Contributions to Anthropology, Number 13, Volume 1: Yellowstone Archaeology: Northern Yellowstone

Douglas H. MacDonald
Elaine S. Hale

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VOLUME 1: NORTHERN YELLOWSTONE

Edited by
Douglas H. MacDonald and Elaine S. Hale

The University of Montana
Department of Anthropology
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Craig M. Lee
List of Contributors

Jacob S. Adams
Department of Anthropology, Washington State University, Pullman, WA 99164
Email: jacobsadams@gmail.com

David S. Dick
Department of Anthropology, University of Montana, Missoula, MT 59812
Email: davidsdick@charter.net

Jannifer W. Gish
JG Research, 5621 Grant Ave. Loveland, CO 80538
Email: jgresearch@yahoo.com

Elaine S. Hale
Elaine Skinner Hale, Archeologist, RPA, Branch of Environmental Compliance, Yellowstone Center for Resources, PO Box 168, Yellowstone National Park, WY 82190
Email: Elaine_Hale@nps.gov

Mary Hektner
Branch of Environmental Compliance, Center for Resources, PO Box 168, Yellowstone National Park, WY 82190

Richard E. Hughes
Geochemical Research Laboratory, 20 Portola Green Circle, Portola Valley, CA 94028-7833
Email: rehughes@silcon.com

Craig M. Lee
University of Colorado, Institute of Arctic and Alpine Research, 450 UCB, Boulder, Colorado, 80309
Email: craig.lee@colorado.edu

Michael C. Livers
Department of Anthropology, University of Montana, Missoula, MT 59812
Email: mclivers@gmail.com

Lester E. Maas
Department of Anthropology, University of Montana, Missoula, MT 59812
Email: lester.maas@umconnect.umt.edu

Douglas H. MacDonald
Department of Anthropology, University of Montana, Missoula, MT 59812
Email: douglas.macdonald@umontana.edu

Robin J. Park
Branch of Environmental Compliance, Yellowstone Center for Resources, PO Box 168, Yellowstone National Park
Email: Robin_Park@nps.gov

Steven D. Sheriff
Department of Geosciences, University of Montana, Missoula, MT 59812
Email: steven.sheriff@umontana.edu

Pei-Lin Yu
Rocky Mountains Cooperative Ecosystem Studies Unit, NPS, Department of Anthropology, University of Montana Missoula, MT 59812, Email: pei-lin.yu@cfc.umt.edu
PREFACE

Douglas H. MacDonald and Elaine S. Hale, editors

Yellowstone National Park is a wonderful place, one of America’s true gems. While many folks think of the park as a sort of drive-through wildlife refuge, many don’t realize the deep prehistory and history of the park. Certainly, the Euro-American history of the park has been well-documented by Lee Whittlesey’s research as park historian. Loendorf and Nabakov, among others, have also provided an outstanding picture of Native American life in the park prior to Euro-American contact. However, the prehistory of the park is documented so far only in a few research articles and cultural resource management reports for highway and other infrastructure development projects in the park. This research has documented the rich prehistory of the park, but not in a way amenable to the public. The current volume takes some of those cultural resource management studies and synthesizes them into one research volume for the northern area of the park.

Many of the papers in the current volume were originally prepared for a seminar at the 2010 Plains Anthropological Conference in Bismarck, North Dakota. These papers have been refined and other papers added to complete this volume. We plan to finalize a second volume—fittingly entitled Yellowstone Archaeology, Volume 2: Southern Yellowstone—for the southern portion of the park in 2012. The University of Montana, among others (University of Wyoming, Lifeways of Canada, Midwest Archaeological Research Center), have been working in the southern park area for many years now, providing a rich body of knowledge from which to form the second volume.

This current volume on northern Yellowstone includes several papers (Chapters 1-7) by University of Montana students, staff, and faculty from the Departments of Anthropology. All of these individuals—Doug MacDonald, Michael Livers, Jacob Adams, Lester Maas, Steve Sheriff (Geosciences), and David Dick—worked on our 2007-2008 Montana Yellowstone Archaeological Project, otherwise known as MYAP. Now entering its fifth year in 2011, the MYAP’s first two years were devoted to completing an archaeological study of 3,000 acres of hot and dry terrain within the Gardiner Basin, between approximately Yellowstone’s North Entrance in Gardiner on the south and Reese Creek (the northern park boundary) on the north. This work was funded by Yellowstone, the University of Montana (College of Arts and Sciences, Department of Anthropology, and the Provost’s Office), and the Rocky Mountain Cooperate Ecosystem Study Unit (RM-CESU) of the National Park Service. This latter organization’s involvement was crucial to the project’s success, spearheaded by then cultural resources coordinator for the RM-CESU, Christine Whitacre.

Along with numerous graduate student staff and undergraduate field school students, the University of Montana worked with Yellowstone National Park staff Mary Hektner, Elaine Hale, and Ann Johnson to document archaeological resources in the 2007-2008 survey area (known locally as the Boundary Lands); this project is summarized in Chapter 1 of this volume. David Dick provides a summary of his University of Montana thesis research at the historic train town of Cinnabar in Chapter 2, while Steve Sheriff provides his results of sub-surface imaging of that site in Chapter 3. The volume than focuses on the prehistory of the Gardiner Basin and surrounding areas, with an overview of the prehistory and prior research by Maas et al. in Chapter 4.

MacDonald and Maas provide a summary of Late Archaic research in the Gardiner Basin in Chapter 5, while Livers studies the Late Prehistoric use of stone circles in the Gardiner Basin in Chapter 6. In Chapter 7, Adams et al. compare Late Archaic and Late Prehistoric lithic raw material use in the Gardiner Basin, focusing especially on comparing prehistoric use of Obsidian Cliff obsidian and Crescent Hill chert. Archaeobotanist Jennifer Gish compares ethnobotanical results from Gardiner Basin prehistoric sites in Chapter 8, while Robin Park analyzes the cultural dimensions of lithic use in Yellowstone in Chapter 9, summarizing the results of her wonderful Master’s Thesis from the University of Saskatchewan. Finally, Chapter 10 provides details of Craig Lee’s outstanding ice patch archaeology in the high peaks of Yellowstone’ northern range. We hope you enjoy this collection of ten papers on the historic and prehistoric archaeology of the northern portion of Yellowstone National Park. We certainly enjoyed working on these projects and hope the research proves useful.
CHAPTER 1
PREHISTORIC/HISTORIC ECOLOGY AND LAND RESTORATION WITHIN THE GARDINER BASIN, YELLOWSTONE NATIONAL PARK

Douglas H. MacDonald, Elaine S. Hale, Pei-Lin Yu, Mary Hektner, and David S. Dick

Introduction

Archaeological and paleoenvironmental data collected within the Gardiner Basin of Yellowstone National Park provide an excellent window into changing land-use patterns during the Holocene within the Greater Yellowstone Ecosystem (GYE). The Gardiner Basin is the lowest-elevation portion of Yellowstone National Park and is located between Township of Gardiner, Montana, and Yankee Jim Canyon, a distance of about 10 miles along the Yellowstone River (Figure 1). While various environmental and ecological changes occurred during the Holocene—including oscillating precipitation and temperature trends—Native American hunter-gatherers used the area for 11,000 years until the onset of Euro-American homesteading. The homestead and National Park eras disrupted the well-established cultural ecology of the Gardiner Basin. Recently, Yellowstone National Park recognized the deteriorated condition of the area. The Gardiner Basin Restoration Project is an attempt to re-establish native plant communities within the basin, in essence bringing it back to the ecological conditions present during much of prehistory.

This paper will provide an overview of the pre-European paleoenvironment of the Gardiner Basin, as well as a brief overview of Native American use of the area during the last 11,000 years. We then discuss historic data, as well as results of archaeological excavations at Cinnabar (Yellowstone’s original train station) and other archaeological sites in the area, to provide insight into how land-use changed during the last century. Finally, we discuss Yellowstone’s efforts to restore the former agricultural fields to native vegetation. We use site-specific archaeological, paleoenvironmental, and historical data to better understand the Gardiner Basin’s historic and prehistoric ecology from a landscape perspective. By building data from specific sites, we hope to come to grips with the changing ecology and human adaptation within the entire landscape.

Ecology and Environment of the Gardiner Basin

On its surface, the Gardiner Basin appears to be an area in which human habitation has been a struggle; certainly the historic use of the area might reflect some difficulty in adapting to the brutal heat of the summer, contrasted by the sometimes harsh winters. However, does the prehistoric record show a similar human struggle? How did people use this landscape prior to the arrival of Europeans? In the end, what would the Gardiner Basin look like today if Europeans had never arrived? What is a “pristine” Gardiner Basin? Is it when hunter-gatherers were present, say prior to 300 years ago? Is it when no people were present, say prior to
12,000 years ago? Obviously, figuring out what “pristine” means is difficult; however, for the purposes of this paper, we mean ground conditions as they were prior to the arrival of European-Americans, or approximately before 1800 A.D.

Landscapes are comprised of various interconnected resources, including rivers, mountains, springs, plants, insects, and animals, including humans. The current composition of resources in the Gardiner Basin includes a variety of species adapted to a marginal environment. The Gardiner Basin is ecotonal in character, with the Rocky Mountains bordering it to the west and east, the Yellowstone Plateau bordering it to the south, and the Great Plains bordering it to the north. The basin is thus surrounded on three sides—east, south, west—by high-elevation landforms. It is for this reason that the Northern Pacific Railroad decided to proceed no further than Gardiner in its installation of tracks into Yellowstone National Park along the Yellowstone River. Beyond Gardiner, to the south, the rugged conditions of the Black Canyon of the Yellowstone and the steep terrain of the Gardiner River to Mammoth Hot Springs, effectively marked the town of Gardiner as the last stop. Today, it is the last stop for tourists entering the park through the North Entrance. After Gardiner, the wilds of Yellowstone begin.

This modern use of the area is reflected in its historic use. The Gardiner Basin has always been used as a staging area to enter the park. Early brochures tout Gardiner as the ideal location through which to enter the park. Beginning in 1903, the railroad stopped there and people then used wagons and eventually motorized vehicles to venture southward into the park. Even today, the Gardiner Basin is home to Yellowstone’s northern corral operations, evidence of the continued use of the adjacent geography for trip staging. For many people who live in Gardiner, Montana, the area of our study is often referred to as the Boundary Lands.

The Boundary Lands is a fitting name for the area, not just for the historic, but also for the prehistoric, periods. Native American hunter-gatherers used the basin as a launching point from which to obtain obsidian tool stone from Obsidian Cliff, among a host of other natural resources. Historically, late 19th and early -20th century Europeans focused on alleviating the harsh setting of the Boundary Lands. For those of you who are unfamiliar with the Boundary Lands—or Gardiner Basin—it is generally hot and dry in the summer and cold and fairly dry in the winter as well. Ideally, it is comprised of sagebrush/grassland steppe vegetation, but historic use of the area has resulted in mostly non-native weeds.


The Yellowstone River flows northwesterly through the basin, acting as the Yellowstone National Park’s northern boundary. Reese Creek is a free-flowing stream which marks the dogleg of the park boundary, a few miles north of the North Entrance arch. The Rocky Mountains—including the majestic Electric and Sepulcher peaks at 10,992
and 9,652 ft above mean sea level—mark the Gardiner Basin’s southwest boundary. One can literally walk straight east, west, or south into the heart of the Rocky Mountains from the Boundary Lands. A northward trek brings you through Yankee Jim Canyon to the glorious Paradise Valley and on into the grasslands of the Great Plains.

Other interesting geological features of the Boundary Lands include glacial moraines and outwash features, reflecting the melting and receding of the glaciers more than 12,000 years ago. Glacial meltwater washed through the Gardiner Basin, leaving huge piles of glacial debris in the otherwise flat glacial valley of the Yellowstone River. After the retreat of the glaciers, a large landslide of waterlogged soils washed over the Gardiner Basin just north of Gardiner, pushing the mighty Yellowstone River northward to its current channel. Evidence of this landslide is glaringly apparent today as one drives along Route 89 just north of Gardiner. Landslide Creek borders the gigantic landslide feature to its north. Numerous small ponds and spring seeps characterize the landslide area above the Gardiner Basin.

The elevation of the Gardiner Basin is approximately 5,300 feet, compared to the elevation of Mammoth Hot Springs of 6,500 ft. and of Yellowstone Lake at 7,800 ft. At this comparatively low elevation, the Gardiner Basin is within the rain shadow of the Madison and Absaroka-Beartooth mountain ranges. The area typically receives less than 10 inches of precipitation per year, and stays relatively free of snow. Summertime temperatures can exceed 100 F. There is a reason that the Gardiner Basin is a wintering grounds for a huge array of ungulates, including bison, antelope, elk, and deer. In winter especially, the Gardiner Basin is somewhat of an oasis, with comparatively mild winters compared to the bordering landscapes, making vegetation available year round; in summer, the situation reverses and the oasis is the high-elevation Yellowstone Plateau and the low-elevation Gardiner Basin is harsh, dry, and hot.

Gardiner Basin Prehistory & Paleoenvironments
Because of its low-elevation and comparatively warm weather compared to the surrounding area, not only has it always served as a wintering ground for ungulates, but also for hunter-gatherer peoples—Native Americans between 11,000 and 300 years ago. In the following, we characterize more fully the human use of the Boundary Lands, in light of archaeological, paleoenvironmental, and historic data. Dates utilized in this discussion are in uncalibrated radiocarbon years.

Until at least 12,000 years ago, the Gardiner Basin was filled with glaciers, and melt water formed the incipient Yellowstone River. Global warming caused the melting of the glaciers and by 11,000 years ago, hunter-gatherers occupied or travelled through not just the Yellowstone Valley and the GYE, but also all of the Americas. Most of the Upper Yellowstone region probably resembled glacial-edge landscapes that are visible in places like the Brooks Range in Alaska today, with meltwater streams, swamplands, and otherwise harsh conditions. Paleoenvironmental data indicate that emergent tundra was dominant in the post-glacial Yellowstone Plateau (Huerta et al. 2009).

For reasons of scanty populations that kept on the move, and a dynamic environment that erased archaeological sites, Early Paleoindian sites are fairly rare in the Yellowstone ecosystem. Only two 11,000 year old Clovis projectile points have been found in the Gardiner area, one during construction of the post office and one by the University of Montana (UM) near the old town site of Cinnabar (MacDonald et al. 2010). A very small number of Clovis points of Obsidian Cliff obsidian indicate that the earliest human use of the GYE was in part motivated by the need for high quality stone for projectile point manufacture. The closest substantial Clovis site to the Gardiner Basin is the Anzick Clovis burial site, north of Livingston (Lahren 2006). Certainly, Clovis people were in the GYE, but their population densities were very low.

There is little evidence of intensive use of Yellowstone Park until the Late Paleoindian period, approximately 9,000 years ago. Until that time—between 11,000 and 9,000 years ago—paleoenvironmental data suggest that the Yellowstone Plateau and the far upper reaches of the Yellowstone River (including the Gardiner Basin) were in a period of environmental transition from tundra to pine and spruce parkland. Summer temperatures and winter moisture both increased at this time. By 9,000 to 8,000 years ago, however, those transitional, post-Pleistocene conditions gave way to a more stable environment which was exploited by Native
American hunter-gatherers at sites like Osprey Beach on the southern shore of Yellowstone Lake (Johnson 2001; Shortt 2003). As reported by Cathy Whitlock (Whitlock et al. 1991, 1995) of Montana State University, pollen profiles for ponds and lakes in northern Yellowstone indicate a climate that was wetter than today, with more pine-juniper-birch and less Douglas fir. Forest fire frequency was also fairly low at this time (Huerta et al. 2009). Native Americans hunted and gathered a wide variety of resources within the Yellowstone region, including bison, deer, bighorn sheep, bear, rabbit, among others (Sanders 2001). Fish was not a significant portion of the diet, even at sites along rivers and lakes.

Between 8,000 and 5,000 years ago, climate conditions changed throughout the region, bringing a fairly hot and dry climate dubbed the altithermal climatic period by Ernst Antevs (1953). The altithermal has been documented in other regions throughout North America, particularly the Great Plains (Meltzer 1999). In the Gardiner Basin and the northern range of Yellowstone, paleoenvironmental data collected by Whitlock (Whitlock et al. 1991) among others suggest advancing forest and steppe vegetation after 7,600 years ago. Sagebrush and native short grass prairie pushed into the area at the expense of the pine parkland.

After 8,000 years ago, human occupation of the GYE was focused in the uplands to escape the hot and dry lowlands. For example, Mummy Cave (Husted and Edgar 2002) near the East Entrance to the park—elevation of 6,215 ft.—and the Fishing Bridge Point Site at Yellowstone Lake (MacDonald and Livers 2010)—elevation 7,800 ft.—indicate fairly active use of high-elevation river valleys and lake resources during this period. At Yellowstone Lake, grassland steppe vegetation dominates during this period, whereas prior to 8,000 years ago, pine and spruce are much more common (Huerta et al. 2009).

The dominance of grass pollen is a testament to the dramatic climate change that occurred during the altithermal at high elevation settings like Yellowstone Lake; it was so severe that forests in uplands around the lake were replaced by grasslands. Forest fire frequency also increased during the mid-Holocene, likely due to the increased summer insolation of the altithermal (Millspaugh et al. 2000). The increase in fire frequency is likely attributable to both cultural and natural mechanisms. Natural fire events increased due to the hot and dry climate; however, the role of Native Americans should be considered as well. It was common for Native Americans to use controlled fire to improve forage for prey species or for other purposes.

In the Gardiner Basin, grasslands faltered under increasing summer temperatures of the altithermal, forcing game, and in all likelihood, people into uplands. During the University of Montana archaeological survey of the Gardiner Basin in 2007-2008 (Maas and MacDonald 2009), the University of Montana did not recover any Early Archaic (Altithermal period) artifacts in this hot low-elevation landscape. In contrast, UM recovered several projectile points and a hearth feature of Early Archaic age at the high-elevation Yellowstone Lake (MacDonald and Livers 2010). These data support the hypothesis that hunter-gatherers probably travelled through places like the Gardiner Basin in their quest to get to cooler, more biodiverse locations like Yellowstone Lake. It was during this period that Pleistocene bison—*Bison antiquus*—became extinct, while the modern *Bison bison* emerged due to its ability to adapt to the harsh conditions of the Altithermal.

After 5,000 years ago—during the Middle Plains Archaic period—large bison herds emerged on the landscape with the ameliorating climate and increasing biomass of improved grasslands. During this period, paleoenvironmental data indicate increased moisture and decreased summer insolation bringing back short-grass prairies to the Gardiner Basin, with decreasing sagebrush and increasing stands of pine in well-watered areas (Huerta et al. 2009). Pollen profiles at Middle Archaic and Late Archaic sites in the Gardiner Basin show a dominance of pine, sagebrush, and grass, a similar type of pollen profile that we would see in undisturbed areas today (Gish 2010). Thus, it is at this time—between 5,000 and 3,000 years ago—that the essentially “modern” or “pre-contact” landscape emerged in the Gardiner Basin, as well as throughout the Plains and Rockies. The essential character of the environment at 4,000 years ago more or less resembled that of 300 or so years ago prior to the arrival of Europeans.

The most intensive period of use in the Gardiner Basin during all of prehistory was the last 5,000 years, peaking between 3,000 and 1,500 years ago, when grasslands sustained large herds of ungulates. Blood
residues on projectile points, as well as faunal remains from archaeological sites, indicate that a variety of game were hunted by Native Americans living in the Gardiner Basin and Greater Yellowstone (Sanders 2001). While the period between 3,000 and 1,500 years ago marks the emergence of the classic Plains Bison Hunting Culture, people living in the Greater Yellowstone Ecosystem (GYE) utilized a wide range of hunted and gathered resources.

While prior research suggests a drop-off in use of the Yellowstone region during the 1,500 years prior to European-American contact (Johnson 2001:82), UM’s recent research suggests active use of the Gardiner Basin and Greater Yellowstone during this period (MacDonald 2010). UM has excavated several Late Prehistoric features—fire pits and hearths, mostly—and projectile points which indicate active use of a variety of Late Prehistoric resources, including widespread use of plants, such as cheno-ams (herbaceous forbs from the goosefoot and pigweed families) likely used as a flavoring or moisture protectant during the roasting of game. Chenopodium seeds are edible as well.

Research certainly indicates that Yellowstone was used by Native Americans until Euro-American encroachment in the area. Two of UM’s three excavated hearths from the 2008 work at the Airport Rings stone circle site just north of Gardiner show use of tepee structures as recently as 250 years ago (Livers and MacDonald 2010). Two hearths at Yellowstone Lake near Fishing Bridge yielded dates within the last 250 years as well. Archaeological data from these sites in the GYE show continued hunting and gathering of the vast variety of resources in the region, including active use of Obsidian Cliff obsidian and a variety of game and plants.

Pollen and ethnobotanical analysis of those Late Prehistoric features’ contents provides an interesting window into the types of plants in the area just prior to European contact with native peoples (Gish 2010). Pollen profiles contain a variety of native arboreal species, including pine, spruce, douglas fir, Juniper, and elm, likely representing wind-blowen pollens from trees in nearby uplands. Non-arboreal pollen within the Late Prehistoric features include native grasses, greasewood, sagebrush, and goosefoot (chepodium), all of which might have been used as wild resources by Native American hunter-gatherers. Macrobotanical plant fragments were also recovered in the features, indicating processing of prickly pear cactus and goosefoot as food and sagebrush as firewood. This suite of native plants suggests that the Gardiner Basin, despite its dry and arid condition, provided ample vegetation for hunting and gathering people to live quite comfortably.

However, while we have abundant archaeological and ethnoarchaeological evidence which indicates active use of the park’s land by Native American hunter-gatherers, linking specific tribes to the park’s prehistory continues to be a challenging task. There are few historic accounts of Native American use in northern Yellowstone National Park after the park’s creation in 1872. This is mainly due to efforts by the early administrators of Yellowstone National Park to downplay or eliminate Indian involvement and usage of the park, intended to encourage American and European tourists to feel safe after the 1877 Nez Perce encounter in the park and the 1878 Bannock War. In general, though, most of the more contemporary sites, dating from about A.D. 1500 onward, are dominated by Shoshone, Blackfoot, Crow, and Salish tribes (Nabokov and Loendorf 2002).

At 1500 A.D., the overall ecological setting of the Gardiner Basin was similar to today, with the exception that at that time, the vegetation was dominated by a variety of native grasses and shrubs. Today, as described below, while sagebrush remains ever present, non-native grasses and invasive weeds dominate the former agricultural fields.

**Historic Use of the Gardiner Basin**

The introduction of European-Americans into the Gardiner Basin was fairly devastating to the local ecology. Agriculture (plowing and irrigation for crops) and cattle grazing removed most native vegetation on the tilable, non-rocky areas, and non-native weeds now dominate the abandoned fields. To track this change, we now provide a brief overview of the historic use of the Gardiner Basin, with an eye on the major differences with its use compared to the prehistoric period.

While a definitive date for the establishment of the first Euro-American settlement in the Gardiner Basin is unknown, Lee Whittlesey’s research suggests that James Henderson and his brother A. Bart Henderson established residence in 1871 when they built their “Bozeman toll road” along the Yellowstone River (Whittlesey 1995). The next recorded settlement in the
The project area was George W. Reese in April 1875. In 1880 the town of Gardiner was founded at the mouth of the Gardiner River by James McCartney after he and Harry Horr were evicted from their illegal hot-springs bathing business site near Mammoth Hot Springs. One of the first structures erected in the Gardiner area was a horseracing track on the southern side of “Gardiner Flats”, southwest of the North Entrance Station (Whittlesey 2008).

During their ownership of the ranch, George Reese and his sons had at least three different ranch houses in the area. A portion of Reese’s property (likely a right of way) was sold to the Northern Pacific Railroad (NPRR) in June of 1883 (Whittlesey 1995). The right of way now allowed the Northern Pacific Railroad to bring its tracks to within three miles of Gardiner. According to Whittlesey, during this same year Hugo John Hoppe established his homestead just south of the Cinnabar town site on August 4th and moved his family there (Dick and MacDonald 2010).

Historic accounts and early photographs of Cinnabar confirm the rather bleak aesthetics of the town. A visitor who passed through Cinnabar in August 1884 stated that the town consisted of “four houses and a depot in a box car” which indicates that the town had not grown much in the year since its founding. By 1885, an actual building had been established as a depot, while a traveler to the town described Cinnabar as “a few ranches, a hotel, two or three stores, twice as many saloons, a few private houses, and the railroad depot.” (Whittlesey 1995). The saloon was located just south of the hotel. It is not clear where the other saloon was located. Hoppe eventually owned a hotel with a dining room, a saloon, large barn, warehouse, and general store. The store was run by Billy Hall who founded the Hall Company in Gardiner. Later that summer, Hoppe built a livery stable, blacksmith shop, mill, icehouse, and other homes (Dick and MacDonald 2010).

The Northern Pacific railroad was finally extended to Gardiner on December 15th, 1902, which signaled the collapse of Cinnabar. After the Park Line extension of the railroad into Gardiner, several businesses left Cinnabar and relocated to Gardiner. In 1903, President Theodore Roosevelt visited Yellowstone and his train was parked for sixteen days at Cinnabar instead of Gardiner (Whittlesey 1995). The Cinnabar Hotel became the “temporary White House” during his visit. Roosevelt held many of his cabinet and presidential details in the hotel. After Roosevelt’s stay, however, Cinnabar was largely abandoned and the area quickly reverted to ranch land.

In the 1930s, over 7,000 acres of this area were added to the northwest corner of Yellowstone National Park though purchase and eminent domain to provide key low elevation winter range for elk, pronghorn, bison, and deer. Approximately 700 acres of the addition were irrigated agricultural fields. Following acquisition, the park ceased irrigation and seeded the fields to crested wheatgrass (Agropyron cristatum), an exotic perennial grass which was recommended because it was aggressive, would crowd out weeds, was drought resistant, undergoes early green up and was (erroneously) thought to provide better forage than native plants. It thrived and for many decades was almost the only plant species present.

**Fixing Historic Damage to the Gardiner Basin**

The overall effect of this historic use of the area was a complete removal of nearly any native vegetation in the lowland tillable flat areas along the Yellowstone River. Without vegetation to hold the soil in place, wind can cause significant soil movement and degradation of the soils. The University of Montana’s archaeological excavations at Cinnabar revealed the extent of the wind erosion in the Gardiner Basin. UM’s excavations focused on the basement to Hoppe’s hotel, abandoned in the earliest 20th century soon after Roosevelt’s stay. At the time of the abandonment, the hotel was removed, leaving the basement open to the elements. During the next 100 years or so, the 5-ft.-deep and 2,500 sq.ft. basement filled with approximately 12,500 cubic feet of sediment, evidence of the extreme erosion due to westerly winds blowing through the basin.

Figure 2 shows a profile of UM’s excavations within the hotel foundation, revealing layer upon layer of eroded, wind-blown sediment. Other evidence of the historic use of Cinnabar has been nearly erased from the ground surface, with most former building locations completely invisible on the ground surface.
UM’s use of sub-surface imaging technology facilitated the identification of buried house features that were otherwise not observable on the ground surface at Cinnabar (Sheriff et al. 2009).

As revealed by UM’s archaeological work at Cinnabar, while the Gardiner Basin was utilized for agriculture for less than 60 years, the effect was fairly devastating. Today, the former fields are dominated by non-natives: crested wheatgrass, a remnant of the park’s post acquisition seeding efforts, and an exotic mustard, desert alyssum (Alyssum desertorum). In drought years even those weeds suffer in the heat of the Gardiner Basin, leaving large patches of vegetated soil, vulnerable to even more wind erosion. The current vegetation provides poor forage for ungulates and the physical and ecological condition of these sites continues to degrade. The park has attempted a variety of native vegetation experiments that have failed. In retrospect, they were too small in scale, too short term, and failed to recognize the special remedial actions needed to repair these degraded semi-arid soils so that they can again sustain the native vegetation.

Restoring a Ruined Landscape

In recognition of the deteriorated condition of the area, Yellowstone National Park has begun a long-term pilot restoration project for the former agricultural fields. The goal of the project is to restore ecologically sustainable native plant communities. While revegetation projects had been successfully completed in other areas of the park, none were in as dry and hot a landscape as the Gardiner Basin.

Led by Mary Hektner and colleagues from the Yellowstone National Park Center for Resources, the Gardiner Basin Restoration Project proposes to restore native plant communities to approximately 700 acres of former agricultural fields between Gardiner and Reese Creek. Recognizing that the park staff did not have the experience in arid land restoration that was needed, the park joined with Gallatin National Forest and the Montana State University-based-Center for Invasive Plant Management to convene a restoration workshop in April 2005. Ten specialists in arid land restoration were invited to help Yellowstone and Gallatin National Forest (which acquired similar former agricultural lands for wildlife habitat adjacent to the park) develop recommended long-term restoration/ management plans for approximately 1,200 acres of former agricultural fields within Yellowstone and Gallatin National Forest.

The workshop resulted in recommended strategies and extended timeframes to restore a mosaic of sustainable native plant communities that provides wildlife habitat and forage. Desired species include, but are not limited to Sandberg’s bluegrass (Poa secunda), bluebunch wheatgrass (Elymus spicatus), needle and thread (Hesperostipa comata), Junegrass (Koeleria macrantha), Indian ricegrass (Achnatherum hymenoides), wild onion (Allium textile), winter fat (Krascheninnikovia lanata), saltsage (Atriplex garderni), rabbit brush (Ericameria nauseosa and Chrysothamnus viscidiflorus), greasewood (Sarcobatus vermiculatus), western wheatgrass (Elymus smithii), Wyoming Big Sage (Artemisia tridentata var. wyomingensis) and prickly pear cactus (Opuntia polyacantha). As discussed above, archaeological features from the Airport Rings stone circle site just north of Gardiner contained several of these very species.

Four pilot areas totaling 50 acres were fenced in 2008 and 2009. The first 23 acre site which was fenced in 2008 was treated with herbicides and no-till drill seeded to a
cereal barley crop in the spring of 2009. It and a 7 acre pilot site was no-till drill seeded to winter wheat in September 2009 and barley in May 2010. The other two pilot sites were treated with herbicides in May 2010. All four units were seeded to winter wheat in September 2010. No-till drilling of the native grass seed is scheduled for the fall of 2011 and fall of 2012.

Ultimately, the Gardiner Basin Restoration Project has noble goals, especially in a setting as hot and dry as Gardiner Basin. Once the natives take hold, though, the portion of the Gardiner Basin within Yellowstone National Park will greatly resemble the world inhabited by Native American hunter-gatherers prior to European-American contact. The project may become a model for other agencies with similarly-disturbed, high-and-dry landscapes. Park management is thus an important, and enduring, phase of human occupation that has shaped the Gardiner Basin in the Late Holocene, and will provide an interesting phase for our descendants to consider in the long history of Yellowstone National Park.

References


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CHAPTER 2
CINNABAR: ARCHAEOLOGY AND HISTORY OF YELLOWSTONE’S LOST TRAIN TOWN

David S. Dick

Developed in consort with Yellowstone National Park archaeologists, Ann Johnson and Elaine Hale, and The University of Montana (UM) Department of Anthropology, the Montana Yellowstone Archaeological Project—MYAP—is a long-term research project into the prehistory and history of Yellowstone National Park (YNP). The initial 2-year research plan between 2007-2008 entailed a comprehensive survey and evaluation of archaeological resources in a ca. 3000-acre tract along the Yellowstone River between the newly-constructed Heritage and Resource Center (HRC) on the south and the park boundary near Gardiner, Montana, on the north (see Figure 1, last chapter) (Maas and MacDonald 2009). Much of this research in 2007-2008 was devoted to studying Yellowstone’s original train town, Cinnabar.

This paper provides archaeological results of the MYAP’s 2007-2008 test excavations at Cinnabar, Site 24YE355 (Dick et al. 2010). Cinnabar was established in the early 1880s as the train station for tourists coming to visit the newly-established Yellowstone National Park. There is nothing left at Cinnabar accept some depressions that show the former locations of buildings and a few scattered historic artifacts. Due to possible impacts from a proposed reseeding vegetation project led by the YNP Center for Resources (directed by Mary Hektner), the University of Montana (UM) was called upon to define the boundaries of Cinnabar and determine its eligibility for listing on the National Register of Historic Places. As such, UM’s work at Cinnabar was completed under the auspices of the National Historic Preservation Act Sections 106 and 110 which require federal agencies to consider the impacts of projects on cultural resources (Section 106) and to provide inventories of cultural resources on their lands (Section 110). In addition to the requirements of the NHPA, the project required an Archaeological Resource Protection Act (ARPA) permit and a Yellowstone National Park (NYP) scientific research and collecting permit (No. YELL-SCI-5656) to conduct archaeological fieldwork in YNP during the summers of 2007-2008.

As shown in Figure 1 of the previous chapter, Cinnabar is located adjacent to the Yellowstone River northwest of Gardiner in Park County, Montana. The project area is within the far northern portion of Yellowstone National Park, north of the famous North Entrance arch and northwest of the recently-constructed Heritage and Research Center (HRC) in Gardiner.

Historic Context

To understand the history of Cinnabar we must begin with the first settlers in the Cinnabar Basin. This chapter utilizes data collected by Yellowstone National Park historical archivist Lee H. Whittlesey, who wrote “They’re Going to Build a Railroad!”: Cinnabar, Stephens Creek, and the Game Ranch Addition to Yellowstone National Park” and “A History of the Gardiner Hay Ranch ("Gardiner Flats") Area East of the Roosevelt Arch at Gardiner, Montana” as well as other literary resources. These works provide a comprehensive historic overview of the northern Gardiner Basin, or Boundary Lands, portion of Yellowstone National Park.

While a definitive date for the establishment of the first settlement in the boundary lands project area is unknown, we know that James Henderson and his brother A. Bart Henderson established residence by 1871 while they built their “Bozeman toll road” (Whittlesey 1995). Yellowstone National Park was established on March 1, 1872, through the “Act of Dedication” on the authorization of President Ulysses S. Grant. The park quickly became a destination for wealthy tourists desiring to explore the “Wild West”. The establishment of the town of Livingston, Montana, in 1882 facilitated access to the park.

The next recorded settlement in the project area was George W. Reese in April 1875. When Captain William Ludlow passed the area in August 13th, 1875 on military patrol, he noted that there were only two ranches in the area (Whittlesey 1995). It is presumed that the Reese property had a useful ferry across the Yellowstone river, as a government surveyor described Reese’s ranch as having “a store and a ferry” in 1879 (Whittlesey 1995).
Hoppe played a vital role in creating the landscape at Cinnabar, although it is not clear whether Hoppe sold or leased his properties. With several proprietors listed for the hotel and livery, it may have been the latter as the properties always ended up in Hoppe’s hands.

Hugo Hoppe was born into the house of Hans Carl Leopold von der Gablentz, the Premier of the Prussian/German Ducedom of Saches-Altenberg. In 1850, Hans Hugo Fredrich Emil (Hugo John) Hoppe accompanied his father to the United States. Throughout his life, Hugo longed to live the life he was accustomed to back in Germany. It was this lust for wealth that led Hoppe into the goldfields of California, the silver mines of Nevada, and the gold rushes of Alder and Last Chance Gulch. For Hoppe the news of these strikes always came too late to cash in on the riches. The final strike at Last Chance Gulch was the turning point for Hoppe, after years of searching for his riches, the mining claims finally paid out (Whittlesey 1995).

News about the Northern Pacific Railroad and its plans to run a spur down to Yellowstone National Park sparked Hoppe’s imagination of the future. Hoppe resigned from his post as sheriff of Custer County, making plans to build a great town at the terminus of the Northern Pacific. By 1884 Hoppe had the beginnings of what he had hoped would be a great western town, one that would rival those around the region. These hopes were bolstered by the freighting business that Hoppe had owned and those of the mining riches that Hoppe had would be transported out of the region through his new town. As stated earlier, by 1884 Hoppe had built several buildings including the hotel, saloon, livery, and general store. It was these buildings that a visitor in 1884 had seen.

In 1887, a side track was laid at Horr, a mile north of Cinnabar, to assist in transportation of coal and coking operations. By 1887, Owen Wister stated that businesses were becoming well established. E.J. Keeney is said to have established and ran the hotel, livery, and feed stable that summer. Keeney stated that he purchased the land from Hoppe, but that it was he who built the structures not Hoppe. It seems unlikely that Keeney built the structures that he claimed to because they were reported by previous travelers prior to Keeney living at Cinnabar. In 1887, Buffalo Bill Cody arranged to audition riders, ropers, and other performers for his 1887 tour of
Buffalo Bills Wild West Show in Europe (Moore 2008). A
newspaper article dated 1891 stated that Mrs. Kenney
was running the hotel during that time. Due to limited
information on record of the transactions in the Cinnabar
Basin, it is unclear as to the extent that Hoppe played in
the later years of his life. It is during this period that
properties seem to move fluidly through several
individuals.

During the spring, summer, and fall of 1883, the
Northern Pacific Railroad laid the Park Branch up the
Yellowstone River from Livingston, Montana to Cinnabar
establishing the first rail line to Yellowstone National
Park. While the Northern Pacific Railroad’s original
intention was to extend the railroad for another three
miles to Gardiner, Montana, they were halted by their
inability to purchase land or right of way across Buckskin
Jim Cutler’s land which was directly in the path of the
railroads expansion (Whittlesey 1995). Buckskin Jim
jumped the original claim that was on this property, and
subsequent legal battles reverted the property back to its
original owner who subsequently decided not to assist
the Northern Pacific. This is what brought Hoppe to
Cinnabar. The town of Cinnabar received its first post
office on June 20th, 1882. The original Cinnabar was not
much of a town until the railroad reached Livingston on
January 15, 1883 (Whittlesey 1995). The first official
train service to Cinnabar began September 1, 1883,
though some records indicate unofficial rail service
earlier in the summer (Whittlesey 1995). Hoppe’s dream
of a prosperous town was never realized. Hoppe died a
year after his wife in 1895 several years before the
Northern Pacific Railroad acquired the rights for the Park
Line extension.

The railroad was finally extended to Gardiner on
December 15th, 1902, which signaled the collapse of
Cinnabar as predicted by one of the residents. After the
Park Line extension of the railroad into Gardiner, several
businesses left Cinnabar or relocated to Gardiner. Even
with the extension of the railroad to Gardiner, Cinnabar
still had some life left. In 1903, President Theodore
Roosevelt visited Yellowstone and his train was parked
for sixteen days at Cinnabar instead of Gardiner
(Whittlesey 1995). The Cinnabar Hotel became the
“temporary White House” during his visit. Roosevelt held
many of his cabinet and presidential details in the hotel.

The depot at Cinnabar officially closed on May 3rd,
1903 while the post office lasted until June 15th, 1903.

After the collapse of Cinnabar, the area quickly
reverted to ranch land. The most notable ranch was
owned by the Hoppe family. Questionable land
distribution practices among those families in Cinnabar
Basin led to many legal battles, which took many years to
work out (Whittlesey 1995).

Following the presidential proclamation of October
20, 1932, 7,609 acres were added to Yellowstone
National Park, about 1,163 acres of privately held land
remained within the boundaries of the new park
boundaries (Whittlesey 1995). After legal and political
debates, Yellowstone National Park acquired the
remaining lands at the end of 1939 and in early 1940
(Whittlesey 1995).

**Archaeology of Cinnabar**

Yellowstone National Park called upon the University
of Montana to identify the location of Cinnabar, as its
specific location had largely been lost during the 20th
century. Using the archaeological survey methods
described in Dick et al. (2010), the University of Montana
team identified two main areas of historic artifact
concentrations, including the Cinnabar dump (Area C)
and Cinnabar (Area B), immediately west of Area C on
the western side of the railroad berm. We focus
hereafter on the archaeological results from Area B,
Cinnabar.

One of the main goals of fieldwork was to map and
excavate the former town site of Cinnabar, or Area B of
Site 24YE355. The ultimate purpose of work at the site
was to determine Cinnabar’s potential eligibility for
listing on the National Register of Historic Places. Work at
Cinnabar was comprised of two main phases, including:
1) Initial Phase I survey and mapping; and 2) Phase II
excavations. UM mapped the distribution of features in
Area B, Cinnabar, and subsequently excavated several
prominent features at the site.

To determine site boundaries of 24YE355 at Cinnabar,
the UM team conducted close-interval pedestrian survey
of the entire area between the old Yellowstone Road in
the east and the foothills in the west, as well as between
a large hill in the north and the edge of the expansive
field in the south. The boundary to the south was less
well-defined by geographic features and also was most
uncertain in terms of Cinnabar’s limits. Results of the Phase I survey indicated a concentration of artifacts and features approximately within the center of the surveyed area. As mapped in Figure 1, Cinnabar measures approximately 325 m (1000 ft.) north-south adjacent to the Old Yellowstone Road and approximately 185 m (590 ft.) east-west. The total acreage of Cinnabar is approximately 13.5 acres within the basin between the Old Yellowstone Road and the former Northern Pacific railroad berm in the east and the foothills to the west.

No surface artifacts were collected during this phase of work at Cinnabar. The MYAP team recorded nine surface features across the site, each of which is shown in the planview map. Each of these features is in the central portion of the site, designated by a broad array of surface scatter of historic materials, including wood, brick, glass, and metal fragments. The only portion of the site with the potential to yield information from excavation is the area that encompasses the features. The core of the site that contributes to NRHP-eligibility measures 125 m (400 ft.) east-west and 190 m (610 ft.) north-south for a total of 5.6 acres. The remaining 7.9 acres surrounding this core area lacks features and does not contribute to the site’s eligibility for listing on the National Register of Historic Places.

Archaeological Excavations at Cinnabar

After mapping the surface distribution of artifacts and features (Figure 1), the UM team excavated several of the substantial depressions—the hotel, store, privy, blacksmith shop, and livery among others—to determine their integrity and potential to yield information regarding the historic use of the site. Six test units were excavated in 2007 with an additional sixteen in 2008.

Feature 2 Excavations, Cinnabar, 24YE355 Area B.

Ground Penetrating Radar (GPR) was used to locate

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Figure 1. Planview of Cinnabar with Excavation Features Noted.
subsurface structures located in Feature 2, likely the Cinnabar Hotel. The GPR investigation showed a subsurface anomaly present in the vicinity of Feature 2 and appears to be a foundation wall. The GPR was unable to determine depth or other extent of the wall within the Feature 2 at Cinnabar. As such, the MYAP team conducted excavations in Feature 2 to determine the depth and extent of the possible sub-surface foundation present in the large depression (Figure 2). A large broken rectangle of river cobbles roughly surrounds the large depression and it was thought (prior to excavations) that the cobbles could be the upper tier to a shallow cobbled building foundation, as preliminarily determined by the GPR study. The overall size of Feature 2 depression is approximately 13 m north-south and 13 m east-west. The foundation tapers downward from its exterior walls to a central depth of approximately 25 cm below ground surface. An interior wall is located in the central portion of the feature as well, also marked by a line of cobbles on the ground surface. This interior wall was the focus of excavation in TU 6.

Test Units (TUs) 1 and 4 were located in the northwestern corner of Feature 2 (Figure 2), while TU 6 was located on the central interior wall in an area with a line of 7-8 large cobbles. TUs 1 and 4 were placed in order to encounter the foundation’s corner, while TU 6 was placed adjacent to the line of rocks to determine the depth and means of construction of the interior cobbled wall.

Results of Excavations, TUs 1 and 4, Cinnabar (Area B, 24YE355). As discussed above, TUs 1 and 4 were placed as a 1x2-m block on the far northwest corner of the largest rectangular depression in Area B. Figure 2 shows the wall in planview in TUs 1 and 4. An assortment of large river cobbles followed the corner and it was thought that this might mark the corner foundation of the building. As such, we excavated two test units along the northern wall along the line of boulders. Excavation of the test units was difficult due to the presence of the wall; the initial 10-cm level entirely exposed the upper row of cobbles. As such, the remainder of excavation was focused on exposing the interior portion of the wall in TUs 1 and 4, south of the cobble wall (Figure 2).

Interior of the wall, excavations revealed assorted cobbles and mortar that had tumbled from the wall itself; sediment appears to be comprised of tannish brown aeolian silt, but may contain backfill as evidenced from the material collected in each level of excavation. Excavations proceeded in 10 cm levels within the tight space between the foundation wall and the southern test unit walls. Upon excavation of three 10-cm levels, the corner of the wall was clearly visible in planview and in profile. Excavations proceeded in 10-cm levels to a depth of 110 cm below datum, or 100 cm below ground surface. No additional excavations were possible beyond this point, due to the narrow space in the base of the test units. In the end, a full meter of the interior corner wall of the foundation was exposed in TUs 1 and 4. The wall was comprised of large river cobbles plastered together with mortar. The wall contains two tiers of cobbles, one interior and one exterior. Upon excavation, the corner of the foundation wall was clearly visible in planview and is pictured in Figure 2.

![Figure 2. Planview of Feature 2 Depression (Corner, Hotel Foundation) showing the Locations of TUs 1, 4, and 6, Cinnabar, Area B, 24YE355.](image-url)
Fragments of metal and other structural debris were observed and collected in TUs 1 and 4, as were fairly abundant faunal remains and samples of the mortar which held together the cobbles. In total, 1,835 artifacts were recovered from the interior wall of TUs 1 and 4, including 1,553 historic-period artifacts and an additional 282 faunal remains. The historic-period artifacts were dominated by domestic refuse, including 833 kitchen-related artifacts (53.6%), 238 machine part fragments (15.3%), and 296 architectural/building artifacts (19.1%).

were largely found toward the bottom of the excavations in levels 6-8. The base of the floor slopes downward from the edge of the wall in TU 4 toward the interior of the wall; thus, TU 1 was excavated more deeply with artifacts occurring deeper in the profile as well.

As revealed in Figure 3 below, the diversity and abundance of faunal remains from this area confirms the general kitchen-related use. Eight different animal types were recovered from TUs 1 and 4 in the northwest corner of Feature 2. Of the 282 total fragments of bone, only 88 could be identified to genus or family, with dog/coyote (n=24) and large ungulates (n=20) comprising the majority. Eleven fragments of yellow-bellied marmot and cow/bison were recovered, while 10 grouse/chicken bones were also found in Feature 2. Bird (n=7), ungulates (n=3) and bushy-tailed woodrat (n=1) round out the faunal assemblage from the northwest corner of Feature 2. Of the 288 faunal remains, 13 showed evidence of cutting or sawing, while 58 showed burn marks. Overall, the faunal assemblage from the northwest corner of Feature 2 indicates the processing and cooking of a variety of wild and domesticated animals in or near the

![Figure 3. Summary of Faunal Remains (Common Names) from Feature 2, TUs 1 and 4, Cinnabar (Area B), 24YE355.](image-url)
kitchen/dining room of what may be the remains of the Cinnabar Hotel. The high ratio of dog/coyote may stereotype the Chinese, but it appears that these remains may be from butchering. A further analysis is needed to distinguish the general characteristics of butchery marks and pot polish to see if these were actually cooked. Unfortunately, due to the fragmentary nature of the remains, it was difficult to identify genus or species, with most being characterized by size.

Results of Excavations in TU 6, Interior Wall, Feature 2, Area B (Cinnabar). Excavations in TUs 1 and 4 were successful in defining the limits of the corner foundation wall of the largest structure at Cinnabar. While excavations did not reach the base of the cobble wall in these two test units, excavations in TU 6 were successful in that regard. TU 6 was placed along a row of river cobbles that was thought to mark the interior central wall to the large structure (Photograph 2).

Based on the few cobbles on the ground surface, the interior wall of Feature 2 was thought to be no more than a few cobbles deep; however, excavation in TU 6 revealed an entirely larger wall than anticipated. Layer after layer of aeolian-deposited silty sand were exposed in the test unit and the base of the cobble wall was still not determined. Finally, after excavation of 17 10-cm levels, the base of the cobble wall was identified at a depth of 170 cm below datum (bd) or 160 cm below surface, or precisely 5 ft. deep. An additional 10-cm level was excavated beyond the wall base to ensure that we had reached the bottom (Figure 4, Photograph 2).

As with the corner wall discussed above, this portion of the wall is comprised of two tiers of cobbles, one interior and one exterior. The wall apparently was built within an excavated basement, as no evidence of a trench wall was observed in the test unit profile (Figure 4). The basal layer of sediment is a light brown sand, which may have been laid on the basement floor during its use or prior to construction. The profile of TU 6 shows alternating bands of wind-blown sediment which completely in-filled the basement of the structure after its removal (Photograph 2; Figure 4).

Assuming that the structure was moved to Gardiner or elsewhere in 1903 (as suggested by historical and informant accounts), an estimated rate of aeolian deposition is possible for the basement. Sixty inches of sediment were deposited between 1903 and 2007 (104 years) for a deposition rate of approximately 0.57 inches (1.6 cm) per year. A small charcoal sample was collected from approximately 1.2 m deep in the southern wall and could provide additional data on rates of deposition.

Photograph 2. Profile of North Wall of TU 6 showing Cinnabar Hotel’s Cobble Foundation, Feature 2, 24YE355.

Only 139 artifacts were recovered in the interior wall portion of Feature 2, compared to more than 1,300 artifacts that were recovered in the corner of Feature 2 in TUs 1 and 4 (discussed above). TU’s 1 and 4 seem to be limited to the kitchen/dining room. Of the 1,300+ artifacts located in these units other than the architectural materials, one Chinese porcelain sherd was recovered which may indicate a link to the Chinese cook. There were also some personal items recovered that points to a feminine presence at the hotel. These personal effects were also recovered from TU’s 1 and 4.

In great contrast to the corner area, no faunal remains were recovered from the interior wall portion of Feature 2. In fact, the few artifacts recovered in TU 6 are largely restricted to mortar (59%) and wood fragments (40.3%). No ceramics, glass, or other similar items were recovered in the interior portion of Feature 2. In general, this portion of the feature was cleaned fairly well prior to demolition and little refuse was deposited during use of the structure.
24YE355b FT 2 Inside Wall
TU 6 East Wall Profile

A 10YR7/11 light grey dry / blocky
B 10YR5/2 grayish brown sand
C 10YR6/2 light brown grey dry blocky clay
D 10YR7/2 dry silty clay
E 10YR7/2 light grey blocky dry clay
F 10YR7/2 light brownish grey silty clay w/ 10YR7/8 yellow mottling
G 10YR3/2 very dark greyish brown clay w/ charcoal (possible brush fire)
H 10YR5/2 greyish brown dry blocky clay
I 10YR5/3 brown silt w/ 10YR6/2 light grey mottling
J 10YR5/3 brown sand

Figure 4. Profile of East Wall, TU 6, Showing Edge of Feature 2, 24YE355.
Based on Phase II excavations in TUs 1, 4, and 6, Feature 2 is the basement of a large square 13x13-m (41x41 ft.) building. The 5 ft. deep basement foundation walls are comprised of interior and exterior walls constructed from river cobbles and mortar. Cobbles were likely procured from the nearby Yellowstone River, approximately 0.5 mile east. The basement walls were constructed upon the basement floor; no evidence of trenches was visible in either the corner wall at TUs 1 and 4 or the interior wall at TU 6. Thus, the 5 ft. deep basement was dug prior to wall construction, then the walls were built on the layer of sand (and were not laid within trenches).

After the building’s removal to Gardiner in 1903 or soon thereafter, the basement was left open for 100 years, with only wind-blown silt and sand filling it up over time. However, the northwest corner of the basement indicates that it was in or near the kitchen, as evidenced by abundant kitchen-related artifacts and faunal remains.

Historic records and ethnographic interviews indicate that the largest building at Cinnabar was the Cinnabar Hotel; as such, until additional information becomes available, it is assumed that Feature 2 is the remains of the Cinnabar Hotel. Given the large amount of faunal remains, the northwest corner of the structure likely was near the kitchen/dining room, where they apparently processed a wide variety of wild and domesticated birds and mammals.

Feature 5 Excavations, Cinnabar (24YE355, Area B). Approximately 40 m (128 ft.) south of Feature 2, the MYAP team excavated three 1x1-m test units (TUs 2, 3 and 5) within an apparent entry/exit way to a fairly large rectangular building depression, Feature 5 (Figure 5). Feature 5 measures 7 m (22 ft.) east-west and 10 m (32 ft.) north-south. Feature 5, thus, is approximately half the size of the larger Feature 2 described above. Two entry/exit ways are present, one in the southeast corner and another in the center of the western edge of the depression. Only a few cobbles are visible on the ground surface in this location around the wall perimeter, as are isolated brick fragments around

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**Figure 5. Planview of Feature 5 Depression, Cinnabar (Area B), 24YE355.**
the edges of the depression. Based on these initial data, it seems likely that the basement was excavated and a small tier of bricks and perhaps cobbles were then laid as the foundation, upon which was likely a wooden structure.

UM excavations in Feature 5 were focused on the western entry/exit way. The entry/exit is marked on the ground surface by a depression measuring approximately 3.5 (11.1 ft.) m east-west and 2.1 m (6.7 ft.) north-south. Brick and small metal fragments were visible on the ground surface surrounding the entry/exit way. Two 1x1-m test units—TUs 2 and 5—were placed at the very end of the exit/entry way, parallel to its apparent wall. The goal was to excavate the test units to reveal the outline of the foundation feature. In order to further explore the depression, a third 1x1-m test unit (TU 3) was placed immediately east of TU 2. Thus, excavations in Feature 5 consisted of an L-shaped 1x2-m block around the very edge of the exit/entry way.

After removal of an initial 10-cm level of wind-blown sediment, UM encountered a dark brown stain shaped in an arc around the far western edge of the exit/entry way. Each of the three test units was excavated down to contact with the feature stain and then the feature walls were excavated within 5-cm levels to its base, following the edges of the feature to define its shape. The exit/entry way was only approximately 5-cm deep at its far western edge near the exterior wall, but became gradually deeper as it proceeded eastward into the center of the basement. As such, at the far eastern wall of TU 3, the exit/entry way measured 20 cm deep.

Based on excavation of TUs 2, 3, and 5, the exit/entry way consists of a shallow (5-20 cm) depression that gently slopes from west to east from the edge of the structure to its center. The depression likely functioned as an exit/entry way from the exterior of the structure directly into the basement. Based on the large amount of trash in the feature, as discussed below, it may have also functioned as a refuse disposal area.

In contrast to the interior wall portion of Feature 2 described above, which revealed few artifacts, Feature 5 revealed a dense midden of historic-period debris, including abundant glass, metal, ceramic, and faunal artifacts. As with the corner portion of Feature 2, it appears as if trash was deposited into the feature upon removal of the exterior structure and/or during its use.

Feature 2 yielded a total of 3,582 artifacts, including 3,261 historic-period items and 321 faunal remains.

Kitchen items dominate the Feature 5 artifact assemblage (50.7%, n=1654), with assorted metal fragments also prevalent (32.9%, n=1072). Among the most interesting artifacts from Feature 5 are newspaper fragments from Livingston, Montana, as well as boot leather and revolver bullets that date to the late 19th century. In general, these historic artifacts are similar in type to the northwest corner of Feature 2; however, the diversity is greater, with more evidence of general domestic debris, rather than exclusively kitchen debris. These items confirm the late-19th century period occupation at Cinnabar. The newspaper dates to 1929 and likely reflects casual discard after the abandonment of Cinnabar.

As with the northwest corner of Feature 2, Feature 5 yielded abundant faunal remains (n=321), most of which (n=230) were unidentifiable to animal genus or family (Figure 6). Of the 91 bones that were identifiable, dog/coyote (n=44) and untyped even-toed hoofed mammal (n=16), such as deer/elk/bison/pronghorn, dominate the assemblage, similar results to Feature 2 above. As reflected in Figure 6, cow/bison (n=7), elk (n=5), pig (n=4), chicken/grouse (n=3), chicken (n=3), black bear (n=2), woodrat (n=2), deer (n=1), horse/donkey (n=1), and untyped hoofed animal (n=1) round out the Feature 5 faunal assemblage. Of the 321 bones in Feature 5, only five (1.6%) showed evidence of modification, with all having saw marks, and none of the bones in Feature 5 showed evidence of burning.

The bone modification data from Feature 5 contrast with those in the northwest corner of Feature 2, in which more than 20 percent showed burning and 5 percent showed evidence of sawing/cutting. In contrast, the bones in Feature 5 seem to be largely unprocessed, or at least lack obvious signs of processing. Interestingly, there is a higher incidence of wild animals in Feature 5 as well, with black bear, deer, coyote, and elk all identified to genus (Figure 6). The precise cause of the differences in degree of game processing and quantity of wild game between the two features is uncertain. Local informants indicate the presence of a bear trap upslope on Stephens Creek west of the project area. Perhaps individuals who used Feature 5 participated more in hunting wild game than those in Feature 2 (hotel).
As with the northwest corner of Feature 2, the smaller Feature 5 exit/entry way contains abundant artifacts, which indicate a largely domestic occupation. However, Feature 5 contains more wild game and less intensive animal processing than Feature 2. In contrast to Feature 2 which likely functioned as a hotel or similar structure with a kitchen, Feature 5 may have been a residence or a small business/residence (restaurant, butcher, or saloon). The domestic nature of the artifacts—kitchen items, newspapers, leather fragments, etc.—and the faunal remains (including black bear, chicken, cow, deer, dog/coyote/elk, horse, and pig) supports this assertion. The high ratio of dog/coyote again appears as a stereotypical Chinese influence as evidenced in the previous section. This may also point to dog fighting in the “old west”. Unfortunately, background research is insufficient to provide additional information regarding who may have lived in Feature 5 or what its overall function was within Cinnabar.

**Feature 6 Excavation, Cinnabar, 24YE355 Area B.**
During the 2008 field season, a large depression in the far southwestern corner of the site was identified during archaeological survey. Identified as Feature 6, it was presumed to be the location of the privy. The depression had been filled with many old steel pails, bedsprings, and many historic glass bottle shards. It was determined from the surface collection to have a high probability for being a privy associated with the site due to the high quantity of surface artifacts and smaller size for a feature. The depression was approximately 3.5 m north-south and 3.5 m east-west and 1.5 m in depth below the ground surface.

One test unit was laid directly in the center of feature 6. Test Unit 8 was placed in the middle in hopes that we would come down upon a fertile layer of soil that would support the preliminary interpretation for feature 6 having been a privy. TU 8 was placed in the center of Feature 6. The TU was placed as a 1x1-m unit within feature 6. Prior to excavation, several surface artifacts had to be pulled out of the depression and the native grasses were trimmed in order to place the TU on plane. TU 8 was taken down 10 cm at a time or until a there was a visible strata change. This TU proved to provide the highest ratio of historic artifacts at this site. This particular TU produced artifacts down to a depth of 90 cm from the opening depth. Every 10 cm exposed numerous shards of glass bottles, hundreds and
sometimes thousands of metal fragments, ceramics, and faunal remains.

The soil was comprised of dark grayish-brown Aeolian silt down to around 70 cm. Below 70cm the soil changed to a very dark brown loamy silt with significant organic deposition. The last 30 cm show that this feature was the privy. The organic deposition signifies the depth of the last period of usage prior to backfill with domestic refuse and soils. While it is probable that the privy maintains integrity since being backfilled, it is difficult to get an accurate date because the stratigraphy was modified during the backfill process. The top 70 cm appear to have been filled with many different artifacts that were manufactured during many different years (Dick et al. 2010).

The profile of the north wall revealed that the privy was used at a later date to discard much of the refuse from the town of Cinnabar. The wall was primarily bare with two distinct horizons. The upper stratum was littered with glass, nails, a railroad spike, metal springs, metal lashing, and several other metal fragments along with two distinct oxidized sections from metal contact. The lower stratum included faunal remains, leather, and had a high concentration of earthworm activity.

In total, the artifact counts for the privy were very high. Metal fragments and glass shards were the highest ratios. Metal fragments added up to approximately 11,686 pieces, which includes pieces down to approximately 1/8th of an inch. The glass shards included partial bottles and glass stoppers. These shards added up to 577 shards of glass down to approximately 1/8th of an inch. There were also approximately 38 pieces of historic ceramics, 22 pieces of wood timber, 5 bone fragments, and 3 pieces of sulfur. The highest ratio of historic artifacts were metal which made up approximately 94.8% of the artifacts in the privy, glass made up about 4.7%, while the ceramics, wood, bone fragments, and sulfur accounted only for 0.5%. The metal fragments appear to be from several sources, primarily metal cans, but not exclusively. There were several other metal sources that could have contributed to the metal fragments in each level of the excavations.

In addition to providing one of the highest concentration of artifacts, the privy also contained some interesting and unusual historic artifacts. The high concentration of glass and metal artifacts likely indicates that this privy may have seen communal use.

The historic artifacts from the privy included many bottles, ceramics, ammunition, and several clothing accessories. During the excavation of level five, the crew unearthed a suspenders clip, corset stay, a glass stopper from a likely vial of holy water or medicinal bottle, and an empty whiskey bottle. This assemblage of artifacts speaks to a likely interesting archaeological site formation story, as detailed in a summer, 2008 newspaper article on the site in the Bozeman Chronicle (McMillan 2008).

Probably the most interesting artifact from the privy was a cartridge recovered in level nine of the privy (Photograph 3). The dimensions for the bullet classify the cartridge as being in the .64 caliber family. Unfortunately, none of the dimensions of the cartridge match any known cartridge ever in production. Subsequent examinations of the artifact show that someone tried to remove the projectile by cutting into the casing.

More in-depth examination of the cartridge was conducted, using X-Ray technology provided by Adair Kanter, a Radiological Technician at Health Services of the University of Montana Curry Health Center. Also, Pepper Burruss, Head Athletic Trainer for the Green Bay Packers and President of the International Ammunition Association, examined the cartridge, revealing that it has a broken internal spring. After consulting with several other archaeologists, the unknown cartridge is a head spacing cartridge that allows for testing the head spacing of a belt-fed .64 caliber machine gun, probably a Gatling Machine Gun.

Photograph 3. Cartridge Recovered from Privy at Cinnabar.
Feature 7 Excavations, Cinnabar (24YE355, Area B). Feature 7 is located approximately 35 m (114.8 ft.) east southeast of Feature 6. Feature 7 measures approximately 8 m north-south and 8 m east-west (Photograph 4). Upon investigation of the area surrounding Feature 7, several key artifacts were located that allowed the preliminary identification of blacksmith shop. Among the artifacts were unusually high concentrations of charcoal and slag, metal goods (i.e. horseshoes, springs, and tools), an unusual central fire place/pit that was circular in nature with orange and reddish brown firebrick, and a wood plank board. A secondary feature of the BSS was a clearly visible outline of a structure that had been etched into the soil from a building that left its mark long ago.

Seven 1x1-m test units were excavated at Feature 7 (Photograph 4). Starting from approximately 8 cm below the datum, TU 9 was excavated three levels to a depth of approx 24 cm. Within these three levels, UM uncovered a ceramic pipe, metal springs, a horseshoe, obsidian, and more wood planking. One of the more interesting finds was the cover plate for a harmonica.

The goal of excavations at Feature 7 after finding the wood plank boards was to determine the extent of the timber flooring. TU 15 was excavated directly southwest of TU 9 following the wood planking. TU 15 was excavated three levels similar to TU 9. TU 15 started at approximately 8 cm below datum and was excavated to a depth of approximately 22 cm. The primary artifacts located in TU 15 were the wood plank boards, while secondary artifacts included glass shards, metal fragments, slag, a ceramic sherd, and orange firebrick. The wood planking contained large metal driving nails.

Following the timber plank boards, TU 16 was excavated west of TU 15, adjacent to TU 15. TU 16 started approximately 9 cm below the datum and was excavated down three levels to a depth of approximately 16 cm. TU 16 proved to follow from the first two excavated test units, following the timber plank boards. Again, the plank boards proved to be the primary artifact of the excavated unit, with secondary artifacts being comprised of glass shards, metal fragments, slag, charcoal, and mortar. TU 18 was excavated northwest of TU 15 and northeast of TU 16. TU 18 started at approximately 11 cm below the datum and was excavated three levels to a depth of approximately 23 cm. TU 18 continued following the timber boards hoping to excavate a majority of the flooring for the BSS. TU 18 was primarily comprised of the timber flooring with some glass shards, metal fragments, and ceramics as secondary artifacts.

After closing out the final test unit, we were able to determine the orientation of the blacksmith shop and using the artifact counts were able to substantiate this feature as being associated with the blacksmith shop. The blacksmith shop was mostly oriented north-south. It is difficult to determine the exact size of the blacksmith shop given that we only have a portion of the floor beams left at the site. It most likely was constructed as a timber plank structure. The final plan view shows the extent of the timber floor boarding. Using historic photographs, we could also substantiate the site as the Blacksmith Shop (Dick et al. 2010).

Photograph 4. Feature 7, Blacksmith Shop Wood Flooring After Excavation.
Conclusion

After President Grant signed The Act of Dedication in 1872, Yellowstone Park started seeing its first visitors to the park. The long overland trips were dirty and hot. This led to the railroad battle to see who could lay the first line to the park. It was at this time that Hoppe and others headed toward the park to establish towns that could accommodate the large influx of visitors that were expected to arrive to share in the wonders of the natural beauty that Yellowstone offered. The public plans presented by the railroads allowed Hoppe to find a location near the north entrance to the park and establish the location as Cinnabar, Montana.

The location chosen by Hoppe was an ideal spot because of the large flat basin. It was also along the historic Nez Perce Trail which included two skirmishes with American settlers that were trying to establish homesteads in the Cinnabar basin. It was also the exact spot that the Northern Pacific Railroad Company had decided to be the terminus for their Yellowstone spur.

Hoppe banked the majority of his savings that Cinnabar would become the largest town to service Yellowstone National Park. Hoppe built much of what we see in historic photos from the late 1800’s. Alas, Hoppe was to lose his dream because the Northern Pacific wanted to own the town at its terminus and plans were made to purchase a site a few miles south of Cinnabar. Unfortunately, Hoppe passed away prior to the completion of the new town of Gardiner, Montana. People who had built at Cinnabar tore down their structures and transported them to Gardiner. This was the last straw for Cinnabar as future visitors would bypass the small town for the hustle and bustle of the park town.

The remains at Cinnabar consist of several depressions that are visible from the surface and a scattering of historic artifacts across the boundary lands of Cinnabar (Photograph 5). There were two foundations uncovered during excavation. These foundations were the most significant finds in terms of building materials. The basement walls of the hotel show great integrity and used local materials for the construction of the 5-ft.-deep river cobbles foundation. The blacksmith shop still retains its timber flooring, but has experienced weathering due to the minimal covering of sedimentation at the site. The most amazing array of cultural materials came from the privy. The features associated with the general store and the restaurant/saloon show moderate integrity, but there are little surface features with the general store and the restaurant/saloon has slight integrity issues with the foundation walls appearing to have slightly collapsed inward after the abandonment of the site. The other features and test units around Cinnabar show little to no cultural materials that are diagnostic or have been disturbed by surface work.

The University of Montana excavations at Cinnabar—Area B of 24YE355—were extremely productive. Data were collected that convincingly show that this portion of the site is Cinnabar. Artifacts support the period of occupation—1883-1903—and informants confirm the location was Cinnabar. While a newspaper fragment bearing a 1929 date was recovered, it is interpreted to be discard by later individuals passing by the site; its provenience near the ground surface supports this hypothesis. The location of the nine features adjacent to the road and railroad, in addition to historical documents and photographs (see Dick et al. 2010), also support the contention that Area B of 24YE355 is Cinnabar.

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CHAPTER 3
TOTAL FIELD MAGNETIC EXPERIMENTS AT A HISTORIC TOWN SITE, YELLOWSTONE NATIONAL PARK, USA: AEROMAGNETIC TECHNIQUES AND ARCHAEOLOGICAL TARGETS

Steven D. Sheriff

Introduction
The Montana-Yellowstone Archaeological Project, a joint endeavor of The University of Montana Department of Anthropology and Yellowstone National Park, studies the prehistory and history of the northern portion of Yellowstone National Park (MacDonald 2008). The historical component of interest entails identifying the former location and extent of Cinnabar (see map in prior chapter), the original Northern Pacific Railroad depot for visitors to Yellowstone National Park between 1883 and 1903.

The main area of Cinnabar contains the remains of 11 building foundations, identifiable as depressions upon the current ground surface (see Figure 1 in prior chapter). Yet a modern layer of up to 10 cm of silty aeolian sand complicates recognition of the vestiges of old structures in much of the area.

Individuals traveling to Yellowstone on the railroad photographed the central areas of Cinnabar during the late-19th century. Limited oral history along with two old photographs provides some guidance to the limits of Cinnabar. The historic photographs also helped corroborate archaeological field efforts within specific building foundations, such as the hotel, store, privy, and blacksmith shop. The area southeast of central Cinnabar (see Figure 1, last chapter) lacks building foundations, any adequate photography, or any surface-indication of former buildings. However, the area contains a scatter of historical debris, a possible indicator of buried archaeological deposits associated with Cinnabar. We chose to assess a portion of the area with total field magnetic observations in order to delineate buried or otherwise obscured features from the outlying parts of Cinnabar. Such exploration yields guidance for subsequent archaeological test units.

Archaeological geophysicists commonly choose to use magnetic gradiometry over total field magnetics at both historic and prehistoric sites (e.g. Aspinall, Gaffney, and Schmidt, 2008). Measuring total field intensity is often a better choice because measuring the gradient of the magnetic field accentuates the signal from debris lying on or near the surface (where visual detection is more efficient) at the expense of subtle signals from buried features. Magnetic gradiometry also requires closer sample intervals due to the more rapid decrease of anomalies with distance than that for total field intensity. Consequently, acquisition of total field intensity observations can speed field time.

At historic archaeological sites in the western United States, scattered ferromagnetic debris seems ubiquitous. This randomly scattered debris complicates magnetic surveys and interpretation at historic town sites (e.g. Kvanme, 1998; Larson et al., 1999), particular mining towns, in the western United States. Such debris may include steel cans, lumber, horseshoes, nails, roofing steel, machinery parts, and other cultural artifacts such as flower containers in cemeteries. In archaeological work at such sites we typically seek signals from residential foundations, building perimeters, or perhaps corral and stable boundaries. Those features of interest usually have a length scale of meters to several meters or more. The lower part of that spatial range is also the upper range of magnetic anomalies from the surface litter. We locate and map that debris when it lies on the surface. Unfortunately the magnetic signal of ferromagnetic surface scatter, with its steep gradients and high amplitudes, dominates contour scales and obscures more subtle anomalies having longer spatial wavelengths. Often we wish to separate the signals from sources at varying depths with different spatial dimensions.

Separating the longer wavelength anomalies from deeper sources with respect to shallow sources requires collecting observations of total field magnetic intensity as opposed to magnetic gradiometry. Separation filtering of potential fields is a classic topic including techniques in the Fourier domain (e.g. Syberg, 1972; Jacobsen, 1987) or using wavelet transforms (e.g. Fedi and Florio, 2003;
Paoletti et al., 2007). The filtering we find most appropriate and successful for separating sources on or near the ground surface from those buried in the shallow subsurface is matched filtering (Syberg, 1972; Phillips, 2001). Matched bandpass filtering entails fitting the radially averaged power spectrum of the total field magnetic data with a series of power spectra corresponding to simple equivalent layers at the archaeological site. For data with little impact from surface debris upward continuation by an amount equal to one half the line spacing works well.

Beyond matched filtering and upward continuation, we successfully treated our total field data to other processing techniques standard in aeromagnetic and ground magnetic exploration for mineral and energy resources using readily available software. These techniques include decorrugarion (Urquhart, 1988), the pseudogravity transform Baranov (1957), and calculation of the horizontal and total gradients for edge detection. Though not commonly used in archaeological applications, we exploit these methods not only for experimentation but because they offer a number of advantages for filtering noisy data, separating sources, edge detection, and preparation for existing visualization and inversion packages (e.g. MAG3D, 2007).

Excavation of test units following the magnetic survey and our processing clearly indicate the remains of a buried domestic feature, perhaps the foundation to a house or other building, associated with the late-19th to early-20th century use of Cinnabar. The application of matched filtering to another test plot demonstrates its ability to filter the effects of scattered surface debris. Thus, application of these processing techniques in areas of archaeological interest with difficult acquisition situations or substantial surface scatter is worthwhile.

Magnetic Survey

We acquired total field magnetic intensity observations (figure 3) at 5 Hz while walking bidirectional transects spaced one meter apart using a Geometrics G858 Cesium vapor magnetometer. We used ropes and tape measures for spatial guidance during acquisition. Walking marked lines typically adds noise to the desired signal due to mislocations, sensor movement, variable walking speeds, and directionally dependent sampling frequencies; rugged surface conditions add additional noise during acquisition. We countered these problems with post-acquisition filtering, experimenting with several filtering techniques developed for aeromagnetic scale surveys designed to delineate tectonic features or for exploration by the energy and mining industries.

We collected our total magnetic field intensity data in about three hours on a magnetically quiet day as observed by NOAA (NOAA, 2009) and our on-site observations. There was neither forecast nor observed sunspot activity sufficient to drive significant magnetic variations during the time in which we completed our survey. In confirmation, successive and repeat observations at stationary sites during the day showed minimal high frequency variance of the total magnetic field. Regardless, given our lack of a recording base station, geomagnetic variations will be present in the data. The frequency spectrum of such geomagnetic variance can be broad. Low frequency components have periods similar to the acquisition time of several transects and longer. High frequency components have periods ranging from the time for acquiring a few observations to that for acquiring a few transects. In the filtering described below, we deal with the possibility of long period geomagnetic variation in combination with that for regional, or geologic, sources. We treat the potential effects of high frequency variance with filtering techniques adapted from the energy and mining industry. This proved successful as is demonstrated by the final maps. The ultimate anomalies of interest in this project have amplitudes of 30’s to 100’s of nanoteslas.

Our total magnetic field intensity observations (Figure 1), gridded by kriging, include features at several scales. First, there is corrugation (also referred to as striping, zigzag, herringbone, or staggering) which is typical in ground and airborne magnetic surveys where observations are acquired at relatively high spatial frequency along more widely spaced transects. Despite the usual efforts to keep the sensor a constant distance from the ground, bunch grass, rough surfaces, rocks and wind combine to interfere with the operator and impact the distance of the sensor from the ground while walking and acquiring observations at 5 Hz. This manifests as linear magnetic anomalies highly correlated with the direction of acquisition. There are several methods for decorrugating magnetic data.
dependent correction, and Odah et al. (2005) translate every other line by up to 1.5 meters to clean their data. Those choices have been in part dependent on available equipment and accompanying software. More recent contributions from Tsivouraki and Tsokas (2007) and Fedi and Florio (2003) address denoising and corrugation respectively and provide alternative methods for grid filtering based on the discrete wavelet transform. Regardless of the algorithm, decorrating a magnetic map yields a better estimate of anomalies due to other causative sources of greater interest.

Filtering – Regional Removal, Decorruggation, and Upward Continuation

The ambient geomagnetic field strength, about 55,000 nT in our area, dominates the scalar value of total magnetic field intensity and is very consistent across most surveys of archaeological scale. Typically one removes the regional component by a scalar subtraction of the mean value of the acquired observations or by fitting and subsequently subtracting a low order polynomial surface fit to the data. We removed the regional field from our data by subtracting a least squares best-fit plane that decreases about 0.8 nT per meter to the northeast.

Decorruagating by Urquhart’s (1988) method involves three general steps. The first step uses a low pass frequency filter to separate the grid of data into its short and long wavelength components in the acquisition direction. Next, the resulting long wavelength component of the grid is long-wavelength filtered (again with a low pass frequency filter) in the direction perpendicular to the acquisition direction. It is this direction, perpendicular to acquisition, which contains short wavelength components resulting from variable heights and nonlinear positioning of the sensor during acquisition of the magnetic observations. The low pass filter removes the short wavelength components perpendicular to the acquisition direction; these short wavelength components result in corrugations observed in the contoured data. This second step yields a smooth long wavelength grid. Finally, add the smooth long wavelength grid to the short wavelength components isolated in the first step. The result is decorrugged (Figure 2). We used Phillips (1997, 2007)

Figure 1. Total field intensity contoured at 10 nanotesla (nT); horizontal dimensions are meters. The vertical axis trends 130° east of north. The bidirectional acquisition direction, with one meter spacing, is vertical in the figure. The corrugation is apparent as the periodic herringbone pattern on north-south contours.

Urquhart (1988) developed a widely used technique for decorruggation filtering of aeromagnetic data. We use this, as discussed below, because it operates rapidly on a grid of data, allows visual inspection of results from successively larger filter operators, and thus empirical determination of a suitable operator size. Urquhart’s (1988) method is also readily available in public domain software (Phillips, 1997, 2007). Other methods are more common among archaeological geophysicists who have generally performed line by line adjustments as opposed to filtering a complete grid of data. For example Ciminale and Loddo (2001) align nearest neighbor traces using correlation, Becker (2001) uses a GPS based speed
implementations for decorragating and much of the subsequent filtering.

Iterative experimentation is necessary when separating the grids into short and long wavelength components for decorragation. The best choice of filter wavelengths is determined by examining successive filtering experiments with increasing wavelengths. If one chooses a long wavelength filter that is too long, then images of the noise will contain too much archaeological or geological information. Examining the decorragated results allows visual confirmation that you are removing the correct wavelengths. Ultimately, this is subjective image processing and the greater the spectral overlap of signal and noise, the more difficult the decision. We used filter lengths of nine samples and nine lines along and across acquisition lines respectively. Representative subgrids from our total magnetic intensity grid show the positive effects of regional removal and decorragation along with an example of the aliasing parallel to the acquisition direction which we removed Figure 2).

**Separating Magnetic Effects of Surface Debris**

The left hand edge of our magnetic data (Figure 3) parallels a road and an older railroad right of way. Over the years, both were sources of ferromagnetic debris which adds to that left by Cinnabar residents and their farming and ranching operations. This surface scatter is particularly prevalent near the road and yields numerous high amplitude and high gradient magnetic anomalies. Thus, we extracted a subset (Figure 3) from our decorragated data to demonstrate the utility of matched filtering for separating the magnetic effects of surface debris.

The numerous small dipolar features on the decorragated magnetic map (Figure 3) at the scale of 0.5 to 2 meters result from randomly scattered ferrous sources on or near the ground surface. At the Cinnabar site, these objects include horseshoes, bits of cast iron stoves, scrap sheet metal, nails, and the like. Such objects have a combination of induced and remanent (permanent) magnetizations. An induced magnetization would typically cause a dipolar signature which is a paired set of high and low amplitudes with the low amplitude offset towards magnetic north (12.5° east at the study location).

If there is a remanent magnetization vector added to the induced magnetization, the dipole signature points in an alternative direction depending on the vector sum of the induced and remanent magnetizations. These differences in direction are not important in the separation of anomalies by matched filtering.

![Figure 2](image.png)

*Figure 2. The left image is representative of the total magnetic intensity map with data acquisition parallel to the vertical axis. The central image has had the regional removed and is decorragated. The right hand image is the corrugation removed from the left.*
Finally there are some longer wavelength (~10 meter east-west) signals which trend north-south through the area. These features correlate with subtle drainages apparent on satellite imagery. Therefore at least some of the anomalies may result from variable concentration of magnetic minerals in old fluvial deposits. Yet, in the final analysis, there is some suggestion that a few may be cultural features. Typically we wish to separate these longer wavelength anomalies and the shorter wavelength dipolar anomalies. We do so using the general assumption that high amplitude steep gradient anomalies have shallow sources and lower amplitude relatively low gradient anomalies result from deeper sources. Numerous potential field methods (e.g. Blakely, 1995) exist to attenuate or enhance signals of interest in a magnetic data set. Most of those methods make use of the spatial frequency (or wavenumber) domain following a Fourier transformation of the data. For example, evaluating successive upward continuations (e.g. Jacobsen, 1987) of the total field anomaly to a height of around one to two times the survey’s line interval will typically remove the dipolar expression of surface debris at archaeological sites.

Upward continuation involves multiplying the power spectrum of the total magnetic field by a filter which decreases exponentially in the spatial frequency domain. Unfortunately, this upward continuation also attenuates high spatial frequency (short wavelength) content beneficial to resolving other features. Differencing successive upward continuations approximates the vertical gradient of the field and isolates shallow sources (Figure 4). Alternatively, one can enhance the dipolar features by calculating the analytic signal of the total field (Roest et al., 1992).

Figure 3. Subset of data highlighting high gradient anomalies at the left edge of the study. Decorrugated total field intensity with planar regional field of about 54,000 nanoteslas removed. The contour interval is 5 nT; horizontal dimensions are meters.

Figure 4. Enhanced signals from causative sources on or near the surface; horizontal dimensions are meters. Left: analytic signal of the total magnetic intensity. Right: synthetic vertical gradient calculated by differencing the total field intensity with an upward continuation of 0.2 meters; the zero contours are suppressed for clarity.
If one is searching for the sources of those dipolar anomalies missed in a surface survey publically available Magpick© software by Tchernychev (2008) allows one to interactively pick, locate, and number dipolar anomalies on a magnetic map. Unfortunately, none of these three techniques (analytic signal, differencing upward continuations, or locating dipolar sources) provides a way to remove their contribution to the total field map. Another technique, threshold filtering, removes components of a signal whose amplitudes are below a specified level (the threshold) regardless of their position on the wavenumber axis. White \((1/f)\) noise is flat in the wavenumber domain. Thus, applying successive threshold filters with increasing thresholds to the data allows one to remove increasing amounts of white noise, sometimes bringing out features not otherwise seen. Threshold filtering decrements signal at a constant level across the spatial frequency spectrum but the dipolar anomalies typically have high power due to their shallow depth. Therefore the dipolar anomalies are not effectively isolated with threshold filters. Removing components across the frequency spectrum also lowers resolution in edge detection of larger scale features.

Matched bandpass filtering is an effective way to separate magnetic anomalies from different depths. The method is based on equivalent sources (Pedersen, 1991) which are fictional layers below the observation surface where the distribution of magnetization produces the observed magnetic field. Spector and Grant (1970) showed that equivalent source layers at different depths yield radially averaged logarithmic power spectra, from gridded magnetic data, with segments of constant slope. These linear segments in the power spectrum represent magnetic sources at similar depths and characterize features at the principal depth ranges of causative sources. Syberg (1972) proposed matching bandpass filters, in the spatial frequency domain, to the characteristic parts of the power spectrum for different features. Filtering the total field magnetic data with the matched bandpass filter extracts the frequencies corresponding to these principal depth ranges. For example, the spectrum of a layer of magnetic dipoles is linear at high spatial frequencies but becomes concave down and achieves a maximum at low spatial frequencies. Fitting a line to the high frequency end of that power spectrum and removing that component from the total spectrum separates the dipole layer from the remaining signal.

Employing matched bandpass filtering for anomaly separation has a long history (Nabighian et al., 2005) in the application of aeromagnetic data to tectonics, structure, and resource exploration, but not in archaeology. Anomaly separation by matched bandpass filtering in the spatial frequency domain is successful when the signal (feature) of interest dominates one spectral band of the magnetic field’s power spectrum. Generally, there may be a noise layer with low-amplitude high-frequency noise related to acquisition, a layer which corresponds to the surface (or near surface) magnetic sources, and one or more additional layers from deeper magnetic sources. In an archaeological study these may correspond to acquisition and instrument noise, debris on or near the surface, somewhat deeper sources such as foundations or compact living surfaces, and possibly a deeper signal from underlying geological sources. Shallow and deeper magnetic sources dominate the high and low spatial frequency ends of the power spectrum respectively.

**Matched Filtering of the Example Data**

The general idea in matched filtering is to fit the radially averaged power spectrum of the total field magnetic data (Figure 5) with a series of power spectra corresponding to simple, equivalent layers at the archaeological site. One then uses the equivalent layer information to construct bandpass filters which separate the original magnetic field data into wavelength groups that contain the magnetic anomalies in each equivalent layer. As noted by Spector and Grant (1970) and later workers, the power spectra of these equivalent layers are linear segments in the log power spectrum of the data. Existing software (Phillips, 1997; Phillips, 2007) based on the contributions of Syberg (1972) facilitates the calculations.

For an example, consider a two layer case consisting of a magnetic dipole layer with amplitude spectra \(A_1\) and average depth \(d_1\) overlaying a deeper magnetic half space at depth \(d_2\) with amplitude spectra \(A_2\). The depth terms will dominate the spectrum and, ignoring any noise, the total magnetic intensity (TMI), which is their sum, will have two independent linear segments in its radially averaged log power spectrum. Let their
intercepts, at wavenumber \((k) = 0\), have values of \(c_1\) and \(c_2\) for the dipole layer and deeper half space, respectively.

![Graph showing log power against cycles/meter](image)

**Figure 5.** Radially averaged power spectrum of the total magnetic intensity. The symbols show the power spectrum, the solid lines illustrate the separation of two equivalent layers forming the basis for matched bandpass filters as discussed in the text.

Then, the amplitude spectra for the components look like:

\[
A_1(k) = c_1 \exp(-d_1k)
\]
\[
A_2(k) = c_2 \exp(-d_2k).
\]

Their combined power spectrum is:

\[
E(k) = [A_1(k) + A_2(k)]^2, \quad \text{or} \quad E(k) = [A_1(k) * (1 + A_2(k)/A_1(k))]^2.
\]

Substituting for \(A_1(k)\) and \(A_2(k)\),

\[
E(k) = [c_1 \exp(-d_1k) * (1 + (c_2/c_1) \exp((d_1-d_2)k))]^2.
\]

The inverse of the second factor in the previous expression is

\[
F(k) = 1/ (1 + (c_2/c_1) \exp((d_1-d_2)k)).
\]

\(F(k)\) is the filter to separate the shallow magnetic dipole layer from the deeper magnetic half space. Multiplying the Fourier transform of the total magnetic intensity by the filter and then applying the inverse Fourier transform to the product separates the components. The constants \(c_1\) and \(c_2\) are the intercepts of the appropriate linear segments read off the graph of log radial power spectrum versus wavenumber at \(k=0\). We obtain the depths \(d_1\) and \(d_2\) from the slopes of the linear segments with depth \(-\text{slope}/4\pi\) when the horizontal axis is cycles/wavelength. Phillips’ (2007) implementation, as used in this study, utilizes a nonlinear least squares refinement to the initial observational fits of linear segments on the log power spectrum.

The radially averaged log power spectrum of our example data has two obvious linear segments (Figure 5). The segment with steeper slope at longer wavelengths (fewer cycles per meter) results from relatively deeper sources. The segment with lower slope at shorter wavelengths (more cycles per meter) is from the scattered debris on or near the surface. We calculate the matched bandpass filters (Figure 6) for separating equivalent layers as the quotient of the spectrum of each single layer divided by the spectrum of the total field (Syberg, 1972). Applying the matched bandpass filters (Figure 6) to the Fourier transform of the total field magnetic intensity data (Figure 5) separates the magnetic anomalies by their apparent depth to causative sources (figure 9). In this case the equivalent layer for the shallow sources is at 0.5 meters, and that for the deeper sources at 3.0 meters. Those depths indicate adequate separation, but it is worth recalling that there is no inherent depth information in magnetic observations. Adding the two grids (shallow and deep) would yield the original data set. The benefit of this approach is that the source layers are isolated without losing information as is the case with enhancing surface features using magnetic gradiometry, analysis by upward continuation, or the analytic signal.

![Graph showing filter amplitude against cycles/meter](image)

**Figure 6.** Matched bandpass filters in the spatial frequency domain. Triangles show bandpass for long wavelength signal, diamonds indicate bandpass for short wavelength signals. Parameters for the filters are determined empirically as discussed in the text.
Figure 7. Total field magnetic intensity separated into two equivalent layers; horizontal dimensions are meters. Left: magnetic field from the deeper equivalent layer separated by applying the long wavelength bandpass filter to total field intensity; contoured at 2 nT. Right: anomalies from on or near surface sources contoured at 10 nT; the zero contour is removed for clarity. The sum of these two maps equals the original decorrugated data (figure 5); X1 through X4 mark locations mentioned in text.

The shallow source components of the magnetic data (Figure 7) are well separated from the total field data and obviously distinct from the deeper sources. The shallow sources are more concentrated to the left (northeast) of the map, which parallels the long-lived road through the study area. Most of the shallow sources lie on the ground surface and are more reasonably found by visual inspection than by magnetometry. The map of shallow sources bears strong resemblance to the analytic signal of the total field intensity and the synthetic vertical magnetic gradient created by differencing upward continuations (Figure 4). Any of these three methods serves to isolate and locate the shallow causative sources. The advantage of separating the shallow sources with matched bandpass filtering is that no information is lost; the remainder of the information remains in the map of deeper sources (Figure 7).

Following separation, the magnetic signals from the randomly distributed sources littered on and near the ground surface cause much less degradation of the deeper sourced anomalies (Figure 7). There is some spectral overlap in the signals and the filters (Figure 6) and areas with apparently larger concentrations of surface debris still have some expression on the map of deeper sources (e.g. X1 labeled on Figure 7) but the deeper source layer is now easier to interpret. In particular, magnetic lows labeled X2, X3, X4 (Figure 7) have edges, as judged by high magnetic gradients, at distinct angles to the dominate north-south trend of the underlying fluvial sediments. These three anomalies are strong candidates for future archaeological excavations.

**Edge Detection on Isolated Anomalies**

Two larger areas of very high amplitude anomalies dominate the right hand edge of our total field intensity data (Figure 1). This complicates the separation of sources. The high frequency character of these anomalies demonstrates that the sources are near surface. Because there is not nearly as much contamination from surface...
debris in this portion of the study area we proceed directly from the decorrugated map to further analysis. Thus, following decorrugation we further attenuated high frequency noise by upward continuing the data by half a meter (one half of our line spacing during acquisition) using standard Fast Fourier Transform (FFT) techniques for level-to-level continuation (e.g. Blakely, 1995). Before calculating the forward FFT for this and subsequent filtering steps we extended the grid by 20% and cosine tapered the result to reduce edge effects and aliasing. Upward continuation mathematically transforms the data measured on one surface to the magnetic field values that would be measured on another surface farther from causative sources. The shorter the wavelength (higher spatial frequency) of the upward continued anomaly, the greater the attenuation. Typically, upward continuation by an amount equal to or less than line spacing attenuates short wavelength noise due to variable motion of the sensor and sources on the surface without undue loss of signal from more significant causative sources. Upward continuation by half of our line spacing produced distinct, characteristic anomalies. These anomalies (Figure 8), as enhanced by regional removal, decorrugation, and upward continuation, are similar to our expectations for anomalies caused by deeper sources such as foundations with spatial dimensions of several meters. That is, the overall anomalies are similar in scale to a building’s footprint (e.g., Larson et al., 1999) while magnetic anomalies from individual foundation walls broaden as the depth to their tops increases. In our analysis, we focus on those anomalies because they are of the appropriate spatial scale of interest for our investigation.

**Edge Detection on Isolated Anomalies**

On inspection of our processed data, we isolated two higher amplitude anomalies (Figure 9) with length scales greater than four meters that dominate the contour scale of our total field intensity data. Each anomaly is within our scale of interest for discovering and delineating structures at the periphery of the Cinnabar site. One was the site of preliminary excavation before the magnetic survey. However, the second showed no readily discernible ground evidence of a historic structure and is beyond the area where a historic photograph showed the limits of the town. We extracted the two high amplitude anomalies from the total data set after removing the ambient field, decorrugating, and upward continuing as discussed above.

Given good residual magnetic maps, isolating a target anomaly is a straightforward procedure. For features the size of foundations or compacted living surfaces applying edge detection techniques to the resulting anomalies helps guide the location of initial excavations. A number of edge detection techniques beyond traditional maps of first and second vertical derivatives exist (e.g. Roest et al., 1992; Blakely and Simpson, 1986; Thurston and Smith, 1997; Fedi and Florio, 2001; Cooper and Cowan, 2008) and several are implemented by Phillips (1997, 2007). As one would expect, the more that such methods depend on higher order derivatives the more susceptible they are to noise in the data set. Despite decorrugation and upward continuation of the data set, our observations from a historic town site with significant debris on the surface still contain short wavelength anomalies associated with that debris.

![Figure 8. Field intensity contoured at 5 nT following regional removal, decorrugation, and upward continuation of 0.5 meters; total range is 653 nT.](image)

To delineate edges on the isolated anomalies (Figure 9), we use the horizontal gradient method (HGM) of Blakely and Simpson (1986) which only requires first-order derivatives. The value calculated in HGM analysis is
The square root of the sum of the squared derivatives of the field in the \(x\) and \(y\) coordinate directions. Pseudogravity is the first vertical integral of the reduction to pole transform (e.g., Phillips et al., 2007). The dependence on RTP transformation presents problems in areas of low latitude with shallow magnetic inclination which is not the case at Yellowstone National Park. For our transformations, we assumed induced magnetization of the soil and sediment was much greater than any remanent magnetization and used the local declination and inclination of 12.5° east, 70° down, respectively.

Typical applications for which HGM was developed have depth scales of kilometers. In that situation, the determination of the appropriate transformation (RTP or pseudogravity) drives the ability to get depth estimates from the method depending on whether the expected source consists of thin or thick sheets.

The horizontal gradient method requires that one first subject the magnetic data to one of two different but related transformations. Reduction to pole (RTP) is an FFT-based transformation (e.g., Blakely, 1995) that yields a phase shifted anomaly as if the causative source is located at the magnetic pole, thereby removing most of the dipolar character of the signal. Poisson’s relation shows that for a body with both uniform magnetic susceptibility and density the magnetic potential is proportional to the derivative of the gravity potential in the direction of magnetization. Baranov (1957) exploited this relation to develop the pseudogravity transformation, another linear filter typically applied in the Fourier domain.

The pseudogravity transformation yields magnetic scalar potential with vertical magnetization, hence ‘pseudogravity’ in that the transformed field looks more like a gravity anomaly, centered over the source, which was among Baranov’s (1957) intentions.

The pseudogravity transformation also accentuates long wavelengths while attenuating shorter wavelengths. RTP and pseudogravity are related in that the

**Figure 9.** Two anomalies isolated for further interpretation. Each is decorrugated and upward continued by 0.5 meters. Contour interval is 20 nT.

**Figure 10.** Plan view of the causative sources as determined by inverse modeling of the total field anomaly. The shaded dots are maxima of the horizontal gradient; darker and larger dots represent more significant maxima. In both cases, the larger maxima of the horizontal gradient of the field intensity coincide well with the edges of the causative sources as estimated independently by inversion.
When used solely for edge detection, HGM on a pseudogravity transformation tends to have fewer false contacts than when calculated for an RTP transformation that includes more high frequency effects due to the vertical integral relation of pseudogravity to RTP. In practice, comparing HGM on the two transformations allows one to see where they overlap.

The top two quartiles of maxima in the horizontal gradient of the pseudogravity superposed on the two extracted anomalies outline the estimates of the edges of subsurface causative sources (Figure 10) creating the magnetic anomalies. Thus, the maxima serve to help locate initial excavation units. Maxima shown with larger symbols are more significant. The lower two quartiles of maxima (not shown) highlight lesser gradients in the anomalies we judge to be less significant for our interests. These may be from deeper natural sources, remaining noise, or artifacts in the data. For these anomalies, maxima of the horizontal gradient of reduction to pole and pseudogravity transformations were essentially equivalent.

**Modeling and Depth Estimates**

Magnetic data contain no inherent depth information. Yet, steep gradients on anomalies typically indicate shallow sources and help constrain modeling results which yield a three dimensional model of the subsurface. Another approach to depth estimation uses equivalent sources. Jacobsen (1987) made a strong case for using upward continuation filtering as a method for separating causative sources from various depths. Thus, we experimented with two different approaches to estimating the depth or bottom of the subsurface sources causing the anomalies (Figure 10).

First, we inverted the total field data (MAG3D, 2007; Li and Oldenburg, 1996). Those inversions result in best-fit models of subsurface magnetic susceptibility that produce their observed anomalies closely. These three dimensional models thereby provide estimates of depth as well as edges. The plan view (Figure 11) and 3D subsurface models (Figure 12) generated by MAG3D (2007) compare very well with the maxima of the horizontal gradient of the field intensity results. Thus the two independent methods yield very similar estimates for the edges of the causative sources. The subsurface magnetic susceptibility models (Figure 12) from MAG3D (2007) are three dimensional and thus estimate the depth extent of the sources as well.

![Figure 11. Total field intensity of isolated anomalies contoured at 20 nT. Dots are the superposed maxima of the horizontal gradient of the pseudogravity. Darker and larger dots represent more significant maxima and locate subsurface edges of the causative sources.](image)

We experimented with MAG3D (2007) inversions by generating and constraining solutions a number of different ways, a typical procedure to verify robustness of inverse solutions. For every case, for both anomalies, the depth to the bottom of the causative source was always within about two meters or less of the ground surface. Piro et al. (2007) also successfully used MAG3D (2007) for an archaeological investigation and provide further insights and analysis for its application to other...
situations. Estimating the depth of sources by differencing successive upward continuations (Jacobsen, 1987) for both of the anomalies suggests that greater than 90% of the equivalent sources are shallower than two meters. Thus, either method indicates sources within the depth range we expect for foundations and further suggest that deeper geologic sources do not generate the anomalies.

Figure 12. 3D renderings of solutions from the inverse modeling; contours are magnetic field intensity. The depicted isosurfaces are those near the maximum gradient of susceptibility in the inverse solutions.

Field Testing and Excavations

Subsequent to the magnetic study, we focused archaeological investigations on the two higher amplitude anomalies discussed above to evaluate the possible presence of archaeological features, such as building foundations, buried below the ground surface. Ultimately, we chose to investigate one with an excavation test unit. First we evaluated the area of both isolated anomalies with an in-depth surface reconnaissance.

The anomaly near \((x = 55, y = 5)\) coincides with a linear surface feature which extends away from Cinnabar to the southeast. We interpret that linear feature to be a former field-access road or irrigation ditch, both of which are common to the project area due to the use of the area for agriculture in the early-mid 20th century (prior to its purchase by Yellowstone National Park). Based on its association with the linear feature, we chose not to subject it to archaeological investigation thinking it has a lower potential for associated archaeological materials.

However, based on our positive results from the second anomaly, there are probably remains of a buried historical structure along that old road or irrigation canal.

The area around the anomaly at \((x = 50, y = 57)\) contained a scatter of historic glass and metal fragments on the ground surface, a possible indication of historic activity associated with Cinnabar. Thus, we excavated two one meter square test units (TU) to investigate the strong magnetic signature of the area. TU 13 is within the central portion of the magnetic anomaly, while TU 14 is approximately 20 meters to the west-northwest outside the area of the larger anomalies (see prior chapter for Cinnabar map). This test unit yielded limited artifacts including a few square nails, a cartridge, a button, and a suspender clip distributed within a few centimeters of the surface, perhaps indicating a house in the area.

Results of archaeological investigations in TU 13, within the magnetic anomaly, documented the presence of an intact archaeological feature within the area, likely associated with a former domestic structure on the southeastern flanks of Cinnabar. Of particular interest, TU 13 yielded a buried living floor containing burned wood fragments, charcoal, mortar, glass, and nails approximately 15-20 cm below ground surface (Figure 13). These artifacts indicate that a structure was present at one time, but possibly burned after or during the abandonment of Cinnabar in the early 20th century. Excavation of TU 13 also identified plow scars stratigraphically above the building remains, suggesting that the area was plowed in the early-mid 20th century, further obscuring the presence of the former building. Finally, after agricultural use of the area ceased in the mid-1900s, a 10-cm thick layer of silty aeolian sand blew over the surface of the feature, effectively masking its presence from the ground surface but not from magnetic detection.
Figure 13. Profile of the east wall from a square meter excavation (Test Unit 13) on the south central anomaly at about x=50 m, y=57 m.

Summary

One component of the Montana-Yellowstone Archaeological Project was determining the spatial extent of a historic town site, Cinnabar, Montana, at the edge of Yellowstone National Park. To help constrain the spatial extent of Cinnabar, we acquired total field magnetic intensity observations over a portion of the proposed southeast extent of the town. We then subjected those observations to various filtering techniques, edge detection, and modeling techniques common in aeromagnetic and ground magnetic exploration for energy and mineral resources.

We processed our data, which were originally quite noisy (Figure 1), by first subtracting a slightly dipping ambient field characterized by a first order, best-fit, polynomial surface. Next, we decorrugated the residual field with a two dimensional frequency filter (Urquhart, 1988; Phillips, 2007). Following that decorrugation, we subject two subsets of the data set to different filtering, processing, and interpretational techniques.

For a portion of our data adjacent to a long-lived road and abandoned railroad we use matched filtering to separate the signal from scattered ferromagnetic surface debris from that of deeper archaeological and geological sources. Matched bandpass filtering entails fitting the radially averaged power spectrum of the total field magnetic data with a series of power spectra corresponding to simple equivalent layers at the archaeological site. It is a very effective way to separate magnetic signals from sources on or near the ground surface from signals arising from deeper sources. A major advantage of the technique over magnetic gradiometry, differencing upward continuations, or employing the analytic signal, is we separate the source effects without losing any signal. That is, we are not limited to only collecting signals from the shallowest sources nor do we lose information from deeper sources when we isolate the signal from shallow sources.

A second portion of our data did not have nearly as much signal contamination from scattered surface debris. Following the decorruagration of those data, we used upward continued by one half of the line spacing used during acquisition to reduce acquisition noise. These processing steps successfully isolated the longer wavelength anomalies characteristic of buried foundations or historic building perimeters and greatly reduced the dipolar noise from ferromagnetic objects distributed on the ground surface (Figure 3). Once we isolated the anomalies characteristic of foundations, we further accentuated them with standard edge detection and modeling techniques. The horizontal gradient method (HGM) of Blakely and Simpson (1986) provides good estimates of the edges of buried causative sources which coincided well with edges determined by modeling (Figure 11). Nabighian et. al. (2005) provide the history and complete referencing of these methods and we deem them successful in accentuating features of interest in areas where acquisition is difficult and/or surface scatter contributes significant high frequency noise.

Test unit excavations within the south-central anomaly of this second subset of our data clearly indicate the remains of buried domestic feature, perhaps the foundation to a house or other building associated with the late-19th to early-20th century use of Cinnabar. The lack of surface indicators or adequate historic photography precluded the identification of this buried feature without the aid of the magnetic study. The result is that we identified an important and previously-
unidentified domestic feature of Cinnabar through the combined use of total field ground-acquired magnetic data, processing and filtering techniques common in the application of magnetics to energy and mineral exploration, and archaeological excavations. Ultimately, the collaboration of the two investigative approaches provided important historic archaeological data by which to interpret Cinnabar and its abandonment more than a century ago and contribute to the development of archaeological magnetometry.

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References


MAG3D; A Program Library for Forward Modelling and Inversion of Magnetic Data over 3D Structures, version


CHAPTER 4
PREHISTORY AND ARCHAEOLOGY WITHIN THE GARDINER BASIN, YELLOWSTONE NATIONAL PARK, MONTANA/WYOMING

Lester E. Maas, Michael C. Livers, Elaine S. Hale, and Douglas H. MacDonald

While the previous three chapters focused upon the historic-period use of the Gardiner Basin, the subsequent chapters in this volume discuss prehistory of the area. The current chapter provides a basic framework for understanding the prehistoric cultural history of the northern portions of Yellowstone National Park and vicinity, including much of the upper Yellowstone River Valley. This area is known locally as the Gardiner Basin due to its proximity surrounding the town of Gardiner, Montana. Maps of the study area are provided in previous chapters.

Much of the work here is synthesized from Elaine Skinner Hale’s 2003 University of Montana Master’s Thesis Culture History of the Yellowstone River and Yellowstone Lake, Yellowstone National Park, Wyoming and Montana. In addition to Hale’s thesis, several alternative cultural histories (see Frison 1978; Metcalf 1987; Mulloy 1958; Reeves 2006; Zier et al. 1983) provide supplementary contextual information for a well-rounded picture of the culture history of the Gardiner basin and vicinity. This information is crucial in providing context for assessing whether or not archeological sites in the project area should be considered eligible for listing on the NRHP. Following Hale, we organize the following prehistoric culture history into four chronological periods, including Paleoindian, Early Holocene, Middle Holocene, and Late Holocene.

Paleoindian Period
Little is known about the site structure, dwellings, group organizations, inter-group relationships, mobility and subsistence patterns, and mortuary practices of the Paleoindian period of Yellowstone Park and most of the Northern Plains (Hofman and Grahm 1998). The most widely accepted elements of Paleoindian life were their organization into small, mobile bands that left evidence of short-term habitation. While they were considered big game hunters, they were orientated to a broad spectrum of hunting and gathering (Butler 1986; Chatters and Polotylo 1998; Frison 2001; Frison, Toom, et al. 1996; Stanford and Day 1992).

Specific details of the postglacial environment are not well understood for YNP and the Northern Plains due mainly to the lack of organic materials surviving from that time. Deflation and desiccation of sedimentary records, degraded pollens, and environmental changes that are both time-transgressive and unique to an area provide challenges to paleoenvironmental reconstructions (Frison et al. 1996).

Dynamic environmental and ecological change at the end of the Pleistocene resulted in the extinction of 33 species of megafauna. In addition, the resulting habitat variation caused significant change in how early people used the high altitude areas of the Northwestern Plains, with some strategies never to be used again (Hofman and Grahm 1998).

The earliest known occupation in the Yellowstone region is the Clovis culture, radiocarbon dated from 11,500 to 10,900 years ago at the. The Clovis cultural complex is generally comprised of projectile points that are long, finely crafted lanceolates with retouched edges and a flat, or slightly concave or convex proximal end that is sometimes rounded. Fluting at the proximal ends is another characteristic of the Clovis Complex projectile points. Percussion flaking initiated at one margin and terminating at the opposite margin is characteristic of Clovis and can be seen in both their biface performs as well as their projectile points.

Few Clovis points have been recovered within park boundaries. The most proximate Clovis point recovered was from the construction of the Gardiner Post Office (Janetski 2002). Approximately 70 miles north of the project area, the Anzick Clovis Cache yielded a wealth of data regarding Clovis burial and cache behavior in the northern Plains (Bonnichsen 1972). Finally, during the 2007 University of Montana survey north of Gardiner, a red porcelainite Clovis point was recovered at site 24YE0357 (MacDonald et al. 2010).

As with Clovis, the Folsom complex is rare in YNP and this portion of the Yellowstone River basin. The Folsom cultural complex dates to approximately 10,800 to
10,300 years before present, and the culture is characterized by a subsistence pattern oriented toward bison hunting (MacDonald 1999; Hill 2007). While most Folsom sites with faunal remains yield bison, excavations conducted at the Indian Creek (Davis and Greiser 1992) and MacHaffie (Davis 1997) sites in Montana (north of the current project area) indicate a broad subsistence base for Folsom individuals in the Rocky Mountain foothills, confirming recent research by Hill (2007). Associated with the Folsom complex are the technologically similar but unfluted Goshen, Midland, and Plainview points. While Goshen may represent a completely separate cultural group from Folsom (perhaps a regional variant), the few excavated Goshen sites do not allow for a full understanding of their cultural association to Folsom (Frison et al. 1996). Technologically, Plainview and Midland points are inseparable from Goshen as well, with all technologically and chronologically also related to Folsom (Frison et al. 1996; Hofman and Graham 1998). Most Folsom sites contain both the fluted and unfluted (Midland?) varieties of Folsom points, further confusing the Plainview/Midland/Goshen typology.

Evidence for Folsom, Goshen, Midland, and Plainview technology is rare in YNP. A Folsom point found in the Bridger-Teton forest south of Yellowstone was sourced to Obsidian Cliff, indicating that Folsom individuals clearly entered the park to collect stone (Cannon et al. 1997). An unfluted Folsom or Plainview point, geochemically similar to stone from Obsidian Cliff, was recovered during archeological excavation on the shores of Yellowstone Lake (Hughes 2003a, b). The Folsom component of the Indian Creek Site also yielded obsidian sourced to Obsidian Cliff in YNP (Davis and Greiser 1992).

Agate Basin cultural complex occupations have been radiocarbon dated to 10,500 to around 10,000 years before present at the Brewer and Agate Basin sites in Wyoming and the Frazier site in Colorado. Agate Basin projectile points are long, narrow, and finely crafted straight-based lanceolates projectile points with thick lenticular cross sections (Frison 1991). Cascade points, found in the Eastern Yellowstone Plateau, have morphological similarities to Agate Basin points, but generally are attributed to cultures inhabiting the Columbia Plateau and northern Great Basin to the west (McLeod and Melton 1986; Roll and Hackenberger 1998). During 1958-1959 archeological investigations in YNP, two Agate Basin points were identified in collections at the Mammoth Hot Springs Museum (Taylor et al. 1964). One of these was collected from Alum Creek, a drainage of the Yellowstone River, while the other was collected in the Fishing Bridge area at the outlet of Yellowstone Lake. Two more Agate Basin-like points were recovered via pedestrian inventory from the Yellowstone Lake shore sites at Fishing Bridge and Pumice Point (Taylor et al. 1964).

The 1958-1959 survey of YNP recovered four Hell gap points from the surface; three sites along the shores of Yellowstone Lake and one on the banks of the Yellowstone River near Cascade Creek. Records of two additional Hell Gap points that were previously collected and curated in the Mammoth Museum indicate one point was found at the mouth of Bridge Creek on Yellowstone Lake (Taylor, et al. 1964). Again, there have been no excavations conducted to investigate the nature of any of the Hell Gap points.

Generally included in with Agate Basin points in the Plano Complex of unfluted Paleoindian lanceolates, Hell Gap points are characterized by a distinct shoulder and a broad point that tapers to a straight base. The base, which can sometimes be slightly concave, has medial flaking patterns that result in a lenticular cross section (Hofman and Graham 1998). It is thought that the Hell Gap complex is a direct descendant of the Agate Basin, though the reason behind the adoption of the shouldering is at this time not well understood, and may simply be a result of intensive reworking of broken Agate Basin points (Frison 1991).

Reeves (2004) indicates that indented base points with stems—attributed to the Windust Complex within the Columbia Plateau and Great Basin to the west—have been identified within Yellowstone National Park. Taylor (et al 1964) recovered one of these points from site 48YE303 along the Yellowstone River. In 2001, a stemmed point of this tradition was also recovered (Meyer 2004) at Site 48YE1025 along Hellroaring Creek near its confluence with the Yellowstone River.

Scottsbluff points have triangular or parallel side blades with small shoulder and broad stems nearly the width of the blades. The cross section is generally oval in shape, while the stems are usually ground. Variations of the Scottsbluff have wider triangular blades, are thin and
lenticular in cross sections, and have more clearly defined shoulders. Eden points are similar to the typical Scottsbluff, but are narrower in relation to their length. The shouldering for the stems is more subtle and sometimes not noticeable. Most Eden points are collaterally flaked and have a well defined median ridges and diamond cross section. Some cases of transverse parallel and median ridges are known, but these are considered rare variations of the Eden typology.

Cody knives consist of two main parts, a stem and a blade. While the stem, which is very similar to a Scottsbluff or Eden projectile point stem is very difficult to distinguish, the blade is distinctive. The blade, which usually has an angle of less than 45 degrees, usually has a small shouldering or notching where the stem edge and blade meet which sometimes forms a small spur. The blade is usually transversely flaked.

Johnson et al. (2004) remarks that the Osprey Beach Subphase component of the Cody Complex, is well represented in Yellowstone National Park, especially at Yellowstone Lake. The first substantive information about Paleoindian use of Yellowstone comes from Cody Complex excavations located along the shores of Yellowstone Lake. Prior to subsurface investigations, the 1958-1959 inventories recovered a Cody knife from the south shore of the West Thumb of Yellowstone Lake. Excavations conducted in 1989 at the Fishing Bridge peninsula (Reeve 1989) recovered a Cody Complex lanceolate (Scottsbluff) projectile point.

In 1992, the Midwest Archeological Center (MWAC) of the National Park service conducted surface collections and subsurface testing of the Fishing Bridge area in anticipation of road construction. Three Cody Complex tools were recovered, including a Cody knife and portions of two stemmed projectile points. A Cody Knife (or fragments of a Cody Knife) was found at 48YE979 along the Yellowstone River by Reeves in 1999 (Reeves 2006).

In 1996, Shortt and Davis (1998) recovered a Scottsbluff Point from 24YE62, located about 700 meters west of Cottonwood Creek on the north bank of the Yellowstone River. A gold chert Scottsbluff point was recovered as part of the Class III Inventory of the Canyon-Lake road in 1999 (Sanders 2000b).

The 2000 Wichita State University surface reconnaissance of beachfront of the south shore of the West Thumb produced Cody knives and diagnostic portions of Eden and Scottsbluff projectile points. Multiple tool types were discovered such as shaft abraders, perforators, a hide abrader, core, biface knives, gravers, hammer stone and choppers were identified (Shortt and Davis 2002). These tools were associated with nearby charcoal dated to 9,360 years before present. Subsequent excavations by Johnson et al. (2004) provide an outstanding window into the Late Paleoindian Cody Complex period at Yellowstone Lake.

Reeves (2006) notes that the West Thumb Subphase, which he describes as obliquely flaked lanceolates and stemmed points, were discovered by surface finds and test excavation in Yellowstone (Reeves 2006) as well as from the Malin Creek site. Shortt and Davis (1998) discovered a Lusk point from site 24YE9. During the inventory of sites 24YE139, 48Y 712, and 48YE979, Reeves (2006) notes that the "lanceolate point tips recovered may relate to this [West Thumb] subphase or the earlier Osprey Beach Subphase.”

**Early Holocene**

The Early Holocene is marked by various fluctuations of climatic conditions, including the warm and dry period known regionally as the altithermal which resulted in the extinction of *Bison antiquus* and the evolution of the modern *Bison bison*. In addition to bison, an essentially modern suite of fauna were present during the Early Holocene, including as elk, moose, mule deer, pronghorn, mountain lion, wolf, coyote, fox, beaver, weasel, wolverine, marmot, rabbit, and squirrel (Good and Pierce 1996).

Sometimes referred to as the Corwin Springs Subphase (Reeves 2006), the Early Holocene is characterized by both continuity and change. This period of time is indicated by a broad based foraging and hunting strategy coupled with small group mobility similar to the Terminal Paleoindian. Diagnostic elements of the Early Holocene, such as grinding tools and stone filled roasting pits, increased in frequency and from their first appearance during the Late Paleoindian (Frison, Toom, et al. 1996, Hofman and Graham 1998).

Within the Yellowstone region, hunter-gatherers increased their dependence on plant foods and small game such as marmots, grouse, and rabbits. This trend marked a noticeable decline in the quality of lithic
technology, with a greater concentration on local sources (Larson 1997). Pit houses and cave habitation sites suggesting continuity of use, although seasonally intermittent, beginning in the Early Holocene have been found in areas adjacent to YNP but not in Yellowstone itself (Butler 1986, Frison 1991). It was also during this time and the grasslands surrounding Yellowstone were used for bison jumps, though at this time no known jumps exist within the park boundaries (Reeves 1978).

Albanese (2000) suggests that the increase in alluvial floodplain sediments and colluvial deposits in the Early Holocene may be partially to blame for the lack of sites, while Larson (1997) and others believe that mountains resources, such as those found in YNP, were widely distributed in sparse patches, and ephemeral use may have left little archeological evidence.

During the Early Holocene, there was a decrease in the use of Paleoindian stemmed and lanceolates projectile points with a corresponding increase in the use of large side notched points. While there is much debate about the use of corner notched projectile points and their use in dating methods (Bamforth 1997; Larson 1997; Frison et al. 1996; Reeves 1973), the Early Holocene side-notched projectile points are distinctive and likely are associated with the adoption of the atlatl, or spear thrower. Distinguishing Middle and Late Holocene side and corner-notched points from those produced in the later Holocene is difficult (Buchner 1980; Frison et al. 1996; Gryba 1980; Larson 1997; Reeves 1973; Roll and Hackenberger 1998). The 1998 MOR testing at site 48YE762/24YE33 in the Black Canyon recovered a side notched brown chert from the basal component (Reeves 2006).

Early Holocene sites with side-notched Pahaska, Blackwater, and Hawken points are sparse, but a few sites have been discovered along the Yellowstone River. Road construction compliance work has discovered Early Archaic side-notched projectile points along the shores of the Yellowstone River in Hayden Valley (Sanders 2000b, 2001a). Several other Early Holocene era projectile points have been discovered around parts of Yellowstone Lake (see Cannon 1996; Shortt and Davis 1998, 2002; Shortt et al. 2001).

Husted and Edgar (2002) describe the medium-to-large projectile points with straight-to-concave lateral edges and straight-to-weakly concave bases as Pahaska Side-Notched. This description is similar to those classified in Idaho as Blackwater Side-Notched, leading to some confusion in the classification. The Hawken site in Eastern Wyoming, which had large side-notched projectile points, displays some similarities to the Pahaska/Blackwater points. Several possible Pahaska/Blackwater points were identified in the Black Canyon of the Yellowstone during Sanders’ 2005 Field season.

The Bitterroot Side-Notched, along with the Salmon River Side-Notched varieties, are recognized on the Eastern Plateau (Roll and Hackenberger 1998) around 8,200 years ago though some similarities in form with other Early Holocene side-notched points are noted (Reeves 1969). The Bitterroot Complex is also identified on the Snake River Plain of the Northern Great basin and continues to the Middle Holocene period (Swanson 1972).

A Bitterroot component was recorded at the Myers-Hindman site along the Yellowstone River valley north Yellowstone National Park near Livingston (Lahren 1976). Investigations of buried sites along the north potions of the Yellowstone River indicate that the older, Early Holocene and Paleoindian components are often deeply buried. An obsidian Bitterroot Side Notched base was found at site 24YE137 (Reeves 2006), as well as one identified by Shortt (1999b) at 24YE00883 during archaeological investigations conducted for the Mammoth – Gardiner Road construction and located near the present day North Entrance Ranger Station just outside Gardiner, Montana.

Additionally, a Elko-Eared projectile point was identified (Shortt 1999b) from site 24YE0089 located near a seasonal pond located approximately 400 meters north-west of Slide Lake near the old Gardner to Mammoth road. Lakeshore and riverbank erosion is exposing and eroding sites buried many thousands of years ago and may provide us an opportunity to re-assess use of Yellowstone’s landscape and resources 8,000 to 5,000 years ago (Hale 2003).

**Middle Holocene**

Encompassing what is generally referred to as the Middle Plains and Late Plains Archaic (or Middle Prehistoric) periods, this era is characterized by more varieties of projectile points on the Northwestern Plains,
including several with bifurcated bases such as Oxbow and McKeans.

Oxbow projectile points mark the end of the Early Holocene and the beginning of the Middle Holocene, dating regionally to approximately 5,000 to 3,000 BP. The Oxbow is characterized by a concave, bifurcated base and notched sides and is thought to be the precursor to the McKeans Complex.

There is some debate as to the relationship between Oxbow and McKeans, with suggestions of reuse of Oxbow points by other cultures (Melton 1988), the development of McKeans out of the Oxbow (Brumley 1998), as well as other suggestions for the origin of the Oxbow-McKeans relationship (Reeves 1983). Chronologically, sites with McKeans projectile points overlap with Oxbow between approximately 5,000 and 1,500 BP. The local representation of the McKeans tradition is, according to Reeves (2006), the Hayden Valley Subphase. Reeves (2006) describes this subphase as being “characterized by the McKeans Lanceolates (least common), Duncan Stemmed, Hanna Stemmed, Hanna Corner Notched, and Mallory points.”

McKeans points are stylistically and technologically similar to the Hanna and Duncan (additional regional point variants with bifurcate bases), and all are usually referred to as McKeans Complex. McKeans proper usually has a pronounced notched or bifurcate base, while the Duncan points tend to have a flared concave base. Hanna points typically have wide, shallow side notches (SAS 2007).

Projectile points of Duncan, Hanna, and McKeans typologies were recovered during a pedestrian inventory of the Black Canyon of the Yellowstone River as well as other areas showing increased human use along the Yellowstone River and Yellowstone Lake. A projectile point with a bifurcated base and a shallow side notch (possibly stemmed point) with ground margins was recovered from site 48YE762/24YE33, and was interpreted by Dorwin to be a Duncan or Hanna point.

In 1996, Hanna and Duncan points were found at site 48YE762/24YE33 (Shortt and Davis 1998). Again in 1997, Shortt (1998) identified a Duncan point recovered from 24YE0350, which is located on a small terrace directly east of the modern day North Entrance Ranger Station. During the 2003-2004 season, test excavations conducted in the Black Canyon by the Office of the Wyoming State Archeologist identified Hayden Valley Subphase components in sites 24YE1, 24YE2, 24YE23, and 24YE24 (Sanders 2005). Reeves (2006) mentions that the Malin Creek site, as well as test excavation at site 48YE1027 on Hellroaring Creek (Meyer 2004), had Hayden Valley components. As noted by Reeves (2006), the Upper Yellowstone River and the Hayden valleys are well suited for this time frame. Excavations along the Yellowstone River at the North Entrance area of the park provided radiocarbon dates from eroding hearths indicating multiple occupations from around 5,000 years before present to 1,500 years ago. Hanna-like projectile points were associated with the assemblage (Sanders 2000a).

Pelican Lake projectile points, which appear to replace the McKeans Complex (Frison 1991), indicate a substantial increase in bison hunting, using techniques of the pound and jump (Foor 1982, Reeves 1990), widespread use of circular shelters outlined by stone, and basin-shaped rock-filled hearths (Dyck and Morlan 2001). Pelican Lake projectile points have deep corner notches near the base and create a “tanged” or pointed shoulder. The base is usually slightly concave, but can be straight. Referred to as the Lamar Valley Subphase by Reeves (2006), some Pelican Lake points are quite small, around the size of arrowheads made during the Late Holocene. Pelican Lake points are considered Middle Holocene, as the adoption of the bow and arrow marks beginning of the Late Holocene (Saskatchewan Archaeological Society 2007), though Reeves (2006) notes that the Lamar Valley Subphase encompasses a variety of styles and types.

Along with the change in projectile points, rock filled (roasting) pits, sandstone grinding tools, beveled edge side-notched knives, and concentrations of stone circles are other cultural hallmarks of the Middle Holocene (Frison 1991). During the 1998 FHWA Mammoth – Gardiner archaeological inventory two Pelican Lake projectiles points were collected (Shortt 1999b). The first was during a revisit of site 24YE0344 which is located 1.35 km south/southeast of the confluence of the Gardiner and Yellowstone Rivers on a small terrace (Shortt 1999b). The second Pelican Lake point was recovered from site 24YE0078 which is located roughly 95 meters west of the Gardiner River and 260 meters...
north-northwest of the bridge at the 45th parallel (Shortt 1999b).

As noted by Shortt (1999b), excavations at 24YE0032/48YE0765 resulted in the discovery of an intact Pelican Lake occupation with FCR, butchered faunal remains, lithic debitage, and diagnostic projectile points.

**Late Holocene**

The beginning of the Late Holocene is indicated by a change in projectile point types and sizes. These changes were derived from the technological innovation and subsequent widespread adoption of the bow and arrow.

Reeves (2006) notes that this time of transition, which he calls the Late Precontact Period, and is separated into three subphases, including: the Black Canyon subphase ca. 1600-1200 years (which correlates with the Avonlea Horizon); the Tower Junction subphase ca. 1600-800 years ago (an overlapping time frame of the Avonlea, but more representative of the Unita Phase); and the First Blood subphase ca. 800-300/200 years ago. Reeves refers to the latter as the local representation of the Ahvish Phase or Old Women.

Intermountain pottery, though not as pervasive as the new weapon technology, appears in the region and is found throughout Wyoming, Montana, Utah, Idaho and southern Colorado and is considered indigenous to the mountainous regions of the Northwestern Plains (Frison et al. 1996).

The Late Holocene indicates the widespread use of communal bison kills as well as evidence of pronghorn and sheep trapping. Large numbers of bison drive lines and associated jumps, some with pounds and capture corrals and others without, are located adjacent to YNP to the north and west (Arthur 1966a; Davis and Wilson 1978; Frison 1991). Large aggregations of domestic stone circles are also evident regionally in the area, located mainly along the river valleys and often close to bison drives. Stone circles are found in various locations in Yellowstone, but only singularly or a few clustered together, indicating smaller groups of foragers were using the area.

Slab-lined food preparation pits for processing both plants and animal food increases during the Late Holocene (Connor 1989). These pits contain evidence of plant, seed, and bone grease processing taking place.

Stone-lined roasting pits and ground stone tools become more prevalent in archeological sites along the Yellowstone River and on Yellowstone Lake during this time period.

Steatite (or soapstone) vessels are associated with this time period and have been recovered in various locations in YNP, two of which were found along the Yellowstone River just north of the park boundary and another trail east of the Grand Canyon of the Yellowstone River near a thermal area (Adams and Daniels 1995; Frison 1982).

The first appearance of Avonlea projectile points, which is widely regarded as documentation of the adoption of the bow and arrow, marks the boundary between the Middle Holocene and the Late Holocene (Hale 2003). There is abundant evidence that Late Holocene groups used the Yellowstone River and lake areas and demonstrated diversified local resource use. Avonlea projectile points, known for their fine workmanship and delicate form, are usually thin, shallowly side-notched, although some are up-slanted with notches close to the base (Johnson 1998; Frison 1991).

Avonlea and Avonlea-like arrow points have been reported in association with radiocarbon dates at sites along the Yellowstone River near the northern boundary of the park, indicating occupations 1,100-1,250 years before present. Other sites along the northern portion of the Yellowstone River yielded dates of 1,420-1,120 years before present. Rock filled roasting pits, a grinding stone (mano), and grass seeds were recovered from Late Holocene sites.

Avonlea style points were recovered from the Malin Creek excavation, as well as in test excavations and surface collections on the Yellowstone River below and within the Black Canyon (Shortt and Davis 1998; Reeves 2006) as well as in test excavations at 48YE1027 on Helroaring Creek (Meyer 2004).

The Rose Springs typology consists of a triangular body with an expanding stem and corner notches. In comparison, the Unita, also called the Desert Side Notched point, is long and thin in relation to its width with notches placed (typically) high on the sides but does share the overall triangular shape of the Rose Springs projectile point typology.
Side-notched arrow points have been collected from the surface along the Yellowstone River banks and on the shores of Yellowstone Lake (Samelson 1983; Smithsonian Institute 1999; Taylor, et al. 1964). There is insufficient information available to place the points as Avonlea or Rose Springs classificatory schemes, though Reeves (2006) places the Unita points within the Tower Junction Subphase. The Rose Springs classification is problematic as it is, as there is debate on the association between the Rose Springs from the eastern Plateau and the Great Basin (see Frison 1991).

During the Roosevelt Lodge sewer system upgrade, excavations at two sites (48YE216, 48YE217) uncovered Rose Springs Corner Notched points with an associated radiocarbon date of 1050±60 BP (Beta 82801) from 48YE217 (Aaberg 1996). Other sites that have recovered Rose Springs Corner Notched points are 24YE502 and 48YE677 by Shortt (1998), 48YE1027 on Hellroaring Creek by Meyer (2004) and sites 48YE979, 48YE1033, and 24YE352 by Reeves (2006).

Beginning around 1,200 years ago and extending past the end of the Late Holocene into the Historic Period, Late Plains side-notched points, contemporaneous to Old Woman’s Phase, were used in areas of Montana and northern Wyoming (Hale 2003). Reeves (2006) identifies the First Blood Subphase (which has the same chronological time frame as the Old Women’s) as containing Desert Side/Tri-Notched and Cottonwood Triangular arrow points. Although typically known as specialized bison hunters, faunal remains in many sites show a wide and diverse set of resource adaptations. These points are present along the Yellowstone River corridor and on the lakeshores in the same archeological context as Avonlea Complex and Rose Springs arrow points. Yellowstone River sites have also yielded Plains and Prairie Side-Notched points from surface (Shortt 1998, 1999a) and subsurface excavations (Sanders 2000b) and in association with radiocarbon dates (Marceau and Reeve 1984, Sanders 2001). Fist Blood components were identified at 48YE993, 48YE974, 24YE137, and 48YE1027. Shortt (1998,1999b) found specimens of First Blood at sites 24YE350, 48YE881 and 48YE0717.

Many of the hallmarks of the Late Holocene, such as side-notched arrow points, pottery, and wider use of plants and animal resources are found along the Yellowstone River north of the park. However, many other hallmarks of the period, such as bison drives and jumps, sheep and pronghorn traps, aggregations of domestic stone circles, winter habitation sites, horticulture evidence by bison scapula hoes, rock art, medicine wheels, and variations in pottery styles (Frison et al. 1996) have yet to be found in YNP.

Much of this section is based on data collected by Park Historical Archivist Lee H. Whittlesey, who prepared the “They’re Going to Build a Railroad!”: Cinnabar, Stephens Creek, and the Game Ranch Addition to Yellowstone National Park” and “A History of the Gardiner Hay Ranch” (“Gardiner Flats”) Area East of the Roosevelt Arch at Gardiner, Montana”. These works provide a comprehensive historic overview of the Boundary Lands of Yellowstone National Park.

There are numerous archaeological sites of Native American origin in the greater Yellowstone National Park area, some that have become world famous such as Mummy Cave, located just 13 miles east of the East Entrance to the Park. While the number, composition, and specifics of each site is large and varied, in general most of the more contemporary sites, dating from about A.D. 1500 onward, are of Crow, Salish, Nez Perce or Shoshone origin.

According to Crow explanations for how they became a discrete ethnic group on the Plains they have a story of how one of two brothers, No Intestines, was directed to look for seeds of the sacred tobacco during his vision quest. During his wanderings, he took his people over much of the Great Plains, specifically passing through a place “where there is fire’, perhaps Yellowstone National Park or a fiery coal pit” (Nabokov and Loendorf 2002 quoting Voget 1984). After settling in the Big Horn Mountains, the Crow began to separate into regional subdivisions. Of these, the largest was the Mountain Crow, who consider (and still claim) the region near present-day Yellowstone National Park as part of their aboriginal territory (Nabokov and Loendorf 2002).

In contrast, the Shoshone are often considered the only “permanent” residents of Yellowstone National Park. It is important to understand that “permanent” does not mean sedentary, but that a significant portion of their semi-nomadic lifestyle took place within Yellowstone National Park (Nabokov and Loendorf 2002). Of another special note, it is important to understand
that the Shoshoni or “Sheep Eaters”, as they are commonly (and often incorrectly) referred to by Euro-Americans, are actually comprised of several groups of Shoshonean-speaking Indians that were recognized and distinguished among themselves primarily by their dominant food pursuits (Nabokov and Loendorf 2002).

Once Euro-Americans entered the Rocky Mountains region, they assigned different names to these groups, specifically: 1) The Lemhi, often called Northern Shoshone and referring to western group of Sheep Eaters and “salmon eaters”; 2) Eastern or Plains Shoshone including primarily the “buffalo eaters”; and 3) the Sheep Eaters, sometimes called the Mountain Shoshone, who lived throughout the warmer months in Yellowstone National Park and the adjacent area following bighorn sheep. In addition, many Euro-American accounts and literature of the different people lump these three groups of Shoshone together as Snake.

That the Shoshone lived, traveled in, and utilized Yellowstone National Park is without question. They are best known for several types of diagnostic features that have shown repeated association with Shoshone (not to say other tribes do not show this association, but it is strongest with Shoshone), specifically: 1) their use of dogs instead of horses; 2) several distinctive stone tools, especially Wahmuza lanceolates even after the adoption of the bow and arrow and the willow leaf “Shoshone knife”; 3) their relatively extensive use of steatite in the production of bowls, pots, and other implements; 4) their preference for obsidian and associated cultural stories of obsidian gathering activities; 5) their singularly distinctive manufacture and use of horn bows which were widely sought after as a trade good by other tribes; and 6) their use of compound arrows.

There are few protohistoric or historic accounts of Native American use in northern Yellowstone National Park after the parks creation in 1872. This is mainly due to efforts by the early administrators of Yellowstone National Park to downplay or eliminate Indian involvement and usage of the park (Nabokov and Loendorf 2002, Introduction, and pp. 103-112).

On October 14th, 1811 the Hunt party, bound for Astoria, Oregon, crossed the Rockies just south of the Grand Teton and camped near a post near St. Anthony, Idaho, and encountered father and son of Shoshone affiliation (Janetski 2002b). There is an account of a party of fur trappers, which included Joe Meek, who are attacked in 1829 by a party of Piegans between the Yellowstone River and Devils Slide, located only a few miles north of the project area (Chittenden 1895). In 1835, the highly literate and active trapper Osborne Russel encountered a small Shoshone family camped in the Lamar Valley (Janetski 2002b).

In 1929, Crow leader Plenty Coups gave an account to Horace La Bree about a buffalo hunt that took place when Plenty Coups was 12 years old (c. 1860) (Nabokov and Loendorf 2002). This account, which correlates to the area near Hellroaring and Coyote Streams area, as well as the nearby area called Buffalo Flats, so named in 1870 by a group of prospectors because “we found thousands of buffalo quietly grazing” is located northeast of Tower Junction (Nabokov and Loendorf 2002).

There are mostly undated but numerous accounts of wickiups throughout the park, attributed to numerous Native American groups such as the Crow, Salish, Blackfeet, and Shoshone (Nabokov and Lowendorf 2002). Some, such as site 24YE301, are less than 15 miles from the Gardiner Basin, and it not a great stretch of the imagination that the Shoshone, who Nabrokov and Loendorf attribute the majority of the wickips to, traveled through the project area. Wickiup Cave, 24BE601, is a well known structure of timbers, branches, pine boughs and rocks used to create a shelter within a small rockshelter (Davis 1975).

A sheep hunting blind located north of the Yellowstone River in Gardiner has possible Shoshone associations, while another well known camp site, the Eagle Creek Site (24PA301) has known Shoshone association with the closest intermountain pottery to Yellowstone National Park (Jackman 1997). In addition, intermountain pottery has been recovered by Cannon (1996) in the Arnica Creek area sites near Yellowstone Lake and by Shortt (1998) at a site on the Yellowstone River just east of Hellroaring Creek.

Chapters 2 and 3 of this volume provide adequate background regarding historic use of the region, so we do not discuss it here. The remainder of this chapter is dedicated to a brief description of prior archaeological work in the Gardiner Basin, Montana, and vicinity.
Previous Archaeology in the Gardiner Basin and Vicinity

The Gardiner Basin culture history described above provides a context for description of archeological results discussed in following chapters. Sporadic informal surveys have been conducted along the Yellowstone River by YNP archeologists as well as local collectors. In particular, local avocational archeologist Tom Jerde recorded several prehistoric archeological sites along the banks of the Yellowstone River in 1986 north of the current location of the HRC building. He also recorded the probable location of the historic train depot at Cinnabar on the site form for 24YE355, the Yellowstone Bank Cache Site. In 1994, Walt Allen completed a surface reconnaissance of the Gardiner Basin in expectation of its use as part of the Stephens Creek bison management area. No report was generated during this project, with limited updates of Jerde’s original site forms (and some site boundary changes) being the main result.

In 1997, Shortt (1999b) located and identified three sites within the Gardiner Basin: 24YE0083 which is located directly east of the North Entrance Ranger Station on a small terrace overlooking the Gardiner River: 24YE0118, which is located to the northwest of the North Entrance Station in an open field; and 24YE0072, which is located on the south side of the Gardiner-Mammoth Road on a well defined terrace to the west of the road. Below we provide an overview of prior archeological investigations in the vicinity of the MYAP project area to provide a basis for the work completed in 2008.

During the 1950s and 1960s, initial archeological surveys were conducted of the Yellowstone Valley and vicinity (Malouf 1958, Hoffman 1961). Subsequently, George Arthur (1966) documented 47 prehistoric sites along the Yellowstone River drainage during a survey of the Yellowstone River drainage from Big Timber to the Yellowstone Park boundary. In his report, Arthur reported the identification of a Clovis point found during the excavation of the Gardiner Post Office (Arthur 1966:94-95), though no additional reports mention artifacts of this antiquity.

Lahren reexamined Arthur’s sites and recorded additional sites, bringing the total to 117 sites in the Gardiner-Livingston portion of the upper Yellowstone River valley. The Eagle Creek site (24PA301), excavated by Arthur between 1962 and 1967 on the tributary stream, revealed four occupation levels, of which the lowest level (IV) is thought to be 3000 years old based on the probably association with surface Middle Archaic age projectile points (Arthur 1966a, 1966b, Conner 1967). Eagle Creek is also one of the few sites in the region with prehistoric pottery. A Master’s Thesis completed by Janet Jackman at The University of Montana in 1997 indicated that the pottery has technological affinities to both Crow and Shoshonean wares.

The Carbell site (24PA02), also excavated by Arthur, is located about 12 miles downstream of Gardiner, near Yankee Jim Canyon. Level 2 of the site contained most of the artifacts including Middle and Late Archaic and Late Prehistoric points and faunal remains. Unfortunately, the site was not intact as it had been heavily looted by the time of Arthur’s investigation (Arthur 1966).

In 1973, Lahren conducted a survey between Mammoth and Gardiner for a sewer line trench and marked the first prehistoric cultural materials exposed within the area. Of the artifacts identified during the study, there were projectile points referable to Early, Middle and Late Archaic period and as well as Late Prehistoric. Some of the 46 sites identified contained stone circles and cairns that appeared to form alignments, possible for game drives or service some religious or ceremonial function (Shortt 1999a). The stone circles suggest that some of these sites also served as residential sites.

Test excavations conducted in 1997 at 24YE344 by MOR archaeologists failed to relocate those conducted by Lahren but did identify various artifacts that suggested prehistoric occupations dating from the Middle Archaic McKean period with additional Late Archaic Pelican Lake Periods as well (Shortt 1999a).

Excavations upstream from the project area within the Black Canyon were conducted by Cannon and Phillips (1993) at 24YE353. Their excavations revealed three eroded hearth features that yielded radiocarbon dates between 1189 and 1289 B.P. Additional tests were conducted at 24YE353 in 2002 by the Museum of the Rockies (MOR), and then again in 2004 by Lifeways of Canada Ltd. While these investigations are ongoing, they have so far uncovered a series of buried cultural levels that ranged from Late Prehistoric (Avonlea), Late Archaic (Pelican Lake), Middle Archaic (3500 B.P.), and a late Paleoindian Cody Complex component dated at 8800 B.P.
with three additional levels occurring below the 8800 B.P. level.

Three test excavations were conducted by MOR at
three sites within Wyoming (48YE882, 48YE1025, and
48YE1027) on Hellroaring Creek approximately 12 miles
upstream from the project area, at its confluence with
the Yellowstone River from the project area (Meyer
2004). These investigations revealed buried cultural
materials at all three sites. Site 48YE1025 had diagnostic
artifacts related to Paleoindian and Early Archaic periods,
while site 48YE1027 provided projectile points ranging
from Late Prehistoric through Middle Archaic periods
(Meyer 2004).

In 1997 Janet Jackman wrote a summation of
previous work conducted at Eagle Creek (24PA301), and
mentions that previous research conducted by Walter E.
Allen in 1992 and 1993 determined that the site had an
Intermountain tradition of ceramics, indicating a likely
Shoshone occupation due to their extensive use of this
style (Jackman 1997).

Additional class III cultural resource inventory was
conducted by MOR archaeologists in 1998 along the
Mammoth to Gardiner road (Shortt 1999b). These
investigations revealed three sites located within, or
immediately adjacent to, the project area: 24YE0083,
24YE0118, and 24YE0072. Investigation at 24YE0083
uncovered one Early Middle Precontact (Bitterroot or
Hawken) projectile point, one indeterminate Middle
Precontact Period atlatl point, a Late Precontact Period
arrow point, three projectile point tips, and one
projectile point midsection. In addition, a biface
fragment, endscrapper fragment, two retouched flakes,
and one utilized flakes were also uncovered. Features
for 24YE0083 include five stone circles and two rock-
lined pits.

Site 24YE0118 consists of lithic scatters of varying
density. In total, 187 obsidian tertiary flakes, 2 opaque
red chert flakes, 2 semi-translucent white chert flakes and
a single black quartzite flake were observed at 24YE0118.
In addition, a semi-transparent white chert side-scaper
was collected, while there were no features associated
with the site.

Site 24YE0072 consists of a scatter of approximately
150 obsidian debitage flakes that are evenly dispersed
over the terrace. Features for the site consists of six
stone circles, located on the southern portion of the
terrace, combined with twelve cairns in vary alignments
and arrangements. It is postulated by Shortt (1999b)
that these cairns could be the either the remains of a
game procurement system, such as a drive line and or
corral, or possibly remains of a structure with associated
sacred or religious meaning.

Throughout the years, assortments of archaeological
remains have been identified along the Yellowstone River
valley downstream from Gardiner to Livingston.

In 2000, Sanders conducted test excavations at site
24YE14 just south of the project area to investigate the
potential for buried cultural materials. The site 24YE14,
previously tested in 1997 by archaeologists with
Montana State University, Museum of the Rockies (MOR)
(Shortt and Johnson 2000), and contained radiocarbon
samples that indicated prehistoric occupations dating to
1650/1700, 2350/2380, 2510/2570 and 5200 years B.P.
Cultural materials included chipped stone tools and
debitage, faunal remains, fire-cracked rock, and hearth
features. Projectile point’s diagnostic to the Late and
Middle Archaic periods were also recovered (Sanders
2000).

During the summers of 2003-2004, Sanders (2005)
directed site re-recording and test excavations within the
Lamar Valley and the Black Canyon of the Yellowstone.
Four of the sites in the Black Canyon (Sites 24YE14 were
originally recorded in 1992 by John Dorwin of the
Northwest Community College in Powell, Wyoming,
while these and two others (24YE23 and 24YE24) were
investigated in 2001 by MOR archaeologist (Shortt 2002).
While one of the sites could not be relocated (24YE4),
four of the others (24YE1, 24YE2, 24YE 23, 24YE24) in the
Black Canyon were deemed eligible for nomination to the
National Register of Historic Places. The investigations
of the prehistoric sites found that they were mostly
comprised of non-obsidian flaking debris and a variety of
chipped stone tools. The projectile points that were
recovered spanned the entire chronological spectrum,
from Early Archaic to Late Prehistoric periods.

In 2007-2008, the University of Montana conducted
its survey and evaluation of sites in the Boundary Lands
north of Gardiner, many of which are discussed in this
volume. While projectile points collected by the 2007-
2008 UM crew are predominately Late Archaic and Late
Prehistoric in origin, the presence of Middle Plains
Archaic and Paleoindian points support the hypothesis
that Native Americans have utilized the Boundary Lands area for at least 10,000 years. There was a notable absence of Early Archaic points in the survey area. The variation of lithic raw material varied over time, with the Paleoindian and Middle Plains Archaic showing a fairly even distribution of obsidian, Crescent Hill chert, and other materials including porcellenite and dacite. As discussed by Adams et al. (this volume), during the Late Plains Archaic, Crescent Hill chert appears to be favored over obsidian, which is the opposite case during the Late Prehistoric period. The identification of stone circles at two sites (24YE0356 and 24YE0357; see Livers, this volume), in conjunction with the positive identification of the historic location of Cinnabar at 24YE0355 provided valuable contributions to the archaeology of the Gardiner Basin.

Finally, in 2008, Craig Lee assisted Yellowstone in a high-elevation survey of ice patches near the Gardiner Basin, results of which are presented in Chapter 10 of this volume. Also, in 2011, the University of Montana and Gallatin National Forest conducted test excavations at the Late Archaic/Late Prehistoric Little Trail Creek site (24PA1081), with some initial results presented in Chapter 5 below.

As the above review attests, the archaeology of the Gardiner Basin is fairly well researched compared to some nearby regions. The remainder of this volume presents results of some of the more-recent archaeological studies in the area.

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CHAPTER 5
LATE ARCHAIC LITHIC TECHNOLOGY AND LAND USE WITHIN THE GARDINER BASIN, UPPER YELLOWSTONE RIVER, MONTANA/WYOMING

Douglas H. MacDonald and Lester E. Maas

Archaeological excavations within the Gardiner Basin of Montana have yielded abundant evidence of Late Archaic Native American occupation. This paper reports on several sites in the Gardiner Basin, Montana (Figure 1), that provide insight into hunter-gatherer use of the Yellowstone River near its headwaters in Yellowstone National Park between 3,000 and 1,500 uncalibrated radiocarbon years ago. Lithic analysis of Late Archaic artifacts indicates active use of local Crescent Hill chert and Obsidian Cliff obsidian, both with sources 20-25 miles from the site. Large bifaces were transported from the material sources to the Gardiner Basin en route northward to the Paradise Valley and beyond. Lithic data indicate that the Gardiner Basin was, thus, a staging area for Late Archaic hunter-gatherers entering and exiting the nearby Yellowstone Plateau and its rich and diverse ecosystem.

Introduction
The Late Archaic was a peak period of Native American use of the Greater Yellowstone Ecosystem, with numerous sites along the Yellowstone River and Yellowstone Lake yielding Late Archaic Pelican Lake and Besant projectile points that date to between 3,000 and 1,500 uncalibrated radiocarbon years ago (Sanders 2000, 2001; MacDonald et al. 2010). This paper summarizes recent work at four Late Archaic sites in the Gardiner Basin, including results of University of Montana’s (UM) work at the Yellowstone Bank Cache Site (24YE355), first reported upon in MacDonald et al. (2010). In addition, UM excavated Late Archaic occupations at the RJP-1 Site (24YE190) along the Yellowstone River and the Little Trail Creek Site (24YE1081) in an upland stream tributary of the Yellowstone River. Finally, Sanders et al. (2000) excavated 24YE14 in Gardiner, Montana, another Late Archaic site in the study area. These four sites—Yellowstone Bank Cache, RJP-1, 24YE14, and Little Trail Creek—provide detailed information regarding Late Archaic use of the Gardiner Valley, Montana, between 3,000 and 1,500 uncalibrated years ago. We focus upon the lithic technological organization of Late Archaic hunter-gatherers in the Gardiner Basin, results of which compliment papers in this volume by Adams and Park.

Figure 1. Project Location with Sites Mentioned in Text.

Background and Setting
The study area for this paper is the Gardiner Basin of the Yellowstone River, an approximately 15 mile stretch of the river bound by its confluence with the Gardiner River on the south (in Gardiner, Montana) and Yankee Jim Canyon on the north (Figure 1). To the north, the Yellowstone River opens up into the vast and wide Paradise Valley, while to the south, the river exits the rugged Yellowstone Plateau and the river’s headwaters at Yellowstone Lake, some 30 miles south. The area of the study is mostly within the confines of Yellowstone National Park (YNP), but also includes sections of the Gallatin National Forest (GNF). Three of the key sites in discussion are within YNP (Yellowstone Bank Cache, 24YE14, and RJP-1), while one (24PA1081) is within nearby uplands of the GNF.
The three valley-floor sites—Yellowstone Bank Cache, RJP-1, and 24YE14—are located on gently-sloping alluvial terraces comprised of Pleistocene gravels with a thick (ca. 2 m) mantle of Holocene-age alluvium (Good and Pierce 1996; MacDonald et al. 2010; Pierce 1973; Rodman et al. 1996). Glacial moraines, colluvial landslides, and other features of Late Pleistocene age occur in the valley floor and in uplands near Little Trail Creek. Little Trail Creek is within an upland stream valley bounded by basalt outcrops upslope and glacial moraines onsite. Soils at the site are largely a mix of Little Trail Creek alluvium and upslope colluvium. Large glacial moraine features are located adjacent to each of the four sites in the study area, suggesting some Late Archaic preference for site establishment near these features, perhaps as protective landforms.

Various researchers have established a baseline of paleoenvironmental data for northern portion of YNP (Beiswenger 1991; Bright 1966; Meyer et al. 1995; Rhode 1999; Sanders 2001; Whitlock 1993). These studies provide a fairly reasonable approximation of the prehistoric environment in the Yellowstone Valley. The Late Archaic period—ca. 3000 to 1500 B.P.—was a period of active Native American use of the Yellowstone Valley, coinciding with a fairly mesic climatic period of cooler and moister conditions, favorable to grasslands in the northern Plains and vicinity. Recent analysis of botanical remains and pollen from Gardiner Valley sites by Gish (this volume) suggests the presence of largely modern suites of vegetation in the valley and nearby uplands, largely dominated by sagebrush and grasses in the valleys and pines and sagebrush in the uplands.

In confirmation of these mesic conditions (compared to preceding warm and dry periods), Sanders (2000:58-60) and Albanese (1999) documented two paleosols at Site 24YE14. The two paleosols dated to ca. 1600 and 2300 B.P., similar to the dates achieved on the four prehistoric features from a paleosol at another site in this study, the Yellowstone Bank Cache site approximately three miles north. The buried soils at these sites attest to increased moisture and vegetation on stable landforms during the Late Archaic period in the Gardiner Basin.

Habitation of the upper portions of the Yellowstone Plateau by prehistoric peoples was likely seasonal due to the heavy winter snows that blanket most of YNP and surrounding areas. The current project is within portions of the winter range of bison, elk, mountain sheep, deer, and antelope which extends down-valley along the river to Livingston, Montana, where the Yellowstone River exits the mountains (YNP 1993). This winter range for large ungulates provided good hunting for prehistoric hunter-gatherers, as well as sheltered areas for winter camps due to the limited snowfall in comparison to the nearby mountains.

Prior Research

Overall, Native American use of the northwestern Plains and Rocky Mountains increased during the Late Archaic, reflecting abundant and diverse resource availability due to the comparatively moist and cool climate (Frison 1991; Husted and Edgar 2002; Lahren 1976; Sanders 2001). Referred to as the Lamar Valley Subphase by Reeves (2006) for YNP sites, the Pelican Lake and Besant phases of the Late Archaic period (3,000-1,500 B.P.) was a time of active use of the Yellowstone ecosystem by Native Americans (Johnson 2001; Sanders 2000, 2001). Several archaeological sites in the study area and greater Yellowstone have yielded Late Archaic Besant and Pelican Lake projectile points, including the four sites discussed in the current study.

During the UM survey of a 3,000 acre portion of the Gardiner Basin in 2007-2008 (Maas and MacDonald 2009), the Late Plains Archaic accounts for more than 50% (n=48) of the projectile points recovered from both excavated and surface contexts (Figure 2). Overall, these point data show a substantial and strong occupation of the Gardiner Basin during the Late Plains Archaic, as well as during the preceding Middle Plains Archaic and subsequent Late Prehistoric periods, trends supported by chapters by Park and Adams in this volume. These data are corroborated by other portions of the park as well, including Yellowstone Lake and the nearby Hayden Valley (MacDonald and Livers 2011; Sanders 2001).
As discussed in more detail below, the Yellowstone Bank Cache site, Little Trail Creek, and 24YE14 fit many of the Late Archaic site type criteria, including use of basin-shaped rock-filled hearths. While there is no evidence of Late Archaic use of stone circles sites in the Gardiner Basin, several stone circle sites were identified in the UM study area (Livers, this volume) and evidence of game hunting features are present at the nearby Six Point Site (24YE176), immediately west of the Yellowstone Bank Cache site discussed herein (Figure 3). UM collected 27 projectile point and biface fragments at Six Point, which is located atop a glacial moraine at an elevation of approximately 5240 ft. amsl, overlooking the Yellowstone Bank Cache site below. The moraine contains large glacial outwash chutes lined by glacial boulders associated with Late Pleistocene glacial melting in the valley (Pierce 1973).

Native Americans apparently drove game from west-to-east up the Late Pleistocene glacial outwash channels—using them essentially as natural drive-lines—to the top of the moraine, where the fauna were dispatched by waiting hunters. During the Late Archaic, and multiple other time periods, game apparently were hunted at the Six Point Site on the moraine top and processed below at the Yellowstone Bank Cache Site (MacDonald et al. 2010). The presence of several Late Archaic projectile points at both the Six Point site and the Yellowstone Bank Cache site attests to their repeated and conjoined use during prehistory.

The remainder of this paper provides an overview of the lithic artifacts recovered at the four key sites in the study area, including Yellowstone Bank Cache, RJP-1, 24YE14, and Little Trail Creek. The focus is on the lithic technology of site occupants during the Late Archaic occupations; other studies provide additional site details which supplement those provided below (MacDonald et al. 2010; Maas and MacDonald 2009).

![Graph showing projectile point counts by period in Gardiner Basin Survey](image1.png)

**Figure 2. 2007-2008 Projectile Points by Period (n=93 total), UM Gardiner Basin Survey.**

![Schematic Geomorphological Cross-Section of Yellowstone River at the Yellowstone Bank Cache Site](image2.png)

**Figure 3. Schematic Geomorphological Cross-Section of Yellowstone River at the Yellowstone Bank Cache Site.**

**Yellowstone Bank Cache Site**

UM survey results of the Yellowstone Bank Cache Site indicate long-term use of the site during the middle-to-late Holocene, with most active use during the Late Archaic and Late Prehistoric periods. Avocational archaeologist Tom Jerde identified the Yellowstone Bank Cache Site during the summer of 1986 when he observed several concentrations of fire-cracked rock (FCR) and lithic artifacts on the ground surface and eroding from the banks of the Yellowstone River.

Details of the cache find location are provided elsewhere (MacDonald et al. 2010); our focus herein is on the lithic technology of the two bifaces in the cache that were available to study, both of which are similar in
morphology and technology of production (Table 1; Figure 4). Both bifaces were produced by removal of large biface thinning flakes to produce high width-to-thickness ratios of 5.44 and 5.04, respectively. Both bifaces weigh between 48-49 g and measure 90-95 mm long, 46-48 mm wide, and 8-10 mm thick. The bifaces were also both produced from high quality cherts and were heavily retouched for use as cutting/butchering tools. Hafted-biface retouch indexes (HRI; Andrefsky 2006) are moderately high (>0.25) for both bifaces, suggesting long-term curation of the bifaces in toolkits.

FS 543 was produced from material that matches hand samples of Crescent Hill chert (see Adams, this volume). The material is a white chert/chalcedony with large areas of pink/reddening that is largely opaque except for slight translucency on its edges. FS 544 was produced from moss agate, available in south-central Montana and north-central Wyoming (although more proximate sources are possible). Use-wear is present along the lateral margins of both bifaces, suggesting their use as knives or other cutting tools. In particular, FS 543 was clearly hafted as a knife. Both bifaces in the cache are reminiscent of knife forms shown in Frison (1991:129) dating to the Late Archaic from other sites in the northwestern Plains.

<table>
<thead>
<tr>
<th>FS</th>
<th>Wgt (g)</th>
<th>Material</th>
<th>Description</th>
<th>L (mm)</th>
<th>W (mm)</th>
<th>Th (mm)</th>
<th>W:T ratio</th>
<th>HRI</th>
</tr>
</thead>
<tbody>
<tr>
<td>543</td>
<td>48.0</td>
<td>Crescent Hill chert</td>
<td>Late stage biface/knife</td>
<td>95.44</td>
<td>47.98</td>
<td>8.82</td>
<td>5.44</td>
<td>0.438</td>
</tr>
<tr>
<td>544</td>
<td>49.2</td>
<td>Moss Agare</td>
<td>Late stage biface/knife</td>
<td>90.53</td>
<td>46.26</td>
<td>9.17</td>
<td>5.04</td>
<td>0.25</td>
</tr>
</tbody>
</table>

Based on the high concentration of features and artifacts in the northern portion of 24YE355, as well as Tom Jerde’s cache location, Area A was deemed a high-priority area for test unit excavations. In particular, YNP was interested in the excavation of three of the prehistoric features—Features 3, 4, and 6—that were in danger of eroding from the edge of the Yellowstone River terrace escarpment (Table 2).
During the excavation of those three features, an additional prehistoric fire feature—Feature 36—was identified in Test Unit (TU) 3. As such, four prehistoric features were excavated, each of which was identified approximately 20-25 cm below ground surface (bgs) within the buried paleosol. As discussed below, each of the features yielded radiocarbon dates and Pelican Lake artifacts which place occupation of the buried surface between 500 B.C. and 400 A.D. (Table 2).

In association with the four features, UM recovered 2,824 prehistoric artifacts from the four features at the Yellowstone Bank Cache site, including 1,381 faunal and 1,443 lithic artifacts (Table 2; Table 3). In particular, excavations yielded a flintknapping feature adjacent to Features 36 and 3, which matches the general provenience of Jerde’s original cache location.

Nearly 75 percent of all prehistoric artifacts, including faunal and lithic materials, are from Feature 36. As discussed in MacDonald et al. (2010), excavations revealed a dense concentration of faunal and lithic debris within this densely-packed rock-lined fire feature. The following discussion is focused on the lithic organization of Late Archaic occupations. Table 3 summarizes lithic artifact assemblages from the features by material type.

Table 3. Lithic Artifacts, Yellowstone Bank Cache Site.

<table>
<thead>
<tr>
<th>Feature</th>
<th>Obsidian</th>
<th>Crescent Hill</th>
<th>Other chert</th>
<th>Other mat</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feat. 3</td>
<td>64</td>
<td>19</td>
<td>11</td>
<td>2</td>
<td>96</td>
</tr>
<tr>
<td>Feat. 36</td>
<td>455</td>
<td>415</td>
<td>84</td>
<td>12</td>
<td>966</td>
</tr>
<tr>
<td>Feat. 4/37</td>
<td>223</td>
<td>42</td>
<td>15</td>
<td>0</td>
<td>280</td>
</tr>
<tr>
<td>Feat. 6</td>
<td>60</td>
<td>31</td>
<td>6</td>
<td>4</td>
<td>101</td>
</tr>
<tr>
<td>Total</td>
<td>802</td>
<td>507</td>
<td>116</td>
<td>18</td>
<td>1443</td>
</tr>
<tr>
<td>%</td>
<td>55.6</td>
<td>35.1</td>
<td>8.0</td>
<td>1.2</td>
<td>100.0</td>
</tr>
</tbody>
</table>

Feature 36 Lithics. In the northern portion of Area A of 24YE355, UM focused on the excavation of features eroding from the Yellowstone River terrace. Along with the nearby Feature 3 (discussed below), Feature 36 was the furthest north of these features. Feature 36 was comprised of a concentration of fire-cracked rock and charcoal in close proximity to the location of Jerde’s original cache. A wood charcoal sample returned a conventional radiocarbon age of 2280±40 B.P. (Beta-250835) with a 2-sigma calibration of Cal B.C. 400 to 350 and Cal B.C. 300 to 210. This date places use of Feature 36 squarely within the Late Archaic period.

Table 2. Summary Data from Features, Yellowstone Bank Cache Site.

<table>
<thead>
<tr>
<th>Feature</th>
<th>Northing</th>
<th>Easting</th>
<th>C14 Age</th>
<th>Fauna (n)</th>
<th>Lithics (n)</th>
<th>Total (n)</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>1398.76</td>
<td>736.84</td>
<td>1670±50</td>
<td>85</td>
<td>96</td>
<td>181</td>
<td>6.4</td>
</tr>
<tr>
<td>36</td>
<td>1398.39</td>
<td>735.96</td>
<td>2280±40</td>
<td>1181</td>
<td>966</td>
<td>2147</td>
<td>76.0</td>
</tr>
<tr>
<td>4/37</td>
<td>1389.53</td>
<td>740.43</td>
<td>1600±70</td>
<td>4</td>
<td>280</td>
<td>364</td>
<td>12.9</td>
</tr>
<tr>
<td>6</td>
<td>1384.97</td>
<td>743.10</td>
<td>2530±40</td>
<td>101</td>
<td>132</td>
<td>234</td>
<td>4.7</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1381</td>
<td>1443</td>
<td>2824</td>
<td>100.0</td>
</tr>
</tbody>
</table>
Excavation of Feature 36 and its associated perimeter yielded more than 2,000 lithic and faunal artifacts, including 966 lithic artifacts and 1,181 bone fragments (Table 2). Given the association of faunal remains (discussed in MacDonald et al. 2010), it is likely that the feature was utilized as a roasting pit for a variety of medium and large game.

In direct association with the Late Archaic radiocarbon date, UM recovered two Pelican Lake projectile points within feature matrix (Figure 5). The points both were produced from high quality varieties of Crescent Hill chert. FS 128 was produced from a bluish black chert with red inclusions, while FS 140 was produced from a dark red chert/jasper with white inclusions. Both of these materials match hand samples collected by the senior author from the Crescent Hill source in YNP. As discussed by Adams (this volume), the Crescent Hill chert source area is located 15 miles east-southeast of the Yellowstone Bank Cache site.

In addition to the two Pelican Lake projectile points, lithic artifacts from Feature 36 include a high density concentration of flaking debris, reflecting an intensive episode of lithic tool production. Tool production was oriented toward the manufacture of middle and late stage bifaces and projectile points. Based on an analysis of lithic raw materials, as well as their close provenience, Feature 36’s intensive lithic reduction area appears to be associated with the previously-identified cache. The presence of these lithics support the hypothesis that individuals produced large bifaces and Pelican Lake projectile points while seated adjacent to Feature 36.

Among the lithic assemblage recovered in association with Feature 36 are 945 flakes, including 599 indeterminate flake fragments. Of the typed flake assemblage (n=346), biface reduction (n=151, 43.6%) and pressure/shaping flakes (n=138, 39.9%) are the dominant varieties, indicative of the middle-late stages of biface and projectile point manufacture. Of these middle and late stage flakes (n=289, 84% of typed flakes), the majority (n=167, 58%) are the byproducts of Crescent Hill chert biface manufacture (Figure 6). Other lithic materials recovered from Feature 36 include obsidian (discussed below) and an assortment of other materials in low quantities, including dacite (n=1), orthoquartzite (n=11), jasper (possibly Crescent Hill chert; n=49), and untyped chert (n=35).

As reflected in Figure 6, there was a significant difference in the use of Crescent Hill chert and obsidian by people sitting adjacent to Feature 36 ($\chi^2=14.437; df=1; p=0.000$). One or more individuals produced primarily middle-late-stage bifaces from Crescent Hill chert, while finishing bifaces and projectile points from obsidian. Eleven obsidian flakes from the feature were submitted for XRF analysis (Hughes 2008b), with all coming from Obsidian Cliff (18 miles south). Three additional flakes were submitted for analysis from the adjacent Late Archaic Feature 3 (discussed below), each of which also yielded an Obsidian Cliff source designation.

![Figure 6. Comparison of Crescent Hill Chert and Obsidian Use, Feature 36.](image)

As discussed further by Adams (this volume), these differences in lithic raw material use between the obsidian and Crescent Hill chert reflect variable land-use cycles of distinct individuals or, alternatively, distinct trips by the same individual to the respective lithic sources. In either scenario, Crescent Hill chert entered the site in an earlier stage of biface reduction than the obsidian, reflecting variability in mobility and land-use during the Late Archaic site occupations.

**Feature 3 Lithics.** UM excavated Feature 3 in the adjacent 1x1-m test unit to the east of Feature 36 discussed above. Feature 3 was eroding into the river and the ultimate goal was to salvage its contents prior to its complete disappearance. While Feature 36 contained...
more than 2,000 artifacts, Feature 3 yielded only 181, including 96 lithic and 85 faunal artifacts.

While its overall artifact densities were less than the adjacent Feature 36, Feature 3 contained a very high density of FCR and charcoal, yielding a conventional radiocarbon date of 1670±50 B.P. (2-sigma calibration of Cal AD 250-450, AD 450-460 and AD 480-530) (Beta-238180). This date provides a direct age for the obsidian Pelican Lake projectile point base found in the feature matrix (Figure 7). In contrast to the two Crescent Hill points in the nearby Feature 36, the Pelican Lake point from Feature 3 was produced from Obsidian Cliff obsidian and was serrated along its only intact lateral edge. Its intact lateral tang is also more strongly pronounced than the two in Feature 36, although it is within the range of variation of Pelican Lake points found elsewhere in the northwestern Plains and vicinity (Foor 1982, 1998; Frison 1991: 104).

Figure 7. Obsidian Pelican Lake Point, Feature 3, Yellowstone Bank Cache Site.

Of the 96 lithic artifacts collected from Feature 3, flaking debris comprise a majority (n=91), with only two bifaces, two unifacial tools (both sidescrapers), and a single core comprising the remainder. Both sidescrapers were produced from obsidian and show extensive use along their lateral margins for cutting/scraping. The single core is a large fragment of red ochre, or hematite, perhaps used in a ritual or other purpose by Native Americans at the camp site. The flake assemblage (n=91) from Feature 3 is comprised largely of obsidian flake fragments and indeterminate flakes (n=45), with Crescent Hill chert flakes (n=19) not nearly as abundant as in Feature 36. These lithic data are significantly different than the nearby Feature 36 which had a higher proportion of Crescent Hill chert than obsidian ($X^2$=7.777; df=1; p=0.005).

Feature 4/37 Lithics. Approximately 8.84 m (28 ft.) south of Features 3 and 36 discussed above, upstream along the Yellowstone River, the MYAP team excavated another burn feature—Feature 4/37—within TUs 4 and 6. FCR was packed with charcoal throughout Feature 4/37 fill. As with Feature 3 discussed above, Feature 4/37 dates to the terminal portion of the Late Archaic period, as determined by a radiocarbon date of 1600±70 B.P. with a 2-sigma calibration of Cal AD 260-290 and AD 320-610 (Beta-238179).

The overall artifact counts from Feature 4/37 are low compared to Features 36 to the north, but fairly similar to Feature 3. Statistically, no significant difference was observed in lithic raw material use between Features 3 and 4/37, reflecting similar stone tool manufacturing activities in the two feature areas. The similar radiocarbon dates (ca. 1,600 years ago) and lithic technology suggests contemporaneous occupation and use of the two features at the end of the Late Archaic period.

In total 346 lithic and faunal artifacts were recovered in Feature 4/37, including 280 lithics and 66 faunal remains. The lithic assemblage from Feature 4/37 is comprised largely of flaking debris from the manufacture of obsidian (79.6%) bifaces. Compared to Feature 36 to the north, Crescent Hill chert (15%) is infrequent in Feature 4/37, but compares favorably with Feature 3 which also had higher ratios of obsidian than Crescent Hill chert. As such, it appears as if several individuals used obsidian predominantly at this site, while one or more preferred or simply carried with him or her more Crescent Hill chert to Feature 36. The lithic assemblage from Feature 4/37 yielded predominantly flaking debris (n=273, 97.5%), with the only stone tools being five bifaces and two unifaces. Typed flakes are dominated by middle-late-stage biface reduction (n=28/75, 37.3%) and pressure/shaping flakes (n=28/75, 37.3%). Clearly the emphasis of flintknappers at this location was the reduction of middle and late stage bifaces and projectile points, predominantly from obsidian.

Among the bifaces are three obsidian projectile points, including a midsection/tip fragment (FS 214) and two untyped notched base and midsection fragments (FS 213). Each of the projectile points was recovered from
feature fill. Each of the points is broken, with only one of the points possibly diagnostic. FS 214 is a small obsidian point base that resembles the Pelican Lake form in size and shape; however the fragment is of the very proximal base and lacks most of the notching and all of the blade.

**Feature 6 Lithics.** As with Features 3, 36, and 4/37 discussed above, Feature 6 is another FCR-laden fire pit eroding from the Yellowstone River terrace in the northern portion of Area A of 24YE35S. Feature 6 is approximately 4.4 m (14 ft.) south, upstream along the river from Feature 4/37. Charcoal collected from the feature received an AMS conventional radiocarbon date (Beta-250834) of 2530±40 B.P. with a 2-sigma calibration of Cal B.C. 800-530. This date is in close correspondence to Feature 36 (ca. 2300 B.P.), an indication of long-term use during the entire terminal portion of the Late Archaic period, between approximately 500 B.C. and 400 AD.

UM recovered 130 artifacts from Feature 6 and associated excavation levels, including 99 lithics and 31 faunal artifacts. The lithic artifact assemblage from Feature 6 is comprised entirely of flaking debris. No bifaces, projectile points, or other stone tools were recovered in Feature 6. The flake assemblage is comprised of obsidian (60.6%) and Crescent Hill chert (31.3%), with small amounts of red jasper (4%) and untyped chert (2%). As with Feature 3 to the north, small nodules of hematite (red ocher) were also recovered in Feature 6. The hematite was likely used for ritual or other decorative purposes. Most of the recovered flakes are indeterminate fragments (72.8%), with biface reduction and shaping flakes appearing in higher counts (n=15) than early-stage-reduction flakes with cortex (n=4).

These data confirm similar lithic reduction strategies for individuals at Feature 6 as those at the other three features excavated at the site. The focus of Late Archaic site occupants was clearly on the middle to late stages of biface reduction, using materials collected at the Obsidian Cliff and Crescent Hill chert sources. Based on lithics from these four features at the Yellowstone Bank Cache site, the Gardiner Basin was a staging area from which Late Archaic hunter-gatherers exploited the abundant and diverse ecosystem of the Yellowstone Plateau to the south. After completing hunting and gathering activities in the plateau (including lithic raw material collection), hunter-gatherers re-grouped in the Gardiner Basin prior to venturing northward into the Paradise Valley and the Great Plains and Rocky Mountains beyond.

**RJP-1 Site Lithics**

The Yellowstone Bank Cache site provides an outstanding window in the organization of lithic technology for Late Archaic hunter-gatherers in the Gardiner Basin. Three other sites in the study area—RJP-1, 24YE14, and Little Trail Creek—also provide Late Archaic data by which to better understand a wider range of lithic-reduction activities in the study area.

In 2008, the UM team identified another Late Archaic lithic-reduction site—RJP-1 (24YE190)—approximately one mile southwest of Yellowstone Bank Cache Site (see Figure 1). The RJP1 site is a moderate to high density lithic scatter located on the northern edge of a long terrace that roughly parallels the Old Yellowstone Trail Road that runs along the Yellowstone River between Gardiner and Corwin Springs. The western edge of the terrace has a series of boulders and associated debris that form a northwestern “hook”, within which is nestled a dense lithic scatter identified by UM as the RJP-1 Site (24YE190). Based on the distribution of cobbles upon the terrace, the landform resembles a glacial outwash channel with cobbles washed off the upper terrace down onto the lower terrace in the Late Pleistocene, similar to the Six Point Site (24YE0176) identified by UM in 2007 and discussed briefly above (MacDonald 2008).

Lithic data from RJP-1 provide support for the model of Late Archaic technological organization provided herein. UM collected a total of 199 lithic artifacts from the RJP1 Site. Most of the artifacts observed and collected were obsidian (N=193, 97.47%), with chert comprising only a small amount of the total materials collected (n=4, 2.02%). A single dacite biface rounds out the lithic assemblage. Projectile points comprise the most significant portion of the non-flake artifacts (n=6, 40%), with late stage bifaces having a strong presence (n=4, 26.67%). Of the debitage collected, all was produced from obsidian, with the high number of shaping and biface reduction flakes (n=42, 22.95%) indicative of extensive late-stage biface and point production, similar to the pattern described above at the Yellowstone Bank Cache site.
Late Archaic projectile points were the only type recovered at the site, suggesting its Late Archaic age (Figure 8). No features were identified at the site. Several of the recovered tools at RJP-1 are worthy of note. FS 2 is a broken Obsidian Cliff obsidian Late Archaic corner-notch projectile point that shows no evidence of use. The two intact edges show no evidence of retouching, and it is likely that the projectile point broke from end-shock during final stages of manufacture. FS 4 is an obsidian projectile point that shows heavy retouch on both lateral edges of the reverse face. There is also light retouching on the reverse face. As this artifact is an intact, functional projectile point it is not known why it was discarded, though loss due to human error is possible.

As shown in Figure 8, FS 6 is an Obsidian Cliff obsidian biface fragment tip of a late stage or ultra-thin biface. The artifact resembles the Late Archaic bifaces from the Yellowstone Bank Cache discussed above. The artifacts exhibits little retouching but there is a suggestion of end-shock break resulting in transverse fracture. FS 7 (Figure 8) is a white chert Late Archaic Pelican Lake point broken by end-shock during use.

FS 5 is of special note, as it is the lone Knife River flint (KRF) artifact recovered by UM in its work in the Gardiner
Basin (Figure 8). Its source material—KRF—is evidenced by its macroscropic characteristics, including its rootbeer brown chalcedonic character and its orange/green ultraviolet response which match hand samples of Knife River flint collected by the lead author in the source area. The artifact is a heavily-retouched utilized flake that had the tip sharpened and broken during use as a drill. There is a perforator point on proximal end near the original flake platform, and the artifact show signs of being hafted. The retouching on the artifact results in a sharp angle for the blade, which may indicate use in a sawing function.

FS 9 is a very large obsidian bifacial core (Figure 8). The artifact experienced heavy use as a cutting tool, likely during butchering of large game. This artifact was sourced to Obsidian Cliff, Wyoming, but blood-residue analysis of the artifact was negative. The biface measures 164 mm long and weighs more than 1000 grams. It likely functioned as a core for flake blanks and as a heavy-duty cutting tool.

In summary, the RJP-1 Site is a moderate-density obsidian lithic scatter of likely Late Archaic origin, based on projectile point association. Obsidian dominates the lithic assemblage, reflecting recent travel toward the Obsidian Cliff source by site occupants. The lack of Crescent Hill chert at the site indicates no travel southward along the Yellowstone by Late Archaic hunter-gatherers at RJP-1; this stands in contrast to those that camped at the nearby Yellowstone Bank Cache site discussed above. The site likely is a single occupation camp for Late Archaic hunter-gatherers returning from a trip that brought them near Obsidian Cliff, likely up the Gardiner River.

The large biface fragments from RJP-1 confirm data from the Yellowstone Bank Cache site discussed above, namely that large bifaces were produced at the quarry sites and transported as usable cores, cutting tools, and preforms. The presence of two exotic artifacts at RJP-1—a blade-like tool sourced to the Knife River flint quarries of western North Dakota and a biface sourced to Big Southern Butte near Idaho Falls, Idaho—suggest long-distance trade across the Yellowstone ecosystem during the Late Archaic.

**Site 24YE14**

Sanders’ (2000) work at Site 24YE14 provides complimentary data for those recovered by UM at Late Archaic sites in the Gardiner Basin, Montana. Site 24YE14 is located approximately three miles south of Yellowstone Bank Cache and a mile south of RJP-1. As discussed above, two paleosols of Late Archaic age were identified at the site. At 24YE14, Sanders (2000) recovered Pelican Lake projectile points and diverse faunal remains—including deer and elk—in two components dated to between 1600 and 2300 B.P., precisely the two periods of Late Archaic occupation defined at the Yellowstone Bank Cache as well.

Lithic data from 24YE14 include 317 lithics from test units and 58 from shovel test pits (Table 4), comprised of approximately 75 percent (n=279) obsidian and 22 percent (n=81) chert. All lithic data from all Middle and Late Archaic occupations from 24YE14 (Sanders 2000: 34, 51) are grouped together for this analysis.

### Table 4. Lithic Artifacts from 24YE14.

<table>
<thead>
<tr>
<th>Lithic Type</th>
<th>Obsidian</th>
<th>Chert</th>
<th>Other</th>
<th>Total</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flakes</td>
<td>269</td>
<td>76</td>
<td>15</td>
<td>360</td>
<td>96.0</td>
</tr>
<tr>
<td>Points</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>3</td>
<td>0.8</td>
</tr>
<tr>
<td>Bifaces</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>2</td>
<td>0.5</td>
</tr>
<tr>
<td>Unifaces</td>
<td>7</td>
<td>3</td>
<td>0</td>
<td>10</td>
<td>2.7</td>
</tr>
<tr>
<td>Total</td>
<td>279</td>
<td>81</td>
<td>15</td>
<td>375</td>
<td>100.0</td>
</tr>
<tr>
<td>%</td>
<td>74.4</td>
<td>21.6</td>
<td>4.0</td>
<td>100.0</td>
<td>26.7</td>
</tr>
</tbody>
</table>

Lithic data from 24YE14 compare well with lithics from three of the four features at Yellowstone Bank Cache, with the high percentage of chert in Feature 36 at the latter site somewhat anomalous compared to the various Late Archaic occupations in the valley bottom discussed herein. Sourced obsidian artifacts from 24YE14 (n=3) were exclusively from Obsidian Cliff (Hughes 2000), similar to the Yellowstone Bank Cache site. While Sanders did not identify Crescent Hill chert, specifically, at 24YE14, we assume that a large percentage of those chert artifacts are from Crescent Hill, the most proximate chert source to the site.

**Little Trail Creek Site**

Finally, UM’s excavations at the Little Trail Creek site (24PA1081) provide complimentary data regarding Late
Archaic use of upland landforms above the Gardiner Basin proper. The site is located north of the Yellowstone River at an elevation of approximately 6,000 ft. amsl and likely represents camp occupations associated with upland hunting and gathering activities by people with larger camps in the valley proper, such as at Yellowstone Bank Cache or 24YE14.

Fieldwork was conducted in 2011 by UM and Gallatin National Forest. The focus of excavations was to evaluate the National Register eligibility of the site and determine its age relative to other sites excavated by UM in the Gardiner Basin. Based on preliminary results, the site contains substantial Late Archaic and Late Prehistoric occupations. Faunal remains support its role as an upland hunting camp, with several fire-cracked rock concentrations supporting use of the site for itinerant hunting camps. A near-surface Late Prehistoric occupation overlies an earlier Late Archaic occupation, as represented by diagnostic Besant and Pelican Lake projectile points (Figure 9).

![Figure 9. Late Archaic Points, Little Trail Creek Site.](image)

Based on preliminary laboratory counts of all artifacts from all site occupations, chert represents a significantly greater percentage of lithic materials (ca. 45%) at the upland Little Trail Creek Site than in most of the valley site occupations discussed above. Although full analysis remains incomplete for this site, the percentage of chert—mainly the local Crescent Hill chert—increased during the Late Archaic compared to the Late Prehistoric, a trend highlighted in Adams’ paper in this volume. Late Archaic Native Americans camped at Little Trail Creek after visiting the Crescent Hill chert source area, perhaps within a seasonal round that pushed people southward through the Black Canyon on the south side of the Yellowstone River and then crossing to the north side and working back westerly toward the Gardiner Basin where they utilized sheep hunting blinds located above the Little Trail Creek site before descending back into the valley bottom at sites like Yellowstone Bank Cache, 24YE14, and RIP-1.

**Summary and Conclusions**

The lithic data from the these four Late Archaic sites—Yellowstone Bank Cache (24YE355), RIP-1 (24YE190), Little Trail Creek (24PA1081) and 24YE14—support the hypothesis that Late Archaic Native Americans actively used the ecotonal nature of the Gardiner Basin to their advantage. With the Yellowstone River as the primary route of movement, individuals traveled southward and eastward into the Yellowstone Plateau and along the foothills of the Rocky Mountains to exploit a wide variety of resources in the Gardiner Basin.

The lithic source data indicate that the primary lithic raw materials used by site occupants—Crescent Hill chert and Obsidian Cliff obsidian—derive from sources within approximately 20 miles east and south of the Gardiner Basin, respectively. Use of these two source areas varied depending on individual travel patterns, lithic material needs, and animal/plant resource availability, as discussed further by Adams et al. in this volume. As reflected by Figure 10, the extreme variation in lithic raw material use between the two sources indicates variable Late Archaic travel patterns which sometimes included the Gardiner River and Obsidian Cliff and other times included the Black Canyon of the Yellowstone and Crescent Hill.

As shown in Table 5, 23 of the 27 (85%) sourced Late Archaic volcanic artifacts from UM-identified sites in the Gardiner Basin are from Obsidian Cliff, with three dacite artifacts from southwest Montana and a single exotic artifact from Big Southern Butte, Idaho, some 220 miles south of the site (Hughes 2008a, 2008b). Sourced lithics from 24YE14 (Hughes 2000) are all from Obsidian Cliff. While Late Archaic travel clearly was focused locally...
(within 20 miles of the Gardiner Basin), extra-local travel was focused north and westward toward southwest Montana, as evidenced by dacite artifacts at the sites. Wider super-local trade networks extended to the south into the northern Great Basin (as reflected by the Big Southern Butte obsidian from near Idaho Falls, Idaho) and to the east into the Dakota prairies (as reflected by the KRF retouched flake from RJP-1).

Table 5. XRF Results, Late Archaic Volcanic Artifacts collected by UM in 2007-2008, Gardiner Basin, Montana (Hughes 2008a, 2008b).

<table>
<thead>
<tr>
<th>Site</th>
<th>FS</th>
<th>XRF Source</th>
<th>Lithic Artifact Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>YellowBankCache</td>
<td>134</td>
<td>Obsidian Cliff</td>
<td>Biface Reduction Flake</td>
</tr>
<tr>
<td>YellowBankCache</td>
<td>134</td>
<td>Obsidian Cliff</td>
<td>Utilized Flake</td>
</tr>
<tr>
<td>YellowBankCache</td>
<td>134</td>
<td>Obsidian Cliff</td>
<td>Utilized Flake</td>
</tr>
<tr>
<td>YellowBankCache</td>
<td>134</td>
<td>Obsidian Cliff</td>
<td>Block shatter</td>
</tr>
<tr>
<td>YellowBankCache</td>
<td>134</td>
<td>Obsidian Cliff</td>
<td>Early reduction flake</td>
</tr>
<tr>
<td>YellowBankCache</td>
<td>136</td>
<td>Obsidian Cliff</td>
<td>decorication flake</td>
</tr>
<tr>
<td>YellowBankCache</td>
<td>136</td>
<td>Obsidian Cliff</td>
<td>Block shatter</td>
</tr>
<tr>
<td>YellowBankCache</td>
<td>136</td>
<td>Obsidian Cliff</td>
<td>Biface fragment</td>
</tr>
<tr>
<td>YellowBankCache</td>
<td>136</td>
<td>Obsidian Cliff</td>
<td>Utilized Flake</td>
</tr>
<tr>
<td>YellowBankCache</td>
<td>136</td>
<td>Obsidian Cliff</td>
<td>Biface Reduction Flake</td>
</tr>
<tr>
<td>YellowBankCache</td>
<td>438</td>
<td>Obsidian Cliff</td>
<td>Sidescraper</td>
</tr>
<tr>
<td>YellowBankCache</td>
<td>443</td>
<td>Obsidian Cliff</td>
<td>Flake Fragment</td>
</tr>
<tr>
<td>YellowBankCache</td>
<td>472</td>
<td>Obsidian Cliff</td>
<td>Late Archaic point</td>
</tr>
<tr>
<td>YellowBankCache</td>
<td>474</td>
<td>Obsidian Cliff</td>
<td>Biface Reduction Flake</td>
</tr>
<tr>
<td>24YE356</td>
<td>19</td>
<td>Cashman Dacite</td>
<td>Late Archaic point</td>
</tr>
<tr>
<td>24YE356</td>
<td>25</td>
<td>unknown dacite</td>
<td>Late Archaic point</td>
</tr>
<tr>
<td>24YE186</td>
<td>7</td>
<td>Obsidian Cliff</td>
<td>Late Archaic point</td>
</tr>
<tr>
<td>24YE184</td>
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<td>Obsidian Cliff</td>
<td>Late Archaic point</td>
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<td>24YE182</td>
<td>8</td>
<td>Obsidian Cliff</td>
<td>Late Archaic point</td>
</tr>
<tr>
<td>24YE181</td>
<td>2</td>
<td>Obsidian Cliff</td>
<td>Late Archaic point</td>
</tr>
<tr>
<td>24YE193</td>
<td>5</td>
<td>Obsidian Cliff</td>
<td>Late Archaic point</td>
</tr>
<tr>
<td>24YE198</td>
<td>1</td>
<td>Cashman Dacite</td>
<td>Late Archaic point</td>
</tr>
<tr>
<td>RJP1</td>
<td>1</td>
<td>Obsidian Cliff</td>
<td>Late Archaic point</td>
</tr>
<tr>
<td>RJP1</td>
<td>3</td>
<td>Obsidian Cliff</td>
<td>Late Archaic point</td>
</tr>
<tr>
<td>RJP1</td>
<td>4</td>
<td>Big Southern Butte, Idaho</td>
<td>Late Archaic point</td>
</tr>
<tr>
<td>RJP1</td>
<td>5</td>
<td>Obsidian Cliff</td>
<td>Late Archaic point</td>
</tr>
<tr>
<td>24YE179</td>
<td>1</td>
<td>Obsidian Cliff</td>
<td>Late Archaic point</td>
</tr>
</tbody>
</table>

The Obsidian Cliff source (ca. 18 miles south) would have been most easily accessed following the Yellowstone River-Gardiner River-Obsidian Creek route, which is approximately the path of Route 89 through YNP today. For Crescent Hill chert, Native Americans had a slightly easier route of procurement, following the Yellowstone River upstream for approximately 15 miles eastward through the Black Canyon of the Yellowstone then traversing feeder streams into the uplands to the Crescent Hill basalt formation from which the chert derives. The trip from the Gardiner Basin to Obsidian Cliff would have required an increase in elevation some 2,200 ft. from the valley floor (5,200 ft. amsl) to the top of the Yellowstone Plateau (ca. 7500 ft. amsl), while the trip to the Crescent Hill chert source (ca. 6500-7500 ft. amsl) required a climb of between 1,300-2,300 ft., depending on the location of procurement within the outcrop itself.

In corroboration of these likely routes of travel, multiple prehistoric sites have been investigated along the Black Canyon of the Yellowstone River (ca. 10 miles upstream of the Gardiner Basin), with several occupations dating to the Late Archaic period (see Park, this volume; Arthur 1966; Hale 2003; Sanders 2001, 2005). These Black Canyon sites have very high incidences of chert, likely from the Crescent Hill chert source just upstream of the Black Canyon. The increased visibility of chert in the Black Canyon confirms use of the Yellowstone River as a travel corridor for individuals hunting and gathering within the Yellowstone Plateau toward the headwaters of the river at Yellowstone Lake. During their activities, they collected cherts from Crescent Hill and probably other unidentified sources in the area and brought them back to the Gardiner Basin on their travels back northward to the Plains and Rockies.

Davis et al. (1995) and Hale (2003) confirm that the Late Archaic was one of the most active periods of procurement of Obsidian Cliff obsidian as well. Based on data from these sources, in consort with that collected from lithic artifacts from sites in the Gardiner Basin, the route of travel from the stone sources on the Yellowstone Plateau back into the northern Plains was along these probable routes.
Travel to either Obsidian Cliff or Crescent Hill would likely not have occurred in winter, given the abundant snowfall in the Yellowstone Plateau; however, the presence of Jerde’s obsidian and chert cache at the Yellowstone Bank Cache suggests the possible storage of bifaces at the site for use during the winter, when both sources would have likely been inaccessible. Alternatively, occupancy of the Yellowstone Bank Cache Site occurred in spring, summer, or fall when both Obsidian Cliff and Crescent Hill were accessible. If this is the case, then individuals may have cached material at the site for future use (during winter perhaps), but simply never returned to the site to retrieve their stored lithic material.

Regardless of the season of occupancy, Late Archaic individuals clearly finished Crescent Hill chert and Obsidian Cliff bifaces and projectile points at the respective sites in this study. These data support a lithic production model in which individuals collected material at the sources and completed early-middle stage biface manufacture in the near-source uplands, transporting bifaces in their middle-late stages to the site for finishing, perhaps over a multiple day lithic and subsistence procurement trip. As discussed in MacDonald et al. (2010), faunal remains support the idea that individuals also conducted hunting during their expeditions into the uplands prior to their arrival at the site.

In summary, excavations at several sites in the Gardiner Basin suggest that the Upper Yellowstone River Valley near Gardiner, Montana, functioned as a conduit through which Late Archaic Native Americans traveled from the Yellowstone Plateau to the northern Plains and beyond. UM excavated four well-dated Late Archaic features at the Yellowstone Bank Cache site which show repeated use of the site landform between 500 B.C. and 400 A.D. Similar occupations were observed at nearby sites 24YE14 and Little Trail Creek. Late Archaic Native Americans processed medium and large game animals at these sites and produced Obsidian Cliff obsidian and Crescent Hill chert bifaces, both with sources in uplands ca. 15-20 miles south and east, respectively.

As shown in Figure 10, three of the hearths (Features 3, 6, and 4/37) excavated at the Yellowstone Bank Cache Site show an emphasis on Obsidian Cliff obsidian use, while one shows a heavy reliance on Crescent Hill chert. Variation in lithic raw material use is also reflected at the three other sites, with chert accounting for nearly half of the lithics at the upland Little Trail Creek site, but only 20 percent at 24YE14 and only two percent at RJP-1.

Despite the variation in use of chert and obsidian by Late Archaic Native Americans, both materials were transported from source areas as middle-late stage bifaces to the four sites in the Gardiner Basin. The valley provided a wintering ground for Native Americans moving out of the Yellowstone Plateau and northward into the Montana Great Plains, with the storage of obsidian and chert bifaces at valley sites a risk minimization measure due to the restricted access to

\[ \text{Figure 10. Comparison of Lithic Material Use, All Late Archaic Occupations Discussed in Text} \]
In consort with other prior studies, these four Late Archaic sites provide a window into lithic organization of Late Archaic Native Americans within the Yellowstone River Valley and the Gardiner Basin of Montana. The Late Archaic period—between 3,000 and 1,500 years ago—was one of the most active in Northern Plains and Rocky Mountain prehistory, with Native Americans from all over the region venturing into the Yellowstone Plateau. Sites in the Gardiner Basin represent base camps from which Late Archaic Native Americans ventured to and from the nearby Yellowstone Plateau and Rocky Mountains to exploit its rich and diverse ecosystem. Lithic debris at these sites reflect the variable use of the Plateau by Late Archaic hunter-gatherers, with some venturing into the Plateau via the Gardiner River past Obsidian Cliff, while others entered the Plateau by following the Yellowstone River through the Black Canyon past the Crescent Hill chert sources. Decisions on which travel route to use were likely driven by past individual experiences, the need for stone, as well as scouting reports by others in the area regarding game availability. This decision-making process is discussed further in this volume in chapters by both Adams et al. and Park.

Acknowledgements. Former University of Montana students Jonathan Hardes (faunal analysis) and Meg Tracy (illustrations) provided valuable contributions to this and another prior publication on Yellowstone Bank Cache site (MacDonald et al. 2010). Kristin Hare conducted preliminary lithic analysis and photographed the artifacts from the Little Trail Creek site. All other analyses of UM site lithics was conducted by the lead author. Richard Hughes conducted XRF analysis. California State University Bakersfield (Robert Yohe) conducted blood-residue analysis, all of which proved negative for UM artifacts in the Gardiner Basin, unfortunately. Christine Whitacre and the Rocky Mountain Cooperative Ecosystem Study Unit (CESU) of the National Park Service provided essential funds toward YNP project completion. Ann Johnson, Mary Hektner, and Elaine Hale provided key assistance during the UM survey of the Gardiner Basin in 2007-2008. Justin Moschelle, Walt Allen, and Carl Davis provided field assistance, project management, and funding for the 2011 Gallatin National Forest project at Little Trail Creek. The UM Office of the Vice President of Research and the Department of Anthropology also providing assistance.

REFERENCES CITED


CHAPTER 6
AIRPORT RINGS: STONE CIRCLE ARCHAEOLOGY IN THE GARDINER BASIN, MONTANA

Michael C. Livers

The Montana Yellowstone Archaeological Project (MYAP) has become a long term program providing research and learning opportunities for the University of Montana (UM) as well as archaeological services for Yellowstone National Park (YNP). During the initial two years of the project, UM worked at a total of 47 sites and collected almost 10,000 artifacts, including 2,725 lithics and 7,254 historic artifacts (MacDonald 2008; Mass and MacDonald 2009). The second year of the project resulted in the excavation of the first stone circle or “tipi ring” site within the boundaries of YNP. With nearly 3,000 acres of survey coverage in the Gardiner Basin (Figure 1), the Airport Rings Site (24YE357) was one of six stone circle sites identified in the project area and the only one tested. The results of the Airport Rings excavation provide evidence for multiple occupation episodes and suggest cold-weather use of the landform.

Project Setting
The Upper Yellowstone River Valley sits in an intermediate zone between the Northern Great Plains and the higher-elevation Intermountain Zone of the Rocky Mountains. This Intermountain region is defined as encompassing not only the entire Rocky Mountain range, but also many of the adjacent basins and plateaus with a broad elevation range anywhere between 4,200 and 12,500 feet (1300-3700m) (Madsen and Metcalf 2000). While the Rocky Mountains surround the river valley on all sides, the valley proper and the project area are in a High Plains setting, dominated by sagebrush and short-grass prairie.

Figure 1. 2007-2008 UM Gardiner Basin Survey Area.
Airport Rings is located in the Gardiner Basin, which represents the lowest and driest portion of Yellowstone National Park (Gardiner 2005). The elevation of UM’s Gardiner Basin study area ranges between approximately 5,150 and 5,430 ft. amsl, much lower than the majority of the Yellowstone Plateau proper, which averages 8,000 ft. amsl.

Precipitation averages slightly over 10 inches annually, with 33 percent of the total received from March through June. Snowfall averages around 40 inches annually, but is patchy and intermittent and seldom persists throughout the winter months (Gardiner 2005) unlike the higher elevations within the park where snow can still be as deep as several feet into late spring.

The terrain around Airport Rings is predominately sloping alluvial fans with a notable Holocene age landslide (Pierce 1973) located within the southern third of the project. Damming of the Yellowstone River about 10,000 years ago (Gardiner 2005) due to a landslide at Yankee Jim Canyon approximately 10 miles north of the project area inundated the floor of the Gardiner Basin with water and formed a temporary lake lasting several thousand years. Lake beds reached an altitude of about 5,200 feet and are made of brown to tan beds of silt and clay (Gardiner 2005). The clay-rich sediments deposited within this lake are responsible for the lowest parts of the broad flat valley-floor within the Gardiner Basin (Gardiner 2005).

Crewmembers excavated a 6 cm wide auger hole to test for buried soils and to better define the landform deposition. The auguring of the feature went to a max depth of 104 cm below ground surface before hitting a level of glacial cobbles and gravels. The topsoil was similar across the landform comprising a gray brown sandy silt stratum with remains of surface vegetation. Beyond the first two strata comprising the silty sandy A Horizon, the Bt Horizon is comprised of a hard dark yellowish brown, blocky clay layer intermixed with sandy silty pockets in the flaky lower regions of the clay level. The following 70 some centimeters are silty and sandy loam deposits, the results of glacial outwash activities on the terrace probably during the Late Pleistocene.

Based upon pollen samples in the southern portion of YNP, the present ecozones (sagebrush steppe, montane conifer forest, and alpine tundra) were established sometime during the Late Pleistocene to Holocene transition between 10,500 and 9,000 B.P. (Whitlock 1993). These same samples also show a spike in steppe-dominating grasses between 7000 and 5000 B.P., suggesting a maximum dryness in the area occurring during this time. By 5,000 B.P., environmental conditions similar to today prevailed across the northern Plains, including Yellowstone. Known as the Medieval climate optimum or anomaly (Bettinger 1999), the Late Holocene dates to approximately 1,000 – 600 years ago; this was the period of occupation of three of the stone circles at the Airport Rings Site. This warm-dry period is marked by reduced distribution of pine when compared to other Holocene periods.

Current surface vegetation within the project area consists predominantly of a sagebrush grassland community, with some stands of sagebrush are up to eight feet tall, signifying the relatively dry unchanging nature of the area. The Gardiner Basin contains many of the species typical of the middle Rocky Mountains but also harbors species more commonly encountered in the Great Plains to the east and the Great Basin to the west. Spiny hopsage is a typical component of the Great Basin flora but is a rarity in Montana. Wyoming big sage, bluebunch wheatgrass, prairie junegrass, and Sandberg’s bluegrass, make up the understory community of the lowest elevation of the Gardiner Basin (Gardiner 2005). With the exception of Reese Creek in the northern portion of the current project area, the Yellowstone River in the portions of the project area has very few cottonwoods. The adjacent slopes of the drainages are open woodland with limber pines, Rocky Mountain juniper, and Douglas-fir.

Yellowstone has a diverse ecosystem, which is currently home to many large mammals; bison, elk, moose, bighorn sheep, deer, antelope, grizzly and black bear, mountain lions, coyotes, and wolves. In addition to these varied large game species, a variety of birds and other small animals are also present in the region. The patterns may have been different in the past; Frison (1991: 334) observes from his work in northwest Wyoming that there were very few bison roaming the higher elevations during the entire Holocene and fewer antelope numbers in the area until the Late Archaic period. There has been some debate on the availability of various ungulates (specifically elk, bison, and
mountain sheep) during more distant prehistoric times (see Frison 1978; and Wright 1984).

The wide variety of flora and fauna would have provided prehistoric peoples with a range of potential subsistence sources, some of which have been identified within the archaeological record (Haines 1977; Janetski 1987; NPS 1993, 1999; Hunt 1993; Cannon et al. 1994; Davis et al. 1995). Antelope, or pronghorn, hunting has occurred in the Yellowstone region since the Paleoindian period (Frison 1991) and more than likely occurred in the Boundary Lands, evident of the many pronghorn noticed in the area during both field seasons. Faunal materials recovered from the Eagle Creek Site only a few miles to the northeast of the Boundary Lands included pronghorn, canid, elk, and bison remains indicating these were hunted in the past 500 to 1200 years (Jackman 1997).

Heavy snow in the uplands of the Intermountain region make, “mid range latitudes uninhabitable during winter” meaning a group “must make base camp in adjacent valley foothills or mouths of canyons” (Madsen and Metcalf 2000: xi). With the assurance of wintering camps at lower elevations and widely accepted idea of restricted movement in the winter (see Larson and Francis 1997), it is logical that habitation of the upper portions of the Yellowstone Plateau by prehistoric peoples would probably have been seasonal due to the heavy winter snows that blanket most of YNP and surrounding areas.

Snowfall during the fall, winter and spring months causes animal migration to lower elevations generally beginning in October to areas with less than two feet of snow accumulation (Osborn 1993). A study observed animals unable to maximize feeding potential without a significant energy loss as the cause for the move to lower wintering elevations, a model that is applicable across all upland areas of the Rocky Mountains (Osborn 1993).

The current project is within portions of the winter range of bison, elk, mountain sheep, deer, and antelope, which extends down-valley along the river to Livingston, MT, where the Yellowstone River exits the mountains (YNP 1997). This winter range for large ungulates would have provided productive hunting activities during the winter months for prehistoric and historic peoples as well as providing sheltered areas for winter camps due to the limited snowfall in the area compared to the nearby mountains.

Plant seasonality ties in with expected land use patterns. “Plant cover is obviously almost always likely to stand in relation to culture. It largely expresses climate; it tends heavily to determine the fauna; and it enters directly into subsistence, besides as times affecting travel and transport” (Krober 1969: 351). Within the Upper Yellowstone Valley, the plant cover is poor compared to other Intermountain regions like the higher elevations within YNP (Whitlock 1993). It is no surprise then that intermountain area research points to a trend of seasonal variation in resource availability causing rounds of domestic mobility related to subsistence and procurement strategies of these resources (Hale 2003; Kelly 2007; Madsen and Metcalf 2000). This is similar to other parts of the world where the actual loci of hunting, fishing, agricultural and gathering activities radically shift during seasonal weather extremes (Roy 1982).

Archaeological and Historical Overview

Prehistory. The Upper Yellowstone River Valley has been in constant use over thousands of years by hunter-gatherer populations. This is evident from very important sites within the valley such as the Carbell buffalo jump (24PA302), showing stratified occupation going back more than 6,000 years, the Myers-Hindman Site (24PA504) (Lahren 1976, 2006: 152-153) dating over 7,000 years of continuous occupation, and finally, to the north of the valley, the only Clovis age, Paleoindian burial discovered in North America, the Anzick Site (24PA506) (Lahren 2006: 96-101). The Yellowstone River provides a natural corridor or conduit for the migration of animals and people following resources along the valley (Davis et al. 1995; Hale 2003). It should come as no surprise that all of the regional prehistoric societies occupying the interior of the park were hunter-gatherers as well (Davis et al. 1995).

Even within the Great Yellowstone Area (GYA) there are numerous archaeological sites of Native American origin. Some of these sites have become world famous such as Mummy Cave, located just 13 miles east of the East Entrance to the Park (Husted and Edgar 2002). Looking to the interior of the YNP, sites like Osprey Beach (Shortt 2001) detail the continued use of the upland...
areas of the park since the Late Paleoindian period. While the number, composition, and specifics of each site is large and varied, in general most of the more contemporary sites, dating from about A.D. 1500 onward, are dominated by Blackfoot, as well as, Crow, Salish, and Shoshone origin (Nabokov and Loendorf 2002).

Understanding the use of the upland regions of the park by the same cultural groups living on the Plains come with its challenges. Life in the valley is different from that of the upland interior in many ways. This is evident by the changing site types from the surrounding valleys into the uplands. One form of cultural remains left behind by early inhabitants that changes with the transition from the valley to the interior are stone circles, or the remains of tipis, the mobile hide structures so popular among Plains Native Americans over the last 3,000 years. Stone circles are found in various locations in Yellowstone, but generally only as single rings or a few clustered together, indicating seasonal use of the area by small groups of foragers (Photograph 1). Such structural remains are virtually non-existent in higher elevations of the Yellowstone ecosystem, but are more common at lower elevations of the park, such as the current Boundary Lands Project Area.

The period of original adoption of a skin-covered lodge held in place with rocks, left in the archaeological record as stone rings, is unknown. Irwin-Williams et al. (1973), suggest in their report of Early Archaic or Paleoindian occupations in the Hell Gap area of southeast Wyoming, that the discovery of a structure containing nine rocks at the Frederick Phase level of the excavation (6,400-6,000 B.P.), was similar enough in arrangement to compare with the stone rings found on the Plains. General assumptions about the age of stone circles are that these remnants of prehistoric domestic sites were the result of technological adaptations of prehistoric groups sometime during the Late Archaic Period (Frison 1991). A majority of stone circle sites located on the Plains are concentrated in Montana, Wyoming, North Dakota, and Alberta, Canada (Brasser 1982), meaning it should come as no surprise some of the oldest verified stone circle sites are located in this area. Archaeologists compiling known dates from the

sites in this concentrated region have concluded that stone circle formation was most prevalent after 2,000 B.P. (Dooley 2004) as the result of shifting subsistence strategies focused on bison hunting.

Photograph 1. Shoshoni camp near Yellowstone National Park; Location Unknown; Photographer Unknown; 1871. Courtesy Yellowstone National Park Digital Archive.

Stone circle sites older than 2,000-3,000 B.P. do exist in the archaeological record but are few in number. Two stone circles predating these dates are the oldest recognized stone circle sites on the Plains and the oldest dated stone circle site in Montana. Discovered in 1969, The Cactus Flower Site (EbOp-16) sits on the Suffield Military Reserve in southeast Alberta. Cactus Flower maintains the oldest accepted date for any stone circle site with radiocarbon dates and diagnostic artifacts indicating site occupation during the McKeen Phase (Brumley 1975). Most archaeologists conducting tipi ring studies since this excavation have associated the relative beginning date of 5,000 B.P. for the McKeen Phase, as the date for The Cactus Flower Site, thus the reason for the site’s acceptance as the oldest tipi ring site.

The second site produced a similar Middle Archaic Period date making 24BH2317 the oldest stone circle site in Montana. Located in Big Horn County, Montana, 24BH2317 was first tested in 1984 by Steve Aaberg and again in 1998 (Brumley and Dickerson 2000). A charcoal sample was collected from a hearth feature within one of the rings during the 1998 excavation. The charcoal sample returned an uncalibrated AMS date of 3,940±60
B.P. and a one sigma calibrated date of 4,275-4,430 B.P. (Brumley and Dickerson 2000: 61).

The Airport Rings site (24YE357) exhibits several of the characteristics noted within this period. Even though it is difficult to accurately associate buried cultural materials with surface materials, the excavations at Airport Rings uncovered a partially slab lined, rock filled roasting pit inside one of the rings correlating with the beginning or time immediately before this period. As well as the radiocarbon C-14 date gained from the hearth sample, point chronologies consistent with the Oxbow tradition make the Airport Rings hearth, as far as what information is available from the literature, the earliest date for a hearth found within a stone circle by several hundred years.

**Previous archaeology near Airport Rings.** Prior to the 2007-08 MYAP work, only three major archaeological surveys have occurred along the Upper Yellowstone River drainage system (Malouf 1958; Hoffman 1961; Arthur 1966). Sporadic informal surveys have been conducted along the Yellowstone River by YNP archaeologists as well as local collectors. Local archaeologists like Ken Deaver, Larry Lahren, and Tom Jerde recorded most, if not all, of the stone circle sites in these valleys. No cultural resource inventories have occurred in the Boundary Lands apart from the limited salvage work conducted along the Yellowstone River by Jerde in 1986.

The high altitude upland valleys and foothills in the Greater Yellowstone region have shown a continued occupation by hunter-gatherer populations throughout the last 10,000 years B.P. (Baumler, et al. 1996; Bender, et al. 1988; Frison, et al. 1976; Kornfeld, et al. 2001; Meltzer 1999; Reeves 1973; Short 1999a, 1999b; Smith and McNees 1999). Malouf (1958) noted the recovery of a Paleoindian Clovis point during excavation of the Gardiner Post Office. Middle Archaic through Late Prehistoric Period occupations were present at The Eagle Creek site (24PA301) located northeast of the Boundary Lands project area (Arthur 1966, 1966b; Conner 1967). Additional Middle Archaic through Late Prehistoric occupations were uncovered at The Carbella Site (24PA02) downstream of Gardiner (Arthur 1966).

In 1997, Shortt (1999b) located and identified three sites near the MYAP 2008 project boundaries, including a stone circle site. Excavation at the stone circle site (24YE83) uncovered artifacts from the Early Archaic, Middle Archaic, and Late Prehistoric Period. Shortt (1999b) recorded another six stone circle sites in the Gardiner River Valley between Gardiner and Mammoth. Using projectile point chronology, Shortt (1999a) associated occupation of the stone circle sites occurring from the terminal Late Prehistoric to possibly the Early Archaic Period.

South of the project area Lahren conducted testing for a sewer line trench between Gardiner and Mammoth in 1973. Early Archaic through Late Prehistoric projectile points were collected from deeply buried deposits suggesting an extended use of this upland area (Shortt 1999a). Further testing in the late 1990s produced even more evidence associated with Middle Archaic and Late Archaic occupations (Shortt 1999a). Testing of sites in this area during the 2000 field season resulted in the recovery of artifacts and charcoal samples dating to the Middle and Late Archaic Periods (Shortt and Johnson 2000; Sanders 2000).

At the Malin Hole Fishing Site (24YE353) several miles up the Yellowstone River, excavations by Cannon and Phillips (1993) as well as Lifeways of Canada (Johnson et al. 2004) produced a series of buried cultural levels ranging from a late Paleoindian Cody Complex component dated at 8800 B.P. to Middle Archaic through Late Prehistoric occupations. Testing of several sites along the Yellowstone River during the early 2000 summers produced similar evidence of enduring occupation (Sanders 2005). Projectile points collected during these surveys covered the entire chronology of points between the Early Archaic and Late Prehistoric Periods.

The park’s first excavation of a stone circle site resulted in the establishment of site 24YE357 as a domestic stone circle occupation site with both Late Prehistoric and Middle Archaic occupations of the landform. The full reports of investigations from the MYAP research (MacDonald 2008; Maas and MacDonald 2009) are available through Yellowstone and The University of Montana. The current project, thus, represents the most recent of this long line of prior archaeological work in YNP’s northern portion near Gardiner, Montana.
Field and Analysis Methods

Survey Methodology. The University of Montana archaeological team conducted a systematic surface survey of the project area. During the survey, individuals spaced approximately 5 ft. (3 m) apart walked slowly across the project area to observe artifacts on the ground surface. When artifacts were identified, the team assembled to conduct a detailed examination of the ground surface around the find spot. All additional artifacts were marked with pin flags. Subsequent to discovery, field personnel, under the direction of the Principal Investigator and/or the graduate student teaching assistant, mapped each artifact identified on the ground surface using forms created for the project. A sample of artifacts representative of the surface scatter were individually described and photographed. Students also recorded attributes such as artifact type, dimensions, color, and raw material for these surface-identified artifacts. The crew collected diagnostic artifacts for curation at the Heritage Research Center (HRC). Each diagnostic artifact collected in the field received identification by a unique field specimen (FS) number linked to its provenience within the site and overall project grid. The unique artifact information was recorded in an FS log and upon the plastic collection bag for each artifact.

During survey, crewmembers kept a detailed project map using both global positioning system (GPS) and total station technology. A map was subsequently generated using Maptech software which placed the GPS coordinates on 7.5 minute United States Geological Survey (USGS) quadrangle maps. Site boundaries were delineated and recorded using the GPS unit.

Excavation Methodology. MYAP tested The Airport Rings after identification and delineation. Test units consisted of 1-x-1-m squares, excavated stratigraphically within natural and cultural soil horizons, using trowels and shovels (Photograph 2). The number of test units excavated at the Airport Rings was determined based on the overall site dimensions and its research potential. MYAP members created a detailed project area map using a Leica TCR407 Power Reflectorless Total Station owned by The University of Montana. Utilizing the total station allowed for accurately placed test units within the established site grid based on a datum established at an arbitrary 1000N 1000E location with an elevation of 100 m. Project investigators also provided sketched overview maps of the site and ring features.

Within strata containing cultural materials, excavations proceeded within 5 cm levels and diagnostic and select additional artifacts were point provenienced whenever possible to provide for precise vertical and horizontal artifact control. Within recognized subsoil strata with no cultural material, excavations proceeded within 10-cm levels. In non-feature contexts, sediment was screened through 6-mm (0.25-inch) hardware cloth for systematic artifact recovery. Within identified features, samples of sediment were screened through 0.5-mm hardware cloth to increase recovery of small artifacts, including faunal and botanical remains, among other items (e.g., charcoal, etc.). As requested by Park Archaeologist, Ann Johnson, MYAP submitted the recovered botanical remains to PaleoResearch, Inc. of Colorado for analysis.

Artifact Analysis Methods. Four main types of artifacts were recovered during the 2008-2009 field seasons, including flaked stone artifacts, faunal remains, ethnobotanical remains, and historic artifacts. The analytical approach to stone tool production and use can be described as techno-morphological; that is, artifacts were grouped into general classes and further divided into specific types based upon key morphological attributes, which are linked to or indicative of particular stone tool production (reduction) strategies. Function is inferred from morphology as well as from use-wear.
Surfaces and edges of tools were examined for traces of use polish and damage with the unaided eye and with a 10x hand lens. Principal Investigator MacDonald relied upon data derived from experimental and ethnoarchaeological research during the identification and interpretation of artifact types (Andrefsky 1998; Root 1999; MacDonald et al. 2006).

Lithic artifacts were separated into one of six artifact classes, including debitage, cores, bifaces, unifaces, fire-cracked rock, and cobble tools. All types were quantified by both count and weight in grams. Projectile point types were assigned in comparison with appropriate comparative specimens, as illustrated in major regional works (e.g., Frison 1991). Debitage includes all types of chipped-stone waste that bears no obvious traces of having been utilized or intentionally modified after being discarded.

During detailed lithic analysis, debitage was sorted into eight types, and observations on raw material and cortex are recorded. Detailed analysis involved placing flakes in those categories that provide information on the types of tools produced and their production stages. This typological analysis was combined with mass analysis, including size grading and weighing of groups of flake types (Ahler 1989; Hall and Larson 2004). Artifacts were size graded by placing them on a template with concentric circles at 1, 2, 3, 4, 5, 6, 7, and 8 cm diameters. After grouping artifacts by raw material, size, and type, each debitage group was weighed collectively. The ultimate goal of lithic analysis is to characterize the lithic technological organization of site occupants.

Lithic raw material sourcing is one of the best means by which to trace prehistoric human movement on the landscape. As such, researchers submitted a limited number of obsidian and dacite samples to Dr. Richard Hughes at the Geochemical Research Laboratory in Portola Valley, California, to determine their locations of origin. In addition to obsidian, the proposed research entailed the collection of chert cobbles across Yellowstone National Park to characterize the variability in locally available cherts. Sourcing of obsidian, dacite, and chert samples provides a means to understand site and regional use by prehistoric Native Americans (see Adams et al. and Park chapters, this volume).

Additional Analysis Methods. As described above, soil samples were collected for analysis by Paleoresearch, Inc. Botanical remains collected from flotation samples and macrobotanical samples hand-collected during excavations were analyzed by Paleoresearch and Jannifer Gish (this volume).

As with botanical remains, faunal remains from features were analyzed to determine subsistence strategies of prehistoric and historic site occupants. When possible, element, portion, side, and the presence of human modifications were recorded for each specimen. Faunal analysis through Zooarchaeological taphonomy studies would provide representative samples indicative of subsistence strategies (Brewer 1992). Specific goals pertaining to faunal collection is finding subsistence evidence of large game species such as elk, moose, bison, deer, and antelope suggesting a fit into the large game hunting strategies proposed for groups in this region by Frison (1991) and others.

Radiocarbon dating analysis is another important tool used for dating organic remains at a site allowing for comparisons of the plant and animal resources used at a site. The team obtained three radiocarbon dates from samples of wood charcoal in good archeological contexts. Samples of charcoal were subsequently submitted for radiocarbon dating to Beta Analytic, Inc. of Miami, Florida.

Survey and Testing Results

The Airport Rings Site is a multicomponent archaeological site with prehistoric features and artifacts as well as a historic trash scatter. The entire site, including the historic artifact scatter, measures approximately 2,200 ft. east-west and 600 ft. north-south, for a total of ca. 30 acres. The prehistoric component of the site—the main focus of this section—measures ca. 3 acres, with the remainder of the site comprised largely of an ephemeral scatter of historic debris and scattered isolated lithic artifacts. The prehistoric site component, including the 11 stone circles, is located within a fairly narrow—175 ft. x 900 ft. (3.6 acres)—upland flat protected on all sides by natural features (Photograph 3).

The site is within a Late Pleistocene glacial outwash channel, bordered to the south by the Old Yellowstone Road and to the north by the former Northern Pacific track berm, while the Yellowstone River is an additional 75 ft. to the north (Figure 2). Prehistoric lithic scatter
Site 24YE172 is located immediately adjacent to the river to the north (MacDonald 2008: 80-82). The Gardiner sewage treatment plant and Gardiner Airport are directly across the river. The site is immediately across the road from the Henderson Homestead Site (24YE196), discussed in Maas and MacDonald (2009).

Avocational archeologist Tom Jerde originally identified the Airport Rings Site in 1986. Jerde identified all 11 stone circles at the site, as well as a scatter of historic debris (including a possible foundation) to the west. Jerde also recorded several lithic debitage scattered around the stone circles, extending down onto the river floodplain. Given the nearly 600 ft. of down slope lacking cultural material between the stone circles and the flakes along the river, the MYAP field team recorded the locations as two different archeological sites. As described in Macdonald (2008), the flakes along the river received the site name DHM 4, or 24YE172.

MYAP resurveyed and mapped the Airport Rings site during the 2007 field season (MacDonald 2008: 83-89). In 2008, the MYAP team revisited 24YE357 to conduct archaeological excavations at three of the 11 stone circles. The crew resurveyed the site once more, confirming the presence of a historic site component concentrated on the opposite side of Reese Creek, away from the stone circles and likely associated with the use of the Henderson Homestead (24YE196).

A scatter of historic/modern debris was observed west of the stone circle portion of the site on the
opposite side of Landslide Creek. No evidence of a foundation was observed at this location, as Jerde had recorded in 1986; however, MYAP identified foundations across the road at the Henderson Homestead. Based on artifact distributions, it is clear that the focus of the historic debris is west of the stone circles in proximity to Henderson Homestead. However, a few isolated scraps of metal as well as a few bits of broken glass were identified within the area of the stone circles and an extensive trash dump is present above the site on the cobble ridge directly opposite Henderson Homestead. The historic use of the area had little impact on the stone circles though, with only a few scattered historic items noted on the ground surface. Based on their ephemeral nature and uncertain role in the use of the Henderson Homestead, the historic site component does not contribute to the 24YE357’s eligibility for listing to the NRHP.

Survey Results. In addition to the mapping of the stone circles (discussed below), initial reconnaissance and survey of the stone circle portion of the Airport Rings site resulted in the collection of 10 prehistoric lithic artifacts from the ground surface. None of these 10 surface-collected artifacts can be directly associated with any of the stone circles. A Late Prehistoric Tri-notched projectile point was collected 100 ft down slope of the site. This projectile point was produced from obsidian and according to XRF analysis, originated from the local Obsidian Cliff source. The other surface-collected artifact from the 2008 reconnaissance is a quartzite end scraper recovered on the far eastern edge of the stone circle portion of the site near Reese Creek.

In addition to the two surface-collected artifacts from 2008, eight artifacts were collected in 2007, including six orthoquartzite flakes and two tested obsidian cobbles. Each of these artifacts was collected west of Reese Creek, away from the stone circle site into the area identified within the historic site component. This area also contains a low-density scatter of prehistoric lithics in addition to the scatter of historic refuse.

Mapping Results. Most of the stone circles are circular to oval in shape, with the east-west dimension generally larger (n=9) than the north-south dimension (Table 1). The smallest of the circles—including Features 4, 5, and 6 in the central portion of the site—measure less than 20 square meters, while the largest measures 48.3 m² (Feature 7). Ring dimensions were measured from boundaries of interior walls. Square footage for each ring was not determined by using the formula to find the area of a circle as a majority of the rings are not perfectly round. Ring areas included in Table 1 are based on finding the area for a square because square test units were used during excavation.

Several of the features overlap on their edges, including Features 2, 3, and 4, while Features 7 and 8 also overlap slightly. With Feature 5, it appears rocks were cleared from an area within the rubble field on the edge of the terrace instead of gathering rocks from an alternative location and bringing them into the open area of the terrace. Despite it being one of the smallest of the circles, Feature 4 contained the largest number of stones (n=24), while Feature 1 on the far western edge of the site yielded the fewest (n=11). There is a significant difference between the number of stones utilized for large and small circles (Anova: F=6.245; DF=17; p=.02); however, the difference is the inverse of the expected, as the smaller circles tend to have more stones on average than the larger circles. Regression analysis of stone circle area (m²) compared to the stones per m² shows a significant (p<.01) and fairly strong (Multiple R=0.75)

Table 1. Airport Rings Site (24YE357) Stone Circle Data.

<table>
<thead>
<tr>
<th>Feature</th>
<th>UTM (E)</th>
<th>UTM (N)</th>
<th>N-S (m)</th>
<th>E-W (m)</th>
<th>Area (m²)</th>
<th>Stones (n)</th>
<th>Stones per m²</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0519927</td>
<td>4987919</td>
<td>4.08</td>
<td>7.56</td>
<td>21.2</td>
<td>11</td>
<td>.52</td>
</tr>
<tr>
<td>2</td>
<td>0520001</td>
<td>4987927</td>
<td>4.56</td>
<td>7.90</td>
<td>24.6</td>
<td>13</td>
<td>.53</td>
</tr>
<tr>
<td>3</td>
<td>0520011</td>
<td>4987931</td>
<td>7.83</td>
<td>7.81</td>
<td>38.6</td>
<td>19</td>
<td>.49</td>
</tr>
<tr>
<td>4</td>
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<td>4987935</td>
<td>4.5</td>
<td>5.5</td>
<td>19.6</td>
<td>24</td>
<td>1.22</td>
</tr>
<tr>
<td>5</td>
<td>0520028</td>
<td>4987944</td>
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<td>4.56</td>
<td>15.2</td>
<td>17</td>
<td>1.18</td>
</tr>
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<td>0520041</td>
<td>4987904</td>
<td>4.51</td>
<td>5.21</td>
<td>19.6</td>
<td>19</td>
<td>.97</td>
</tr>
<tr>
<td>7</td>
<td>0520055</td>
<td>4987912</td>
<td>7.44</td>
<td>8.01</td>
<td>48.3</td>
<td>22</td>
<td>.46</td>
</tr>
<tr>
<td>8</td>
<td>0520068</td>
<td>4987914</td>
<td>5.3</td>
<td>5.7</td>
<td>22.9</td>
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<td>4987915</td>
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<td>7.87</td>
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<td>.38</td>
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<td>.44</td>
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<td>4987917</td>
<td>6.72</td>
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<td>17</td>
<td>.60</td>
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correlation with the smaller circles having more stones per m$^2$.

For example, Features 4 and 5 are two of the smallest features at the site, but both have greater than one stone per m$^2$; in contrast, the largest circle—Feature 9 at 48.3 m$^2$—has the second lowest stones per m$^2$ (.38). This may reflect recycling of stones from larger features for small circles, although this hypothesis does not make sense given the assumption that earlier circles are on average smaller than the more recent ones. If this assumption of size and age is correct, one would expect larger circles to be more recent and, thus, to have more stones than earlier (presumably smaller) circles.

Several inquiries can be made about intersite and intrasite patterning founded on the information recorded during the mapping of stone circle sites. Light (1984) notes a minimum of four possible behavioral factors that could influence the distribution of individual rings at a site. These factors include such behaviors like the one obviously present at Airport Rings concerning the number of occupations occurring at a site. Couple the number of occupations with the amount of people per episode, the need for defense, and kinship or other social relationships between the people, and any one of these would create a unique intrasite camp pattern (Light 1984: 38-39). Often with larger campsites, there are no discernable patterns associated with the layout of individual rings at the site (Kehoe 1960; Light 1984; Oetellar 2006). Often enough this is because there were multiple occupations of the area and even though larger tipi ring sites contain different areas of use associated with each occupation, archaeologists consider all of these different areas part of a whole. More work beyond just a pedestrian survey would be necessary to address and differentiate periods of use, something many archaeologists do not have the time or interest in pursuing.

Kehoe (1960) believes that there are several additional factors causing the change in camp layout involving subsistence strategies and ceremonial or religious practices derived from various topographic settings, though he did not establish trends related to geographic setting. This is the one possible instance where a pattern does present itself in the archaeological realm in terms of large-scale site patterns. Ethnographic observations have recorded the knowledge of a camp circle from tribes on the Northern Plains coming together during the summer months for communal buffalo hunts (Kehoe1961; Oetellar 2006). These camps circles could also have relations to sun dance ceremonies performed in conjunction with the communal summer hunts.

Based on the evidence of rock recycling, ring completeness, and the dates associated with several of the present rings, it appears that occupation of the landform moved from west to east over time. The rings and dates suggest a decrease in age from earlier to later occupations the farther east one moves along the terrace. Looking at Kehoe’s (1960) site trends, associated dates, and the construction of current features, the Airport Rings site could have had at least six different occupation events during the past 5000 years. Given the potential for re-use on an annual basis, more than six occupations could have taken place at the Airport Rings site. In the site’s present condition, Kehoe’s study is able to point out six of the many occupations episodes probably occurring on the landform.

Excavation Results. After mapping the surface distribution of artifacts and features, the MYAP team excavated three of the most intact stone circles at Airport Rings to determine their integrity and potential to yield information regarding the prehistoric use of the

<p>| Table 2. Summary of Excavation Results, Airport Rings (24YE357). |
|--------------------|-----|---------|-----|----------|-----------------|-----------------|----------|-----------------|</p>
<table>
<thead>
<tr>
<th>FT #</th>
<th>Size (m$^2$)</th>
<th>TUs (n)</th>
<th>FT % Exc.</th>
<th>Lithics (N)</th>
<th>Lithics/m$^2$</th>
<th>Interior FT</th>
<th>Faunal</th>
<th>Botanical</th>
<th>Historic</th>
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<tr>
<td>4</td>
<td>19.6</td>
<td>14</td>
<td>71.4</td>
<td>350</td>
<td>25</td>
<td>2 hearths</td>
<td>Bison, Large Mammal</td>
<td>Juniper, Sagebrush</td>
<td>2</td>
</tr>
<tr>
<td>6</td>
<td>19.6</td>
<td>12</td>
<td>61.2</td>
<td>178</td>
<td>14.8</td>
<td>none</td>
<td>Unidentified</td>
<td>N/A</td>
<td>0</td>
</tr>
<tr>
<td>8</td>
<td>22.9</td>
<td>13</td>
<td>56.7</td>
<td>155</td>
<td>11.9</td>
<td>1 hearth</td>
<td>Large, Medium Mammal</td>
<td>Willow, Sagebrush</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>62.1</td>
<td>39</td>
<td>Avg. 62.8</td>
<td>683</td>
<td>Avg. 17.5</td>
<td>3</td>
<td>Bison, other unknown mammals</td>
<td>4 fuel sources</td>
<td>2</td>
</tr>
</tbody>
</table>
site. A total of 39 test units were excavated in 2008 within stone circle features 4, 6, and 8. The three stone circles selected for excavations—Features 4, 6, and 8—are among the most intact at the site. Features 4 and 8 each also had portions of rock exposed in their center, providing a possible opportunity to yield dateable material from a hearth (Table 2). Feature 6 was selected because it is among the smallest of the stone circles at the site, providing an opportunity to explore its function and possible age compared to the larger circles such as Feature 8.

In total, the MYAP 08 team excavated 39 test units during the 2008 field season at the Airport Rings stone circles, including 14 associated with Feature 4, 12 at Feature 6, and 13 at Feature 8.

These test units represent 50-75 percent samples of the three stone circles (Table 2). Excavations consisted of north-south and east-west longitudinal cross-sections in each of the stone circles in an attempt to uncover a central hearth feature supporting hypotheses about the site’s function. Additional test units were excavated to the north and south of each stone circle to provide an evaluation of the use of space outside of the stone circles themselves, a task important in determining differences in artifact assemblage formation.

During excavations of the three stone circles, 687 lithic artifacts were recovered, including 350 associated with Feature 4, 178 from Feature 6, and 155 from Feature 8. Four additional artifacts were surface collected for a total yield of 687 lithics from the site. These artifacts ranged from lithic tools such as bifaces and unifaces to modified cobbles and lithic debitage (Table 2).

Feature 4 had the most stone tools with 10 bifaces and 5 unifacial flakes, while Feature 6 had the four remaining bifaces recovered during excavation (Table 3). Some of the bifacial tools are projectile points that are discussed further in the following sections providing more detailed information on the excavation results for each feature. Feature 8 had several cobbles and only three unifacial flakes. The remaining lithic artifacts from each feature consist of lithicdebitage and a count of fire-cracked rock collected from fire features in both Features 4 and 8.

The lithic debitage collected from each feature consists of a small number of flake types indicating different forms of tool production and maintenance. Decortication and early reduction flakes are flake types associated with early stages of tool production while bifacial reduction and shaping flakes are associated with late stage tool manufacture and maintenance. Early stage reduction flakes from Feature 4 account for only 10 of the 350 total flakes, or 3.5 percent of flakes, while 126 late stage flakes comprise 36 percent of combined Feature 4 lithics (Table 4). Feature 6 early stage flakes comprise less than 1 percent (n=1) of the 178 total flakes from the feature and late stage production flakes make up approximately 38 percent (n=68) of identifiable reduction flakes from the feature. Combined early stage reduction flakes from Feature 8 consist of three (2%) out of 155 lithics and late stage flakes number 54 or 35 percent of the total (Table 4).

In a 2009 Archaeology in Montana article, John Pouley used mass analysis to test for lithic reduction activity areas within several stone circles at a site in North Dakota. Pouley (2009) uses Stevenson’s (1985) idea of three occupation phases occurring in the cycle of site occupation, use, and abandonment, in support of the

| Table 3. Lithic Class Counts by Feature, Airport Rings Site. |
|-----------------------------|----------------|--------------|-------------|---------------|----------|
| FT # | Biface | Debitage | FCR/rock | Uniface | Total |
| 4  | 10    | 296      | 14        | 5       | 325     |
| 4.1 | 0     | 10       | 0         | 0       | 10      |
| 4.2 | 0     | 2        | 13        | 0       | 15      |
| 6  | 4     | 174      | 0         | 0       | 178     |
| 8  | 0     | 136      | 4         | 3       | 143     |
| 8.1 | 0   | 2        | 10        | 0       | 12      |
| Surface | 1  | 1        | 0         | 2       | 4       |
| Type Count | 15 | 621      | 41        | 10      | 687     |
different types of lithic activities occurring during each phase. During the initial phase, site occupants finalize tool production, during the exploitation phase reduction activities consist of tool maintenance or possible manufacture, and finally during the abandonment phase tools are discarded while new tools are prepped for the move (Stevenson 1985). If this three-phase settlement system is applicable to all stone circle sites in the region there appears to be an absence of lithic debitage associated with the manufacture of new tools at the Airport Rings site.

If Stevenson’s (1985) three-phase settlement system is applicable to all stone circle sites in the region there appears to be an absence of lithic debitage associated with the manufacture of new tools at the Airport Rings site. Testing of the site may have missed early stage reduction work activities within the rings due to placement of test units or simply not digging deep enough within the features. However, this evidence provides a more likely interpretation where the terrace was the location of a brief stop off or resting point for small foraging groups coming out of the park interior on their way back to the larger winter encampments further up the valley. If this was just a brief resting spot for small groups coming out of the park it does not seem at all unlikely that the occupants would wait until their return to the larger camp to begin tool manufacture activities if the camp was not more than several miles away.

This idea is increasingly supported by Stevenson’s Model (1985) and Pouley’s (2009) discussion of multiple occupation within a structure. Pouley (2009: 10) notes that only the last activities taking place in the feature would be “distinguishable in the archaeological record”. If the excavation results of Airport Rings point to a lithic reduction trend associated mainly with the first two phases of occupation (i.e., lack of early stage reduction flakes, lack of highly discernable reduction areas, and a dispersed artifact assemblage) then the site was very likely just a brief stopping point, occupied repeatedly over time but only for brief periods. If just a brief resting spot for small groups, coming out of the park, it does not seem at all unlikely that the occupants would wait until their return to the larger wintering camp to manufacture new tools if the camp was not more than several miles away.

**Table 4. Lithic Type Counts by Feature (Airport Ring Site).**

<table>
<thead>
<tr>
<th>Feature</th>
<th>BF</th>
<th>BS</th>
<th>DF</th>
<th>ER</th>
<th>ES</th>
<th>FF</th>
<th>HS</th>
<th>IB</th>
<th>IF</th>
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<th>rock</th>
<th>SF</th>
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<td>5</td>
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<td><strong>7</strong></td>
<td><strong>30</strong></td>
<td><strong>687</strong></td>
<td></td>
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</table>

Key: BF=bifacial reduction flake; BS=block shatter; DF=decortication flake; ER=early reduction flake; ES=endscraper; FF=flake fragment; HS=hammerstone; IB=indeterminate biface; IF=indeterminate flake; LB=late stage biface; MB=mid stage biface; PP=projectile point; RF=retouched flake; SF=shaping flake; UF=useware retouch flake

**Table 5. Sourced Artifact Type Counts by Feature (Airports Rings Site).**

<table>
<thead>
<tr>
<th>Feature</th>
<th>Bear Gulch</th>
<th>Grasshopper Knob</th>
<th>Obsidian Cliff</th>
<th>Feature Count</th>
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<td>1</td>
</tr>
<tr>
<td><strong>Total Source Count</strong></td>
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<td><strong>4</strong></td>
<td><strong>27</strong></td>
<td><strong>33</strong></td>
</tr>
</tbody>
</table>
Selected obsidian artifacts from the site were submitted for XRF analysis, resulting in a range of raw material sourcing locations up to 100 miles away from the site. X-Ray Fluorescence sourcing of 33 of the artifacts indicated that the majority (n=25, 71.43%) are from Obsidian Cliff, Wyoming (Table 5). Two obsidian artifacts were from Bear Gulch, Idaho, including FS 9 (a late stage biface) and a late stage preform (FS 115). Four artifacts derive from Grasshopper Knob, a relatively poorly known dacite source in west-central Montana. Field specimen 31 is an untyped biface, while FSs 38, 111, and 127 aredebitage (Table 5). Additional XRF interpretation is provided for each feature in the sections below.

A small amount (n<100 total) of faunal remains were recovered from each circle allowing for limited taxonomic identification from a total of 208 individual fragments (Figure 3). Bison identification, derived from the presence of molar fragments, was the only positive match, while the other remains remained unidentified beyond general mammal size classification due to heavy fragmentation.

Although a majority of remains were unidentifiable (N=179, 86%), several specimens were identified as Bison (N=9, 4%) while the remaining artifacts were classified as large mammal (N=12, 6%), medium mammal (N=4, 2%), or general mammal (N=4, 2%) (Figure 3). The faunal evidence suggests the possibility of a range of game utilized by hunters in the valley. Large game species in the area include bison and elk, while medium sized mammals could be any variety of medium ungulate (deer, pronghorn, mountain goat, or bighorn sheep). Feature 4 had 101 (49%) of the faunal remains collected, including six large, three medium, two general mammal, and 90 unidentified specimens.

Feature 4.1 had 34 (16%) faunal artifacts including the Bison molar fragments, one large, one medium mammal, and 23 unidentified. Feature 6 had one unidentified faunal remain recovered during excavation accounting for less than 1 percent of faunal materials. Feature 8 had two large, two general mammal, and 11 unidentified counts comprising a total of 15 specimens or 7 percent of all faunal remains. Finally, Feature 8.1 had 57 artifacts, including three large mammal and 54 unidentified specimens making up the final 27 percent of recovered faunal material.

**Feature 4 Excavation Results.** UM excavated 14 1-x-1-m test units associated with Feature 4 (Figure 4; Photograph 4). Twelve test units were placed within the feature while another two were placed outside of the ring. Feature 4 measures approximately 4.5 x 5.5 meters in diameter, with its east-west dimension slightly larger than its north-south dimension with a total area of Feature 4 is 19.6 m² (Figure 4). No clear differences were noted in the soil profiles of Feature 4 suggesting a brief occupation or one short enough not resulting in a dense living surface within the ring. Lithic artifacts were generally within the upper 10-30 cm of sediment, suggesting a single occupation.
Figure 4. Planview of Stone Circle Feature 4, Airport Rings Site.
In total, the MYAP 08 team recovered 350 lithic artifacts from stone circle Feature 4. The lithic artifacts are comprised largely of late-stage biface thinning and pressure flakes from the manufacture of bifaces and projectile points. While late stage reduction flakes account for over one third (36%) of all lithic artifacts from Feature 4 (see Table 4), there are really no discernable reduction activity areas within the ring. Artifact numbers generally become larger towards the center of the ring indicating that Feature 4.1 was the center of activities in this structure. Reduction activities would have taken place facing the fire providing the necessary light inside the tipi.

While the vast majority (88%) of the lithic debris from Feature 4 is flaking debris, excavations recovered 15 stone tools, including five unifaces and 10 bifaces, among which were five projectile point fragments. The five unifacial tools include four expedient utilized flakes used for daily tasks within the lodge. Two unifaces each were produced from obsidian and Crescent Hill Chert. Diagnostic projectile point includes three Late Prehistoric side-notched arrow point fragments, a Middle Archaic Oxbow point base, and an untyped (probable Late Archaic) point fragment. Two of the three arrow points (FS 20 and 101) were produced from obsidian, while a third (FS 8) was produced from a tan-white fine-grained variety of Crescent Hill Chert. The two Late Prehistoric obsidian points were sourced to the local Obsidian Cliff source inside of the park (Table 5). All of the arrow points are basal fragments likely broken during use and discarded at the site. One of the Late Prehistoric point fragments (FS 20) has deep side notches with fairly pronounced lateral tangs and may be a Late Prehistoric Rose Spring arrow point.

Based on the presence of three Late Prehistoric arrow points, a Middle Archaic point, and the fifth untyped (but probably Late Archaic) point, Feature 4 is a stone circle used on multiple occasions during prehistory, beginning as early as 4,500 years ago, as denoted by the Oxbow point and the Feature 4.2 radiocarbon date (discussed below). Feature 4.1 was dated to the Late Prehistoric period, which corroborates the multiple use periods of the stone circle. Based on the overall low density of lithic debris, occupations seem to have been brief and perhaps limited to one or more camps on a seasonal basis.

Interior fire hearths are common in cooler seasons; during warm seasons, fires were generally exterior of tipis. Early stone circle investigations by Kehoe (1960) noted the presence of very few inside hearths out of 100 or more stone circle from several sites leading him to suspect there was a reason for this trend. Later ethnographic studies conducted by Kehoe (1960: 446) provided an internal perspective as his informant described to him that the use of inside hearths for cooking was limited only to times when weather was bad.

As such, our working hypothesis is that Feature 4 was a late-Fall-winter occupation and that the lithic production area to the north of Feature 4 is a secondary dump after cleaning up the lodge’s interior. While the age of the stone-tool production episode in the northern portion of Feature 4 is uncertain, the most proximate diagnostic projectile point is the base of a Late Prehistoric side-notched arrow point found one meter to the north in TU 9. As discussed below, however, Feature 4.2 was radiocarbon dated to 4,500 B.P. suggestive of a Middle Archaic occupation. The dump area could be results of both the Late Prehistoric and Middle Archaic occupations as there is no differentiation between the two occupation episodes.

Photograph 4. Feature 4 Hearths.
Nevertheless, the single peak in artifacts within Figure 5 is significant, as it indicates only one living surface within stone circle Feature 4. As discussed below, one of the hearths in Feature 4—Feature 4.2—was dated to the Middle Archaic period, ca. 4,500 B.P., while later occupations are also indicated by portions of Late Prehistoric projectile points and a Late Prehistoric date on Feature 4.1. The unimodal vertical artifact distribution indicates that all site occupations were likely on the same living surface, more or less the equivalent of the modern surface. In other words, there is no discernable vertical separation between the occupations occurring in Feature 4.

![Figure 5. Graph showing Lithic Artifacts by Excavation Level, Stone Circle Feature 4.]

A small number of faunal remains were recovered in Feature 4, providing minimal chance for interpretation beyond class and size due to the nature of heavy processing. The only specific match was the recognition of several bison molar fragments. Other than the identification of the Bison molar, the other identified fragments provide data suggestive of a camp subsisting on large and medium game species available in the region. The interpretation of large to medium game subsistence activities for the Airport Rings site fits in with known patterns of hunter-gatherer subsistence in the Greater Yellowstone Region (Frison 1991; Jackman 1997).

*Fire Features.* As noted above, two fire features were excavated within the interior of stone circle Feature 4. The features were identified as Feature 4.1 in the very center of the stone circle and Feature 4.2 in the northeast corner of the stone circle (Photograph 4). Feature 4.1 was initially identified as a dark brown to gray soil stain with surrounding fire-cracked rock within TU 7 of Feature 4.

Overall, Feature 4.1 appears to be a fairly-ephemeral, basin-shaped hearth feature at the very center of the stone circle Feature 4. The shallow maximum depth around 5 cm, the presence of very few rocks lining the hearth, low density of FCR, charcoal, and artifacts indicates a short-term use episode (Photograph 5). Feature 4.1 yielded a conventional radiocarbon date of 340±40 B.P. (Beta-251175). The radiocarbon date associated with Feature 4.1 was achieved using the AMS method on wood charcoal from the feature fill. The Late Prehistoric occupation episode is substantiated by the recovery of two diagnostic obsidian projectile points associated with Feature 4.

![Photograph 5. Feature 4.1 Bisection (Stone Circle Feature 4). View north.]

Floral analysis results showed a domination of *Artemisia* charcoal, with a smaller amount of *Pinus* charcoal present, suggesting that sagebrush and pine wood were burned as fuel during the Late Prehistoric occupation of Feature 4. Two charred spine fragments were found in the sample, but could not be identified to any taxonomic level and there are several plants native to the region exhibiting protective or hard structural spines.

The presence of a second hearth within the interior of stone circle Feature 4 may corroborate a winter occupation. Feature 4.2 was identified approximately one meter to the northeast of Feature 4.1 at an approximate depth below surface around 12-14 cm, a difference of only 4-5cm in the depth from the surface of
Feature 4.1 (ca. 10 cm) (see Photograph 4). This fire feature resembles the construction of other Archaic age rock or sandstone slab-lined roasting pits recorded by Frison (1991) and Wandsnider and Camilli (1992) in the northwest uplands of Wyoming. Although the pit was not “slab” lined per say, large rocks were placed around the hearth walls and several sandstone pieces do line the northern interior of the pit.

Much older than Feature 4.1, Feature 4.2 yielded a conventional radiocarbon date of 4,520±40 B.P. (Beta-250333). The recovery of diagnostic projectile points, including a possible obsidian Middle Archaic Oxbow point base, substantiates a Middle Archaic occupation episode for Feature 4.2 and possibly even for Stone Circle Feature 4. Data from the floral analysis of the sample revealed the presence of several fragments of Juniperus charcoal, indicating that juniper wood was burned as fuel. Besides the juniper source, no other charred remains were recovered from the soil sample. However, Gish (this volume) identified the pollen of low-spine Asteraceae—likely ragweed, povertyweed or giant sumpweed—and Liguliflorae (e.g., wild lettuce or wire lettuce), the seeds of which could have been used culturally during the Middle Archaic site occupation.

Francis (2000) recorded multiple Middle Archaic hearths in the Intermountain region, similar to Feature 4.2, where submitted soil samples contained traces of sage, cottonwood, willow, and juniper. The results of this study showed that the juniper had been brought into the region by the groups. The plant remains recovered from 24YE357 are all from local sources and there is no indication to why certain sources were specifically used over another. Francis’s study may indicate the importance of juniper as a fuel source during the Middle Archaic if groups were transporting it with them. The remains recovered from Feature 4.2 may be the result of a Middle Archaic trend.

Ultimately, stone circle Feature 4 appears to have been occupied on at least two and probably three occasions beginning as early as 4,500 years ago. Each of the occupations likely was during the late-fall to winter, as indicated by two interior hearths, as well as lithic reduction activity. The presence of three projectile points of probable Late Prehistoric age as well as the Late Prehistoric dated Feature 4.1 provides strong support for an occupation approximately 500-1500 years ago, while the Oxbow projectile point and the Feature 4.2 date indicate a substantially earlier occupation ca. 4,500 years ago.

**Feature 6 Excavation Results.** The UM team excavated 12 1-x-1-m test units associated with stone circle Feature 6 (Photograph 6). The overall dimensions of Feature 6 are approximately 4.5 by 5.2 meters, or approximately 19.6 m². Feature 6 appears smaller than Feature 4 in plan due to the large number of exterior rocks that mark its limits and encroach upon its interior (Photograph 6). The overall shape of Feature 6 is more difficult to interpret due to the large number of rocks, several of which have rolled into the interior of the stone circle. No features were identified during excavations.

within Feature 6. Artifacts were generally concentrated at approximately 10-20 cm below surface, likely marking the living surface during occupation. No definite soil differences were observed between interior and exterior test units, nor were there significant differences in artifact counts between interior and exterior units.

Feature 6 yielded comparatively few artifacts (n=178), or approximately 14.8 per m². Lithic artifacts are comprised of 174 flakes and four biface fragments (see Table 3). The four biface fragments were classified as projectile points (n=2), a late stage biface (n=1), and a mid stage biface (n=1). The remaining lithic artifacts consist of either indeterminate flakes (n=10) and flake fragments (n=93). The flaking debris recovered during excavation indicates production of a variety of bifaces and projectile points, as biface thinning (n=21) and shaping flakes (n=47) dominate the typed flake assemblage in Feature 6 (see Table 4).

A majority of the late stage reduction flakes are concentrated towards the northeast corner of the feature in Test Units 3, 4 and 21. This evidence suggests that the northeast corner of the feature was the location of a lithic reduction activity area. No decortication or other early-stage flaking debris were recovered in Feature 6, indicating an emphasis on production of bifaces and projectile points. The lithic artifacts collected from test units outside of Feature 6 (Test Unit 37 and 38) signify that lithic reduction activities were also taking place outside of the feature at some point during occupation of the landform. These artifacts may not be associated with the use of Feature 6 but provide evidence of a wider area of use on the landform than just within the present stone circle features.

Three of the four bifaces were submitted for XRF analysis indicating Obsidian Cliff as the obsidian source for both of the obsidian bifaces (FS 5 and 45) while the Grasshopper Knob dacite formation is the lithic material source for FS 31. Two of the four bifaces were untyped fragments while the other two bifaces were most likely Avonlea projectile points.

The period of occupation of stone circle Feature 6 may have been the earliest portion of the Late Prehistoric period, as denoted by the presence of a nicely worked Avonlea arrow point from a tan, fine-grained orthoquartzite (FS 16). Another fragment (FS 5) of a possible Avonlea or other Late Prehistoric arrow point was also recovered within the interior of Feature 6 (Photograph 7). Both of these projectile points indicate a Late Prehistoric occupation, perhaps between 1000–1500 years ago. Unfortunately, no fire features were excavated within Feature 6 to corroborate this period of occupation; however, the fairly low density of lithic debris and the two projectile points may indicate a single occupation or series of occupations dating to the early portion of the Late Prehistoric period.

Photograph 7. Late Prehistoric Point, Airport Rings (24YE357), FS 16, Feature 6.

**Feature 8 Excavation Results.** Finally, excavation of stone circle Feature 8 included 13 1-x-1-m test units. Test units 15-20 were excavated in a south-north transect across the stone circle’s center, while TUs 27, 28, 31, and 32 provided an east-west cross-section. TU 29 was excavated to explore the perimeter of Feature 8.1 in the east-central portion of the stone circle, while TU 36 was excavated immediately north of and overlapping the northern edge of the circle to explore the distribution of an ash layer observed within the interior of the circle (Figure 6). Excavations within stone circle Feature 8 resulted in the identification of a single fire feature (Feature 8.1), as well as 153 lithic artifacts.

Among the lithic artifacts from Feature 8 are 138 flakes, three unifacially retouched flake tools, and one possible hammerstone. Fire cracked rock and two natural rock pieces make up the rest of the lithic material collected from Feature 8 (see Table 3). The identifiable flaking debris is dominated by biface thinning (n=14) and shaping flakes (n=40), indicating a focus on late-stage biface and projectile point manufacture, similar to both other excavated stone circles. The remaining lithic debitage consists of one piece of shatter, two indeterminate flakes, and 78 flake fragments.
fire at the center of the tipi. The slightly higher numbers on both the north and south edge of the ring may point to episodes of cleaning but may not as lithics seem to have a higher concentration as one moves towards the middle of the feature.

**Feature 8 Fire Feature.** In addition to lithics, excavations within Feature 8 yielded a fairly intensively-used fire feature, likely a hearth or roasting pit, at its center. Charcoal and FCR packed the feature, indicating an intensive and hot fire within the stone circle. Charcoal collected from the feature was submitted for radiocarbon dating, resulting in a conventional radiocarbon age of 270±50 B.P. or AD 1630-1730 (BETA-250334). The 2-Sigma calibrated radiocarbon age is CAL AD 1480 to 1680 and CAL AD 1770 to 1800. These radiocarbon data indicate an occupation of Feature 8 and use of Feature 8.1 during the terminal portion of the Late Prehistoric to the Contact Period.

Floral and faunal analyses indicate the possible cultural use of cheno-ams by Native Americans in the Late Prehistoric Feature 8.1 (see Gish, this volume). Additional macrobotanical floral analysis identified three charred monocot/herbaceous dicot stem fragments. The stem fragments as well as several pieces of charred vitrified tissues were not identified. The other plants used for fuel during the occupation of the site during the Late Prehistoric Period were willow, birch, and small amounts of sagebrush. Faunal analysis classified several unknown mammal tooth and bone fragments around the hearth. Although the elements could not be identified, the presence of animal remains in the hearth clearly indicates Feature 8.1 was a food-processing feature.

In association with the hearth feature, excavations revealed the presence of a thick ash layer (ca. 15 cm thick at its deepest) in the northeastern portion of the stone circle. The ash extends like a plume from the fire feature northeastward. Excavations in TUs 15, 17, 21, 27, and 28 revealed thick layers of ash immediately surrounding the feature and extending in the northern

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**Figure 6. Airport Rings Stone Circle Feature 8 (24YE357).**

No diagnostic projectile points or bifaces were recovered, with tools restricted to three obsidian unifaces and a possible hammerstone. Two natural chert pebbles were collected during excavations, as it was unknown at the time whether the items were natural or the result of prehistoric activities in Feature 8. All seven obsidian artifacts sent for sourcing matched the Obsidian Cliff source (see Table 5). The other two artifacts were identified with chemical signatures of the Grasshopper Knob dacite formation in southwestern Montana.

Based on the distribution of late stage flaking debris, even with the small numbers per test unit, it may suggest a similar type of reduction activity focused towards the
and eastern portion of the circle. Excavations within all other test units to the west and south revealed only sporadic lenses of the ash, if any at all.

In addition, excavations within TU 36 overlapping the northern edge of the circle indicated that the ash layer extends to the interior edge of the stone circle but does not extend exterior of the circle. These data suggest that the ash layer accumulated within the interior of the lodge during its use. One plausible interpretation is that a small family burned a very hot fire during a cold-weather storm, while a southwesterly wind blew through the lodge pushing ash against the east-northeast portion of the interior of the lodge.

At least two large cobbles in TU 27 rest on top of the ash layer itself (Photograph 8), indicating that the ash layer formed initially, with the subsequent movement of the cobbles onto the ash surface, perhaps after the occupation of the lodge. Once the lodge hides were taken up by the Native American inhabitants, the rocks could have rolled onto the leftover ash layer.

The distribution of ash in association with the hearth indicates that stone circle Feature 8 likely experienced a single cold-weather-period occupation during the terminal Late Prehistoric to Contact period, or approximately AD 1480 to 1630. The low density of lithic debris (ca. 12 per m²), most of which is concentrated around the fire feature, supports a brief occupation in which inhabitants kept warm by the hot fire and waited out a storm. During this time, they maintained their lithic tool kit and conducted other daily tasks while the west-to-east moving storm blew through the Yellowstone Valley. The lack of stratification within Feature 8.1 also indicates a single occupation, rather than multiple uses over time.

Summary

As reflected in Table 6, the 2007-2008 survey identified 32 stone circles at five sites in their Gardiner Basin (Boundary Lands) study area. The setting of the five sites varies from upper terraces overlooking the Yellowstone River—Stephens Creek (24YE356) and Airport Rings (24YE357)—to upland flats and high benches adjacent to springs and low-order feeder streams (all three sites in 2008). All of the sites are in well-protected settings, generally with water and a good view on one side and a hill or enclosed valley on the other.

Overall, the chronological trend supports long-term use of stone circles in the Boundary Lands, with sites dating to the Late Archaic—GMS-1 (24YE182)—and Late Prehistoric—Airport Rings (24YE357). The latter site also yielded a Middle Archaic hearth within one of the stone circles, leaving open the possibility of the earliest dated stone circle in the Northern Plains. However, it is possible that the Late Prehistoric stone circles simply overlay an early Middle Archaic occupation of the site.


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<td>24YE203</td>
<td>JLF-1</td>
<td>6</td>
<td>Unknown</td>
<td>Upland valley</td>
<td>Unnamed crk</td>
<td>Surface survey</td>
</tr>
<tr>
<td>2008</td>
<td>24YE204</td>
<td>HRC Rings</td>
<td>3</td>
<td>Unknown</td>
<td>High Bench</td>
<td>Unnamed crk</td>
<td>Surface survey</td>
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<tr>
<td>2007</td>
<td>24YE356</td>
<td>Stephens Creek</td>
<td>7</td>
<td>Unknown</td>
<td>Upper terrace</td>
<td>Yellowstone</td>
<td>Surface survey</td>
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<tr>
<td>2007</td>
<td>24YE357</td>
<td>Airport Rings</td>
<td>11</td>
<td>L. Prehistoric</td>
<td>Upper terrace</td>
<td>Yellowstone</td>
<td>Excavations</td>
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The 2008 UM crew conducted NRHP-evaluations of the site in order to recover additional data for verification of certain hypotheses pertaining to age, spatial usage patterns, and overall intrasite patterning. Excavations at the site removed ca. 9 m$^3$ of soil from test units inside and outside of three of the 11 features present at the site. The breakdown of excavations in each feature is provided in Table 7.

Some interpretations we were able to address concern period of use (age), probable seasonality, type of subsistence strategies being used at the site, and some comparative intersite patterning. Excavation of the three stone circles at the Airport Rings Site suggests multiple prehistoric occupations over the last 5,000 years. During the Middle Archaic period, Oxbow site occupants were possibly the first to build a stone circle with an interior fire hearth, yielding a single Oxbow bifurcate projectile point in association with a fire hearth dated to a conventional radiocarbon age of 4,520±40 B.P. Evidence supporting the occupation of stone circle Feature 4 points towards the stone circle likely remaining unutilized until a Late Prehistoric occupation around 340±40 B.P. if the circle was originally created by Middle Archaic people.

Feature 6 yielded two Late Prehistoric points, including an Avonlea point, suggesting occupation ca. 1,500 years ago, although no fire features were excavated to corroborate the period of use. Finally, Feature 8 yielded a Late Prehistoric to Contact period date (AD 1480 to 1630) associated with an intensive winter occupation that produced a thick ash layer in its northeast corner. Both stone circle Features 4 and 8 likely are indicative of winter occupations, while Feature 6’s occupation season is uncertain.

With not only relative but also absolute dates for the two periods of occupation discovered in Feature 4, the artifact evidence also supports the two-occupation interpretation. Roughly twice as many artifacts were recovered from the excavations of Feature 4 than the number of artifacts produced from either Feature 6 or Feature 8.

The higher number of artifacts recovered from Feature 4 could just be a coincidence or provide the direction needed for the study of new comparative methods in future stone circle excavations to test for multiple use occupations. Provided this idea is validated with stone circle data it could aid the process of verifying multiple occupations of the same ring or landform.

**Conclusion**

The University of Montana excavations at Airport Rings provided crucial information to understand prehistoric use of stone circles in Yellowstone National Park. UM’s work at Airport Rings remanist he lone substantial stone circle excavation within the park’s boundaries or the Upper Yellowstone Valley. Results of the excavation at the Airport Rings site have provided sufficient data to answer several important questions pertaining to the larger picture of stone circles studies.

This geographic location would have been a perfect camp for any prehistoric group’s travels into the park during late spring to late fall. Small groups of maybe two or three families at most visited Airport Rings per occupation event based upon the current site formation. Although there are 11 rings the probability of all of them being occupied at the same time is highly unlikely due to indication of rock reuse and the wide range of dates associated with artifacts. A general trend based upon the current formation of the rings suggests a decrease in age from west to east across the landform. Rings farther west are less complete and appear imbedded deeper into the soil than those encountered past Feature 6 suggesting they are older. However, Feature 4 did have a Late Prehistoric component suggesting that different parts of the landform were used during different periods of occupation. The size of the rings also show a trend of increased size from west to east again suggesting the age

<table>
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<th>Table 7. Feature Excavation Results for 24YE357.</th>
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<tr>
<td>Feature 4</td>
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<tr>
<td># of Test Units</td>
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<td>Area exc. inside FT</td>
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<td>Area exc. outside FT</td>
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<td>Total Area exc.</td>
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use of the terrace, determining the age of a stone circle based upon the size could prove an inaccurate method. A majority of the rings as one travels to the east are fairly intact and other data recovered from the sight implies the landform saw increased use during the Late Prehistoric Period.

Many different cultural phases are present within the archaeological record of YNP and at the Airport Rings Site. The excavations from the three stone circle features at 24YE357 resulted in the evidence for Middle Archaic, Late Archaic, and Late Prehistoric occupation events at the site. Three hearths were uncovered providing charcoal samples from each, which were analyzed to provide absolute radiocarbon dates pertaining to the associated occupation of the ring. These samples provided one date around the beginning of the Middle Archaic Period, and two dates for the Late Prehistoric Period within 100 years of each other, more evidence for the implications of increased use during this period. The temporal ranges from projectile points recovered during excavation support the dates from radiocarbon samples from the hearths.

Projectile point chronology also covers dates not supported by the charcoal sample dates, signifying that the points may not have been associated with the use of the features. In all likelihood, the projectile points are probably associated with the radiocarbon dates, but this hypothesis is one possibly valid alternative interpretation. All of the points recovered from the site were incomplete after having suffered some type of damage associated with its use. The best type affiliations associated with these point fragments put the seven points into five possible phases covering the range of dates from 5000 B.P. to 400 B.P. One of the points was classified as a Middle Archaic Oxbow type; another was determined to be a Late Prehistoric Avonlea, two were linked to the Late Archaic Pelican Lake phase, and the others were all untyped Late Prehistoric forms.

Subsistence information based upon the floral and faunal analysis of recovered artifacts remains relatively unexplored for the site as the excavations turned up sparse amounts of data from which to draw conclusions. The one observation that did come from the analysis of plant and animal remains was the lack of plant remains generally associated with hunting and gathering suggesting that the site was in a better area for hunting. Hunter-gatherer archaeology on the Great Plains over the past several decades has established the general acceptance of subsistence, or survival, activities based upon the hunting of large game species. Subsistence models of intermountain archaeology (Madsen and Metcalf 2000) indicate seasonal rounds of travel more focused on gathering plant resources during peak growing periods at elevations above 7-8,000 ft. for the Greater Yellowstone Region. Taking the low density of plant resources recovered from the site (see Gish, this volume) and the evidence of medium-large game species (e.g., deer and bison) in the faunal remains, it is highly likely that this seasonal strategy was utilized in this region. The remains from the Airport Rings site represent an example of a subsistence strategy that could be interpreted as confirmation that the site was used as a seasonal stop over location for travel in and out of YNP uplands. As Gish points out (this volume), seasonal use of the site during both the Middle Archaic and Late Prehistoric periods was likely during warmer months. The data from Feature 8.1 also indicates a cool-weather occupation which, in this region, does not preclude spring, summer, or fall (evening temperatures often drop into the single digits well into summer).

The 2008 UM excavations at the Airport Rings Site (24YE357) were just the first step taken in developing data sets pertaining to the many unanswered questions about occupation of the Greater Yellowstone Region. The goal of the project was exploratory and allowed for the interpretation of recovered archaeological data answering questions on a small scale pertaining to prehistoric life specific to the site. These interpretations paint the picture of daily life and purpose of the site over an extended stage of tenancy by those native groups living in the Greater Yellowstone Region. Site-specific and small-scale questions need to be addressed before the grand scheme is unveiled in studies directed towards understanding stone circle use of the past. Results of the varied analyses conducted from Airport Rings data have provided preliminary explanations to such questions like what subsistence strategies were employed in the area, whether resources were exploited on a seasonal basis or by task groups, and one of the more important questions regarding the lack of stone circles in the Park uplands.

Acknowledgements. Many people contributed to the success of the MYAP excavations at Airport Rings. Doug
MacDonald was the editor of this chapter, contributed to the final report, and conducted lithic analysis, with contributions by University of Montana students Lester Maas (background research), Laura Kurz and Helen Keremedjiev (data entry). John Douglas, Steve Sheriff, and Elaine Hale provided peer review comments on the final Airport Rings report as part of Livers’ UM Professional Project toward completion of his master’s degree (Livers and MacDonald 2010).

Radiocarbon dating was conducted by Beta Analytic, Inc. (Miami, Florida), while Linda Scott Cummings and Kathryn Pusman of PaleoResearch, Inc. (Colorado) conducted ethnobotanical identification of 24YE357 feature contents. Pollen analysis was conducted by Jennifer Gish. Richard Hughes conducted XRF analysis of selected igneous materials from the project area. Project funding and management was provided by Ann Johnson, Elaine Hale, and Mary Hektner of YNP.

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CHAPTER 7
PREHISTORIC LITHIC RAW
MATERIAL USE IN THE GARDINER
BASIN, MONTANA

Jacob S. Adams, Douglas H. MacDonald, and Richard E. Hughes

As introduced by MacDonald and Maas’ paper earlier in this volume, the Gardiner Basin in Yellowstone National Park provides an excellent case study to examine the differential use of lithic raw materials by prehistoric hunter-gatherers. With two procurement areas—Obsidian Cliff obsidian and Crescent Hill chert—located equidistant from the project area, an examination of the differential use of raw material provides insight into landuse patterns in prehistory. Here we discuss both raw material sources in detail, as well as examine the use of lithic raw materials at the Yellowstone Bank Cache Site (MacDonald and Maas, this volume) and the Airport Rings Site (Livers, this volume). One of the main purposes of this paper is to examine and characterize Crescent Hill chert. First identified and recorded by Yellowstone National Park (YNP) employees and consultants Ken Cannon, Robin Park, and Ann Johnson, Crescent Hill chert represents the second most abundant raw material type in archaeological assemblages of the Gardiner Basin. The University of Montana (UM) followed up Robin Park’s initial reconnaissance survey in 2006-2007 with a comprehensive analysis of the Crescent Hill chert procurement area in 2009-2010, results of which are summarized herein and more fully described in Adams (2011).

Introduction

Hunter-gatherer decision-making regarding lithic raw material procurement strategies is often dependent upon many variables, such as human and geological factors (Andrefsky 1994a, 1994b; Elston 1992). Looking at the differential use of raw materials at archaeological sites provides a vast amount of information regarding the lithic technological organization of these peoples (Nelson 1991). When examining the relationship of archaeological sites and raw material procurement locations, it is of extreme importance to be able to match chipped stone artifacts to their initial procurement location. This elucidates a vast amount of information in regard to hunter-gatherer landuse and mobility patterns.

In this paper, we provide an overview of the two most utilized raw material procurement locations for hunter-gatherers of the Gardiner Basin area, Obsidian Cliff obsidian and the recently-identified Crescent Hill chert (Figure 1). Human and geological factors will be taken into account for each procurement area and provenance studies will be discussed. Lastly, we examine the differential use of Obsidian Cliff obsidian and Crescent Hill chert between the Late Archaic and Late Prehistoric time periods at two sites previously discussed in this publication, the Yellowstone Bank Cache Site and the Airport Rings Site.

Obsidian Cliff

In 1879 W.H. Holmes, in regard to Obsidian Cliff, stated that, “the various Indian tribes of the neighboring valleys had probably visited this locality for the purpose of procuring material for arrowpoints and other implements...a finer mine could hardly be imagined, for inexhaustible supplies of the choicest obsidian” (Holmes...
Obsidian Cliff (Photograph 1) was visited throughout prehistory and is found ubiquitously in cultural contexts across the landscape of Yellowstone National Park. However, the material was not spatially isolated but has been found in archaeological assemblages across the United States (Davis et al. 1995). Geologically, Obsidian Cliff obsidian is a high quality, homogeneous, isotropic siliceous stone with superior flakeability.

In regard to abundance, the material is found in three contexts: in large nodules that have eroded out of the cliff face, as material in the cliff face, and as bedrock. These three contexts provided prehistoric hunter-gatherers with options in regard to procurement of the obsidian. For instance, there is substantial evidence for quarrying the bedrock of the source (Davis et al. 1995). By doing this, peoples were able to exploit a raw material free of mechanical and chemical weathering and obtain a material of the utmost quality. In regard to the distribution of the source area it is a dense, fairly concentrated source that encompasses an area of approximately 3,580 acres.

Obsidian Cliff, along with other obsidian flows, has a unique chemical fingerprint. This allows for the provenance of the material to be determined using geochemical techniques, such as X-ray fluorescence spectrometry (XRF). XRF is used to match the elemental composition of chipped stone artifacts to their original procurement location (Andrefsky 2005). This technique is most commonly used for sourcing obsidian and other igneous rocks. Obsidian shows little to no inter-source visual variation and can’t be properly assigned to a source by solely relying on macroscopic observations. Thus, geochemical characterization has become a popular and extremely accurate means of distinguishing volcanic rock sources, including obsidian and dacite (Figure 2). Obsidian is an excellent candidate for geochemical techniques and XRF provides an extremely high degree of accuracy matching lithic artifacts to their original source areas.

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Figure 2. Sample XRF results for Obsidian Artifacts from Yellowstone National Park (Crescent H listed above does not represent Crescent Hill chert).

Crescent Hill Chert

Next to Obsidian Cliff obsidian, Crescent Hill chert is the second most utilized raw material in the Gardiner Basin (see MacDonald and Maas, this volume). The Crescent Hill chert outcrop area was first identified in 1998 as being an area of importance used during prehistory (Cannon and Phillips 1993). Robin Park of YNP followed up with a more-detailed survey in the 2000s, laying the foundation for the 2009-2010 UM field surveys
of the outcrop area (Adams 2011) (Photograph 2). More than 20 separate exposures of the chert (Photograph 3) were identified by UM within nine general outcrop areas. Unlike Obsidian Cliff, there was no empirical evidence that the material was pit quarried, but surface exposures of the rock revealed extensive evidence of lithic reduction activities during prehistory.

Crescent Hill chert formed within the Crescent Hill basalt formation and occurs in two contexts: 1) eroding from hilltops or knobs; and 2) as chert lenses within the Crescent Hill columnar basalt formation. The basalt formation is Eocene-era (55.8-33.9 ma) in age and is within the Sunlight Group of the Absaroka Volcanic Supergroup (Howard 1937). With most cherts forming in deep-sea environments and shallow water contexts, Crescent Hill chert presents an interesting scenario, with the chert being formed directly within the basalt formation (Andrefsky 2005). Geologically Crescent Hill cherts are extremely heterogeneous in appearance and morphology. Cherts range from extremely high quality fine-grained materials to coarse-grained inclusion ridden materials.

In regard to abundance, Crescent Hill chert is scattered across approximately 2,124 acres in the two specific contexts discussed above. The outcrop areas are patchy across the landscape and locating the high quality raw materials would have been a difficult task for prehistoric hunter-gatherers. As discussed above there was no evidence of quarrying of raw materials at Crescent Hill. This means that raw material was being taken directly from the outcrop area, which in turn

Photograph 2. Crescent Hill Chert Survey Area.

Photograph 3. Crescent Hill Chert Lens in Bedrock.
means that the material was exposed to chemical and mechanical weathering processes making a less desirable raw material. With the patchiness associated with Crescent Hill, the procurement of the material may have been an embedded phenomenon when other tasks were being performed (Binford 1979).

With the unique geological occurrence of Crescent Hill chert, we hypothesized that the chert may contain unique trace elements of the parent rock that could be identified through XRF analysis. Only a handful of cherts in the world have been successful sourced using the XRF method (Hughes et al. 2010; Warashina 1992). The third author analyzed five samples of Crescent Hill chert from five different outcrops, along with samples of several regional cherts including: South Everson Creek, Knife River Flint, Spanish Diggings, and Tensleep chert. There is extreme variation in the trace elements between the various Crescent Hill outcrops and it is chemically indistinguishable from several of the regions most prominent cherts (Figure 3). Geochemical techniques are often subject to a high degree of error when dealing with cherts due to the several episodes of diagenesis the material goes through.

With the cherts resilience to geochemical techniques there is a heavy reliance on macroscopic and petrographic techniques for the characterization of the material. Macroscopically hand samples of the chert are matched to lithic artifacts found in archaeological assemblages (Adams 2011). The cherts exhibit the presence of diagnostic features such as quartz stringers that can be viewed macroscopically and in detail with a petrographic microscope. Petrographic thin section analysis provides information on the formation processes of the chert and the mineral composition. For instance, macroscopically, Crescent Hill chert is extremely hard to distinguish from varieties of the Wyoming chert, including Big Horn Mountain phosphoria (Photograph 4). But when viewed under a petrographic microscope, the differences between Crescent Hill chert and phosphoria are obvious in regard to the formation of the cherts (Photograph 5). Crescent Hill chert contains no organic material, which is what would be expected from its unique formation. On the other hand, the phosphoria

Figure 3. XRF results for Crescent Hill and other regional cherts (Chert Hill represents Crescent Hill chert).
sample has organic sponge spicules throughout its matrix. This is extremely diagnostic when comparing the two materials.

Photograph 4. Hand-Sample of Crescent Hill Chert.

Photograph 5. Thin Section comparison of Crescent Hill chert (right) and look-a-like chert, Phosphoria (left).

Unlike volcanic materials, a suite of techniques needs to be employed to characterize Crescent Hill chert artifacts with their original source area. It is extremely difficult to characterize Crescent Hill chert due to its elementally scattered nature and the extreme heterogeneity associated with the materials. However, with the use of macroscopic and petrographic techniques, these materials can be successfully characterized. Future research will explore the use of scanning electron microscopes (SEM) to source Crescent Hill cherts. Unlike making thin sections for petrographic analysis and destroying the hand sample, SEMs provide a non-destructive way of viewing the cherts in comparable detail. This would be particularly advantageous for examining artifacts in microscopic detail and comparing them to hand samples.

**Human Factors of Procurement**

For the human factor of the equation, distance plays a major role in how far peoples were willing to go to obtain materials. In the case of Obsidian Cliff, it was likely only accessed during snow free times, due to the substantial snow accumulations on the Yellowstone Plateau (Figure 4). Obsidian Cliff is located approximately 20 miles south of the Gardiner Basin Sites and would have been accessed following the Yellowstone River upstream, then heading south following the Gardiner River. To gain access to Obsidian Cliff from the Gardiner Basin there is an approximate elevation gain of 2,195 feet, with the most elevated part of the journey being from the Gardiner Basin to the Swan Lake Flat area. From that point on a fairly constant elevation prevails. This seems to be the most feasible route of approach to access the materials.

As is the case with Obsidian Cliff, Crescent Hill is within the Yellowstone Plateau, potentially limiting access to the source to warm-weather seasons. To gain access to Crescent Hill, peoples likely followed the Yellowstone River through the Black Canyon of the Yellowstone for approximately 15-20 miles. There, feeder streams would have been followed southward (and upward) into the Crescent Hill area; the trip entailed an elevation gain of between 1,300-2,300 ft. (MacDonald et al. 2010). Of the two sources, Crescent Hill was the easiest to access, but spottiest on the landscape. Both sources provide raw materials, but hunter-gatherers likely considered various criteria in their evaluation of the basic economics of procuring these resources.

**The Archaeological Sites**

With a description of the two main raw material types found at the archaeological sites in the Gardiner Basin of Yellowstone National Park, it is now pertinent to look at the differential use of raw materials at the Yellowstone Bank Cache Site and the Airport Rings Site. In the context of these two sites, lithic raw material can be looked at from a temporal context due to well-dated hearth features associated with diagnostic projectile points at both sites (see chapters by MacDonald and Maas and Livers, this volume).
Figure 4. Map showing travel routes from the Gardiner Basin to procurement areas.
Figure 5. Differential Use of Crescent Hill and Obsidian Cliff at the YBC Site during the Late Archaic.

Figure 6. Use of Crescent Hill and Obsidian Cliff at the Airport Rings Site during the Late Prehistoric.
As discussed by MacDonald and Maas (this volume), the Yellowstone Bank Cache Site (YBC) is located along the upper banks of the Yellowstone River in the Gardiner Basin Portion of Yellowstone National Park. From radiocarbon dating and corresponding diagnostic projectile points, it is evident that the site represents a series of multiple Late Archaic (3,000-1,500) occupations. From the lithics data, these sites seem to represent an area associated with intensive lithic reduction. An examination of the lithic assemblages shows variable use of both Crescent Hill chert and Obsidian Cliff obsidian during the Late Archaic (Figure 5). One outlier was the high presence of more than 400 Crescent Hill chert flakes, side by side with a similar amount of obsidian flakes. The overall trend of use for these lithic data is approximately 25% Crescent Hill chert, 65% Obsidian Cliff, and the remainder other material types.

As described by Livers (this volume), the Airport Rings Site represents a Late Prehistoric occupation, with 11 stone circles situated on a terrace above the Yellowstone River in the Gardiner Basin of Yellowstone National Park. Of three prehistoric features excavated by MYAP, two yielded radiocarbon dates going back to the Late Prehistoric (1,500-300 years ago) time period (Livers and MacDonald 2010). As with the YBC Site, Obsidian Cliff obsidian and Crescent Hill chert were the most prevalent raw material types in the archaeological assemblage (Figure 6). However, during this period there is an even higher reliance on obsidian. Overall, obsidian accounts for a mean average of 80%, with Crescent Hill representing a mean average of only 13%, and the remainder of other material types.

Summary and Conclusions

It is clear that Obsidian Cliff obsidian is of superior geologic quality to Crescent Hill chert. This notion is supported by the heavy use of Obsidian Cliff obsidian at both the Yellowstone Bank Cache Site and the Airport Rings Site. Another line of evidence, in regard to the cultural use of Crescent Hill chert and Obsidian Cliff obsidian, is from the projectile points found in the Gardiner Basin. Of the 93 points recovered by UM in its 2007-2008 survey (Maas and MacDonald 2009), obsidian accounts for 67% with Crescent Hill chert accounting for 20% of the total collected points. Obsidian Cliff apparently was a destination source, whereas Crescent Hill was an area that my have been encountered during other activities. Thus, despite the fact that Crescent Hill was the easier of the two materials to procure based on geography, Obsidian Cliff was still the preferred material.

During prehistory, Gardiner Basin hunter-gatherers went out of their way to acquire raw material from Obsidian Cliff, whereas Crescent Hill chert was likely procured via an embedded procurement strategy. The rationale for these lithic procurement decisions was likely directed by material quality, availability, and morphology. Obsidian Cliff obsidian was directly procured because of its high value, while Crescent Hill chert was incidentally procured if convenient during other hunting and gathering activities. This pattern of procurement increased during the Late Prehistoric period at Airport Rings, with obsidian clearly the preferred material. Future research will explore this chronological shift in material preferences.

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CHAPTER 8
ARCHAEOBOTANICAL RESULTS
FROM GARDINER BASIN SITES,
YELLOWSTONE NATIONAL PARK,
MONTANA

Jannifer W. Gish

Archaeological pollen samples were studied from two sites in Gardner Basin, Montana. At 24YE355—the Late Archaic Yellowstone Bank Cache Site (MacDonald and Maas, this volume)—four samples were analyzed from basin-shaped firepit/hearth features and fire-cracked rock concentrations. At 24YE357—the Airport Rings Site (Livers, this volume)—one sample was evaluated from a Middle Archaic period thermal feature and a second from a Late Prehistoric period thermal feature.

Both sites are located on terraces of the Yellowstone River, with Yellowstone Bank Cache at an elevation of 1,577 m and Airport Rings at 1,594 m (MacDonald 2008). The modern vegetation at both sites is sagebrush (Artemisia spp.) steppe. A nearby riparian zone along the river supports pine (Pinus sp.), Rocky Mountain juniper (Juniperus scopulorum), mountain ash (Sorbus scopulina), and willows (Salix spp.).

Pollen Sample Processing

The six pollen samples were chemically processed at the Laboratory of Paleocology, Northern Arizona University, Flagstaff. Samples of 20 cc volume were collected from the bulk soil samples submitted by Dr. Douglas MacDonald of The University of Montana. Prior to the chemical processing a known concentration (37,168 grains) of club moss (Lycopodium) spores was added to each sample to enable pollen concentration calculations. Each sample was then pretreated with a 10% solution of hydrochloric acid to dissolve calcium carbonates, and then sieved through a 180 μm mesh screen to remove coarse material (roots, charcoal pieces, rocks, sand, and so on). The fine fractions were then mixed with 20 ml of warm sodium hexametaphosphate (less than 2% solution) and 1000 ml of hot distilled water and allowed to settle for 8 hours. After 8 hours, the muddy liquids were decanted. These timed decants were repeated using only distilled water until the liquids were clear after eight hours of settling time. After the settling cycles, the samples were soaked overnight in hydrofluoric acid (49% solution), followed by a density separation in lithium polytungstate (1.9 specific gravity), and acetylation, which reduces plant lignin and other organic materials. The recovered residues were rinsed in alcohol and stored in glycerol (Smith 1998:29-33, and Smith 2010, personal communication).

The six samples yielded sufficient abundances of well-preserved pollen to obtain 200-grain counts of combined arboreal and non-arboreal pollen for each sample (Table 1). During the counting process, a separate tally of Lycopodium spores was maintained. Pollen concentrations were calculated based on the following formula:

\[
\text{number of introduced spores X 200-grain count} \\
\text{number of spores counted X sample volume}
\]

The counts and identifications of the pollen were conducted at 400X magnification. After each count was completed, the slide was scanned completely at 100X magnification to find any additional taxa that were not encountered during the count. An “X” in Table 1 indicates such taxa. Also, during both the counts and scanning, aggregated occurrences of pollen were recorded. Such aggregates are tallied as single grains during the counts to avoid overrepresentation of individual taxa. But, these occurrences can indicate very local plant presence, or cultural introduction of plant matter into contexts through food preparation, use of fuels, or other activities, and hence potentially have ecological or ethnoecological implications. Aggregated occurrences are coded in terms of both size and frequency. The designation “a” signifies one aggregate, “b” means two to five aggregates, “c” six to ten aggregates, and “d” 11 to 25 aggregates. Hence, a designation of “Ch-25c”, for example, means that six to ten aggregates of Cheno-Am pollen were observed during the count, with the largest aggregate consisting of about 25 grains.
In addition to the above procedures, which are standard, one sample (Field Specimen 106) from Airport Rings (24YE357) was subjected to large-fraction scanning (LFS). In this technique, the sample residue is split and part of the residue is thinned with alcohol and screened through a 45 µm mesh sieve. Using a disposable pipette, the residue on the sieve surface is transferred to a slide for microscopic examination. After analysis, the LFS slide and screened residue are discarded, with only the unmodified residue retained for curation. The LFS procedure serves to recover and concentrate additional
large-sized pollen types that might provide further insight into the past ecology or plant use at a site.

**Pollen Taxa**

Twenty pollen taxa were differentiated in the six samples. Of these, seven are arboREAL taxa. These are: pine (*Pinus*), pine pollen fragments (*Pinus* fragments/3), spruce (*Picea*), Douglas-fir (*Pseudotsuga*), fir (*Abies*), juniper (*Juniperus*), and oak (*Quercus*). The pine pollen fragments category is a tabulation of fragmented Pinaceae pollen grains, which is divided by three to avoid overrepresentation of Pinaceae members in the counts. Although this category could include pieces of fir and spruce grains, the largest portion is, by far, pine, and hence the designation used here. With the exception of willow, the arboREAL taxa all reflect wind-pollinated plants. Willows are both wind- and insect-/self-pollinated. Of the 13 non-arboREAL categories, six reflect wind-pollinated plants. These are: joint-fir (*Ephedra nevadensis*-type), grass family (Poaceae), the Cheno-Am category (goosefoot family [Chenopodiaceae] excluding greasewood [*Sarcobatus*], but including amaranth [*Amaranthus*] in the amaranth family [Amaranthaceae]), greasewood (which is morphologically distinct from other Chenopodiaceae), Low-spine Asteraceae (low-spine pollen grains, such as ragweed [*Ambrosia*], in the sunflower family), and sagebrush (*Artemisia*). The remaining seven non-arboREAL taxa reflect insect-/self-pollinated plants. The use of the suffix “type” in some pollen designations means that other species or genera besides the designated one could be subsumed in the taxon. *Ephedra nevadensis*-type, for example, includes *E. fasciculata* and *E. viridis*, but not *E. torreyana* nor *E. trifurca*. Most of the pollen taxa designations are at the genus, genus-group, subfamily, or family levels.

The interpretation of pollen records can be complicated, but the separation between wind-pollinated pollen categories and insect-/self-pollinated categories is particularly important for interpreting past vegetation compositions and inferring any direct cultural use of plants. Representations of wind-pollinated categories can derive from local, regional, or extra-regional source plants. Representations of insect-/self-pollinated plants, on the other hand, are generally more local in origin. Hence, the latter taxa often provide a tighter perspective of local vegetation and changes in plant community compositions over time. There are, of course, other factors to consider. High values of wind-pollinated taxa, for instance, still suggest local presence of source plants. Large and common aggregates of both wind- and insect-/self-pollinated plants also imply local plant presence. And, cultural activities can affect interpretations of local vegetation due to the transportation of non-local plant materials into a site. All of these factors have to be considered in the interpretations of the pollen assemblages from the two sites that are presented here.

Before discussing the results, two other categories recorded in the pollen samples warrant comment. These are little clubmoss (*Selaginella*), and oribatid mites. *Selaginella* spores were found in several samples, although they were not included in the pollen counts. Their presence was noted in the results, however, because this moss generally occupies dry slopes, so the spore occurrences provide additional ecological insight. Actually, several types of spores were noticed in the samples, including different kinds of fungal spores. These other spores reflect such broad groups of plants that they have limited ecological meaning, and, generally, are not mentioned in pollen studies.

The presence of oribatid mites (beetle mites) is a different matter. Such mites are normal constituents of the micro-flora in soils. They can be specific to certain types of plant matter, however, so potentially could provide additional ecological, or ethnobotanic, insight into the Yellowstone sites. Identification of such mites, however, is usually very difficult and is beyond the scope of the current study. It is still interesting to note that mites were found in five of the six samples from the Gardner Basin sites, so identification of such mites could provide an additional avenue of productive research in future pollen studies of sites from Yellowstone National Park.

**Results by Site**

In the discussions of the results from the two sites, the implications of the pollen concentration calculations are considered first. Then, descriptions of the pollen taxa proportions are provided, followed by interpretations of the environmental and ethnobotanic meanings of the pollen results.
Yellowstone Bank Cache (Site 4YE355). The pollen concentrations among the four samples from the Yellowstone Bank Cache Site (MacDonald and Maas, this volume) varied from a low of 4,589 grains per cc of soil in Feature 4 to a high of 74,336 grains per cc of soil in Feature 37. In Feature 3, the concentration is 14,295 grains per cc of soil while it is 24,777 grains in Feature 6. Pollen concentrations can be influenced by many factors, but often relate to the ages of deposits. Hence, the soils in Feature 37 appear younger than those in the other contexts, particularly in contrast to the soils in Feature 4. Three of these features are directly dated to the Late Archaic period, with Feature 6 at 2530±40 B.P., Feature 3 at 1670±50 B.P. and Feature 37 at 1600±70 B.P. Feature 4 is undated but adjoins Feature 37 and is at the same stratigraphic horizon and, from an excavation perspective, is comparable in time to Feature 37. Hence, it seems here that pollen concentration does not correlate strongly with feature/soil age, and that pollen is simply especially well preserved in Feature 37.

Pollen taxa variety also often correlates with the age of the deposits, with greater variety in younger deposits. No such suggestion is apparent in the Yellowstone Bank Cache (24YE355) samples, as all four samples yielded low to moderate taxa varieties ranging from 12 categories in Feature 37 to 15 categories in Feature 6.

All four pollen counts are dominated by pine, with values ranging from 31.0 to 50.0 percent. Pine fragments were consistently recorded. Other pine family occurrences included minor representations of spruce, Douglas-fir, and fir. Juniper pollen was consistently present in all four counts, while only a rare occurrence of oak pollen was noted in Feature 37.

Among the non-arboreal pollen categories, the grass, Cheno-Am, and sagebrush taxa are all moderately well represented. There is some variation, with the highest value of grass pollen (20.5 percent) occurring in Feature 6, and the highest Cheno-Am value (25.5 percent) occurring in Feature 4. Other taxa that are consistently represented are greasewood, Low-spine Asteraceae, and High-spine Asteraceae (high-spine pollen grains, such as sunflower [Helianthus], in the sunflower family). Sporadically occurring categories are joint-fir, draba-type (Draba-type) which, as used here, signifies three-furrowed (tricolpate) pollen forms in the mustard family (Brassicaceae), Papilionoideae (a subfamily of the pea family [Fabaceae]), spurge-type (Euphorbia-type), prickly-pear cactus (Opuntia [Platypuntia]), Jacob’s ladder (Polemonium), and Liguliflorae (a group in the sunflower family, which includes wild lettuce (Lactuca). Selaginella spores were observed in the Feature 4 sample.

Almost all of the arboreal pollen taxa have correlates in the modern vegetation either near 24YE355 or elsewhere within Yellowstone National Park. Pines, for example, grow along the Yellowstone River and in the Gallatin National Forest Uplands overlooking Yellowstone Bank Cache (24YE355), and pine stands and conifer forests occur throughout much of the area of Yellowstone Park (Despain 1990:32, 34, and 42). These stands and forests include whitebark pine (Pinus albicaulis), lodgepole pine, and limber pine (McDougall and Baggley 1956). Such pines tend to occur on drier slopes and rocky places, although they are not restricted to such settings (Nelson 1969:63-64). Subalpine fir (Abies lasiocarpa) dominates conifer forests at higher elevations in the park where spruce (Picea engelmannii) also can be found (Despain 1990:14-15). Occurrences of Douglas-fir (Pseudotsuga menziesii) tend to be intermixed with sagebrush communities (Despain 1990:36). The fir, spruce, and Douglas-fir are more characteristic of cooler settings with moist soils such as occur in ravines and on north-facing slopes. The juniper pollen representations also correlate with plants that can be found within the park. Rocky Mountain juniper trees are particularly common on dry slopes, and occur along the Yellowstone River near Yellowstone Bank Cache (24YE355), while common juniper (Juniperus communis) usually occurs as an understory shrub in conifer forests on cooler settings. The juniper pollen values at 24YE355, then, could reflect dry or moist conditions, or influx from plants in both settings. It should be reiterated, at this point, that the sources for the arboreal pollen proportions in the four counts are not necessarily limited to plants that grew within the park region in the past. Extra-regional pollen influx also is probable, given the wind-pollinated nature of these arboreals. It is simply more likely that local and/or regional plants are contributing the bulk of the pollen. A likely, distinct, example of extra-regional pollen influx is the presence of oak (Quercus) pollen in Feature 4. Oaks are not documented as being components of the recent/modern natural vegetation within the park by either McDougall and Baggley (1956) or Vizgirdas (2007).
The single pollen grain in FS 413 is likely to reflect extra-regional pollen influx rather than any growth of oaks at Yellowstone Bank Cache (24YE355) in the past. In the modern vegetation of Wyoming, oaks are found primarily in the southwest part of the state (Nelson 1969:103-104).

Most of the non-arboreal pollen taxa in the Yellowstone Bank Cache (24YE355) samples also correlate with plants that can be found in the modern vegetation within Yellowstone Park. An exception is joint-fir. Minor occurrences of this taxon were noted in Features 6 and 37. Joint-fir shrubs occupy dry, sandy or rocky plains, and, although they are considered constituents of Rocky Mountain vegetation (Harrington 1967:356), they are found only well outside the current area of study, and to the south. As the plants are wind-pollinated the pollen occurrences simply provide another example of extra-regional pollen influx into the site deposits. It is unlikely that any joint-firs actually grew near the site in the past.

One key indicator of local environmental conditions in prehistoric times is the presence of greasewood pollen in all four samples (1.0 to 7.5 percent). Black greasewood (Sarcobatus vermiculatus) occurs in the recent/modern vegetation of Yellowstone National Park (McDougall and Baggley 1956:72, Vizgirdas 2007:277). These shrubs occupy dry, alkaline, land, and low arid slopes adjoining such land. Unlike other greasewood species, black greasewood is dependent on fairly shallow groundwater (Meinzer 1927:37-39), so the plant distributions have narrow ecological meanings. Even though these shrubs are wind-pollinated, due to their restricted distributions, the consistent pollen representations at Yellowstone Bank Cache (24YE355) are sufficient to suggest these plants grew locally in the past. Certain other plants, which also are tolerant of saline conditions, tend to be associated with greasewood vegetation. The saltbushes (Atriplex spp.) are prime examples. One native saltbush species (A. gardneri) occurs in the park (McDougall and Baggley 1956:70). The Atriplex genus is subsumed in the Cheno-Am pollen taxon, which is quite broad and includes many plants besides saltbush. Many of these, like species of goosefoot (Chenopodium spp.), winterfat (Eurotica lanata), povertyweed (Monolepis nutalliiana), amaranths (Amaranthus spp.), spiny hopsage (Grayia spinosa) and others, are all documented as occurring within the park (McDougall and Baggley 1956:70-72).

Some, like the saltbushes, are tolerant of saline conditions, although most are not restricted to such habitats (Vizgirdas 1990:155-160). As these plants are all wind-pollinated, it is likely that many species contributed to the consistent representations of Cheno-Am pollen (11.0 to 25.5 percent) seen in all four samples. Still, it is plausible to infer that some of the more salt-tolerant species occurred locally at 24YE355 in the past in association with greasewood shrubs.

Another pollen category, which probably reflects local prehistoric shrub presence, is sagebrush. The sagebrush pollen values in the four counts varied from 5.5 to 15.0 percent. McDougall and Baggley (1956:151-152) note that 14-17 herb and shrub species of sagebrushes have been recorded in the park. Most can be found on dry settings on flat ground and hillslopes (Nelson 1969:306). Sagebrush-steppe is the predominant plant community at 24YE355 today, and, although the plants are wind-pollinated, the pollen representations are sufficient to suggest that sagebrush species also occurred locally in the past.

Of the remaining pollen taxa recorded at Yellowstone Bank Cache (24YE355), which have not yet been discussed, several have very broad ecological meanings because they subsume such a large variety of plants. These include the grass family, Low-spine Asteraceae, and High-spine Asteraceae. These all include many species that grow in the park today. The High-spine Asteraceae pollen representations most likely reflect locally growing species in the past, due to the insect-self-pollinated nature of plants in this group. The other two categories could signify local plants, in part, but probably also derive from regional and extra-regional sources as they are wind-pollinated. All three of these taxa subsume plants that can grow in dry or wet conditions, and in the open or in dense forest, so the ecological meanings are unclear. Similarly, the implications of the mustard pollen in Feature 6 and Papilionoidea pollen in Feature 3 are uncertain. Although both taxa consist of insect-/self-pollinated plants, which evidently grew at Yellowstone Bank Cache (24YE355) in the past, such plants can be found under a broad range of environmental conditions. Many plants subsumed by these taxa were recorded as constituents of the Yellowstone Park flora by McDougall and Baggley (1956). In contrast to these broad categories, the spurge-type pollen found in Feature 4 is
suggestive of an open field-like setting, while the prickly-pear pollen in Feature 6 is markedly indicative of open, dry conditions. The Jacob’s ladder pollen in Feature 6 is suggestive of moist or disturbed soils, while the Liguliflorae pollen in Feature 3 is more variable in meaning. All four of these taxa consist of insect-/self-pollinated plants, which apparently grew at the site in the past. All four taxa correlate with plants in the recent/modern vegetation of the park (McDougall and Baggley 1956). Finally, the presence of Selaginella spores in Feature 4 is suggestive of dry conditions. Little clubmoss (Selaginella densa) was found by McDougall and Baggley (1956:19) within the park boundaries.

From an environmental perspective, then, the pollen results from 24YE355 present a picture of the prehistoric vegetation that only partly agrees with the modern situation. The modern setting is sagebrush steppe, with occasional pine, juniper, mountain ash, and willows growing along the nearby Yellowstone River. In contrast, the high pine values in all four subsurface pollen records suggest that pine stands grew at, or quite close to, the site in the past. This pine evidence, however, must be balanced against the evidence for local presence of greasewood shrubs prehistorically. The greasewood representations suggest soil conditions were somewhat saline in the past. The pines that grow today in Yellowstone Park are not salt-tolerant, so it seems likely that pines only grew near the site prehistorically, not directly at the site. Perhaps they were common along the river or elsewhere in the area but in non–alkaline soils. Greasewoods were not the only shrub element growing at the site in the past. Sagebrush plants also appear to have been present locally. The pine and sagebrush representations, along with spurge-type, prickly-pear, and little clubmoss, suggest that site conditions might have been fairly dry. Greasewood, on the other hand, implies more moist conditions, at least in the sense that groundwater was close to the surface. Jacob’s ladder also is suggestive of moist soils. Other diagnostic pollen indicators of moist, or wet, conditions were not recorded, and the proximity of the river is not evident in the 24YE355 samples. Overall, the local on-site vegetation seems to have been shrubby with nearby pines.

Suggestions of direct cultural use of plants at Yellowstone Bank Cache (24YE355) appear minor, although many of the pollen taxa in the counts subsume plants that are potentially useful. Pines, for example, can be used for firewood and lodge poles, and the inner bark and seeds can be eaten (Zalucha 1986:152-154, Vizgirdas 1990:35-35). Junipers can be used for fiber and firewood and the berries are edible (Harrington 1967:242, Kirk 1970:19). Members of the grass family can be used for edible grains, basketry, and other non-food purposes (Harrington 1967:304, 310, 320-322; Kirk 1970:177-187). The seeds and greens of members of the mustard family are edible (Harrington 1967:307-308, Kirk 1970:35-39). Prickly-pear cactus yields edible fruits and joints (Kirk 1970:50). Other examples can be cited, but the pollen assemblages at 24YE355 appear mostly natural so a more thorough accounting of potential plant uses is unwarranted at this time. One exception involves the Cheno-Am taxon in Feature 4. The highest value of Cheno-Am pollen (25.5 percent) at Yellowstone Bank Cache (24YE355) occurred here, along with more (and larger) Cheno-Am pollen aggregates than elsewhere. Although these attributes simply could be due to local plant presence in the past, these are two factors (higher percentages and greater proportions of aggregates) that often reflect direct plant use. Hence, the Cheno-Am value could be enhanced culturally in this context. The leaves and seeds of saltbushes are edible as are the greens and seeds of many herbaceous members of this taxon (Harrington 1967:55-62, 69-71; Kirk 1970:56-63). These leaves, greens, and seeds primarily would have been available for gathering in the summer. Additionally, in Feature 4, the greasewood taxon could be enhanced by plant use. The young twigs of greasewood shrubs are edible and would be available in late spring and early summer (Kirk 1970:62). As discussed previously, Feature 4 probably dates to the Late Archaic period. One can suggest, then, that summer gathering was an activity that occurred at 24YE355 during the Late Archaic.

It should be noted that flotation samples were analyzed previously from Features 3, 4, and 6 at this site by Kathryn Puseman of Paleoresearch Inc. (MacDonald 2008). The overall variety of burned items included wood charcoal identified as pine, Douglas-fir, juniper, possibly aspen (Populus tremuloides), alder (Alnus), maple (Acer), and sagebrush, and also a burned female pine cone scale fragment, a pine needle fragment, pine and juniper seeds, grass floret fragments, a grass grain, a goosefoot
(Chenopodium) seed, and a nightshade (Solanum) seed (MacDonald 2008:139, 145-146, 149-150). Also, a radiocarbon sample from Feature 3 was identified as probably subalpine fir, while radiocarbon samples from Feature 4 were identified as pine and probably subalpine fir (MacDonald 2008:137 and 142). The flotation and pollen results agree, then, in the use of Cheno-Am resources, while the flotation results and radiocarbon identifications also indicate a far larger variety of utilized plants at 24YE355 than can be directly inferred from the pollen results. This sometimes occurs in archaeobotanical analyses. Pollen results can provide evidence of plant use and, in particular, can provide a more comprehensive picture of vegetation than often can be obtained from flotation samples. Flotation results, on the other hand, can often provide a more specific picture of plant use, which also has environmental implications. Both pollen and flotation analyses are usually needed to obtain a thorough perspective of prehistoric environments and botanical aspects of subsistence.

Airport Rings Site (24YE357). The two pollen samples from this site yielded distinctly different results, and the pollen concentration is higher (10,619 grains per cc of soil) in the Late Prehistoric Feature 8.1 than in the Middle Archaic Feature 4.2 (4,322 grains per cc of soil) (Table 1; see Livers, this volume). This contrast coincides with the different ages of the cultural deposits as Feature 4.2 dates to the Middle Archaic period, while Feature 8.1 dates to more recent, Late Prehistoric times.

Among the arboreal taxa, a 32.0 percent pine value was recorded in Late Prehistoric Feature 8.1 versus only 9.5 percent in Middle Archaic Feature 4.2. Other arboreal representations included pine fragments, spruce, and juniper in both samples, and Douglas-fir in Feature 8.1.

Some of the noteworthy differences in the non-arboreal taxa between the two samples include a higher value of Cheno-Am pollen (35.0 percent) in Feature 8.1 than in Feature 4.2 (20.5 percent), and higher values of Low-spine Asteraceae, sagebrush and Liguliflorae pollen (7.5, 28.0 and 13.0 percent, respectively) in Feature 4.2 than in Feature 8.1 (only 2.0, 11.5 and 1.0 percent, respectively). Other consistently represented non-arboreal pollen taxa are grass and High-spine Asteraceae. Sporadically occurring categories are joint-fir in Feature 4.2, and greasewood and mustard family pollen in Feature 8.1. Little clubmoss spores were observed in both samples.

After standard analysis, the sample from Middle Archaic Feature 4.2 also was subjected to large-fraction scanning to see if additional taxa could be identified in this, older, Middle Archaic Period, context. An oribatid mite was observed, but no additional kinds of pollen were found.

From an environmental perspective, the Late Prehistoric Feature 8.1 record suggests a fairly dry, shrubby setting with sagebrush, greasewood, and possibly shrub members of the Cheno-Am group. Pines apparently grew close to the site. In contrast, although the setting during the time of the activities associated with Middle Archaic Feature 4.2 also seems to have been shrubby with sagebrush and probably shrub members of the Cheno-Am taxon, pines seem to have grown much farther from the site. The low, 9.5 percent, pine value is only suggestive of regional or extra-regional pollen influx, not local tree presence. These results suggest that vegetation conditions changed drastically between the Middle Archaic occupation of Feature 4.2 and the Late Prehistoric occupation of Feature 8.1. It is possible, however, that direct cultural uses of plants account for some of the differences in the two records. Plant use is particularly well expressed in Feature 4.2, as will be discussed shortly, and this could be suppressing the proportion of pine in the sample. Hence, the low pine pollen value could be an indirect consequence of cultural activities, not a real indication that pine trees were particularly scarce at the time Feature 4.2 was utilized. This statement, however, needs to be moderated by the fact that results from a pollen column at 48YE381, located along Yellowstone Lake, show a clear trend over time from low pine in the Early Archaic to much higher pine by the Late Prehistoric period (Gish 2010). Although it is not certain that such dynamics also apply to the Gardiner Basin area, it does seem likely that the contrast in pine proportions between Late Prehistoric Features 8.1 and Middle Archaic 4.2 realistically reflects differences in environmental conditions. This does not alter the fact, however, that the samples also appear to reflect direct uses of plants.

From an ethnobotanical perspective, the Cheno-Am taxon in the Airport Rings Late Prehistoric Feature 8.1 could be enhanced through food use (note pollen
aggregates). As mentioned previously, both shrub and herbaceous members in the Cheno-Am group can be used for food. Such use indicates a summer gathering activity. In Middle Archaic Feature 4.2, the 7.5 percent value of Low-spine Asteraceae pollen also could reflect plant use. This group includes ragweed (*Ambrosia acanthicarpa*), povertyweed (*Iva axillaris*), and giant sumpweed (*Iva xanthifolia*), all of which produce edible seeds, although they also are major hayfever plants. All three of these are listed by Vizgirdas (2007:71, 94-95) as occurring in either Yellowstone or Grand Teton National Parks. McDougall and Baggley (1956), on the other hand, did not find these plants growing within Yellowstone Park at the time of their research. So, potential sources are unclear for the Low-spine Asteraceae representation in Feature 4.2. Still, the 7.5 percent value suggests that plants in the Low-spine Asteraceae group were once utilized for food. The 13.0 percent value of Liguliflorae pollen in Feature 4.2 also could reflect plant use. Examples of species in this group are wild-lettuce (*Lactuca pulchella*) and wire-lettuce (*Stephanomeria tenuifolia*), both of which were recorded in the park by McDougall and Baggley (1956:161, 164). Wild-lettuce, in particular, can be used for food (Kirk 1970:150). Aggregates of Liguliflorae pollen were common in the Feature 4.2 sample and support an ethnobotanic interpretation. The higher sagebrush value (28.0 percent) in Feature 4.2 also might reflect cultural enhancement, although aggregates are not outstanding. Sagebrush seeds (achenes) are edible and the leaves can be used for flavoring and tea (Kirk 1970:141, Vizgirdas 2007:77). It also can be noted that a large aggregate (Hi-20a) of High-spine Asteraceae pollen was observed during the counting of the Feature 4.2 sample, although the value was only 2.5 percent. This also could reflect plant use, as many species in this large group yield edible seeds, greens, and roots (Harrington 1967:312-315, Kirk 1970:132-139). It is interesting to note that all four of these enhanced categories in Feature 4.2 are in the Asteraceae family. Perhaps the simultaneous availability of edible members of this family was the focus of the prehistoric activities associated with Feature 4.2. Summer gathering is suggested. Altogether, then, the results from both features indicate summer activities, but the focus of plant gathering seems to have been quite different between the Middle Archaic and Late Prehistoric occupations.

**Conclusion**

In conclusion, from an environmental perspective, pines seem to have occurred locally at both Yellowstone Bank Cache and Airport Rings during the Late Archaic and Late Prehistoric periods, respectively, although not during the earlier Middle Archaic period at Airport Rings. The pine contrast provides the clearest indication that environmental conditions at, or near, the sites changed over time. Shrub vegetation also is well reflected at both sites, with constituents including sagebrush, shrub members of the Cheno-Am group, and greasewood. The latter taxon indicates saline conditions existed at, or near, both sites in the past. With the exception of greasewood, which is suggestive of high groundwater, riparian taxa are not represented in the six samples. The proximity of the Yellowstone River, then, is not reflected in the pollen results.

From an ethnobotanical perspective, both the Cheno-Am and greasewood representations in the Late Archaic Feature 4 at Yellowstone Bank Cache (24YE355) probably reflect food use of plants. Both of these resources would have been available for gathering in the spring and summer. Subsistence activities are not clearly demonstrated in the other three features from this site. At Airport Rings (24YE357), the use of chenopodiaceous plants is indicated in Late Prehistoric Feature 8.1, while members of the Asteraceae family appear accentuated in Feature 4.2 from the Middle Archaic Period. There appear to be differences in the kinds of subsistence plants that were emphasized between the Middle Archaic and Late Prehistoric periods at this site. The various utilized plants would have been available for gathering in the spring and summer.

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CHAPTER 9
OBSIDIAN, CULTURE, AND CONVENIENCE: NEW PERSPECTIVES FROM YELLOWSTONE

Robin J. Park

Many years have been spent accumulating obsidian sourcing data for Yellowstone National Park, WY. This ongoing work has resulted in an extensive database of Yellowstone obsidian. This database is robust, yet at the time of this study’s completion (2008) there had been no published attempts at a comparative analysis by time period and geographical area to address specific archaeological problems like travel routes or socio-cultural preference (but, see Cannon and Hughes 1993; Cannon and Hughes 1994). In effect, we were amassing information without thoroughly analyzing it. Thus, the purpose of this project was to make a preliminary effort to take a new approach to obsidian use studies, and provide a simple analysis of a portion of the Yellowstone obsidian sourcing database. This study was of obsidian use patterns in Yellowstone, and examined obsidian sources within the Greater Yellowstone Ecosystem (GYE) important to Yellowstone prehistory. The main goal was to try and analyze spatial and temporal patterns of obsidian procurement by pre-contact people passing through the modern-day park boundaries.

The central research questions to be addressed were fourfold. First, is there a pattern of selection? If there is, why are sources selected? Based on convenience/proximity, the quality of the material, or for reasons which cannot be quantified? We know that the influence of socio-cultural factors over decision making can be significant—is there some socio-cultural preference for certain sources over others? For example, were people favoring some sources over others when the quality of the material was comparable? Does this pattern (if any) change with geographical location or time period? Finally, does the pattern of exploitation of obsidian sources give clues to the movement of people through Yellowstone and surrounding areas?

There is indisputably a relationship between the distance from source to the location where an artifact is discarded or lost. This relationship can be explained in several ways, most often in economic or logistical/migrational terms. Analyses of this relationship should also take into account socio-cultural influence. The distance from source could potentially indicate regular seasonal movement of a group, cultural preference (not based on quality of material or convenience of source), convenience, or simply more or less inclination towards curation of stone tools. The influence of culture on the daily lives of people throughout time is often ignored in lithic provenance analyses. The concept of a cultural preference for one source over another has never been addressed in the literature on Yellowstone. The approach of this paper is an attempt to address what is certainly a large gap in the research.

This study found that despite the potential for socio-cultural influence over source selection, selection based purely on “cultural preference” did not seem to be a factor in the results. There seemed to be more correlation between the location and quality of a source and site location. However, the archaeological evidence in this study clearly shows preference for the Obsidian Cliff source and this preference can be interpreted in both economic and cultural terms. It is the source of high quality obsidian and is easily accessible from most directions, yet the ethnographic evidence suggests that the role of Obsidian Cliff as a monument on a cultural landscape also contributes to the source’s popularity. A preliminary discussion of a more “local” round of resource exploitation and possible travel corridors was also undertaken based on the results of this study.

Yellowstone: Archaeology and Tool Stone

Situated in the extreme northwest corner of Wyoming (with boundaries extending into Montana and Idaho), Yellowstone has had a rich cultural history both before and after its dedication as a National Park. While the traces of their daily lives were often ephemeral, people have been visiting and inhabiting Yellowstone for the past 12,000 years (see Maas et al. this volume; Hale 2003).

The archaeology program in the Park has only been in existence since the mid 1990’s. Approximately 3% of the
Park has been surveyed, but within that 3% over 1,800 sites have been recorded. The majority of these sites are pre-contact.

The types of tool stone locally available in Yellowstone include chert, chalcedony, petrified wood, quartzite, sandstone, dacite and most importantly, obsidian. The Park sits atop a volcanic caldera, ~75 km long by 55 km wide. This caldera has been very active in the past, ejecting tons of volcanic ash and lava. It remains active today, as evidenced by over 10,000 hydrothermal features. All this makes for the perfect environment for the production of tool grade obsidian, formed when lava is extruded from vents in the ground and cools very quickly, so that the structure of the material is glassy with few inclusions.

The Sample and Study Areas
It was decided that only artifacts that were either diagnostic (based on typology) or found in situ in an identifiable and applicable culture level and in good context would be included. This controls for time and addresses that aspect of this research. The total sample for this research was therefore composed of diagnostic artifacts gleaned from the sites described above, from miscellaneous geochemical analysis reports which included artifacts from sites in the study areas, and key surveys performed by contractors/cooperators with the Park within the study areas.

Geochemical analysis of all artifacts included in this sample was performed by Dr. Richard Hughes over a period of twelve years (1997-2009). X-ray fluorescence (XRF) and energy dispersive x-ray fluorescence (EDXRF) techniques were used consistently throughout this time period (see Hughes 2009 for an example). All analysis was performed at the Geochemical Research Laboratory in Portola Valley, California. This author submitted 20 obsidian artifacts for sourcing during 2008 as part of this study. The remaining 65 artifacts which make up the total sample had previously been sourced as part of survey, inventory or data recovery projects.

The sample for this research (n=85) was limited temporally to the Archaic period. This was in the hopes of getting the largest sample size, as the Archaic is the most well represented time period in Yellowstone archaeology. The Middle Archaic (comprised of the McKean complex ~5500-3000 BP) and Late Archaic (the Pelican Lake culture ~3000-1600 BP) periods were compared, including some projectile point types which showed temporal overlap with either period. The research focus was divided into two distinct geographical areas, with approximately 105 km of distance between the two. These are referred to as the North Study Area (NSA) and the South Study Area (SSA) (Figure 1). Within these two geographical areas, three major sites were examined as representing in situ occurrence of obsidian.

![Figure 1. North Study Area (NSA) and South Study Area (SSA), Yellowstone National Park.](image)

The Osprey Beach site (48YE409-see Johnson et al. 2004) is a multi-component Cody Complex site on the West Thumb of Yellowstone Lake (Figure 2). The results of extensive sourcing of obsidian from the Cody Complex component will be considered as a comparison to the results of the sample group from the Archaic period (when discussing the annual movement of people through greater Yellowstone). This research includes seven Archaic period projectile points from the Osprey Beach site that had not previously been sourced.
Inventories

Figure (triangles)

One the proposed routes. Yellowstone most likely served as a focal point along the routes. Yellowstone (McKean 2008:2) and alternative travel routes over Fawn Pass or Bighorn Pass, indicated by dotted lines.

The Donner site (48YE252; Vivian 2009) is located on the southwest shore of the Southeast Arm of Yellowstone Lake. The site represents a campsite with most intensive use during the Middle and Late Archaic (McKean and Pelican Lake cultures). All of the obsidian projectile points from that excavation have been included in this research.

The Malin Creek site (24YE353) is located on a terrace along the bank of the Yellowstone River in the Black Canyon of the Yellowstone, in the north end of the park (Vivian et al. 2008:2) (see Figure 2). Six projectile points from this site are included for analysis.

Inventories and Surveys

Several surveys and inventories from the two study areas provided further samples for this study (see Park 2010 for details). Six surveys represented the North Study Area for this project, providing 28 projectile points for the sample and including over 200 pre-contact sites. One survey (of the south shoreline of Yellowstone Lake) represented the South Study Area, providing 28 projectile points for the sample and including nearly 100 sites. This was the largest scale survey in the SSA area when this sample was first analyzed in 2008.

Obsidian: A Brief Discussion

As discussed by Adams et al. (this volume), many other types of stone (such as chert) display distinct chemical signatures that differ between sources, but are problematic for archaeological applications as they often display high variability of chemical “signatures” within a single source. Obsidian, however, is a unique stone in that it allows for analysts to consistently distinguish between different geochemical sources of the material in a way that is useful to archaeologists. It can be analyzed for its chemical composition accurately and non-destructively providing a unique “fingerprint” for each source because of low intra-source variability. Tools made of obsidian can be traced back to their source using this fingerprint, which allows us to match up artifacts with where they came from.

Obsidian is therefore an ideal tool stone for determining source affinity to a degree that is archaeologically applicable. Instrumental trace element analysis of obsidian can be performed and results obtained through EDXRF, which is a relatively inexpensive, non-destructive, and highly accurate technique. Intra-source variability in obsidian typically falls into a predictable range for those sources in the Yellowstone area. The Obsidian Cliff source in Yellowstone, for example, is quite homogenous in its chemical makeup and thus this major source shows high geochemical integrity (Davis et al. 1995:41). Thanks to intensive and extensive sampling of the Obsidian Cliff flow, the composition of this source is known to cluster within an expected range and the geochemical integrity of the source has been well established (see Hughes 1990:2).

It is important to note that the term “source” here refers to the geochemical group and not necessarily the primary geographical location of a lava flow. While the two concepts are sometimes one in the same, it is important that the term be understood to refer specifically to the geochemical makeup of a material and not a locality (see Hughes 1998 for a discussion). The main localities where these obsidian sources are
available for collection are shown on the map in Figure 2. Indeed, there are instances where the flow created an outcropping of material in one place, but useable obsidian bearing the same chemical makeup may also be located miles away. This is often seen in older (Quaternary age) flows where over time useable cobbles are moved by natural forces away from the original geographical “source” or extrusion.

**Obsidian in the Greater Yellowstone Area**

Obsidian of differing quality is found in abundance in the area due to this high volcanic activity. Obsidian in the GYE ranges in color from black to brown, red, green and even white (Davis et al. 1995:21). Its tendency for conchoidal fracture and extremely sharp edges make it a prized tool-making material which was heavily exploited in Yellowstone (Davis et al. 1995). It was an extremely popular choice as a tool stone material throughout prehistory for these reasons, as well as the fact that it is abundant and available locally within the GYE.

In Yellowstone, there are two main geological units comprising the rhyolite plateau. The first is the Yellowstone Tuff covering approximately 1,560 square kilometers (Davis et al. 1995:19). The second unit consists of the younger flows on the Madison (in the Western part of the Park), Pitchstone (in the Southwest), and the Central plateaus. These younger flows cover approximately 2,600 square kilometers of the Park (Davis et al. 1995:19). The Yellowstone Plateau is the result of several cycles of caldera eruption and collapse with the most recent being the collapse approximately 600,000 years ago, followed by the eruption of Lava Creek Tuff (Davis et al. 1995:19). The Yellowstone rhyolites are all of Quaternary age (Davis et al. 1995:20).

Through time, each pre-contact group had access to different obsidian sources in the GYE. There are over 45 rhyolitic flows in Yellowstone containing obsidian, however, only about 15% have obsidian with the right qualities (such as absence of flaws in the material and usable cobble size) to be made into tools (Ann Johnson, personal communication 2009). There are 19 confirmed, named geological obsidian sources appearing in Yellowstone archaeological assemblages at the time of publication (see Park 2010 for detailed descriptions). Not all of these sources appear in the results of this study. They are (in alphabetical order): American Falls/Mud Lake, Bear Gulch, Big Southern Butte, Cascade Creek, Cashman Quarry (dacite), Conant Creek, Cougar Creek, Crescent H (also called Teton Pass variety 2/Grassy Lake), Huckleberry Ridge, Lava Creek, Malad, Obsidian Cliff, Packsaddle Creek, Park Point, Parker Peak, Reas Pass, Teton Pass, Timber Butte, and Warm Creek.

The Obsidian Cliff source locality is a National Historic Landmark and a highly significant raw material source for the Plains and beyond. Artifacts made from obsidian from this source are found as far afield as Texas, Washington State, southern Alberta, and Hopewelian burial mounds in the Ohio River Valley, indicating it was a prized material that was also extensively traded or exchanged by people for thousands of years (Davis et al. 1995).

**Some Considerations for Utility and Geochemical Analysis**

While it is useful to know where major obsidian outcroppings or cobbles are available in a given region, the quality of the material must also be considered. There may be several obsidian sources available to people in a particular area, however, only those with tool stone quality are considered when attempting to apply source affinity data to determine seasonal rounds, homeland territory or other research questions. Yellowstone provides excellent examples of both high quality tool stone obsidian sources (such as the Obsidian Cliff flow; Figure 3) and poor tool-making quality material that is considered strictly “geological” (such as the Otter Creek flow) (Johnson 1999:5). During formation, obsidian and other volcanic glasses may acquire inclusions making them unsuitable for knapping (Figure 3).

The age of a flow may also affect the utility of the obsidian for pre-contact peoples. Obsidian contains tiny amounts of water. This makes it unstable and “mechanical strains develop with the expansion of water...thereby transforming the obsidian to perlite” (Baugh and Nelson 1987:315-317). This process effectively destroys the utility of the material for tool making. Thus, the best quality obsidian for tools making are typically younger age flows with few crystalline inclusions.
Figure 3. Material quality is an essential part of the selection process. A projectile point with a few small inclusions within otherwise high quality material (top L); a cobbles of obsidian from the Obsidian Cliff source, tested for quality by a pre-contact tool-maker (top R); and heavily included raw material, unsuitable for tool-making (from the Huckleberry Ridge tuff source).

Certain trace elements are assigned more analytical weight in analysis based on findings that the elements Rubidium (Rb), Strontium (Sr), Yttrium (Y), and Zirconium (Zr) show the most consistent inter-source variability for the region (Hughes, personal communication 2008). These elements are considered “diagnostic”, signifying that these trace elements are well-measured by XRF and show high variability between sources, while maintaining low intra-source variability (Hughes 2007:1). These diagnostic elements are therefore most useful in distinguishing between different geochemical sources. The trace elements Zinc (Zn) and Gallium (Ga) are also recorded but not considered diagnostic of distinct chemical groups because they “don’t usually vary significantly across obsidian sources [in the Greater Yellowstone area]” (Hughes 2007:1).

Due to the nature of their formation, the chemical composition of ash-flow tuff shows an unusually high variability in trace element values, and can be a problem for sourcing studies (see Hughes 2008 for an example). Much more sampling of some of these sources (such as Park Point, Warm Creek and Cascade Creek in Yellowstone) is needed because of this potential for variability. These sources, however, are slowly progressing towards “official” recognition (see Szamuhel 2008).

Socio-Cultural Aspects of Obsidian and Obsidian Cliff

Obsidian was used to make symbolic or decorative objects in regions surrounding the Plains as well as Mesoamerica. For example, obsidian from Yellowstone was used to make “magnificent ritual bifaces in Ohio, California, and elsewhere” (Nabokov and Loendorf 2004:63). The fashioning of religious or ritual objects out of obsidian by groups who lived in the Yellowstone region was not the norm (Nabokov and Loendorf 2004:163). However, there is at least one example of obsidian found in a burial context in Yellowstone (see Hoffman 1961; Willey and Key 1992; Wright et al. 1982). The records of the excavation of this burial do not provide adequate information on the typology of the associated obsidian points, nor was obsidian sourcing technology available at the time. The skeletal remains and associated artifacts from this burial site have been reburied in accordance with the Native American Graves Protection and Repatriation Act (NAGPRA), and are unavailable for further analysis or sourcing. However, the inclusion of obsidian in at least one burial context provides preliminary archaeological evidence that obsidian had some socio-cultural significance for pre-contact people in Yellowstone.

In the GYE there are multiple sources known to have been exploited by pre-contact people. Situated in the northern part of the Park, Obsidian Cliff is a large and striking natural landmark and a vital lithic resource “that served the utilitarian imperatives and ceremonial requirements of early native peoples over a large area of North America for more than 11,000 years” (Davis et al. 1995:59) (Figures 4 and 5). Obsidian Cliff is obviously not always the closest or most convenient source for all locations in the Park. Some other sources (such as Cougar Creek, which contains many phenocrysts) are not of comparable quality to Obsidian Cliff obsidian (Johnson et al. 2004:viili). However, it is essential to examine additional reasons (beyond its quality and location) why Obsidian Cliff tends to dominate obsidian assemblages in
the GYE, and seems to have been preferred by pre-contact people.

![Obsidian Cliff Plateau](image1)

**Figure 4. Photograph (taken by M. Meagher in 1990) of Obsidian Cliff Plateau- the locality of Obsidian Cliff obsidian. Note columnar structure of cliffs (from Meagher and Houston 1998: 62).**

Nabokov and Loendorf (2004) examined the ethnohistoric evidence for Obsidian Cliff as a special location that was shared territory for different tribes in the area. They discussed the idea that “obsidian was so important that its major quarry in the park [Obsidian Cliff] constituted a sort of sacrosanct zone”, or neutral place where temporary peace would be abided by enemy tribes in the interest of procuring this valuable material (Nabokov and Loendorf 2004:162). The authors remained unconvinced of the “neutral ground” argument because of “too little hard data” (Nabokov and Loendorf 2004:163). They claimed that the great availability of good obsidian from different sources weakens the idea that Obsidian Cliff would have been in such high demand as to necessitate it being a neutral ground (Nabokov and Loendorf 2004:164). The authors’ doubts, however, do not take into account the idea that Obsidian Cliff could have simply been a meaningful place to many different groups. This idea is particularly appealing considering that alternative good-quality sources were available within a few days distance.

Many of the modern-day American Indian tribes with ancestral or historical associations with Yellowstone have indicated to Park ethnographers that Obsidian Cliff is a spiritually and ideologically significant place. There are oral histories on file with the Park’s ethnography department that indicate specific reference to use of Obsidian Cliff obsidian, its quality, and etiquette and rules that were associated with quarrying at this place. In addition, there are references to an attitude of reverence shown when in the area. In an interview with Grant Bulltail, he indicates that the Crow “revered the Obsidian Cliff area, and prayed before collecting there” to the “Holders of the Earth...[who] inhabited (and still inhabit) the area” (Loendorf and Stroupe 2003:19). These Holders of the Earth are part of Crow mythology and are beings who were responsible for the replenishing of obsidian at Obsidian Cliff after the Crow collected there, and offerings were left after obsidian was removed (Loendorf and Stroupe 2003:19).

There is also reference to the timeframe of occupation during collection sessions. Information gathered from the same interview with Grant Bulltail indicates that the Crow would only remain at Obsidian Cliff for a few days, “because they did not want to ‘taint the area’” (Loendorf and Stroupe 2003:19). This statement conveys two key pieces of information. First, quarrying/procurement activities were targeted events that occurred when the group was passing through the area. Perhaps the larger group would camp nearby while a smaller procurement group would go to quarry/collection obsidian and camp at the Obsidian Cliff only while completing their task.

![Obsidian Cliff Plateau in 1884](image2)

**Figure 5. Photograph of Obsidian Cliff Plateau in 1884 (by F. J. Haynes 1884, on file in Archaeology Lab, YNP).**
Members of the Shoshone-Bannock of Fort Hall, Idaho have stated that historically, the Obsidian Cliff area was a regular stop over for hunting parties during the fall and summer bison hunts (Katharine L. White [of the Yellowstone National Park Ethnography office] personal communication 2009). This information presents a more specific aspect of seasonality for use of the area as well as specifying who would be camped there. This suggests that the hunters were also the ones who would procure raw material, in a multi-tasking outing involving both lithic procurement and hunting of bison further afield. An interview with a Tukudika (a tribe also known as “Sheep Eaters” or Mountain Shoshone-see Loendorf and Stone 2006:xi-xii) descendant adds to the attitude of reverence shown by the Crow for the site. “Because their [the Tukudika] prayers were left [at Obsidian Cliff] with whatever they left there...it also would be considered a sacred site” (Nabokov and Loendorf 2002:125). Shoshone references to Obsidian Cliff may indicate the importance of this source through time back to the pre-contact period, as Shoshone presence in the area dates to at least the Late Prehistoric, and possibly earlier.

Perhaps the most compelling evidence for Obsidian Cliff as a “place” (with cultural meaning) instead of just a “space” is that the Crow, Shoshone and Bannock all have names for the site in their own languages (Sh<iptachawaxaawe, Duupi, and Tupeshakabna’, respectively) (Katharine L. White, personal communication 2009). Indeed, the naming is one of the defining features of a location becoming a culturally meaningful place, and may increase the potential for socio-cultural selection of some obsidian sources over others. The status of Obsidian Cliff as a place of meaning may also be extended to pre-contact times if we accept the usefulness of analogy as a tool for archaeological interpretation (see Park 2010 for a discussion).

A Matter of Convenience?

There is a certain expectation in lithic procurement studies to see clear associations between the distance/convenience of obsidian sources and the frequency in the archaeological record of a given site. Bradley (2000:86) describes the tendency to focus on questions related to efficiency when examining lithic quarry sites and an underlying belief in the “principle of least effort” (Bradley 2000:86). In some studies, however, the “character of the place seemed at least as important as the qualities of the material that was found there” (Bradley 2000:86-87) (see Park 2010).

Analytical techniques applied to the study of lithic sources typically involve some sort of spatial modeling. The questions asked by researchers are aimed at understanding if a material was obtained directly or through trade based on the distance from the site to the source. This information is then calculated in terms of cost-efficiency; if a source is within a certain distance, direct procurement is assumed. An inverse relationship should is expected between the distance to a source and the quantity of obsidian present at a site. Yet a simple “distance-decay” model is not always in evidence when analyzing lithic procurement patterns in areas with significant obsidian exploitation (such as the Southwestern United States). The obsidian assemblage at the Lookingbill site (in the Absaroka Mountains southeast of Yellowstone) for example, does not conform to a distance-decay model (the largest number of obsidian artifacts came from the Bear Gulch source, which was the furthest away of all represented) (Kornfeld et al. 2001:316). Other studies (Barge and Chataigner 2003; Mitchell and Shackley 1995) have indicated that socio-cultural importance of a source may play a role in the selection process (see Park 2010 for a discussion).

Results: Cultural Preference?

A total of 85 projectile points were selected for analysis (Table 1), with 40 (or 47%) from the North Study Area and 45 (or 53%) from the South Study Area (Figures 6, 7, 8 and 9). Forty-seven samples were projectile points of the McKeen complex or related Middle Archaic types, and 38 projectile points were form the Pelican Lake phase (or Late Archaic period). Overall, 62 points were from the Obsidian Cliff source, eight were from the Teton Pass source, six from Bear Gulch, two from Cashman Quarry, two from Crescent H, one from Conant Creek, one from Cougar Creek, one from Huckleberry Ridge, one from Packsaddle Creek, and one from an unknown source.
Table 1. Obsidian Source Data used in the Study.

<table>
<thead>
<tr>
<th>Study Area/Obsidian source</th>
<th>Middle Archaic (n=47)</th>
<th>Late Archaic (n=38)</th>
</tr>
</thead>
<tbody>
<tr>
<td>North (n=40)</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>Obsidian Cliff</td>
<td>18</td>
<td>17</td>
</tr>
<tr>
<td>Bear Gulch</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>Cashman Quarry dacite</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>Packsaddle Creek</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>South (n=45)</td>
<td>27</td>
<td>18</td>
</tr>
<tr>
<td>Obsidian Cliff</td>
<td>18</td>
<td>9</td>
</tr>
<tr>
<td>Teton Pass</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>Bear Gulch</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Crescent H</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Conant Creek</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Cougar Creek</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Huckleberry Ridge tuff</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Unknown Source</td>
<td>0</td>
<td>1</td>
</tr>
</tbody>
</table>

These results must first be examined in relation to the question of a preference for certain sources that can be explained by cultural constructs as opposed to economic reasons. In order for a cultural preference to be indicated by the archaeological record, there would have to be a significant percentage of obsidian being utilized from a source that is a) not as convenient in terms of distance or accessibility or b) not as high quality as a source of comparable or less distance. Through the process of eliminating obvious “practical” reasons, a cultural/social influence may be considered.

The findings of this study indicate that while it is important to consider the cultural perspective, the selection of sources seems to be based on the quality and location of the source relative to the site, a similar conclusion to Adams et al. (this volume). There was little indication in the results of this sample that significant consideration was given to reasons beyond the practical to utilize an obsidian source. The archaeological record did not show a purely cultural selection or preference for one source over another.

The Obsidian Cliff source may be the exception to this conclusion. Representing 87% of the sample in the North Study Area and 61% in the South Study Area, Obsidian Cliff was certainly an important source as evidenced by its use through time and space (see Figure 6 and 7). It is the dominant source in both study areas, and as represented in the sample from both cultures examined. This is likely due in large part to its superior quality as a tool stone. However, the ethnographic evidence suggests that the role of Obsidian Cliff as a monument on a cultural landscape also contributes to the source’s popularity.

The archaeological evidence in the study sample clearly shows preference for this source and this preference can be interpreted in both economic and cultural terms. That is, the quality of Obsidian Cliff obsidian makes tool stone from this source a good “investment” of time and energy (economic selection), and the location can be considered accessible and conducive to either easy direct procurement from either study area or to local trade between the two study areas. The Obsidian Cliff source therefore stands out among the other sources as a potential testament to the concept of a cultural landscape at work in pre-contact times, and demands further investigation in this regard.

Seasonal Rounds

The seasonal or annual round model that has previously been proposed for Yellowstone (see Johnson et al. 2004) is based on lithic procurement patterns because other indicators of seasonality (such as faunal and plant remains) have not been well represented at sites to date.

The proposed seasonal round in use for Cody complex occupations in the park is based on the assemblage at the Osprey Beach site. Based on the results of sourcing obsidian artifacts associated with the Cody complex at this site, an early summer to early fall occupation is suggested for Lakeshore sites. While there, people would utilize the closest source (Park Point) potentially accessing it through use of watercraft. Groups then moved south in the fall to the Jackson Hole area (exploiting Teton Pass, Crescent H, Conant Creek and other nearby obsidians) and northwest into the foothills of Idaho during the winter. In early spring, groups would move further north and east back into the Park (passing the Bear Gulch source), stopping to collect obsidian at Obsidian Cliff before heading back down to the Lake in the summer (see Johnson et al. 2004 for a discussion).
This model is based on an assumption of direct procurement of lithic materials as an activity undertaken during regular migration.

A similar large annual round has also been proposed for the Jackson Hole area, in Grand Teton National Park. Dubbed the “Northern Teton-Centennial Range pattern” by Connor (1995:38), it is based on assemblages at sites within the area and is “the most consistently seen pattern in the prehistory of Jackson Hole” (Connor 1995:38). This pattern follows the same route as that pattern proposed by Johnson et al. (2004) for the Osprey Beach site/Cody complex in Yellowstone. However, it is interesting to note that Connor (1995:38) does propose another hypothesized settlement pattern for some sites (Jenny Lake and String Lake) in the Jackson Hole area which involves much more localized movement and is focused on procurement of Teton Pass obsidian. This hypothesis will be returned to later on in this discussion.

The analysis performed for this paper has also rested on the assumption of direct procurement of obsidian by those who used it for tools. This assumption of direct procurement is based on the idea that all sources represented are within the parameters of a feasible annual travel distance for a mobile hunter-gatherer group. This assumption is typically the easiest for preliminary stage research on lithic procurement patterns. Taking trade or exchange out of the equation simplifies the line of inquiry by limiting variables.

However, subsequent examination of the existing model of annual round proposed by Johnson et al. (2004) resulted in questioning of this model for two reasons. First, the total distance that such a route would entail is extremely great, even though it is acknowledged that hunter-gatherers sometimes travel great distances for resources. The total “home range” area would be approximately 28,500 square kilometers, with a distance of close to 600 kilometers traveled in a single round based on the location of obsidian sources. Second and perhaps most importantly, it is unnecessary for people to travel such great distances in the GYE to obtain necessary resources. A plausible scenario for “unnecessary” travel presented in this paper is cultural preference. However, the results
of this paper have not indicated that this influence played a significant role in the samples examined (with the exception of Obsidian Cliff).

A Proposal for “Local” Rounds

Instead of the large annual round proposed for the Cody complex (by Johnson et al. 2004), more localized “southern-oriented” and “northern-oriented” rounds should be considered (see Figure 2). An alternative model to the large annual round was proposed in the same report on the Osprey Beach site:

Alternatively, of course, we could have Cody Complex groups moving seasonally up from the south to the Yellowstone Plateau in the summer and returning to sites such as Lawrence in the fall. Then, they would move on to winter camps in the foothills to the west of the Tetons [Johnson et al. 2004:145].

This alternative model was rejected by the authors with the statement that if this were the case, we should see more “formed tools and flakes from southern obsidian sources at Osprey Beach” (Johnson et al. 2004:145). The materials from the southern and western sources represent what was collected during the fall and winter, and the dominance of Obsidian Cliff and Bear Gulch obsidians indicate that these were the last visited sources on a group’s travels back south to the Lake (Johnson et al. 2004:144). However, the alternative model seems to have gained credence based on the results of this study.

Discussion: Concepts of Efficiency, Consideration of Trade

Applying efficiency principles to the results of this study indicate that a simple time-decay model is not applicable for both study areas. The most heavily exploited sources in this study were not always the closest, and quantity does not “drop off” consistently the further away the source is from the site area. The North Study Area does show a time-decay relationship between source and find location to a certain degree. Obsidian Cliff is the closest source to the North Study Area with an approximate distance of 27 km one way (from the Malin Creek site) (see Figure 2). It is also the best represented source in the North Study Area, dominating the assemblage with 87% of the total amount of obsidian artifacts.

The Bear Gulch and Cashman Quarry source locations are both represented by five percent of the total and should be the next closest source localities following this...
model. The Bear Gulch source is approximately 182 km distant from the Malin Creek site and the Cashman Quarry is approximately 100 km away as the crow flies (Figure 2). However, it is important to consider that the distance to Cashman Quarry is not representative of actual travel on foot. Either the Gallatin mountain range would have to be crossed (at Fawn Pass or Bighorn Pass—see Figure 2), making direct access to this source from the Malin Creek site fairly difficult, or a much longer trip would be made following the Madison River drainage west and then north (see Figure 2). The Bear Gulch source also requires travel across the Gallatin mountain range, and into the Centennial Mountains to access the source locality. Travel from either of these source localities to the Malin Creek site would not be considered convenient by any standards—the easiest route (topographically speaking) would be the longest, along the Madison River drainage. We might hypothesize that these exceptions to the time-decay model is because obsidian from these distant sources was not collected directly, but rather exchanged within a local trade system between the North and South Study Areas and with groups to the west.

The Cougar Creek source would be the next closest source after Obsidian Cliff to the Malin Creek site (at approximately 59 km from the Malin Creek site), yet it is not represented in the North Study Area sample. This may be due to the inferior quality of Cougar Creek obsidian.

For the South Study Area, a similar pattern is discerned. Obsidian Cliff represents the highest percentage of obsidian (at 62%) in the sample. This source locality is approximately 77 km from the Osprey Beach site (following the proposed travel route—see Figure 2). Obsidian Cliff is not the closest source represented in this sample.

A southern locality of the Conant Creek source is approximately 45 km distant as the crow flies yet represents only two percent of the total sample. Although not represented in Figure 2 as a proposed route, travel as the crow flies from Osprey Beach to the Conant Creek source is possible without much topographical impediment. This source should therefore be considered the closest and most efficiently accessed source from Osprey Beach. Yet it is not represented in the sample to the degree expected by time-decay models.

The Teton Pass/Crescent H source locality is 129 km from the Osprey Beach site (see Figure 2) and is the second most popular source represented in this sample. Interestingly, the Bear Gulch source follows with nine percent of the total despite being the furthest away of all sources represented. The Bear Gulch source locality is approximately 120 km as the crow flies, and 307 km (or over 600 km round trip) following proposed travel routes from the Osprey Beach site (see Figure 2). Again, access to this source area as the crow flies requires crossing difficult terrain and mountain ranges. If we reject the idea of a large annual round which would take people out to this source during the course of regular annual travel, direct procurement of Bear Gulch obsidian from the South study area is eliminated as a possibility. To account for its apparent popularity, trade must be considered in future studies.

The occurrence of trade must also be acknowledged as a possibility when considering the proposal of separate northern and southern oriented annual movement. There is evidence during specific time periods for extensive trade (and perhaps the maintenance of elaborate trade networks) of obsidian from Yellowstone’s Obsidian Cliff to places as far away as the Ohio River valley. The appearance of Obsidian Cliff obsidian in Hopewelian burial mounds and other archaeological contexts begins approximately 2950 BP, and lasts until ca. 1550 BP (during the Pelican Lake phase in Yellowstone) (Davis et al. 1995:45).

It is known that during the Pelican Lake phase Obsidian Cliff obsidian was traded to the east, and this would fit the new localized model if there was a significant presence of this material during this phase in both Study Areas. Interestingly, the number of projectile points in this sample sourced to Obsidian Cliff from the North Study Area was evenly distributed between the Middle and Late Archaic. In the South Study Area, however, there were twice as many Middle Archaic than there are Late Archaic points sourced to Obsidian Cliff. This result does not seem to support the hypothesis that trade of Obsidian Cliff obsidian to the Ohio River Valley during the Late Archaic might also mean an increase/beginning of more localized north/south trade within the GYE during this time period.
When examined by time period, the results show a fairly even exploitation of the Obsidian Cliff source during both the Middle and Late Archaic (see Figure 7). Mirroring the analysis by study area, the Obsidian Cliff source is well represented, which is a testament to its high quality. A significant change in source utilization is observed in the results when examined by time period, for both the Bear Gulch and Teton Pass sources. During the Middle Archaic, a wide variety of sources are represented in this sample, including 4% from Bear Gulch and 6% from Teton Pass. During the Late Archaic, the number of projectile points from these two sources increases significantly compared to other sources (to 11% and 13%, respectively) (see Figure 7). When broken down further (Figures 8 and 9), all of the projectile points sourced to Bear Gulch in the North Study Area were from the Late Archaic. In the South Study Area, an equal number of points from the Middle and Late Archaic were sourced to Bear Gulch. All of the projectile points in this sample sourced to Teton Pass were from the South Study Area, and there were twice as many Late Archaic points from the Teton Pass source as there were Middle Archaic.

While these results are interesting and give some hints to a pattern, they are not conclusive. Add to these results the fact that the single sample in the North Study Area from the Packsaddle Creek source (~160 kms to the south) is from the Late Archaic period, and the argument for local trade could be tentatively made. Obsidian from “southern” sources such as Packsaddle Creek may have appeared in the North Study Area as a result of local trade (as opposed to direct procurement) during the Late Archaic, which may in turn be related to increased trade of Obsidian Cliff obsidian during this time period.

**Travel Corridors**

These results demonstrate that there is a definite trend towards exploitation of more local obsidian resources. This can be taken further to suggest that by following naturally created and historically documented travel corridors, all the sources represented in each study area could be accessed within a more localized travel sphere. When examined by study area, sites on the Lake represent more variety in source selection; yet the variety is among the “southern-oriented” sources, which are almost completely absent from the specimens analyzed in the North Study Area.

The Thorofare is a modern-day hiking route and historically documented travel corridor which exits the park following the Yellowstone River to its headwaters south of Yellowstone Lake (see Figure 2). The Thorofare route remains one of the easiest ways to access the Lake from the Jackson Hole/Snake River valley area. It was described by William Jones during his expedition in 1873 to explore Northwestern Wyoming, as part of an “Indian Trail” which follows the Snake River from Jackson Hole where one fork bends “sharp around to the northeast, follows up Pacific and down Atlantic Creeks to the Yellowstone River, down which it follows...to the east of Yellowstone Lake” (Jones 1875:54). Clearly this route was known and used by the Shoshone-his guide on this trip was a “Sheep Eater” (possibly Togwotee, a famous medicine man and guide) (Nabokov and Loendorf 1999:289).

Movement along major waterways was practical for navigation and for providing relatively easy-going routes. The Thorofare was very likely used through pre-contact times as well, and archaeological evidence along this route is limited only due to the lack of inventory and survey work performed in this most remote corner of the Park. This travel corridor would provide a practical route between Yellowstone Lake and the Jackson Hole area (and camps such as the Lawrence site in Grand Teton National Park) and access to the obsidian sources nearby (see Figure 2).

In the North Study Area the only artifact that was from a “southern source” is a point from the Malin Creek site sourced to Packsaddle Creek (approximately 160 km away as the crow flies). Besides this single sample, the remainder of artifacts in the North Study Area were sourced to “northern-oriented” sources. In the North Study Area one route giving access to sources to the west (such as Bear Gulch) is over Fawn Pass in the Gallatin Mountain range. The pass area shows archaeological evidence for the presence of people in this alpine environment during the Archaic (and earlier) (Vivian and Mitchell 2005). Preliminary analysis of the Fawn Pass area and the Madison River valley to the south indicates that these may have been well used pre-contact period travel corridors, providing access between the North
Study Area (and occupants of the Malin Creek site, for example) and obsidian sources to the west (see Figure 2).

It may be that there is less of a “round” and more of a regular movement of groups through the landscape back and forth within a known landscape. Hunted animals such as elk, deer, antelope and smaller mammals would have been available much more locally in both study areas. There seems to be little practical reason for groups to make such an arduous and lengthy round every year when food, shelter at lower elevations, and good tool stone were available within a much smaller area. The significant percentage of Obsidian Cliff obsidian in the South Study Area could be explained as the result of focused, task specific trips made by a group to obtain this material. These trips would have been made due to the quality and potentially the cultural significance associated with the source. Occasional trade with northern-oriented groups might also be a possibility, but the distance to this source and its potential cultural significance supports the idea of direct procurement.

**Subsistence Strategies and Movement Patterns**

A brief discussion of subsistence strategies must be brought into the discussion at this point, to better understand arguments for alternative seasonal or annual movement patterns. Johnson et al. (2004:187) suggested that from Cody times onwards, a pattern of “seasonal subsistence variation” is in evidence. This comment reflects on the diversity of game and other resources on the Yellowstone Plateau. A diverse subsistence strategy employed by pre-contact people in the area included the hunting of elk, bighorn sheep, bison and smaller mammals, fishing (from about 3000-1250 BP), and the seasonal harvest of berries, roots and nuts. A more diverse strategy typically means that there is less need to travel great distances in search of resources.

Winter occupation and year round use has not been established archaeologically in Yellowstone. This is the primary reason why annual rounds proposed for the area include an exiting of the high altitude plateaus and mountain areas of the park and movement to the lower elevation valleys to the south and west. The area around Jackson Hole in Grand Teton National Park shows evidence of year round use as early as the Early Archaic (Connor 1993:10). Indeed, Conner (1995:38), suggests a more localized “Teton Pass-Snake River pattern” of settlement for the people using the Jenny Lake and String Lake sites near Jackson Hole as an alternative hypothesis to the large annual round pattern (the “Northern Teton-Centennial Range pattern” described above) proposed for other sites in the Jackson Hole valley. This localized pattern included “people wintering in southern Idaho, in or near the Snake River plain, and moving into Jackson Hole via one of the southern Teton routes...[which] allowed people an opportunity to retool at the Teton Pass obsidian quarries, then move north into the valley and exit in the north Teton or at the south end of the valley” (Connor 1995:38).

The Myers-Hindman site, down the Yellowstone River valley north of the North Study Area, is interpreted as representing a fall/winter occupation (Lahren 1976, 2005). These two sites are examples of how the movement of people with the seasons could be more localized than once thought, without challenging the lack of evidence for winter occupation in Yellowstone proper, and maintaining a “mountain-foothills” (see Frison 1991, 1992) diversified economy model.

Modern observations by wildlife managers in the Park confirm that the movement of game animals (such as elk, deer and bison) in the Northern Range is relatively “local” as well. In fact, the winter ranges for these animals in the north end of the Park correspond with the proposed travel route north along the Yellowstone River. The Myers-Hindman site (with evidence of winter occupation during the Archaic) is only 90 km away from the Malin Creek site following the excellent travel and game corridor provided by the Yellowstone River valley (see Figure 2).

Other confirmed winter ranges for bison are within the central plateau of Yellowstone and near the northern boundary of the Park along the Yellowstone and Lamar rivers directly in the North Study Area (Gates et al. 2005:84). Assuming that people followed game in the colder months, forays out to the Bear Gulch source would not be part of the annual round as game was available much closer. It is true that during the historical period, when bison numbers were dwindling and traditional local hunting grounds were not productive, groups moved eastward from Idaho, crossing the modern-day Montana Idaho border in search of better hunting grounds. In this case, however, extreme stress on the resource forced people to travel greater distances.
and cross mountain ranges in search of food. When considering terrain, distance, and local availability of resources, pre-contact trade with a group that had Bear Gulch as part of their “home range” emerges as a possible scenario for both the North and South Study Areas.

**Future Directions of Study**

Although a purely cultural preference “factor” has not been seen in these results, consideration of the landscape approach to obsidian use in Yellowstone is still useful when interpreting the movement of people through time and space. Further inquiry into the proposed travel routes is essential. Patterns of wildlife migration, historically used travel corridors, and archaeological evidence along proposed travel routes must be examined in more depth in conjunction with obsidian source locations. These considerations emerged as key elements of interpretation during the development of this research and they demand further attention, but were beyond the scope of this study.

While this paper limited analysis to projectile points in order to control for time period, by focusing on excavated sites with good stratigraphic integrity this control can still be maintained and all obsidian artifacts can be considered. This type of “whole assemblage” analysis should be the next step in the study of obsidian use patterns in Yellowstone. Indeed, recent work performed by MacDonald and Livers (2010) has found that obsidian recovered in situ at the Fishing Bridge Point site (48YE381), along the north shore of Yellowstone Lake, predominately comes from Obsidian Cliff (95%); but interestingly, also from the Cashman dacite quarry (the only other obsidian source represented) some 150 kms north of the northern lakeshore (MacDonald et al. 2011:1). This source was not represented in the results for the sites around Yellowstone Lake in this study, and indicates a slightly different use pattern may be in effect for the northern lakeshore than the southern lakeshore. These results came from analysis of obsidian found within an Early Archaic occupation layer. This may indicate a new temporal variable in obsidian selection patterns as well, as MacDonald et al. (2011:2) suggest that these data may represent a shift to “a constricted, tethered mobility pattern in the Early Archaic” in the Yellowstone Lake area. Future research is expected to shed further light on the topic following fieldwork along the south, southeast and southwest shorelines of Yellowstone Lake in 2011 and 2012.

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CHAPTER 10
ICE PATCH ARCHAEOLOGY IN YELLOWSTONE’S NORTHERN RANGES

Craig M. Lee

Three areas of perennial snow and ice within the northern portion of Yellowstone National Park were surveyed in late August 2008 for archaeological and paleobiological materials. Conditions were less than optimal following unusually heavy late-spring snowfalls that completely obscurred all areas of permanent ice, including the normally exposed forefield—the area downslope of the ice patches—where organic artifacts might be encountered. The characteristics of two of these ice patches are consistent with other ice patches within the Greater Yellowstone Ecosystem (GYE) where Native American artifacts have been recovered. Inclusive of the 2010 field season, at least seven prehistoric sites associated with melting “ice patches” have been identified within the GYE. Archaeological discoveries at ice patches in the GYE include sites with organic and chipped stone artifacts as well as sites with butchered animal remains exposed by melting ice. At present, within Yellowstone, the only archaeological materials recovered in association with an ice patch consist of chipped stone artifacts. The same ice patch yielded a ca. 640-year-old paleobiological sample, indicating that this ice patch may contain ancient ice that could hold archaeological materials, including organic artifacts.

As the earth’s climate warms, archaeological and paleobiological materials are being discovered in association with destabilized and melting perennial snow and ice resources around the world (e.g., Dixon et al. 2005; Farnell et al. 2004; Finstad 2007; Hare et al. 2004; Lee et al. 2006; Müller et al. 2003). Although artifacts are occasionally found on glaciers (i.e., moving ice), they are primarily recovered at smaller, perennial snow and ice features, or “ice patches,” that persist in many mountainous regions as a result of seasonal accumulations of windblown snow.

In ancient and modern times, ice patches have been a refuge for animals seeking relief from biting insects and summer temperatures, as well as an opportune place to slake their thirst and find fresh, well-watered forage. Copious quantities of dung, such as those documented in the Yukon and Northwest Territories as well as in Alaska, attest to the regular presence of game animals in these locations (Andrews et al. 2009; Hare et al. 2011). The regular presence of prey animals in these locations was not lost on ancient hunters, and, depending on the time of year (almost certainly mid-to-late summer) and snow conditions, the humans who visited these locations to pursue animals and other resources occasionally lost their equipment, some of which became entombed within a veritable subnivean freezer.

In contrast to glaciers, ice patches exhibit little or no evidence of internal deformation and/or movement. This stable ice retards decay and can keep otherwise perishable materials frozen in suspension in virtually unaltered states for millennia. Archaeological materials in these locations are at risk because global warming destabilizes their previously protective coverings of snow and ice. Once released from their depositional environment, arrested taphonomic processes resume and organic components begin to decompose. The recovery of the exposed material is of interest to Native Americans and archaeologists alike, as evidenced by the collaborative projects occurring in Alaska (Dixon et al. 2005), the Northwest and Yukon Territories (Andrews et al. 2009; Hare et al. 2011), and in Glacier National Park (Kelly and Lee 2010; Lee et al. 2011).

Ongoing archaeological surveys in the Rocky Mountains of Montana and Wyoming are producing spectacular evidence of the archaeological and paleobiological potential of low latitude ice patches. Discoveries include organic archaeological materials such as ancient wooden atlatl darts and foreshafts made of saplings, other wooden artifacts of unknown function, butchered animal remains, and chipped stone artifacts. Perishable artifacts other than unmodified bone rarely occur at prehistoric sites in this region. Ice patches provide an important context for recovery of this nearly invisible element of hunter–gatherer technology.

Because freezing retards the decay of organic material, in some instances, these features have preserved otherwise perishable hunting gear and
associated equipment in the context in which it functioned for millennia (Lee 2010, 2011; Lee et al. 2010). One of the most remarkable and oldest artifacts recovered from GYE ice patches in recent years is a complete wooden dart foreshaft made from a birch
(Betula sp.) sapling trimmed of its branches (Figure 1). The artifact was AMS $^{14}$C dated to 9230 ± 25 BP, calibrated age 10,281–10,497 BP ($p = 1.0$), and is contemporaneous with the late Paleoindian Cody complex (ca. 9200–8400 $^{14}$C BP or 11,220–9445 cal BP) (Lee 2010). Locally, this time period coincides with the Alder complex (Davis et al. 1989).

Two groups of three evenly spaced lines on opposing sides of the artifact are inferred to be ownership or property marks (Lee 2010). Ethnographic observations indicate ownership marks occur on hunting weapons designed to remain in the bodies of large game; they typically consist of simple lines and can be specific to either an individual or community (Boas 1899). Five parallel oblique marks on a much younger artifact dating to ca. 7000 cal BP suggest long-term continuity in the regions in marking tools in this way (Lee 2011). The ability to differentiate weapons based on distinctive marks suggests other elements of these artifacts (e.g., projectile points) were not indicative of or distinctive to the person using the weapon, and lends credence to the hypothesis that particularly skilled individuals within a band or group may have crafted many of the technically demanding points during the Paleoindian time period (Lee 2010a).

Identification of Permanent Snow and Ice in the Greater Yellowstone Ecosystem
The long-term trend toward melting subpolar mountain glaciers (Dyurgerov 2001, 2002; Dyurgerov and Meier 2000, 2005) is also affecting glaciers and ice patches in the Greater Yellowstone Region (Figure 2). The United States Forest Service’s Beartooth Climate Change Project (BCCP) has identified specific years (e.g., 1987 and 1994) when significant melting occurred on ice patches in the Custer, Gallatin, and Shoshone national forests (Lee et al. 2009; Seifert et al. 2009).

Figure 1. Dart foreshaft. Clockwise from large image: A) the complete foreshaft; B) detail of the hafting element at the tip (the probable ownership marks are visible near the bottom of the image); C) detail of animal damage (probably a trampling fracture that occurred when the artifact was saturated and partially buried in slush); D) detail of the base portion of the foreshaft. Scale in centimeters. Photographs: Tara L. Hornung. (Duplicated from Lee 2010a).

In contrast to the higher elevation plateaus on the Custer and Shoshone national forests to the northeast of Yellowstone National Park (hereafter referred to as the Park), there are relatively few areas in the Park that
retain snow and ice year round. Three areas with potentially permanent ice in the northern half of the Park were selected for paleobiological and cultural resource inventory in 2008 (Lee 2009). Unfortunately, the preceding winter was atypical with regard to the previous decade in terms of snowfall, and, as a result, the target ice patches and surrounding areas remained completely covered by snow from the previous winter. This late-lying snow severely hampered the survey, forcing the crews to look for preserved organics well away from the core area of preservative ice.

The techniques used to identify permanent ice patches in Yellowstone National Park (Lee 2009) were adapted from those used to find similar features on the nearby Custer, Gallatin, and Shoshone National Forests (Lee 2007a, 2007b, 2007c, 2008a, 2008b). Critical factors affecting ice patch use include proximity to mountain passes and archaeological sites; relative ease of access; relative isolation of ice patches from one another, which appears to focus activity toward a specific location; and proximity to lower elevation, ice patch–free country.

The ice patch identification process involved using virtual globes (VG) and other sources of publicly available satellite and aerial imagery to scan the northern portion of the Park for areas where snow and ice were still present in the late summer/early fall before new seasonal snowfall began (Lee 2009). VGs can easily manipulate complex geospatial data in three dimensions to maximize topographic relief and to focus on the northeast-facing exposures where ice patches exist. In particular, Google Earth version 5.0 (and higher) contains a “time slider” that can allow for the comparison of images from multiple years.

**Survey Areas**

Each of the survey areas within the Park is discussed in detail below. The report concludes with a discussion of the importance of this project relative to work being conducted elsewhere in the Greater Yellowstone Region.

**Parker Peak.** Parker Peak lies in the Absaroka Mountain Range in the eastern part of the Park. It was named by Park Superintendent P. W. Norris in 1880 for William H. Parker, one of the men who accompanied him on a survey of the area (Whittlesey 1988). Targeted survey occurred at an area of permanent ice on the northeast slope of the Peak. Analysis of aerial photography and satellite imagery indicated this was one of only two areas of permanent snow/ice in this part of the Park. The other ice patch lies on Hoodoo Peak on the Shoshone National Forest (Figure 3). When the location was surveyed in 2008, there were approximately one hundred ephemeral snow patches present within the immediate viewshed, a circa 4-square-mile basin (Figure 4).

Areas of late season snow, including the remnants of a large cornice, were also visible on Parker Peak. Seasonal snow covering the ice patch extended well beyond the feature’s normal footprint, completely obscuring any ancient ice that might be present. We surveyed the toe and margin of the ice patch, as well as the run-off channels, in the hope of finding archaeological material transported away from the area of core ice. Unfortunately, no artifacts were observed.
In addition to surveying the margins of the ice patch, we surveyed the area on top of Parker Peak to look for any prehistoric features that might be associated with the ice patch. No definitively prehistoric features were located; however, we relocated a modern cairn known to Dr. Ann Johnson, park archaeologist (retired), and Mike Ross, park ranger, as well as a rock alignment forming a stylized arrow that appears to point toward campground 3M6.

Due to the unusually heavy amount of snow cover present in 2008, the archaeological significance of the Parker Peak ice patch remained unclear. Not surprisingly, given the conditions, no archaeological material was observed in direct association with the ice patch. In spite of a lack of readily apparent evidence, the location retains characteristics that suggest it has the potential to be archaeologically significant. Specifically, the Parker Peak ice patch: 1) can be easily accessed from several approaches; 2) exists in relative isolation, which suggests that any animal activity prone to occur on these features would be concentrated here; and 3) exists in relatively low elevation, ice patch–free country, making it more accessible to humans. Under normal conditions, by late summer this is one of only two ice patches in this region of the Park (Figure 3), making the Parker Peak ice patch unique. Given its relative isolation, it is highly probable that prehistoric people living in the Park were well aware of the existence of these features. The ice patch is located within 0.25 km (0.15 miles) of a meltwater lake and fen fed by the ice patch. The area around the lake has evidence of prehistoric and historic use relating to general camp and provisioning activities at 48YE506.

Quadrant Mountain. Quadrant Mountain is in the Gallatin Mountain Range. It was named by topographer Henry Gannet in 1878 during the third Hayden survey because its slightly curved surface resembles a segment of the surface of a sphere or globe (Whittlesey 1988:127). The primary survey target was a permanent ice patch southwest of “The Pocket,” and a secondary target, one of five small ice
patches on the east flank of Quadrant Mountain, was
surveyed en route to this location (Figure 5).

Figure 5. Aerial view of Quadrant Mountain indicating
the primary and secondary target ice patches that were
surveyed. (Image adapted from Flash Earth).

The secondary target ice patch on the east flank of
Quadrant Mountain was entirely covered with extensive
snow from the preceding winter. The melting edge of the
snow was covering meadow grasses, suggesting that any
old ice was significantly buried. None of the vegetation-
free forefield area, where materials exposed during
previous years might be expected, was exposed. Despite
these disappointing observations, the run-off channels
and the entire downslope margin of the existing snow
pack were surveyed for the presence of archaeological
material. None was observed.

Tracks and scat on the snow surface of the secondary
target ice patch revealed that a bear and an elk had
visited the location. Although not surprising given the
location of this ice patch near a trail to the top of the
mountain, this is the first recorded incidence of a bear
visiting one of these features in the Greater Yellowstone
Area. Skeletal remains of bison, bighorn sheep, and mule
deer have been recovered in association with mid-
latitude ice patches elsewhere in the Rocky Mountains
and in the GYE (Lee 2011; Lee et al. 2006).

The primary target ice patch on top of Quadrant
Mountain was also overgrown with recent snow (Figure
6). In aerial extent, the snow covering the ice patch was
nearly triple what could be expected in a high melt year.
As before, the survey party walked the margin of the
extant snow in the hope of indentifying associated
archaeological material, especially preserved organics, which may
have been carried away from the vegetation-free zone via either
running water or strong winds.

No organic artifacts were encountered; however, we
collected one piece of non-
anthropogenic wood. The wood
was identified as spruce (*Picea* sp.)
and assigned catalog number
148655 under accession YELL-2522.
A sample submitted for AMS $^{14}$C
dating to the INSTAAR Laboratory for Radiocarbon
Preparation and Research (NSRL) returned a date of 640
± 15 radiocarbon years BP (CURL-10167; wood; $\delta^{13}$C = -
22.8‰). At 2$\sigma$ this date has two possible calibrated age
ranges with > 0.05 relative area under the probability
distribution: 560–598 cal BP ($p = 0.60$) and 632–661 cal
BP ($p = 0.40$) (Stuiver et al. 2009).

Figure 6. Overview of eastern end of primary target ice
patch on Quadrant Mountain looking west at the
suspected area of core ice (not visible due to remaining
snowfall). (Photo: YELL-2522-33).
The presence of ca. 600-year-old wood at this location indicates that under certain conditions the area around the ice patch can be colonized by woody vegetation. Such conditions may have existed during the Medieval Warm Period (ca. A.D. 1100 to 1400) (Mann et al. 1999) prior to the cooling events of the Little Ice Age (LIA) (ca. A.D. 1600 to 1850) (Grove 1988). At present, no trees grow in the vicinity of the ice patch. Extinct tree stands have been found in association with ice patches elsewhere in the Greater Yellowstone Region. The wood associated with these locations is not always characterized by distorted varieties typical of the upreaches of tree line but instead frequently consists of full-sized trees with substantial trunks. Two such tree bases were found rooted in growth position in sediment underlying the melting edge of an ice patch on Grass Mountain in the Absaroka-Beartooth Mountains of Montana (Carrara 2011; Lee 2007a, 2007b); the trees were found well above modern tree line and radiocarbon dated in excess of cal. 8 ka BP. The remains of mature trees predating the LIA are also present above tree line on Mount Washburn in the Park (Ann Johnson, personal communication 2009). The presence of preserved wood in association with these features has also been noted in Colorado (Benedict et al. 2008).

Archaeological Site 48YE1537. The 2008 reconnaissance of the Quadrant Mountain ice patch resulted in the rediscovery of archaeological site 48YE1537. Artifacts were observed within 25 m of the downslope edge of the ice patch. Site 48YE1537 was originally recorded by Lifeways of Canada Limited during a Class II survey of the eastern edge of the Gallatin Mountain Range in Yellowstone National Park (Vivian and Mitchell 2005). The site was described as a diffuse lithic scatter consisting of ca. 20 tertiary flakes of obsidian and one complete obsidian projectile point within a roughly 20 x 20 m area on an open knoll southeast of a small meltwater lake.

The projectile point (YELL Catalogue # 68625) noted in the original site description is consistent with Pelican Lake corner-notched projectile points found elsewhere in the Park (Vivian and Mitchell 2005:Plate A-1E). The presence of this temporally diagnostic artifact suggests the site has a component that dates to the Lamar Valley subphase, ca. 3000 to 1600 BP (Vivian and Mitchell 2005:Figure 56). The Lamar Valley subphase is approximately one hundred and fifty years shorter than Frison’s (1991:101–103) date range for Pelican Lake. Pelican Lake projectile points are relatively large, corner-notched projectile points that were probably used with atl atl technology (Wetlaufer 1955).

During the reconnaissance of the ice patch forefield, we located additional flake concentrations in a dry run-off channel immediately east of the knoll described by Vivian and Mitchell (2005:53) and along the western margin of an active run-off channel further to the east. The active run-off channel originates below the area of core ice. Several USGS aerial photos suggest that even in extreme melt years the core ice in this location provides a continuous source of water for the lake.

Six obsidian artifacts representing the range of macroscopic variation observed at the site were collected for trace element analysis. In some situations macroscopic variation has been shown to be an effective means of differentiating obsidian from distinct sources (e.g., Lee 2001; Levine et al. 2007). All six artifacts were submitted to Dr. Richard Hughes’ Geochemical Research Laboratory for trace element analysis. Energy dispersive x-ray fluorescence revealed all six were consistent with Obsidian Cliff volcanic glass from Yellowstone National Park (Hughes 2008). The projectile point collected by Vivian and Mitchell (2005:53) was also made of material from Obsidian Cliff. At less than 10 miles from the site, Obsidian Cliff was an obvious source of raw material for prehistoric groups living in the Greater Yellowstone Region (Davis 1988). The six obsidian artifacts collected by the current project were assigned catalog numbers 148649 through 148654 in the Yellowstone National Park curation system under accession YELL-2522. The collected artifacts include a projectile point and a scraper/spokeshave (Figure 7).

The projectile point (catalog number 148651) is corner-notched and made on a flake through minimal marginal retouch. Though simple in outline, it is generally consistent in morphology with other Pelican Lake projectile points from the Park depicted in Vivian and Mitchell (2005) and MacDonald and Maas (this volume). The projectile point was probably sufficient for use in hunting. The scraper/spokeshave (catalog number 148653) is a heavily utilized flake with marginal retouch, suggesting it saw use in a variety of scraping activities. One edge of the artifact has been used as a spokeshave.
The primary target ice patch on top of Quadrant Mountain is potentially very significant. It bears notable similarities to other ice patches where archaeological discoveries have been made (Lee 2011). The ice patch meets all of the critical criteria identified at the beginning of the report, including: 1) relative ease of access; 2) relative isolation from other ice patches; and 3) proximity to lower elevation, ice patch–free country. In addition, its proximity to the meadow-covered top of the mountain and excellent game habitat and its broad flat surface, which is conducive to congregating and resting animals, also suggest this ice patch holds exceptional potential (Meagher, personal communication 2008).

Figure 7. Two obsidian artifacts from 48YE1537. Collected from meltwater run-off channels: A) corner-notched projectile point (catalog number 148651); B) scraper/spokeshawe (catalog number 148653). (Photo: Craig Lee).

The presence of archaeological site 48YE1537, a lithic scatter consisting of at least fifty pieces of lithic debitage with two temporally diagnostic projectile points and flake tools, at this location is not coincidental. The projectile point in the run-off channel below the ice patch might indicate that a formal tool (e.g., a dart) was lost in the snow during a hunting episode at the ice patch, and that sometime during the intervening 3,000 to 1,600 years since it was lost (based on typology) the dart melted out and became permanently exposed and transported away from the patch by fluvial action. Although the amount of exposure necessary to destroy the organic components is unknown, it would surely be measured in decades if not single years. The debitage at 48YE1537 might represent the remains of butchery activities associated with game taken on the ice patch.

The presence of a substantial lithic scatter with diagnostic artifacts in association with an ice patch in an area of good game habitat suggests that this location holds potential to shed light on an important part of the Park’s prehistory. The ice patch is within the Gallatin Bear Management Area and consequently any archaeological materials that might melt out are afforded some protection from inadvertent collection by Park visitors. If organic artifacts have been previously exposed at this location and are now lying exposed on the ground surface, albeit covered by fresh snow, this is additional cause for concern. Research in Colorado has shown that because temperatures rarely drop below freezing beneath high-altitude snowbanks, organic matter is subject to decomposition for much of the year (Holtmeier 2003:81). Thus, artifacts will disintegrate after they melt free of protective ice, even when reburied by subsequent snowfalls.

Electric Peak. Electric Peak is in the Gallatin Mountain Range. It was named during the 1872 Hayden survey following a mid-summer incident during which the atmosphere around the peak became sufficiently charged as to raise the hair on the heads of a survey party (Whittlesey 1988:51). An area of permanent ice in the north-facing, scree-filled cirque of Electric Peak was targeted for survey (Figure 8).

Aerial photography indicated the presence of a permanent ice patch to the west of a small drainage in the cirque. Although this area did not meet all of the criteria typical of archaeologically productive ice patches (specifically, ease of access), the inclusion of this area provided nearly complete coverage of the perennial snow and ice resources in the northern part of the Park. Available imagery also hinted at the presence of a few ice patches in couloirs on the east side of the peak. The ice in these features is probably ephemeral since the ice patches likely experience significant melting at their bases as a result of meltwater and other precipitation flowing down the drainages from above. Because there was little chance of the couloirs containing material of interest and because there is no safe approach to the area, they were not surveyed.
Prior to radiocarbon dating, the wood samples were examined by Jeff Lukas at the University of Colorado’s INSTAAR Dendrochronology Laboratory (Lukas 2008). A brief description of the samples is provided below. Two fragments of highly weathered wood were recovered from Locality 1, approximately twenty meters downslope of the melting snow at the largest ice patch in the cirque (Figure 9). The fragments are circa 23 cm (YELL-189701a) and 32 cm (YELL-189701b) long, respectively, and were resting on talus at the time of discovery. Although similar in appearance, the two fragments do not refit. The wood was identified as pine (Pinus sp.).

As was the case on Parker Peak and Quadrant Mountain, the Electric Peak ice patch was covered in significantly more snow than aerial images suggest occurs in most years. In addition to the area of permanent ice, two areas comprised of annual snow were present during the 2008 survey. The survey party concentrated on the area where the permanent ice was present, but also walked the lateral margins of the other two ephemeral snow fields in the off chance that they were once permanent to ascertain if organic material might still be present. All of the snow and ice in the cirque appears to be resting on talus, and water could be heard running through the rocks near the edge of the snow-covered margin below the toe of the largest ice patch.

The survey resulted in the discovery of six pieces of wood of certain anthropogenic origin from four localities below the largest ice patch. No obvious modifications are present on the specimens, and their size and shape suggest they may be fragments of discarded walking sticks. Given their recovery well away from the core area of preservative ice, the specimens were interpreted to be of recent origin. The specimens were cataloged into the Park system under accession YELL-2522, catalog numbers 189701 through 189704.

Figure 8. Overview of three ice patches in the Electric Peak Cirque, facing south–southeast. In high melt years the only permanent ice exists under the right side of the large central ice patch in this image. This ice was the target of the survey, but all three were visited. (Photo: YELL-2522-40).

Figure 9. Two wood fragments in talus below the ice patch in the Electric Peak Cirque (Locality 1). Artifacts YELL-189701b (left side of photo) and YELL-189701a (right side of photo). (Photo: YELL-2522-43).

Locality 2 was a single piece of weathered wood (YELL-189702) resting on talus within one meter of the melting snow edge. Based on imagery available to the principal investigator, this locality is normally at least 15 m away from any permanent snow/ice by late August. The fragment is circa 18 cm in length and has been identified as pine (Pinus sp.) This piece of wood bears some similarity to the two fragments found at Locality 1 but is less weathered and does not refit with those two fragments. Given the locality’s proximity to the melting snow, its seasonal snow coverage reduces the amount of UV exposure and wet–dry cycles experienced by the associated wood fragment, resulting in better preservation.
A single piece (YELL-189703) of lightly weathered wood was found lying on the talus in Locality 3, which is approximately ten meters downslope of the melting snow edge. Measuring 69 cm long, this was the largest piece of wood recovered from the Electric Peak Cirque. It has been identified as spruce (Picea sp.) and represents a branch from a tree.

Locality 4 contained two fragments of wood lying approximately 15 meters apart. The fragments were 36 cm (YELL-189704a) and 51 cm (YELL-189704b) long, respectively. Although the fragments could not be perfectly refit, they appear to be from the same piece of wood. The fragments were identified as pine (Pinus sp.) and represent a branch from a tree.

Two of the six samples of wood were submitted to the INSTAAR NSRL for AMS $^{14}$C radiocarbon dating. The dated samples include one of the Locality 1 pine specimens (YELL-189701a) and a sample of the spruce specimen recovered from Locality 3 (YELL-189703). The pine sample returned a date of 175 ± 15 BP (CURL-10178) and the spruce sample dated to 160 ± 15 BP (CURL-10179). When calibrated, the radiocarbon ages have modern intercepts, suggesting they may be very recent.

The discovery of wood in the Electric Peak Cirque was unexpected and surprising because the characteristics of the ice patch do not bear obvious similarities to ice patches where prehistoric artifacts have been found elsewhere within the Greater Yellowstone Ecosystem, or elsewhere in North America. Specifically, the cirque has difficult access, and there are no obvious approaches that would allow for resting animals to be surprised. Given the talus floor of the cirque, there is little if any forage available to animals, further reducing the attractiveness of the ice patch.

Given the elevation and the complete absence of soil, the substantial pieces of wood recovered are undoubtedly manuports. The wood recovered in the Electric Peak Cirque is consistent with species that grow locally at lower altitudes. Morphological characteristics of the better-preserved wood fragments suggest they represent branches from relatively long-lived trees. Branches of this size can easily remain attached to the parent tree for decades after they die (Lukas, personal communication 2009). Consequently, there is nothing to suggest the wood fragments represent anything more than the discarded remains of walking sticks used by recent adventurers, especially in light of the popularity of the climb to Electric Peak. The sticks could have been left in the vicinity of the ice patch or possibly thrown into the cirque from the peak or ridge. Additional photos of the wood specimens are included in the project documentation on file in the Park archives.

Summary and Conclusions

Although extensive late-lying snow coverage hampered the project, and no organic artifacts of definitive antiquity were identified in direct association with the ice patches, the effort was not a loss. It resulted in the re-discovery and update of a known archaeological resource in association with an ice patch as well as ca. 640-year-old paleobotanical discovery. The field observations provide a baseline for the condition of these features in the late summer of 2008 and ranks the three locations in order of potential archaeological significance, with Quadrant Mountain and Parker Peak being the most likely to yield archaeological material.

Perishable artifacts rarely occur at prehistoric archaeological sites. Ice patches provide an important context for the recovery of this nearly invisible element of hunter-gatherer technology. As a result of their completeness and unique ecological area of recovery, they illuminate the systemic context in which the tools functioned. As such, they contribute new data and interpretative insights into hunter-gatherer subsistence and land use patterns in low latitude, high altitude environments. Ice patches hold the potential to stimulate scientific inquiry ranging from the technological analyses of artifacts to paleoclimatic reconstructions.

This research is important to multiple stakeholders, including: 1) archaeologists interested in material culture; 2) the general public as a tangible, local effect of global warming and as a storehouse of information about ancient peoples; 3) Native American groups whose cultural heritage is tied to these environments; 4) federal and state agencies with management responsibilities for these resources; and 5) scientists in allied disciplines who are interested in Earth climate systems. There is an urgent need to continue systematic research at these sites and to geographically and intellectually expand the scientific potential of ice patch archeology through survey, analysis, publication and public
education/outreach. Given the trend toward warmer global temperatures, the few permanent ice patches within the Park should be considered critically endangered.

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