FIRE ON THE MOUNTAIN: ROASTING PITS IN THE SHEEP RANGE ON DESERT NATIONAL WILDLIFE REFUGE

by

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DEDICATION

This thesis is dedicated to my mother and father who pushed me to find something that I love as a profession.

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ABSTRACT

Roasting pits are earth oven facilities commonly found scattered throughout southern Nevada. The term earth oven refers to the process or event of baking foods, often plants, in a cooking pit with hot rocks which is covered by an earthen cap. While roasting pits were used to bake a variety of food stuffs, desert succulents such as agave and yuccas were likely the most commonly cooked. Within the Sheep Range in southern Nevada, more than 200 roasting pits were identified and 193 were subsequently documented in the field. Due to the accumulation of discarded materials surrounding the central cooking pit (e.g., spent rocks, organic material, and sediment), along with the color change that occurs in limestone and dolomite after they have been heated, most documented roasting pits were identified via Google Earth.

Standard field methods were used to document roasting pits in the field. This included measuring the exterior and central depression dimensions, as well as the central cooking pit when visible. Photographs and descriptions were also taken, and small-scale surveys were conducted in the area surrounding each feature to identify associated artifacts. Key data was then entered into ArcMap 10.2 where additional analysis was conducted, including Nearest Neighbor and Hot-Spot analysis, as well as analysis with a vegetation coverage map for the Sheep Range.

Nearest Neighbor analysis determined that all recorded roasting pits within the Sheep Range are spatially related to each other. Hot-Spot analysis identified that roasting

pits with larger torus and exterior measurements were concentrated near the north-central portion of the Sheep Range. Torus size is interpreted as a general indicator of use, and this concentration is believed to represent the area of the Range that was most heavily used for plant baking.

Statistical analysis, including regression and Mann-Whitney U tests were also conducted on roasting pit measurements. Regression for all three roasting pit measurements, exterior, torus, and central depression, identified that exterior and torus measurements were larger at higher elevations than at lower elevations. Mann-Whitney U tests identified that roasting pits built in Creosote Brush communities had smaller torus and exterior measurements than those built vegetative zones at higher elevations, including Black Brush, Mixed Shrub and Pinyon-Juniper communities.

Experimental testing of rocks found in the Sheep Range determined that the local dolomite turns white when subjected to temperatures of 875° C and higher. Based on the experimental work I conducted, I reason that dolomite was used in earth oven baking as well as limestone in the Sheep Range.

This thesis represents the first extensive documentation of roasting pits within the Sheep Range. Further archaeological investigations are necessary for a greater understanding regarding the purpose, period, and intensity of use of roasting pits in the Sheep Range.

I. INTRODUCTION TO ROASTING PIT FEATURES IN THE SHEEP RANGE

Heated rocks have been used in earth oven facilities to bake food in North America for at least the past 10,000 years (Black and Thoms 2014). Remnants of these cooking features, known as roasting pits, are abundant throughout the Sheep Range in southern Nevada (Figure 1.1). A total of 232 roasting pit features were identified using Google Earth and 193 of them documented in the field. Ethnographic accounts indicate several Southern Paiute (or *Nuwuvi*) bands cooked foods, such as agave and yuccas, in roasting pits within the Sheep Range. This method of cooking was so common for the Chemehuevi, a Southern Paiute group, that one “could tell from great distances when people gathered mescal; could see fires on all mountains” (Kelly 1932-1934 in Fowler 1995:108).

For this thesis, my objective is to document and explain the nature and distribution of roasting pit features within the physiographic setting of the Sheep Range. I focus on roasting pit size variation according to elevation and vegetative zone with the use of statistical and Geographical Information Systems (GIS) analysis. Variation in roasting pit size based on the amount of thermally-altered rock suggests that features found at higher elevations were utilized more frequently, likely due to a greater presence of resources, such as edible plants and fuel, than present in lower elevations. Nearest Neighbor and Hot-Spot analysis conducted using GIS demonstrate roasting pits are clustered throughout the Sheep Range, as opposed to be evenly or randomly dispersed, and a concentration of larger features is located near the center of the Range. Mann-Whitney U tests found significant measurement differences between roasting pits in different vegetation communities. A chi-square goodness of fit statistical test suggests that a number of roasting pits likely went unidentified in Pinyon-Juniper communities due to the thick tree canopy. Results of my survey data are incorporated with

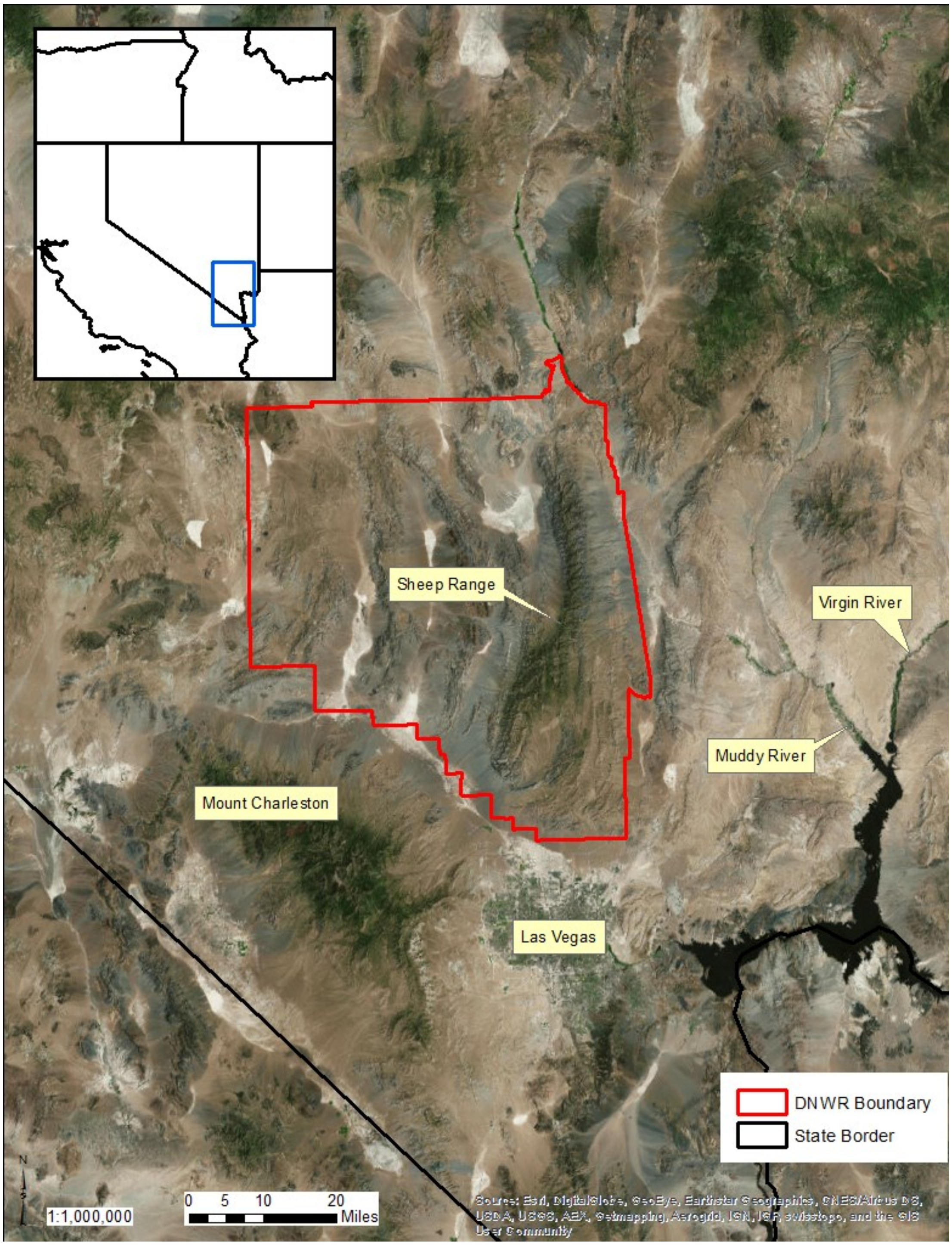


Figure 1.1. Satellite image of the Sheep Range within the Desert National Wildlife Refuge (red), where my research was conducted for this thesis.

ethnographic accounts to provide additional interpretations of activities associated near roasting pit locations. Since roasting pits are visible from Google Earth due to a color change that occurs in some of the roasting pit rocks when thermally-altered, experimental work was conducted to better understand this phenomenon. Experimental work indicates that dolomite was likely used in addition to limestone as a heating element within roasting pits and that both likely turned white as a result of intense heating.

As discussed by Black and Thoms (2014), cooking with the aid of hot rocks has been referred to as many things, including earth oven cooking, plant baking and pit roasting. Baking foods in this manner results in the accumulation of thermally-altered rock, also known as burned rock or fire-cracked rock (FCR). Massive concentrations of FCR provide the primary indication that earth oven cooking occurred, as the identification of the cooking pit itself it not always discernible. The archaeological remains of earth oven cooking are known by several terms, including earth oven facilities, burned rock middens and ring middens. Within southern Nevada, these features are most commonly referred to as either roasting pits or agave roasting pits. The term roasting pit refers to both the central earth oven pit, where foods may be baked for several days, as well as the associated, often surrounding torus of FCR. The aforementioned terms will be used interchangeably in this thesis. Regardless of the terminology, the use of hot rocks for thermal storage defines this method of cooking.

Cooking in this manner is based on the principle that transferring thermal energy to an object with a high thermal mass will allow heat to radiate for a prolonged periods of time (Black and Thoms 2014). The most common way to do this is by transferring heat from a fire into a mass of stone, such as limestone. This allows for longer baking periods while requiring less fuel when compared to a surface fire. Certain plants such as agave, referred to elsewhere as desert succulents (Black and Thoms 2014) or prebiotics (Leach 2005), are detoxified and rendered edible after prolonged baking. Geophytes, which are plants with underground tubers, roots or bulbs, such as camas, benefitted from this method of cooking as well. It is no coincidence that desert succulents are commonly found in environments in which earth ovens have been constructed, such as in the Sheep Range.

Beginning in January 2012, Google Earth was utilized to identify over 200 roasting pits within the Sheep Range, which is located on the Desert National Wildlife Refuge (DNWR) roughly 20 miles north of Las Vegas. These features are visible via aerial photography due to a reaction that occurs to the utilized limestone and dolomite after it has been exposed to heat. Both limestone and dolomite found within the Sheep Range go through a thermo-chemical transformation after prolonged exposure to heat and appear bleached white as a result. Roasting pit ring middens, though not entirely comprised of white thermally-altered limestone and dolomite, typically have enough to be identified from aerial imagery. On average, a roasting pit may be comprised of roughly 10-30% white thermally-altered rock, with the remaining being thermally-altered rock and some seemingly unburned rocks. This thermo-chemical transformation thermally degrades the rock and changes its color, which is subsequently discarded after use (Blair 1986). Over time, large middens consisting of spent materials form a raised, typically circular mound surrounding the central cooking pit. Midden size and the density of thermally-altered white limestone allow these features to be identified via aerial photography (Figure 1.2).

Figure 1.2. View of several roasting pits (circled) within the Sheep Range visible from 7500 ft. “eye elevation” in Google Earth.

There are several reasons why this method of cooking was an attractive option to prehistoric peoples utilizing the Sheep Range. The Sheep Range is a transitional zone both hydrologically and floristically between the Great Basin to the north and the Mojave Desert to the south. As mentioned, the inherent efficiency of cooking within an earth oven requires less fuel than cooking over an open flame, an understandably attractive aspect in an otherwise fuel-poor desert environment.

Secondly, desert succulents associated with the Mojave Desert, such as agave and various species of yucca, are present within the Sheep Range. In their natural state, these foods are composed of complex carbohydrates (inulin) and toxins (saponins) which render them indigestible and potentially hazardous to the human digestive system. However, by cooking desert succulents in roasting pits with the addition of moisture, a crucial component often supplied by adding green vegetation as packing material, they go through the process of hydrolysis. As defined by Wandsnider (1997:4), “hydrolysis is one process by which complex molecules are cleaved into smaller molecules through the uptake of a water molecule.” In essence, prolonged baking with moist heat transforms the long-chain complex carbohydrates which comprise most desert succulents into shorter-chain sugars which the human body can more easily absorb nutrients from.

The prevalence of roasting pits in the Sheep Range is not necessarily surprising considering a significant increase in earth oven use has been documented throughout Western North America dating between 4,000 – 2,000 years ago (Thoms 2009; Yu 2006). Roasting pits have been documented and excavated in various parts of southern Nevada, including the California Wash (Blair 1986) and Gold Butte areas (McGuire et al. 2013), as well as elsewhere (Blair et al. 2000; Brooks et al. 1975; Ellis et al. 1982, Louderback 2013). Most radiocarbon dates from roasting pits in southern Nevada date between the Terminal Archaic to the Post-Puebloan periods (Roberts and Ahlstrom 2012), while the oldest sample (3,800 B.P.) dates to the Late Archaic (Ellis et al. 1982). A summary of these excavations were recently included within a "prehistoric context" for the southern Nevada (Roberts and Ahlstrom 2012). However, the majority of roasting pit features within the Sheep Range were previously unrecorded and their use had not been addressed. Roasting pits were noted within the Sheep Mountain Range Archaeological District site form (26CK2610) as contributing evidence to Native American utilization of the area and the information herein should serve to bolster this evidence (Miller 1974). These features have the potential to provide important data on regional subsistence practices and the changes in subsistence strategies throughout prehistory.

The presence of roasting pits may suggest a focused subsistence strategy reflecting resource intensification and population packing during the primary period of their use. Binford (2001:188) defines intensification as "any practice(s) that increase food productivity per unit area." Plants such as agave and yuccas found within the Sheep Range are low in acquisition cost, immobile and readily accessible, though costly to process. The presence of earth ovens has been argued elsewhere as evidence of population packing based on resource and land use intensification (Thoms 2009; Yu 2006). Land use intensification is the increased procurement of previously underutilized, often low ranked resources, measured over a period of time. Primary reasoning behind this assertion is two-fold. On one hand, increasing the use of previously underutilized foods such as desert succulents into the annual diet opens up a greater amount of potential calories, resulting in more food to feed more people. On the other hand, it has been argued that the focused intensification of previously underutilized foods stemmed from necessity to feed an already expanding population. Regardless, the abundance and density of these features throughout the Sheep Range potentially signify resource intensification aimed at desert succulents.

I was unable to excavate any roasting pits within the Sheep Range due to U.S. Fish and Wildlife refuge policy. Collection of artifacts for analysis was also not permitted. While the lack of subsurface data prohibits certain types of analyses, the spatial data I have collected provides a robust dataset.

Though none of the roasting pits in the Sheep Range have been excavated, it is apparent after recording nearly 200 of them that they were typically utilized numerous times. Variability is apparent; documented features range from possible single-use events to features likely reused hundreds of times and they range from isolated individual roasting pits to clusters of up to 13 within a half-mile area. Ethnographic evidence suggests Southern Paiute groups returned annually to roast a variety of foods (Fowler 2013a and 2013b) and perhaps in large groups as part of a communal gathering (Blair 1986). While ethnographic accounts are helpful, not every aspect of cooking within a roasting pit is described. Fortunately, numerous ethnographic accounts exist regarding the use of this cooking technology by Native Americans elsewhere in the American Southwest. These additional ethnographic accounts concerning the use of earth ovens have been incorporated to provide additional context as to the importance these features may have served in the Sheep Range.

I have utilized Geographic Information Systems (GIS) to try and make sense of how roasting pits are distributed across the landscape. For instance, Nearest Neighbor analysis was conducted using ArcMap to determine the spatial relationship between roasting pits through the Sheep Range. Hot-Spot analysis was also utilized, to determine if roasting pits are significantly spatially clustered. A synthesis of numerous vegetation maps for the state was utilized in ArcMap to identify the vegetative communities where roasting pits were most commonly built. If the use of these features represented a significant amount of calories to the annual diet, several areas would have been exploited annually.

I was also interested in how the size of these features, which can be roughly correlated to intensity of use, relate to the aforementioned variables. Size in this case was determined by the dimensions of the associated burned rock midden of a given roasting pit, which were then separated into basic size categories. Effort was made to take the topographic setting into account since these features are often found extending into adjacent washes.

Various archaeological theories and models exist concerning earth oven use throughout North America. These concepts are discussed herein to provide a greater understanding as to the likely role, significance and implications the presence of roasting pits played for the Sheep Range. Theoretical models help us understand roasting pits in a larger context.

The format of this thesis is as follows. Chapter 2 provides an overview of earth oven technology and theory associated with their use. Chapter 3 presents background information for the study area, including environmental, geologic and prehistoric information, as well as an overview of previously conducted archaeological work within the Sheep Range. Chapter 4 offers an ethnographic overview of how these features were utilized by various Southern Paiute bands and other Native American groups from the American Southwest. Chapter 5 presents the results of an independent study concerning the testing of limestone and dolomite from the Sheep Range. Chapter 6 outlines the methods I employed, including how these features were initially identified via Google Earth, how field work was conducted and how GIS was used to analyze distribution. Chapter 7 presents the results obtained from this research, as well as various analyses I performed. Finally, Chapter 8 provides a concluding overview.

II. EARTH OVEN TECHNOLOGY AND THEORY

Throughout human existence, food has been an integral aspect of daily life, after all humans have a vested interest in eating. While some foods may be digested in their raw state, many foods are nutritionally enhanced by cooking. Inulin-rich plants, including desert succulents such as agave and yuccas, are not digestible by the human body in their raw state, but may be consumed after prolonged exposure to heat. Numerous health benefits have been shown to accompany a diet consisting of cooked foods as compared to a raw foods diet, including higher levels of energy, vitamin B12 levels and HDL cholesterol (also known as "good" cholesterol) (Wrangham 2009:26). Incorporating inulin-rich plants into the diet promotes positive microbial heath in our guts, in addition to "reduced gut infections, improved lipid metabolism, improved mineral absorption, enhanced immunomodulation, and a reduced risk of carcinogenesis" (Leach 2010:1). Prehistorically, inulin-rich plants were often cooked in earth ovens with the aid of heated rocks which served as thermal elements to prolong the duration of cooking.

Outside of southern Nevada, the method and subsequent remains of earth oven cooking with the aid of hot rocks has been referred to as many things including hot rock cooking, plant baking, pit roasting and earth oven cooking. Within southern Nevada, these features are referred to as roasting pits, which includes both the central cooking pit and associated surrounding midden (Figure 2.1). This method of cooking relies heavily on utilizing rocks to act as units of thermal storage. Heat from an initial fire is transferred into rocks which maintain and radiate heat over a greater period of time than a rock-less fire. Incorporating hot rocks within an earth oven allows foods to be cooked efficiently over a prolonged period of time. There are two important distinctions to consider when discussing earth oven cooking: the act of baking plants and the remnants thereof.

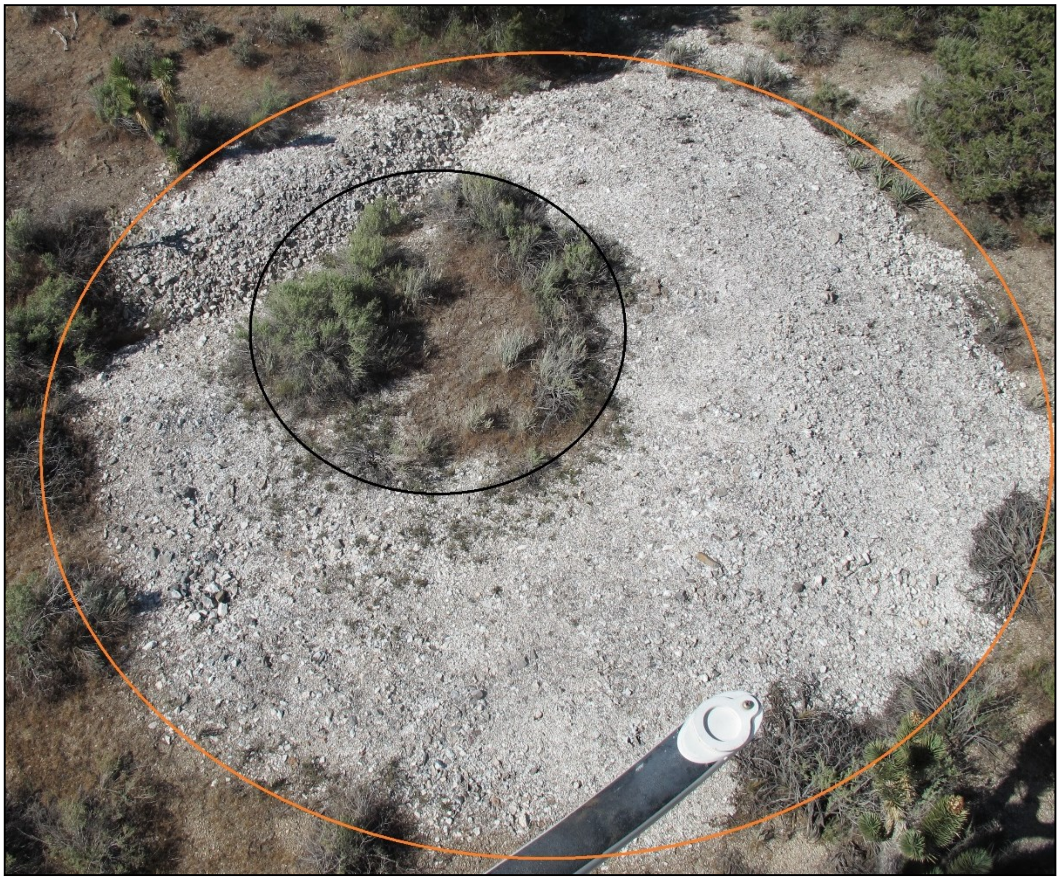


Figure 2.1. Overhead shot of a roasting pit (RP-152) with an exterior dimension of nearly 14 m. The black circle denotes the boundaries of the central depression which is partially obscured by vegetation. The outer limit of the midden (orange) is the exterior boundary. The white, thermally-altered rock within the orange circle but outside of the black circle is the torus.

The term earth oven refers to the process or event of baking foods, often plants, within a cooking pit which is covered by an earthen cap. A cooking pit is a basin shaped depression excavated into the ground. The purposeful arrangement of hot rocks used to bake plant foods in an earth oven is referred to as a heating element. Once heating element rocks are exhausted, i.e., become highly fractured by thermal cycling, they are discarded. Rarely are intact heating elements identified in situ. Rather, each midden associated with a cooking pit consists of discarded rocks from numerous earth oven episodes, as well as charcoal and carbon-stained sediment. Terms such as roasting pit and earth oven facility refer to both the central cooking pit in which foods were baked, as well as the associated discard midden formed through repeated use. These terms will be used interchangeably throughout this thesis to avoid redundancy. Regardless of the terminology used, the use of hot rocks for thermal storage underlies this method of cooking. Before discussing the presence of these features in southern Nevada, it is important to first put these roasting pits into greater context.

Overview of Cooked Stone Technology

Overall, utilizing rocks for cooking dates back to at least 10,500 years ago in North America and between 35,000-31,000 years in Europe (Black and Thoms 2014:206; Leach et. al 2006:3). A significant increase in the use of these features throughout western North America from 4,000-2,000 years ago has been noted (Thoms 2009, Yu 2006). An increased use of this technology has been attributed to land use intensification (Thoms 2008a:122), population packing leading to subsistence intensification (Leach et al. 2005:4; Thoms 2008a:123 in reference to Binford 2001), response to climatic changes (Thoms 2008b:444; Thoms 2009:586) and as a response to agricultural intensification (Thoms 2009:587). These attributions are not mutually exclusive and have been put forth as explanatory measures in various regions. Regardless of the underlying reasons, intensification typically resulted in the focused exploitation of previously underutilized resources, such as geophytes and desert succulents, that require long baking times to be rendered edible (Thoms 2003:87; Wandsnider 1997:8).

The general technique for earth oven cooking was recently described in Black and Thoms (2014) and characteristically entails the following steps. For a pit being prepared for the first time, a two to three meter circular, basin shaped hole was excavated and the material within removed. Next, fuel was placed within the pit with rocks either intermixed or placed atop. In some cases, pit ovens were lined with rocks prior to building the fire; ethnographic accounts and archaeological evidence for southern Nevada provide evidence that this occurred in the study region at least to some degree (Fowler 2012a:108). After the fire was reduced to coals and ash, the hot rocks were repositioned with a long pole to form a circular pattern centered on the bottom of the pit. With the heating element in position, green vegetation, typically grass or padded cactus such as prickly pear or beavertail, was placed directly on top of the hot rocks. Foodstuffs, such as agave or yucca, were then placed atop the packing material, followed by an additional layer of green vegetation and capped by a thick layer of sediment. The purpose of the green vegetation, also known as packing material, is twofold: to keep the food relatively clean and unburned, as well as to supply moisture. Moisture is essential for the process of hydrolysis to occur, which renders foods such as agave and yucca digestible for humans (Wandsnider 1997:4).

When a cooking pit was reused, remnants from the previous cooking event and debris that had since eroded into the pit would be removed prior to reconstructing a new oven. The large size of many of the roasting pits within the Sheep Range suggests they were used numerous times, likely over a considerable period of time. Radiocarbon dates from similarly-sized roasting features in the Las Vegas Valley suggest they were used over hundreds, or even thousands of years (Blair et al. 2000:243).

After cooking for roughly 48 hours, the earth oven was opened and the baked foodstuffs removed. Spent materials such as thermally-altered rock, charcoal, ash and carbon-stained sediment were removed from the pit and dispersed around the central cooking area while the food was set aside for additional processing (Black and Thoms 2014:210). With thermal cycling, earth oven rocks become degraded and progressively break down into smaller and smaller fragments with each use. Rocks used within earth ovens are thermally degraded and broken down from each use. Limestone and dolomite found within the Sheep Range go through a thermo-chemical transformation after prolonged exposure to high temperatures and appear bleached white as a result. This transformation also thermally degrades the rock (Blair 1986:37). Rocks that have been significantly thermally degraded, either by turning bleached white or by fragmentation (or both), lose their heat retention capabilities and are subsequently discarded. Over time, large middens consisting of spent materials form a ring-shaped mounded accumulation surrounding the central cooking pit. Midden size and the density of thermally-altered white limestone allow these features to be visible via aerial photography.

Mounded midden accumulations consisting of waste material vary in size reflecting the number of times they were reused, the size of the roasting event(s), the steepness of the slope on which the pits were constructed and/or the degree to which they have eroded. Roasting pits built on steep slopes are often relatively large in plan view, though not necessarily in mass, because gravity elongates the associated fire-cracked rock midden; however, their central depressions do not appear to be significantly larger than those of roasting pits built upon flat surfaces.

There are several benefits to cooking in a pit with the aid of hot rocks. One benefit is the reduced need for fuel, an understandably attractive aspect in fuel-poor environments. One study estimated that cooking agave bloom stalks over an open fire requires four times as much fuel than in an earth oven (Black and Thoms 2014:209). Pit roasting food requires less fuel due to basic thermodynamic concepts such as convection and thermal radiation as explained by Black and Thoms (2014:207-208). A burning fire heats the air around it, causing that air to expand and rise into the atmosphere. Escaping hot air is subsequently replaced with cool air thus creating a cycle known as convection. Heat is continually lost unless it is transferred to something in the immediate vicinity, which leads to thermal radiation. Infrared waves moving through the air will only release heat after hitting a surface that will absorb it. By confining the fire within a pit, infrared waves will make contact with the surrounding sediment and be absorbed. Dry, loose sediment acts as an effective insulator, and serves to help retain heat. Another way to reduce heat loss is to transfer the heat into something with a high thermal mass, such as a rock. Larger rocks are preferred over smaller rocks as the relatively smaller amount of surface area (with large rocks) results in reduced heat loss. By conserving fuel and heat, food packed within these features may be cooked for several days (Black and Thoms 2014:209). Limestone has been shown to excel at retaining heat for extended periods of time (Blair et al. 2000:183; see also Jackson 1998).

The ability to cook for an extended period of time allowed otherwise inedible foods to be incorporated into the diet. Foods most commonly associated with these features, such as geophytes (e.g., wild onion) and desert succulents, are rendered digestible by humans after an extended cooking period with the addition of moist heat.

Such foodstuffs contain a type of carbohydrate known as fructan inulin which resists digestion due to its complex chemical makeup (Leach 2007:18; Wandsnider 1997:5). Before the majority of nutrients from fructan inulin can be absorbed by the human intestinal tract, they must first go through a process called hydrolysis. As defined by Wandsnider (1997:4), "hydrolysis is one process by which complex molecules are cleaved into smaller molecules through the uptake of a water molecule." This process effectively breaks down complex molecules such as long-chain carbohydrates and turns them into simpler, short-chain sugar molecules that the human body can absorb. While hydrolysis occurs naturally in the human body, it does not occur quickly enough to break down these complex polymers for sufficient nutritional absorption. By initiating hydrolysis in a roasting pit, a greater amount of nutrients are rendered available after consumption (Black and Thoms 2014:209; Wandsnider 1997:4).

The Importance of Roasting Pits

A distinction may be made when discussing the importance of earth oven facilities. That is, these features were, and continue to be, important both to the native peoples who utilized them and to archaeologists interested in learning more about their significance to prehistory. For Native Americans in southern Nevada, roasting pits appear to have served as an integral aspect of annual life, both economically and socially. On the most basic level, roasting pits are facilities in which otherwise inedible foods can be transformed and incorporated into the diet. Agave and yuccas provide some of the first available foods in the early spring months extending into the summer. Once processed, these foods potentially could also be stored in dried form and consumed throughout the year. The ability to transform relatively easy-to-obtain foods found abundantly within the Sheep Range into edible items would have impacted the lifeways of those employing that technology in various ways. Not only were roasting pits important based on the caloric return they provided, they also served as significant cultural locations.

Roasting pits were not merely mundane locations in which desert succulents like agave and yuccas were baked into edible foods. Ethnographic accounts indicate cooking food within earth ovens sometimes served as an important social occasion, especially when agave was baked for the first time in spring. Around the beginning of spring, ripe agave rosettes send up a flower stalk from their center with the ecological intent of spreading seeds (procreation). It is also during the outset of this period that agave is nutritionally best to be picked and consumed, before the plant expends its sugar content to grow its central stalk (Hodgeson 2001:15). Burkholder (1995) describes these social events as Agave First-Fruit Rituals, where Southern Paiute groups would gather to communally roast agave, sing, dance and play games. Large amounts of agave were cooked during these events and feasted upon after being cooked for two days. Ethnographic accounts for the Southern Paiute within the southern Great Basin region concerning the religious importance of agave are scarce, but information from other Native American tribes is presented in Chapter 4 to provide a fuller understanding for these plants importance.

For archaeologists, earth ovens serve as a significant resource that often yields valuable information concerning the annual lives of the people who used them. Inferences about their use have been made based on their presence on the landscape and artifactual evidence recovered through excavation. High concentrations of earth oven facilities elsewhere in North America has been argued as an indicator of increased land use and resource intensification, which leads to an increase in population size (Thoms 2003:88). These terms and the implications therein are discussed further below.

Excavations of roasting pits in southern Nevada, as well as earth ovens throughout the world, have recovered identifiable and datable charred plant and animal remains, pollen, phytoliths and artifacts such as pottery sherds and projectile points. Even ash may be analyzed to determine the types of plants that were used to fuel the fire (Pierce et al. 1998). These data have the potential to inform us about the types of foods that were being cooked, when roasting events occurred and the identity of the cultural group(s) involved. It should be noted that burials have also been identified within earth ovens, such as the pre-teen found at 26CK1992 in southern Nevada (Ellis et al. 1982:20), though this cultural phenomena appears to be uncommon in the region.

Additional interest concerns the role earth ovens played to the people who used them, including how much they helped contribute to the group's annual caloric yield and how costly earth oven facilities are to construct. Several theories concerning these topics have been put forth in the archaeological literature.

One significant theory applied to the use of earth ovens is the concept of resource intensification. Simply put, resource intensification is the act of creating more food by increasing food production. Put more eloquently by Ames (2005:70):

> Intensification is the processes by which one or more elements of production (e.g., labor, land, technology, skill, knowledge, organization) are increased relative to other elements in order to maintain or increase food production (or the production of some other commodity).

There are various ways of measuring intensification, but the crucial points are the inherent benefits, effects and associated technology that often accompany intensification. Perhaps the biggest benefit is the most apparent: creating more food allows you to feed more people, thus allowing populations to grow. Arguments have been made concerning which came first, population growth or intensification. However, for the purposes of this thesis I am primarily concerned with the agreed upon outcome: more food allows you to feed more people.

When you begin to create an excess of food, it is beneficial if you can save it to minimize waste. It is no coincidence that one of the aspects often associated with intensification is the addition or presence of storage technology. Without storage, people must continually expend energy to obtain resources for consumption. With storage, food can be saved for the future, allowing people to expend more energy over a shorter period of time to create a greater amount of resources. By doing this, a surplus of food may be created.

The ability to rely even a fraction of your annual diet on a stored food source is beneficial. Throughout the American Southwest, pottery was a preferred method of storage and examples of sealed jars containing dried food such as agave have been recovered (Euler and Jones 1956:88). Ethnographic accounts for the Southern Paiute depict additional methods of storage, including hanging dried sheets of agave in caves or placing them in lined dug out holes covered with vegetation (Fowler 2012a). Cooking foods such as agave and yuccas in roasting pits can provide the means to which such a surplus could be achieved.

To create a surplus, a group must process more food than it immediately needs. Cooking desert succulents inside earth ovens provides an opportunity to create such a surplus. Earth ovens are costly to build, require gathering time for resources, rocks and fuel, and food may be laborious to process after it has cooked. To create a surplus of these foods, a considerable amount of labor would be expended on these tasks. However, a new earth oven facility would not necessarily have to be constructed prior to each roasting event. The energy expenditure would take the form of cleaning out debris from the previous cooking event as opposed to digging a brand new pit.

It is important to understand the benefits and disadvantages associated with intensifying earth oven use. Incorporating otherwise inedible foods into the annual diet is beneficial as it provides an additional means of sustaining a group. Depending on the type and density of plant foods available, ramping up the intensity in which foods are cooked in earth ovens would have provided a greater caloric return as compared to other available options. The caloric return may not be substantial, but another benefit lies in the fact that desert succulents are relatively stable and reliable resources. A greater amount of resource return and the ability to depend on this relatively stable source of calories provides the means for population growth.

One disadvantage to earth oven cooking concerns the high associated cost, which includes gathering necessary resources (fuel, food and stone) and subsequently processing cooked foods (Dering 1999). However, expending an increased amount of energy may not necessarily be a disadvantage if the increased caloric return is necessary to sustain the group.

While intensification may be a relatively straight-forward concept to understand, measuring its occurrence it not necessarily an easy task. Several arguments regarding the best methods to measure intensification are covered in Ames (2005) and other sources.

Jochim (1976) argues that intensification may be measured according to time, space or labor. For example, to identify roasting pit intensification, one could try to measure increases in their construction per unit of time, space, or labor. Put another way, one could measure whether the intensity in roasting pit use increased from one period of another, whether their density increased for a given area, or whether the investment in labor increased.

Zvelebil (1986) contends that intensification must be identified by measuring the amount of labor invested in production. For example, to address the potential intensification of earth oven use, archaeologists must look for artifacts that represent increased labor, such as more roasting pits or an increased amount of tools associated with this task.

Two other important views concerning this concept come from Boserup and Broughton. Boserup's (1965) work was influential for modern views of resource intensification and she preferred to view this notion in terms of units of land. Broughton (1997:646) defined resource intensification in a similar manner to Boserup, stating that it is the "process by which total productivity or yield per areal unit of land is increased at the expense of declines in overall caloric return rates or foraging efficiency."

One method of measuring resource intensification is with a diet breadth model, an optimal foraging theory from human behavioral ecology (Winderhalder 1979). A diet breadth model attempts to calculate the net caloric gain achieved by a group from the act of procuring certain resources. It considers the labor cost necessary to attain certain foods, including preparation time to create necessary equipment, travel time to gather or hunt food, and processing time to render the food edible, and subtracts from that the caloric return gained from the return. Resources are then ranked according to this differential with the highest ranked resources being those with the greatest net caloric return. Certain foods require high labor cost, such as desert bighorn sheep. The labor cost of preparing tools, stalking, killing and dressing the prey, followed by returning the prize back to camp and preparing it for consumption may be great. In contrast to bighorn sheep, desert succulents have lower associated labor costs since they are easier to obtain and require simple technology to harvest, but also yield a lower caloric return. Due to this, desert succulents rank lower on the diet breadth spectrum (see Dering 1999).

Diet breadth model and resource intensification are connected when you consider that certain foods may be easily gathered *en mass*. Once again, intensification is simply the act of creating more food. A single earth oven will return a certain amount of calories, whereas multiple earth ovens will return a greater amount of calories. To obtain the food necessary to fill multiple roasting pits, the gathering rate of food must be increased. The costs associated with gathering a greater amount of food will certainly increase, but the rate at which it increases is lower than the initial cost of collecting for a single oven. Also, plant foods such as desert succulents lend themselves to being gathered in higher quantities if they are abundant in an environment. Desert bighorn sheep on the other hand are more elusive and scattered throughout the landscape making it harder, if not impossible, to simply obtain more of them.

Plant foods often lend themselves to being intensively harvested. Vegetation is immobile and requires relatively simple lithic technology to collect. Processing plant foods are when high labor costs are encountered, which may vary from grinding large volumes of mesquite into flour with a mortar and pestle to extracting agave flesh by pounding it into sheets. Obtaining resources via a particular method can only be done for so long before reaching a point of diminishing return. Until that point is reached, a greater caloric return can be obtained in relation to a lower energy input until a pinnacle is reached where the greatest amount of calories are achieved for the least amount of energy necessary.

It is presently unknown whether the intensification of roasting pit use in southern Nevada was gradual or immediate (this will be discussed further in Chapter 7). Regardless, a gradual transition of earth oven use has been documented in other parts of North America where earth ovens are employed; as time progresse, their use and density increase upon the landscape. By increasing the amount of energy expended on gathering and processing resources, the degree to which the landscape is being utilized also increases. This is referred to as land use intensification.

Archaeologists have used the concept of land use intensification in a myriad of ways, some of which have already been described. Thoms (2009) argues that as desert succulents are incorporated into the diet, people may obtain an increased amount of calories along with a higher labor cost. His model utilizes the diet breadth model to show that an increased amount of calories are available when compared to alternative resource procurement strategies. It also states that as caloric return increases available surplus increases as well, which allows the population of the group employing said strategy to also grow. After a certain point, the use of this technology became relied upon and integrated into the annual routine to sustain the population level for which it has provided.

Within southern Nevada, it is possible that after a certain point in time the use of roasting pits intensified. Evaluating the timing and intensity of earth oven cookery in the Sheep Range will require the excavation of multiple roasting pits. However, the sheer quantity, size and density of these features throughout the Sheep Range, in conjunction with ethnographic accounts of their use, highlight the importance these features played to the groups that utilized them. Cooking food in a roasting pit is an excellent fit for desert regions such as those in southern Nevada. They require minimal fuel, rocks preferred for heating elements (limestone and dolomite) are common, and foods typically cooked, such as agave and yuccas, are abundant.

III. GEOLOGIC, ENVIRONMENTAL AND PREHISTORIC BACKGROUND

This chapter provides background and context for the geology, environmental landscape and prehistory of the Sheep Range and southern Nevada. A geologic background provides greater context for the types of landforms roasting pits were constructed on. Descriptions of each plant community roasting pits were found in are also presenting, including: Creosote Brush, Blackbrush, Mixed Shrub and Pinyon-Juniper communities. Prehistoric background regarding life in southern Nevada provides context for the ways in which the Range, as well as southern Nevada in general, was utilized by Native Americans.

Geologic Background

My study area is the Sheep Range, a north-south trending mountain range located within the boundaries of the Desert National Wildlife Refuge (DNWR) in southern Nevada (Figure 3.1). This region is a part of the Basin and Range physiographic province, known for its generally north-south trending mountain ranges separated by low alluvial basins (Fenneman 1931). Dutton (1886:116) described the region as being "composed of many short, abrupt ranges or ridges, looking upon the map like an army of caterpillars crawling northward." The Sheep Range is located within the southern Great Basin physiographic section of the Basin and Range Province and is bordered to the south by the Mojave-Sonoran Desert and Mexican Highlands provinces (Mayer et al. 2012:11).

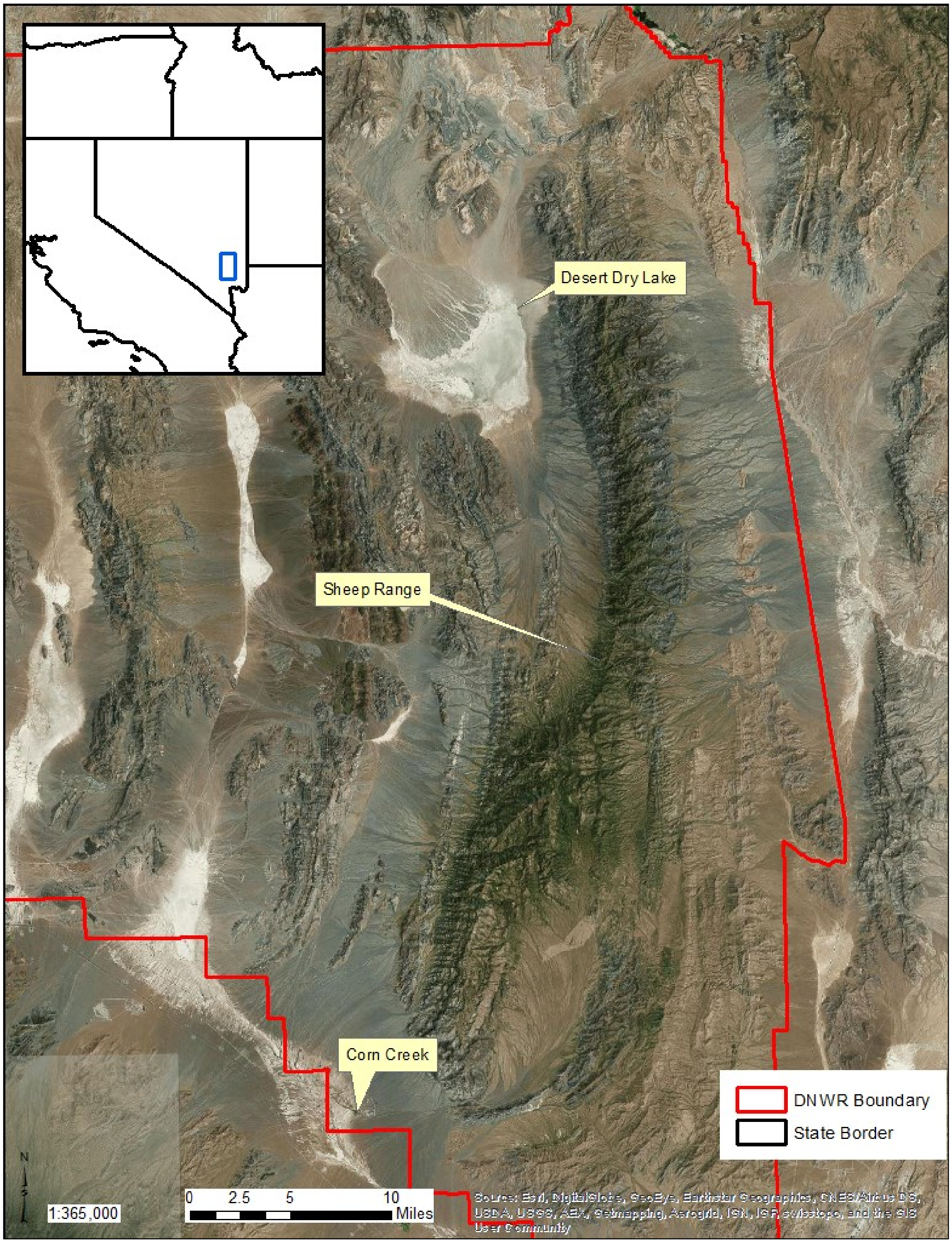


Figure 3.1. Map of the Sheep Range with the location of Desert Dry Lake and Corn Creek highlighted.

Mountain ranges in this area occur on fault blocks formed through geologic uplift. Uplifted mountain ranges within this desert province form intermontane basins which differ based on whether they drain internally (bolsons) or externally (semi-bolsons) (Peterson 1981:4). For example, the western portion of the Sheep Range's northern extent is a bolson based on the presence of Desert Dry Lake, whereas the eastern portion of the Sheep Range drains externally forming a semi-bolson. Regardless of drainage, similar landforms are found in both and are further categorized according to their location on the basin floor or piedmont slope. Roasting pits in the Sheep Range were identified on numerous topographical landforms, predominately on alluvial fans, within canyons and on mountain saddles.

Roasting pits within the Sheep Range were commonly constructed near the apex of alluvial fans emanating from individual canyons. Alluvial fans are formed over millennia by heavy rains redepositing sediment from further upslope, often from within a canyon. Ephemeral drainages act as primary channels through which sediment is deposited and over time these drainages cut through previously deposited alluvium. Along the outer edges below a canyon mouth are alluvial terraces, raised remnants of older alluvium that have since been bisected by canyon discharge. Alluvial terraces are relatively stable landforms protected from heavy rains rushing downhill through the active drainages during periods of punctuated precipitation, though these locations were still subject to sheet wash. Roasting pits are often found along the edges of alluvial terraces directly overlooking the primary wash emanating from a canyon. Occasionally, roasting pits are also found on erosional fan remnants, essentially alluvial islands flanked on either side by ephemeral washes.

Earth ovens were also constructed on ballenas, “ridgeline remnants of fan alluvium that are distinctively round topped … in ideal examples, the concave footslopes of adjacent ballenas join along an ephemeral wash channel in a notably concave flute” (Peterson 1981:14). Ballenas may occur in large groups along mountain fronts or in smaller isolated groups further downslope along the alluvial fan (Figure 3.2).

When constructed within a canyon, roasting pits were most commonly identified on alluvial terraces. Alluvial terraces chosen for roasting pit construction appear to differ in two ways: terraces located along the sides of canyon walls and alluvial highstands

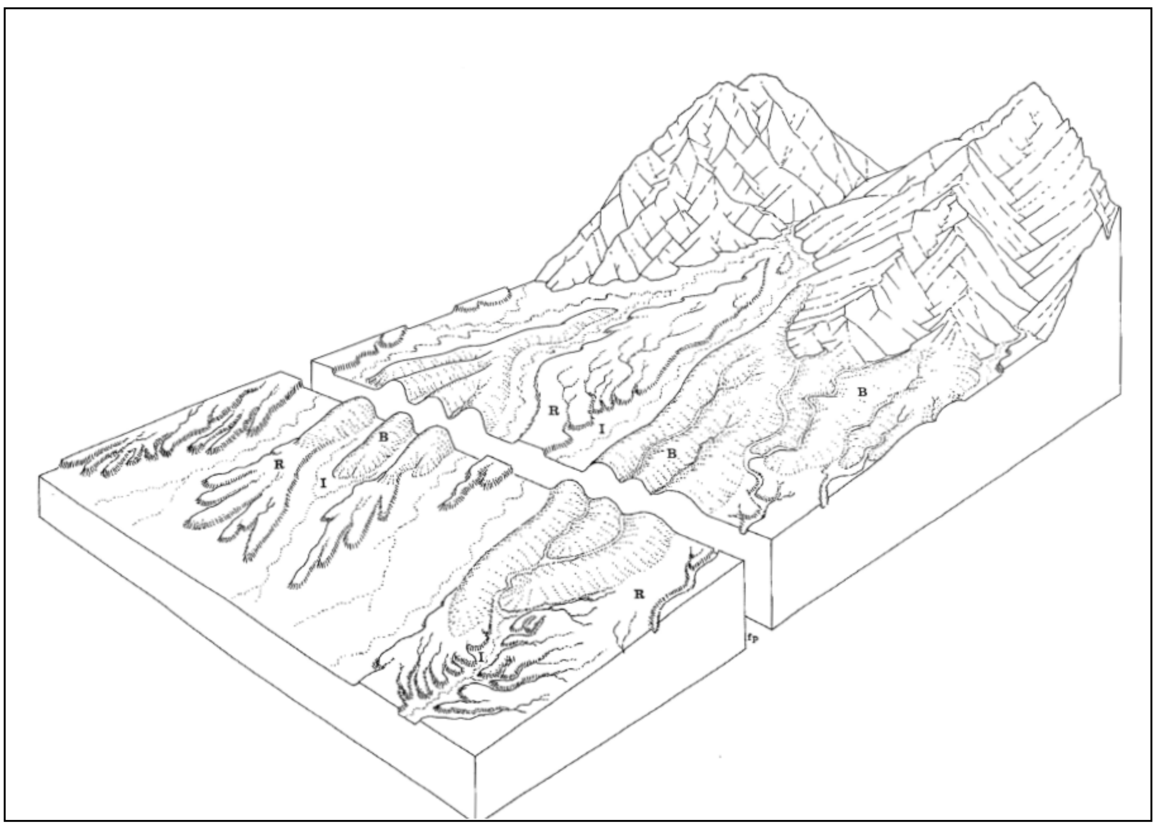


Figure 3.2. Illustration of a mountain-front alluvial fan from Peterson (1981:15) depicting ballenas (B), erosional fan remnants (R) and inset fans (I).

within the middle of a canyon flanked on either side by an ephemeral wash. Alluvial highstands appear to be similar to erosional fan remnants found along alluvial fans; stable landforms consisting of alluvium from older erosional events. Similar to those constructed directly outside the canyon's mouth, roasting pits were also built on the edges of alluvial terraces within the canyon.

Saddles located along Sheep Range represent the highest elevations in which roasting pits were recorded (Figure 3.3). Typically present around 7,000 ft., saddles are generally flat gaps separating the otherwise rugged spine of the Range. Saddles are flanked on two opposing sides by steep talus slopes leading into the canyons below.

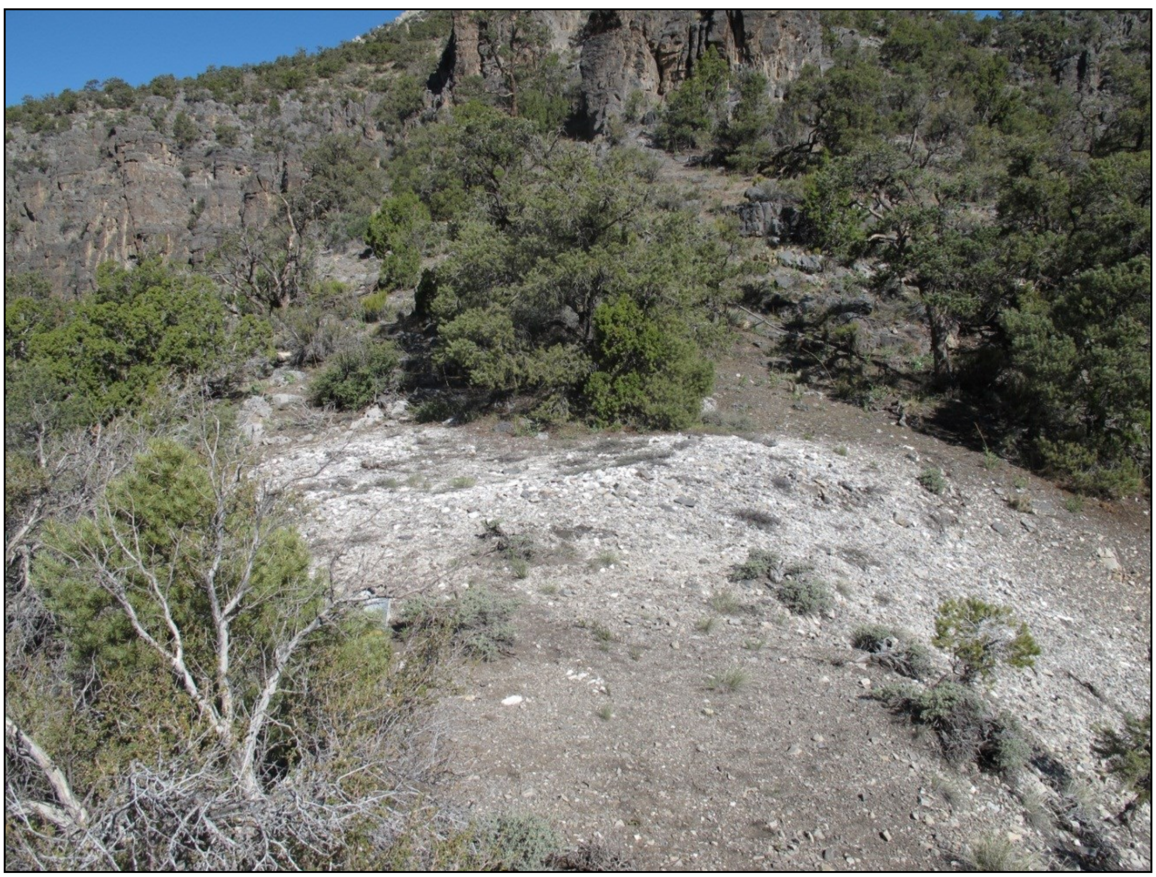


Figure 3.3. Example of a roasting pit (RP-071) found on a mountain saddle.

These gaps provide the easiest way to traverse from one side of the mountain range to another. Roasting pits were identified in every examined saddle within the northern portion of the Range. Yet, due to the high elevation, plant foods such as agave and yucca are rarely present in abundance.

Environmental Background

From a biotic standpoint, the Sheep Range is located within a unique transitional zone between the Great Basin to the north and the Mojave Desert to the south. While located in the Great Basin physiographic section of the Basin and Range Province, plant communities encompassing the Range are primarily associated with the Mojave Desert. Of particular interest to this thesis are the abundant desert succulents native to the Mojave Desert which were cooked in roasting pits, such as agave (*Agave utahensis*) and various species of yucca, including banana yucca (*Yucca baccata*), Mojave yucca (*Yucca schidigera*) and Joshua trees (*Yucca Brevifolia*). Desert succulents were also used to create a plethora of items, such as baskets, sandals and brushes (Fowler 2012a; Rhone 2002:101). While these plants were used in a myriad of ways, it is their source as a foodstuff that is of primary interest here.

Plant life throughout the Sheep Range can be grouped into two primary vegetation zones, the Desert Shrub and Montane Vegetation Zones. These zones are broken down further into plant communities based on elevation and biotic life. The Mojave Desert Shrub Vegetation Zone is comprised of four plant communities, the Creosote Bush community, the Blackbrush community, the Mixed Shrub community and the Desert Wash community (Niles and Leary 2007). The Montane Vegetation Zone is comprised of the Pinyon-Juniper community, the Montane Wash community, the White Fir-Pondorosa Pine community and the Bristlecone Pine community (Niles and Leary 2007:5-6). While foods were undoubtedly obtained from all these communities, only those with significant densities of desert succulents will be discussed below.

Difficulties may arise when differentiating between two plant communities for a certain location. As described by Rhode (2002:4):

> Mojave Desert shrub associations do not segregate into highly distinctive, rigidly bounded communities. Instead, different species mix according to subtle habitat preferences, such as soil texture and depth, the number of days of frost, summer and winter moisture availability, and the compatibility of neighboring plants.

I distinguished between similar vegetative zones (e.g., the transition between Blackbrush and Mixed Shrub communities) by identifying dominate species and noting the topographic setting.

The lowest biotic community within the Desert Shrub Vegetation Zone is the Creosote Brush community, typically present below 4,000 ft. elevation (Figure 3.4). As indicated by the name, creosote bush (*Larrea tridentata*) is the dominant species for this community and is associated with different subdominant species based on the landform

Figure 3.4. Example of a roasting pit (26LN7100) within a Creosote Brush community.

it is found on. In areas with deep sandy soils, white burrobush (*Ambrosia dumosa*) acts as the subdominant species to form a *Larrea-Ambrosia* association (Beatley 1976). In areas dominated by desert pavement, such as the lower extents of alluvial fans, shadscale (*Atriplex confertifolia*) or saltbush (*Atriplex canescens*) is typically also present to form a *Larrea-Atriplex* association (Fowler 2012a). Mojave yucca also grows among desert pavement in these communities, as well as several species of cholla.

Extending above the Creosote Brush community is the Blackbrush community which typically extends from 4,000 – 6,600 ft. in elevation (Figure 3.5). The dominant species for this community is blackbrush (*Coleogyne ramosissima*) and is also found with big sagebrush (*Artemisia tridentata*), spiny hopsage (*Grayia spinosa*), banana yucca and agave. Onions (*Allium* spp.) are also found here, though the distribution of these plants is not widely known. Joshua trees, a species strongly associated with the Mojave Desert, may also be found among this community in varying densities. This community is most often found covering alluvial fans throughout the Sheep Range.

Figure 3.5. Example of a roasting pit (RP-007) within a Blackbrush community.

The Mixed Shrub community is found at roughly the same elevation range as the Blackbrush community (4,000 – 6,000 ft.), but more often within major canyons and rocky outcrops (Fowler 2012a). This community is comprised of a mixture of plants also found in the Blackbrush and Pinyon-Juniper communities, including: Utah service berry (*Amelanchier utahensis*), rabbit brush (*Ericameria nauseosa*), agave and all three local species of yucca (Figure 3.6). When associated with this community, Joshua trees and Mojave yucca are most commonly found immediately outside the mouths of canyons. Pinyon pine (*Pinus monophylla*) and Utah juniper (*Juniperus utahensis*) may also be found intermixed within this community, most commonly within canyons.

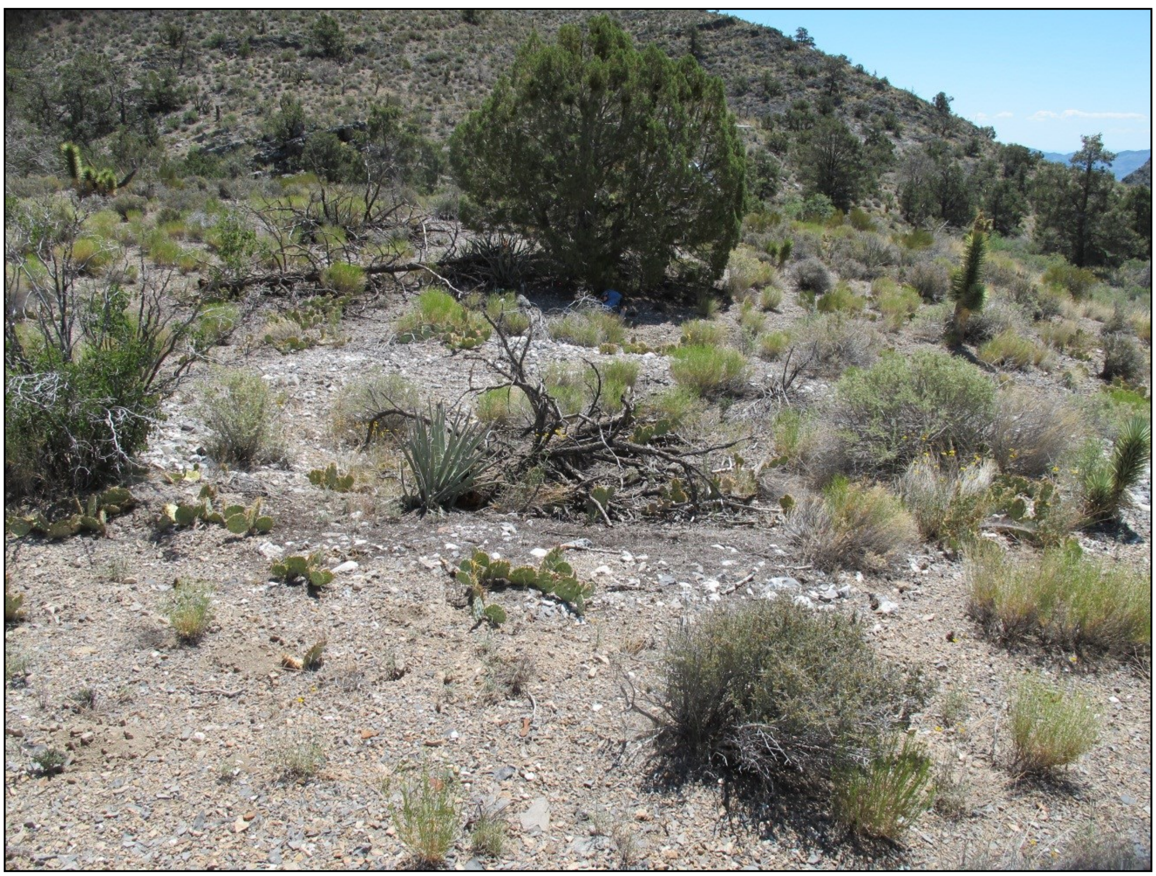


Figure 3.6. Example of a roasting pit (RP-132) within a Mixed Shrub community.

Moving to the Montane Vegetation Zone, the aptly named Pinyon-Juniper community is known as a "pigmy forest" typically extending from 4,100 – 8,200 ft. elevation (Fowler 2012a:43). Big sagebrush, rabbit brush, Gambel Oak (*Quercus gambelii*) and banana yucca are also found associated with this community (Figure 3.7). Though banana yucca is present, pinyon pine cones were likely of greater importance to prehistoric peoples accessing this plant community. Ethnographic accounts indicate that roasting pits were used to cook green pinyon cones, as discussed in Chapter 6.

Figure 3.7. Example of a roasting pit (RP-140) within a Pinyon-Juniper community.

Prehistoric Background

The presence of roasting pits in southern Nevada has not been systematically documented and the limited excavations have been primarily associated with mitigation efforts through cultural resource management projects (Roberts 2012). Subsequently, the role roasting pits played in the region's prehistory is not well understood. The archaeological context in which earth ovens have been identified within southern Nevada is summarized below. For a more in depth discussion, the reader is directed to Roberts and Ahlstrom (2012), a thorough prehistoric overview for southern Nevada.

Most archaeologists believe that agave roasting in southern Nevada began during the Archaic period and continued in the region through the Post-Puebloan period. It is also believed that roasting pits were primarily used to cook agave, based in part on ethnographic accounts (Ellis et al. 1982:56; Fowler 2010; Rhone 2002; Stuart 1945a:79). Macrobotanical evidence, though sparse, has been used to support this claim (McGuire et al. 2013; Roberts 2012:197). Though limited, archaeological evidence for the region suggests these features were also used to cook a variety of plant foods and animals (Blair 1986; Louderback et al. 2013). Roberts (2012) has inferred that an increase in the use of these features occurred around the transitional phase of the Puebloan and Post-Puebloan periods. Additional radiocarbon and microbotanial samples are necessary to broaden our knowledge of the use of these features through time and establish other foodstuffs cooked within.

A brief overview is provided for each period up until the Terminal Archaic, where a more throughout description is provided. Time periods are adapted from Warren and

Crabtree (1986). Most of the information presented here regarding the prehistoric background of the region comes from Roberts and Ahlstrom (2012).

Paleoindian Period (11,150 – 9,050 B.C.)

The earliest evidence of occupation by Native Americans in southern Nevada dates to the Paleoindian Period (Roth 2012). As reported by Roberts and Ahlstrom, during this period the weather was cooler and wetter than modern day and Pleistocene lakes were present within the Great Basin and Mojave Desert. Sites dating to this period are typically surface finds near pluvial lake shorelines and lowland valleys, occasionally consisting of fluted Clovis-like projectile points (Roberts and Ahlstrom 2012:87). While it is generally believed that Clovis people were highly mobile hunters, stratified evidence of Clovis technology with Pleistocene megafauna has not been found in the Great Basin or Mojave Desert (Beck and Jones 2009). Roasting pits have not been dated to this time period in southern Nevada.

Early Archaic (9,050 – 5,550 B.C.)

The Early Archaic period in southern Nevada is primarily represented by stemmed points referred to as the Great Basin Stemmed series. Roberts and Ahlstrom (2012) indicate stemmed points dating to this period are mostly found in lowland valley settings, though they have also been recorded in upland contexts. In contrast to fluted points, stemmed points from this period appear to have been used for multiple functions, as opposed to only as a dart points (Beck and Jones 2009). Due to the varied use of stemmed points dating to this period, in addition to the contexts in which they have been identified, it appears that a wider array of wild resources was used. Roasting pits have not been dated to this time period in southern Nevada.

Middle Archaic (5,500 – 2,600 B.C.)

Towards the end of the Early Archaic, the environment in southern Nevada began to shift towards a warmer and dryer climate, also known as the Altithermal (Antevs 1955). As remnant Pleistocene lakes dried up, reliable water sources such as springs and streams continued to be used, as were uplands and mountain foothills (Roth 2012:93). Sites dating to this period are typically associated with Pinto points. An increase in the presence of groundstone is also noted at Middle Archaic sites as compared to those from the Early Archaic. This likely represents a more generalized foraging focus with an increase incorporation of seeds (Warren and Crabtree 1986). Roasting pits have not been dated to this time period in southern Nevada.

Late Archaic (2,600 – 200 B.C.)

An increase in moisture is noted near the beginning of this period, which is believed to have recharged both springs and lakes to a degree (Roth 2012:99). Several dart point styles portray this period, including Gypsum, Elko Series and Humboldt Concave Base points (Warren and Crabtree 1986). The increased use of groundstone continued during the Late Archaic and the initial identification of the mortar and pestle dates to this period which is believed to have been used for mesquite processing (Roth 2012). A radiocarbon date from the Hidden Valley site (3,800 BP) represents the oldest dated roasting pit in southern Nevada (Ellis et al. 1982).

Terminal Archaic (200 B.C. – A.D. 200)

The Terminal Archaic period for southern Nevada dates between 200 B.C. to A.D. 200 and is transitional between the Archaic and Puebloan periods. It is during this period that maize agriculture was introduced to the region (Roth 2012:110). Archaeological evidence obtained from storage pits at the Larder Site (26CK6146) indicates the use of a broad range of plant resources, such as mesquite, cacti and maize. Radiocarbon dates obtained from the Roadside Roast site (26CK1091), which includes several roasting pits, fall within and continue beyond this period (Blair 1986). Due to a limited number of tested archaeological sites dating to this period, it is unknown whether roasting pits were extensively used during the Terminal Archaic.

Climate in this region over the past 2,000 years appears to have been variable, though generally wetter than during the Middle Holocene that preceded it. Mayer et al. (2012) states the primary sources of these climatic fluctuations in the region include the North American Monsoon, El Nino-Southern Climate Oscillation (ENSO) and the Pacific Decadal Oscillation (PDO). Although generally wetter, "most regional paleoenvironmental records indicate distinct fluctuations in moisture over the last 2000 ^{14}C B.P." (Mayer et al. 2012:41). The region appears to have been cool and dry during this period based on paleoenvironmental data obtained from woodrat middens in Holt Canyon (Mayer et al. 2012).

The extent to which agave and yucca were affected by fluctuations in precipitation and temperature over the past 2000 years is presently unknown. As a general rule, periods of increased moisture and lower temperatures would have encouraged the growth of both species, while periods of decreased moisture and higher temperatures would have resulted higher rates of die off (David Charlet, Personal Communication 2015). However, this is a complex issue with many working parts. For example, yuccas rely on pollinators to propagate their species. The affect climatic variation has on pollinators may play a bigger role in the persistence of yucca than changes in the climate alone. It is inferred for present purposes that periods of higher precipitation and cooler temperatures would have facilitated the growth of these plants.

Puebloan Period (A.D. 200 – 1300)

Roberts and Ahlstrom (2012) refer to the next period as the Puebloan period, which spans roughly A.D. 200 to 1300. The period signifies the presence of a distinctive Puebloan archaeological culture found within southern Nevada (Ahstrom and Roberts 2012:115). The cultural pattern is typically characterized as Western Virgin Puebloan for two primary reasons: its position in southern Nevada along the western edge of the Virgin Puebloan boundary and the shared material-culture with other Virgin Puebloan groups. As stated by Ahlstrom and Roberts (2012), this culture is believed to have been concentrated in the valleys around the confluence of the Virgin and Muddy Rivers, located roughly thirty miles east of the Sheep Range. Agriculture was practiced along the floodplains in this area, including the cultivation of maize, beans and squash. Archaeological evidence indicates that upland resources, such as game and agave, were obtained by Puebloan groups during this period (Ahlstrom and Roberts 2012). A radiocarbon sample from a roasting pit at the Black Dog Mesa Archaeological Complex, located near the heart of Puebloan occupation in southern Nevada, indicates that agave was consumed during this period (Winslow 2009).

Southern Nevada was also inhabited by non-Puebloan groups during this time. One of those groups was the Patayan, a culture typically identified by their ceramics. The antiquity of Patayan ceramics in southern Nevada is unknown, though evidence generally suggests they began to appear in Las Vegas Valley by A.D. 1100, if not earlier (Ahlstrom and Roberts 2012). Evidence exists for the use of roasting pits by the Patayan archaeological culture, which was primarily located in the southeastern extent of southern Nevada. Patayan groups are believed to have been hunter-gatherers and at present there is no archaeological evidence supporting the cultivation of maize or other domesticates at Patayan sites (Ahlstrom and Roberts 2012). Archaeological sites in the Upper California Wash and Gold Butte-Virgin Mountains areas demonstrate that upland resources, like agave, were exploited during this period by both Puebloan and non-Puebloan peoples (Blair 1986; McGuire 2013). Additional evidence suggests that non-Puebloan and non-Patayan groups inhabited southern Nevada during this period as well, though their histories remain to be understood in detail.

The Corn Creek Site, a small habitation complex located on the southwest extent of an alluvial fan emanating from the Sheep Range, was occupied during this period by non-Puebloan and non-Patayan people (Roberts and Lyon 2011). Adobe-like building material and Puebloan style pottery were identified at the site, though the structures do not resemble Puebloan style buildings. Locally manufactured Puebloan style pottery at Corn Creek indicates the presence of someone knowledgeable in that style, which suggests contact between Puebloan and non-Puebloan groups during this period (Roberts and Lyon 2011). Evidence of horticultural activities, such as the farming of maize, has also been identified at the site, though it is suggested that wild plants, particularly honey mesquite, were still important (Ahlstrom and Roberts 2012:143). Given the site's proximity to the Sheep Range, it seems reasonable that prehistoric inhabitants ventured into the uplands to procure game and gather wild plants such as pine nuts and agave.

Rafferty (1990) has argued that perishable items such as agave were traded locally between non-Puebloan and Puebloan groups from locations as far as 50km away including the Spring Mountains. If this is true, it seems likely that resources from the Sheep Range would also have been incorporated into this trade network.

Around A.D. 900 to 1000, the archaeological record reflects an increased use of small rockshelters and open air sites (Roberts 2012:177). Many of these sites, including Garrett's Shelter (26CK5712) and site 26CK4908, have roasting pit features associated with them and were occupied during the Puebloan and Post-Puebloan periods. Increased use of rockshelter sites during this period may reflect an important cultural and subsistence transition.

Important technological changes mark this period including pottery manufacture and the bow and arrow. The initial introduction of maize in southern Nevada predates this period, but by this time we find it well-established in the archaeological record (Roberts and Alhstrom 2012).

The end of this period is marked by the abandonment of the region by Virgin Puebloan groups and the arrival of people who made Great Basin Brownware and Buffware pottery (Ahlstrom and Roberts 2012). Current archaeological evidence suggests that groups who made Brownware pottery were affiliated with Great Basin populations such as the Southern Paiutes. Buffware pottery is linked to Colorado River cultures such as the Patayan who were likely ancestral Yuman and appear to have ventured further north into southern Nevada following Puebloan abandonment.

The best evidence for Virgin Puebloan abandonment in the region comes from the Yamashita sites located in the Moapa Valley (Lyneis 2012). Radiocarbon dates obtained from this site indicate Puebloan use into the A.D. 1200s, if not later into the 1300s (Lyneis 2012:163). Charcoal samples obtained from a fire built on top of adobe debris from a collapsed Puebloan structure (Structure 4) and a luminescence date obtained from a Southern Paiute potsherd produced overlapping dates around the A.D. 1300s (Lyneis 2012:164). As stated by Lyneis (2012) additional radiocarbon and luminescence dates were obtained respectively from a thermal feature and a Southern Paiute potsherd found next to the wall of a Puebloan structure (Structure 1). Dates indicate the feature post-dates A.D. 1500, suggesting a more recent use of the area. These dates indicate a relatively short time gap between Puebloan abandonment and subsequent occupation by Southern Paiute groups (Roberts and Ahlstrom 2012). Several potential reasons have been proposed to explain Puebloan abandonment including environmental effects (e.g., climate change and resource imbalance), regional conflict by outside groups and the movement of Patayan groups further north into the region.

The dry and cool climate that characterized the Terminal Archaic appears to have continued into the Puebloan period until roughly A.D. 500 – 600. Based on woodrat midden data from Holt Canyon, this period appears to have been followed by several centuries of cool, moist conditions around A.D. 860 – 1150 (Mayer et al. 2012). Pollen obtained from Lower Pahranagat Lake provides evidence for "centennial-scale increases in effective moisture at 1500, 900, 700, and 500 B.P." (Mayer et al. 2012:41). These data suggest this period was characterized as generally wetter than before with increased levels of moisture variability (Mayer et al. 2012). Plants such as agave and yuccas would have likely benefitted during these periods of lower temperatures and increased precipitation.

Post-Puebloan Period (A.D. 1300 – 1776)

The Post-Puebloan period is viewed as the period of time between Puebloan abandonment and the beginning of the Historic period (Roberts 2012:165). A spirited debate concerning the introduction of Numic speakers into the area has produced several models regarding the timing and mechanisms involved (e.g., Bettinger and Baumhoff 1982); however, this debate is outside the scope of this thesis. Briefly, it is generally believed that following the abandonment of the area by Puebloan groups, migration into the region by Numic speakers from the Owens Valley area occurred (Bettinger and Baumhoff 1982). However, there is evidence that suggests an overlap between these two events, during which cultural interactions occurred between Numic speaking and Puebloan peoples (Roberts 2012:165). Some archaeologists argue Numic speaking groups were established in the area dating back to at least the Archaic period (Blair et al. 2000). The Numic groups in southern Nevada, also referred to as Southern Paiute or Nuwuvi, practiced a diverse subsistence strategy, potentially including both resource procurement along the arid slopes and uplands for agave and game, in addition to mesquite and the practice of agriculture in the valley bottoms (Roberts 2012:191).

Archaeological sites dating to this period have been found in a variety of contexts. Within the region surrounding the Sheep Range, most dates for this period have been obtained from small rockshelters and open air sites with hearths or roasting pits (Ahstrom and Roberts 2012:117). Subsistence focus during this period appears varied, with a continued use of upland resources, including desert succulents and large game, as well as horticultural practices in valley bottoms with staples such as maize. Nonetheless, most subsistence data suggest a focus on wild plants such as desert succulents cooked within roasting pits. The diversity in resource types for this period appears to "support a model of settlement mobility with a mixed economy and periodic movement to wild resource patches" (Roberts 2012:178).

Post-Puebloan habitation features have not been identified within the Sheep Range. It should be noted however, that there has been only limited research focused on this time period, leading to ambiguity for this phase. The end of the Post-Puebloan period is marked by the arrival of Euroamericans into the region.

Climate during the beginning of this period appears to have continued to be generally cool with periods of punctuated moisture, as it had been at the end of the Puebloan period. Towards the end of this period the Little Ice Age appears to have taken effect. As discussed by Mayer et al. (2012), this period lasted roughly between A.D. 1600 – 1900 and is characterized as generally cooler and wetter than previous climatic episodes. During this period, increased spring discharge and the development of wetlands occurred at Ash Meadows, treeline boundaries at numerous mountain ranges lowered and a final increase in the levels at Lake Mojave occurred (Mayer et al. 2012). Plant foods such as agave and yuccas would have continued to benefit during this period of lower temperatures and increased precipitation.

IV. ETHNOGRAPHIC ACCOUNTS RELATING TO THE USE OF ROASTING PITS

As Chapter 3 shows, roasting pit use likely began long before Numic peoples entered the region. However, all ethnographic accounts in the Sheep Range vicinity are from Southern Paiute groups. Of the all desert succulents found within the Sheep Range, in the ethnographic record agave is the most commonly associated with the use of roasting pits. Other desert succulents, such as yucca, likely served an important role in the annual diet of the Southern Paiute. Archaeological evidence suggests animals were sometimes cooked within roasting pits as well, though there are few ethnographic accounts regarding this practice. Ethnographic data regarding the baking of agave both within the study area and the surrounding regions is more readily available than for other types of foods. It is for these reasons that agave will be the primary focus of this chapter: however, a brief overview of the other types of foods that may have also been cooked within roasting pits is provided at the end of the chapter.

While there are ethnographic accounts concerning the role agave and yucca played for the Southern Paiute, not every aspect of plant baking is described in detail. Fortunately, numerous ethnographic accounts exist regarding the use of these foodstuffs to Native Americans elsewhere in the American Southwest. These additional sources are incorporated below to provide a greater potential understanding regarding the use of earth oven facilities. Ethnographic information presented here includes the following Native American groups: Southern Paiute, Ute, Western Shoshone, Chemehuevi, Chiricahua and several Apache groups including the Mescalero, Yuma and Mojave.

Agave Procurement and Transportation

While a variety of foodstuffs appear to have been cooked within roasting pits, agave (*Agave utahensis*) is the plant most commonly associated with pit ovens. Ethnographic accounts indicate that agave may be procured, processed and eaten at any time of the year, though baking during the spring was the most common. Large group communal bakes between February and May were culturally significant social events to many tribes, including Southern Paiute groups (Hodgson 2001:32). These events lasted several days and were associated with first spring ceremonies, during which singing, dancing and gambling also occurred (Blair 1986:45; Fowler 1995:106; Hodgson 2001:32). During this event, an individual was put in charge of overseeing the procurement and cooking of agave. This person was most commonly reported to have been a woman born in the summer, though Southern Paiute groups had both men and women as agave specialists (Hodgson 2001:32).

During the early spring, a flower stalk grows from the center of agave, indicating the plant is mature and ready for procurement. In optimal conditions, stalks have been reported to grow as rapidly as one foot per day (Castetter et al. 1938:5). It was important to procure agave before its stalk grew too much. During this period, agave expends its metabolic energy as the stalk grows (Hodgson 2001:15). By cooking agaves with minimal stalk growth, a greater amount of nutrients are present within the plant. It was also important not to cook agaves lacking a stalk as they tasted bitter. Ethnographic accounts indicate that adding non-blooming agave to a roasting pit would spoil the flavor of the other ripe agaves (Castetter and Opler 1936:35). According to at least the Mescalero and Chiricahua Apache, agave plants not in bloom were referred to as “man” plants and were transformed into "woman" plants once the stalk began to grow (Castetter and Opler 1936:35). They explained that "man" would smoke inside the pit and saturate the other agave therein.

Several accounts indicate that agave was sometimes baked during various parts of the year, such as the winter, though this was not as common as baking during the spring (Castetter et al. 1938:40; Fowler 2012a:45; Hodgson 2001:32). When non-blooming agave was chosen to bake, plants believed to become ripe the following year were preferred over others. It was possible to determine which plants would ripen the following spring based on whether its leaves were sufficiently swollen or not.

Gathering and transporting agave was a precarious task considering the plants sharp pointed leaves and juices which were known to irritate the skin. The most commonly reported method of extraction was with the use of a wooden wedge to pry the crown from the ground. The end of the stick was pounded with a rock until the stem loosened enough for it to be cut free with a mescal knife (Castetter and Opler 1936:35-36). A Southern Paiute ethnographic account states the central stalk of the agave was removed first with the same wooden chisel used to pry the plant loose (Fowler 2012a:109). After removal, the sharp leaves were often trimmed down with a mescal knife, a stone blade inserted into a wooden handle (Baldwin 1944:331). This activity was typically conducted by women, though men and children are also reported as collecting agave within Southern Paiute groups (Fowler 2012a:109; Hodgson 2001:32).

Transporting the agave from the procurement location to the roasting pit was reportedly accomplished a number of ways. The Mescalero and Chiricahua would cut all but two leaves from each plant so that several agave trimmed stalks could be tied together, making them more convenient to carry (Castetter and Opler 1936:36). The Southern Paiute and Chemehuevi, as well as the Yuma and Mojave Apache, would cut off all the leaves and carry the bulbous plants in burden baskets (Corbusier 1886:327; Fowler 2012a:108). According to Fowler (2012a:109), a Moapa Paiute stated that wrapped-stitch carrying baskets were used to transport agave, while a Pahranigat Paiute said regular burden baskets were used. Other accounts state that plants were transported in nets and minimally processed prior to cooking so as to avoid contact with the skin-irritating juice (Hodgson 2001:15). When a roasting pit could not be constructed near dense stands of agave, it may have been necessary to travel considerable distances.

Hodgson (2001:14) reports traveling long distances during collecting trips was common, and could be 16 – 26 km in one direction, while Louderback et al. (2013) suggests Southern Paiute groups may have traveled 8 – 10 km on foot in one direction to gather yuccas fruits.

Baking Agave

Once the trimmed plants were ready to be cooked, either a new pit or a previously used one was prepared. The dimensions given of these pits varied per ethnographer. Corbusier (1886:327) reports that the Yuma and Mojave Apache would dig a pit anywhere from 3 – 10 feet (0.9 – 3 meters) wide and 2 – 4 feet (0.6 – 1.2 meters) deep, while Castetter and Opler (1936:36) state the pits were 10-12 feet (3 – 3.6 meters) wide and 3-4 feet (0.9 – 1.2 meters) deep. Sometimes these pits were “lined” with rocks (Fowler 2012a:110; Hodgson 2001:14) while other times there was no mentions of rocks (Corbusier 1886:327).

After the pit was prepared, the fire was created. Reported fuelwood differed according to environment and ranged from hardwood to small woody brush. One Southern Paiute account states the pit would be filled with a large amount of brush with rocks placed on top (Fowler 2012a:109). Detailed accounts of fuelwood used by Southern Paiute groups have not been identified.

The fire was most commonly started just before the sun rose by someone born in the summer, though this was not always explicitly stated Castetter and Opler 1936:36; Corbusier 1886:327; Stuart 1945a). In most cases, rocks were incorporated with the fuelwood to absorb heat from the start of the fire. Other times, rocks were laid on top of the red-hot coals after the fire had burned down, followed by an additional layer of rocks after the agave had been placed within the pit (Fowler 1995:106). Some groups, such as the Hualapai, placed significant meaning in the creation of the fire itself. Their fires were created such that four open "doors" were built corresponding with each cardinal direction and the fire was initiated through each door (Hodgson 2001:32).

After the fire died down and the rocks were sufficiently hot, wooden poles were used to position the rocks into a flat surface. Afterwards, each person taking part in the event would dump their agave into the pit; all accounts suggest that the cooking pits were communal. Some indicate that women would leave unique marks on their agave to designate possession, another indicated that rocks were used to separate sections of agave, while another stated that women would either remember theirs or the remains were divided equally (Corbusier 1886:327; Hodgson 2001:17; Stuart 1945a). Various types of moist vegetation have been reported to be placed within the pit prior to the placement of agave within the pit. This vegetation primarily consisted of grasses and cactus which provided crucial moisture necessary for the process of hydrolysis. Hodgson (2001:32) states that after Southern Paiute groups placed their agave within the smoldering pit, each person would cover their portion with rocks, followed by dirt. According to a Pahranigat tribal member, agave hearts were placed into a pre-heated pit, covered with grass and hot rocks, then covered in earth to bake for several days (Fowler 2012a:110).

With the hot-rocks, agave and moist vegetation in place, the pit was capped with an earthen layer. Sediment was obtained from excavating the cooking pit and additional material was available surrounding the earth oven facility. After the pit was thoroughly covered, it was monitored closely for any escaping steam indicative of a leak. These leaks were covered as quickly as possible to retain the heat necessary to sufficiently cook the agave. Most reports state agave was left to cook for two full days. According to Hodgson (2001:32), Southern Paiute groups would build a fire on top of the roasting pit after it was covered which was allowed to burn into the following day. While the effectiveness of this method remains unclear, it was presumably done to retain heat within the pit as food cooked. The creation of an additional fire on top of the pit is not always mentioned for the Southern Paiute.

While foods were being cooked, the individual in charge of the roast may engage in special prayers to ensure the agave was cooked properly (Fowler 1995:106). Cultural restrictions were also put in place for the same reason. Menstruating women or new mothers, while allowed to construct the pit, were not allowed to scratch themselves with their fingers afterwards, the individual in charge of overseeing the event was to abstain from consuming agave and all members were to abstain from sexual intercourse. These taboos were enforced only while the pit was closed to ensure that the agave would fully cook and not be bitter upon completion (Castetter and Opler 1936:37). According to a Pahranigat ethnographic account, the woman in charge of the roast was not allowed to eat any light-colored food while the agave cooked, otherwise the food would not darken (Fowler 2012a:110). This individual would also be the first to remove and try the agave.

Processing Baked Agave

After the agave was cooked, the pit was opened and the baked foods inside extracted. Various accounts indicate the Southern Paiute carried the cooked plants home to be further processed, while other groups processed the plants near the cooking pit. The interior core of the plant could not be stored and was often eaten immediately. Most accounts state the outer leaves were removed and the flesh was pounded with a groundstone implement. These tools were most commonly described as a mano and metate, but some groups, such as the Southern Paiute, are described as using a mortar and pestle (Hodgson 2001:32). Once the agave was processed, it was shaped into large sheets or circular cakes and was laid out and dried over several days (Fowler 2012a:110). In instances where the agave was dried in large sheets, it was later cut into strips, sometimes drizzled with agave juice and then stored. Storage consisted of covering the dried pulp with skins, hanging them in caves, or kept in sealed vessels. Although processing techniques undoubtedly varied among groups, storing food in ceramic vessels was likely a common method.

Additional processing techniques were used depending on the cultural group. For example, the Apache were recorded as sprinkling “mescal juice” over drying agave pulp

(Castetter and Opler 1936:37). A hermetically sealed jar containing processed mescal also appeared to have been "soaked in syrup and then dried," which was found in Kingsman, Arizona, roughly 100 miles south-southeast of the Sheep Range (Euler and Jones 1956:88). The Southern Paiute were noted as incorporating mesquite pods into their processed agave and accounts indicate other groups included pinyon nuts and juniper berries (Hodgson 2001:32).

Non-Agave Foodstuffs

Banana yucca (*Yucca baccata*) is a desert succulent whose nutritional output benefits from extended cooking, though prolonged cooking was not essential for consumption. It is also one of the primary yucca species that constitute the "yucca complex," a term that reflects the importance of yucca foods to Mojave Desert peoples (Fowler 1995:106). The flowers, stalks and buds were eaten raw, boiled, or roasted within an earth oven during the early spring. The fleshy fruits were also eaten raw, roasted, or dried and ground into meal during the late spring and summer when they were available. One account states that Southern Paiute groups would cook green yucca fruits within a fire and stir them constantly until they turned brown, after which they were removed, split open to remove the seeds and dried for future use (Fowler 2012a:114). Partially dried fruits were sometimes pressed together to form cakes for preservation. Dried fruits were rehydrated in boiling water before consumption and a fermented beverage could also be made (Blair et al. 2000:20). Another account states that the fruits were "cut into strips, the seeds were removed, and the flesh was dried for storage" (Rhode 2002:100). Moapa and Pahranigat ethnographic accounts state these fruits were also processed with groundstone and formed into cakes and dried for storage (Fowler 2012a:110).

The fruiting buds from Mojave yucca (*Yucca schidigera*) and Joshua trees (*Yucca brevifolia*) were reportedly consumed in the early spring prior to blooming (Fowler 1995; Stoffle et al. 1989). These foods achieved their peak nutritional output after prolonged cooking, though this also was not essential for consumption. Similar to banana yucca, fruits from Mojave yucca were also eaten fresh or dried for later consumption. Ethnographic accounts state that immature fruits would be buried in a shallow pit for an undetermined period of time to hasten the ripening process by exposing them to self-generated ethylene gas (Louderback et al. 2013:284). Another way to accelerate the ripening process was to break, but not sever, the stem of the fruit from the plant itself (Fowler 2012b:129). A Moapa Paiute ethnographic account states the flower buds were picked off and boiled as opposed to roasted (Fowler 2012a:114). While these foods would have been available around the time that agave was beginning to bloom in the spring, the absence of their mention in the ethnographic record suggests they were not commonly cooked within roasting pits. It seems likely they were cooked over a bed of hot rocks and coals similar to the method described for Banana yucca.

Ethnographic and archaeological evidence from Nevada and Arizona indicate that cholla buds were also commonly cooked within stone-lined pits (Greenhouse et al. 1981:229; Rhode 2002:108). However, the apparent specialized cholla roasting pits are reportedly much smaller than most of the pits found within the Sheep Range. One ethnoarchaeological example states these pits were rock lined, somewhat conical in shape and roughly 1 meter in diameter by 0.5 to 0.7 meters in depth (Greenhouse et al.

1981:229). Another ethnographic account for the Pimas indicates that roasting pits used to cook cholla were smaller than those used to cook agave (Hodsgon 2001:20). Since the time necessary to cook cholla, roughly 18 hours (Greenhouse et al. 1981:229), is less than that of agave (36 hours or more) it seems unlikely that these foods were commonly cooked together.

It is also likely that green cone pinyon processing occurred with the aid of hot rocks within the Sheep Range. Green cones do not require prolonged baking periods. Two Southern Paiute ethnographic account states that 1-3 hours of cooking is sufficient to open the cones and retrieve the interior seeds (Fowler 2012a:105; Fowler 2012b:118). Another account by Stuart (1945b:155) states that green pinyon cones were left to cook overnight. Green cone processing in an earth oven has not been extensively studied, though Gamble and Mattingly (2012) have argued that over 200 fire-cracked rock features in southern California represent intensive processing of the Torrey pine nut. One Southern Paiute account states a roasting pit would be filled with roughly 3 feet of Big Sagebrush (*Artemisia tridentate*) with the green cones placed on top of the fuel (Fowler 2012a:105). A fire was started, four individuals with long poles would stir the contents and then the pit would be covered with earth and allowed to bake for "a few hours" (Fowler 2012a:105). A Pahranagat Paiute reported a similar account, stating green cones were placed in a baking pit, covered with earth and left to bake for one to two hours (Fowler 2012a:106). Stuart (1945b) was informed by an elderly Moapa woman that stones were placed under the fuel and cones were added once the fuel burned down followed by additional rocks to cover the pit. Once covered with rocks, an additional fire was created and lit on top of the pit, which would burn all night. While pinyon is not found as abundantly throughout the Sheep Range as desert succulents, roasting pits have been documented in pinyon-dense areas.

During periods of stress, pads from flat-leaved cactus, such as beaver tail or prickly pear were also cooked within a pit and consumed. According to a Pahranigat Paiute account, pads were placed in a pre-fired pit, sprinkled with water, covered with dirt and allowed to cook until the following morning (Fowler 2012a:116).

Finally, it appears that meat was also cooked within roasting pits, though the extent to which is unknown. Within the ethnographic record, skulls were documented to have been cooked within earth ovens. Corbusier (1886:329) reports that skulls were pit baked for roughly 12 hours, with no indication this occurred alongside agave or other foods. Fowler (2012a:130) reports big horn sheep skulls were "broken open and either boiled or baked," and the brains were later used for tanning. Ethnographic accounts do not explicitly state the reasoning behind pit baking skulls. Another account states desert tortoise meat was also pit-roasted in ashes (Fowler 1995:109). Archaeological evidence from southern Nevada has identified animal bones in several roasting pits (Blair et al. 2000:183; Roberts and Lyon 2011).

V. EXPERIMENTAL TESTING OF ROCKS FROM THE SHEEP RANGE

Since beginning this project, I was curious as to why and under what conditions limestone in the Sheep Range changes color from heat exposure. After all, my ability to identify roasting pits from aerial photography, the basis of my entire thesis, would have been impossible without this color change. It is possible that the limestone was simply turned into lime, which requires temperatures around 900° Celsius. Since fuel is not necessarily plentiful throughout the Sheep Range, it seemed unlikely that fires were consistently getting that hot. Roasting pit middens are typically a mixture of white and non-discolored fire-cracked rock, including limestone, dolomite and other materials; suggesting that while several material types were being used for thermal storage, only some of them were changing color. I decided to test rock samples from the Sheep Range to determine the temperature threshold at which color change is observed. Powder X-Ray Diffraction tests were run on samples from both baked and unbaked samples to identify material type.

Background

Outside of the Sheep Range, the presence of white fire-cracked rock is also found associated with roasting pits. At the Agave Ovens site (26CK1991), located in the Virgin Mountains in southeast Nevada, McGuire et al. describe pieces of fire-cracked rock in the midden of a roasting pit as "burnt to white, almost transformed into lime, which would indicate a very high temperature burn" (McGuire et al 2013:77). Blair (1986:37), in her description of roasting pits within the California Wash region of southern Nevada claims that “limestone loses its heat retention properties after one time of use”. She later asserts that limestone has a naturally high thermal retention level when compared to other material types (cf. Jackson 1998), but does not explain why color change occurs.

The Sheep Range is comprised of sedimentary rocks formed during various geologic periods, including the Late and Middle Cambrian, Ordovician and Devonian periods (Stewart 1980). The Range is primarily comprised of limestone, with dolomite the most common minor constituent. Other materials found within the range, though to a lesser degree include: shale, quartzite, siltstone, sandstone, chert and general conglomerate.

Geologic data available from the National Resources Conservation Service (NRCS) was used to identify geologic formations that comprise the Range. Formations shown in Figure 5.1 are differentiated by color and a two or three-letter label. The Sheep Range is comprised of seven formations, labeled Cc, CZq, Oc, Dc, Mc, Sc and Ths.

The two formations which primarily comprise the Sheep Range are Cc (red) and Oc (orange). The light blue area (Dc), in the southern portion of the range, is where samples for this test were obtained. A brief description of each formation is as follows:

Dc - Formed during the Devonian period, this layer primarily consists of Devil’s Gate Limestone and dolomite (Sevy and Simonson), with minor amounts of sandstone and quartzite. This layer is also referred to as the Guilmette or Nevada formations.

Cc - Formed during the Late Cambrian to Middle Cambrian periods, this layer consists primarily of Geddes Limestone and dolomite (Eldorado and Hamburg) in addition to sporadic concentrations of shale and siltstone. This layer is also referred to as the Bonanza King formation.

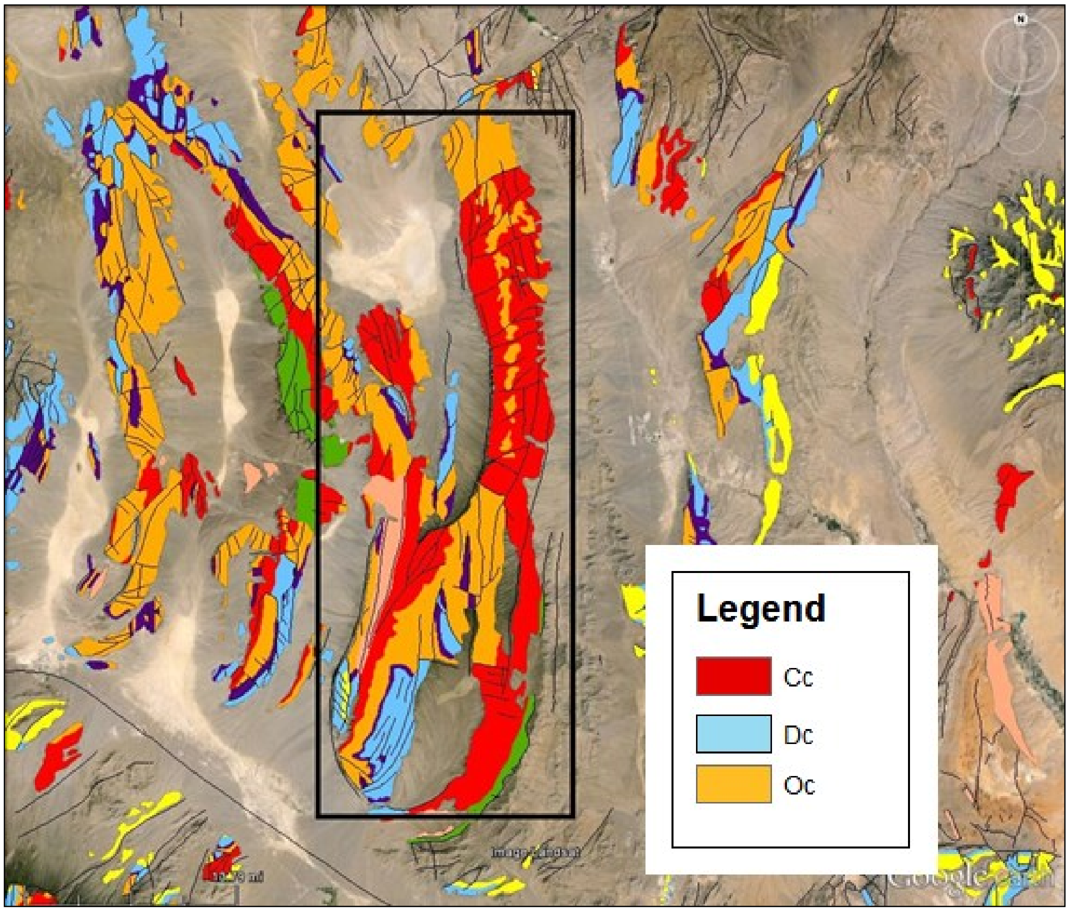


Figure 5.1. Geologic units of the Sheep Range (outlined). Note the Dc formation (blue) located in the bottom portion of the Range where samples were obtained.

Oc - Formed during the Ordovician period, this complex layer consists primarily of limestone and Ely Springs Dolomite, with smaller amounts of Eureka Quartzite, shale and chert.

Methods

Samples were obtained from Long Canyon's primary drainage located in the southern extent of the Sheep Range (Figure 5.2). This location was chosen based on the presence of several roasting pits located on an alluvial terrace overlooking an ephemeral wash. Prior to sample selection, fire-cracked rocks from a roasting pit, white or

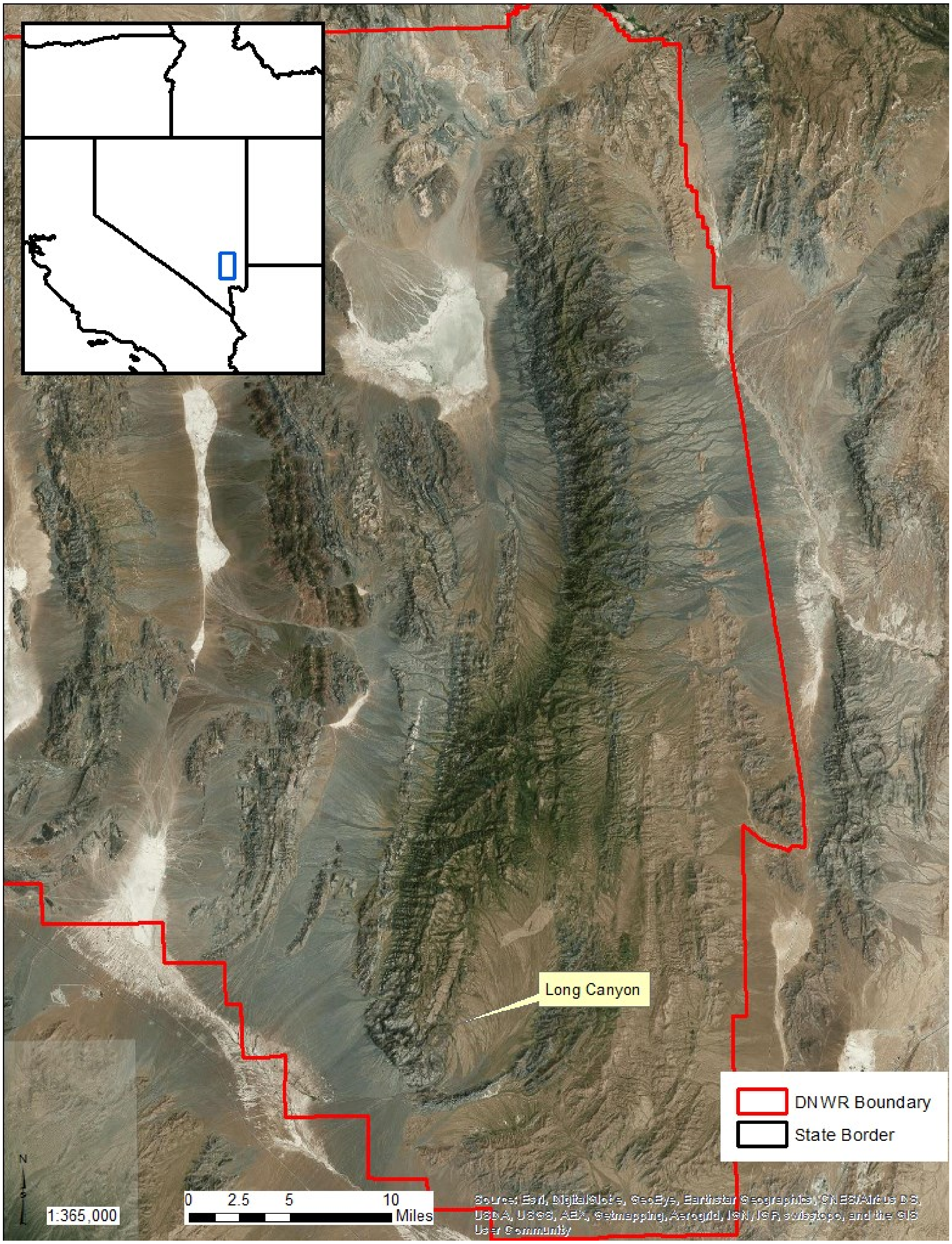


Figure 5.2. Location of Long Canyon (highlighted) where samples were obtained.

otherwise, were examined and compared to rocks naturally occurring in the drainage below. Based on the proximity to the wash and size of available material therein, the drainage was a likely source of rocks for prehistoric cooking in a roasting pit. Rock samples were chosen according to their appearance and texture based on similarities to white thermally-altered rock. Additional limestone samples were obtained from Cretaceous formations near Langtry, Texas for comparative reasons. In total, samples were separated into three different groups, assigned according to their color and texture, but Sample One was later omitted (Figures 5.3 and 5.4).

Figure 5.3. Group Two of rocks obtained from Long Canyon for thermal testing.

Figure 5.4. Group Three of rocks obtained from Long Canyon for thermal testing.

Testing began by randomly selecting a rock from each group and subjecting them to series of temperatures in an Amaco electric kiln model LT-3. The initial set of rock samples were heated up to certain temperatures. Once the peak temperature was reached, the kiln was shut off and subsequently cooled down. The kiln was opened the following day to assess whether any discoloration was observable. Tests continued until complete discoloration of the samples occurred. To determine the temperature at which color change occurs, the initial sample was heated to 500° C. Following tests were increased by roughly 50° until significant discoloration was observed (Table 5.1). All samples were heated up to 250° C in the kiln to assure they were devoid of moisture prior to testing.

Table 5.1. The peak temperatures and results of each thermal test conducted within the kiln.

Test Number	Peak Temperature	Result
Test 1	525° C	No change observed.
Test 2	650° C	No change observed.
Test 3	715° C	No change observed.
Test 4	750° C	No change observed.
Test 5	825° C	Slight white discoloration.
Test 6	875° C	All samples turned completely white.
Test 7	900° C	All samples turned completely white.

All tested samples turned completely white after reaching a peak temperature of 875° C. Since the same rock samples were used in all six initial tests, I wanted to be sure that peak temperature was causing discoloration as opposed to cumulative baking events. A seventh test was run with two Nevada limestone samples and one Texas limestone sample. Peak temperature for the seventh test reached 900° C.

After identifying the point at which the first rock samples turned white, I wanted to determine whether my samples were truly transformed into lime. I further tested my baked rock samples using X-ray powder diffraction (XRD) to determine their composition. XRD "is a rapid analytical technique primarily used for phase identification of a crystalline material and can provide information on unit cell dimensions" (Dutrow and Clark 2015). Results from the XRD test are then compared to an existing database of materials to determine what each sample is comprised of. With the assistance of Dr. Ben Martin, professor in the College of Science and Engineering at Texas State University, my samples were tested within the XRD lab.

To prepare my samples for XRD testing, I ground a section of each sample into a fine powder using a hand Dremel with a diamond bit. Each powder sample was then placed in individual 8cc paleomagnetic sample cubes prior to testing. XRD powder samples were obtained from rocks baked in the seventh test, as well as unbaked rocks from the same individual groups.

Results

The accumulative effect of baking rock samples numerous times to temperatures lower than 875° does not appear to be significant. Rocks samples from both Nevada and Texas turned white after being subjected to temperatures of 875° to 900° C. Before and after photos are shown below for a sample from Nevada and Texas (Figures 5.5 – 5.6).

Figure 5.5. Texas limestone before (left) and after (right) being heated to 900° C.

Figure 5.6. Nevada dolomite sample prior to baking (left) and after (right) being heated to 900° C.

XRD results are presented in the order in which they were obtained. The results from the Texas limestone sample (Figure 5.7) indicate high levels of Calcium Oxide (CaO) and Calcium Hydroxide ($Ca(OH)_2$), also known as quicklime or burnt lime. Quartz (SiO_2), Calcite ($CaCO_3$) were also present.

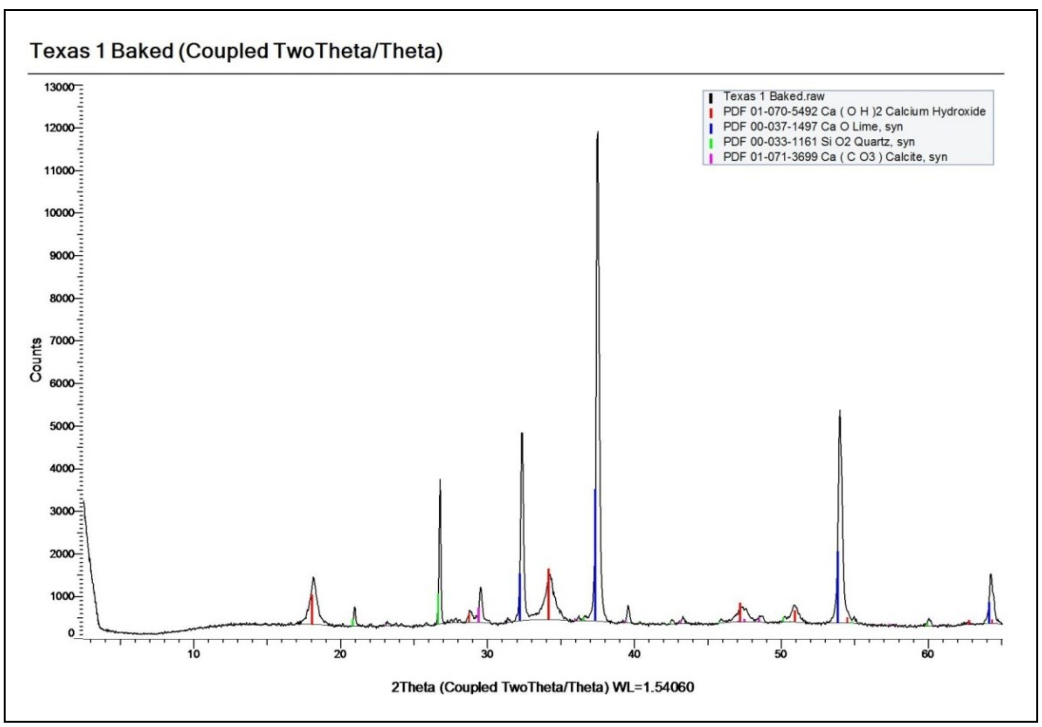


Figure 5.7. XRD reading of the baked Texas limestone sample.

Results for the Nevada sample were similar with one significant difference being the presence of Magnesium Oxide (MgO) (Figure 5.8). The limestone sample from Texas did not show any signs of magnesium. In addition to Calcium Oxide, the Nevada sample also had Calcite ($CaCO_3$) and Portlandite ($Ca(OH)_2$). Two baked Nevada samples were tested; however, results for the second sample were identical to the first and are therefore not provided here.

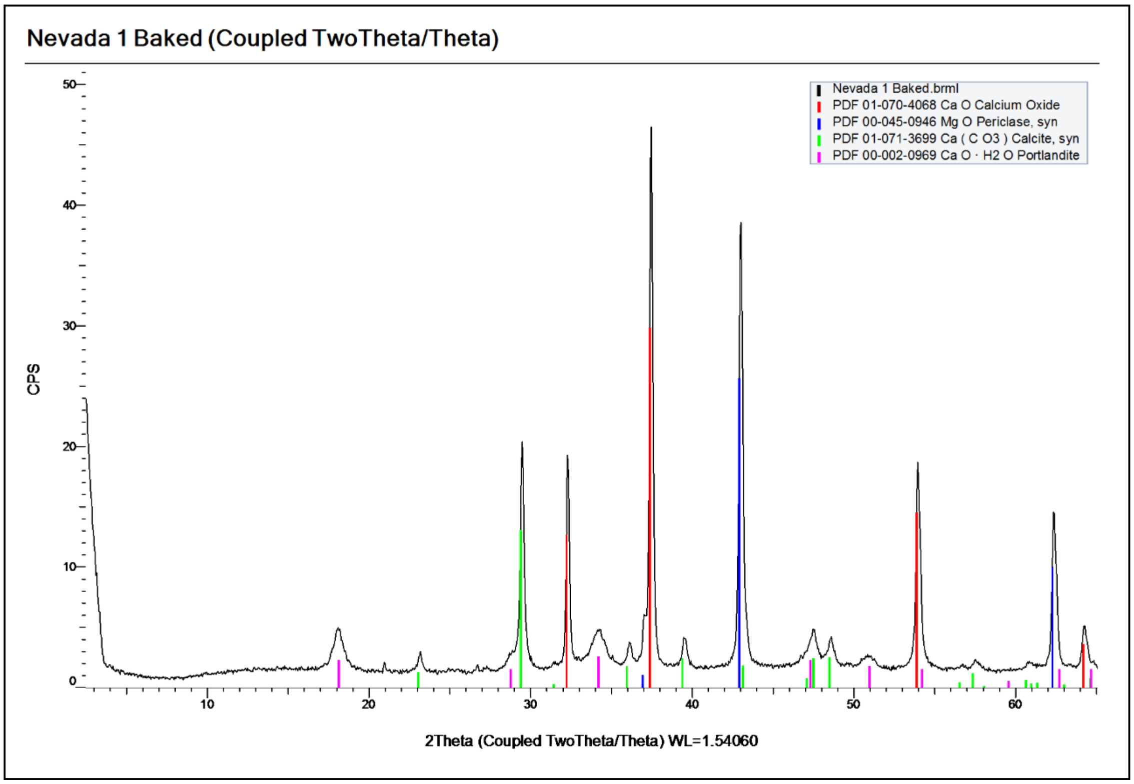


Figure 5.8. XRD reading of the baked Nevada sample. Note elevated levels of CaO and MgO.

After the initial tests were complete and the elevated amount of Magnesium was noted in the Nevada sample, additional XRD tests were run. For the second test, samples were obtained from unbaked rocks. The purpose of this test was to determine the material from Nevada was actually limestone. Care was taken to pick samples that were similar in color and texture to the originally baked rocks.

According to the second round of XRD tests, the material I was working with from Nevada was actually dolomite and not limestone (Figure 5.9). As previously mentioned, dolomite is also commonly found within the Sheep Range, but to a lesser degree than limestone. Dolomite and limestone have similar chemical composition with one notable exception. While limestone is composed of calcite or calcium carbonate ($CaCO_3$), dolomite is composed of calcium magnesium carbonate $CaMg(CO_3)_2$. For comparison, the XRD test for the Texas limestone is shown in Figure 5.10.

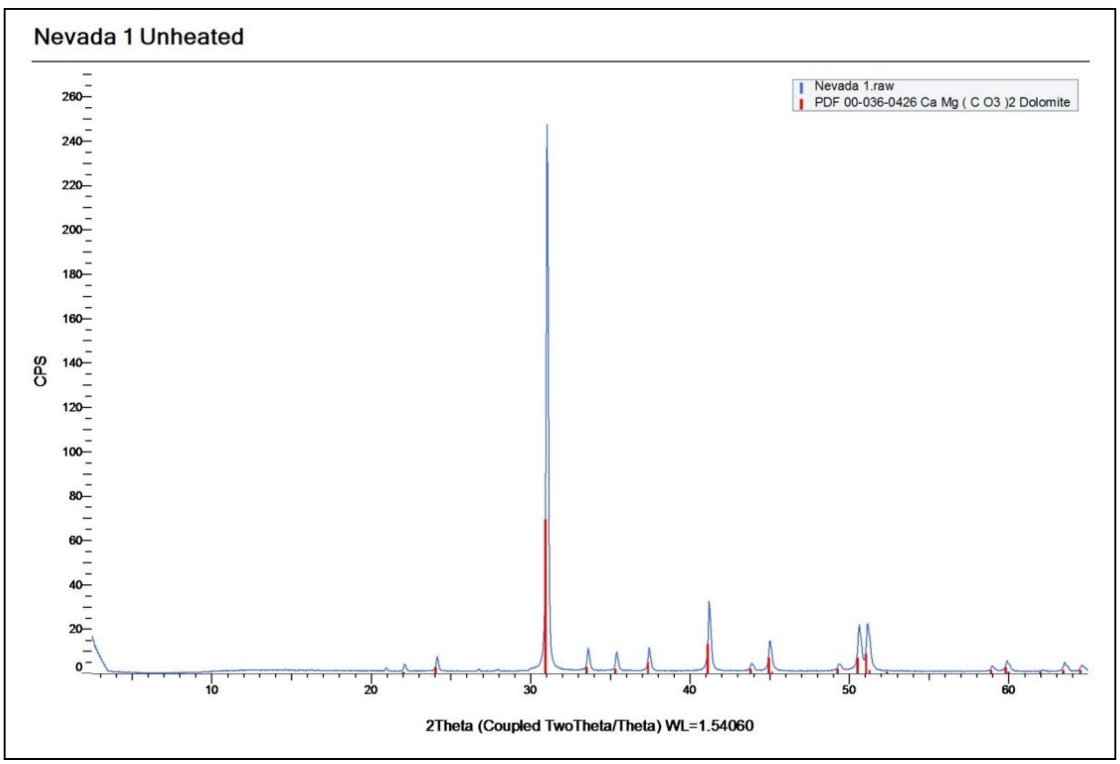


Figure 5.9. XRD results for an unbaked Nevada sample. Results indicate the rock is dolomite.

Determining the difference between limestone and dolomite based on macroscopic differences (color, texture) can be difficult. Small drops of hydrochloric acid will assist in assigning the correct type. According to a geology professor at Texas State University, hydrochloric acid dropped on limestone will cause it to fizz, while acid dropped on dolomite will not (Rene DuPont, Personal Communication 2015).

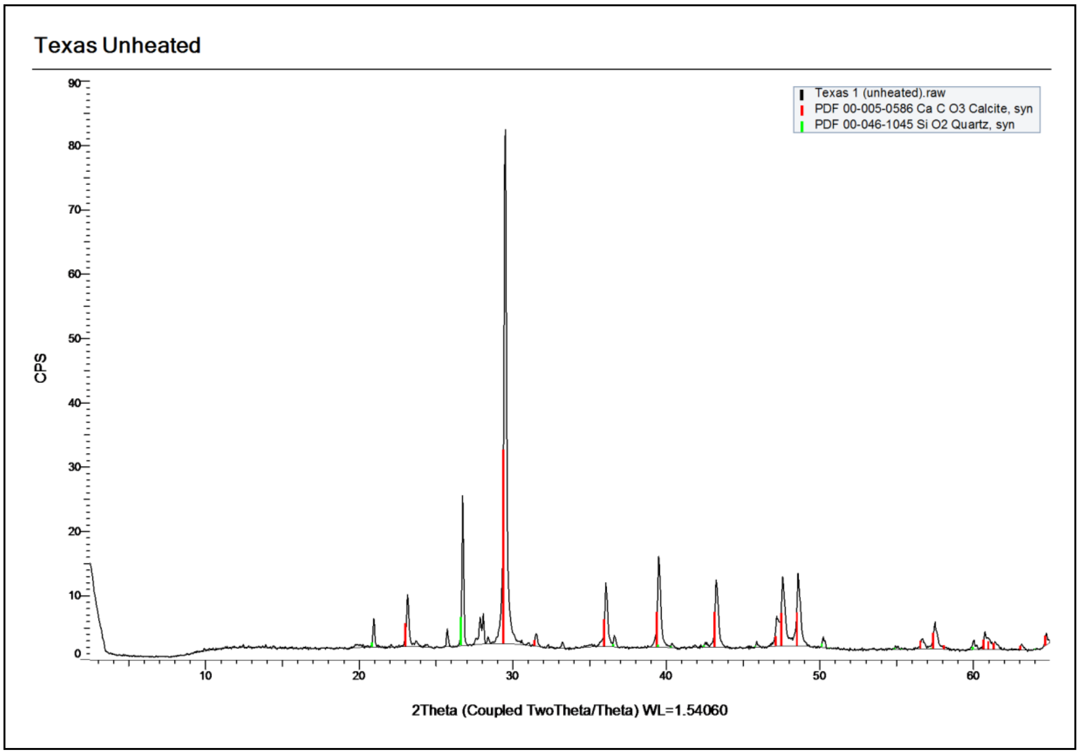


Figure 5.10. XRD results for an unbaked Texas sample. Results indicate the rock is limestone.

Discussion

Additional work is necessary to better understand the relationship between white thermally-altered rocks found at roasting pits in southern Nevada and their parent material. It is likely that roasting pits are comprised of both limestone and dolomite, since both are transformed white as a result of exposure to temperatures exceeding 875° C. However, it is possible that dolomite is more common due to chemical differences between the two material types. The primary difference between dolomite and limestone is the presence of magnesium as opposed to calcium oxide.

After rocks were used in a roasting pit, they were discarded and exposed to the natural elements where they began to reabsorb moisture and carbon dioxide. The reabsorption of moisture and carbon dioxide into the material may be enough to reverse the observed color change. This was observed experimentally when some heated samples shed their white exterior several days after exposure. Samples that did not shed were later confirmed to be dolomite through XRD. Unfortunately, samples that did shed were not tested by XRD prior to baking.

A possible explanation for why some rocks remain white while others do not may be due to inherent chemical differences. Magnesium oxide (found in dolomite) and calcium hydroxide (found in limestone) have different rates of water solubility. Magnesium oxide has a water solubility of .00062g/100mL (0° C), while calcium hydroxide is .189g/100mL (0° C) (Benjamin Martin, Personal Communication 2016). Calcium hydroxide is therefore nearly 305 times more water soluble than magnesium oxide. It is possible that the presence of magnesium allows baked dolomite to resist moisture more than limestone and thus has a greater chance of remaining white. However, research is necessary to test this hypothesis.

Another explanation may be due to the environment. High concentrations of white thermally-altered rock are not typically found associated with earth oven facilities elsewhere in the world. It is possible that the southern Nevada environment is so arid, especially during the periods when earth oven baking was most commonly conducted, that moisture reabsorption was a non-factor. It is interesting to note that nearly all heated samples shed their white exterior several days afterwards. Rocks shedding may be due to increased humidity levels in Texas as opposed to Nevada. Rarely is white FCR found associated with earth oven facilities in Texas.

Temperatures between 900 – 1100° Celsius are required to create limestone and dolomite white. If fires were commonly this hot, why does every roasting pit I documented have non-discolored fire-cracked limestone associated with its midden? It stands to reason that rocks closest to the heat source and subjected to the greatest amount of heat were more likely to be transformed It is possible that all non-discolored fire-cracked limestone and dolomite samples were simply not subjected to the same degree of heat as those pieces that turned white.

Expanded experimental research with Nevada baked limestone and dolomite is warranted. Future research should include testing thermally-altered rocks from roasting pits, both white and otherwise. Conducting XRD on thermally-altered rocks may indicate whether dolomite is more likely to remain white than limestone. Testing should also indicate the different types of material used for thermal storage within roasting pits.

VI. METHODS

The methods used to locate, document and analyze roasting pits within the Sheep Range are discussed herein. In short, Google Earth was utilized to identify roasting pits. Roasting pit locations were then accessed, either by foot or helicopter, and documented using standard field methods. After this data was incorporated into a geographic information system (GIS), additional analysis was conducted to further understand the location and setting in which roasting pits were typically constructed. These methods were used to identify and analyze over 230 roasting pits within the Sheep Range, of which 193 were documented in the field.

This project was born from observations made by Fish and Wildlife Regional Archaeologist Anan Raymond. Following a survey project in late September 2011 at Desert National Wildlife Refuge (DNWR) during which we encountered a number of roasting pit features, Anan remarked at the mass of white rocks found in association with each cooking feature. He wondered whether these features would be identifiable from aerial imagery provided by Google Earth.

Shortly after beginning my stint as the DNWR refuge archaeologist in 2012, I field tested several Google Earth images of potential roasting pits provided by Anan which served as the foundation of this research. A survey was conducted of the locations corresponding to the aerial images to test the validity of this claim. After two separate surveys returned positive results, it was apparent that many Sheep Range roasting pits are clearly visible on aerial imagery. I then began to use Google Earth to systematically search the Sheep Range and adjacent ranges to look for more of these features.

Google Earth

The process I used to identify roasting pits via Google Earth was relatively straight forward. Archaeological literature was initially reviewed to determine the most common landscapes upon which roasting pits were built in southern Nevada. According to Brooks (1982), roasting pits are typically found close to agave stands, near permanent to semi-permanent water sources and fuel resources. Brooks also noted that roasting pits in the Las Vegas valley were typically found above 3,000 feet elevation, while subsequent archaeological reports have documented their presence at various elevations in the region (Blair 1986; Roberts and Lyon; Louderback et al. 2013).

Based on these archaeological accounts, I focused my search at the mouths of canyons and drainages extending from either side of the Sheep Range. My initial search began at the mouth of the canyon containing Cabin Springs, a west facing canyon at the border of Clark and Lincoln counties. This location was chosen for numerous reasons: It is a central location for the Sheep Range as a whole; it is in close proximity to a known water source (Cabin Springs); and there are several previously identified roasting pits in close proximity. After each potential roasting pit location was marked in Google Earth using the pushpin function, their UTM coordinates was transferred into ArcMap 10.2. Immediately after transferring the first points into Google Earth, I became aware that some roasting pits within the Sheep Range had been previously identified and noted on topographic maps.

As depicted in Figure 6.1, several “Ruins” were found randomly dispersed across topographic maps covering the Sheep Range. These Ruins denote the location of large roasting pit features originally identified by the cartographers who mapped the region using aerial photography. Once it was discovered that Ruins represent roasting pits, their locations were identified using ArcMap and subsequently located in Google Earth.

After all 24 Ruins noted on topographic maps of the Sheep Range were located and their positions marked, I began my identification effort using Google Earth at the canyon containing Cabin Spring.

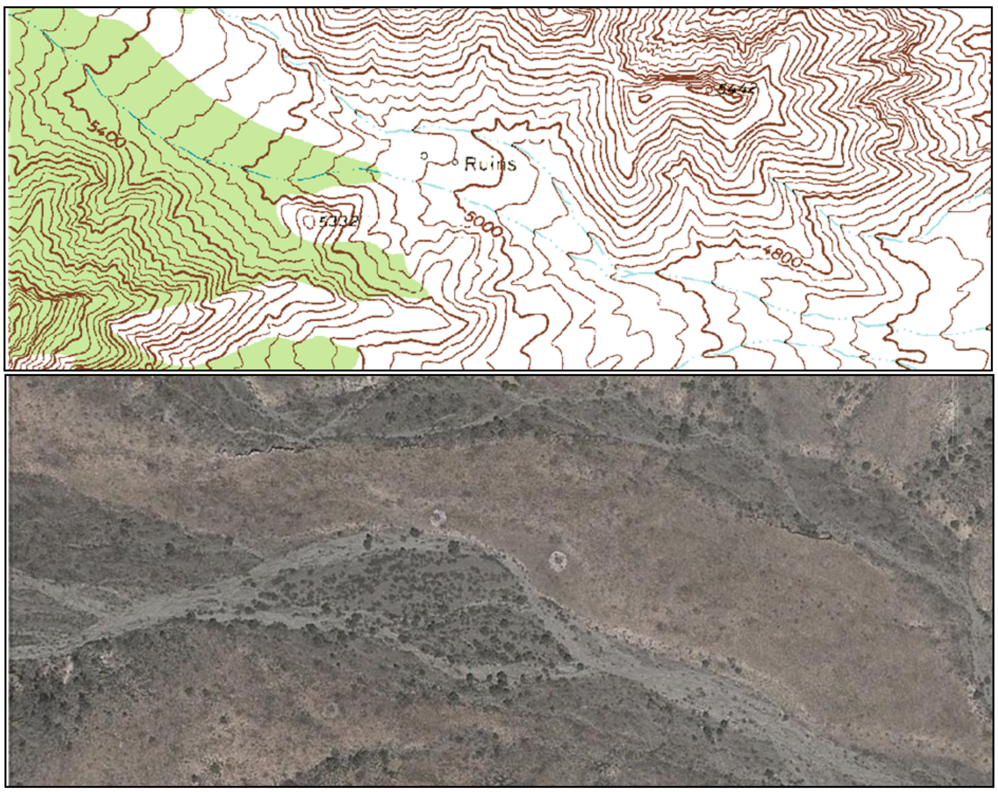


Figure 6.1. A comparison between a topographic map with two roasting pits labeled as "Ruins" (top) and a corresponding image from Google Earth (bottom) showing the same roasting pits.

The general method employed to identify roasting pits was simple and straight forward. From the initial location of Cabin Spring, I continued scanning northward along the western side of the Sheep Range. My general focus was along the head of each alluvial fan while inspecting every drainage encountered. It was quickly determined that these features are most clearly visible from 7,000 - 10,000 feet above the ground surface in Google Earth. From there, the search continued northward and incorporated each canyon and corresponding alluvial fan within the Sheep Range.

Using the pushpin function in Google Earth, each potential feature was documented and a corresponding color assigned based on how convinced I was of its validity. Green stood for likely, red for unlikely and yellow for possible. Additional searches were later conducted in the Las Vegas, Mule Deer and East Desert ranges with extremely limited success. In total, over 200 suspected roasting pits were identified in the Sheep Range using this method.

Access

Once roughly 100 potential roasting pits were identified, field work was conducted to evaluate the localities that proved to be roasting pits. Accessing these localities was initially accomplished by foot. Gravel roads of varying quality provide the primary means of travel through the Refuge and these were used to get as close as possible to roasting pit locations. From there, I typically hiked uphill along alluvial fans and ephemeral washes to wherever the potential roasting pit was located. Printed maps and a Trimble GPS unit were both used in the field to locate potential roasting pit locations.

After nearly 80 roasting pits were accessed by foot and documented, I was fortunate to be able to utilize a helicopter to reach more isolated areas. Some roasting pits, most notably those located on the eastern side of the Sheep Range, are located up to eight miles away from the nearest road. Coordinates for all potential roasting pits were provided to the pilot prior to the excursion, with the goal of recording about ten a day. In a stereotypical canyon, I was dropped off at the furthest uphill roasting pit locality the pilot could access and worked my way downslope to the lowest feature, recording all roasting pits encountered along the way. Several features were identified while in transit that were otherwise too faint to be identified via Google Earth. Helicopter travel also allowed me to investigate topographic landforms where roasting pits were often found elsewhere in the Sheep Range, but did not produce positive hits in aerial images.

Helicopter transportation allowed my coworker and I to record many roasting pits over short periods of time. Over the course of three separate, three-day trips nearly 90 roasting pits were recorded using this method; without the helicopter most would have likely remained unrecorded due to inaccessibility.

Recordation

Documentation typically began by measuring the roasting pit, including the exterior length and width of the associated ring midden, the length and width of the central depression, the height of the surrounding midden relative to the surrounding landscape and the dimensions of the cooking pit when clearly defined (Figure 6.2). Total length and width measurements were taken from the exterior edges of the roasting pit as defined by the extent of contiguous FCR of each ring midden. Scattered FCR beyond the concentrated debris were ignored. Measurements were then taken of the central depression, which are often relatively flat in comparison to the mounded ring midden surrounding it. The extent of each central depression was determined by the point at which the raised

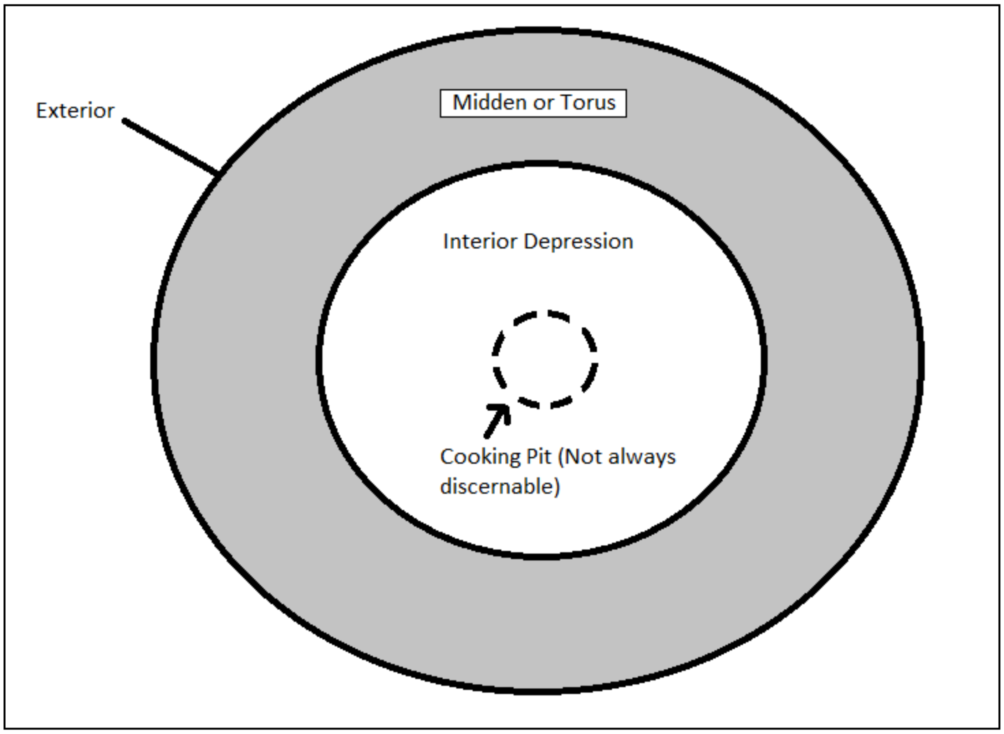


Figure 6.2. Schematic illustrating the terms used for defining a roasting pit.

surrounding ring midden met with the flat interior portion. Due to the irregular nature of these features, length and width were arbitrarily assigned to North-South and East-West measurements respectively.

Additional measurements including midden height and slope were also attempted, however, these often proved troublesome. Midden height was determined with string, line level and measuring tape from the center of the pit to the peak of the surrounding ring midden. However, these measurements are likely unreliable given the unknown depth of the original ground surface. The measurement of slope for each pit was also attempted, however, since these measurements were often inaccurate due to difficulties in differentiating the landscape's original slope from that of the roasting pit.

A meandering survey was also conducted around the vicinity of each roasting pit to identify associated artifacts, additional roasting pits and potential food resources. The extent of each survey was determined by the landscape surrounding each pit and the available time. Adjacent ridges were given higher priority than adjacent washes due to the potential of identifying in situ artifacts. When additional earth ovens were identified during survey, often because these features were too ephemeral to be seen on aerial images, GPS coordinates were obtained using a Trimble. Identified artifacts were measured, photographed and recorded among the overall roasting pit notes. The Refuge's non-collection policy was strictly followed.

Photographs of each roasting pit were taken from as many angles as feasible. Due to the size of these features some difficulties were encountered. In dense pinyon-juniper environments, the presence of trees often made capturing the extent of a roasting pit difficult without obscuring the view. In areas lacking tree cover, the bright mid-day sun combined with the white thermally-altered limestone made it difficult to capture the extent of some roasting pits. Photographs were sometimes bleached out or the extent of the roasting pit blended in with the surrounding environment. Additional photographs were taken with a survey participant or measuring stick placed in the center of the feature to provide scale to both the height and extent of the roasting pit. These photographs were taken on the same plane as the roasting pit so as not to distort the height of the surrounding midden. The first photo was taken from a standing position, while the second was taken while kneeling. While this method helped provide general contrast for the size of the roasting pit, its usefulness in providing accurate measurements of the surrounding midden yielded mixed results. Photographs were also taken of any artifacts identified in association with these features.

Finally, written descriptions were made at each roasting pit location. These notes documented the overall condition of the roasting pit, the topographic landform they were built on, the surrounding biotic zone, foodstuffs associated with roasting pits within view of the feature, descriptions of artifacts and site elevation.

Roasting pit condition was described in terms of the degree to which settling and erosion had affected their form. Deflated roasting pits middens are flattened and the presence of carbon-stained sediment is evident. The flat appearance is due to erosional forces filling the central depression of roasting pits with sediment. Such roasting pits with a significant amount of infilling may be older than roasting pits with more deeper central depressions (Ellis et al. 1982:55). Middens of non-deflated roasting pits come to a sharper apex at the top and have a higher ratio of rocks consisting of both thermally-altered and non-thermally-altered limestone, to carbon-stained sediment. Roasting pit condition was also determined based on erosion. As roasting pits were commonly constructed adjacent or sloping into an active drainage, many of these features have been partially eroded by monsoon rains.

Topographic landform descriptions considered both the micro and macro placement of roasting pits. This included, for example, if a roasting pit was constructed on a small finger ridge (micro) as part of a larger alluvial fan (macro).

The environmental zone surrounding a roasting pit was characterized using Rhone's (2002) description of biotic zones for southern Nevada. I searched for key indicator plants belonging to specific biotic zones, such as the presence of creosote, as well as the elevation the feature was located at. If a biotic zone was not easily determined, note was taken of the two closest biotic zone types that appeared to have blurred together in said location.

Additional notes concerning the presence of edible plant foods, elevation and types of artifacts found near the roasting pit was also taken. The presence or absence of plant foods believed to have been cooked in roasting pits, such as yuccas and agave, were noted based on their visibility from the roasting pit. Elevation and location data was collected in the field using a Trimble and later cross referenced using Google Earth and topographic maps in ArcMap. Artifacts were described in detail and determination of artifact type, such as projectile point or pottery type, were made to the best of my ability in the field. Additional analysis and identification of artifacts was made later from photographs taken in the field.

Each recorded roasting pit was assigned a unique number (i.e. RP-053) and documented separately from other features found in the vicinity. Number designations refer to individual roasting pits, as opposed to individual archaeological sites. When multiple roasting pits were found at a given location, identified features were individually numbered but recorded as a single site. Copies of photographs and site forms for all documented roasting pits in the Sheep Range are curated at the Desert National Wildlife Refuge.

Geographic Information System (GIS)

Key data collected concerning roasting pits in the Sheep Range was loaded into ArcMap 10.2, otherwise known as GIS. A shapefile was created which included every roasting pit identified by Google Earth and another shapefile for every roasting pit documented in the field. As mentioned, when a potential roasting pit was identified via Google Earth, its coordinates were uploaded into a shapefile in ArcMap. Potential roasting pits were turned into verified roasting pits following field documentation. Additional metadata, including the location, elevation and measurements of the roasting pit, as well as the presence of artifacts and foodstuffs found nearby were also added to this shapefile.

Three methods of analysis were used with GIS as part of this thesis. They are: Nearest Neighbor and Hot-Spot analysis, as well as analysis with a vegetation coverage map for the Sheep Range. The Nearest Neighbor analysis tool in ArcMap is useful for determining the spatial relationships within a dataset. Of primary interest to me is whether roasting pits in the Sheep Range are considered a spatially clustered dataset. In other words, I want to know whether they tend to occur close to one another or are more scattered throughout the Range. Hot-Spot analysis was conducted to determine whether roasting pits are significantly clustered according to their size.

My final analysis with GIS utilizes a “living” vegetation map (Peterson 2008). This raster GIS file provides a synthesis of vegetation maps collected from all over the state. For the Sheep Range, this information provides the ability to quantify coverage of the various vegetative communities I documented in the field. As Peterson notes, this synthesis map is not a completed product, as one should expect for such an expansive dataset combined from many sources. However, this data provided me another avenue through which to analyze my survey methods, as well as the vegetative assignments I made in the field.

VII. RESULTS AND ANALYSIS

This chapter presents the results of my survey data as well as GIS and statistical analysis. I begin with the documentation of roasting pits, including the overall number of earth oven facilities recorded in the Sheep Range and the artifacts found in association. Next, size variation of roasting pits is discussed, followed by a breakdown of the vegetative communities they are found in. Statistical tests including regression and Mann-Whitney U were performed on roasting pit size classes according to vegetative zone to determine significance. A chi-squared goodness of fit statistical test was run to assess the accuracy of roasting pits in Pinyon-Juniper communities. Finally, Geographical Information Systems (GIS) analytical tools including Nearest Neighbor and Hot-Spot analysis were used.

Roasting Pits in the Sheep Range

Using Google Earth to identify roasting pits within the Sheep Range proved highly successful, with 193 suspected roasting pits located and subsequently field documented (Figure 7.1). An additional 39 potential roasting pits were identified as well; however, time did not allow for these features to be evaluated (Figure 7.2). The success rate of this method was very high after I became accustomed to the process. Following my initial field test, approximately 85% of all suspected roasting pits were confirmed to be legitimate features. Roasting pits with a well-defined ring midden were easily identifiable, while older earth oven facilities infilled with sediment were more prone to blend into the surrounding landscape. The remaining 15% of potential roasting pits often turned out to be patches of exposed bedrock or locations washed out by the sun. Roughly 10% of all documented roasting pits were not identified via aerial imagery, but rather discovered in the field while accessing suspected roasting pits.

It stands to reason that the longer a roasting pit is subjected to the elements, the greater effect erosion will have on the feature. Some roasting pits in the Sheep Range appear older than others due to a greater amount of sediment infilling their central depressions. Substantial vegetation growing from the central depression of a roasting pit, such as a Pinyon, Juniper or Joshua tree, may also indicate greater antiquity than features lacking such vegetation.

Roasting pits initially recognized in the field were either older infilled earth ovens or smaller features which I infer were not extensively used. Older roasting pits were differentiated from standard roasting pits by their physical state and the degree of erosion.

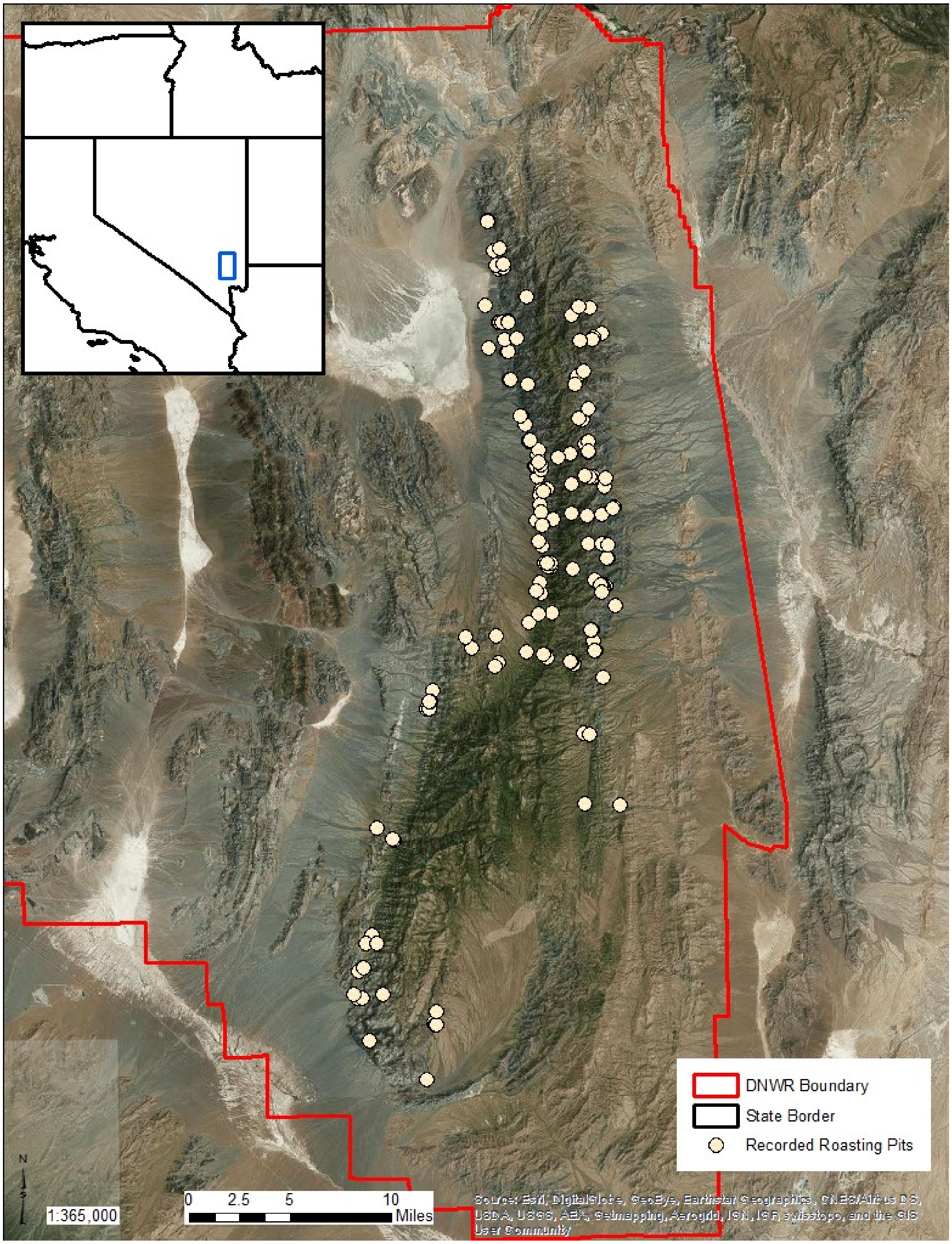


Figure 7.1. Location of every roasting pit documented for this thesis. Note that not all 193 roasting pits are visible due to overlap that occurs at this scale.

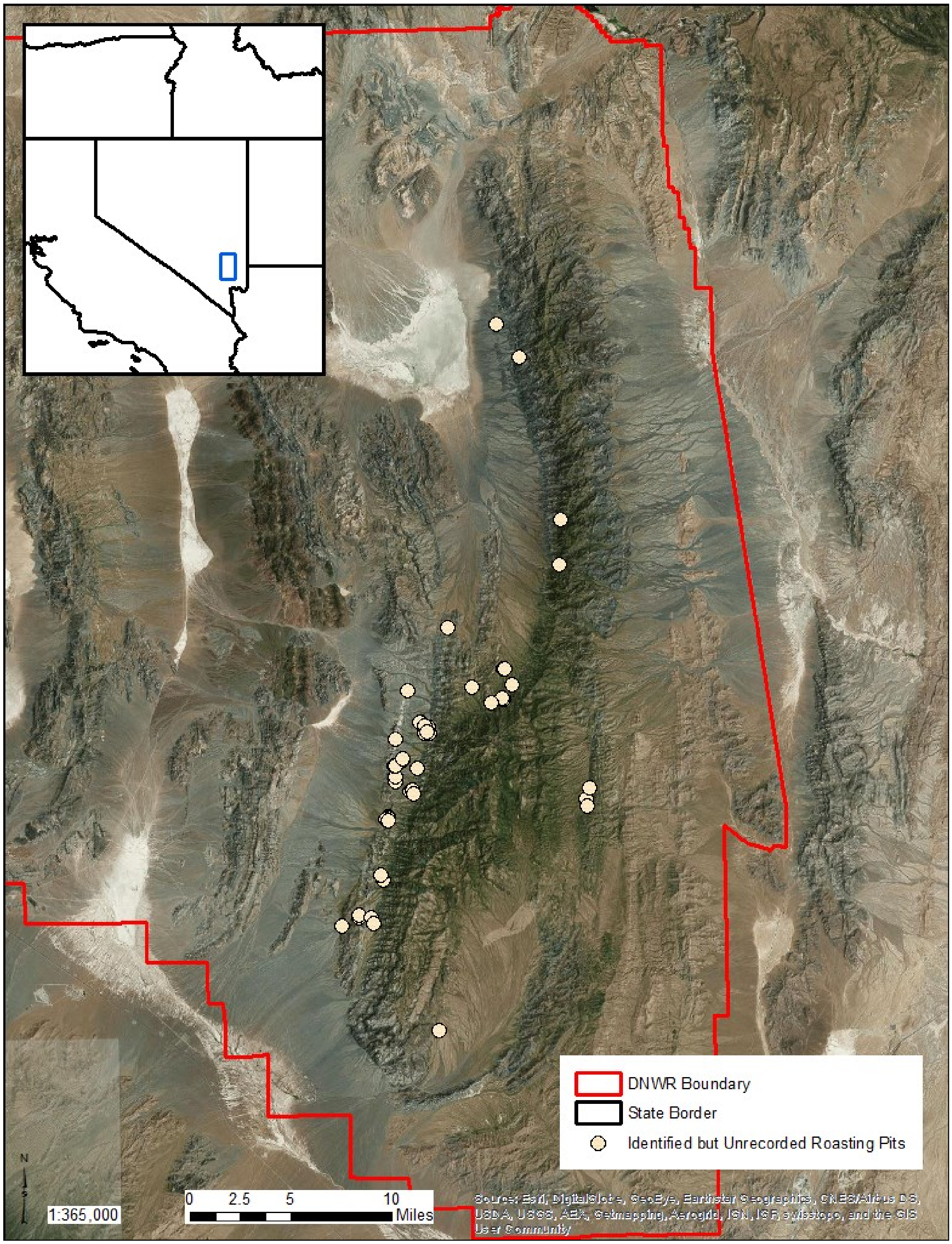


Figure 7.2. Potential roasting pits identified in Google Earth but not recorded. Note that not all 193 roasting pits are visible due to overlap that occurs at this scale.

Infilled roasting pits appeared flatter and less topographically distinct than a typical roasting pit (Figure 7.3). Due to the greater amount of erosion, seemingly older roasting pits were less likely to have a pronounced ring midden. Grass and other vegetation growing within apparently older roasting pits also partially obscured the extent of the middens.

Figure 7.3. Example of an older deflated roasting pit with a tree growing in the center.

Smaller cooking features were also identified in the field, including possible griddles and small roasting pits. Griddles are small cooking surfaces consisting of a tight and relatively flat cluster of fire-cracked rocks in which food is placed directly on top to cook in an open environment. Small tight clusters of white thermally-altered rock measuring a meter or less in diameter were interpreted as griddles. When identified, griddles were found as isolated occurrences and were not concentrations of FCR that eroded downslope from another roasting pit. None of these features were included within the overall roasting pit dataset.

Small roasting pits appear to be features that were simply not extensively used, thus only modest amounts of cooking debris accumulated. Like older roasting pits, smaller features including minimally utilized roasting features and apparent griddles were often found in proximity to other larger roasting pits. Small roasting pits were included in the overall roasting pit count.

A possible single use feature identified in the field was RP-174 (26LN7095) located on a bajada overlooking Desert Dry Lake (Figure 7.4). The roasting pit appears to be an example of a single-use roasting pit feature (Figure 7.5). The feature consists of a central cooking pit characterized by a concentration of large rocks and pieces of charcoal, surrounded by an incomplete single line of white thermally-altered rocks. Roasting Pit 174 was difficult to recognize photographically due to the small number of visible white limestone cobbles. However, it is interesting that white FCR appear to have been purposefully placed in a circle surrounding the central cooking feature at a set distance away as opposed to haphazardly discarded from the cooking pit. Also, the central "depression" of the roasting pit, though in this instance the entire feature was flat, appears to have been prepared. Rocks within the central portion of RP-174 were predominately uniform in size and completely devoid of larger rocks. No artifacts were found associated with this roasting pit.

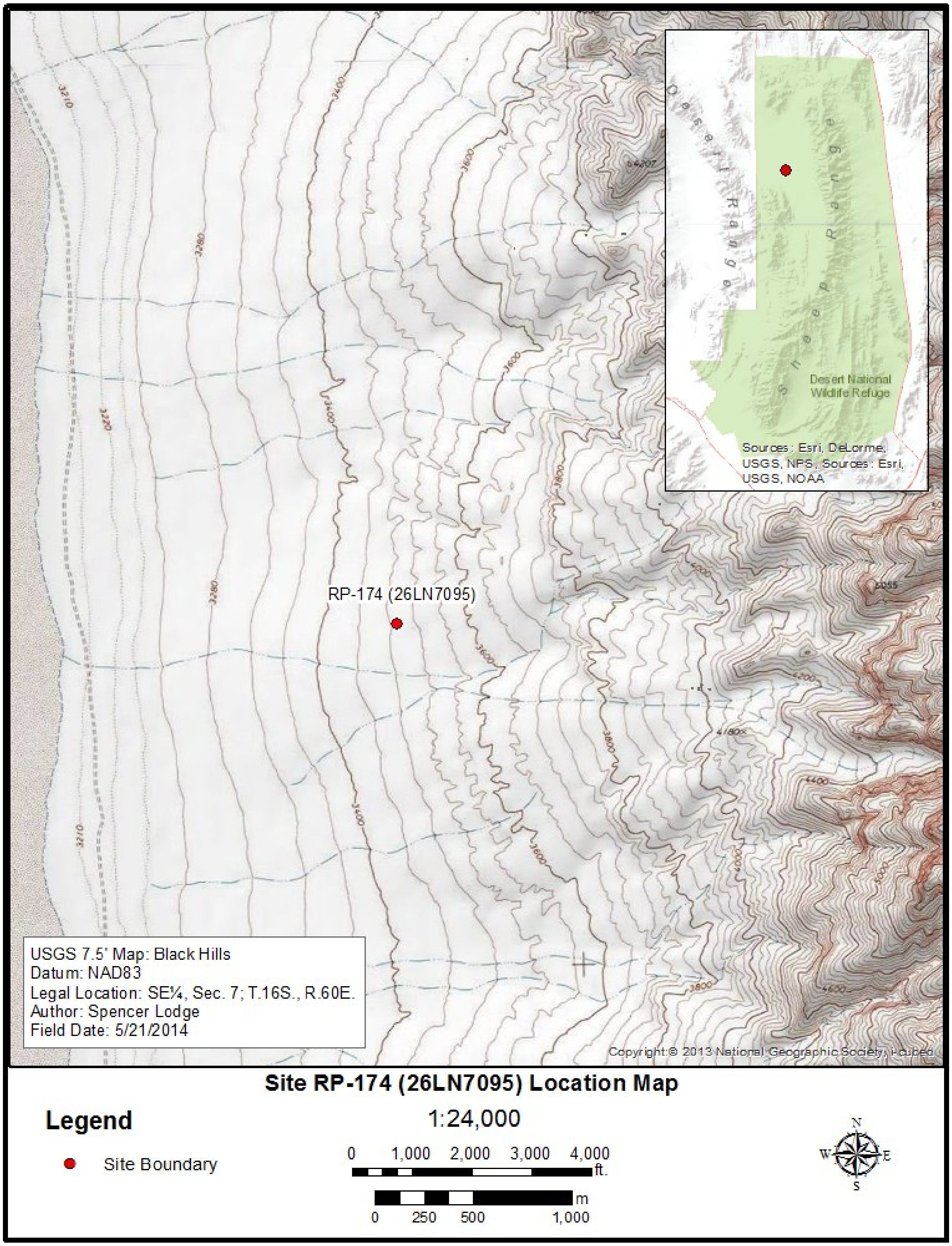


Figure 7.4. Location map for RP-174 (26LN7095), a possible single-use roasting pit.

Figure 7.5. Photo of RP-174 (26LN7095), a possible single-use roasting pit (circled).

Roasting Pit Size Variation and Composition

The size of roasting pits throughout the Sheep Range varied by the dimensions of the exterior, torus and central depression. Accurate measurements could not be obtained on certain features due to severe erosion. In some instances, exterior dimensions were misleadingly elongated as thermally-altered rock eroded downslope. Older roasting pits were often overgrown with vegetation and partially covered with sediment making accurate measurements difficult.

Visible exterior dimensions of measureable roasting pits varied from 6 to 20 m in diameter and averaged 10.3 by 10.3 m (i.e., circular). Of the 193 documented roasting pits, 178 had adequate definition to be considered for this measurement. Acceptable central depression measurements varied from 1.2 to 6 m in diameter and averaged 3.7 by 3.6 m. Accurate central depression measurements were obtained from 148 of the 193 documented roasting pits. The area of the torus of a roasting pit, also referred to as a ring midden, was measured by subtracting the central depression dimension from the exterior dimension for a given roasting pit. The result was subsequently converted into square meters using the formula for a circle. Torus size ranged from 16 to 174 m^2 with an average of 81 m^2. Appendix A provides the measurement data for individual roasting pits.

Measuring the height of the ring midden would be helpful to determine volume associated with each roasting pit. Unfortunately, measuring midden height was not successful in the field for two reasons. The first reason is based on the surrounding topography, as it was typically impossible to determine where the underlying ground surface ended and the overlying midden began. The second reason is due to the inconsistent height of the midden itself, as the downslope side of the feature consists of more debris than the uphill side.

While roasting pit dimensions fluctuated, their shape remained typical of earth oven facilities found throughout the southern Nevada area (e.g., the Agave Ovens site, 26CK1991; McGuire et al. 2013:74). Most recorded Sheep Range roasting pit features have a relatively circular ring midden surrounding a predominately circular central depression. Within the Sheep Range, the surrounding ring midden was comprised of thermally-altered and non-thermally-altered rock, charcoal, dark carbon-stained sediment and artifacts. Rocks were predominately limestone and dolomite but occasionally included other types. Rock size varied from coarse gravel to large cobbles. Pieces of charcoal were sometimes observed among the midden, typically ranging in size from 1 to 3 cm. Dark midden sediment was not always observed, especially among older deflated features and younger non-deflated features comprised primarily of larger rocks. When observed, artifacts found atop the midden included stone tools and pottery sherds. Other artifacts were found on the surrounding terrain in proximity to a feature.

Central portions are often lower than the surrounding FCR midden, creating a central depression. Small gravels typically dominate the central depression whereas larger rocks dominate the surrounding midden. While not usually observable from the surface, distinct cooking pits were sometimes apparent within the central depression of a roasting pit. When present, cooking pits were defined by a concentration of fist-sized cobbles that averaged a meter in diameter and were near the center of the overall feature (Figure 7.6). The size of cooking pits varied from 70 to 160 cm with an average size of 100 by 100 cm (i.e., 1 m in diameter). Cooking pits were observed in 23% (45/193) of all documented roasting pits.

Figure 7.6. An example of a defined cooking pit at Roasting Pit 110.

The overall condition of a roasting pit, that is to say the degree of erosion, differed in various ways. Three apparent differences were a roasting pit's overall definition, the composition of its midden and the degree of sediment infilling. The definition of a roasting pit was primarily judged by gauging the exterior and central depression extents of the feature. Visibly distinct roasting pits have clearly discernible boundaries, both for the exterior and the central depression. Visibly indistinct roasting pits have a midden whose overall extent is exaggerated by erosional forces, artificially elongating a feature's exterior size (Figure 7.7). The central depressions of poorly defined features were completely indiscernible from the surrounding midden, so that it was impossible to distinguish where one began and the other ended (Figure 7.8).

Figure 7.7. Example of a roasting pit (RP-074) not chosen for analysis due to the effect of erosion on the feature. The exterior dimensions of this roasting pit have been misleadingly increased as white FCR (which continues downslope off camera) erodes downslope on either side.

Figure 7.8. Example of a roasting pit (RP-108) without a discernible central depression.

The upper surfaces of middens varied in their composition in regards to the ratio of fire-cracked rock to sediment. Some roasting pit middens consisted of coarse matrix that appeared to be mostly rock-on-rock, such that space was easily observable in the voids left between rocks. Other middens consisted of rocks suspended within fine matrix. Roasting pits with more pronounced sediment often, though not always, appear to be deflated as if covered by colluvium over a greater period of time, as compared to rock-on-rock middens.

The landform upon which a roasting pit was constructed plays a significant role in preserving or hastening in the erosion of the feature. Roasting pits constructed at the base of a hill were often filled with sediment due to sheet wash. Earth ovens constructed directly adjacent or sloping into an ephemeral wash were more likely to have a portion of their midden eroded away, decreasing the feature's definition. Conversely, roasting pits built near the apex of a landform in wooded areas were often in pristine shape.

Associated Artifacts

Lithic debitage, pottery sherds, groundstone, bifaces and unifaces were the artifact types identified at roasting pit sites. Artifacts were not commonly found at roasting pits. Of the 193 documented roasting pits, artifacts were identified at 86 (45%) of them. Lithic debitage was the most frequently identified artifact type, followed by pottery sherds, bifaces, groundstone and unifaces.

Lithic Debitage

Lithic debris was the most commonly identified artifact type associated with roasting pits, found at 69 sites (Figure 7.9). Secondary and tertiary bifacial thinning flakes were the most common. Four cores were found at three roasting pit sites (RP-71, 105 and 156) and the majority of identified primary flakes were located at these sites. Pressure flakes were uncommon but hard to see and almost entirely observed only at multicomponent or saddle sites, where primary flakes were often observed as well. In general, pressure and primary flakes were found at sites with larger lithic assemblages. While the presence of debitage was typically identified in low densities, often ranging from 1 to 10 flakes, this was not always the case. Significantly increased debitage counts were observed at a few sites, most notably on saddles and in close proximity to springs. Roasting pits found in these settings often do not have a standard raised circular midden

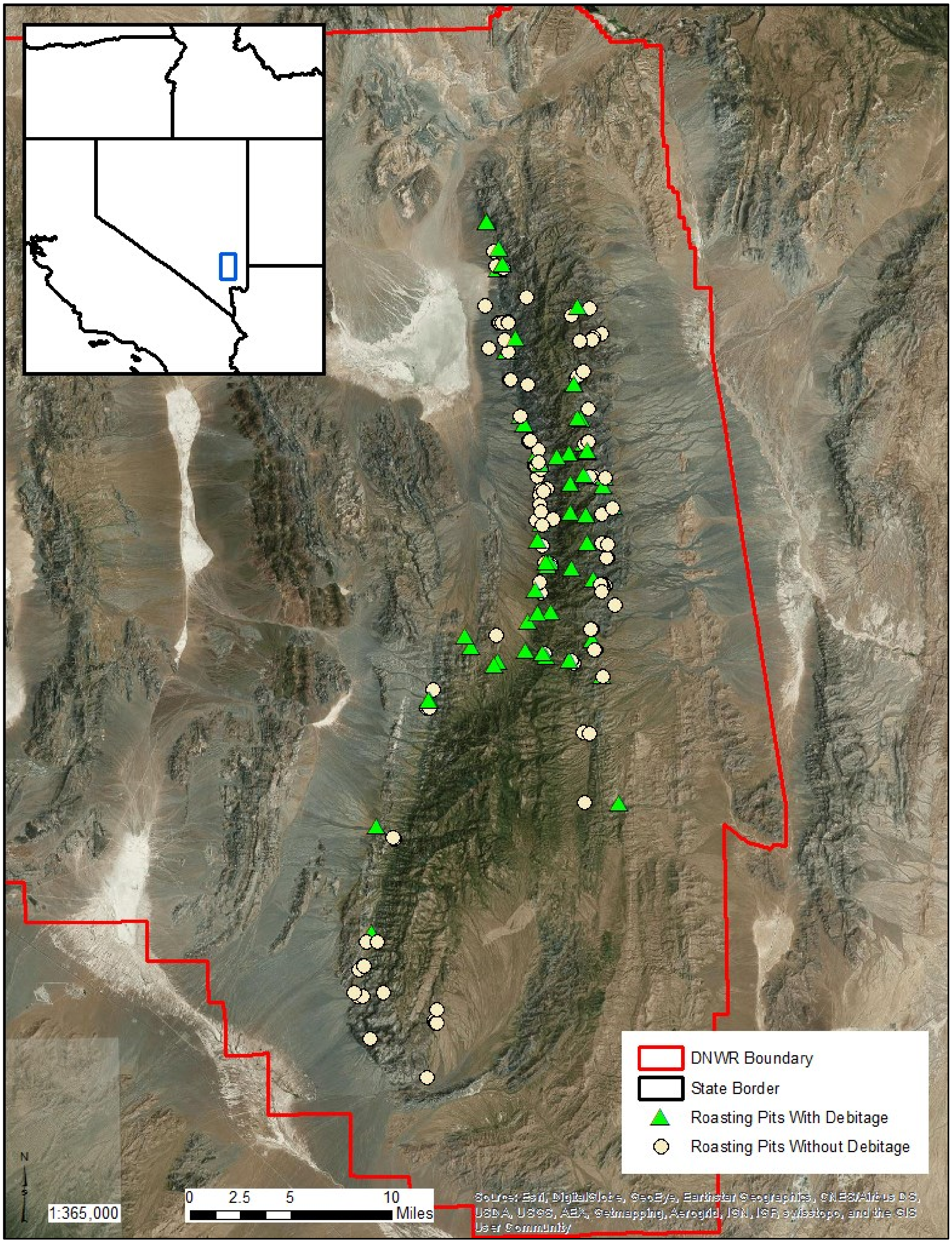


Figure 7.9. Location of all recorded roasting pits where lithic debitage was identified.

surrounding a central depression. Rather, they are comprised of a continuous layer of white thermally-altered rock spread out across a wider area than a typical roasting pit. Due to the high elevations of these saddle sites, plant resources such as pinyon are common and agave is not. Without excavation it is difficult to determine if thermally-altered rock concentrations in these locations served a different purpose than typical roasting pits. However, it appears that tool maintenance and manufacture occurred at higher rates at saddle sites than at typical roasting pits. Also, the vast majority of chert found at these locations showed signed of being heat treated and it is possible some of these burned rock features were used to heat treat toolstone.

Two examples of sites with an increased density of debitage and an associated thermal feature not representative of a standard roasting pit are RP-036 and RP-072 (Figure 7.10). RP-036 is comprised of a high density lithic scatter spread across a large area (100 m^2) consisting of over 500 flakes, 7 bifacial tools at various stages of completion and a thermal feature measuring 15 by 25 m. The site is located on a low saddle flanked by drainages on both sides and overlooking seven other roasting pits within a half mile. None of the other cooking features nearby resemble RP-036. However, unlike saddle sites located along the spine of the Sheep Range, RP-036 was at an elevation that permitted the growth of desert succulents.

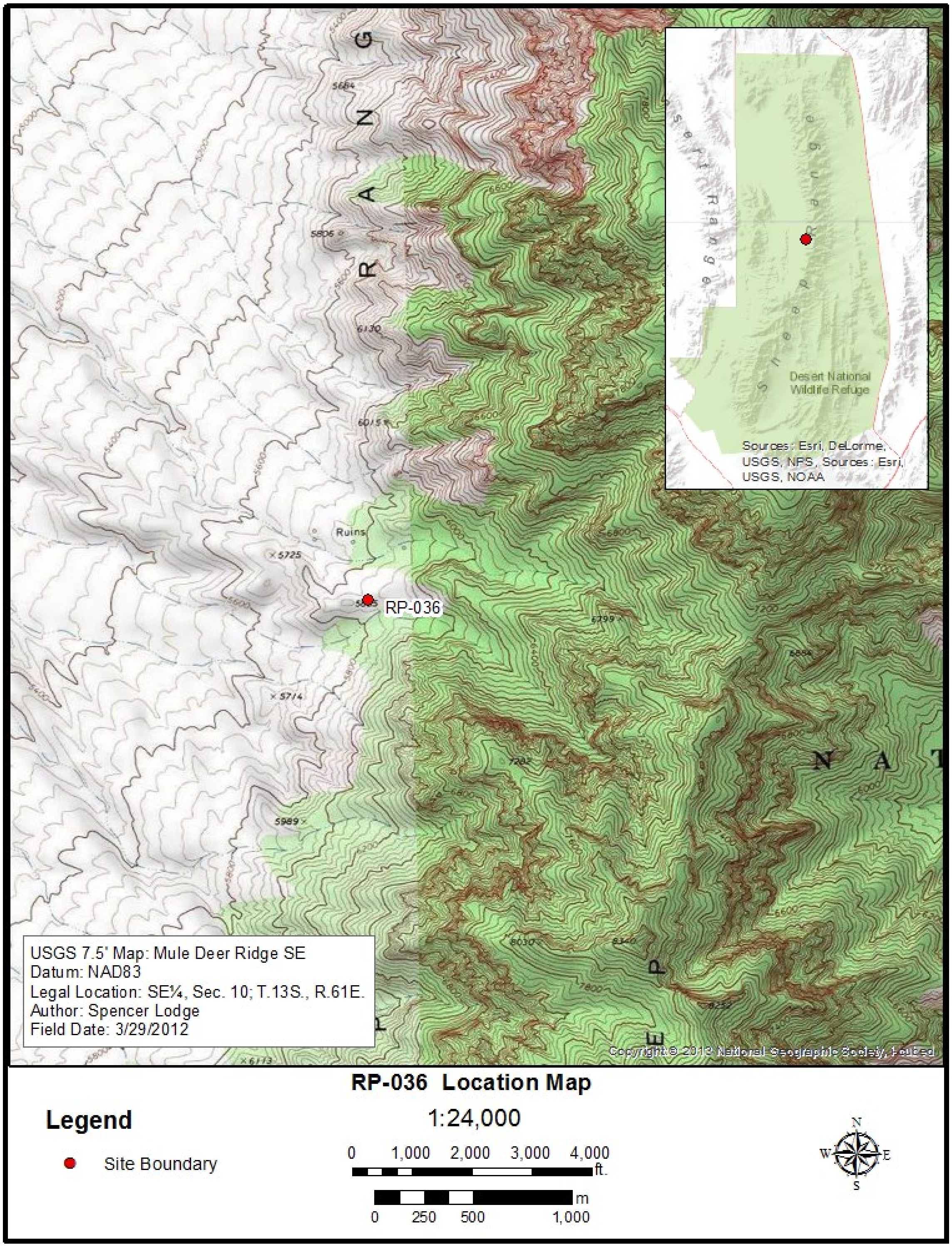


Figure 7.10. Location map for RP-036, a thermal feature with a higher than average density of lithic debitage.

The lithic material at RP-036 was predominately siliceous consisting of a wide array of colors (Figure 7.11), along with a few quartzite and obsidian flakes. Though macroscopic differences between chert samples such as color is insufficient to determine source or type, many of the colors observed here were not identified elsewhere within the Sheep Range.

Figure 7.11. Example of variation in lithic material found at RP-036.

Another example of a site with an increased density of debitage and a concentration of thermally-altered rock is RP-072 (Figure 7.12). Remnants of flintknapping and concentrations of thermally-altered rock were always present on saddles along the spine of the Sheep Range.

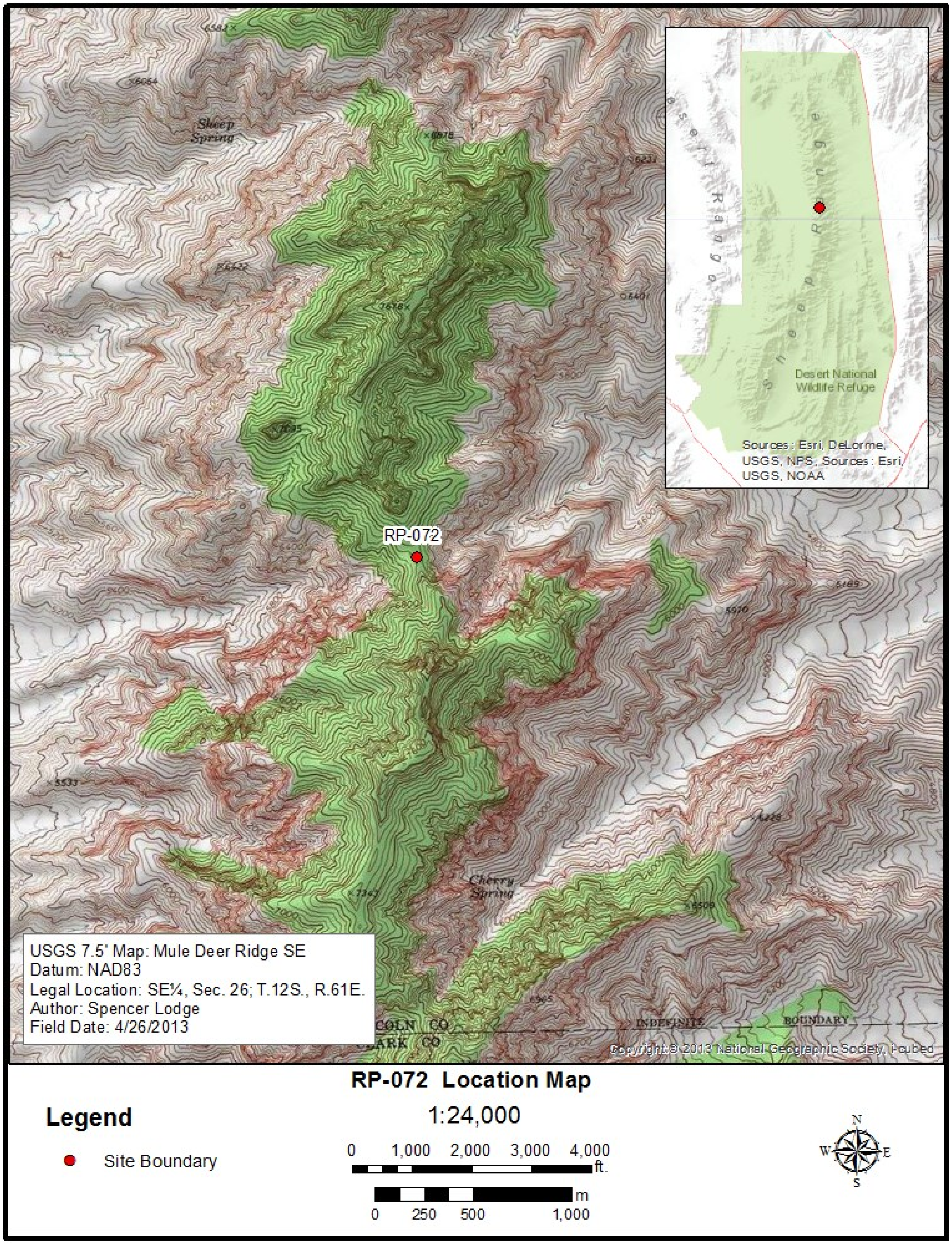


Figure 7.12. Location map of RP-072, a feature with a large quantity of lithics.

When first approached from a helicopter, RP-072 appeared to be an extensive roasting pit with its western half eroding downslope (Figure 7.13). On the ground, however, the feature was found to consist of an amorphous concentration of thermally-altered rock, due in part to erosion but also construction. Instead of a single cooking pit surrounded by a circular midden, numerous ‘cooking pits’ were visible on the surface spread out amongst a concentration of white thermally-altered rock and carbon-stained sediment. An abundance of lithic material was also observed strewn around the site. It is uncertain whether the cooking pits were utilized to heat treat tool stone, cook food, or both.

Figure 7.13. Picture from a helicopter of RP-072 (center) set on a saddle.

An example of a site featuring stereotypical roasting pits with a higher than usual quantity of lithic debitage is RP-098 and RP-099 (Figure 7.14). Both roasting pits were directly adjacent to one another on the side of a hill overlooking Lamb Spring. Debitage and bifacial stone tools were observed around the roasting pits, as well as downslope of

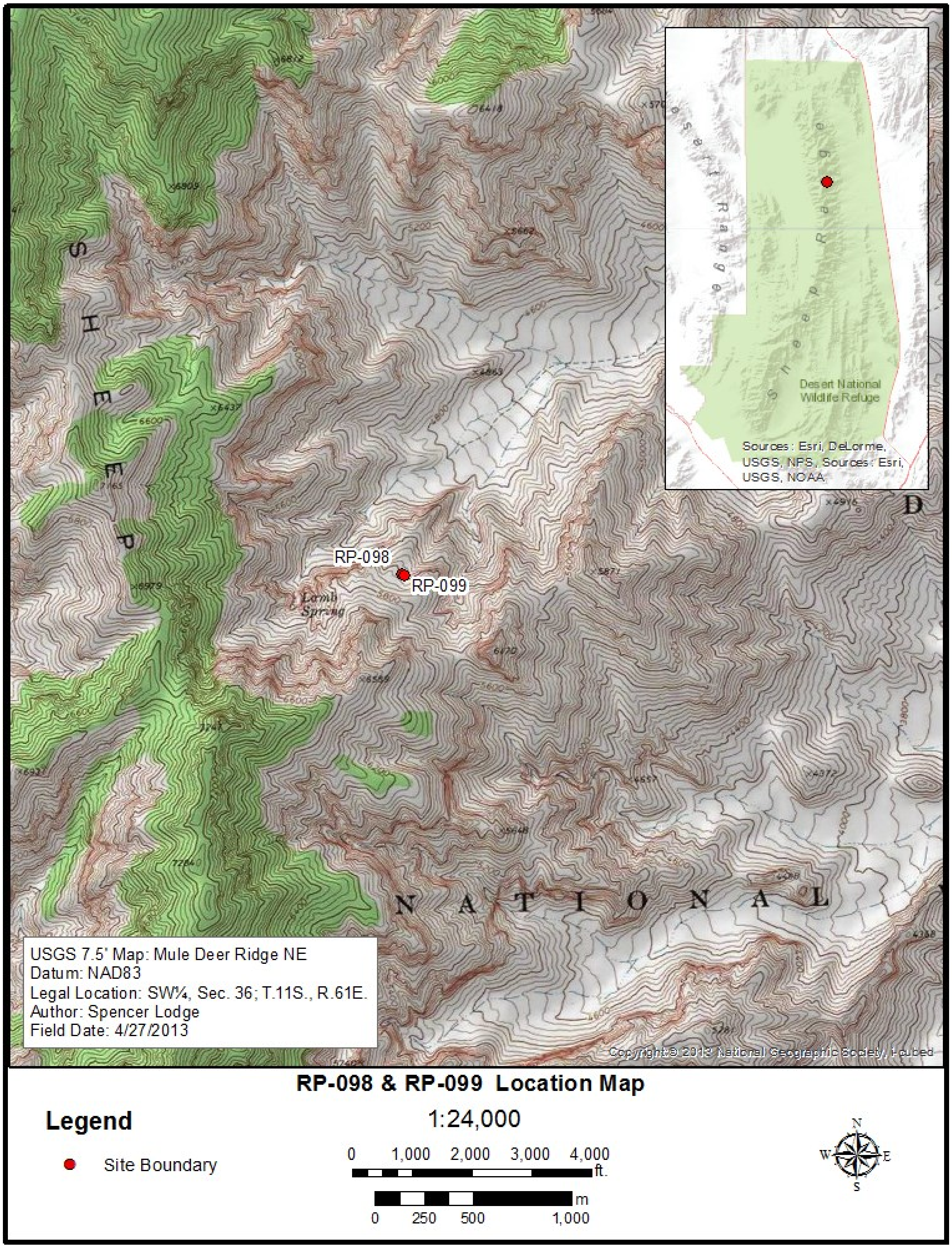


Figure 7.14. Location map of adjacent RP-098 and RP-099.

the two features. Material consisted predominately of chert with obsidian and quartzite observed to a lesser degree. The presence of various edible plant resources, such as Great Basin wild rye (*Leymus cinereus*), and pinyon, as well as the permanent water source (Lamb Spring), likely made this location attractive for longer term occupation.

Four cores were also found at three roasting pit sites, two of which were built on a saddle along the spine of the Range. Three chert cores found at RP-071 and RP-156 were exhausted, none of which measured greater than 7 cm in any dimension. The other core was made of rhyolite and was not extensively utilized, likely due to the coarse material of the stone. The only recorded hammerstone was also identified at a saddle site (RP-156).

Pottery

A total of 110 pottery sherds were identified at 41 of 193 (21%) recorded roasting pits making it the second most common artifact type (Figure 7.15). Sherds ranged in size from 2 to 15 cm and were found either directly on top of the roasting pit, typically on the torus itself, or within 15 m of the feature. Due to limited time in the field and the Refuge’s no-collection policy, in depth analysis of pottery type and temper material was not possible. Multiple photographs of each sherd were taken and used later to identify their type. Confidently recognizing temper material from photographs is not as feasible as I initially had hoped. Numerous pottery sherds were not assigned a type as a result. The diversity and often degraded condition of the sherds further complicated identification.

Sherds were identified with the help of Dr. Karen Harry (UNLV) and Janet Hagopian (HRA Inc.). Differentiating between brownware and grayware provided the greatest difficulty as their typological assignment is not necessarily based on paste color,

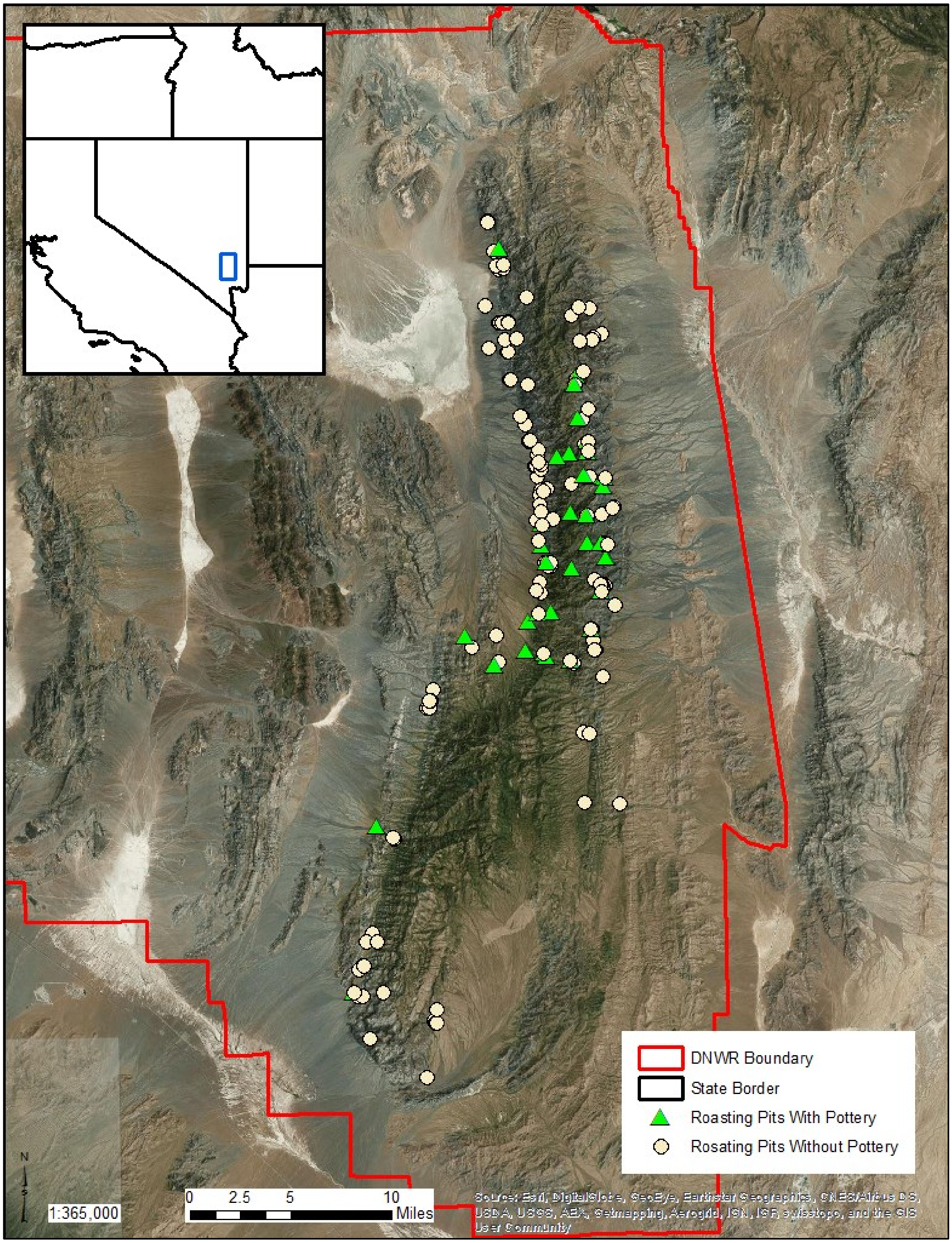


Figure 7.15. Location of every recorded roasting pit with pottery.

but rather the temper used. Overall, brownware was the most common sherd identified followed by grayware. Additional identified sherd types include: Ancestral Puebloan Redware, Dogoszhi and Shinarump Redware.

Brownware was the most common pottery type identified near roasting pits, which included plain, corrugated and incised (Figure 7.16). Lyneis (2004) reports a date range of A.D. 1300 to the 1800s for brownware pottery at the Yamashita site. Brownware pottery is considered locally made and associated with the Southern Paiute.

Figure 7.16. Examples of brownware pottery, plain (left), corrugated (center) and incised (right) found near roasting pits in the Sheep Range.

Grayware was the second most common pottery type identified, including plain and painted (Dogoszhi Virgin Series) wares (Figure 7.17). Grayware is a diverse pottery associated with Puebloan groups. This style is generally differentiated according to the type of temper present and dates to the Puebloan Period (A.D. 500 – 1200) (Lyneis 2008).

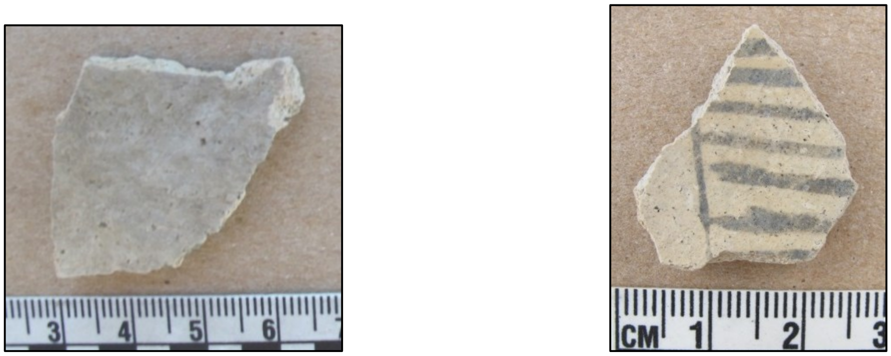


Figure 7.17. Examples of grayware plain (left) and painted Dogoszhi Virgin Series (right).

A variety of painted pottery sherds were identified as well, including: Ancestral Puebloan, Shinarump Redware (possibly Kanab Black-on-Red) and an unidentified Black-on-White sherd (Figure 7.18). The Ancestral Puebloan sherd a tradeware from the east and is roughly dated to the middle-to-late Puebloan Period. Shinarump Redware is generally dated from A.D. 1150 to 1300s (Allison 2010).

Figure 7.18. A variety of painted sherds were found near roasting pits in the Sheep Range, including Ancestral Puebloan (left), Shinarump Redware (center) and an unidentified Black-on-White sherd (right).

Numerous unidentified pottery sherds were identified, including several orangeware sherds identified at one roasting pit (Figure 7.19). A rough time range for these sherds is unknown.

Figure 7.19. Examples of unidentified pottery featuring both sides of each sherd.

Evidence indicates pottery was introduced into southern Nevada around A.D. 500 (see Chapter 3). The presence of cooking vessels (e.g., corrugated brownware) as well as fine painted dishes (e.g., Kanab Black-on-Red) suggests a variety of uses at roasting pits. Finer painted vessels may have been brought out for social gatherings in the spring where large quantities of agave are baked. Cooking vessels were likely used for numerous tasks, including stone boiling. Vessels may have also been used to ferment alcohol which can be made from agave. The presence of numerous types of pottery throughout the Sheep Range may indicate use by numerous groups or access through trade.

A more thorough investigation of the pottery found in association with roasting pits offers a valuable research opportunity. A greater understanding may shed light on the groups who utilized roasting pits throughout the Range, as well as the potential trade of ceramic material culture.

Stone Tools

Seventy-seven stone tools were identified at 29 roasting pit sites, including bifaces, groundstone, projectile points and scrapers (Figure 7.20). Many artifact types were further broken down into sub-groups (Table 7.1) which are described below.

Table 7.1. Breakdown of stone tools identified at roasting pit sites.

Type	**Quantity**
Bifaces	48 (62%)
Groundstone	18 (24%)
Projectile Point	7 (9%)
Unifaces	4 (5%)

Bifaces

Bifaces found associated with Sheep Range roasting pits comprise a broad category of bifacially flaked stone tools likely used for a variety of tasks. Based on the proximity to roasting pits and ethnographic accounts, most of these tools were likely used to process plant materials, both before and after they were baked. Anyone who has processed plants knows that elaborately-crafted stone tools are unnecessary to cut plants; a sharp edge will suffice. To that end, much of the lithic debitage found at a roasting pit site may have been utilized as cutting tools. Since elaborate tools are not necessarily required to process plants, a wide variety in craftsmanship is observed within this tool type. Closer towards the well-crafted side of the spectrum are agave knives (Figure 7.21) (located near a cluster of roasting pits 77-82).

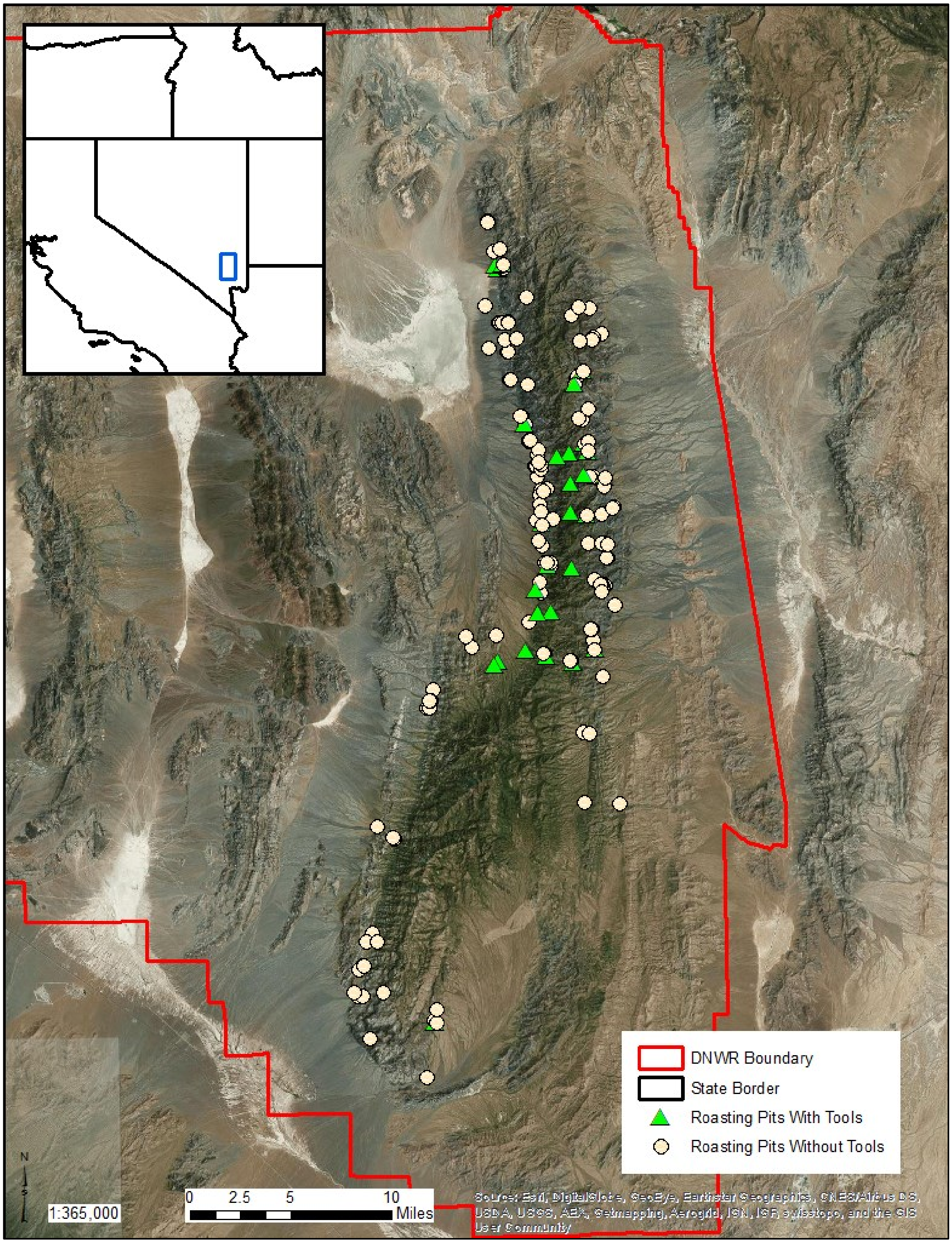


Figure 7.20. Location of every recorded roasting pit with a stone tool.

Figure 7.21. Example of an agave knife found near a cluster of roasting pits 077-082.

Only two stereotypical agave knives were identified. As initially described for southern Nevada by G.C. Baldwin (1944) as mescal knives, agave knives are bifacially flaked with a crescent shape on one side and a flat edge on the other. The flat edge was often set inside a wooden handle. In contrast, numerous cutting implements were identified in which less energy was expended in their creation. An example of a typical expediently crafted biface is shown in figure 7.22 from RP-072. Due to the limited

Figure 7.22. An expedient knife found at RP-072.

amount of lithics typically found at roasting pits, it is inferred that this biface is an expedient processing tool as opposed to a manufacturing reject.

Groundstone

Of the artifact types found associated with roasting pits in the Sheep Range groundstone was the least common, found at eight roasting pit sites (4%). Portable and bedrock grinding features were the most commonly identified type out of the group accounting for six of the eight occurrences. Two hand stones account for the other two groundstone occurrences. Aside from RP-135 where numerous bedrock grinding features were present, groundstone was identified as a singular occurrence at a given roasting pit location. Limestone was the most common material type for bedrock grinding facets, though one was crafted from marble and another from an undetermined material that was not limestone. The two hand stones were made from unidentified material.

The dearth of groundstone near roasting pits in the Sheep Range appears to agree with ethnographic accounts stating that post-baking plant processing occurred away from cooking locations.

Projectile Points

Diagnostic projectile points were rare, with only seven identified near five roasting pit sites. Damaged projectile points lacking diagnostic attributes were included with the biface category. Of the seven projectile points, four were made of obsidian and three from chert. Projectile points were typed by comparing samples from archaeological reports (e.g., McGuire 2013) and with the help of Tatianna Menocal. The seven identifiable projectile points include: a broken Elko base, a complete Desert Side-Notched point, a Cottonwood Triangular, two Gatecliff or Gypsum points, a likely Rosegate and a broken Parowan Basal Notched point.

Elko, Gypsum and Gatecliff points represent the oldest point types found near roasting pits in the Sheep Range (Figure 7.23). Gypsum and Gatecliff points are similar in appearance and all points roughly date to 2000 B.C. to A.D. 800 (Thomas 1981).

Figure 7.23. A broken Elko Eared projectile point (left) and two Gypsum/Gatecliff points (center, right).

Parowan Basal-Notched are often included within the Rosegate series of projectile points due to technological and morphological similarities (Justice 2002). Both styles are noted as being in the region prior to Desert Side-Notched and Cottonwood points. Rosegate points appear in southern Nevada around A.D. 750 while Parowan points are commonly associated with Fremont sites dating to A.D. 950 to 1200 (Holmer and Weder 1980:64). Examples of each point are shown in figure 7.24.

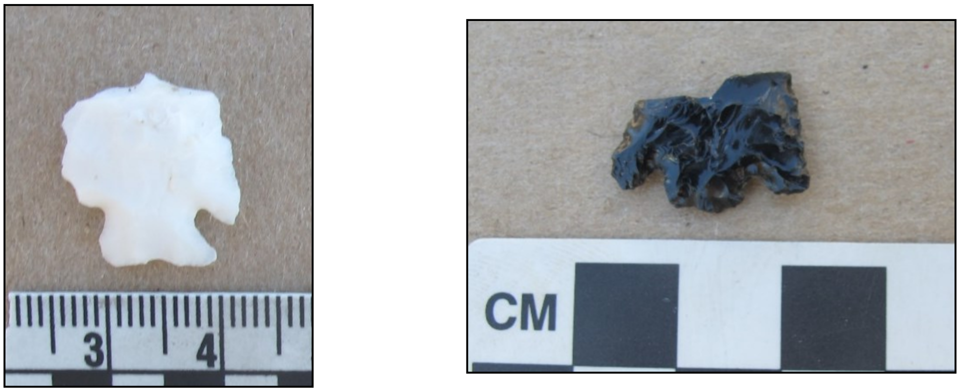


Figure 7.24. A Rosegate series projectile point (left) and a Parowan Basal Notched point base (right).

Desert Side-Notched and Cottonwood Triangular both represent the youngest projectile points found (Figure 7.25). Justice (2002) states Desert Side-Notched points enter the archaeological record approximately A.D. 1100 to 1200. Cottonwood points enter the archaeological record approximately A.D. 900 and were used until the historic period (Justice 2002). General age ranges for each point type are condensed in Table 7.2.

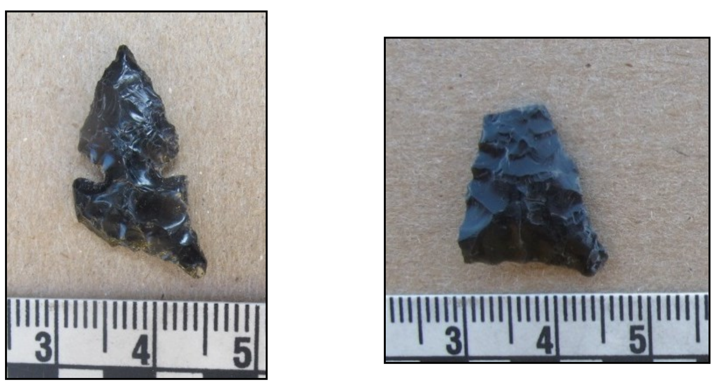


Figure 7.25. A Desert Side-Notched projectile point (left) and a Cottonwood Triangular projectile point (right).

Table 7.2. General age ranges for projectile point types found associated with roasting pits.

Projectile Point Type	Age Range
Gypsum/Gatecliff Points	Late to Terminal Archaic (B.C. 2000 – A.D. 800)
Elko Points	Late to Terminal Archaic (B.C. 2000 – A.D. 800)
Parowan Basal-Notched	Puebloan Period (A.D. 950 – 1200)
Rosegate Series	Puebloan Period (A.D. 750 – 1250)
Desert Side-Notched	Post-Puebloan Period (A.D. 1200 – Historic Period)
Cottonwood Triangular	Post-Puebloan Period (A.D. 900 – Historic Period)

Source: Holmer and Weder (1980), Justice (2002), Brooks et al. (1975), Thomas (1981).

Unifaces

Four unifaces were also found associated with roasting pits. All four were made of chert and exhibit various levels of craftsmanship. Each was rounded at one end and tapered to form a “handle” on the other end. Three of the four unifaces were serrated. An example of one of these unifaces is presented in Figure 7.25.

Figure 7.25. An example of a uniface found at RP-140.

Artifacts in general were not commonly identified in association with roasting pits. When identified, lithic debris was the most common, followed by pottery and stone tools.

A lack of artifacts is not necessarily surprising considering that ethnographic accounts for the region show that baked foods were often transported away from the oven and further processed off-site.

The presence of stone tools at roasting pit sites provides the greatest indication that plant processing occurred, both before and after plants were baked. Bifaces, the most commonly identified stone tool near roasting pits, were likely multi-purpose tools. Ethnographic accounts indicate bifaces were used to trim agave leafs prior to cooking and cut open banana yucca fruits prior to being set in the sun, in addition to any other task requiring a sharp edge. Sparse lithic scatters found at roasting pit sites were likely a product of expedient tool manufacture. Since a sharp edge is often all that is necessary when processing plant foods, many of the lithics found at roasting pits were also likely used for this purpose.

Ethnographic accounts detail the use of groundstone to process agave. Agave leaves were pounded with groundstone to extract the sweet flesh from the fibrous material. Groundstone was also used to incorporate additional foods, such as pinyon nuts or juniper berries, into the agave as it was formed into cakes or sheets. However, groundstone was not generally found associated with roasting pits. Based on observations and ethnographic accounts, a dearth of groundstone seems puzzling. Four behavioral patterns may help explain this relative absence.

One, post-baking plant processing at roasting pit sites may not have been common, as indicated in the ethnographic record for the Southern Paiute. In this instance, baked plant foods were transported to a seasonal or permanent camp to be processed. Two, groundstone was used to process plant foods at roasting pit sites, but the tools were portable enough to be hauled offsite afterwards. Three, groundstone was used to process plant foods at roasting pit sites but was repurposed in a heating element after the tool was spent, and subsequently mixed in with the fire-cracked rock midden. Several broken hand stones with evidence of thermal fracturing were identified on the surface among roasting pit middens. I hypothesize that should a roasting pit in the Sheep Range be excavated, additional evidence of repurposed groundstone would be identified. Four, processing baked plants did not require stone tools. While ethnographic accounts report that agave was pounded into cakes after it was cooked, wooden implements may have been used as well. Unless stored in a dry location, wooden tools exposed to the elements would deteriorate. I hypothesize that should a roasting pit in the Sheep Range be excavated, additional evidence of repurposed groundstone would be identified.

The processing of other plant foods such as grains or nuts may also explain the presence of bedrock groundstone at certain roasting pit sites. For example, the greatest density of bedrock grinding facets identified within the Sheep Range is at RP-135, which is located on the side of a canyon close to Sheep Spring. Also found growing in unusual abundance around the spring is Great Basin Wild Rye, a plant food commonly processed and consumed by people in the Great Basin. The bedrock groundstone facets found at RP-135 are predominately basin shaped, indicative of seed processing. Finally, one of the two identified hand stones was found at another site (RP-149) with Great Basin Wild Rye.

If most baked plant foods were in fact processed away from roasting pit sites, identified groundstone may have been used to process other plant foods. Groundstone was not identified at a roasting pit site within the Pinyon-Juniper vegetation zone;

however, the technology was used to process pine nuts. One ethnographic account states that pine nut “were shelled on a metate with a mano, and later winnowed, parched a second time, and ground into meal” (Fowler 2012a:106). The lack of groundstone at such sites may suggest foods were processed elsewhere or were portable enough to be taken off site afterwards as well.

Finally, groundstone was also used to process plants to obtain fibrous material to create a variety of items. Fibrous material was obtained from agave and other plants, including banana and Mojave yucca. Groundstone anvils were placed under plant material which was pounded with a hand stone. As described by Blair et al. (2000:273):

> Anvils exhibit percussive impact damage from battering and pecking rather than striations from grinding of the surface with a mano. This type of wear patterning suggests that resources were pounded rather than ground, which is consistent with Yucca, Agave, and various cactus preparation and processing.

An example of an anvil found near a roasting pit with possible evidence of pecking from fiber processing is shown in Figure 7.26. The circular pattern of pecking demonstrated in

Figure 7.26. Example of an anvil near RP-007 with evidence of pecking, possibly from fiber processing.

Figure 7.26 also resembles the base of a hopper-mortar. A hopper-mortar is made of a bottomless basket attached to a stone where plants are processed with a pestle.

Based on the artifactual evidence, it appears that plants were processed at roasting pit sites to some degree. Certainly plants were prepped prior to being roasted. Bifaces of varying quality found at roasting pit sites were likely used to trim plants, in addition to accomplishing a variety of tasks. Bifaces and flakes found near roasting pits are indicative of processing that occurred prior to baking, such as removing agave rosettes from their basal stem and trimming leaves. Such tasks can be completed with well-crafted agave knives or crude bifacially knapped tools. Both types of implements were identified near roasting pits, with cruder bifaces the more commonly identified type.

While evidence of flintknapping was identified at 69 roasting pit sites (36%), substantial amounts of lithics were found only at a few sites, most notably on saddles along the spine of the Sheep Range. Concentrations of thermally-altered rock were also found in abundance at these locations, though not always resembling a standard circular roasting pit shape. Most of the lithics at these locations were siliceous material that showed evidence of heat treatment. Additionally, a wider array of manufacture stages were evident from the types of flakes present (i.e., primary flakes to pressure flakes). Based on the density and variety of lithic debitage, I hypothesize these were locations in which tool stone manufacture and maintenance occurred at higher rates than at ordinary roasting pits sites.

Sheep Range Roasting Pit Distribution

As described in Chapter 6, multiple lines of data were collected from each documented roasting pit, including: vegetation community, elevation and size. All these data are compiled in Appendix A, and are summarized and analyzed here.

Vegetation Community

Roasting pits within the Sheep Range were documented among four primary vegetative communities including: Creosote Brush, Blackbrush, Mixed Shrub and Pinyon-Juniper communities. These vegetative communities are found throughout southern Nevada. A breakdown of roasting pits within the various vegetative communities can be found in Table 7.3. Nine roasting pits were found in areas that were a mix between two vegetative communities, where Joshua Trees were the dominant species. Six of the areas were similar to Blackbrush communities (3%) while the other three were similar to Creosote Brush communities (2%).

Table 7.3. Breakdown of the relative frequency of 193 roasting pits among vegetative communities.

Vegetation Community	**Number of Roasting Pits**
Blackbrush	75 (39%)
Mixed Shrub	61 (31%)
Creosote Brush	29 (15%)
Pinyon-Juniper	19 (10%)
Joshua Dominant	9 (5%)

Desert succulents associated with earth oven baking, such as agave and various species of yucca, may all be found within the Blackbrush and Mixed Shrub communities where most documented roasting pits were located. Fuel is also found in varying abundance within both communities, though it is found in greater density in Mixed Shrub communities. Roasting pits were often constructed near the sides of ephemeral drainages regardless of vegetation community. Drainages were noted as often having fuel, both in the form of woody plants as well as larger deadwood debris (e.g., Pinyon or Juniper tree limbs) naturally transported from its original location further up the drainage.

Of the 19 roasting pits documented within the Pinyon-Juniper community, four of them were located on saddles along the Sheep Range. Only one of the four roasting pits found at saddle sites had a well-defined ring midden, while the other three consisted of scattered thermally-altered rock. The limited number of identified roasting pits within the Pinyon-Juniper community may be due to numerous reasons. First, desert succulents are not found in as great a density in this community when compared to the others surveyed. If desert succulents were the most commonly baked food types, a diminished amount of roasting pits in environments lacking these foods is to be expected. Roasting pits are still expected in Pinyon-Juniper communities based on ethnographic accounts which illustrate that green pinyon pine cones were baked in earth ovens.

Another explanation for the relative dearth of roasting pits in Pinyon-Juniper communities may be the method of survey used. Due to the thick tree cover that characterizes the Pinyon-Juniper community, identifying roasting pits via aerial photography was not nearly as effective. While some roasting pits were identified via aerial imagery in Pinyon-Juniper communities, others were previously encountered or found during survey. Despite a relative dearth of desert succulents, ethnographic accounts describe how roasting pits were also used to bake green pinyon cones. It is likely that numerous roasting pits remain hidden within the Pinyon-Juniper community, although the extent to which is unknown.

Elevation

Roasting pits were identified at elevations ranging from 3380 to 7030 feet (Figure 7.27). Cooking features were most commonly found between 4500 to 5500 feet, accounting for 48% (92/193) of all documented roasting pits. Within this one thousand foot elevation bracket, 88% (81/92) of recorded roasting pits were found in either Blackbrush or Mixed Shrub communities. This is not necessarily surprising considering the relationship between elevation and vegetation zones and that edible plants baked in roasting pits are all found within this elevation bracket.

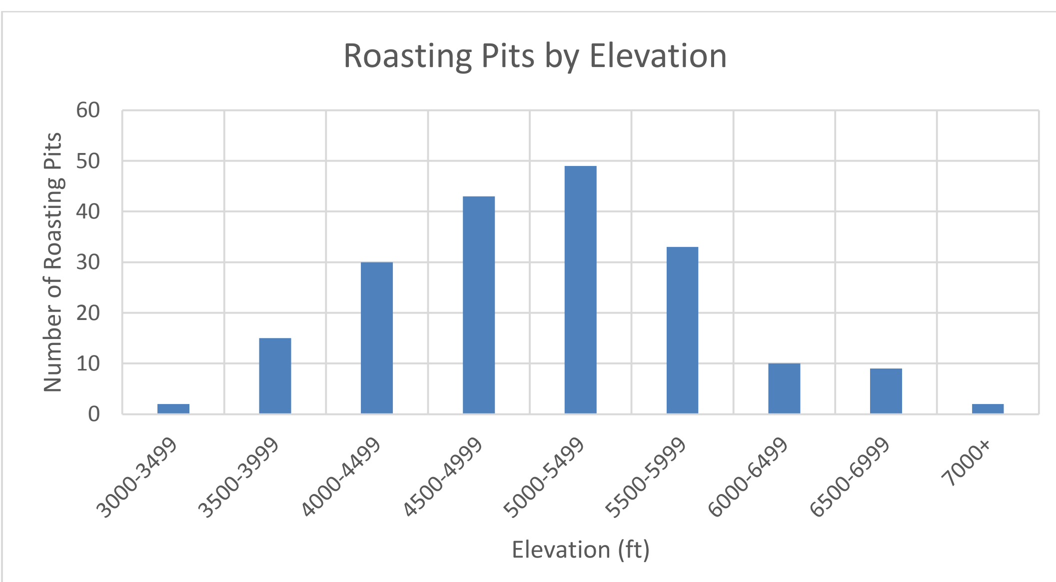


Figure 7.27. Roasting pit occurrence by elevation range.

Size

Roasting pit dimensions varied according to overall length and width, as well as the size of the central depression. Overall diameter for roasting pits ranged from 6 – 20 meters in diameter, with an average length/width of 10.3/10.3 m or circular. Central depression dimensions ranged from 1.6 – 6 m in diameter, with an average length/width of 3.7/3.6m.

Of the 193 documented roasting pits, 139 had adequate definition of both their central depression and exterior, allowing these features to be accurately measured. The following statistical tests were conducted with this 139 roasting pit data set.

I first wanted to test whether roasting pit size differed significantly by elevation. To accomplish this, I converted the measurement data for the central depression and exterior dimensions into square meters using the formula for a circle:

$$A=\pi r^2$$

Since roasting pits are rarely perfect circles, length and width measurements were divided in half to obtain two separate radiuses, which were multiplied and then the sum was multiplied by Pi (3.14). I was able to identify the area of the overall roasting pit feature, which I refer to as the exterior, as well as the sunken center of the feature, which I refer to as the central depression. Once the central depression and exterior dimensions were established, the area of the ring midden, also referred to as the torus, was calculated by subtracting the central depression dimensions from the exterior.

For example, RP-029 had exterior measurements of 11.3 m (north-south) by 12.7 m (east-west) and central depression measurements of 3.6 m (north-south) and 4.3 m (east-west). Beginning with the exterior measurements, 11.3 and 12.7 were divided by two which equals 5.65 and 6.35 respectively. Instead of squaring one of these numbers, are shown in the formula above, 5.65 and 6.35 were multiplied to equal 35.88. This sum was then multiplied by Pi (3.14) equaling 112.65 which was then rounded up to 113 m^2. central depression measurements were calculated in the same way; 3.6 and 4.3 were divided by two equaling 1.8 and 2.15. They were then multiplied which equal 3.87 and then multiplied by 3.14 equaling 12.15, which was rounded to 12 m^2. To calculate the torus, the central depression is subtracted from the exterior (113 – 12) equaling 101m^2.

Compiled measurements for each group (exterior, torus and central depression) are shown below (Figures 7.28-30). Torus and exterior measurements were grouped every 10 m^2, while central depression measurements were grouped every 3 m^2 to present a smoother distribution. Exterior measurements exhibit a jagged bell curve for most of the data, peaking at the 70-70 m^2 group with 17 roasting pits and tapering off in either direction. From 120-180 m^2, roasting pit populations alternately jump from 4 to 8 roasting pits.

Torus measurements exhibit a spiky bell curve, similar to exterior measurements. The primary difference between the two appears to be in the larger measurements where there is less variability.

Central depression measurements present a smoother curve than exterior or torus with a peak of 35 roasting pits falling within the 10-12 m^2 group. However, 31 roasting pits fell between 13-15 m^2, meaning that 47% (66/139) of all accurately measureable roasting pits were between 10-15 m^2 in size.

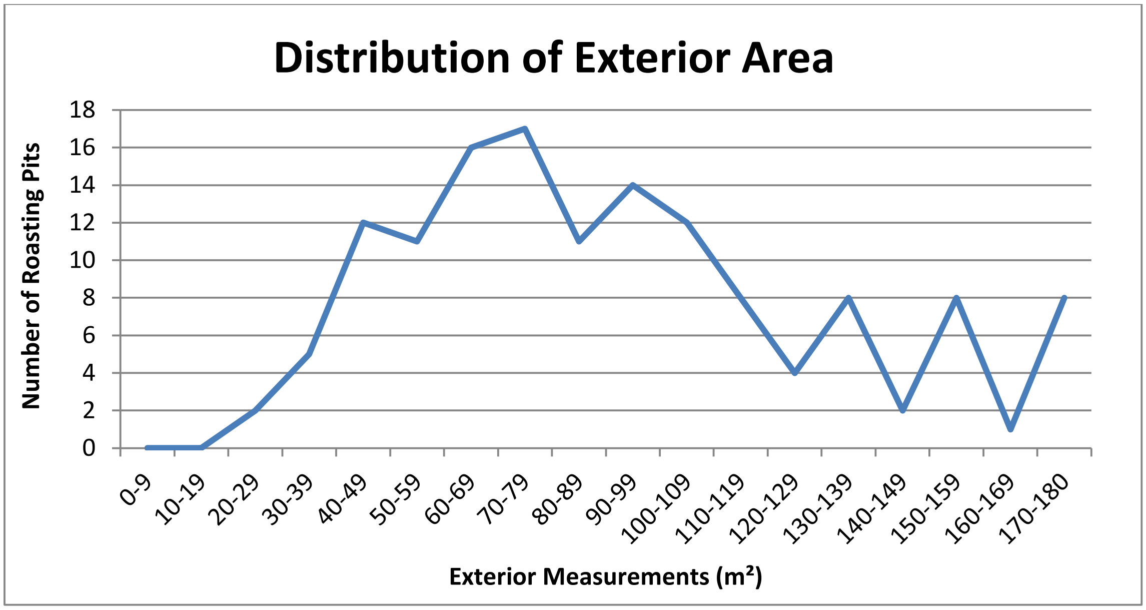


Figure 7.28. Distribution of exterior measurements for roasting pits.

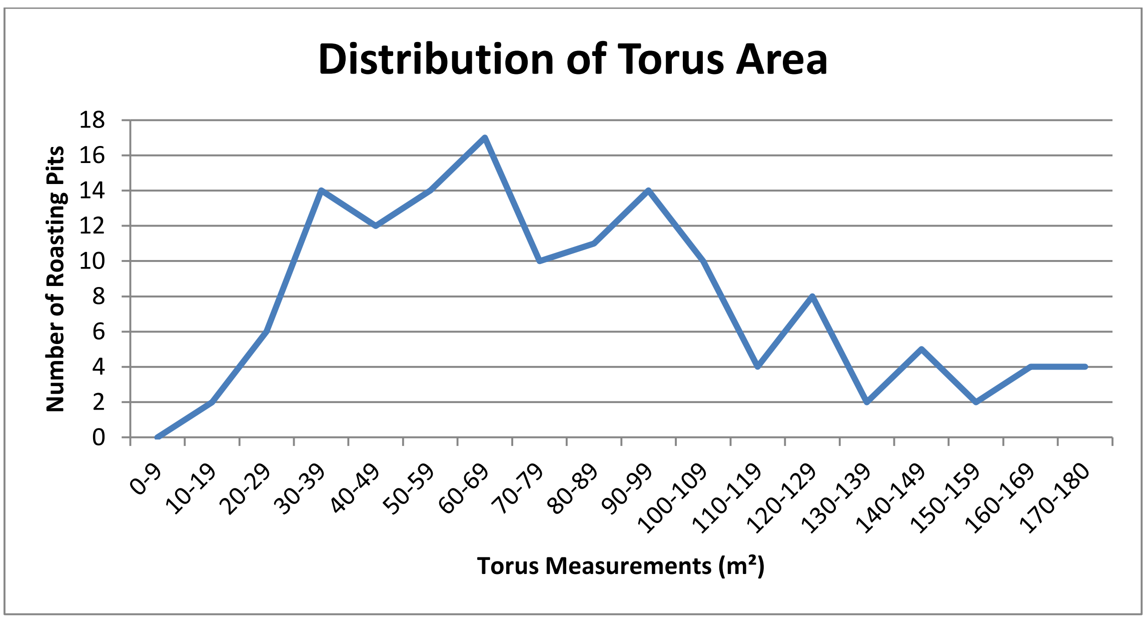


Figure 7.29. Distribution of torus measurements for roasting pits.

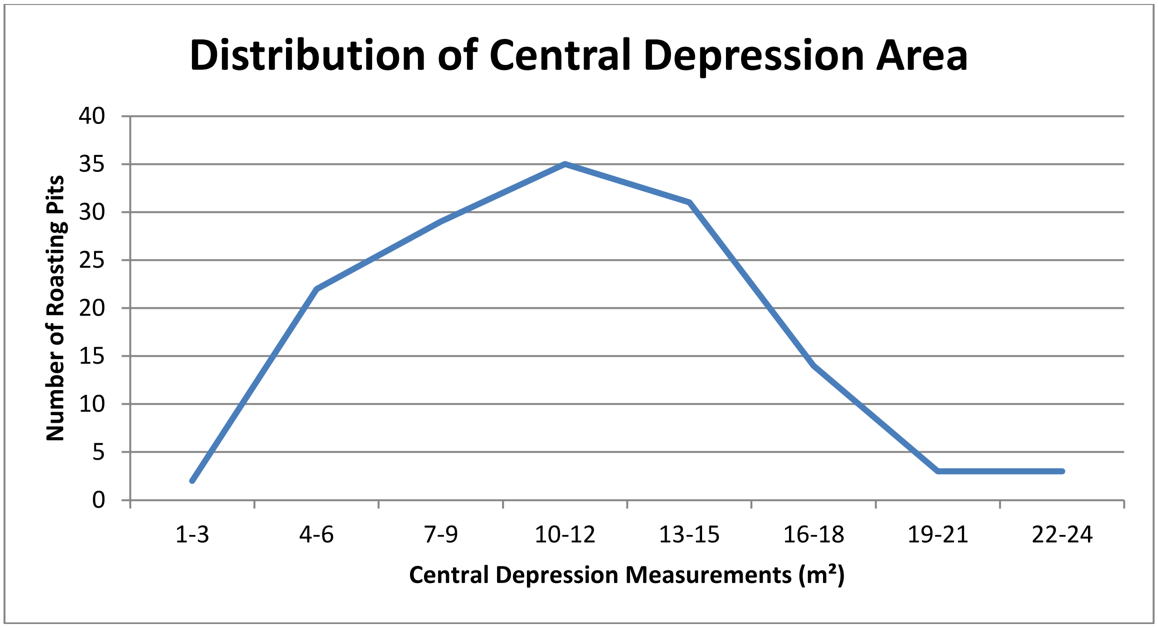


Figure 7.30. Distribution of central depression measurements for roasting pits.

Measurement data for the central depression, exterior and torus along with the respective elevation of each applicable roasting pit was plugged into a scatter plot (Figure 7.31). The scatter plot shows a general trend that as elevation increases so does the exterior and torus size of the roasting pit. However, central depression measurements stay relatively stable. The results indicate a level of significance, albeit not greatly significant, between the data sets. To try and tease out any significance that may exist, next I compared measurement data according to vegetation zone.

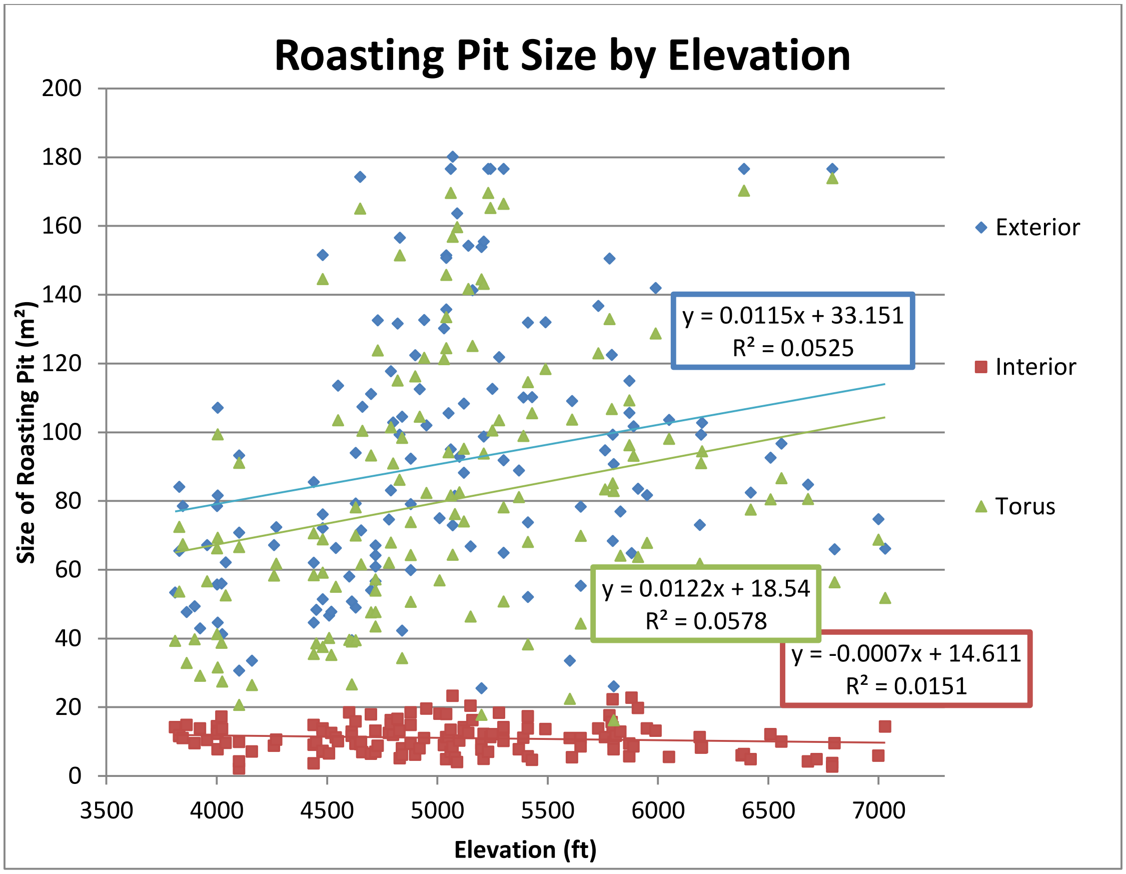


Figure 7.31. Distributions of roasting pit measurements according to elevation.

Out of five vegetative zones, there appears to be a relationship between roasting pit size and elevation for three of them. Within the Creosote Brush and Blackbrush communities, the overall size of a roasting pit as well as the size of its torus, generally increases in size based on the elevation they were constructed at (Figures 7.32 and 7.33). Meanwhile, the central depression size of roasting pits appears to be relatively stable regardless of the elevation the overall feature was built.

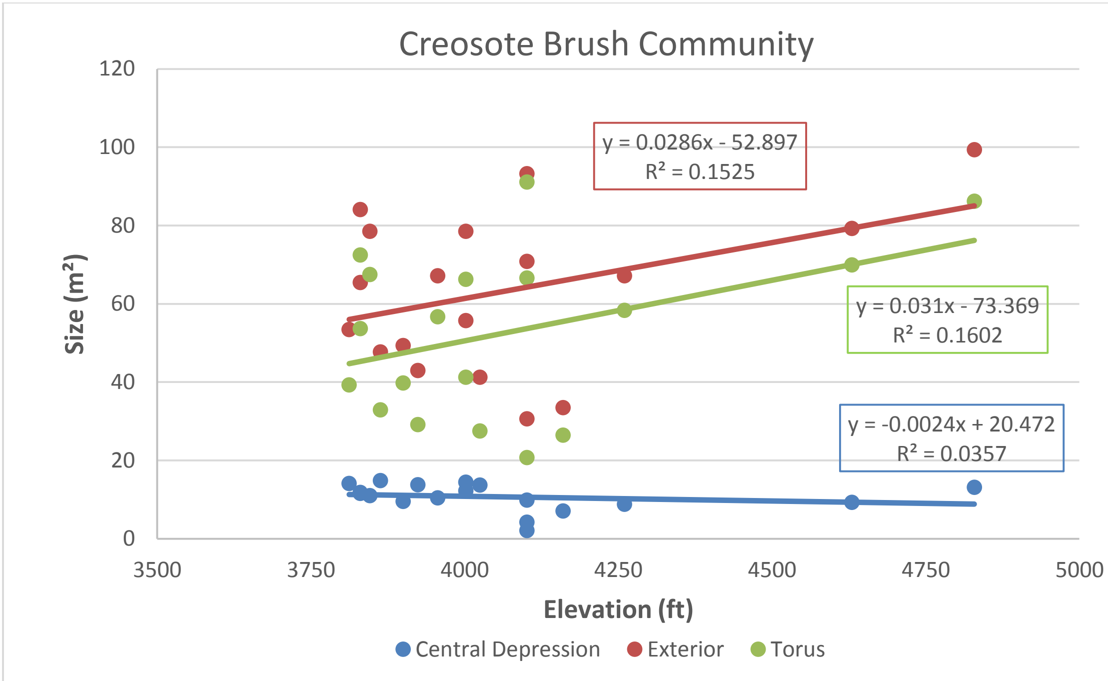


Figure 7.32. Scatter plot of roasting pit size by elevation within the Creosote Brush community.

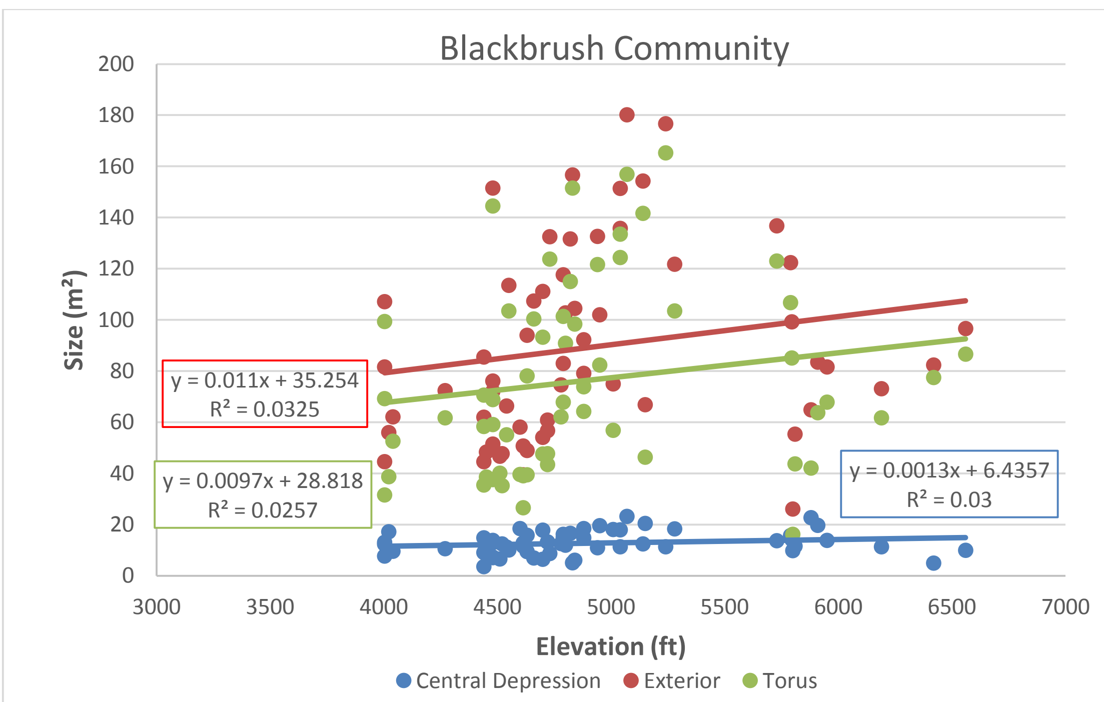


Figure 7.33. Scatter plot for roasting pit size by elevation within the Blackbrush community.

The opposite appears to be true for roasting pits constructed within the other two vegetative zones. Within the Mixed Shrub and Pinyon-Juniper communities, overall roasting pit size and torus size diminish with elevation (Figures 7.34 and 7.35). Just as with the last group, the central depression size of roasting pits within the Mixed Shrub and Pinyon-Juniper communities is stable regardless of elevation.

With size distribution data established for roasting pits according to the vegetative zone they were constructed in, let us now compare variation between those zones. To determine whether roasting pit size varied between vegetative zones, Mann-Whitney U statistical tests were run. Mann-Whitney U tests are nonparametric tests that compare two independent samples from the same population. Independent tests were run comparing each vegetative zone to one another three different times: for the central depression, exterior and torus measurement data. Statistical tests were run in Excel using the add-in Real Statistics. Results for the Mann-Whitney U tests are presented below (Tables 7.4-6). Values between 0 – 0.05 are significant (dark green), while values higher than 0.05 are non-significant (light red). To interpret a significant value, note that vegetative zones listed horizontally are smaller than those listed vertically. For example, a significant value occurred when comparing central depression sizes of roasting pits found in Creosote Brush and Pinyon-Juniper communities (.04213). Since the Creosote Brush community is listed horizontally at the top of the table, it denotes the smaller of the two communities.

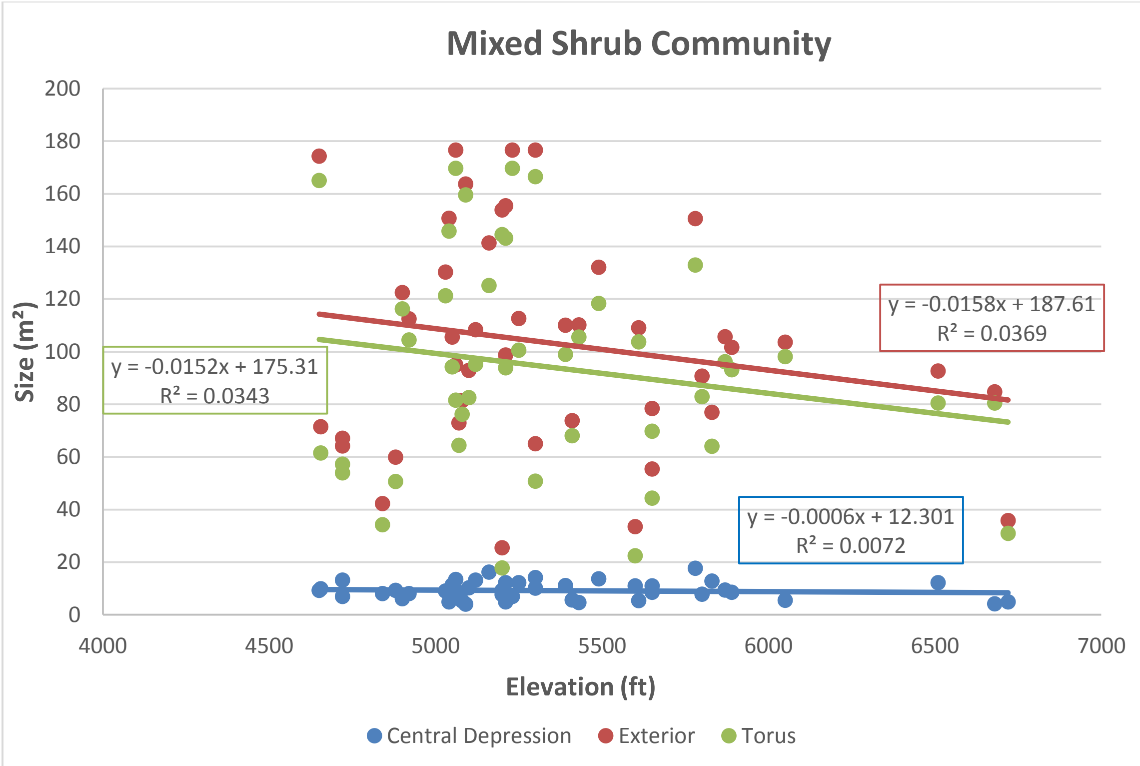


Figure 7.34. Scatter plot for roasting pit size by elevation within the Mixed Shrub community.

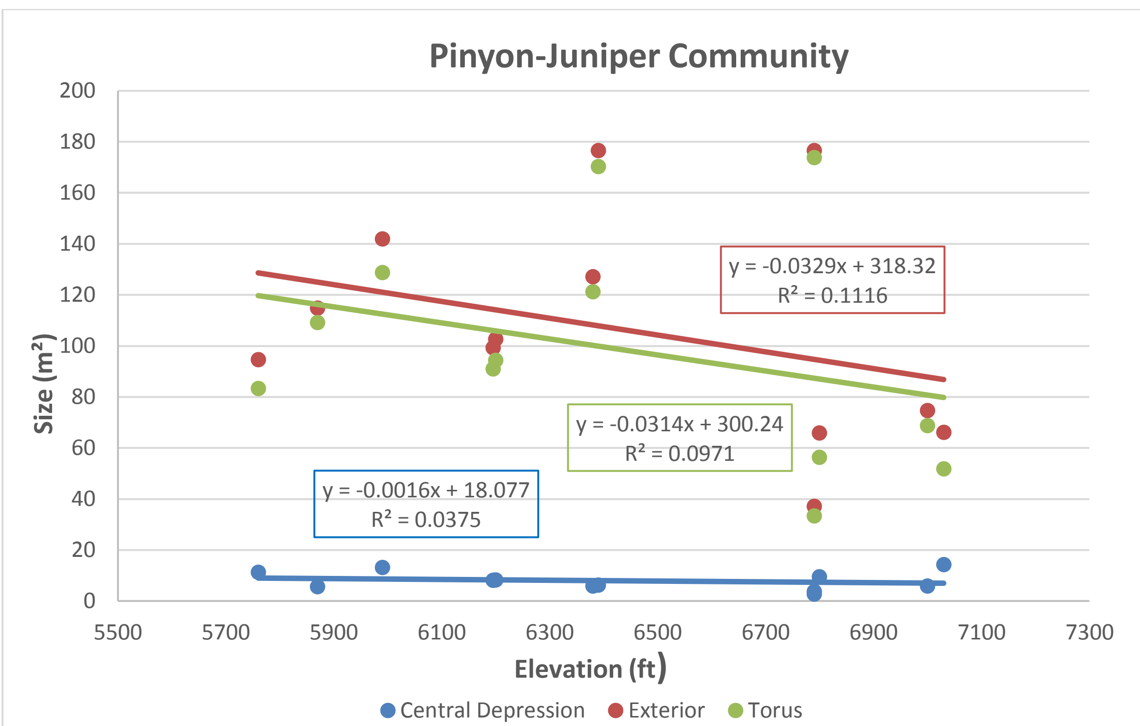


Figure 7.35. Scatter plot for roasting pit size by elevation within the Pinyon-Juniper community.

Table 7.4. Mann-Whitney U test results for central depression measurements.

	Creo	Yucca	BBC	MSC	Pinyon
Creo	-				
Yucca	0.0558	-			
BBC	0.1248	0.2524	-		
MSC	0.0584	0.0057	0.00005	-	
Pinyon	0.0421	0.0097	0.0012	0.3278	-

Table 7.5. Mann-Whitney U test results for exterior measurements

	Creo	Yucca	BBC	MSC	Pinyon
Creo	-				
Yucca	0.0573	-			
BBC	0.0082	0.9187	-		
MSC	0.0002	0.2758	0.0713	-	
Pinyon	0.0055	0.3251	0.2028	0.8183	-

Table 7.6. Mann-Whitney U test results for torus measurements.

	Creo	Yucca	BBC	MSC	Pinyon
Creo	-				
Yucca	0.1035	-			
BBC	0.0148	0.9728	-		
MSC	0.0001	0.1743	0.0236	-	
Pinyon	0.00373	0.21289	0.11580	0.74180	-

For the central depression measurements, five of the ten tests produced significant results: Creosote-Yucca Dominate, Creosote-Blackbrush community, Creosote-Mixed Shrub community, Yucca Dominate-Blackbrush community and between Pinyon/Juniper-Mixed Shrub community. Results for the other five comparisons resulted in non-significant values. While non-significant, values between Creosote-Yucca Dominate and Creosote-Mixed Shrub community were both close to the 0.05 range. Additionally, the value between Creosote-Pinyon (0.04213) is the highest significant value among the bunch.

For the exterior measurements, significant results were only present in three of the ten tests: Creosote-Yucca Dominate, Creosote-Blackbrush community and Creosote-Pinyon. The other seven tests were all non-significant by a healthy margin. Comparisons between torus measurements provided similar results to the exterior tests, with an additional significant value (Mixed Shrub-Blackbrush community). In total, four of the ten tests were positive, while the remaining six were non-significant.

Significant values for torus and exterior measurements suggests that roasting pits built within Creosote Brush communities are smaller than those built in Blackbrush, Mixed Shrub and Pinyon-Juniper communities. One possible explanation for roasting pit size variation is that edible plant resources and fuel are not as plentiful in Creosote Brush communities. Thus, people would either have to travel further to gather resources or visit these locations on a less frequent basis.

A similar distinction between roasting pits size and elevation was identified by Blair (1986) in the California Wash, located roughly 30 miles east of the Sheep Range. She noted that:

> In general where fuel size diminishes and agave ceases to grow in the lower elevations of the valley floors as in California Wash, the Dry Lake and Las Vegas Range valleys, the decrease in roasting pit size is apparent and related to the vegetational changes associated with lower elevations (Blair 1986:109-110).

Blair's observation concerning roasting pit size and elevation appears to apply to roasting pits built in the Sheep Range. Of the five vegetation communities in which roasting pits were identified, the Creosote Brush community is located at the lowest elevations. In general, roasting pit size increases along with elevation.

Traveling considerable distances for plant resources may seem cost prohibitive, but recent archaeological investigations suggest people traveled upwards of 8-12 km to gather yucca fruits to pit bake (Louderback et al. 2013). Ethnographic accounts also suggest that Southern Paiute groups traveled upwards of 16-26 km in one direction to procure agave to cook (Hodgson 2001:14). Regardless, the sheer amount of roasting pits found scattered near resources throughout the Range suggest that people were more likely to construct a new roasting pit rather than travel great distances to cook in an established one.

While earth oven baking is efficient, fuel in the form of woody plants is necessary to heat rocks up to an appropriate temperature. Just like edible plant resources, fuel must be available in sufficient quantity to bake foods in a roasting pit and also need time to replenish after they have been utilized. Most of the Sheep Range is relatively fuel-poor, aside from Pinyon-Juniper and Mixed Shrub Communities. While these supplies may also be gathered by traveling further away subsequent to each cooking event, it was likely easier to simply build a new roasting pit, or use an established one, in an area where cooking has not occurred in a while.

Mann-Whitney U tests performed for torus measurements returned one significant return not present in tests run for exterior measurements. Roasting pits have larger tori in Mixed Shrub than Blackbrush communities. Larger torus sizes present in Mixed Shrub communities may be due to there being a greater amount of fuel and plant resources. The size of a torus may be generally related to the number of times a feature was used; the more it was used, the greater amount of cooking debris (FCR, carbon-stained sediment, etc.) that would accumulate. However, since this is only a general association, additional unforeseen factors may explain this differentiation in size.

A potential explanation for the difference in central depression measurements may once again be related to elevation. Vegetation communities found at the highest elevations (Pinyon-Juniper and Mixed Shrub) have roasting pits with the smallest central depressions, which may also be related to increased use. The more a roasting pit is utilized, the greater amount of spent cooking stones that will be associated with it. Larger roasting pits often appeared to have smaller central depressions due to the greater amount of debris collapsing inward. With the smaller roasting pits found at lower elevations, there was not enough mass of rocks to collapse inward.

GIS Analysis

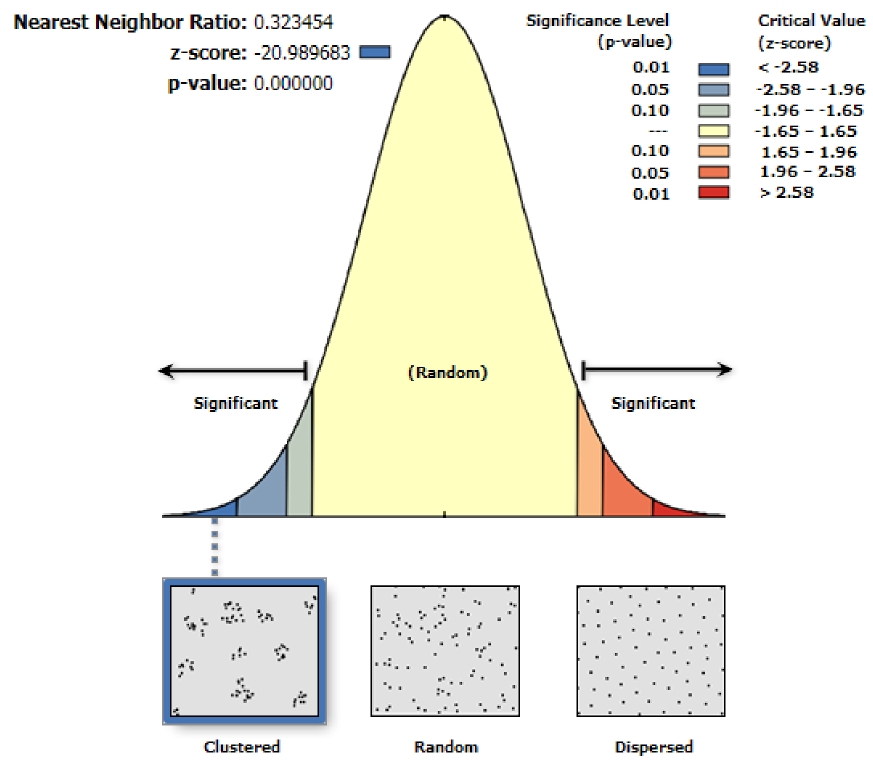
My third research goal was to see what additional insight could be gained from GIS analysis regarding the location of roasting pits throughout the Sheep Range. Elevation, feature size, vegetative zone and proximity to other roasting pits are all measureable data that can be tested for significance. Patterns within the data may shed light into reasons why certain areas were chosen over others. The two GIS tools I used to further analyze my data were the Average Nearest Neighbor tool and the Hot-Spot Analysis tool. I first tested to see whether roasting pits within the Sheep Range were clustered or not using the Average Nearest Neighbor tool. I then used the Hot-Spot Analysis tool to determine if roasting pits were clustered in a significant way based on their size data. All GIS analysis was conducted using ArcMap 10.2.

Nearest Neighbor Analysis

I began with Nearest Neighbor analysis to see if all identified roasting pits in the Range were dense enough to be considered clustered, and if not, were there numerous clusters among the dataset as a whole. I performed this analysis using the Average Nearest Neighbor tool from the Spatial Statistics Toolbox. This tool measures the distance between each point within a dataset, averages those distances and compares that average to a hypothetical random distribution. If the average distance is higher than the hypothetical distribution, the dataset is considered dispersed and if the average distance is lower the feature is considered clustered (Price 2004:508).

As shown below in Figure 6.30, all identified roasting pits are clustered within the Range. The observed mean distance between roasting pits is 365 meters while the expected mean distance was 1128 meters. Unfortunately, ArcMap uses Euclidean distance to measure between roasting pits in a straight line, ignoring the natural topography of the region which would have undoubtedly influenced travel from one roasting pit to another. This does not negate the results but rather is something important to keep in mind. According to the results summary, with a z-score of -20.99 "there is a less than 1% likelihood that this clustered pattern could be the result of random change" (Figure 7.36). Based on these results, roasting pits within the Sheep Range appear to be considered clustered. However, the initial test was conducted on all suspected roasting pits, which includes roasting pits identified via Google Earth but not yet verified on the ground. To be sure roasting pits are considered clustered within the Range, I conducted an additional Average Nearest Neighbor test on all recorded roasting pits.

Average Nearest Neighbor Summary



Given the z-score of -20.9896834127, there is a less than 1% likelihood that this clustered pattern could be the result of random chance.

Average Nearest Neighbor Summary

Observed Mean Distance:	364.8625 Meters
Expected Mean Distance:	1128.0188 Meters
Nearest Neighbor Ratio:	0.323454
z-score:	-20.989683
p-value:	0.000000

Dataset Information

Input Feature Class:	Ruin_Points
Distance Method:	EUCLIDEAN
Study Area:	1338592542.620101
Selection Set:	False

Figure 7.36. Results from ArcGIS Average Nearest Neighbor analysis for all identified roasting pits.

Results from the second Average Nearest Neighbor test were similar to the original test. Minor differences are evident for z-score (-18.81), mean distances (Observed: 374.7 m, Expected: 1282.6 m) and nearest neighbor ratio (.29). The result however was the same; all recorded roasting pits within the Sheep Range are a clustered feature type.

Based on the Nearest Neighbor analysis, all roasting pits within the Sheep Range are considered spatially clustered. In other words, they tend to occur close to one another as opposed to being isolated. This suggests that multiple roasting pits may have been used simultaneously at a given location since reusing an established oven is easier than constructing a new one.

Hot-Spot Analysis

Next, I tested to see if roasting pits were concentrated within the Sheep Range according to different size classifications using the Hot-Spot Analysis tool. The Hot-Spot Analysis tool identifies statistically significant hot and cold spots within a weighted dataset using the Getis-Ord Gi statistic. The same roasting pit dataset and size classifications used to test for statistical significance with Mann-Whitney U tests were used here. The three different size classifications were: the overall size of the feature (exterior), the size of the torus and the size of the central depression. Though I tested the significance of all three size classifications, I was primarily interested in torus and exterior comparisons. For the purposes of this test, I believe that overall size can be roughly equated with overall use. The more baking that occurs at a roasting pit location, the larger the associated midden is expected to be. This test was conducted to see if concentrations of high-use roasting pit sites could be detected, and if so, where in the Range did they occur.

I began by testing the torus measurements for any hot-spots within the Sheep Range. According to the results presented in Figure 7.37, there appears to be a concentration of roasting pits with large torus measurements centralized near the center of the Sheep Range. Conversely, there appears to be a concentration of roasting pits with smaller torus measurements located near the northern extent of the Range. For torus measurements, roasting pits located along the southern and northeastern extent of the Range were not statistically significant. I then ran another Hot-Spot Analysis test for the overall exterior measurements. However, the results were the same and are therefore not presented here.

Two primary reasons may explain why large roasting pits are clustered in this area. First, most of these larger roasting pits are located within canyons that lead up to a saddle along the spine of the Sheep Range. These saddles provide the quickest route to travel from one side of the Range to the other. If these locations were in fact popular routes from one side to another, it seems logical that roasting pits along the way would have been utilized the most. Additionally, the central portion of the Range provides access to a number of vegetative communities and thus a variety of plant and animal resources.

Another reason may simply be due to the elevation at which these features were constructed. As discussed prior, roasting pits built at higher elevations are more likely to be larger in size, or rather, they were used more often than roasting pits at lower elevations. I hypothesize this is because plant resources commonly baked within roasting

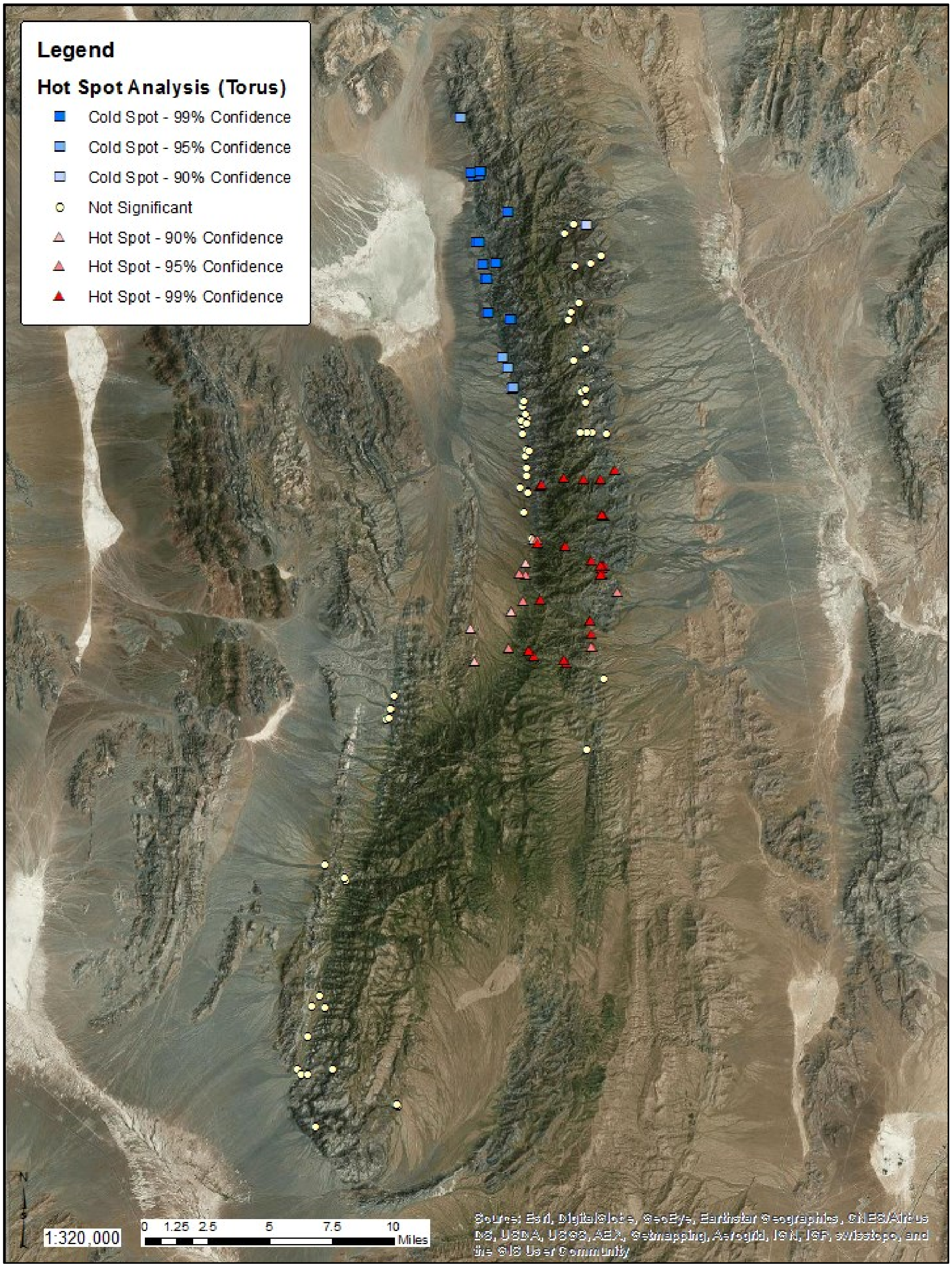


Figure 7.37. Hot-Spot Analysis for torus measurements of roasting pits in the Sheep Range.

pits were more plentiful at higher elevations. Additionally, fuel is more readily available at higher elevations in the form of Pinyon and Juniper. With a greater density of edible plant resources and fuel, higher elevations provide the means to engage in earth oven cooking more frequently.

Conversely, a concentration of roasting pits with smaller exterior measurements is present in the north along the western side of the Range. This may be attributable to several factors. First, most of the roasting pits recorded in this area were found within the Creosote Brush community. As discussed, roasting pits built in Creosote Brush communities are significantly smaller than those found at higher elevations (Blackbrush, Mixed Shrub and Pinyon-Juniper). I hypothesize that roasting pits built in Creosote Brush communities are smaller than those built in other vegetative communities due to less concentrated resources. This includes relatively fewer edible plant resources as well as less available fuel.

Another reason for the concentration of smaller roasting pits in the north may be due to the time of year they were used. Ethnographic accounts indicate that the Pahranagat band of Southern Paiute cooked in roasting pits in the northern portion of the Range during the winter (Fowler 2012a:108). Though the central stem of agave have yet to grow during this time of year, it is purportedly possible to tell which plants would be ripe the following spring by how plump they were. However, agave at higher elevations may have been more difficult to obtain than elsewhere given colder temperatures or the presence of snow.

Another Hot-Spot Analysis test was performed for the central depression measurements. As shown in Figure 7.38, there is a concentration of larger central

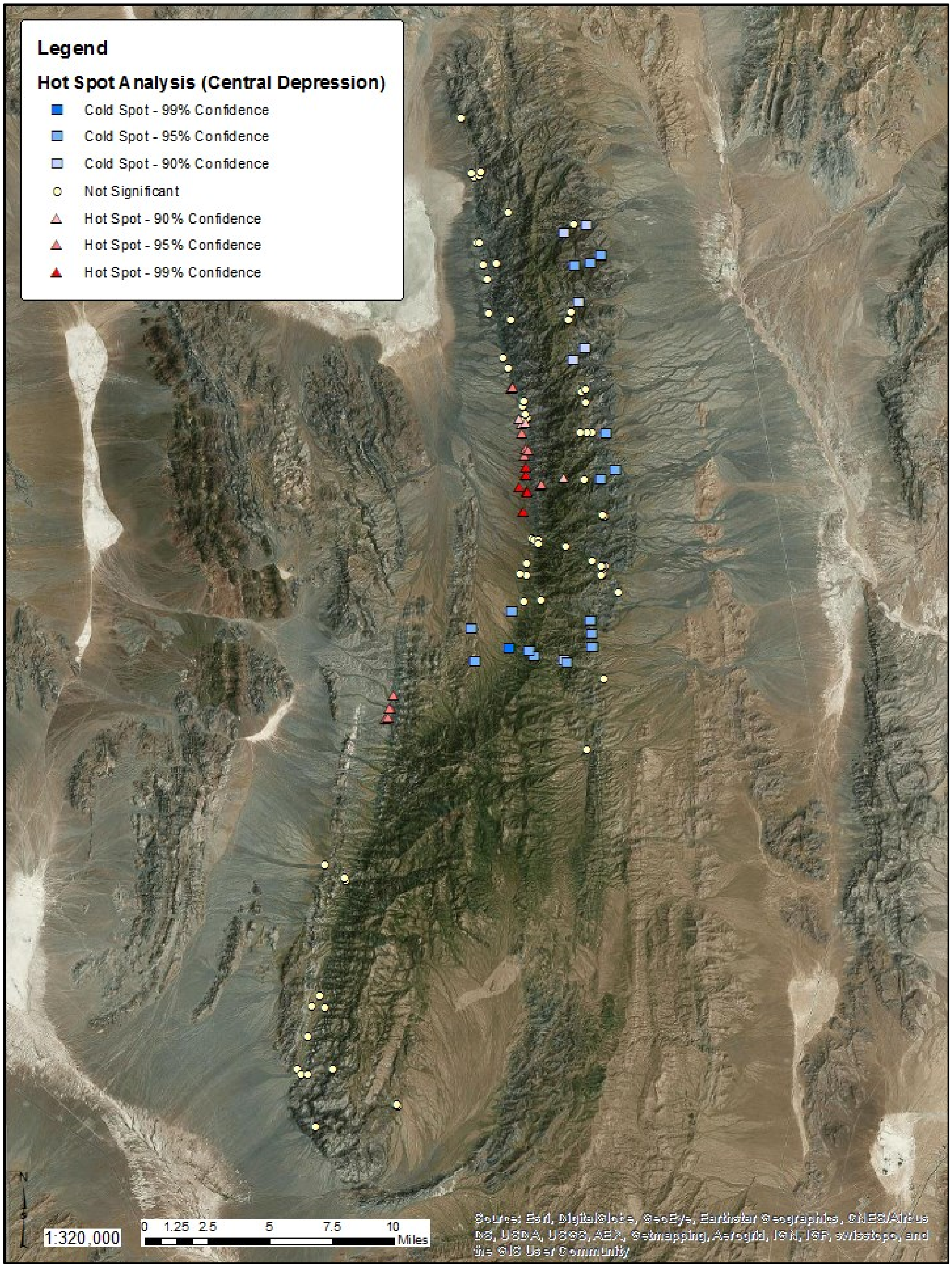


Figure 7.38. Hot-Spot Analysis for central depression measurements of roasting pits in the Sheep Range.

depressions of roasting pits along the western side in the northern portion of the Sheep Range. An additional small cluster of roasting pits with larger central depression measurements may be found along the southwest portion of the Range. However, this may be an anomaly due to the relative lack of nearby roasting pits. There are also tighter concentrations of roasting pits with smaller central depression dimensions scattered along the north-eastern side of the Range, as well as on either side near the Range's center.

Roasting pits with small central depressions appear scattered along the eastern and central side of the Sheep Range. Many of these features are also roasting pits previously highlighted due to their large torus sizes. Small central depression size is perhaps due to erosional forces. As previously mentioned, larger roasting pits often appeared to have smaller central depressions due to the greater amount of spent rocks collapsing inward.

I am hesitant to correlate central depression size with the size of the cooking pits themselves and thus the amount of food cooked within a roasting pit. One reason is illustrated by RP-174, the potentially single-use roasting pit feature highlighted in Chapter 6. RP-174 has a small cooking pit consisting of large rocks, some fire cracked, along with pieces of charcoal and surrounded by a mostly intact ring of white thermally-altered rock. The space between the central cooking pit and the line of thermally-altered rock, which I have referred to as the central depression in other roasting pits, consisted almost entirely of smaller rocks. The uniform consistency of rock size surrounding the cooking pit and the lack of large rocks altogether form a smoother surface, one that was likely created intentionally. If Sheep Range roasting pits were constructed in a similar fashion, then the central depression does not indicate the size of the cooking pit itself.

Clearly defined cooking pits were visible on the surface in 38/193 (20%) roasting pits. Cooking pits were not visible in most roasting pits most likely due to infilling, vegetation growth or prolonged length of nonuse. Roasting pits located along the edges of ephemeral washes and near the head of alluvial fans were often filled in with sediment from sheet wash. Thick vegetation was also commonly present growing from the center of roasting pits, obscuring the ability to identify cooking pits. Older roasting pits in which severe deflation was apparent never had clearly defined cooking pits. This was likely due to a combination of erosion and the duration of time that passed from the point of most recent use to present day.

My final method of analysis in ArcMap incorporated the use of a synthetic vegetation map for the state of Nevada (Figure 7.39). This raster dataset was created by synthesizing vegetation data from multiple sources for the state at 30 m^2 accuracy and is available for free on the internet (Peterson 2008). This dataset provides the ability to quantify land coverage of various vegetative communities throughout the Range where roasting pits were built, which allowed me to run a chi-square goodness of fit test. This statistical test determines if roasting pits are evenly distributed across all identified vegetative communities.

The purpose of this test was to determine whether a statistically significant number of roasting pits were expected within the Pinyon-Juniper community. Since the tree canopy hindered visibility while searching with Google Earth, identifying roasting pits within Pinyon-Juniper communities was less successful. This test was run as a way to statistically test my survey methods.

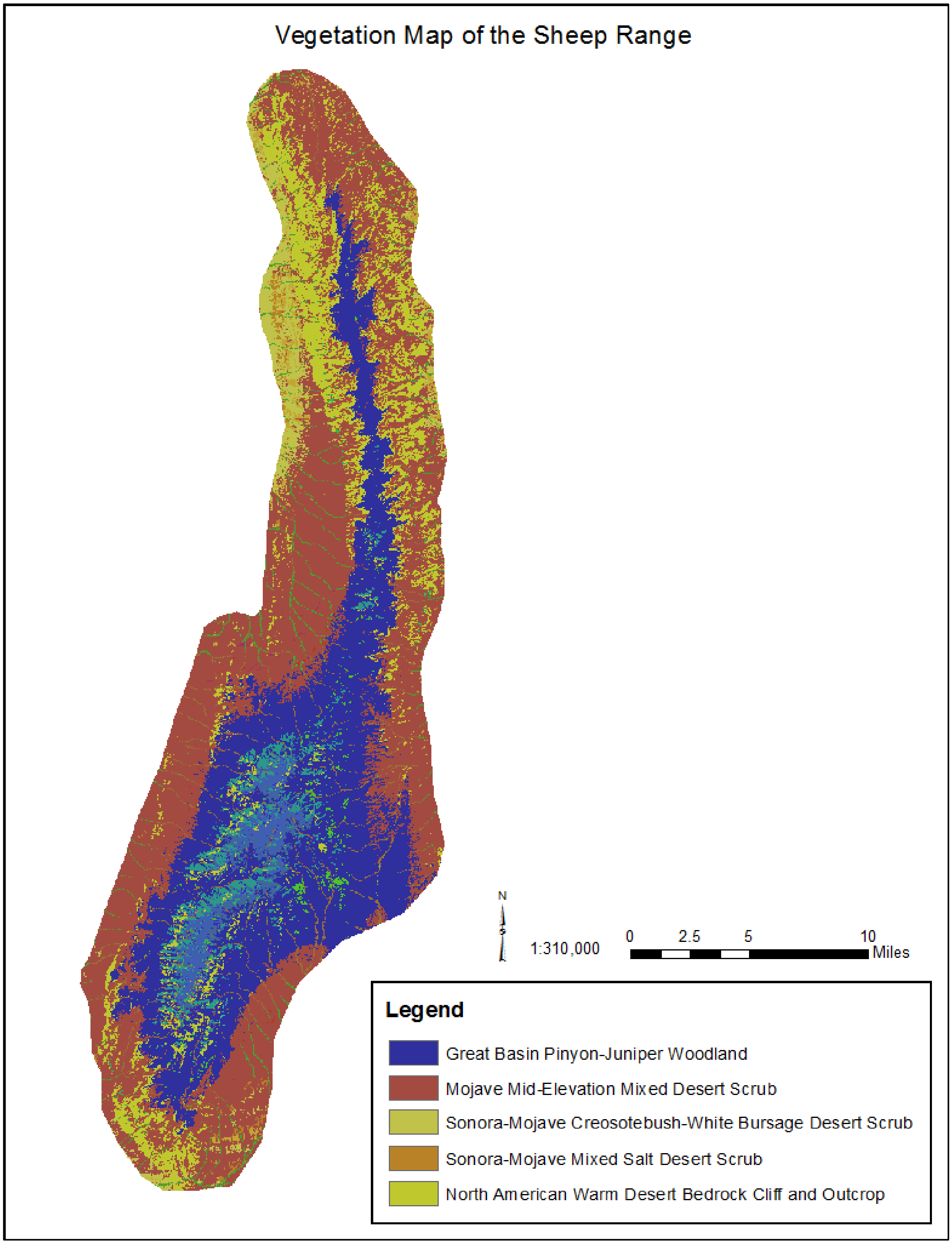


Figure 7.39. Clipped study area of the Sheep Range from a vegetation synthesis map.

I began by using the Clip tool in ArcMap to select my study area, as shown in Figure 7.39. The borders of my study area were determined according to the survey boundaries, both on the ground and through aerial photography. With my study area clipped, I began by comparing the distribution of roasting pits in the vegetative zones provided by the synthesis map. A breakdown of roasting pits per vegetative communities is shown in Table 7.7. Determining which vegetative zone a roasting pit was located in was straight-forward. In two instances, roasting pits were located on pixels described as bedrock. For those two roasting pits, the vegetation community immediately surrounding those locations was chosen.

Table 7.7. A breakdown of roasting pits by vegetation zone according to the synthesis map.

Vegetative Community	Quantity
Sonora-Mojave Creosotebush-White Bursage Desert Scrub	10
Mojave Mid-Elevation Mixed Desert Scrub	167
Great Basin Pinyon-Juniper Woodland	15
Sonora-Mojave Mixed Salt Desert Scrub	1

Next, I determined the land coverage of each vegetation community within my study area. Count data for each vegetative community was present within the metadata of the synthesis map. Since the synthesis map provided 30m accuracy, I multiplied the number of pixels for each vegetative community by 900, the amount of meters within a 30m block. The result provided the meters squared coverage for each vegetative community. I then converted this data into kilometers squared.

Once this data was set, I ran a chi-square goodness of fit for recorded roasting pits within all four vegetative communities. My hypotheses for this test were as follows:

H_0: Roasting pits are evenly distributed across all vegetative zones.

H_1: Roasting pits are not evenly distributed across all vegetative zones.

Based on the results of the test (Table 7.8), we reject the null hypothesis and accept the alternative hypothesis. Roasting pits within the Sheep Range are not evenly distributed within vegetative communities according to the area for which those communities cover.

Based on the results, it appeared that roasting pits within the Pinyon-Juniper community were the primary reason why the initial chi-square test rejected the null hypothesis. To determine whether this was correct, an additional chi-square goodness of fit test was run, this time excluding roasting pits found in the Pinyon-Juniper community.

My hypotheses for this test were the same as before:

H_0: Roasting pits are evenly distributed across all vegetative zones.

H_1: Roasting pits are not evenly distributed across all vegetative zones.

Table 7.8. Chi-square goodness of fit test for roasting pits identified in vegetative zones within the synthesis map. Please note that vegetative community names are shortened to reduce space.

Vegetation Community	Km^2	Observed (O)	Expected (E)	O – E	$(O – E)^2/E$
Creosote	35.569	10	9.235	0.765	0.063
Mixed Shrub	415.265	167	107.820	59.180	32.483
Pinyon-Juniper	288.253	15	74.843	-59.843	47.849
Salt Scrub	4.245	1	1.102	-0.102	0.009

Chi-Square	80.404
Degrees of Freedom	3
P-value	2.5E-17

According to the results of the test (Table 7.9), we accept the null hypothesis. Roasting pits within the Sheep Range are evenly distributed within vegetative communities when we exclude those identified within the Pinyon-Juniper community.

Table 7.9 - Chi-square goodness of fit test for roasting pits identified in vegetative zones within the synthesis map excluding Pinyon-Juniper. Please note vegetative community names are shortened to reduce space.

Vegetation Community	Km^2	Observed (O)	Expected (E)	O – E	$(O – E)^2/E$
Creosote	35.569	10	13.912	-3.912	1.1
Mixed Shrub	415.265	167	162.427	4.573	0.129
Salt Scrub	4.245	1	1.661	-0.661	0.263

Chi-Square	1.492
Degrees of Freedom	2
P-value	0.474

Based on the results of my initial chi-squared test, roasting pits are not evenly distributed across all vegetation communities. To determine whether roasting pits within the Pinyon-Juniper community was driving the results of the initial test, a second test was run excluding this data. According to the second test, roasting pits are evenly distributed across all vegetative communities except for the Pinyon-Juniper community.

The reason why roasting pits are not evenly distributed within the Pinyon-Juniper community is based on the ratio of identified features to vegetative land coverage. While the Pinyon-Juniper community covers nearly 40% of the study area, only 7% of recorded roasting pits were identified there. In contrast, the Mixed Shrub community covers 56% of the study area, but 87% of recorded roasting pits were identified here.

The relative lack of identified roasting pits within the Pinyon-Juniper community may be due to several reasons. One reason may be due to the methodology I used to identify roasting pits. There are likely more roasting pits located in the Pinyon-Juniper portion of the Sheep Range that cannot be seen through the thick tree cover. Given that ethnographic accounts indicate roasting pits were also used to bake pinyon nuts, it is likely that additional unrecorded features exist within such areas. Another reason may be based on behavior. Though roasting pits were indeed used to some degree to bake green cone pinyon nuts, they were more commonly used to bake desert succulents such as agave and yuccas. For this reason, a greater majority of roasting pit features are found in environments that support the growth of desert succulents.

I hypothesize that while additional roasting pits likely exist hidden from sight under the cover of Pinyon and Juniper trees, the baking of desert succulents was the primary focus for this method of cooking. Due to this, the majority of roasting pits are expected to be found in environments that support the growth of desert succulents. However, the inability to identify features through the tree canopy is an important drawback to acknowledge for this method of survey.

Land Use Intensification

Based on the sheer number of roasting pits identified within the Sheep Range, earth oven cooking was undoubtedly commonly employed technology in the area. However, to strongly argue for intensification, more is necessary than a large dataset; one must show that use increased thru time as opposed to remaining steady. Unfortunately, as discussed precise dating is not available for roasting pits within the Sheep Range. Diagnostic artifacts were not typically found with roasting pits. A systematic testing and radiocarbon dating program would be necessary to confidently evaluate land use intensification, as individual radiocarbon dates from roasting pits merely identify a single use event.

Despite the lack temporal data, an argument can still be made regarding land use intensification in the Sheep Range. As stated in Chapter 2, a common tool for measuring land use intensification uses a diet breadth model, which compares calories returned versus calories expended for a particular task. For earth oven baking, tasks typically include: gathering edible plants, fuel and rocks (including travel time), pre and post-bake processing, as well as excavating the cooking pit and preparing it for a fire. Since foods have a caloric return and activities burn calories to accomplish, it is argued that groups would not consistently engage in procuring resources if the outcome was dramatically less than the input.

As described by Dering (1999), baking plants in earth ovens does not necessarily provide a significant caloric return when compared to the caloric energy consumed. This is primarily due to the caloric return of the prehistorically baked plant foods in Dering's study area, namely sotol and lechiguilla. While Dering's experiment occurred in southwest Texas as opposed to southern Nevada, a significant difference in caloric return and expenditure between the two regions is not expected.

Thoms (2009) has argued that edible plants such as desert succulents (e.g., agave and yuccas), lend themselves to being intensively procured and processed. As desert succulents are incorporated into the diet, a greater amount of caloric return is produced which may result in surplus. As caloric returns increase, so may the population sizes of groups incorporating this method of cooking. This concept is illustrated by Thoms' (2009) model (Figure 7.40). With the introduction of pottery, the use of earth oven technology may intensify further as the improved ability to store foods prolongs their shelf-life.

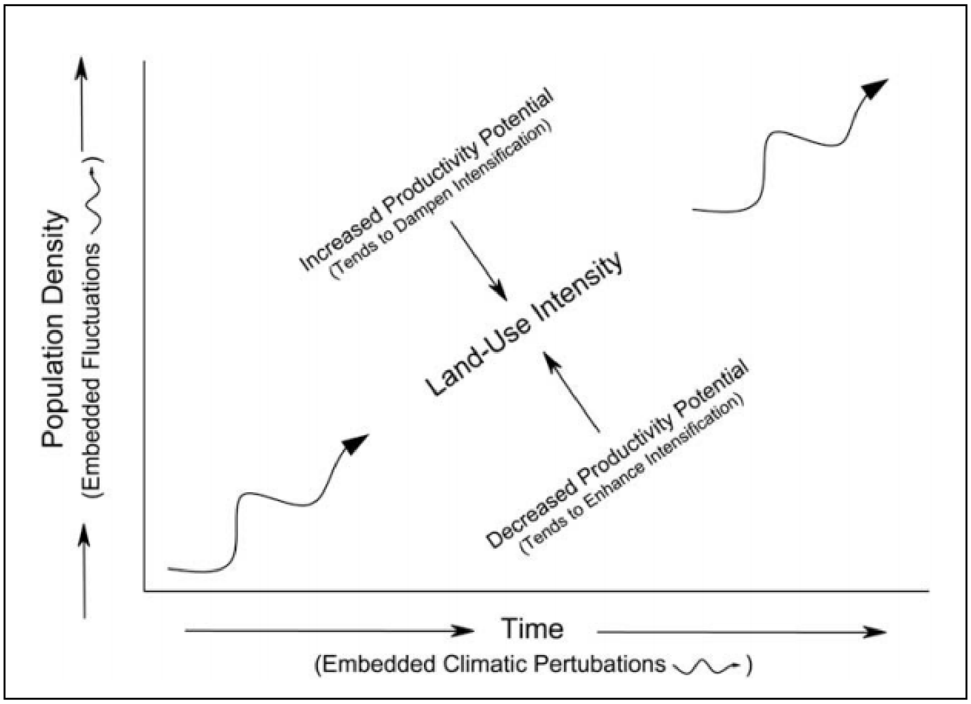


Figure 7.40. Thoms (1989) model (taken from Thoms 2009) predicting how land use will intensify over time as population increases and productivity decreases.

Examples of using pottery to store agave have not been identified for the Southern Paiute. However, an example of a hermetic sealed jar containing processed agave was documented in a cave near Kingsman, Arizona, roughly 100 miles southeast of the Sheep Range. According to the description provided by Euler and Jones (1956:87-88), the jar "contained stored food (mescal) … with about forty-five slabs of dark brown material having the appearance of mats of fiber soaked in syrup and then dried." A radiocarbon date obtained from a piece of mescal was 650 +/- 250 years B.P. (Euler and Jones 1956:88). Euler and Jones identified the pot as belonging to the Patayan culture, who are also believed to have gathered resources from present day southern Nevada during the Puebloan Period (A.D. 200 – 1300).

Evidence for the use of pottery to store agave roughly 100 miles away does not necessarily mean that the same practice was utilized by those who roasted agave in the Sheep Range. However, if Patayan groups were actively engaged in gathering resources in southern Nevada during the Late Prehistoric, it is entirely possible that this technology was disseminated to other groups.

Whether use of the Sheep Range intensified over time or not, several factors were present within the area which would have made it possible. The proliferation of desert succulents, fuel and rocks throughout the Range made earth oven cooking an attractive option, a point highlighted by the number of identified features. Pottery would have allowed for surplus to be stored, which may explain the presence of pottery sherds at roasting pits. While the presence of these factors does not prove that land use intensification occurred within the Sheep Range, they do suggest that such intensification was possible.

VIII. CONCLUSION

The prevalence of roasting pits within the confines of the Sheep Range in southern Nevada suggests baking foods in earth oven facilities was a common practice. While ethnographic accounts indicate a variety of foods was baked in earth ovens, I infer that desert succulents such as agave were primarily cooked in roasting pits. Based on diagnostic artifacts found associated with roasting pits in the Sheep Range and radiocarbon dates obtained from earth oven facilities within southern Nevada, I reason that roasting pits were primarily used during the Terminal Archaic through the Post-Puebloan periods. Roasting pits in the Sheep Range are clustered features, and a concentration of earth oven facilities with large torus measurements is present in the north-central Range. The size of roasting pits, including exterior and torus measurements, generally increases with elevation, while earth oven facilities constructed within the Creosote Brush community have significantly smaller exterior and torus measurements than those built in nearly every other documented plant community. Experimental testing of rocks found near roasting pits determined that local dolomite turns white when subjected to temperatures of 875° C.

Using Google Earth to identify roasting pits within the Sheep Range was very successful. Due to the white appearance of many of the rocks making up roasting pit middens, these features were clearly visible from aerial imagery. In total, 232 roasting pits were identified using this method. I accessed and documented 193 of them by foot or helicopter. The remaining 39 features were not visited and documented due to time constraints.

Statistical analysis of roasting pit measurements yielded several significant results. Regression for all three roasting pit measurements, exterior, torus and central depression, identified that exterior and torus measurements were larger at higher elevations than at lower elevations. Mann-Whitney U tests identified that roasting pits built in Creosote Brush communities had smaller torus and exterior measurements than those built vegetative zones at higher elevations, including Blackbrush, Mixed Shrub and Pinyon-Juniper communities. Vegetative zones at higher elevations also appear to have on average a higher density of fuel and edible plant resources. Sheep Range roasting pit measurement data are consistent with observations previously made by Blair (1986:109-110) elsewhere in southern Nevada.

Several analytical tools in GIS were used to further investigate roasting pits within the Sheep Range, including Nearest Neighbor and Hot-Spot Analysis. Nearest Neighbor Analysis determined that all recorded roasting pits within the Sheep Range are spatially clustered, as opposed to being randomly or evenly dispersed. This suggests that when roasting pits were used in a given area, multiple ovens may have been used simultaneously. It also suggests that these areas were attractive locations for earth oven cooking. Hot-Spot analysis identified that roasting pits with larger torus and exterior measurements were concentrated near the north-central portion of the Sheep Range. Torus size is interpreted as a general indicator of use and this concentration is believed to represent the area of the Range that was most heavily used for plant baking.

As described by Blair (1986), limestone is believed to be the primary material source for hot-rock cooking elsewhere in southern Nevada. The presence of white thermally-altered rocks at roasting pit sites elsewhere in southern Nevada has been interpreted as limestone transformed into lime by high temperatures. Experimental work with rocks from the Sheep Range suggests that dolomite also turns white after being subjected to high temperatures. The natural presence of magnesium in dolomite, which is absent in limestone, may help rocks resist reabsorption of moisture and carbon dioxide after they have been baked. Additional experimental work is necessary to further investigate this claim.

Although artifacts were not commonly found on the surface in association with roasting pits in the Sheep Range, diagnostic artifacts including projectile points and pottery sherds indicate roasting pits were used during the Terminal Archaic through the Post-Puebloan periods. A general dearth of groundstone artifacts in association with roasting pits suggests a majority of post-baking plant processing may have occurred away from earth oven facilities.

My thesis research leads me to put forth several hypotheses that can be evaluated by future research. One hypothesis is that rocks within the Sheep Range, namely dolomite and limestone, are more likely to turn and remain white after heated to high temperatures than material in other locations. This is based on the general lack of white rocks found associated with earth oven facilities elsewhere. Additional XRD testing and geologic sourcing could test this claim. The experimental work I began should be expanded to include a wider range of material types found near roasting pits in various portions of the Sheep Range. Testing burned rock samples from roasting pit middens, both white and non-white, should also identify which material remains white years after baking. Geologic sourcing of materials found near roasting pits would also greatly improve our understanding of this phenomenon.

I also hypothesize that roasting pit use in the Sheep Range intensified at some point from the Terminal Archaic to the Post-Puebloan periods. This hypothesis is based on the fact that the Sheep Range has a prevalence of desert succulents and geophytes which lend themselves to being intensively collected and processed, as well as continental patterns discussed by Thoms (2009). The quantity of roasting pits identified through the Range shows the prevalence of hot-rock cooking in the area. Systematic archaeological excavations are necessary to evaluate this claim.

I also reason that roasting pit use in the Sheep Range began earlier in the Archaic period, perhaps several thousand years earlier. It is clear that some of the roasting pit features I documented are considerably older than others, based on the degree of eroded sediment infilling their central depressions. It is also apparent that some roasting pits were used more often than others based on the size of their associated middens. Aside from one broken Elko projectile point base, the meager sample of diagnostic artifacts found in association with roasting pits in the Sheep Range do not date to the Late Archaic period. However, radiocarbon dates obtained from sites in the Dry Lake Range and Hidden Valley indicates that roasting pits were used during the Late Archaic period in southern Nevada (Ellis et al. 1982). Evidence for roasting pit use during the Late Archaic and perhaps even earlier may also be identified within the Sheep Range if excavation data, including samples of dateable material, were obtained.

To address the hypotheses I have set forth, additional archaeological investigations are necessary. The best way to test these claims is to conduct focused excavations on roasting pits throughout the Sheep Range. Numerous sources of data would be provided by a systematic excavation program, including radiocarbon dates, plant remains and associated artifacts. A greater understanding for the cooking technology of roasting pits should also be possible through excavation, including the fuel materials and oven design used to create temperatures high enough to alter the color of limestone and dolomite. A series of radiocarbon dates from numerous roasting pits could be used to evaluate whether use of roasting pits intensified over time or whether their use remained relatively stable. Radiocarbon dates from roasting pits with exceptionally large torus sizes or features with central depressions filled in with sediment interpreted as being older than those not filled in with sediment are prime candidates for testing this claim. Diagnostic artifacts such as pottery found through excavation would provide additional insight into the groups who utilized roasting pits in the Sheep Range. Plant and, potentially, animal remains found within roasting pits would provide further knowledge regarding the types of foods cooked.

The excavation strategy could vary from extensive to less intrusive. An optimal strategy would consist of relatively modest scale excavations, such as placing a 1m wide trench through the middle of a roasting pit, similar to how these features have been excavated elsewhere in southern Nevada (Blair et al. 2000; McGuire et al. 2013). Miller et al. (2013) used a similar excavation strategy on a large sample of earth oven facilities in the Sacramento Mountains which proved very successful. Excavating a trench provides an excellent chance of obtaining multiple lines of evidence, including samples of dateable material, diagnostic artifacts, oven construction, torus formation and botanical remains. Radiocarbon samples obtained from charred plant food materials, such as yuccas or agaves, are more suitable for dating purposes than wood charcoal since the former are short-lived foodstuffs baked in earth oven facilities.

Smaller scale investigations would also be informative and would cause less damage to the feature. One method would be focused excavations within the central depression of roasting pits perhaps using small 1 x 1 m units. Radiocarbon and flotation samples would provide pertinent data concerning targeted food resources and the period(s) of use for a roasting pit. Excavating in locations of the midden where sediment appears the blackest in color is also suggested, as these locations likely have the best preservation.

Another method of analysis that would greatly improve our understanding of use in the Sheep Range is an in depth study of pottery sherds associated with roasting pits. A robust excavation program would undoubtedly yield numerous pottery sherds, thus permitting additional testing of pottery sherd types, including temper and paste examination. High resolution photographs of pottery sherds would also increase the likelihood of sherd identification. Collecting individual sherds would allow clays and tempers to be sourced, which may identify where the vessel was made. Residue analysis on pottery sherds may provide valuable insight into the role ceramics played at roasting pit locations.

Recent ethnographic work with the Southern Paiute (Nuwuvi) concerning indigenous ecological knowledge has produced valuable information (Lefler 2015; Spoon et al. 2015). The Southern Paiute tribe could provide invaluable information concerning roasting pit use. This effort should be intensified and combined with all available ethnohistoric data from the Southern Paiute and other comparable Native American groups.

Going forward, I suggest conducting additional surveys in Pinyon-Juniper communities. The most significant issue with identifying roasting pits via aerial imagery occurred in areas with thick tree cover. It is likely that numerous roasting pits went unidentified in such locations due to lack of visibility. Since desert succulents are not as common in Pinyon-Juniper communities as in Mixed Shrub and Blackbrush communities, I doubt a substantial amount of roasting pits went undetected. However, as ethnographic accounts illustrate that green pinyon cones were also pit roasted, it is expected that additional roasting pits remain hidden in Pinyon-Juniper communities.

It has been an extraordinary journey from spotting roasting pits on Google Earth to flying in a helicopter to record these features to completing this thesis. My thesis offers a glimpse into the importance of roasting pits and points to the unrealized research potential of these striking features in the Sheep Range of southern Nevada.

APPENDIX SECTION

APPENDIX A: ROASTING PIT MEASUREMENT AND VEGETATION DATA

Table App A.1. Roasting pit measurement data obtained in the field. Zero values indicate the feature was too eroded to accurately measure.

Roasting Pit Number	Exterior – Length (m^2)	Exterior – Width (m^2)	Central Depression – Length (m^2)	Central Depression – Width (m^2)
1	600	600	0	0
2	1200	1300	400	500
3	850	830	370	400
4	800	570	230	270
5	1000	1080	200	270
6	1000	1050	250	250
7	990	960	470	340
8	1190	1260	370	560
9	920	1150	470	410
10	1340	1260	360	310
11	970	800	400	420
12	870	830	400	420
13	1210	1100	290	270
14	850	700	270	310
15	780	780	370	430
16	880	960	420	340
17	1130	1280	400	320
18	780	800	310	390
19	860	860	560	420
20	1170	1210	530	430
21	1110	1180	400	380
22	1060	1130	440	460
23	1200	980	470	500
24	1300	1290	480	440
25	1050	960	450	420
26	1280	1320	400	350
27	1310	1500	380	420
28	990	860	510	510
29	1130	1270	360	430
30	1360	660	0	0
31	1400	1370	500	450

Roasting Pit Number	Exterior – Length (m²)	Exterior – Width (m²)	Central Depression – Length (m²)	Central Depression – Width (m²)
32	1140	1250	0	0
33	1170	1150	400	300
34	1600	1450	0	0
35	1270	1020	330	330
36	0	0	0	0
37	1120	890	0	0
38	1320	1320	450	390
39	910	1050	480	480
40	1160	1450	370	470
41	1190	1180	250	240
42	940	910	330	340
43	1110	1020	330	300
44	1050	1050	0	0
45	950	1030	0	0
46	800	830	420	420
47	1400	1200	460	480
48	1530	1500	570	520
49	0	1220	380	350
50	1070	1050	400	450
51	900	1300	370	470
52	950	980	380	380
53	1150	1100	440	410
54	1000	1010	350	340
55	0	0	0	0
56	970	1600	520	450
57	640	520	350	360
58	1120	950	600	420
59	1020	1020	420	420
60	1000	1000	800	800
61	810	0	430	0
62	1230	1470	0	0
63	610	700	370	380
64	1500	1500	430	400
65	1130	1090	290	440
66	1000	1180	430	360
67	1050	830	580	490
68	1200	0	440	0
69	1090	1060	330	300
70	980	860	480	380
71	1050	800	380	320
72	2200	1800	0	0
73	0	0	0	0
74	1040	960	330	330

Roasting Pit Number	Exterior – Length (m²)	Exterior – Width (m²)	Central Depression – Length (m²)	Central Depression – Width (m²)
75	830	850	380	370
76	1140	1230	430	330
77	800	800	0	0
78	1020	1160	320	410
79	1070	970	260	260
80	1130	1190	380	380
81	1440	1340	520	440
82	860	1080	310	350
83	1320	1500	380	410
84	1400	1400	350	340
85	1040	1210	210	300
86	920	830	370	320
87	900	1120	0	0
88	1500	1480	310	380
89	1000	910	340	370
90	630	630	320	160
91	830	0	370	0
92	700	610	300	300
93	1040	1030	410	360
94	860	970	350	430
95	930	850	210	220
96	710	800	320	360
97	900	880	360	340
98	1230	1130	300	230
99	1200	0	0	0
100	1410	0	0	0
101	770	700	320	320
102	870	940	240	370
103	830	1030	390	430
104	720	910	430	410
105	820	1120	300	550
106	1200	0	220	320
107	1160	1120	520	480
108	1100	1100	0	0
109	1200	1100	270	260
110	870	950	580	500
111	1500	1500	330	270
112	1220	1360	370	310
113	1500	1390	270	190
114	1360	1420	320	280
115	310	310	180	120
116	0	0	0	0
117	1320	1500	250	200

Roasting Pit Number	Exterior – Length (m²)	Exterior – Width (m²)	Central Depression – Length (m²)	Central Depression – Width (m²)
118	1180	1170	420	400
119	890	1360	380	450
120	1500	1500	370	240
121	1280	1500	260	240
122	0	0	0	0
123	1140	1200	260	340
124	0	0	0	0
125	1000	980	0	0
126	1000	940	330	220
127	1240	1360	0	0
128	1330	1500	250	260
129	990	1100	420	450
130	740	0	260	0
131	890	930	430	420
132	1500	1500	430	300
133	1200	1060	0	0
134	1500	1500	380	380
135	1040	760	370	160
136	1120	1280	320	320
137	710	1040	0	0
138	1200	1500	480	430
139	500	650	350	280
140	1040	1160	400	360
141	1220	1200	250	290
142	1240	620	420	0
143	870	780	0	0
144	1000	970	310	300
145	830	830	330	250
146	1130	1380	280	280
147	1320	1310	390	370
148	640	500	290	0
149	1500	1500	350	230
150	1100	1190	330	320
151	850	850	0	0
152	1370	1320	420	400
153	980	1000	410	400
154	960	960	320	420
155	850	900	0	0
156	820	1160	290	260
157	1500	1500	160	220
158	740	640	240	200
159	1420	1500	420	620
160	1150	1100	350	300

Roasting Pit Number	Exterior – Length (m²)	Exterior – Width (m²)	Central Depression – Length (m²)	Central Depression – Width (m²)
161	1080	1500	280	270
162	740	850	380	320
163	1030	1040	0	0
164	720	730	380	460
165	1010	990	400	390
166	910	780	410	450
167	740	740	410	430
168	1120	1130	390	430
169	560	570	0	0
170	600	610	0	0
171	720	620	0	0
172	740	680	420	390
173	1010	640	380	390
174	560	650	0	0
175	770	800	310	400
176	520	490	0	0
177	790	720	450	370
178	1300	800	450	350
179	1050	1300	300	330
180	880	810	510	430
181	1000	1000	390	360
182	960	940	270	200
183	1100	1080	160	170
184	600	650	350	360
185	840	810	450	400
186	790	770	420	450
187	720	610	0	0
188	450	450	0	0
189	550	800	0	0
190	940	910	370	360
191	570	460	0	0
192	660	600	0	0
193	500	550	0	0

Table App A.2. Roasting pit measurement data used for GIS and statistical analysis. Dash marks indicate roasting pit measurements that were either unobtainable in the field or misleadingly elongated due to erosion and not included for analysis.

Roasting Pit Number	Exterior Measurements (m^2)	Torus Measurements (m^2)	Central Depression Measurements (m^2)
1	-	-	-
2	122	107	16
3	55	44	12
4	36	31	5
5	85	81	4
6	82	78	5
7	75	62	13
8	118	101	16
9	83	68	15
10	133	124	9
11	61	48	13
12	57	43	13
13	104	98	6
14	47	40	7
15	48	35	12
16	66	55	11
17	114	103	10
18	49	39	9
19	58	40	18
20	111	93	18
21	103	91	12
22	94	78	16
23	92	74	18
24	132	115	17
25	79	64	15
26	133	122	11
27	154	142	13
28	67	46	20
29	113	101	12
30	-	-	-
31	151	133	18
32	-	-	-
33	106	96	9
34	-	-	-
35	102	93	9
36	-	-	-
37	-	-	-
38	137	123	14
39	75	57	18
40	132	118	14
41	110	106	5

Roasting Pit Number	Exterior Measurements (m²)	Torus Measurements (m²)	Central Depression Measurements (m²)
42	67	58	9
43	89	81	8
44	-	-	-
45	-	-	-
46	52	38	14
47	132	115	17
48	180	157	23
49	-	-	-
50	88	74	14
51	92	78	14
52	73	62	11
53	99	85	14
54	79	70	9
55	-	-	-
56	122	103	18
57	26	16	10
58	84	64	20
59	82	68	14
60	79	28	50
61	-	-	-
62	-	-	-
63	34	22	11
64	177	163	14
65	97	87	10
66	93	80	12
67	68	46	22
68	-	-	-
69	91	83	8
70	66	52	14
71	66	56	10
72	-	-	-
73	-	-	-
74	78	70	9
75	55	44	11
76	110	99	11
77	-	-	-
78	93	83	10
79	81	76	5
80	106	94	11
81	151	134	18
82	73	64	9
83	155	143	12
84	154	145	9
85	99	94	5

Roasting Pit Number	Exterior Measurements (m²)	Torus Measurements (m²)	Central Depression Measurements (m²)
86	60	51	9
87	-	-	-
88	174	165	9
89	71	62	10
90	31	27	4
91	-	-	-
92	34	26	7
93	84	73	12
94	65	54	12
95	62	58	4
96	45	36	9
97	62	53	10
98	109	104	5
99	-	-	-
100	-	-	-
101	42	34	8
102	64	57	7
103	67	54	13
104	51	38	14
105	72	59	13
106	-	-	-
107	102	82	20
108	-	-	-
109	104	98	6
110	65	42	23
111	177	170	7
112	130	121	9
113	164	160	4
114	152	145	7
115	8	6	2
116	-	-	-
117	155	152	4
118	108	95	13
119	95	82	13
120	177	170	7
121	151	146	5
122	-	-	-
123	107	100	7
124	-	-	-
125	-	-	-
126	74	68	6
127	-	-	-
128	157	152	5
129	85	71	15

Roasting Pit Number	Exterior Measurements (m^2)	Torus Measurements (m^2)	Central Depression Measurements (m^2)
130	-	-	-
131	65	51	14
132	177	166	10
133	-	-	-
134	177	165	11
135	62	57	5
136	113	104	8
137	-	-	-
138	141	125	16
139	26	18	8
140	95	83	11
141	115	109	6
142	-	-	-
143	-	-	-
144	76	69	7
145	54	48	6
146	122	116	6
147	136	124	11
148	-	-	-
149	177	170	6
150	103	94	8
151	-	-	-
152	142	129	13
153	77	64	13
154	72	62	11
155	-	-	-
156	75	69	6
157	177	174	3
158	37	33	4
159	167	147	20
160	99	91	8
161	127	121	6
162	49	40	10
163	-	-	-
164	41	28	14
165	78	66	12
166	56	41	14
167	43	29	14
168	99	86	13
169	-	-	-
170	-	-	-
171	-	-	-
172	40	27	13
173	51	39	12

Roasting Pit Number	Exterior Measurements (m²)	Torus Measurements (m²)	Central Depression Measurements (m²)
174	-	-	-
175	48	39	10
176	-	-	-
177	45	32	13
178	82	69	12
179	107	99	8
180	56	39	17
181	79	67	11
182	71	67	4
183	93	91	2
184	31	21	10
185	53	39	14
186	48	33	15
187	-	-	-
188	-	-	-
189	-	-	-
190	67	57	10
191	-	-	-
192	-	-	-
193	-	-	-

Table App A.3. Elevation and vegetation community for each recorded roasting pit.

Roasting Pit Number	Elevation (ft)	Vegetation Community
1	5660	Blackbrush
2	5790	Blackbrush
3	5810	Blackbrush
4	6720	Mixed Shrub
5	6680	Mixed Shrub
6	6420	Blackbrush
7	4780	Blackbrush
8	4790	Blackbrush
9	4790	Blackbrush
10	4730	Blackbrush
11	4720	Blackbrush
12	4720	Blackbrush
13	4840	Blackbrush
14	4510	Blackbrush
15	4520	Blackbrush
16	4540	Blackbrush
17	4550	Blackbrush
18	4630	Blackbrush
19	4600	Blackbrush
20	4700	Blackbrush
21	4800	Blackbrush
22	4630	Blackbrush
23	4880	Blackbrush
24	4820	Blackbrush
25	4880	Blackbrush
26	4940	Blackbrush
27	5140	Blackbrush
28	5150	Blackbrush
29	5250	Mixed Shrub
30	5430	Mixed Shrub
31	5780	Mixed Shrub
32	5780	Mixed Shrub
33	5870	Mixed Shrub
34	5870	Mixed Shrub
35	5890	Mixed Shrub
36	5880	Mixed Shrub
37	5720	Mixed Shrub
38	5730	Blackbrush
39	5010	Blackbrush
40	5490	Mixed Shrub
41	5430	Mixed Shrub
42	4260	Creosote Brush
43	5370	Yucca Dominant
44	5370	Yucca Dominant

Roasting Pit Number	Elevation (ft)	Vegetation Community
45	5400	Yucca Dominant
46	5410	Yucca Dominant
47	5410	Yucca Dominant
48	5070	Blackbrush
49	5065	Blackbrush
50	5120	Yucca Dominant
51	5300	Yucca Dominant
52	6190	Blackbrush
53	5795	Blackbrush
54	4630	Creosote Brush
55	6320	Pinyon-Juniper
56	5280	Blackbrush
57	5800	Blackbrush
58	5910	Blackbrush
59	5950	Black brush
60	5220	Mixed Shrub
61	5610	Blackbrush
62	5770	Mixed Shrub
63	5600	Mixed Shrub
64	5760	Blackbrush
65	6560	Blackbrush
66	6510	Mixed Shrub
67	5795	Yucca Dominant
68	5385	Yucca Dominant
69	5800	Mixed Shrub
70	7030	Pinyon-Juniper
71	6800	Pinyon-Juniper
72	6720	Pinyon-Juniper
73	6500	Mixed Shrub
74	5650	Mixed Shrub
75	5650	Mixed Shrub
76	5390	Mixed Shrub
77	5130	Mixed Shrub
78	5100	Mixed Shrub
79	5080	Mixed Shrub
80	5050	Mixed Shrub
81	5040	Black brush
82	5070	Mixed Shrub
83	5210	Mixed Shrub
84	5200	Mixed Shrub
85	5210	Mixed Shrub
86	4880	Mixed Shrub
87	4830	Mixed Shrub
88	4650	Mixed Shrub
89	4655	Mixed Shrub

Roasting Pit Number	Elevation (ft)	Vegetation Community
90	4160	Blackbrush
91	4170	Blackbrush
92	4160	Creosote Brush
93	3830	Creosote Brush
94	3830	Creosote Brush
95	4440	Blackbrush
96	4440	Blackbrush
97	4040	Blackbrush
98	5610	Mixed Shrub
99	5610	Mixed Shrub
100	4850	Mixed Shrub
101	4840	Mixed Shrub
102	4720	Mixed Shrub
103	4720	Mixed Shrub
104	4480	Blackbrush
105	4480	Blackbrush
106	5060	Blackbrush
107	4950	Blackbrush
108	4960	Blackbrush
109	6050	Mixed Shrub
110	5880	Blackbrush
111	5230	Mixed Shrub
112	5030	Mixed Shrub
113	5090	Mixed Shrub
114	4480	Blackbrush
115	4480	Blackbrush
116	4640	Blackbrush
117	5390	Pinyon-Juniper
118	5120	Mixed Shrub
119	5060	Mixed Shrub
120	5060	Mixed Shrub
121	5040	Mixed Shrub
122	5120	Mixed Shrub
123	4660	Blackbrush
124	4840	Mixed Shrub
125	4890	Mixed Shrub
126	5410	Mixed Shrub
127	5400	Mixed Shrub
128	4830	Blackbrush
129	4440	Blackbrush
130	4440	Blackbrush
131	5300	Mixed Shrub
132	5300	Mixed Shrub
133	5380	Mixed Shrub
134	5240	Blackbrush

Roasting Pit Number	Elevation (ft)	Vegetation Community
135	5550	Blackbrush
136	4920	Mixed Shrub
137	4830	Blackbrush
138	5160	Mixed Shrub
139	5200	Mixed Shrub
140	5760	Pinyon-Juniper
141	5870	Pinyon-Juniper
142	5870	Pinyon-Juniper
143	5910	Pinyon-Juniper
144	4480	Blackbrush
145	4700	Blackbrush
146	4900	Mixed Shrub
147	5040	Blackbrush
148	5035	Blackbrush
149	6390	Pinyon-Juniper
150	6200	Pinyon-Juniper
151	6200	Pinyon-Juniper
152	5990	Pinyon-Juniper
153	5830	Mixed Shrub
154	4270	Mixed Shrub
155	4265	Blackbrush
156	7000	Pinyon-Juniper
157	6790	Pinyon-Juniper
158	6790	Pinyon-Juniper
159	6270	Pinyon-Juniper
160	6195	Pinyon-Juniper
161	6380	Pinyon-Juniper
162	3900	Creosote Brush
163	3921	Creosote Brush
164	4025	Creosote Brush
165	4002	Creosote Brush
166	4002	Creosote Brush
167	3924	Creosote Brush
168	4829	Creosote Brush
169	3380	Creosote Brush
170	3960	Creosote Brush
171	3718	Creosote Brush
172	4613	Blackbrush
173	4613	Blackbrush
174	3492	Creosote Brush
175	4451	Blackbrush
176	4004	Blackbrush
177	4004	Blackbrush
178	4004	Blackbrush
179	4004	Blackbrush

Roasting Pit Number	Elevation (ft)	Vegetation Community
180	4022	Blackbrush
181	3846	Creosote Brush
182	4101	Creosote Brush
183	4101	Creosote Brush
184	4101	Creosote Brush
185	3812	Creosote Brush
186	3863	Creosote Brush
187	3863	Creosote Brush
188	4003	Creosote Brush
189	4009	Creosote Brush
190	3956	Creosote Brush
191	3947	Creosote Brush
192	3947	Creosote Brush
193	3757	Creosote Brush

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