shaping when and how prey will be acquired (Ugan 2005). The return from acquiring and processing individual animals typically favors larger body size species. Technology or circumstances that enable mass collecting or hunting may make some animals, especially small bodied ones, worthy of pursuit however (Reitz and Wing 1999:262-269; Ugan 2005).

The Middle Archaic assemblages of the Birch Creek Site show a possible trend of increased small mammal and fish use through time (Van Galder 2002). If the trend away from large mammal dominance of the hunted game continues into the Late Archaic then small mammals should be more abundant during the Late Archaic than in the Middle Archaic. The size class NISP from the three fill assemblages of the Middle Archaic occupation of the Birch Creek Site were combined to provide a larger sample size from the Middle Archaic, and a simple comparison between periods. The combined Middle Archaic sample and Late Archaic sample size class NISP are presented in Table 9-3.

Table 9-3. Relative Abundance Of Size Class NISP By Site Occupation Period.

Size Class	Late Archaic		Middle Archaic	
	NISP	%NISP	NISP	%NISP
1/2	233	38.3	43	15.0
3	204	33.5	122	42.7
4	5	0.8	16	5.6
5	167	27.4	105	36.7
Total	609	100	286	100

One of the most striking aspects of the comparison of the two assemblage is how much more abundant the Class 1/2 NISP from the Late Archaic is relative to the Middle Archaic. It is possible that these very small mammals actually represent economic species for the Late Archaic, but because they lacked recognizable signs of consumption such as bone burning from cooking, they will be treated as representatives of environmental background rather than potential food remains. The Size Class 4 specimens are limited in both assemblages and probably represent dogs (*Canis familiaris*). The economic species are represented by the Size

Class 3 and Size Class 5 animals. The relative frequencies of these two groups should show an increase in Size Class 3 over time if hunting practices changed to make acquiring smaller mammals more efficient.

To assess the relative importance of Size Class 3 animals the two periods were compared with a simple index of small mammal abundance in the assemblages. An index which takes the Size Class 3 NISP and divides it by the total economic NISP provides the proportion of Size Class 3 in each period.

$$\text{Size Class 3 Proportion} = \frac{\text{Size Class 3}}{\text{Size Class 3 + Size Class 5}}$$

The calculation of this index reveals a Late Archaic Size Class 3 value of 0.55 while the Middle Archaic has a value of 0.54. It appears that there is no difference in the composition of the Late Archaic and Middle Archaic fauna at the Birch Creek Site. A Fishers' Exact test to the two assemblages confirms that the two assemblages are not significantly different (two-tailed p=0.7998).

There was a pattern of increasing use of Size Class 3 mammals identified in the three housepit fills of the Middle Archaic component of the site. Individual indices of Size Class 3 for each fill were calculated to determine if mixing the fills was masking the trend in rising Size Class 3 animal abundance over time. The earliest assemblage (Fill 3) is 0.41, followed by 0.53 for Fill 2, and 0.62 for Fill 1. The index for the Late Archaic falls within the range of indices of individual fill assemblages indicating that a trend toward increased small mammal abundance later in time is not present or masked by an aggregated Middle Archaic assemblage. Among the individual Middle Archaic assemblages only the earliest is significantly different from the Late Archaic (Fishers' Exact results Fill 1 p=0.2508, Fill 2 p=0.8966. Fill 3 p=0.0491). The very low sample sizes of the individual housepit fills may be misleading and simply reflect a preservation bias toward larger, more robust bone from earlier components. The combination of the assemblages may actually reveal a more accurate composition of Middle Archaic assemblages at the Birch Creek Site.

Fish

The fish remains from the Birch Creek Site are a small but important part of the faunal assemblage. The fish bone is comprised of 12 vertebra and eight pieces of bone likely representing cranium. The vertebra are small, measuring from approximately 2.5 to 5.5 mm across the diameter of the centra. Additional fish remains may have been present but not collected because they were smaller than the 3.175 mm screen mesh, and fell into the backdirt.

The twelve small vertebrae were compared to a type collection available through Portland State University (PSU Zooarcheology 2009). The vertebrae all and have a similar morphology to sucker (Cyprinidae) vertebrae though one identifiable cranial bone is likely a minnow (Cyprinidae) pharyngeal. The available comparative collections limit the potential of positive species identification but it is apparent that the fish remains recovered from the Late Archaic component at the Birch Creek Site represent sucker and/or minnow species, which are abundant in the Columbia/Snake River system.

The vertebrae of fish can be used for several forms of analysis, including the determination of live size of the fish (Casteel 1972). The vertebrae of numerous fish species have been studied and found to increase in size directly with weight (Casteel 1976). These changes reflect both the weight of the fish and length of the fish. To estimate the live weight of a fish from its vertebrae a comparison must be made with known dimensions of a fish of the same species. Fish length can be estimated using the length of a vertebrae from a fish when the species is known. The vertebrae centrums are relatively uniform along the length of the spine making it possible for a length at death to be estimated from a single bone.

The exact species of each Birch Creek Site vertebra is not known but the families represented (sucker [Catostomidae] and minnow [Cyprinidae]) are identified. Both sucker and minnow typically have 60 vertebrae and have a spine to total length ratio of 0.81 to 0.85. With this information it is possible to identify the approximate length of fish represented in the faunal assemblage. The vertebra indicate that suckers and minnows were captured when they reached 173-323 mm in length.

Summary

The hunting and fishing practices observed ethnographically among people of the northern Great Basin and Snake River Plain were varied and adapted to the habitat and prey unique to any given location. The archaeological sites of the northern Great Basin and Snake River Plain are equally variable in the composition of species represented at any one location and at any given time. The variability of archaeological assemblages is a product of the practices of the people who created it, the preservation of remains, and the methods of archaeological collection. The Birch Creek Site lies in a unique ecological zone and isolating the effects of human behavior on the assemblages is not a simple task.

The nearby marshes to the Birch Creek Site in the northern Great Basin are resource rich locations with abundant aquatic and terrestrial fauna (Greenspan 1994: Oetting 1999). Tui Chub (*Gila bicolor*) appears to have been particularly important to marsh adapted northern Great Basin people in the past (Butler 1996; Greenspan 1994). The variation of marsh environments on annual, decadal, and longer cycles are unique to those features. Marshes shrink and grow in response to effective moisture, and plant and animal communities react to these changes.

Generally, human adaptations to marsh settings are unique to those environments. For instance, capturing marsh fish requires different technology than capturing fish in a river.

The Birch Creek Site falls in a riverine setting within the large Columbia River drainage system with potential anadromous fish resources available at many locations several different times of the year. The Columbia River and Snake River provide the breeding habitat for the most diverse array of anadroumous fish along the northeast Pacific coast (Schalk 1977). Not all streams on the Plateau are capable of supporting anadromous fish runs, due to water temperature, water permanence, and resident predatory animals (including other fish). The conditions which limit seasonal anadromous fish runs are rare however, and many riverine sites on the Plateau contain evidence of Salmonidae (salmon and trout) in abundance (Butler and Campbell 2004). The use of these resources appears to be well established on the Plateau with a long record of resource stability. The Owyhee River lies in sharp contrast to many other areas in the drainage system with a few steelhead trout remains recovered from Nahas Cave representing the only reported anadroumous fish remains in the entire river valley (Plew 1980a, 1986). Ethnographically, people from the Owyhee Uplands would travel to locations along the Snake River to acquire salmon (Steward 1938) rather than harvest salmon along the Owyhee River.

The view of fish use with an emphasis on large bodied anadromous species may not be a fair perspective on prehistoric fishing along the Owyhee River. Small species of fish can provide a high energy return when efficient technology is employed (Limp and Reidhead 1979). However, the importance of small bodied fish, like many other types of very small remains, may be underappreciated if archaeological recovery techniques do not use appropriate recovery techniques (Limp and Reidhead 1979; Lyman 1994). Both the Birch Creek Site and Nahas Cave contain remains of small bodied resident fish. The resident fish may have been more significant to the prehistoric diet of the people of the Owyhee Valley than archaeologists currently understand.

The terrestrial fauna, as they are analyzed here, do not provide a great deal of insight into the diet of people living at the Birch Creek Site. The simple abundance indices of Size Class 3 mammals appear to be basically unchanged from the Middle Archaic to the Late Archaic. The differences that do exist may be a result of uncontrolled factors such as bone decomposition, treatment of prey, or some small but real difference in hunting strategies over time at the site.

If the components of the Late Archaic and Middle Archaic have been affected by a steady rate of decay then the inference that small game utilization did not change between periods may not be true. The Middle Archaic may have actually lost a larger proportion of less robust Size Class 3 bones due to decay. If this were the case then the relative importance of small mammals may have actually decreased in the Late Archaic.

Small mammals certainly played a role in the diet of people in both time periods, however, the relative importance of large mammals in the diet of people at the Birch Creek Site during the Late Archaic remains uncertain. Evidence exists that Pronghorn increased in abundance toward the later Holocene in some areas of the Great Basin (Byers and Broughton 2004; Hockett 2005). While a number of Late Archaic butchering sites in the Great Basin are associated with rock features suggesting drives and ‘mass kills’ of artiodactyls (Arkush 1986), there is no such apparent association, nor evidence of that behavior, at the Birch Creek Site.

The circumstance surrounding the exploitation of subsistence resources at the Birch Creek Site is largely speculative. While some areas of the Great Basin experienced increased numbers of Pronghorn, others may not have (Hockett 2005). The assumption that people would pursue the most abundant or highest return rate animal may not be valid however, and other influences on the subsistence strategy may be significant (Lupo 2007). The ethnographic people of the Owyhee Valley were known for roots not animal resources. The role of meat acquisition may have been secondary to plant acquisition during the Late Archaic. The species exploited may be a reflection of random encounters with animals while performing other scheduled tasks and have very little to do with preference or strategy.

The faunal sample from the Late Archaic provides some limited evidence of a broad spectrum faunal resource base. It appears that large and small mammals were both important to people living at the Birch Creek Site between 1300 and 1100 BP. They appear to have reduced the bones of these animals for some purpose, possibly for fat/bone grease, or bone tool production. Two bone tools and a possible bone bead fragment were recovered, though they received little attention here. The diet does not appear to have been focused on either large or small mammals. Fish were also used during the Late Archaic.

CHAPTER TEN

CERAMIC REMAINS

The presence of pottery at an archaeological site is significant, especially along the Great Basin/Columbia Plateau border. The use of pottery may be, in some ways, a sign of some degree of sedentism, or a practice of extended residency at a site. It has been demonstrated that sedentism in some form is strongly associated with pottery making (Arnold 1985). A logistically mobile life-way does allow sufficient time in any one location for pottery making provided other conditions are met. A climate that allows sufficient drying before firing and a location with appropriate clay and temper sources is necessary for ceramic technology to develop as well (Arnold 1985). The region surrounding the Birch Creek Site is physically right for pottery production with clay and mineral temper resources, and warm dry summer months. It should be no surprise then that pottery has been recovered at the Birch Creek Site.

During the Late Holocene three major ceramic traditions are recognized for the Great Basin, the Anasazi-Pueblo, Fremont, and Numic (or Pauite-Shoshoni) (Bettinger 1999). The Anasazi-Pueblo pottery occurs in the southern Great Basin well outside the Birch Creek Site area. Fremont pottery is associated with maize agriculture/horticulture and found centered on Utah and extends into northeast Nevada, southeast Idaho, southwest Wyoming, and northwest Colorado (Madsen 1986). There were a variety of vessel forms, both undecorated and decorated, which date from roughly 1500 to 700 BP. The Paiute-Shoshoni pottery appears somewhat later, possibly as early as 700 BP on the Snake River Plain, and is found throughout the Great Basin by 500 BP (Madsen 1986). Some have argued that the shift in pottery from Fremont to Paiute-

Shoshone is one marker of an ethnic replacement of earlier Fremont peoples by Numic speaking ancestors of the ethnographic occupants of the Great Basin (Bettinger 1999; Janetski 1994).

The pottery recovered at the Birch Creek Site is significant, even though there is only one piece. The purpose of this chapter is to explore the information that can be approached with a single sherd. Specifically I review the physical character of the sherd and use those attributes to explain why foragers using the Birch Creek Site might have adopted pottery.

Background

Possibly one of the earliest uses of ceramic technology in the Northern Great Basin is found at the Big M Site in the Fort Rock Basin, where ceramic materials were recovered from the floors of two structures dated to 4800 and 4500 BP (Mack 1994). These remains consisted of two pieces of a pipe bowl and a fired clay pellet. The pipe is similar to forms found in coastal Oregon and Northern California of a similar age. A strong connection between coastal people and the inhabitants of the Big M Site around 4500 years ago is probable based on morphological similarity and the presence of *Olivella* beads at the site. However, the origin of the ceramic technology present the site is unclear based on these data.

In the western Snake River Plain a number of sites containing pottery have been investigated. Ceramics generally termed “intermountain ware” have been found in upland specialized site contexts and in riverine camp contexts (Plew and Bennick 1990). These vessels all have a similar hardness of around 3 on the Mohs hardness scale and tempering agents generally reflect the locally available minerals. They are occasionally decorated and vary in form principally between either flat or round bottom types. Plew and Bennick (1990) concluded that the intermountain ware of the western Snake River Plain was a generic utilitarian ware that could not be assigned to a particular group of people.

The Fremont and Shoshoni ceramic traditions are relevant to the study area and need to be considered. In the eastern Great Basin around Great Salt Lake and onto the eastern Snake River Plain the Fremont and Shoshoni Ware distributions overlap spatially and temporally (Dean 1992). Historically these wares have been described as separate traditions but attempts to document meaningful and replicable differences between them have not been entirely successful. Dean (1992) evaluated the Fremont (Great Salt Lake Gray and others) and Shoshoni (Shoshoni Brown Ware) pottery of the Great Salt Lake region and found that both traditions were technologically similar and that ceramic variability was a function of the local site environments. The implication for these ceramics based on this study is that these are utility wares that hold no indication of ethnic affiliation or, if it does, that the Shoshoni potters are the descendants of Fremont people. A few of the intermountain wares have been defined and for the purposes of comparison are included in Table 10-1.

Table 10-1. Attributes of Pottery Wares Found Within 250 Kilometers of the Birch Creek Site.

	CERAMIC WARE			
	Shoshoni Brown Ware (Pippin 1986)	Desert Gray Ware (Butler 1986)	Great Salt Lake Gray (Butler 1986)	Siskiyou Utility Ware (Mack 1986)
Construction	X Coiled and molded	X Coiled	X Coiled	Molded
Firing Type	X Uncontrolled atmosphere	X Poorly controlled		X Uncontrolled
Temper	X Quartz/ crushed granitic rock and sand	X Obsidian and quartz	X Obsidian and quartz	Dirt
Surface Finish	X Poorly smoothed	X Smoothed to slightly polished	X Smoothed to slightly polished	Slightly smoothed
Hardness	X Walls strong to friable	X Medium strong to friable		X 3-4 Mohs scale
Thickness	X 4-8.5mm, av. 7mm	2.6-7mm, av. 5mm	3-6.5mm, av. 4.9mm	X 2-10mm

‘X’ marks attributes that could describe the Birch Creek Site specimen.

Methods

The ceramic sherd was evaluated using generally non-destructive means to determine physical attributes. This includes the construction of the vessel as well as the general raw material components of the ceramic including temper and organic inclusions. The hardness of the specimen was measured on the Mohs scale using a penny, window glass, and a nail to determine relative hardness. The sherd was measured using digital metric calipers capable of recording increments of 0.01mm. The temper and inclusions were observed using a stereo light microscope.

Results and Discussion

A single ceramic fragment was recovered during the 2006 excavations at the Birch Creek Site (BCAP catalog number 28491). The fragment was recovered from unit N732 E1053 in level 24 (elevation 998.200-998.150) in stratum VI. The stratum that contained this piece is irregular and over thirty cm thick in places. The two dates for this stratum are from units one to two meters east of this artifact and are 1215 ± 32 (AA75315) and 1268 ± 46 (AA75309).

It is a piece of pottery made by the coil wrap method with a highly smoothed though unpolished concave surface and a moderately smoothed convex surface (Figure 10-1). Coil wrapping is recognized by the presence of parallel ridges on the exterior surface which represent individual coils and the troughs between are the filled contacts between coils. A subangular mixed sand (primarily quartz) was used as a temper and organic inclusions are few and irregular. The piece measures 18.7 x 17.7 mm and varies in thickness from 3.4 to 8.8 mm. The hardness of the specimen is approximately 4 on the Mohs hardness scale which falls in the expected range of non-kiln or low-fired pottery (Rice 1987). The ceramic fragment does not have a preserved rim section but based on the curvature of the concave surface and irregular thickness it was most likely part of a bowl of some kind.

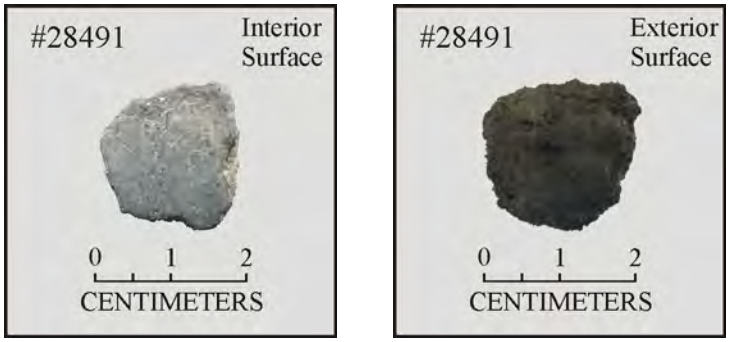

Figure 10-1. Ceramic sherd recovered from 35ML181.

The presence of a ceramic sherd is interesting but the question is, what can this one fragment contribute to knowledge and understanding of the Birch Creek Site? Assigning a single sherd to a specific ware is difficult in this region at best. While the sherd attributes suggest a Shoshoni Brown Ware classification would be appropriate, previous studies have strongly questioned the validity of ware definitions from the northern portion of the Great Basin and Snake River Plain (see Dean 1992). With this in mind I will refrain from typing this sherd and focus on what information the physical attributes can provide and interpret possible function free of a predetermined cultural framework. Some simple questions can be addressed with a single piece, including, could the vessel have been produced on site or carried in, and how could this vessel have been used? The physical properties of the sherd may provide a means of handling these questions.

Questions relating to the nature of the vessel production can be partially addressed by general knowledge and understanding of ceramic use by people. The location of production of ceramic vessels is seen as largely dependent on clay sources (Rice 1987:177). Occupations of pottery producing people located near clay sources may contain a number of indicators of production, including kilns, stored raw materials for pottery making, waste from pottery firing, and a high frequency of vessels. While these are clear indicators of ceramic manufacture when they are present the lack of formal ceramic production technology does not indicate that ceramic production never occurred. None of these indicators of ceramic production have been found at Birch Creek and the single sherd cannot even account for the depositional location of a single vessel. Intermittent, small scale or household vessel production may not leave traces of the production in the archaeological record (Rice 1987:181) though the regular use of ceramics should be visible archaeologically. Prior studies of pottery from southeast Oregon suggest that it was produced during the summer months (Lyons and Cummings 2001). Ethnographic accounts of native peoples in southern Idaho document summer root and seed collection activities in upland temporary camps (Steward 1938). This type of land-use pattern would result in the need to transport any ceramics produced at summer camps during subsequent camp moves. One possibility is that a limited quantity of ceramic vessels were produced at task camps as an embedded activity when those activities were in close proximity to ceramic raw materials. The need to carry any produced ceramics along with subsistence goods could also partially account for the relatively low density of ceramic remains found in the Northern Great Basin and Snake River Plain.

The movement of ceramics in prehistory occurred for a variety of reasons, including the distribution vessels from production areas near raw material sources to culturally affiliated peoples away from those sources (Arnold 1985:58-60). The transport of raw materials and vessels over long distances may have been a result of a physical requirement of a vessel met by a special temper or a social requirement related to stylistic elements of the vessel (Arnold 1985;

Orton et al. 1993). The fragment recovered from the Birch Creek site is undecorated and does not appear to have incorporated specialty materials. In the late prehistoric to proto-historic period of southeast Oregon some evidence of ceramic manufacture and use exists indicating that vessels were made and transported in limited quantity by individuals or small cooperative groups. Lyons and Cummings (2001) found that six pots (deposited as sherds) found in the Harney Basin from a 300 year old context were made over 100 km from where they were deposited. The sources identified indicated that the vessels were made from raw materials found along the Owyhee River and Jordan Creek (a major Owyhee River tributary). The ceramics appeared to be similar but not formally standardized, likely making them the products of personal production by people familiar to one another and not a result of trade.

The physical properties of this one sherd allow for some inferences about how this vessel was used. The thickness of the walls of a vessel has direct implications for how it may best function. A vessel intended for cooking will typically be relatively thin walled because this allows for efficient heat conduction and rapid cooking (Rice 1987) and is resistant to thermal stress fracture (Orton et al. 1993). Alternatively thick walls are stronger and inhibit moisture movement between the interior and exterior of the vessel, as well as resist breakage during pounding and mixing activities. Thick vessels are also heavy and less likely to be transported long distances. The composition of the walls imparts unique properties to the vessel as well. Porous ceramics employing mafic mineral tempers are more resistant to thermal shock than low porosity quartz tempered vessels (Orton 1993:220). Quartz tempers do increase the hardness of a ceramic, however, resulting it an increased resistance to abrasion. The sherd found at Birch Creek appears to have been intended to be physically durable though not too heavy with walls just under 1 cm in thickness and quartz temper. These attributes appear to sacrifice optimum durability or optimum cooking efficiency for a vessel that may be more flexible in varied transport and functional situations.

One explanation of the function of Shoshonean and possibly all low-fired Great Basin pottery is that it served to optimize food resources (Butler 1987). These vessels are not well suited to rapid and intense changes in temperature but could have been used around fire peripheries. Butler (1987) argues that they would have allowed for the efficient extraction of nutrients from meat and vegetable mixtures. The poor durability of the vessels would not have been a major problem because the vessels are easily repaired or replaced.

In south-central Oregon the function of Siskiyou ware has been evaluated (Mack 1990). Siskiyou ware is a low-fired ceramic and is thought of as a neighboring tradition to the pottery of the Great Basin and is concentrated in southern Oregon and northern California (Bettinger 1999). Mack (1990) looked at the form, temper, and wear of these vessels. She found that they were largely comprised of "medium" bowls that had quartz tempers and lacked sooting. The bowls are not very deep and sherds are commonly associated with house pits. Her conclusion was that these vessels were poorly suited for cooking but would have served well as eating vessels. The Siskiyou vessels may be similar in function to the sherd recovered at the Birch Creek Site which has physical characteristics making it poorly suited for cooking and lacks evidence of sooting. Unfortunately the shape of the vessel cannot be determined from the one fragment recovered thus far.

Summary

The Birch Creek Site sherd is significant in its existence. Understanding the reason for it is difficult at this time and leads to speculation more than explanation. The physical properties of the sherd align it with ceramic vessels made by ethnographic Shoshoneans of the Snake River

Plain. However, Butler (1987) and Dean (1992) have argued that these low fired pottery vessels are not indicative of ethnically distinct ceramic traditions. It may be possible to conceive of multiple locally developed ceramic technologies. The knowledge of the properties of clay as a malleable substance that can be transformed into a hard water-tight container is visible in the archaeological record of the northwest going back at least 4500 years (Mack 1994; Osborne 1957).

The requirements of the users combined with the locally available raw materials may have resulted in an *apparent* common ceramic tradition where none existed in reality. If this is the case then using ceramic remains to track or mark the apparent spread of Numic speaking foragers as some have attempted (Bettinger 1999; Janetski 1994; Rhode 1994) may not yield relevant information. The use of ceramic vessels may have developed among different mobile foragers who each had similar needs and found similar compromises in size, design, and function to suit their needs (Eerkens 2003). These rough earthenware vessels appear to have found a place among several mobile Great Basin groups who may have developed ceramic technology as their use of areas became more predictable (Eerkens 2003).

The role of these vessels is still unclear. Did Great Basin peoples use ceramic vessels for cooking or eating out of? Evidence exists to support both possibilities. If Butler (1987) is correct and ceramic pots served to optimize food resources why has only one sherd been recovered from the Birch Creek Site? If this represents a strategy that is meant to benefit all the members of a group there should be sufficient vessels for a group. The one sherd from the early part of the Late Holocene component at the site indicates that ceramics were not extensively used. The bulk of the evidence in fact suggests that ceramic vessels were neither made nor used significantly at the Birch Creek Site though may have been manufactured at specialized task camps during the summer months as was documented ethnographically. A small quantity of multifunctional vessels may have been used at task camps to minimize fuel use through direct heating of food rather than stone boiling, or hold food that is mostly liquid such as a re-hydrated meat and seed porridge. These vessels may have been a small part of an efficient logistically mobile subsistence strategy that was developed to suit a purpose rather than signal a cultural identity.

CHAPTER ELEVEN

LATE HOLOCENE OCCUPATION OF THE BIRCH CREEK SITE, SOUTEASTERN OREGON: SUMMARY, DISCUSSION, AND CONCLUSION

Archaeologists use the term “foraging” to describe the subsistence economy of a wide variety of people and practices in the past. Foragers around the world have different levels of emphasis on hunting, fishing, and plant gathering, as well as different conceptual frameworks for how those resources are accessed and distributed (Kelly 1995). In the Great Basin alone, variability of subsistence economies includes wetland adapted people in prehistoric times, to mobile hunters using the domestic horse in more recent times, among others. The Birch Creek Site contains several excavated components and a well documented ethnographic population utilized the Owyhee Valley, which occupies a boundary area between two different hyrodologic, physiographic, and ethnographic zones, making it well suited to address questions related to changes in subsistence, settlement, and technology over time.

This study was designed to, first, provide a detailed report of the Late Archaic component of the Birch Creek Site excavated in 2006. The second goal of this study was to examine whether evidence of a connection to earlier components of the site, or later ethnographic groups, or both, exists in the material remains of the Birch Creek Site. The evidence for cultural connections between different groups and through time is aided by the use of multiple data sets. This study has examined sediment, ancient pollen, ground stone tools, chipped stone tools and debitage, the sources of obsidian, faunal remains, and ceramic technology at the Birch Creek Site during the Late Archaic. The artifacts recovered at the Birch Creek Site are the products of a settlement, subsistence, and technological strategy used by a specific group of people for roughly

200 years. This chapter brings the studies of individual artifact classes together in a discussion of how they pattern to suggest possible cultural ties to other areas and other time periods.

The hypothesis that the Numic-speaking people occupying the Great Basin at the time of European contact were relatively recent colonists of the region gained widespread attention among archaeologists in the late 1950s (Lamb 1958). Since the time Lamb (1958) suggested the possibility of a Numic migration archaeologists have debated evidence for and against it (Sutton and Rhode 1994). Several models of a Numic migration or "expansion" have been developed, including one featuring a diet breadth and resource exploitation intensity dichotomy, and one structured on forces of selection acting on resource strategies.

The Bettinger and Baumhoff model (1982, 1983) accepts that the Numic expansion took place around 1000 BP. This model links a specific subsistence strategies with Numic and pre-Numic Great Basin people. In this model the pre-Numic adaptation uses a relatively narrow, low-cost and high-return foraging strategy. The pre-Numic adaptation was linked to a higher degree of mobility than the Numic. Numic people were said to be intensified in their strategy, using a wider array of resources, including higher-cost plants that required extensive labor investment to acquire and process. The model predicted that the Numic speakers would outcompete the other people and take over resource areas.

The Aikens and Witherspoon (1986) model also identifies Numic and non-Numic subsistence strategies but is unique in important ways. Their model identified the Numic speaking people, and others such as the Fremont and Lovelock, with a unique adaptive strategy which was selected for or against by environmental conditions throughout the middle-to-late Holocene. The Numic speakers were thought to practice a strategy adapted to relatively dry conditions while others required higher levels of moisture for agriculture or wetland adapted foraging strategies. An important element of this model is that it does not accept the recent movement of Numic speakers across the Great Basin. Aikens and Witherspoon (1986) argue that fluctuations in environmental conditions have resulted in expansions and contractions of Numic speakers across the Great Basin from a "homeland" in the central Great Basin several times in the past. In this model the European colonization of the Americas disrupted the process of adaptation selection at a point when the Numic speakers were expanded.

These models, and others, appear to assume several important elements, including region-wide complementary environmental conditions and limited interaction between people practicing different adaptive strategies. The idea that environmental conditions were similar across an area as large as the Great Basin at any time in the past is difficult to support, and trends in environmental change are only region-wide on a gross timescale and examples of localized environmental variability are abundant (Pielou 1991).

Limited cross-cultural interaction also requires some oversimplification of the past. The way people interacted in the past is difficult to reconstruct but evidence of the transmission of cultural elements such as technology is apparent. The bow-and-arrow is one example of technology that spread across the Americas and across cultural boundaries. In the Great Basin alone the bow-and-arrow appears to have been adopted differently in different areas, possibly reflecting differences in social ties that facilitated learning about new technology (Bettinger and Eerkens 2003).

The study of the Birch Creek Site is not meant to test the models presented above for their relevance to the Great Basin as a whole. This site occupies a unique environment and adaptations to that environment are reflected by the material remains recovered from the sediments. The adaptive strategies evident at the site may reflect changing conditions or changing populations depending on the degree of similarity to earlier and later periods. However, measuring this similarity is difficult and subject to speculation.

The Birch Creek Site

The Birch Creek Site is located along the Owyhee River, which drains north, to the Snake River Plain. While it is part of the externally drained Columbia/Snake River Drainage System, the Owyhee River is bordered to the south and west by the Basin-and-Range physiography of the Great Basin. The Owyhee valley is quite arid, receiving 10 in (25.4 cm) of rain during an average year (NOAA 2008) and the plant and animal communities of the Owyhee River valley are very Great Basin-like (Grayson 1993).

The Late Archaic component of the Birch Creek Site was created by an occupation that has been radiocarbon dated to 1118 to 1310 BP. The excavated component is located approximately 300 meters south of excavations conducted by Washington State University between 1998 and 2003 which exposed Middle Archaic deposits (Andrefsky et al. 2003). The Late Archaic component appears to have accumulated on a sandy riverbank which had been exposed by a scouring flood (see Chapter Four).

The period of Late Archaic occupation appears to have been relatively dry (see Chapter Five). Though the actual severity of aridity is unknown, pollen extracted from the sediment accumulated during and following the occupation suggests that effective moisture increased around the site following the occupation. The relative abundance of greasewood (*Sarcobatus vermiculatus*) compared to sagebrush (*Artemisia* sp.) pollen decreased slightly during the occupation, then abruptly following the occupation. Greasewood is more drought tolerant than sagebrush and will be relatively more abundant during periods of elevated aridity (Rickard 1964, 1967).

The sediment record of the Late Archaic occupation corroborates the pollen evidence of low levels of effective moisture in the region (see Chapter Four). During the occupation the strata reflect cultural processes such as refuse disposal. Following the occupation at least two floods deposited massive sediment loads over the component. In addition to a lack of flood events during the occupation, the first of these floods deposited a dense layer of small mollusk shells in a stratigraphically low area of the site, indicating that slow moving or stagnant water facilitating mollusk growth was flushed from the drainage upstream.

Late Archaic Summary and Discussion

This study has been presented following the categorical structure of the artifact inventory for the Birch Creek Site. It has been necessary to review the recovered materials and analysis by artifact category to provide some clarity regarding methods, results, and material specific research questions. This section provides a summary of the cultural implications of the analysis of individual artifact categories, with regard to the settlement, subsistence, and technological systems expressed at the site.

Settlement

The flood deposits of the Owyhee River suggest that it has experienced several high flow episodes which have eroded and deposited sediments during the Holocene (Vandal 2007; Walker 2001). At the Birch Creek Site the flood sequences have resulted in three terraces (Walker 2001). The most recent terrace was developed sometime prior to the occupation of the Late Archaic component of the site ca. 1300 BP. At the time of occupation a broad surface composed of silty medium to fine sand was available for occupation. The Late Archaic component lies against the riser separating the First Terrace from the Second Terrace and extends toward the river.

The excavations identified several small features but only one is suggestive of a structure. A shallow basin at the bottom of the Late Archaic deposits was uncovered in the excavation units closest to the Owyhee River, within two meters of the bank-full level of the river. This feature was not fully exposed but, assuming the feature was circular, extrapolation of the diameter based on curvature of the exposed side indicates that, the structure would have been roughly 2.75 m in diameter. A single layer of fire-cracked rock was uncovered, which appeared isolated within a small area around the margin of the depression. I suggest this was a sweat lodge.

The occupation lasted for roughly 200 years based on the radiocarbon dates from charcoal at the site. During that time several lenses of artifact rich materials were deposited which reach a total thickness of 40 cm or more in places. Following the occupation at least three floods deposited sand over the occupation, and it does not appear to have been reoccupied prior to historic settlement.

The first terrace has been heavily impacted by erosion but it is possible that the Late Archaic occupation of the site was not limited to the dated time period of 1118 to 1310 BP. Arrow-size points have been found in plowed areas of the Birch Creek Site north of the Late Archaic excavations (William Andrefsky, Jr. personal communication 2006). The loss of site area north of the excavated Late Archaic materials makes it difficult to know if this material is related to a larger or longer term use of the site that extended north. If the site were used annually but lightly built structures were constructed with each occupation the footprint of use during the Late Archaic could have been quite large. However, it is also not possible to reliably determine how many people were using the site at any one time during the Late Archaic given the current data. It may be that an increased population density during the Late Archaic combined with the use of this site as an aggregation site for part of the year would have led to a distribution of people further along the river bank than in earlier periods.

People appear to have reoccupied the Birch Creek Site while the regional climate was drier than modern conditions. The regional effective moisture affects plant communities, and this is visible in the pollen record. Vegetation changes precipitate changes in faunal communities and on human groups. Is it possible that the Late Archaic component was developed by people seeking a more sustainable subsistence base than where they had come from? Obsidian source analysis suggests that during the initial occupation of the Late Archaic component people had a connection with the area around Steens Mountain. The Steens Mountain area is ecologically diverse and it is difficult to know if environmental fluctuations would have been mirrored in neighboring areas.

One of the few instances of pithouse use which may have occurred in the Late Archaic appears at the Givens Hot Springs Locality (Plew 2000). The majority of the excavated structures fall within a period of occupation from 4620 to 3000 BP though some materials are dated to as late as 1100 BP. The Diamond Swamp in the Steens Mountain area contains two excavated sites with multiple occupations (Musil et al. 1995). The Late Archaic occupation of Diamond Swamp appears to have been much more ephemeral and task-oriented than earlier occupations. At Dirty Shame Rockshelter the Late Archaic was a time when people would occupy the site for a season and lived in thatch structures (Hanes 1988). The use of surface-built thatch or stick shelters was observed among ethnographic people as well (Steward 1938). If a settlement pattern is present during the Late Archaic extending into the time of European contact, it may be residential flexibility.

Subsistence

The potential composition of the diet of Late Archaic inhabitants of the Birch Creek Site is indicated largely by pollen remains on ground stone tools and faunal remains. The analysis of materials representing potential Late Archaic diet is limited by preservation. Factors contributing to poor preservation include unfavorable soil chemistry and the apparent processing activities of site inhabitants. Pollen shows better preservation than expected for the alkaline environment, and bone is weathered and appears to have been intentionally fractured when fresh in many cases.

A total of four ground stone pollen washes were completed for the current study (see Chapter Five). The pollen taxa represented on the stones were dominated by goosefoot (Chenopodium) and pigweed (*Amaranthus* sp.) (known as Cheno-*Am*), followed in abundance by sagebrush (*Artemisia* sp.), and traces of other economic genera. The two major pollen taxa represent important economic plants which produce abundant small edible seeds. All of the pollen taxa recovered from ground-stone surfaces are present in the sediment pollen samples from the site indicating a presence in the local site environment.

While these data suggest a possible exploitation of locally available seeds, it is important to note that the two most abundant taxa are also two of the most durable pollen types in the region. Additionally, the relative abundance of the major pollen types is not remarkably different between the sediment and ground stone washes. It appears that the results of the ground stone washes should be viewed cautiously. If small-seed bearing plants were a significant part of the diet of Birch Creek residents during the Late Archaic it should be reflected in the macro-botanical remains. Future studies of Birch Creek flora should incorporate floatation sample analysis in the hopes of finding stronger evidence of the plants used at the site.

Faunal remains are not well preserved from the Late Archaic component of the Birch Creek Site. The faunal assemblage included 609 mammal specimens identified to size class, 547 unidentified mammal specimens, 20 fish specimens, and three shaped objects (see Chapter Nine). Much of the mammal bone was highly fragmented apparently as a result of weathering agents. It also appears that much of the Size Class 3 and Size Class 5 mammal bone was discarded after it had been intentionally fractured, indicated by 104 spiral fractured specimens and eight bone flakes. The fish have been identified as likely belonging to the minnow (Cyprinidae) and sucker (Catostomids) families, which are represented by several species in the Owyhee River including Northern squawfish (*Ptychocheilus oregonensis*), Bridgelip Sucker (*Catostomus columbianus*), and Largescale sucker (*C. macroheilus*).

Some indications of the relative importance of different faunal classes can be inferred, despite the relatively small and poorly preserved assemblage. The Late Archaic mammal assemblage is comprised of nearly equal proportions of rabbit-size (Size Class 3) and antelope-size (Size Class 5) animals. The relative abundance of these animals is similar to that of the Middle Archaic assemblage overall but preservation factors may have skewed the proportions of animals represented in the Middle Archaic assemblages somewhat.

The fish remains are a small but important segment of the faunal assemblage from the Late Archaic. The species indicated by the vertebrae and a pharyngeal are all relatively small, measuring 17.3-32.3 cm in length. Clusters of smaller fish could be efficiently taken using weirs or nets. However, the limited sample of 20 fish specimens recovered from the Late Archaic does not indicate mass harvesting of fish was practiced. It is possible that small fish were processed elsewhere and the discarded remains were generally deposited away from the primary living area of the site. It is also possible that small and fragile remains were simply not preserved and/or too small to remain in the artifact recovery screens.

The regional assemblages beyond the Birch Creek Site are somewhat variable in composition. Occupants of Dry Creek Rockshelter appear to have emphasized large game though a few specimens representing marmot and rabbit were recovered (Webster 1978). The Late Archaic occupation of Diamond Swamp appears focused around marsh resources which include a substantial proportion of large game (Musil et al. 1995). The Dirty Shame Rockshelter is dominated by small mammals with a few specimens of large mammal represented in from the Late Archaic (Hanes 1988). The relative abundance of different types of animals appears to change with each site location, while it may have been very similar through time at locations such as the Birch Creek Site. The composition of individual site assemblages may be a result of the availability of local fauna rather than reflect an approach to subsistence shared by the people of the region during the Late Archaic.

Technology

The Late Archaic component of the Birch Creek Site contains evidence of the bow-and-arrow, numerous small flake tools, several different forms of ground stone tools, and ceramics. The lithic tools appear to be manufactured mostly from local raw materials, while the ceramic could have been made at the Birch Creek Site, or numerous other locations throughout the Owyhee River valley and beyond. The technological strategies employed by people at the Birch Creek Site may provide some of the most important lines of evidence to be used in assessing cultural relationships through time.

The bow-and-arrow is represented by three small Rosegate points. These points are made from chert which could have been acquired from the bed gravels of the Owyhee River at the site, which are rich in high quality chert. The points are not heavily designed and two of the three retain flake blank surfaces. These points represent the bulk of the evidence of hafted biface production recovered from the site. A single hafted bifacial knife was also recovered along with several fragments of non-hafted bifaces which could have broken during the manufacture of additional hafted knives.

The flake tools recovered from the Birch Creek Site Late Archaic component are almost entirely made from chert. A total of 196 chert and nine obsidian flake tools have been analyzed from the Late Archaic. The size of the retouched and non-retouched flake tools was compared against the sizes of a sample of similar tools recovered from Middle Archaic components from the site. Retouched tools from the Late Archaic appear to be somewhat shorter and lighter than their Middle Archaic counterparts while non-retouched flake tools appear to be relatively thinner than those from the Middle Archaic.

The ground stone assemblage from the Late Archaic is composed of stationary and hand-held grinding stones made from basalt cobbles, an abrader made of a hard sandstone, a welded tuff abrader, six hammerstones, and a large amount of basalt fire-cracked rock with remnant ground faceted surfaces. The total ground stone assemblage (17 identified specimens) is substantially smaller than those of the Middle Archaic components, with 43 identified specimens from the Pre-Housepit assemblage and 63 from the Housepit assemblage. Despite the variability in sample sizes the diversity of types of ground stone appears to have been relatively stable from the Middle Archaic to the Late Archaic, with a possible reduction in the intensity of activities using ground stone.

The ceramic sherd is as much a curiosity as an element of a clear technological toolkit at the Birch Creek Site. The sherd is a thick, low fired pottery that could be attributed to Late

Archaic wares on the Snake River Plain, southwest Oregon/northern California, or those of the Fremont. Fired clay was produced in the Northern Great Basin as early as 4800 BP (Mack 1994). This sherd could equally be a product of local small-scale pottery production or a traded item from one of the neighboring regions.

The Northern Great Basin shares many of the technological elements seen at the Birch Creek Site during the Late Archaic. Rosegate points are common in the excavated assemblages from the region with potentially very early dates of these styles appearing 3300 BP at Dry Creek Rockshelter, though most are from components dated 1410 BP and later (Webster 1978). In the Owyhee River drainage at Dirty Shame Rockshelter the Rosegate type appears as early as 2545 BP (Hanes 1988). Dirty Shame Rockshelter and Indian Grade Spring also contain extensive flake tool assemblages from the Late Archaic (Hanes 1988; Jenkins and Connolly 1990). Heavy grinding stone technology appears to be deemphasized at dated sites in the region which coincides with a potential shift toward limited task oriented use of several sites (Hanes 1988; Musil et al. 1995; Webster 1978). Ceramic remains are rare from sites in the region, but in several cases of reported findings they occur in limited activity task oriented camps, possibly focused on hunting (Ferguson and Andrefsky 1996; Lyons et al. 2001; Sappington 1981).

The materials from the Birch Creek Site are small assemblages of small sized tools. This characteristic is not unlike Late Archaic assemblages at other sites in the Owyhee River valley and some nearby areas. There appears to be a limited investment in production costs related to various stone tool types. Could this be a reflection of a tradeoff with increased production costs related to the organic elements in these technological systems, such as the manufacturing of wooden arrow shafts?

Conclusion

The explanations of how the Numic expansion could have occurred generally incorporate adaptive strategies that are suited to specific environmental conditions. One group may have been diversified and outcompeted a more specialized group in a relatively marginal desert environment (Bettinger and Baumhoff 1982). Alternatively different groups practicing various subsistence and settlement strategies may have suffered or benefitted from climatic (and by extension biotic) fluctuations at different times during the Holocene (Aikens and Witherspoon 1986). In any case, people would have been faced with challenges and constant interaction with new environmental conditions regardless of the adaptive strategy they practiced.

The site study adds to the very few excavated sites in the area and it contributes to the base of knowledge about the culture history of the region. This project began with a goal of addressing a question about the cultural continuity of the occupations of the Birch Creek Site. The Middle Archaic adaptive strategy evident at the Birch Creek Site is not remarkably different from that indicated for the Late Archaic, though it is also difficult to argue for a clear pattern of cultural descent. Perhaps the notion of a culturally stable adaptive strategy may not be the proper approach to understanding cultural continuity during the Late Archaic.

The culture of a group of people may certainly have relatively static elements such as social organization, kinship, and language, but these are not easily identified archaeologically. The elements that are identified are linked to materials derived from the needs of their makers, which reflect the needs of a particular group of people at a specific place and time. Future studies could benefit from considering how minor fluctuations in the environment, patchiness of resources, diversity of resources, and changes in population density impact in situ changes in adaptive strategies on a macroscale. Modeling of these multidimensional changes may provide new insight into the changes in adaptive strategies seen in the Late Archaic Great Basin.

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APPENDIX A

EXCAVATED VOLUME AND ARTIFACT DENSITY

Appendix A: Excavated Volume and Artifact Density

Location, Elevation, and Volume Attributes of the Late Archaic Period Excavation Units.

Unit (1x1 m)	Mean Starting Elevation	Ending Elevation	Total Volume (cubic meters)	Mean Late Holocene Top Elevation	Late Holocene Volume (cubic meters)
N730 E1056	999.000	998.700	0.30	998.700	--
N730 E1057	999.000	998.140	0.86	998.700	0.56
N731 E1055	999.030	998.700	0.27	998.700	--
N731 E1056	999.000	998.682	0.32	998.700	--
N731 E1057	998.990	998.150	0.84	998.700	0.55
N732 E1051	999.150	998.650	0.50	998.700	0.05
N732 E1052	999.100	998.200	0.90	998.650	0.45
N732 E1053	999.000	998.100	0.90	998.600	0.50
N732 E1054	999.000	998.000	1.00	998.650	0.65
N732 E1055	999.060	998.000	1.06	998.650	0.65
N732 E1056	999.000	998.200	0.80	998.700	0.50
N732 E1057	998.960	998.200	0.76	998.700	0.50
N732 E1058	998.950	998.700	0.25	998.700	--
N733 E1056	999.050	998.750	0.30	998.750	--
N733 E1057	999.000	998.200	0.80	998.750	0.55
N734 E1056	999.040	998.800	0.24	998.700	--
N734 E1057	999.000	998.200	0.80	998.750	0.55
		Total	**10.90**		**5.51**

Artifact Density of Primary and Total Deposits by Unit of the Late Archaic Period Excavation.

Unit (1x1 m)	Primary Deposit Artifact Total	Primary Deposit Volume (cubic meters)	Primary Deposit Artifact Density (Artifacts/m3)	Unit Artifact Total	Unit Volume (cubic meters)	Total Unit Artifact Density (Artifacts/m3)
N730 E1056	--	--	--	28	0.3	93
N730 E1057	229	0.56	409	253	0.86	294
N731 E1055	--	--	--	71	0.27	262
N731 E1056	--	--	--	65	0.32	203
N731 E1057	364	0.55	662	406	0.84	483
N732 E1051	18	0.05	360	47	0.5	94
N732 E1052	197	0.45	438	252	0.9	280
N732 E1053	706	0.5	1412	762	0.9	847
N732 E1054	631	0.65	971	680	1	680
N732 E1055	974	0.65	1498	1043	1.06	984
N732 E1056	253	0.5	506	335	0.8	419
N732 E1057	355	0.5	710	452	0.76	595
N732 E1058	--	--	--	43	0.25	172
N733 E1056	--	--	--	66	0.3	220
N733 E1057	251	0.55	456	335	0.8	419
N734 E1056	--	--	--	44	0.24	183
N734 E1057	481	0.55	875	638	0.8	798

APPENDIX B

ARTIFACT INVENTORY CODES

Appendix B: Artifact Inventory Codes

All Possible Object Group and Object Type Codes With Explanations for 35ML181 Inventory.

Object Group		Object Type	
CS	Chipped Stone		
		01	Point
		02	Hafted Drill
		03	Point Tip or Midsection
		04	Preform
		05	Other Biface
		06	End Scraper
		07	Side Scraper
		08	Flake Drill or Perforator
		09	Composite Scraper
		10	Unidirectional Core
		11	Cobble Core with a Cutting and/or Scraping Edge
		12	Cobble Core without a Cutting and/or Scarping Edge
		13	Other Core
		14	Flake Debitage with Cortex (with bulb and part of platform)
		15	Flake Debitage with No Cortex (with bulb and part of platform)
		16	Cobble Spall
		17	Flake Shatter (designated as flakes with bulbs and platforms missing)
		18	Angular Shatter (debitage that does not contain flake attributes)
		19	Unimarginal Retouch on Cobble Spall
		20	Bimarginal Retouch on Cobble Spall
		21	Uni/Bimarginal Retouch on Cobble Spall
		22	Unimarginal Retouch on Flake
		23	Bimarginal Retouch on Flake
		24	Uni/Bimarginal Retouch on Flake
		25	Unsorted Debitage (may include other rocks)
		26	Other Core with Cutting/Scraping Edge
GS	Ground-Stone		
		31	Pestle
		32	Mortar
		33	Net Sinker
		34	Hammerstone
		35	Abrader
		36	Fire-Cracked Rock
		37	Ground-Stone Other

Object Group		Object Type	
BN	Bone		
		40	Other Modified Bone/Antler, Flute, Gaming Piece
		41	Harpoon
		42	Awl/Needle
		43	Bead/Elk Tooth
		44	Antler (unmodified)
		45	Fish Remains
		46	Bird Remains
		47	Mammal Remains
		48	Other Bone (includes reptile and amphibian bones, and bone not identifiable to class)
PR	Project Records		
		50	Administrative Records
		51	Background Records
		52	Survey Records
		53	Excavation Records/Notebooks, Maps
		54	Field Catalogues
		55	Analysis Records
		56	Report Records
		57	Photos/Negatives
		58	Photo Catalogues
SH	Shell		
		61	Bead/Dentalia, Olivella
		62	Ornament
		63	Remains
OO	Other Organic		
		65	Hide
		66	Hair
		67	Mat
		68	Basket
		69	Other (includes plant remains)
		70	Cordage
SP	Samples		
		71	c-14 (includes charcoal)
		72	Pollen
		73	Soil (including volcanic ash)/tephra
		74	Floatation
		75	Fine Screen (includes CVS samples)
		76	Other (includes bag residue, natural rock, caliche)
		77	Ochre

Object Group		Object Type	
HM	Historic Materials		
		81	Metal Other/Chain, Spring, Harmonica, Tweezers, Scissors, Trunk
		82	Glass Other/Eye Glasses
		83	Ceramic Other
		84	Trade Beads, and Other Beads Except Shell or Bone Beads
		85	Historic Other (includes clinker)
		86	Wood Other
		87	Leather Other/Wallet, Purse, Pouch
		88	Plastic Other/Comb
		89	Complex Composite
		120	Tin Can/Food, Tobacco
		121	Bottle/Complete, Broken, Neck, Base
		125	Silverware/Knife, Spoon, Fork, Toy
		126	Dishes/Cup, Plate, Serving, Toy
		130	Notions/Button, Snap, Hook and Eye
		131	Safety Pin
		135	Belt- Beaded
		136	Clothing/Shoe, Moccasin, Boot, Cap
		137	Textile Other
		140	Jewelry Other
		141	Bracelet
		142	Necklace
		143	Earring
		144	Ring
		145	Mirror
		150	Bell
		151	Thimble
		155	Coin
		160	Tack/Harness, Bridle, Stirrup, Saddle
		165	Gun/Pistol, Rifle
		166	Cartridge
		170	Knife
		175	Nail/Coffin
LB	Level Bag		
		91	Catalogued Item Bag With Object
		92	Catalogued Item Bag Without Object
		93	Level or Other Unit Bags With Objects
		94	Level or Other Unit Bags Without Their Associated Objects
		95	Unopened Level Bag

MW	Modified Wood		
		100	Modified Wood Other/Coffin, Canoe
		101	Digging Stick
		102	Cradle Board
		105	Bow
		106	Arrow

Raw Material Codes With Explanations for 35ML181 Inventory.

00	Other (including charcoal, clinker, caliche, bag residues, beads that are not yet separated by material type)
01	Bone
02	Wood
03	Shell
04	Glass
05	Metal
06	Ceramic
07	Leather
10	Obsidian
20	Basalt
30	Other Cryptocrystalline/Chert
31	Quartz
32	Quartzite
40	Granite
50	Other Stone
55	Miscellaneous Stone (unsorted debitage and rocks)
60	Paper
70	Plastic
71	Rubber
75	Film
76	Textile

APPENDIX C

GROUND STONE ARTIFACT DATA

Ground Stone Tools

ID #	Unit	OT	RM	Ct.	Wt. (g)	L (mm)	W (mm)	H/T (mm)	Burnt?	Comp?	Shape	Mod Type	Comment
Pestles													
28394	N732-E1056	31	20	1	67.2	47.13	30.73	47.34	Unburnt	Base	Rod	Pecked Ground	
27173	N730-E1057	31	20	1	138.1	25	56.43	50.64	Unburnt	Midsection	Rod	Ground	Ground on 2 sides
25943	N734-E1057	31	20	1	30	30.86	26.99	24.17	Unburnt	Base	Rod	Pecked	Heavily Pecked (17.8x17 mm end)
	Mean Average				78.433	34.33	38.05	40.72					
	Total			3									
Netherstones													
27694	N731-E1056	32	20	1	1595.1	175.01	130.89	48.08	Unburnt	Fractured	Irregular	Ground	Possibly served as anvil, flat
27931	N732-E1053	32	20	1	4300	248.51	188.58	60.79	Unburnt	Whole	Ovate	Pecked Ground	Concave 1-2 mm
27536	N732-E1057	32	20	1	1144	151.89	124.48	36.06	Unburnt	Whole	Ovate	Ground	Flat
26807	N732-E1053	32	20	1	2800	216.12	206.33	52.39	Unburnt	Fractured	Irregular	Ground	Possibly served as anvil, concave 3-4 mm
	Mean Average				2459.8	197.88	162.57	49.33					
	Total			4									
Hammer Stones													
26242	N734-E1057	34	20	1	62.9	52.78	35.48	25.09	Unburnt	Whole	Ovate	Pecked	Battered at 1 end
27755	N731-E1057	34	20	1	146	85.32	50.98	20.81	Unburnt	Whole	Ovate	Pecked	Battered at 1 end
26890	N734-E1057	34	32	1	215.8	70.2	61.88	34.71	Unburnt	Whole	Round	Pecked	Heavily battered at 2 ends
27067	N732-E1053	34	50	1	96.3	79.16	40.96	18.71	Unburnt	Whole	Ovate	Pecked	Light battering at 2 ends
26509	N732-E1053	34	32	1	649.5	95.48	92.56	56.82	Unburnt	Whole	Round	Pecked	Heavily battered at 1 end
27790	N731-E1057	34	20	1	348.8	87.69	81.84	33.85	Unburnt	Fractured	Ovate	Ground	Light wear, possible anvil
	Mean Average				253.22	78.438	60.6167	31.67					
	Total			6									

APPENDIX D

CHIPPED STONE TOOL DATA

Appendix D: Chipped Stone Tool Data

Point/Hafted Biface

Inv#	Unit	Lv	Top El	End El	OG	OT	RM	Ct	Wt (g)	L (mm)	W max (mm)	W neck (mm)	Th (mm)	Flake Visible	Type	Comment
26283	N732-E1053	13	998.500	998.450	CS	1	10	1	1.0	23.71	15.25	8.21	3.73	No	NSN	Tip missing; distal half heavily retouched
25947	N734-E1057	4	998.800	998.750	CS	1	30	1	4.8	60.22	21.48	-	6.19	No	Knife	Base missing; margin retouch visible
25981	N732-E1057	8	998.600	998.550	CS	1	30	1	0.9	25.15	16.10	6.22	3.20	Yes	RG	Distal 1/3 retouched
26007	N732-E1057	6	998.700	998.650	CS	1	30	1	1.4	30.06	20.19	6.26	3.73	Yes	RG	Distal 1/3 retouched; fire damage
26441	N732-E1055	15	998.350	998.300	CS	1	30	1	0.7	22.13	14.49	5.26	2.55	No	RG	Distal 1/4 sharpened

Hafted Drill

Inv#	Unit	Lv	Top El	End El	OG	OT	RM	Ct	Wt (g)	L (mm)	W max (mm)	W bit (mm)	Th (mm)	Comment
26699	Feature 2 Surface Scrape				CS	2	10	1	0.7	23.88	13.13	5.08	2.93	

Point Tip or Midsection

Inv#	Unit	Lv	Top El	End El	OG	OT	RM	Ct	Wt (g)	L (mm)	W (mm)	Th (mm)	Comment
27359	N733-E1057	10	998.550	998.500	CS	3	10	1	0.1	7.45	5.71	2.04	Tip or barb
28361	N732-E1056	6	998.750	998.700	CS	3	10	1	0.1	4.01	7.02	2.07	Midsection

Other Biface

Inv#	Unit	Lv	Top El	End El	OG	OT	RM	Ct	Wt (g)	L (mm)	W (mm)	Th (mm)	Comment
25948	N734-E1057	4	998.800	998.750	CS	5	10	1	0.0	4.93	6.76	2.16	Square; probable haft element
25984	N732-E1057	8	998.600	998.550	CS	5	10	1	1.0	20.74	13.53	4.33	Unidentifiable fragment
27425	N733-E1057	16	998.250	998.200	CS	5	10	1	0.2	6.58	10.98	4.13	Square; probable haft element
27537	N732-E1057	9	998.550	998.500	CS	5	10	1	0.2	10.32	7.94	2.99	Unidentifiable fragment
25403	N732-E1054	13	998.400	998.350	CS	5	30	1	8.7	38.23	34.27	6.67	End fragment
25414	N732-E1054	13	998.400	998.350	CS	5	30	1	0.1	5.25	6.67	2.04	Square to trapezoidal; probable haft element
25415	N732-E1054	13	998.400	998.350	CS	5	30	1	0.7	18.34	8.02	7.06	Unidentifiable fragment
25905	N731-E1057	11	998.450	998.400	CS	5	30	1	16.2	30.70	38.80	11.13	Midsection fragment
27153	N730-E1057	8	998.550	998.500	CS	5	30	1	26.4	61.75	34.46	12.11	End missing; warterworn
27850	N732-E1053	3	998.850	998.800	CS	5	30	1	0.9	15.43	10.12	6.69	Unidentifiable fragment
28241	N732-E1055	13	998.435	998.400	CS	5	30	1	2.0	20.84	18.55	5.54	Unidentifiable fragment; fire damaged
28240	N732-E1055	13	998.435	998.400	CS	5	30	1	7.4	45.77	30.53	7.74	End fragment
25394	N731-E1056	6	998.750	998.700	CS	5	30	1	22.1	59.81	33.81	10.07	Whole; waterworn

Endscraper

Inv#	Unit	Lv	Top El	End El	OG	OT	RM	Ct	Wt (g)	L (mm)	W max (mm)	W bit (mm)	Th (mm)	Comment
28177	N732-E1055	11	998.550	998.500	CS	6	30	1	39.4	58.53	47.47	35.09	19.09	High quality green chert

Appendix D: Chipped Stone Tool Data

Flake Tools

Inv#	Unit	Lv	Top El.	End El.	OG	OT	RM	Ct	Wt (g)	L (mm)	W (mm)	Th (mm)	Mod Type (Retouched, Utilized, Both)	# of Mod Sect's	Comment
26512	N732-E1053	14	998.45	998.4	CS	24	10	1	0.5	17.45	15.24	2.47	Utilized	2	
26933	N734-E1057	7	998.65	998.6	CS	22	10	1	1.8	45.13	15.51	3.19	Utilized	1	
27132	N730-E1057	5	998.7	998.62	CS	22	10	1	0.3	22.19	7.78	1.99	Utilized	1	
27244	N730-E1057	17	998.2	998.15	CS	22	10	1	2.2	37.37	16.41	6.70	Utilized	2	
27627	N731-E1055	3	998.9	998.85	CS	22	10	1	6.1	38.50	26.06	8.01	Both	5	
27685	N731-E1056	6	998.75	998.682	CS	22	10	1	2.1	35.72	17.62	4.00	Utilized	5	
28012	N732-E1054	7	998.64	998.6	CS	22	10	1	1.8	31.29	27.28	4.01	Utilized	2	
28038	N732-E1054	12	998.439	998.4	CS	22	10	1	0.8	25.28	13.17	3.45	Utilized	1	
27598	N732-E1057	15	998.25	998.2	CS	22	10	1	1.6	27.50	17.32	4.13	Retouched	1	
25404	N732-E1054	13	998.4	998.35	CS	22	30	1	16.5	44.18	36.48	13.45	Both	4	
25416	N732-E1054	13	998.4	998.35	CS	22	30	1	2.2	22.66	20.81	5.36	Utilized	1	
25417	N732-E1054	13	998.4	998.35	CS	22	30	1	3.8	29.65	25.31	7.33	Utilized	1	
25493	N732-E1053	24	998.2	998.15	CS	22	30	1	5.5	38.74	31.52	7.93	Utilized	1	
26513	N732-E1053	14	998.45	998.4	CS	22	30	1	1.4	34.12	14.34	3.08	Utilized	1	
26561	N732-E1056	14	998.35	998.3	CS	22	30	1	28.9	70.29	31.89	17.46	Utilized	2	
26562	N732-E1056	14	998.35	998.3	CS	22	30	1	8.4	50.84	28.54	6.32	Utilized	1	
26563	N732-E1056	14	998.35	998.3	CS	22	30	1	3.4	36.68	21.14	5.32	Utilized	1	
26578	N732-E1053	16	998.35	998.3	CS	22	30	1	27.1	51.67	50.07	10.99	Retouched	1	
26579	N732-E1053	16	998.35	998.3	CS	22	30	1	17.1	55.36	35.77	12.91	Utilized	1	
26580	N732-E1053	16	998.35	998.3	CS	22	30	1	6.3	44.29	33.48	5.91	Utilized	1	
25329	N731-E1057	13	998.35	998.3	CS	23	30	1	3.9	33.62	29.48	4.52	Retouched	1	
25362	N732-E1052	14	998.35	998.3	CS	23	30	1	3.2	33.54	28.08	4.35	Utilized	4	
26581	N732-E1053	16	998.35	998.3	CS	23	30	1	4.6	32.14	25.19	8.68	Utilized	2	
25505	N732-E1056	13	998.4	998.35	CS	22	30	1	4.0	38.08	25.55	4.30	Utilized	1	
25773	N732-E1054	20	998.15	998.1	CS	22	30	1	4.8	33.11	24.84	5.34	Utilized	1	
25774	N732-E1054	20	998.15	998.1	CS	22	30	1	4.0	31.95	21.23	7.11	Utilized	1	

25811	N731-E1057	16	998.32	998.195	CS	22	30	1	4.8	39.17	19.50	9.36	Utilized	2	
25866	N730-E1057	18	998.15	998.11	CS	22	30	1	1.8	28.24	22.84	3.48	Utilized	1	
25906	N731-E1057	21	998.2	998.15	CS	22	30	1	0.2	19.09	9.70	1.39	Utilized	1	
26146	N731-E1057	19	998.25	998.2	CS	22	30	1	1.8	21.43	14.54	8.14	Retouched	1	
26180	N732-E1052	19	998.29	998.25	CS	22	30	1	7.3	33.02	21.88	11.62	Retouched	1	
26215	N731-E1057	20	998.25	998.2	CS	22	30	1	1.9	41.99	16.18	2.51	Utilized	1	
26229	N731-E1057	18	998.3	998.25	CS	22	30	1	6.1	33.21	27.58	7.05	Retouched	1	
25922	N734-E1057	8	998.6	998.55	CS	22	30	1	11.0	42.34	37.40	10.38	Utilized	2	
25929	N734-E1057	8	998.6	998.55	CS	22	30	1	1.8	30.34	17.74	3.65	Utilized	1	
25955	N734-E1057	4	998.8	998.75	CS	22	30	1	10.2	46.45	32.58	9.31	Both	2	
25956	N734-E1057	4	998.8	998.75	CS	22	30	1	1.7	34.68	22.79	2.65	Utilized	1	
26236	N734-E1057	12	998.4	998.35	CS	22	30	1	16.0	49.09	30.15	11.15	Retouched	1	
26359	N734-E1057	13	998.35	998.3	CS	22	30	1	0.8	20.40	14.89	3.35	Utilized	1	
26360	N734-E1057	13	998.35	998.3	CS	22	30	1	5.7	35.59	23.61	8.69	Both	1	
26361	N734-E1057	13	998.35	998.3	CS	22	30	1	7.8	45.74	25.93	10.85	Utilized	1	
26761	N734-E1057	11	998.45	998.4	CS	22	30	1	6.0	32.03	27.22	10.41	Retouched	1	
26762	N734-E1057	11	998.45	998.4	CS	22	30	1	2.5	34.09	19.70	4.96	Utilized	2	
26763	N734-E1057	11	998.45	998.4	CS	22	30	1	1.3	25.29	16.87	4.15	Utilized	1	Water worn
26770	N734-E1057	5	998.75	998.7	CS	22	30	1	2.3	24.76	18.49	7.40	Utilized	1	
26809	N734-E1056	2	998.95	998.9	CS	22	30	1	1.4	29.67	11.32	4.82	Utilized	1	
26862	N734-E1057	1	999.01	998.9	CS	22	30	1	1.6	24.99	12.01	6.61	Retouched	1	
26870	N734-E1057	2	998.9	998.85	CS	22	30	1	2.0	29.46	16.87	5.72	Utilized	1	
26871	N734-E1057	2	998.9	998.85	CS	22	30	1	0.6	21.84	12.44	2.06	Utilized	1	
26892	N734-E1057	3	998.85	998.8	CS	22	30	1	10.5	40.81	34.84	10.35	Utilized	1	
26893	N734-E1057	3	998.85	998.8	CS	22	30	1	10.1	34.97	28.56	15.03	Retouched	2	
26894	N734-E1057	3	998.85	998.8	CS	22	30	1	6.4	37.76	22.89	8.95	Retouched	1	
26932	N734-E1057	7	998.65	998.6	CS	22	30	1	4.6	28.94	14.00	8.81	Retouched	1	
26937	N734-E1057	14	998.3	998.25	CS	22	30	1	4.8	44.53	16.59	7.23	Retouched	2	Water worn
26938	N734-E1057	14	998.3	998.25	CS	22	30	1	0.6	18.44	9.58	4.23	Retouched	1	

26869	N734-E1057	2	998.9	998.85	CS	23	30	1	12.0	41.02	23.07	13.66	Both	2
26895	N734-E1057	3	998.85	998.8	CS	23	30	1	1.5	28.34	16.19	4.48	Retouched	2
26891	N734-E1057	3	998.85	998.8	CS	24	30	1	28.9	55.18	43.93	13.94	Both	3
27090	N730-E1056	1	999.068	998.95	CS	22	30	1	0.9	30.23	15.14	2.11	Utilized	2
27116	N730-E1057	2	998.9	998.85	CS	22	30	1	3.8	35.08	23.34	5.74	Retouched	1
27142	N730-E1057	7	998.6	998.55	CS	22	30	1	15.0	40.14	28.22	16.30	Retouched	1
27143	N730-E1057	7	998.6	998.55	CS	22	30	1	6.6	38.86	26.45	9.47	Retouched	1
27144	N730-E1057	7	998.6	998.55	CS	22	30	1	2.7	23.61	20.74	9.42	Retouched	1
27154	N730-E1057	8	998.55	998.5	CS	22	30	1	15.2	48.15	46.98	10.51	Utilized	2
27165	N730-E1057	9	998.5	998.45	CS	22	30	1	11.5	39.08	37.04	12.96	Retouched	1
27191	N730-E1057	11	998.4	998.35	CS	22	30	1	15.7	39.65	30.45	16.38	Retouched	1
27192	N730-E1057	11	998.4	998.35	CS	22	30	1	10.3	47.06	32.08	9.67	Utilized	2
27205	N730-E1057	12	998.35	998.27	CS	22	30	1	17.5	55.10	42.79	13.71	Retouched	1
27206	N730-E1057	12	998.35	998.27	CS	22	30	1	2.9	31.59	22.09	4.91	Utilized	1
27207	N730-E1057	12	998.35	998.27	CS	22	30	1	0.5	20.74	15.05	2.24	Utilized	1
27215	N730-E1057	13	998.27	998.25	CS	22	30	1	25.6	52.42	45.05	12.86	Both	3
27216	N730-E1057	13	998.27	998.25	CS	22	30	1	5.0	34.03	25.72	6.02	Utilized	2
27233	N730-E1057	15	998.25	998.2	CS	22	30	1	8.1	37.64	30.81	10.77	Utilized	1
27234	N730-E1057	15	998.25	998.2	CS	22	30	1	4.7	39.00	29.97	5.34	Retouched	2
27245	N730-E1057	17	998.2	998.15	CS	22	30	1	0.4	17.08	10.31	2.99	Retouched	1
26336	N731-E1057	8	998.6	998.55	CS	22	30	1	3.6	29.56	18.13	6.92	Retouched	2
26337	N731-E1057	8	998.6	998.55	CS	22	30	1	3.9	34.99	33.51	4.21	Utilized	1
27619	N731-E1055	2	998.95	998.9	CS	22	30	1	1.7	30.56	24.04	4.29	Utilized	3
27727	N731-E1057	6	998.698	998.645	CS	22	30	1	1.0	25.43	18.40	2.22	Both	3
27740	N731-E1057	7	998.645	998.6	CS	22	30	1	2.3	22.48	14.60	6.88	Retouched	2
27741	N731-E1057	7	998.645	998.6	CS	22	30	1	2.1	26.89	21.99	5.84	Retouched	2
27791	N731-E1057	11	998.45	998.4	CS	22	30	1	2.0	33.65	24.32	5.06	Utilized	1
27813	N731-E1057	12	998.4	998.35	CS	22	30	1	8.5	39.86	24.13	8.78	Retouched	1
27814	N731-E1057	12	998.4	998.35	CS	22	30	1	2.4	26.05	21.63	6.02	Utilized	1

27815	N731-E1057	12	998.4	998.35	CS	22	30	1	1.8	26.58	21.03	3.20	Retouched	1
27812	N731-E1057	12	998.4	998.35	CS	23	30	1	10.0	38.05	20.84	14.94	Retouched	1
27742	N731-E1057	7	998.645	998.6	CS	24	30	1	15.3	47.41	37.11	10.41	Utilized	1
27062	N732-E1053	13	998.5	998.45	CS	22	30	1	31.1	60.43	46.33	11.49	Retouched	3
27063	N732-E1053	13	998.5	998.45	CS	22	30	1	4.4	39.37	31.80	4.87	Utilized	1
27064	N732-E1053	13	998.5	998.45	CS	22	30	1	4.4	44.19	21.70	6.49	Utilized	2
27065	N732-E1053	13	998.5	998.45	CS	22	30	1	4.3	37.40	26.05	7.38	Utilized	1
27867	N732-E1053	8	998.6	998.55	CS	22	30	1	1.0	23.24	21.84	3.07	Utilized	2
27873	N732-E1053	9	998.55	998.5	CS	22	30	1	7.2	37.92	33.02	9.55	Utilized	2
27885	N732-E1053	10	998.5	998.45	CS	22	30	1	10.8	53.27	37.89	2.65	Utilized	1
27896	N732-E1053	11	998.56	998.55	CS	22	30	1	6.3	39.11	27.78	8.22	Utilized	1
27897	N732-E1053	11	998.56	998.55	CS	22	30	1	5.1	53.79	20.87	4.18	Retouched	2
27898	N732-E1053	11	998.56	998.55	CS	22	30	1	3.2	29.68	21.32	6.88	Utilized	2
27904	N732-E1053	12	998.55	998.5	CS	22	30	1	22.2	48.31	46.99	15.32	Utilized	3
27933	N732-E1053	15	998.4	998.35	CS	22	30	1	4.8	46.09	20.41	6.43	Utilized	1
27934	N732-E1053	15	998.4	998.35	CS	22	30	1	1.8	20.01	14.39	8.44	Retouched	1
27935	N732-E1053	15	998.4	998.35	CS	22	30	1	1.0	26.99	15.85	2.33	Utilized	1
28039	N732-E1054	12	998.439	998.4	CS	22	30	1	0.2	10.29	7.52	4.58	Utilized	1
28079	N732-E1054	15	998.3	998.25	CS	22	30	1	3.0	28.94	28.54	5.28	Utilized	2
27066	N732-E1053	13	998.5	998.45	CS	23	30	1	24.0	49.09	34.44	19.10	Retouched	2
27932	N732-E1053	15	998.4	998.35	CS	24	30	1	37.5	71.93	35.90	17.08	Retouched	3
27962	N732-E1053	22	998.23	998.2	CS	24	30	1	7.1	39.97	24.11	6.48	Retouched	3
26253	N732-E1056	5	998.85	998.8	CS	22	30	1	9.2	43.94	24.02	9.51	Utilized	4
26728	N732-E1056	8	998.65	998.585	CS	22	30	1	1.8	20.39	18.92	6.30	Utilized	1
26370	N732-E1055	18	998.2	998.15	CS	22	30	1	4.2	30.94	28.56	6.83	Utilized	1
26371	N732-E1055	18	998.2	998.15	CS	22	30	1	3.7	33.65	25.76	7.86	Utilized	1
26402	N732-E1055	16	998.3	998.25	CS	22	30	1	12.3	52.41	35.28	8.81	Utilized	3
26409	N732-E1055	16	998.3	998.25	CS	22	30	1	2.9	32.45	20.55	4.58	Utilized	1
26450	N732-E1055	15	998.35	998.3	CS	22	30	1	7.5	46.08	34.79	7.62	Utilized	1

26724	N732-E1056	8	998.65	998.585	CS	22	30	1	29.9	53.73	53.26	12.23	Utilized	1
26725	N732-E1056	8	998.65	998.585	CS	22	30	1	27.4	59.19	42.60	14.64	Utilized	2
26726	N732-E1056	8	998.65	998.585	CS	22	30	1	14.7	48.11	44.66	7.50	Retouched	1
26727	N732-E1056	8	998.65	998.585	CS	22	30	1	4.2	27.04	26.14	10.76	Both	2
27506	N732-E1055	14	998.4	998.35	CS	22	30	1	12.4	60.36	25.92	8.07	Utilized	1
27507	N732-E1055	14	998.4	998.35	CS	22	30	1	0.4	18.55	10.66	2.30	Utilized	1
28179	N732-E1055	11	998.55	998.5	CS	22	30	1	126.8	115.64	79.82	18.55	Utilized	2
28202	N732-E1055	12	998.5	998.435	CS	22	30	1	15.2	60.78	34.94	15.94	Both	3
28203	N732-E1055	12	998.5	998.435	CS	22	30	1	11.5	54.94	35.45	9.39	Utilized	3
28204	N732-E1055	12	998.5	998.435	CS	22	30	1	9.1	44.61	29.93	10.37	Utilized	1
28205	N732-E1055	12	998.5	998.435	CS	22	30	1	6.4	36.97	35.38	7.50	Utilized	3
28206	N732-E1055	12	998.5	998.435	CS	22	30	1	3.5	27.95	26.00	8.48	Utilized	1
28243	N732-E1055	13	998.435	998.4	CS	22	30	1	11.3	33.07	29.37	11.28	Utilized	1
28244	N732-E1055	13	998.435	998.4	CS	22	30	1	6.0	34.61	25.51	5.80	Utilized	1
28245	N732-E1055	13	998.435	998.4	CS	22	30	1	5.8	40.00	23.69	8.52	Utilized	1
28246	N732-E1055	13	998.435	998.4	CS	22	30	1	2.8	30.42	23.72	5.48	Utilized	1
28247	N732-E1055	13	998.435	998.4	CS	22	30	1	1.8	28.90	17.78	4.28	Utilized	1
28248	N732-E1055	13	998.435	998.4	CS	22	30	1	1.0	18.17	13.57	7.92	Utilized	1
28249	N732-E1055	13	998.435	998.4	CS	22	30	1	1.0	26.75	16.23	2.45	Utilized	2
28250	N732-E1055	13	998.435	998.4	CS	22	30	1	0.6	30.56	11.19	1.55	Utilized	1
28327	N732-E1055	17	998.25	998.2	CS	22	30	1	6.4	45.84	29.92	6.69	Utilized	2
28355	N732-E1056	4	998.85	998.8	CS	22	30	1	3.9	30.58	17.31	8.92	Utilized	1
28362	N732-E1056	6	998.75	998.7	CS	22	30	1	7.2	52.81	37.17	8.97	Utilized	1
28424	N732-E1056	9	998.585	998.55	CS	22	30	1	14.3	51.47	35.11	10.02	Utilized	1
28425	N732-E1056	9	998.585	998.55	CS	22	30	1	41.4	67.80	39.26	18.30	Both	3
28434	N732-E1056	10	998.55	998.5	CS	22	30	1	3.4	29.17	19.72	8.07	Utilized	1
28475	N732-E1056	12	998.45	998.4	CS	22	30	1	2.4	38.29	33.96	3.61	Utilized	1
27529	N732-E1055	22	998.1	998.055	CS	23	30	1	67.6	69.07	51.11	18.60	Utilized	1
28178	N732-E1055	11	998.55	998.5	CS	23	30	1	5.6	51.94	21.21	5.39	Both	3

28242	N732-E1055	13	998.435	998.4	CS	23	30	1	16.1	56.50	37.60	9.31	Utilized	2	
28098	N732-E1055	1	999.051	999	CS	24	30	1	13.3	40.72	36.25	9.90	Retouched	3	
26393	N732-E1054	18	998.25	998.2	CS	22	30	1	58.7	82.10	75.61	10.15	Retouched	3	
26797	N732-E1053	18	998.29	998.25	CS	22	30	1	20.9	48.94	35.91	18.13	Utilized	1	
26803	N732-E1053	18	998.29	998.25	CS	22	30	1	3.8	37.43	19.58	6.23	Utilized	1	
25974	N732-E1057	8	998.6	998.55	CS	22	30	1	8.0	35.84	24.53	14.44	Retouched	2	Water worn
26093	N732-E1057	6	998.7	998.65	CS	22	30	1	25.8	57.61	34.21	15.07	Retouched	1	
26094	N732-E1057	6	998.7	998.65	CS	22	30	1	15.4	46.83	45.62	9.48	Retouched	2	
26095	N732-E1057	6	998.7	998.65	CS	22	30	1	14.8	46.56	41.72	9.44	Utilized	3	
26096	N732-E1057	6	998.7	998.65	CS	22	30	1	8.9	40.83	27.26	8.73	Utilized	1	
26097	N732-E1057	6	998.7	998.65	CS	22	30	1	6.7	34.56	20.67	9.17	Utilized	1	
26098	N732-E1057	6	998.7	998.65	CS	22	30	1	3.8	31.63	23.54	9.85	Utilized	2	
26099	N732-E1057	6	998.7	998.65	CS	22	30	1	3.5	37.26	22.93	5.76	Both	3	
26171	N732-E1057	12	998.4	998.35	CS	22	30	1	9.3	51.14	30.47	10.77	Utilized	4	
26276	N732-E1057	13	998.35	998.3	CS	22	30	1	14.5	57.05	38.21	8.58	Utilized	1	
26277	N732-E1057	13	998.35	998.3	CS	22	30	1	7.0	39.78	20.58	15.98	Retouched	1	
26278	N732-E1057	13	998.35	998.3	CS	22	30	1	7.2	39.59	27.18	6.50	Utilized	1	
27000	N732-E1057	7	998.65	998.6	CS	22	30	1	5.9	35.30	29.82	8.05	Utilized	2	
27481	N732-E1057	5	998.75	998.7	CS	22	30	1	43.1	51.27	40.59	16.71	Retouched	1	
27482	N732-E1057	5	998.75	998.7	CS	22	30	1	40.6	60.39	43.87	15.13	Retouched	1	
27483	N732-E1057	5	998.75	998.7	CS	22	30	1	14.5	42.95	31.17	13.59	Utilized	4	
27484	N732-E1057	5	998.75	998.7	CS	22	30	1	10.7	45.15	29.90	10.70	Utilized	4	
27538	N732-E1057	9	998.55	998.5	CS	22	30	1	1.7	25.80	18.81	4.30	Utilized	2	
27557	N732-E1057	10	998.5	998.45	CS	22	30	1	34.9	83.60	32.62	13.07	Retouched	2	
27558	N732-E1057	10	998.5	998.45	CS	22	30	1	6.8	49.91	31.23	6.57	Utilized	2	
27599	N732-E1057	15	998.25	998.2	CS	22	30	1	12.9	60.45	23.65	10.67	Retouched	2	
27600	N732-E1057	15	998.25	998.2	CS	22	30	1	11.9	53.04	42.62	8.86	Utilized	3	
27601	N732-E1057	15	998.25	998.2	CS	22	30	1	2.4	33.51	23.83	3.33	Utilized	1	
27539	N732-E1057	9	998.55	998.5	CS	23	30	1	4.3	29.44	21.69	7.90	Both	2	

26142	N733-E1057	6	998.75	998.7	CS	22	30	1	31.7	73.89	37.04	15.28	Utilized	1	
26143	N733-E1057	6	998.75	998.7	CS	22	30	1	13.2	51.65	22.58	15.18	Utilized	3	
26317	N733-E1057	5	998.8	998.75	CS	22	30	1	9.8	44.81	44.57	9.04	Utilized	4	
26318	N733-E1057	5	998.8	998.75	CS	22	30	1	9.4	37.68	29.95	8.65	Utilized	2	
26319	N733-E1057	5	998.8	998.75	CS	22	30	1	1.9	29.75	14.75	6.14	Utilized	2	
26467	N733-E1057	7	998.7	998.65	CS	22	30	1	22.9	50.66	30.03	20.41	Retouched	1	
26474	N733-E1057	7	998.7	998.65	CS	22	30	1	12.2	44.45	41.36	9.37	Utilized	3	
26475	N733-E1057	7	998.7	998.65	CS	22	30	1	3.0	31.66	22.53	6.99	Utilized	2	
27256	N733-E1056	2	998.95	998.9	CS	22	30	1	2.6	33.68	10.76	10.40	Retouched	2	
27257	N733-E1056	2	998.95	998.9	CS	22	30	1	2.4	24.89	21.65	7.35	Utilized	2	
27268	N733-E1056	3	998.9	998.85	CS	22	30	1	10.3	44.81	23.73	11.50	Utilized	3	
27284	N733-E1056	5	998.8	998.75	CS	22	30	1	4.2	39.79	34.08	4.42	Both	3	
27285	N733-E1056	5	998.8	998.75	CS	22	30	1	3.7	26.60	26.17	7.43	Retouched	1	
27286	N733-E1056	5	998.8	998.75	CS	22	30	1	2.4	29.42	22.47	5.01	Utilized	2	
27287	N733-E1056	5	998.8	998.75	CS	22	30	1	0.7	19.85	17.60	2.65	Utilized	2	
27308	N733-E1057	2	998.95	998.9	CS	22	30	1	1.5	28.90	13.03	3.97	Utilized	3	
27313	N733-E1057	3	998.9	998.85	CS	22	30	1	4.7	29.63	24.42	8.22	Utilized	3	
27345	N733-E1057	9	998.6	998.55	CS	22	30	1	8.3	47.84	25.13	9.74	Both	2	
27360	N733-E1057	10	998.55	998.5	CS	22	30	1	3.1	26.71	19.26	8.34	Retouched	1	
27369	N733-E1057	11	998.5	998.45	CS	22	30	1	17.1	49.88	27.30	12.59	Both	4	
27370	N733-E1057	11	998.5	998.45	CS	22	30	1	2.0	34.42	21.69	2.85	Utilized	1	
27387	N733-E1057	13	998.4	998.35	CS	22	30	1	20.9	49.76	48.96	19.35	Both	5	
27388	N733-E1057	13	998.4	998.35	CS	22	30	1	5.2	36.07	31.49	6.64	Utilized	1	
27407	N733-E1057	14	998.35	998.3	CS	22	30	1	9.1	53.28	39.00	6.26	Utilized	2	
27408	N733-E1057	14	998.35	998.3	CS	22	30	1	9.1	59.30	34.38	6.10	Utilized	1	
27409	N733-E1057	14	998.35	998.3	CS	22	30	1	5.6	46.94	30.33	5.84	Utilized	1	
27410	N733-E1057	14	998.35	998.3	CS	22	30	1	2.4	24.19	16.99	8.48	Both	2	Water worn
27415	N733-E1057	15	998.3	998.25	CS	22	30	1	22.1	45.35	44.85	15.16	Retouched	2	
27426	N733-E1057	16	998.25	998.2	CS	22	30	1	8.3	39.29	30.50	8.24	Retouched	1	

27378	N733-E1057	12	998.45	998.4	CS	23	30	1	171.6	92.42	58.11	30.14	Retouched	3
26979	N732-E1052	1	999.166	998.95	CS	22	30	1	0.3	16.20	16.12	1.53	Utilized	1
26985	N732-E1052	2	998.95	998.9	CS	22	30	1	1.3	23.55	13.10	7.29	Retouched	2
26992	N732-E1052	3	998.9	998.85	CS	22	30	1	3.5	27.85	24.01	9.56	Both	2
26997	N732-E1052	7	998.7	998.65	CS	22	30	1	2.1	27.31	12.75	5.66	Retouched	1

Appendix D: Chipped Stone Tool Data

Cores

Inv#	Unit	Lv	Top El.	End El.	OG	OT	RM	Ct	Wt (g)	L (mm)	W (mm)	Th (mm)	Cortex (1=Yes 0=No)	Water worn (1=Yes 0=No)
25319	N731-E1057	13	998.35	998.3	CS	10	30	1	77.5	73.24	45.82	24.21	1	0
26777	N734-E1057	5	998.75	998.7	CS	10	30	1	177.1	81.98	67.16	29.84	1	0
26010	N732-E1057	6	998.7	998.65	CS	10	30	1	91.6	65.38	61.46	19.68	1	0
26192	N732-E1057	7	998.65	998.6	CS	10	30	1	102.3	69.51	50.31	26.58	1	0
25999	N733-E1057	8	998.65	998.6	CS	10	30	1	122.7	70.08	67.78	37.10	0	0
26300	N733-E1057	8	998.65	998.6	CS	10	30	1	26.4	40.54	27.84	21.92	1	1
27778	N731-E1057	10	998.5	998.45	CS	12	30	1	114.3	75.58	44.07	35.61	1	1
25312	N732-E1054	19	998.2	998.15	CS	13	30	1	155.3	97.74	81.43	20.04	1	0
25372	N732-E1052	15	998.3	998.25	CS	13	30	1	13.2	28.37	24.95	21.07	1	0
25405	N732-E1054	13	998.4	998.35	CS	13	30	1	59.7	43.82	39.53	34.61	1	0
25406	N732-E1054	13	998.4	998.35	CS	13	30	1	32.0	51.58	42.15	19.49	0	0
26557	N732-E1053	14	998.45	998.4	CS	13	30	1	47.4	67.26	45.24	22.44	0	0
26558	N732-E1053	14	998.45	998.4	CS	13	30	1	59.1	72.55	44.00	19.97	1	0
26559	N732-E1053	14	998.45	998.4	CS	13	30	1	35.3	37.25	31.83	23.44	1	0
25889	N732-E1052	9	998.6	998.55	CS	13	30	1	35.5	59.99	38.24	19.48	0	0
26038	N732-E1052	11	998.5	998.45	CS	13	30	1	82.3	57.68	46.49	31.28	1	1
26039	N732-E1052	11	998.5	998.45	CS	13	30	1	5.0	22.22	19.48	14.44	1	0
26069	N732-E1054	14	998.35	998.3	CS	13	30	1	15.1	41.93	26.18	16.98	1	0
25944	N734-E1057	4	998.8	998.75	CS	13	30	1	54.1	63.81	36.93	29.39	1	0
25954	N734-E1057	4	998.8	998.75	CS	13	30	1	36.9	63.44	39.45	20.59	1	0
26230	N734-E1057	16	998.25	998.2	CS	13	30	1	1146.9	146.52	131.41	65.46	1	1
27164	N730-E1057	9	998.5	998.45	CS	13	30	1	57.6	56.08	42.85	35.09	1	0
27661	N731-E1056	3	998.9	998.85	CS	13	30	1	38.2	47.49	38.41	16.72	1	1
28196	N732-E1055	11	998.55	998.5	CS	13	30	1	33.7	54.69	31.07	31.52	1	0

28197	N732-E1055	11	998.55	998.5	CS	13	30	1	109.3	77.28	47.54	31.13	1	0
28198	N732-E1055	11	998.55	998.5	CS	13	30	1	190.9	81.72	64.39	48.06	1	0
28238	N732-E1055	12	998.5	998.435	CS	13	30	1	31.2	48.97	37.39	23.04	1	0
28472	N732-E1056	11	998.5	998.45	CS	13	30	1	48.2	59.47	37.06	24.67	0	0
28476	N732-E1056	12	998.45	998.4	CS	13	30	1	31.9	44.22	38.48	25.39	1	1
25982	N732-E1057	8	998.6	998.55	CS	13	30	1	22.9	42.55	32.21	18.33	1	0
26011	N732-E1057	6	998.7	998.65	CS	13	30	1	85.3	75.41	48.31	32.03	1	0
26193	N732-E1057	7	998.65	998.6	CS	13	30	1	76.7	59.10	55.40	25.68	0	0
26423	N732-E1057	4	998.8	998.75	CS	13	30	1	10.8	34.51	22.13	17.60	1	0
26431	N732-E1057	4	998.8	998.75	CS	13	30	1	15.1	35.75	34.41	11.35	1	0
27559	N732-E1057	10	998.5	998.45	CS	13	30	1	184.1	74.34	71.66	20.74	1	1
27570	N732-E1057	11	998.45	998.4	CS	13	30	1	41.1	59.39	39.94	21.04	1	0
26111	N733-E1057	6	998.75	998.7	CS	13	30	1	223.5	65.62	55.60	37.17	1	0
26473	N733-E1057	7	998.7	998.65	CS	13	30	1	17.4	40.81	36.53	19.44	1	0
27371	N733-E1057	11	998.5	998.45	CS	13	30	1	11.5	27.93	27.23	17.23	0	0
26939	N734-E1057	14	998.3	998.25	CS	26	30	1	17.8	44.06	27.66	16.49	1	1
28433	N732-E1056	10	998.55	998.5	CS	26	30	1	242.3	110.78	97.72	32.30	1	0
27540	N732-E1057	9	998.55	998.5	CS	26	30	1	184.5	109.82	65.18	31.37	1	1

APPENDIX E

SOURCED OBSIDIAN ARTIFACT DATA

Appendix E: Sourced Obsidian Artifact Data

Source	Cat #	Artifact Type	Subtype	Wt (g)	L (mm)	W (mm)	T (mm)	Strat	Age
Remote Source									
Indian Creek Buttes- A									
	25352	PF w/ cortex		0.30	12.21	12.31	2.96	VII	1271-1299 BP
	25858	PF w/o cortex	Biface trimming	2.00	25.58	17.63	4.94	VII	1271-1299 BP
	26033	PF w/o cortex	Biface trimming	0.30	17.44	18.03	1.67	VI	1215-1310 BP
	26184	PF w/o cortex	Biface trimming	1.30	19.88	24.60	3.76	VII	1271-1299 BP
	26186	PF w/o cortex	Biface trimming	0.50	21.55	13.99	2.19	VII	1271-1299 BP
	26699	Drill	Flake	0.70	23.88	13.13	2.93	IV	1139-1189 BP
	27166	PF w/o cortex	Biface trimming	0.40	12.68	15.77	2.29	VI	1215-1310 BP
	27686	PF w/o cortex	Biface trimming	0.50	15.01	14.39	2.70	VI	1215-1310 BP
	Mean			**0.75**	**18.53**	**16.23**	**2.93**		
Owyhee Canyon Group									
Coyote Wells									
	25396	PF w/o cortex	Biface trimming	0.60	25.66	12.69	3.35	VI	1215-1310 BP
	25407	PF w/o cortex	Core reduction	0.40	20.57	14.41	3.67	XVII	1191 BP
	25842	PF w/ cortex	Core reduction	1.90	20.66	21.23	5.99	VI	1215-1310 BP
	26036	Flake shatter		0.60	16.11	18.19	2.66	VI	1215-1310 BP
	26582	PF w/ cortex	Core reduction	1.40	21.60	18.42	4.49	VI	1215-1310 BP
	26810	PF w/o cortex	Biface trimming	0.90	24.40	16.93	2.01	II	--
	27531	PF w/o cortex	Core reduction	1.00	15.67	18.53	4.41	II	--
Coyote Wells East									
	27589	PF w/o cortex	Biface trimming	0.80	25.07	20.17	3.12	VII	1271-1299 BP
	27627	Flake tool	Unimarginal	6.10	37.88	27.73	8.18	II	--
	Mean			**1.52**	**23.07**	**18.70**	**4.21**		
Sourdough Mountain									
	25869	Flake shatter		1.50	21.86	16.43	6.29	X	--
	26564	PF w/ cortex	Biface trimming	0.90	28.33	12.59	3.25	VI	1215-1310 BP
	26565	PF w/o cortex	Biface trimming	0.40	14.81	13.67	2.47	VI	1215-1310 BP
	27240	Flake shatter		1.50	21.86	15.14	6.10	VI	1215-1310 BP
	27244	Flake tool	Unimarginal	2.20	16.55	27.89	6.72	VI	1215-1310 BP
	27560	PF w/o cortex	Biface trimming	0.30	16.33	16.03	1.71	VI	1215-1310 BP
		Mean		**1.13**	**19.96**	**16.96**	**4.42**		
Venator									
	26956	Flake tool	Unimarginal	1.60	25.03	21.26	4.21	VII	1271-1299 BP
	26957	Flake shatter		0.90	14.49	21.16	3.91	XIX	--
	27598	PF w/ cortex	Core reduction	2.20	20.91	25.60	5.95	XIX	--
	27685	Flake tool	Unimarginal	2.10	33.41	17.80	4.33	VI	1215-1310 BP
		Mean		**1.70**	**23.46**	**21.46**	**4.60**		
Owyhee Canyon Group Mean				**1.40**	**22.20**	**18.73**	**4.40**		
Unknown 1									
	26283	Hafted Biface	Northern SN	1.00	23.71	15.25	3.73	VI	1215-1310 BP
Unknown 2									
	27235	PF w/ cortex	Core reduction	7.00	44.29	20.16	8.32	VII	1271-1299 BP

-- no data

APPENDIX F

FAUNAL REMAINS

Awl/Needle

Inv#	Unit	Lv	Beg. Depth	End Depth	OT	RM	Ct	Comment
26105	N732-E1057	6	998.700	998.650	42	1	1	Awl tip
28325	N732-E1055	13	998.435	998.400	42	1	1	Awl tip
			Total				**2**	

Other Modified Bone

Inv#	Unit	Lv	Beg. Depth	End Depth	OT	RM	Ct	Comment
28487	N733-E1057	12	998.450	998.400	40	1	1	Unburnt Possible bead broken in manufacture

Fish Remains

Inv#	Unit	Lv	Beg. Depth	End Depth	OT	RM	Ct	Part	Burnt/ Unburnt	Diameter (mm)	Length (mm)	Fish Lenth Est. (mm)	Comment
										(Vertebra body only)			
26465	N733-E1057	7	998.700	998.650	45	1	2	Vertebra	Unburnt	4.7 5.11	4.35 4.16	307 294	
27255	N733-E1056	1	998.075	998.950	45	1	2	Cranial	Unburnt				Two matching halves
27357	N733-E1057	9	998.600	998.550	45	1	1	Vertebra	Unburnt	5.41	4.58	323	
27528	N732-E1055	22	998.100	998.055	45	1	1	Cranial	Unburnt				
28146	N732-E1055	6	998.800	998.750	45	1	1	Vertebra	Unburnt	2.87	2.97	209	
28344	N732-E1055	17	998.250	998.200	45	1	1	Vertebra	Unburnt	4.13	*	220	Ultimate Vertebra
28486	N733-E1057	6	998.750	998.700	45	1	1	Vertebra	Unburnt	2.9	2.46	173	
28488	N732-E1057	10	998.500	998.450	45	1	1	Vertebra	Unburnt	4.5	3.12	220	
28489	N732-E1055	13	998.435	998.400	45	1	2	Vertebra	Burnt; Unburnt	4.22 5.05	3.51 2.96	247 208	
28490	N732-E1055	14	998.400	998.355	45	1	1	Vertebra	Unburnt	3.18	3.06	215	
28492	N732-E1053	16	998.350	998.300	45	1	1	Cranial	Unburnt				
28493	N734-E1057	6	998.700	998.650	45	1	4	Cranial; Unknown; Vertebra	Unburnt	3.77	3.75	265	

28494	N734-E1057	4	998.800	998.750	45	1	1	Vertebra	Unburnt	3.87	*	268
28495	N732-E1053	15	998.400	998.350	45	1	1	Cranial	Unburnt			
						Total	**20**				*** lenth estimate used length from comperable diameter centrum in assemblage**	

Mammal Remains

Inv#	Unit	Lv	Beg. Depth	End Depth	OT	RM	Ct	Unid.	Size Class 1/2	Size Class 3	Size Class 4	Size Class 5	Flake	Cracked / Fractured
25318	N732-E1054	19	998.200	998.150	47	1	11	5				6		6
25338	N731-E1057	13	998.350	998.300	47	1	6	3				3	1	
25351	N732-E1055	19	998.150	998.100	47	1	3					3		3
25371	N732-E1052	14	998.350	998.300	47	1	1		1					
25383	N732-E1052	15	998.300	998.250	47	1	4	2		2				
25400	N732-E1052	10	998.550	998.500	47	1	2	1				1		1
25470	N732-E1054	13	998.400	998.350	47	1	1					1		1
25471	N732-E1054	13	998.400	998.350	47	1	80	50	30					
25489	N732-E1054	22	998.047	997.980	47	1	16		5	2		9	1	7
25499	N732-E1053	24	998.200	998.150	47	1	3	3						
25666	N732-E1052	16	998.250	998.200	47	1	1					1		1
25667	N732-E1052	16	998.250	998.200	47	1	1					1		
25668	N732-E1052	16	998.250	998.200	47	1	1					1	1	
25669	N732-E1052	16	998.250	998.200	47	1	1		1					
25677	N732-E1052	16	998.250	998.200	47	1	1					1		1
25805	N732-E1054	20	998.150	998.100	47	1	1	1						

25828	N732-E1056	16	998.250	998.200	47	1	2	2					
25840	N732-E1053	20	998.250	998.200	47	1	11	1			10		2
25865	N732-E1055	21	998.150	998.105	47	1	3		2	1			
25892	N730-E1057	17	998.200	998.150	47	1	1		1				
25899	N732-E1056	15	998.300	998.250	47	1	2				2		2
25903	N731-E1057	14	998.300	998.250	47	1	1				1		1
25928	N734-E1057	8	998.600	998.550	47	1	8	5	3				
25930	N734-E1057	6	998.700	998.650	47	1	90	50	13	17	10		7
25950	N734-E1057	4	998.800	998.750	47	1	20	9	4	6	1		
25979	N732-E1057	8	998.600	998.550	47	1	12	9	3				
25995	N733-E1057	8	998.650	998.600	47	1	2			2			
26030	N732-E1055	20	998.200	998.150	47	1	3	1		2			
26068	N732-E1052	11	998.500	998.450	47	1	1			1			
26104	N732-E1054	14	998.350	998.300	47	1	25	13	6	4	2		
26106	N732-E1057	6	998.700	998.650	47	1	3	1		1	1		1
26145	N733-E1057	6	998.750	998.700	47	1	17	3	4	9	1		1
26181	N732-E1052	19	998.290	998.250	47	1	6	1	5				
26234	N734-E1057	17	998.250	998.200	47	1	1	1					
26241	N734-E1057	12	998.400	998.350	47	1	5	4	1				
26279	N732-E1057	13	998.350	998.300	47	1	2				2		2
26302	N732-E1054	21	998.100	998.047	47	1	5				5		5
26316	N733-E1057	5	998.800	998.750	47	1	4		2	1	1		2
26333	N733-E1057	5	998.800	998.750	45	1	1				1	1	

26335	N731-E1057	8	998.600	998.550	47	1	4	4						
26357	N734-E1057	13	998.350	998.300	47	1	3	3						
26369	N732-E1055	18	998.200	998.150	47	1	7		6		1			
26392	N732-E1054	18	998.250	998.200	47	1	11			3		8		5
26404	N732-E1055	16	998.300	998.250	47	1	6	2	1	2		1		1
26428	N732-E1057	4	998.800	998.750	47	1	6	1				5		1
26443	N732-E1055	15	998.350	998.300	47	1	2	1				1		1
26464	N733-E1057	7	998.700	998.650	47	1	23			17		6		9
26493	N732-E1054	11	998.469	998.439	47	1	3	1		2				
26498	N732-E1055	14	998.400	998.350	47	1	16		16					
26511	N732-E1053	21	998.290	998.230	47	1	3	3						
26560	N732-E1053	14	998.450	998.400	47	1	28	20	5	1		2		
26574	N732-E1056	14	998.350	998.300	47	1	2	1	1					
26600	N732-E1053	16	998.350	998.300	47	1	1					1		1
26721	N732-E1056	8	998.650	998.585	47	1	19	5		8		6	1	7
26766	N734-E1057	11	998.450	998.400	47	1	2	1		1				
26775	N734-E1057	5	998.750	998.700	47	1	98	62	7	18		5		
26800	N732-E1053	18	998.290	998.250	47	1	36	34				2		
26838	N734-E1056	4	998.850	998.800	47	1	1			1				
26851	N734-E1057	9	998.550	998.500	47	1	11	2	5	3		1		
26861	N734-E1057	10	998.500	998.450	47	1	2	1		1				
26889	N734-E1057	2	998.900	998.850	47	1	3					3		1
26916	N734-E1057	3	998.850	998.800	47	1	1				1			

26936	N734-E1057	7	998.650	998.600	47	1	46	33	2	9		2		2
26944	N734-E1057	14	998.300	998.250	47	1	9	4		2		3		2
26951	N734-E1057	15	998.250	998.200	47	1	1					1		
26952	N732-E1051	1	999.326	999.050	47	1	2			2				
26978	N732-E1051	9	998.700	998.650	47	1	9	3		6				
26984	N732-E1052	1	999.166	998.950	47	1	1					1		1
26996	N732-E1052	3	998.900	998.850	47	1	1					1		
27002	N732-E1057	7	998.650	998.600	47	1	10	4	2	4				
27071	N732-E1053	13	998.500	998.450	47	1	46	23	14	3		6		5
27068	N732-E1053	13	998.500	998.450	47	1	1					1		1
27108	N730-E1056	5	998.800	998.750	47	1	1	1						
27122	N730-E1057	2	998.900	998.850	47	1	1	1						
27131	N730-E1057	4	998.800	998.700	47	1	1			1				
27162	N730-E1057	8	998.550	998.500	47	1	1				1			
27174	N730-E1057	9	998.500	998.450	47	1	4	3				1		
27190	N730-E1057	10	998.450	998.400	47	1	3	1		1		1	1	
27203	N730-E1057	11	998.400	998.350	47	1	1		1					
27213	N730-E1057	12	998.350	998.270	47	1	1		1					
27243	N730-E1057	15	998.250	998.200	47	1	14			14				
27274	N733-E1056	3	998.900	998.850	47	1	1					1		
27306	N733-E1056	5	998.800	998.750	47	1	16	14		1		1		1
27312	N733-E1057	2	998.950	998.900	47	1	1			1				
27358	N733-E1057	9	998.600	998.550	47	1	13		7	6				4

27368	N733-E1057	10	998.550	998.500	47	1	1		1					
27386	N733-E1057	12	998.450	998.400	47	1	27	22				5		2
27405	N733-E1057	13	998.400	998.350	47	1	2			1	1			
27424	N733-E1057	15	998.300	998.250	47	1	1					1		1
27443	N732-E1058	1	998.974	998.850	47	1	1					1		1
27468	N732-E1058	4	998.750	998.704	47	1	2	1	1					
27479	N732-E1057	2	998.900	998.850	47	1	1			1				
27499	N732-E1057	5	998.750	998.700	47	1	4			3		1		3
27556	N732-E1057	9	998.550	998.500	47	1	25	12	11	1		1		
27568	N732-E1057	10	998.500	998.450	47	1	15	11		1		3		1
27587	N732-E1057	11	998.450	998.400	47	1	9	8		1				
27597	N732-E1057	14	998.300	998.250	47	1	4	2	1		1			
27644	N731-E1055	5	998.800	998.750	47	1	2	2						
27668	N731-E1056	3	998.900	998.850	47	1	2		1			1		
27675	N731-E1056	4	998.850	998.800	47	1	3	3						
27684	N731-E1056	5	998.800	998.750	47	1	1		1					
27777	N731-E1057	9	998.550	998.500	47	1	3		2			1		
27811	N731-E1057	11	998.450	998.400	47	1	3	1		2				
27834	N731-E1057	12	998.400	998.350	47	1	14	9	4	1				
27866	N732-E1053	7	998.650	998.600	47	1	1	1						
27930	N732-E1053	12	998.550	998.500	47	1	11			1		10		
27961	N732-E1053	15	998.400	998.350	47	1	17	8	4	1		4		3
27971	N732-E1053	23	998.200	998.150	47	1	4		1			3	1	

27978	N732-E1053	25	998.150	998.100	47	1	5		4	1				
28030	N732-E1054	9	998.550	998.500	47	1	4	1	3					
28078	N732-E1054	12	998.439	998.400	47	1	1			1				
28091	N732-E1054	15	998.300	998.250	47	1	1					1		1
28094	N732-E1054	24	998.087	998.037	47	1	2	2						
28097	N732-E1053	6	998.700	998.650	47	1	4	2	1	1				
28118	N732-E1055	3	998.950	998.903	47	1	1					1		
28158	N732-E1055	9	998.645	998.600	47	1	2	2						
28176	N732-E1055	10	998.600	998.550	47	1	5	5						
28201	N732-E1055	11	998.550	998.500	47	1	36	7	19	10				
28239	N732-E1055	12	998.500	998.435	47	1	28	18	7	3				
28326	N732-E1055	13	998.435	998.400	47	1	49	19	16	12		2		2
28345	N732-E1055	17	998.250	998.200	47	1	4	1	1	2				
28397	N732-E1056	6	998.750	998.700	47	1	4		1	1		2		1
28423	N732-E1056	7	998.700	998.650	47	1	3	1				2		2
28432	N732-E1056	9	998.585	998.550	47	1	10	8	2					
28458	N732-E1056	10	998.550	998.500	47	1	16	6	3	4		3		2
28473	N732-E1056	11	998.500	998.450	48	1	2	1		1				
28484	N732-E1056	12	998.450	998.400	47	1	2					1	1	
28485	N732-E1056	12	998.450	998.400	47	1	1	1						
		Total					**1163**	**547**	**233**	**204**	**5**	**167**	**8**	**104**