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GROUNDSTONE ANALYSIS AT THE ROCK CAMP SITE

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GROUNDSTONE ANALYSIS AT THE ROCK CAMP SITE

A Thesis

Presented to the

Faculty of

California State University,

San Bernardino

In Partial Fulfillment

of the Requirements for the Degree

Master of Arts

in

Applied Archaeology

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Approved by:

Dr. Amy Gusick, Committee Chair, Anthropology

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ABSTRACT

The use of mortar and pestles has long been associated with acorn processing in California. Based on ethnographic and archaeological evidence, groundstone was used to process a multitude of resources, including small mammals. Twenty groundstone artifacts recovered from the Rock Camp Site in the San Bernardino Mountains were analyzed for protein residues using the crossover immunological electrophoresis (CIEP) method. Using previously obtained data from the Summit Valley, a comparative analysis was done to determine if processing small mammals on groundstone was a common occurrence throughout the San Bernardino Mountain region.

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I would like to acknowledge my thesis committee, Dr. Gusick and Dr. Robertshaw, and my other professors and fellow classmates at California State University, San Bernardino for advising me in completing this thesis. Dr. Robert Yohe and Steve Teteak at California State University, Bakersfield for teaching me the laboratory techniques to carry out my research. Tamara Serrao-Leiva at the San Bernardino County Museum for allowing me access to research and the groundstone necessary for testing. Dr. Mark Allen for sharing his research of Rock Camp. To my family and friends.

DEDICATION

To Penny

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CHAPTER ONE

INTRODUCTION

Groundstone is one of the most common artifact types found at archaeological sites. This is especially the case for sites in Southern California that date to the Millingstone Horizon Period, which lasted from about 4,000-1,500 BP (de Barros *et al.* 1997). The general consensus among archaeologists in the region is that groundstone was used to process plant material, the most common item being acorns (*Quercus spp.*) (Sutton 1993; Yohe *et al.* 1991; Zepeda 2014). Besides being used for processing plant material, groundstone was also used to grind seeds, clay, and animal meat (Zepeda 2014). However, based on ethnographic accounts and the utilization of protein residue analysis, there is ample evidence to support the claim that the Native groups occupying the region during the Millingstone Horizon were also processing small mammals on groundstone. Since groundstone is so commonly found throughout California, there is an opportunity to research a variety of subsistence material that may have been processed using groundstone.

To date, there has been little research done to analyze groundstone for mammal proteins in the Southern California region (Cummings *et al.* 1996; Mealy 2009; Newman 1993a; Newman 1993b; Parr *et al.* 2001; Sutton 1993; Sutton *et al.* 1993; Yohe *et al.* 1991; Zepeda 2014). Currently, groundstone found at only a few sites in the San Bernardino Mountain region has been analyzed for protein residue, including CA-SBR-7691, CA-SBR-6179, and CA-SBR-6580, also known as The Siphon Site (Parr *et al.* 2001; Sutton *et al.* 1993; Yohe *et al.* 1991). These sites are in Summit Valley, which is located on the northern foothills of the San Bernardino Mountains. Based on ethnographic and archaeological evidence, this area was most likely used as a winter base camp for the inhabitants occupying the region. In the spring and summer, they would migrate up into the mountains to exploit resources found at the higher elevations (Altschul *et al.* 1985).

For my research, I utilized protein residue analysis, also known as crossover immunological electrophoresis (CIEP) to determine what materials were being processed on the groundstone at the Rock Camp Site (CA-SBR-342). I then compared my data with previously obtained data from two Summit Valley sites (CA-SBR-7691 and CA-SBR-6580) in order to provide additional evidence for the hypothesis that small mammal processing on groundstone was a common occurrence throughout this region. I chose to test the artifacts at the Rock Camp Site based on Altschul *et al.*'s (1985) settlement and subsistence model for the San Bernardino Mountains. This model posits that the Native inhabitants were using seasonal mobility to exploit a variety of resources at different elevations during certain times of the year. The model proposes that groups occupied the lower elevation area of the Summit Valley during the winter months and migrated up the northern side of the mountain to the higher elevation sites via one or more of the multiple drainage routes during the warmer months. The Rock Camp Site is the first area along the Deep Creek drainage route where pinyons (*Pinaceae*) and acorns were available. This large site is located approximately four miles south of the winter village site of Guapiabit and is likely the base camp for the higher elevation zone (Altschul *et al.* 1985). A map displaying the locations of the sites is shown in Figure 1.

I tested 20 groundstone artifacts that had been previously excavated from the Rock Camp Site and which are currently housed at the San Bernardino County Museum. By testing the groundstone for protein residues, we are able to have a better understanding of subsistence strategies in the region.

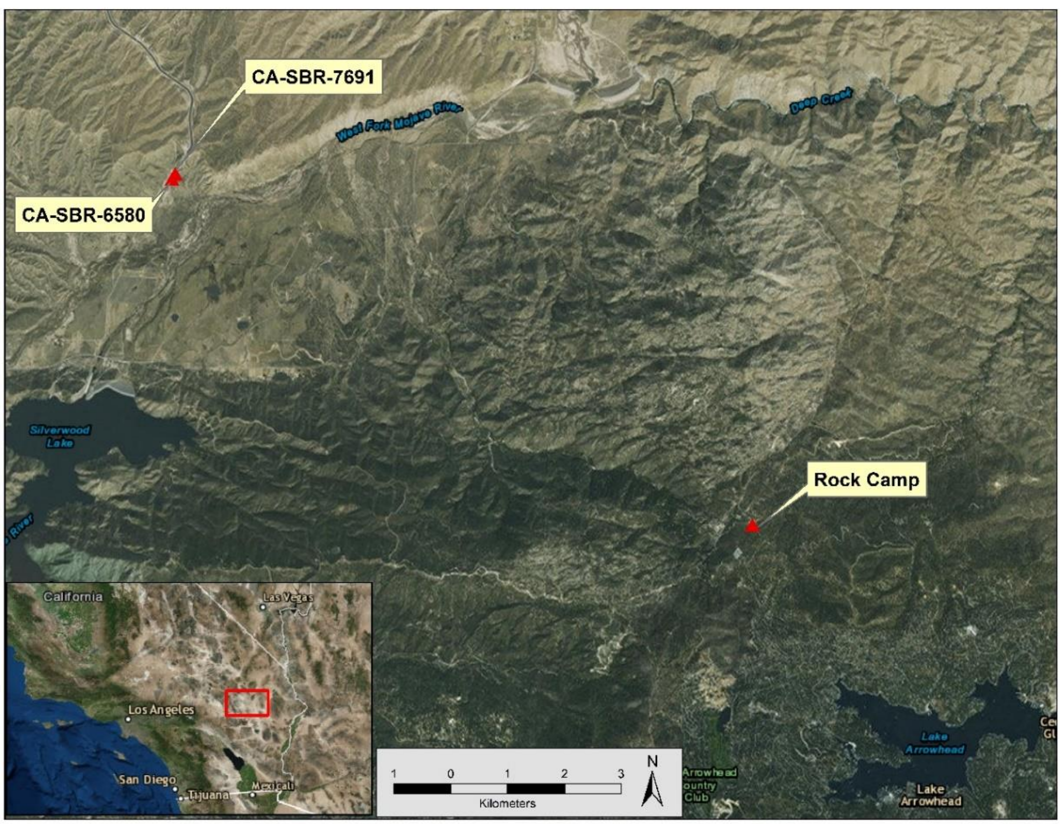

Figure 1. Map of Summit Valley Sites and Rock Camp

CHAPTER TWO

BACKGROUND

Environmental Background

The San Bernardino Mountains are the highest elevation mountains located in Southern California. They are located on the eastern part of the Transverse ranges. The mountains contain a large area of forest that is home to a wide variety of plant and animal species. The San Bernardino Mountains can be separated into four environmental zones: The Lower Sonoran Zone, The Upper Sonoran Zone, The Transition Zone, and the Boreal Zone (Grinnell 1908). The Lower Sonoran Zone includes the Mojave Desert area and reaches onto the foothills of the mountains, about 3,500 feet in elevation (Bean and Saubel 1972). There is little rainfall in this zone. The Upper Sonoran Zone, in which the Rock Camp Site is located, is the largest and includes chaparral belt and the pinon belt (Grinnell 1908). The Upper Sonoran Life Zone stretches from about 3,500 feet up to 5,000 feet in elevation. The weather consists of warm summers and cold winters with an average rainfall of about 15 inches (Bean and Saubel 1972). The Transition Zone includes the forest stretches from about 5,000 feet to 7,000 feet in elevation. Summers are cool and winters are cold, with an average rainfall of 20-30 inches annually (Bean and Saubel 1972). Previous to the end of the Pleistocene, conditions in the region were humid. Since then, interchanging episodes of dry and wet conditions have existed. The current dry episode has significantly decreased the amount of viable plant resources in the region

(Simpson et al. 1972). The highest elevation point within the San Bernardino Mountains is Mt. San Gorgonio which stands at 11,502 feet in elevation. The Rock Camp site is located at an elevation of 4,820 feet. Water systems that flow near the Rock Camp Site include Deep Creek and Willow Creek. Down towards the foothills, Deep Creek runs into the Mojave River, the main water way for the San Bernardino Mountains (Simpson *et al.* 1972). The waterways that are located within the San Bernardino Mountains have decreased since the beginning of the historic period (Simpson et al. 1972). Environmental changes have taken place at the Rock Camp Site as the site is eroding into Willow Creek (Simpson *et al.* 1972).

Biological Background

A wide variety of plant and mammal species are found in the area near the Rock Camp Site. In conjunction with the initial excavation at the Rock Camp Site, a biological survey was done in the immediate area of the site that recorded any mammals or plants that were spotted within a one mile radius of the site. This biological survey took place between April 1966-February 1967 (Simpson *et al.* 1972). A complete list of birds, reptiles, and mammals found during the biological survey of the site are shown in Tables 1 and 2. A variety of small mammals were found during the survey, including rabbit (*Leporidae*), gopher (*Geomyidae*), squirrel (*Sciuridae*), and rat (*Muridae*).

Trees that are located near Rock Camp include various oak trees that provide acorns for the inhabitants, various pine trees that produced pinon seeds, which were a staple resource to the Serrano diet, and manzanita (*Arctostaphylos*). For a complete list of trees found at the Rock Camp Site see Table 3. A wide variety of small plants are found in the region that could have been utilized as food resources as well as used for medicinal or utilitarian purposes. Possible plant resources include fruits, onions (*Amaryllidaceae*), brodiaeas (*Asparagaceae*), bulbs, greens, roots, and mint (*Lamiaceae*). Medicinal plants include mint, coffeeberry (*Rhamnaceae*), yerba santa (*Boraginaceae*), and yarrow (*Asteraceae*). Plants could be used for utilitarian purposes as well, such as basket material, fibers, and cleaning material (Simpson *et al.* 1972). For a complete list of small plants found at the Rock Camp Site, see Appendix A.

Table 1. Mammals of Rock Camp

Raccoon	*Procyon lotor*
Coyote	*Canis latrans*
Bobcat	*Lynx rufus californica*
California Ground Squirrel	*Citellus beecheyi*
Merriam Chipmunk	*Eutamias merriami*
California Mule Deer	*Odocoileus hermious californica*
Mojave Woodrat	*Neotoma fuscipes simplex*
Western Gray Squirrel	*Sciurus griseus*

Gray Fox	*Urocyon cinereoargenteus*
Jack Rabbit	*Lepus californicus*
San Bernardino Mt. Pocket Gopher	*Thomomys altivallis umbrinus*
SEEN WITHIN A 5-MILE RADIUS	
Broad Footed Mole	*Scapanus latimanus*
California Vole	*Microtus californicus*
Black Bear (July 1968)	*Ursus americanus*
Striped Skunk	*Mephitis mephitis*
Brown Bat	*Myotis* sp.
Golden Beaver	*Castor Canadensis*

(Simpson *et al.* 1972: 25)

Table 2. Reptiles and Amphibians of Rock Camp

Brown Shoulder (Sage Brush) Lizard	*Sceloporous graciosus*
Western Fence Lizard	*Sceloporous occidentalis*
Coast Horned Lizard	*Phrynosoma coronatum*
Alligator Lizard	*Gerrhonotus multicarinatus*
Western Skink	*Eumeces skiltonianus*
Gopher Snake	*Pituophis catenifer*
Western Garter Snake	*Thamnophis elegans elegans*

Pacific (Western) Rattlesnake	*Crotalus viridis*
WITHIN A 5-MILE RADIUS	
California Mountain King Snake	*Lampropeltis zonata parvirubra*
San Bernardino Salamander	*Ensatina eschscholti croceater*
Western Toad	*Bufo boreas*

(Simpson *et al.* 1972: 26)

Table 3. Trees and Shrubs of Rock Camp

Western Yellow Pine	*Pinus ponderosa*
Jeffrey Pine	*Pinus Jeffreyi*
Coulter Pine	*Pinus Coulteri*
Sugar Pine	*Pinus lambertiana*
Pinyon Pine	*Pinus monophylla*
Kellogg's Black Oak	*Quercus Kelloggii*
Interior Live Oak	*Quercus Wislizenii* var. *frutscens*
Canyon Oak	*Quercus chrysolepis*
Incense Cedar	*Libocedrus decurrens*
Coffee Berry	*Rhamus californica*
Squaw Bush	*Rhus trilobata*
Wild Rose	*Rosa californica*

Creek Willow	*Salix lasiolepis*
Western Choke-cherry	*Prunus virginiana* var. *demissa*
Mountain Mahogany	*Cercocarpis betuloides*
Flannel Bush, California Slippery Elm	*Fremontia californica*
Creek Dogwood	*Cornus glabrata*
Mountain Lilac	*Ceanothus* sp.
Chamise, Greasewood	*Adenostoma fasciculatum*
Bush Poppy	*Dendromecon rigida*
Parry Manzanita	*Arctostaphylos Parryana* var. *pinetorum*
Pink Bracted Manzanita	*Arctostaphylos Pringlei* var. *drupacea*
Bigberry Manzanita	*Arctostaphylos glauca*

(Simpson *et al.* 1972: 27)

Cultural Chronology

The lack of radiocarbon dates from sites located in this area means that a refined cultural chronology is not yet available. The current cultural chronology for the San Bernardino region consists of the Millingstone Horizon (4,000-1,500 BP), the Intermediate Period (1,500-800 BP), and the Protohistoric Period (800 BP-Historic Period) (de Barros 1997). This is shown in Figure 2. Due to this issue, the sites in this region should be analyzed using the broader cultural chronology available for the Southern California region (Basgall and True 1985).

The dates presented below reflect the chronology for the Southern California region.

Some Cultural Chronologies for Southern California

General Southern California (Wallace 1978)	Mojave Desert (Warren 1984; Warren and Crabtree 1986; Warren et al.1986)	Crowder Canyon and Summit Valley Areas (Basgall and True 1985; Sutton et al. 1993; this report)
A.D. 1769 Horizon IV: Late Prehistoric Cultures 1000 B.P.	1770s Protohistoric Period (800 B.P. - Historic)	1770s Protohistoric Period (800? B.P. - Historic)
	Saratoga Springs Period[b] (1500 - 800 B.P.)	? Intermediate Horizon? (1500? - 800? B.P.)
1000 B.P. Horizon III: Intermediate Cultures 3000 B.P.	Gypsum Period (4000 - 1500 B.P.)	?? Millingstone Horizon (4000? - 1500? B.P.)
3000 B.P. Horizon II: Millingstone Cultures 6000 B.P.[a]	Pinto Period (7000 - 4000 B.P.)	??
6000 B.P. Horizon I: Early Man (also known as San Dieguito or Paleoindian) 12,000 B.P.?	Lake Mojave Period (12,000 - 7000 B.P.)	??

Figure 2. Cultural Chronology for Southern California

(de Barros 1997: Table 2-2)

The Millingstone Horizon was first introduced by Wallace (1955). The Millingstone Horizon is a cultural time period that took place in Southern California between ca. 6,000 and 1,000 BP, but began and ended at slightly different points in time depending on the region. This time period is distinguished by a large amount of millingstone in archaeological assemblages, mainly manos and metates. Other artifacts that are prevalent during this time period include core tools, choppers, scraper planes, cogstones, doughnut stones, and discoidals (de Barros 1997). Projectile points that date to this time period are generally lacking in complexity. Subsistence practices during the Millingstone Horizon are thought to be more focused on processing seeds over hunting, due to a lack of projectile points and faunal remains and the large amount of millingstone found. The lack of faunal remains could be due to excavation and research techniques, taphonomic processes, or the way in which the groups were processing mammal bones (Sutton and Gardner 2010).There is a general absence of bone tools and shell (Wallace 1955). Key developments during this period include the use of millingstone to grind materials and an increased use of marine sources. The Millingstone Horizon is separated into different cultural complexes depending on the area, including Pauma, La Jolla, Oak Grove, and Sayles (Moratto 1984).

The Intermediate Period was introduced by Wallace (1955). This time period lasted from about 3,000 BP to AD 1,000. During the Intermediate Period, the use of acorns as a main subsistence resource began (Wallace 1955). This time period is characterized by an increase in specialization and an increase in the variety of subsistence strategies (de Barros 1997). Based on an increase of projectile points found at sites dating during this time period, it appears an increase in the importance of hunting began. The bow and arrow was introduced during this time, which allowed for easier hunting. There was also an increase in pestles found that date during this time period. One of the main cultural changes during this time period was the increased use of the mortar and pestle combination over the use of millingstone and handstones (Wallace 1955). This may coincide with an increased dependence on acorns. According to Wallace (1955: 223), “Mortars and pestles are regarded as being more efficient for pulverizing and grinding oily and fleshy acorns preparatory to leaching out their tannic acid content.”

The Late Prehistoric Period lasted from around AD 1,000 until colonization. During this time, there was a dramatic increase in specialization, trade, technology, and sedentism (de Barros 1997). The evidence of trade is shown in the increase of exotic goods found in archaeological deposits, including obsidian, shell, and beads. There was also an increase in elaborate grave goods. Settlements that date to this time period are larger than previous time periods, possibly due to an increase in the population. Similar to the Intermediate Period, the Late Prehistoric Period is broken into local complexes, although these complexes are similar overall (Wallace 1955).

Cultural Chronology for the Inland Southern California Region

Cultural time periods for the inland regions of Southern California are usually labeled using terms from the coast, although artifact assemblages vary from coastal sites to inland sites. Inland sites tend to lack shell beads which may be due to limited or no contact with coastal groups (Sutton and Gardner 2010). There were no shell beads found at the Rock Camp site. Sites located in the San Bernardino region are usually considered Late Millingstone (Sutton and Gardner 2010).[1]

Ethnographic Background

Most of the evidence of processing animals on groundstone comes from ethnographic accounts. The most notable being Alfred Kroeber's account, in which he wrote, "The pounding of flesh is a habit common to most of the California Indians" (Kroeber 1925:652). Kroeber studied tribes throughout the Southern California region in the early 1900's, taking down very detailed notes. Kroeber witnessed the Luiseño crushing rabbit on a mortar: "…whatever was not immediately eaten being crushed in a mortar- bones included in the case of rabbits…" (Kroeber 1925:652). Lowell Bean and Katherine Siva Saubel (1972) discuss how the Cahuilla would grind up animal bones into a powder and mix it into other foods. In Delfina Cuero's autobiography, a Diegueño woman said, "We

[1] Sutton and Gardner (2010) propose renaming the Millingstone Horizon the "Greven Knoll Pattern" for the northern part of inland Southern California. What is considered the Sayles Complex in the San Bernardino region would be now referred to as the Greven Knoll III. The term "Greven Knoll" was taken from Kowta's (1969) description of millingstone that pre-dated the Sayles Complex in the San Bernardino region (Sutton and Gardner 2010).

used to eat rats, mice, lizards, and some snakes, but I don't remember what kinds...The little things were pounded on a rock, bones and all and then stewed" (Shipek 1970: 32-33). When Ralph Michelsen studied the Kiliwa tribe in Baja California, Mexico he observed a man grinding a rat on a metate: "…the rib cage, spine and pelvis are placed on a flat rock, sometimes a metate, and crushed with a hammerstone. The carcass, well shredded, is then eaten, bones and all" (Michelsen 1967:76). Michelsen also observed the man grind up a rabbit into a paste with salt and eat it all, including the bones.

These ethnographic accounts give indirect evidence of tribes in the area using groundstone to grind animal remains to consume. All these accounts come from different tribes in the region, which suggests that the practice was widespread. There is more ethnographic evidence for the use of groundstone to process animals than archaeological evidence as many archaeological projects do not include protein residue analysis to determine what may have been processed on groundstone.

<u>The Serrano</u>

According to Sutton (2009), the group occupying the inland region around 3,000 to 1,000 BP were Proto-Yuman. Around 1,000 BP this group adopted the Takic languages and became the group that currently occupy the region today, including the Serrano. Upon the arrival of Spanish colonizers to the San Bernardino Mountains in 1769, the group that was occupying the area referred to themselves as Maarringa'yam, but were renamed by the Spanish as the

“Serrano” or “people of the mountain” (Strong 1929). Kroeber was the first anthropologist to study the Serrano, during his work of studying the various tribes throughout Southern California. The Serrano were organized into clans and moieties that determined their relationships and societal structure within their group and among neighboring tribes (Strong 1929). The Serrano people organized themselves into moieties that were exogamous and patrilineal, and consisted of various clans. (Bean and Vane 2004).

The Serrano were a hunter-gatherer group that utilized various plant and mammal resources, the most important of which was acorns (Simpson *et al.* 1972). Clans had rights over certain territories that allowed the clan access to areas in which they could hunt and gather. Both families and individuals would go on extended foraging or hunting trips and the Serrano would migrate to different areas to procure certain resources, depending on the harvest time (Bean and Saubel 1972). According to Benedict (1924), the Serrano would travel to the higher elevation areas during the harvest time to obtain pinyon and acorns. The oak trees were controlled by certain clans that occupied that region, but were accessible to the other clans as well. During the winter months, they would occupy the base camps and subsist on their stored supply of nuts. During the warm months, some groups would set up camps along the mountainside to exploit the resources available in the median zone, including yucca.

Based on ethnographic evidence, the Serrano find certain mammals to be culturally significant. These mammals include bears (*Ursidae*), sheep (*Bovidae*), fox (*Canidae*), eagles (*Accipitridae*), and ravens (*Corvidae*) (Bean and Vane 2004). The Serrano used the available plant resources for food, utilitarian, and medicinal purposes. A list of plants that are gathered by the Serrano for these various purposes is shown in Table 4.

Table 4. Some Plants Frequently Gathered in the Forest

Plant	**Use**
Acorns	Food
Agave	Food, baskets, fiber for clothing, nets
Beavertail cactus	Medicine, food
Brittle bush	Medicine
Brodiaea	Soap, brushes, fishing
Bulrush (tule)	Cordage, food, baskets
Ceanothus	Medicine, soap
Cedar	Bark for ceremonial dress, toys, games, housing
Chia (thistle sage)	Food, basketry, medicine
Cottonwood	Basketry, firewood, medicine
Deer-grass	Basketry
Desert willow	Cordage, sandals, clothing, construction, medicine, bowmaking

Juncos	Basketry
Juniper	Cordage, food, baskets, medicine
Laurel sumac	Leaves for lip balm
Manzanita	Basketry, food, firewood, tools, pipes
Mule-fat	Hair rinse, eye wash, home construction
Oaks	Dyes, toys, baskets, medicine
Pentsimon	Medicinal
Pine (pitch, nuts, wood)	Food, firewood, construction, medicine, basketry
Sage (white and purple)	Herb, medicine, food
Soap plant (amole)	Soap, brushes, fishing
Stinking gourd (coyote gourd)	Baby rattles, bleach
Sumac (rhus trilobota)	Basketry, food, medicine
Tobacco	Ceremony
Watercress	Food
Wild buckwheat	Basketry, food, medicine
Wild cucumbers	Basketry, food
Wild grapes	Food
Wild Oats	Food
Yerba Santa	Food, medicinal tea and liniment

Yucca	Food, basketry

(Bean and Vane 2004: Table 4)

Archaeological Background

There are three previously recorded sites in the San Bernardino Mountain region from which the groundstone has been analyzed for protein residue, including CA-SBR-7691, CA-SBR-6179, and CA-SBR-6580 (see Figure 1). These sites are located in Summit Valley, which is approximately 10 miles long and two miles wide and located at the northern base of the San Bernardino Mountains and the southern edge of the Mojave Desert (Sutton *et al.* 1993). The sites are southeast of the city of Hesperia, California and the Mojave River and Deep Creek are located near to the sites. Most of the documented sites in the area date to the Millingstone Horizon which dates from about 4,000-1,500 BP in this region (de Barros 1997).

Protein Residue Data from the Summit Valley

This current research is based on previously obtained data from sites that had been excavated in the Summit Valley (Parr *et al.* 2001; Sutton *et al.* 1993; Yohe *et al.* 1991). Artifacts from these sites were subject to protein residue analysis which resulted in positive protein residues. For comparative data with my research, I focused on two of the three Summit Valley sites, CA-SBR-7691 and CA-SBR-6580, also known as the Siphon Site. Various artifacts from both sites, including groundstone and projectile points, were analyzed for protein residues. Since the research was only focused in the Summit Valley area, I decided that artifacts should be tested for protein residues in a different area, which resulted in my focus on the Rock Camp Site, which is located at a different elevation from both CA-SBR-7691 and CA-SBR-6580. . Testing groundstone at different elevations allows for a broader understanding of subsistence strategies in the region.

The Siphon Site. CA-SBR-6580, also known as The Siphon Site, is a site located in the Summit Valley along the Mojave River. A channel flowed near the site, which would likely impact the area intermittently. This site is believed to be a base camp dating to the Middle-Late Millingstone Horizon that was only occupied for a short time span (Sutton *et al.* 1993). The camp was likely used to process a wide variety of resources found in the local desert environment, as well as a location for stone tool manufacturing. Based on radiocarbon dates and obsidian hydration data obtained from the site, occupation lasted from about 1,600 to 1,400 BC (Sutton *et al.* 1993). The site was likely occupied in the fall and winter, as evidenced by seasonality data obtained from the site. The protein residue analysis identified seasonal animals, such as turtle, deer, and pronghorn. Amaranth and juniper berries were also recovered from the site. Amaranth is available from August to December and Juniper berries are available during the month of August (Sutton *et al.* 1993). The Summit Valley contains four plant communities: a creosote brush scrub community, a juniper woodland, a sagebrush scrub community, and a riparian community (Sutton *et al.* 1993). The groups that occupied this area utilized these plant environments in a variety of ways, including for food, utilitarian, and medicinal purposes. The most common mammals found in the region are rodents. Other mammals that inhabit the area include coyote (*Canis latrans*), cottontail rabbit (*Sylvilagus audubonii*), jackrabbit (*Lepus californicus*), and deer (*Odocoileus hemionus*) (Sutton *et al.* 1993). During excavation at the site, 3,161 artifacts and 19 features were discovered. The features include 11 hearths, a cairn, a cremation, a metate cache, and 5 clusters of fire-affected rock (Sutton *et al.* 1993).

The evidence of the occupants' subsistence practices is shown in the projectile points and groundstone recovered. The projectile points were likely used for hunting and the groundstone could have been used to process different resources such as plants and mammals. Based on the artifact assemblage, it is difficult to determine the site organization. Sutton *et al.* (1993) propose that the resource processing area was located in the eastern part of the site, near the water source. The only exotic material found at the site was obsidian from the Coso Volcanic Range (Sutton *et al.* 1993), which may have been transported to the site through long distance procurement or trade with other groups. According to Sutton *et al.* (1993), the site represents a transitional time period between the Middle and Late Millingstone Horizon, based on the dates from the site, the artifact assemblage, and the mortuary practices found at the site.

The Siphon Site has the largest amount of evidence of protein residues on groundstone among the Summit Valley sites and the Rock Camp Site. Only a portion of the site has been excavated, but a considerable amount of groundstone was recovered. The faunal remains found at the Siphon Site were very fragmented, with the only identifiable faunal remains belonging to the pond turtle (*Clemmys marmorata*). However, the protein residue analysis did test positive for several additional species. . One hundred and seventeen artifacts and 27 soil samples were analyzed for protein residues. Groundstone artifacts that were tested - metates, manos, pestles, hammerstones, and scraper planes - had positive protein residues for pronghorn, rat, waterfowl, rabbit, fish, and yucca. Most of the protein residues were found on the metates. A complete list of artifacts tested for protein residues is shown in Table 5.

Table 5. Results of Immunological Analysis, CA-SBR-6580

Sample Type	**Number Processed**	**Results**
Metates	21	1 pronghorn/deer; 1 pronghorn; 1 yucca; 1 nonspecific; 1 rat; 1 waterfowl
Manos	37*	1 rabbit
Pestles	3	None
Projectile points	6	1 rat
Bifaces	13	1 deer; 1 waterfowl
Core	1	None
Core/unifaces	6	1 nonspecific

Core/scraper planes	4	1 waterfowl/fish
Core/hammerstones	4	None
Choppers	8	1 pronghorn/deer
Cobble hammerstones	3	None

*37 samples were taken from 32 manos (Sutton 1993: Table 1)

CA-SBR-7691. CA-SBR-7691 is a Millingstone Horizon site that dates between ca. 3,400 and 3,900 BP. The site is located 500 meters away from the Siphon Site on an alluvial slope above the Mojave River (Parr *et al.* 2001). Much of the site had been destroyed by previous construction projects. The site was likely used as a resource processing locations, based on evidence of projectile points and groundstone. The two projectile points recovered were likely used for hunting and the groundstone was used to process materials such as plants and mammals. Obsidian found at the site suggests a possible trade relationship with groups to the north. The environment and mammals at the site is similar to that of the Siphon Site, due to their close proximity. One of the main differences between the CA-SBR-7691 assemblage and that of the Siphon Site, is that the Siphon Site had the presence of turtle and fish in the faunal remains, and waterfowl was identified by protein residue analysis; however, there were no waterfowl bones recovered from the site (Parr *et al.* 2001). The site is located near the Mojave River, so aquatic resources should have been utilized. Parr *et al.* (1993) proposed the possibility that the river was not flowing during time of occupation or aquatic resources were just not used. It could also be possible that these remains did not preserve well archaeologically. Most of the faunal remains recovered from the site were unidentifiable, although some species of mammals were identified with the use of protein residue analysis on the artifacts. Many of the faunal remains had been burned and were highly fragmented. The poor quality of the bone could have been due to changes that occurred in the soil and the lack of bone could have been due to the group disposing of bones into the fire (Parr *et al.* 2001).

Plants recovered from the site includes bromegrass (*Bromus sp.*), wild buckwheat (*Eriogonum sp.),* red-stem filaree (*Erodium cicutarium*), western chokecherry (*Prunus virginiana*), and juniper (Parr *et al.* 2001). Using the juniper berries as evidence for seasonality, it can be inferred that the site was occupied during the late summer and fall since juniper is available during the month of August.

Five hundred and thirty-two artifacts were found at the site and 18 groundstone artifacts were analyzed for protein residues, including metates, manos, and groundstone fragments. The results came back positive for bird, deer, rat, squirrel, rabbit, and pronghorn. A complete list of artifacts tested for protein residues is shown in Table 6.

Table 6. Results of Protein Residue Analysis for CA-SBR-7691

Artifact	Catalog Number	Provenience	Results
Edge-modified flake	S-001	Surface	Either quail or grouse
Unidentified ground stone fragment	S-003	Surface	Negative
Metate fragment	S-004	Surface	Negative
Metate fragment	S-005	Surface	Deer
Mano fragment	S-006	Surface	Deer
Metate fragment	S-011	Surface	Rat
Metate fragment	S-012	Surface	Negative
Mano fragment	S-017	Surface	Negative
Metate fragment	S-019	Surface	Negative
Metate fragment	S-020	Surface	Either squirrel, porcupine, or beaver
Complete metate	S-021	Surface	Negative
Complete mano	S-022	Surface	Negative

Unidentified ground stone fragment	3-074	TU-3, 10-20 cm	Either squirrel, porcupine, or beaver and sheep
Unidentified ground stone fragment	3-079	TU-3, 20-30 cm	Negative
Metate fragment	3-080	TU-3, 30-40 cm	Either quail or grouse and either squirrel, porcupine, or beaver and rabbit
Complete mano	3-087	TU-3, 30-40 cm	Negative
Mano fragment	14-340	TU-14, 120-130 cm	Negative
Mano fragment	18-475	TU-18, 20-30 cm	Negative
Complete projectile point	18-488	TU-18, 50-60 cm	Negative
Mano fragment	19-514	TU-19, 20-30 cm	Deer and rabbit
Complete projectile point	19-526	TU-19, 60-70 cm	Pronghorn and rabbit

(Parr *et al.* 2001: Table 10)

The Rock Camp Site

The Rock Camp Site is located at 4,820 feet in the northwest area of the San Bernardino Mountains. The site was first excavated in 1966 by the San Bernardino County Museum and local students from Rim-of-the-World High School located nearby. The excavations took place intermittently from 1966 until 1969. Twenty-one pits of various depths were excavated throughout the site and over 200 groundstone artifacts were recovered, the most numerous being manos. There are also numerous bedrock mortars located on granitic boulder outcrops throughout the site. Though processing small mammals may have also occurred in these bedrock mortars, they were not included with the current research. Based on Allen's (2016) obsidian hydration dates obtained from projectile points, Rock Camp was occupied from ca. 7,000-250 BP. The site appears to be older than the other Millingstone sites in the surrounding area

The Rock Camp Site is likely the higher elevation site that was used in the Native inhabitant's seasonal migration (Altschul *et al.* 1985). In this proposed migration, groups would migrate from the Summit Valley, along the Deep Creek Drainage, and ultimately end at Rock Camp. This large site is located approximately four miles south of the winter village site of Guapiabit and is likely the base camp for the higher elevation zone. Simpson *et al.* (1972) suggest that Rock Camp may be a seasonal occupation site used to process acorns, due to the presence of the black oak tree (*Quercus kelloggii*) and multiple milling features, and due to the site location on the route near to the first available pinyons and acorns, which were staple food resources. However, just because a local resource is abundant does not mean that particular resource will be exploited by the group (Kelly 1995).The artifacts found at Rock Camp are similar to ones found at sites located in the Summit Valley (Simpson *et al.* 1972), and suggest that the two sites may have been utilized by the same peoples with a seasonal mobility pattern. Ethnographic evidence supports this assumption as Benedict (1924) describes the Serrano traveling up the mountain to collect pinyon and acorn and coming back down to the base camp and storing the nuts until winter.

Besides the large amount of groundstone found at the site, there are various other artifact types as well. The group that occupied the Rock Camp Site not only utilized the local materials to produce groundstone, they also had imported stones, such as obsidian and quartz (Simpson *et al.* 1972). Pottery sherds found at the site, which are not commonly found in the area, may have been imported from the east, facilitated by Deep Creek which leads to the Mojave River, which was likely a trade route (Simpson *et al.* 1972). Other artifacts found at the site include beads, discs made from stone, pendants, bone artifacts, incised artifacts, and quartz crystals (Bean and Vane 2004).

The archaeological excavation at the Rock Camp Site in 1966 by the San Bernardino County Museum and Rim-of-the-World High School students was the first controlled excavation of a site in the San Bernardino Mountains (Simpson *et al.* 1972). The excavation was done entirely by volunteers throughout the first four seasons. The site encompasses an area of 430 feet east to west and 200 feet north to south. A map showing the 21 test pits is shown in Figure 3.

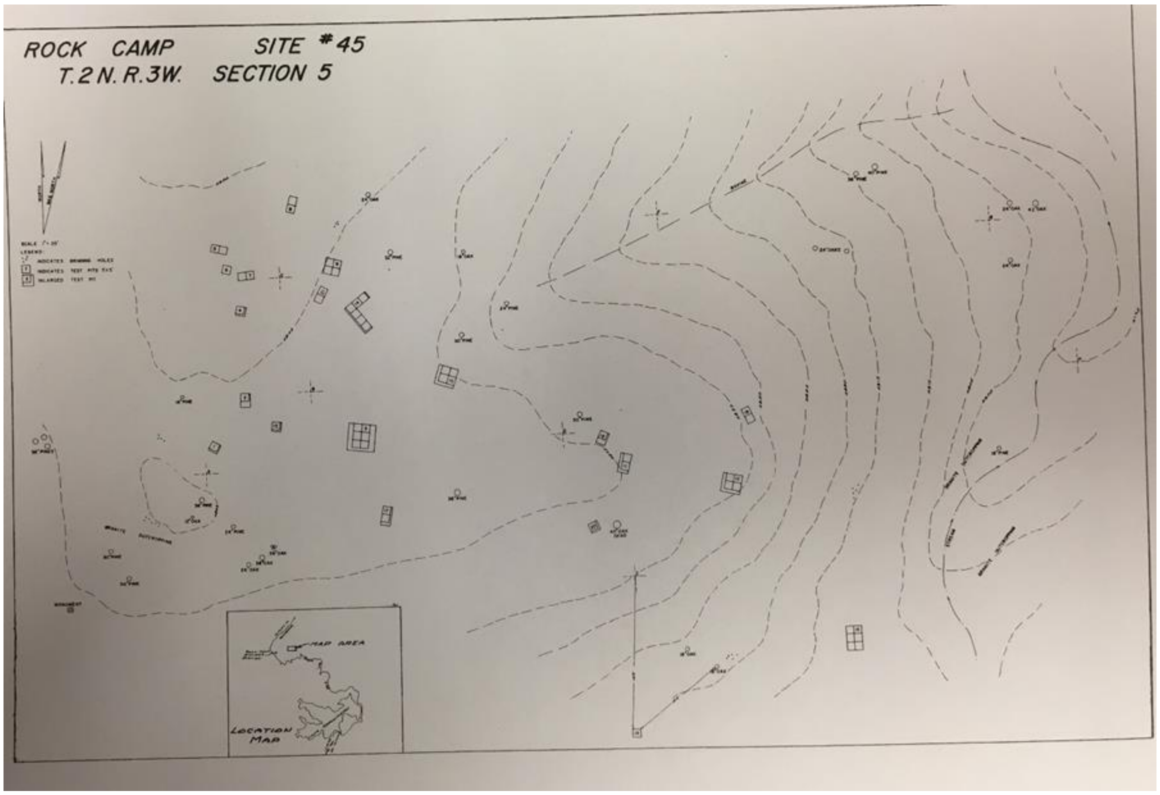

Figure 3. Rock Camp Excavations
(Simpson et al. 1972: 81)

Faunal Remains. A complete list of faunal remains found at the Rock Camp Site is shown in Table 7. Faunal remains from 14 mammal species were recovered from the site with the greatest number from rabbit and deer (each consisting of 12 minimum number of individuals [MNI]). Carnivores are not well represented in the faunal remains and may be a result of a subsistence strategy focused on the easier to capture small mammals. Hunting larger mammals requires time, energy, and skill, and it may have been more efficient to focus on the small mammals that are abundant in the region. Other small mammals aside from rabbit may not be represented in the data due to the use of 1/4 inch mesh screen used during excavation (Simpson *et al.* 1972). The faunal remains recovered from the site indicate there are 12 rabbit MNI. Although this is a relatively high number for the site, it may not be an actual representation of the amount of rabbit being processed there. According to Simpson *et al.* (1972:19), "…the lack of rabbit tarsals and metapoidals…may be the result of a specific type of skinning." Based on ethnographic evidence, native groups may have grinded up the entire rabbit on the groundstone and eaten the entire animal, bones and all, leaving no evidence of the processing among that material collected (Michelsen 1967; Shipek 1970).

Groundstone. The Rock Camp Site is known mostly for its large amount of groundstone. A complete list of groundstone artifacts excavated from the Rock Camp Site is shown in Table 8. The most common groundstone artifact type found at the site are manos, also labeled as handstones throughout the Rock Camp site documents. There were a total of 144 manos recovered from numerous excavation pits and from a variety of levels at the site (Simpson *et al.* 1972). Recovered manos included biface, uniface, and multifaceted whole manos, as well as various broken manos that are beyond recognition. The majority of the manos are of granitic material, but other material types include gneiss, diabase, volcanic, and quartzite (Simpson *et al.* 1972).

The next groundstone category found at the Rock Camp Site are metates, with a total of 49 whole and fragmented metates recovered from excavations. There were three different metate types found, including basin metates, slab metates, and lap metates. Like the manos, the majority of the metates are of granitic material and are found throughout the site, but metates increase in abundance from 18-38 centimeters in depth (Simpson *et al.* 1972).

Another groundstone artifact type found at the site includes pestles. Although there are numerous bedrock milling features located throughout the site (for an example see Figure 6), there were a relatively low number of pestles recovered (n=9) from various depths. Simpson *et al.* (1972), believe this may be due to looters or the possibility that the Native inhabitants did not leave them at the site. Creating a pestle can be time and labor intensive and as they are relatively portable, they may have been carried on the seasonal round. The pestles are mainly made from granitic material, although two are of volcanic material.

There are other various groundstone artifacts found at the site, the most common being bedrock mortars. They are located throughout the site and are found upon the various granite outcrops. I choose to not test the bedrock mortars for protein residues due to the high likelihood of contamination that can occur on surface artifacts, including from weathering and animals.

Table 7. Faunal List for the Rock Camp Site

Syvilagus sp.	12*	Cottontail rabbit
Lepus californicus	1	Jack rabbit
Neotoma sp.	3	Wood rat
Thomomys umbrinus	1	Pocket gopher
Spermophilus cf. beecheyi	1	Ground squirrel
Sciurus griseus	4	Gray squirrel
Urocyon sp. ?	1	Fox
Canis latrans	1	Coyote
Lynx rufus	1	Bobcat
Felis concolor	1	Puma
Ursus sp. (large)	1	Grizzly bear
Odocoileus hemionus	12	Deer
Bos sp.	1	Domestic cow
Homo sapiens	1	Man

*all figures express minimum count of individuals (MNI) (Simpson *et al.* 1972: 20)

Table 8. Rock Camp Groundstone Artifacts

	MANOS				METATES			PESTLES		ORNAMENTAL STONE				PIPE FRAGMENTS	RUBBING STONE	GROOVED STONE	PAINT STONE
	Uniface	Biface	Multiface	Misc.	Basin	Slab	Lap	Utilitarian	Ceremonial	Bead	Disc	Pendant	Tablet				
SURFACE	-	5	-	-	3	1	-	-	-	-	-	-	-	-	-	-	1
0" - 6"	3	5	1	2	-	1	1	3	1	-	-	-	-	-	-	-	-
6" - 12"	-	8	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-
0" - 12"	5	8	-	2	-	-	-	-	-	-	-	-	-	-	-	1	2
12" - 18"	1	10	1	1	2	5	-	1	-	-	-	-	-	1	1	1	-
18" - 24"	4	3	-	-	-	2	-	1	-	-	-	-	1	-	-	-	2
24" - 30"	6	8	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-
30" - 36"	3	5	-	2	3	1	-	-	-	-	-	-	-	-	-	-	1
36" - 42"	4	4	-	1	-	1	-	3	-	1	-	-	-	-	-	-	-
42" - 48"	3	9	1	-	2	5	-	-	-	-	-	-	-	-	-	-	3
48" - 54"	3	8	-	1	4	5	-	1	-	-	-	-	-	-	-	-	-
54" - 60"	-	2	-	-	-	1	-	-	-	-	-	-	-	-	1	-	-
60" - 66"	-	1	-	-	-	1	-	-	-	-	-	-	-	-	-	-	1
66" - 72"	2	2	-	-	1	2	-	-	-	-	-	-	-	-	-	-	-
Clean-up	7	7	-	3	5	2	1	-	-	1	1	1	-	2	1	-	1

(Simpson *et al.* 1972)

Figure 4. The Rock Camp Site

Figure 5. Another View of the Rock Camp Site

Figure 6. Bedrock Milling Feature at Rock Camp

CHAPTER THREE

THEORY

To analyze the data for the current research, I considered Altschul *et al.*'s (1985) settlement and subsistence model for the Summit Valley region within a human behavioral ecological framework, specifically optimal foraging theory (Binford 1981; Kelly 1995; Macarthur and Pianka 1966; Moore and Keene 2014; Smith 1983; Winterhalder and Smith 1981). Optimal foraging theory is based on the assumption that humans will search for food containing the most caloric value, using the least amount of energy and time possible in doing so (Moore and Keene 2014.

Optimal foraging theory, originally developed by evolutionary ecologists (Winterhalder and Smith 1981), is based on neo-Darwinisitic ideas that adaption selects for behaviors that allow an individual to efficiently achieve their goals and that natural selection and competition are the outcome of reproduction in a fixed environment (Moore and Keene 2014). Optimal foraging theory can be used to analyze the way in which hunter-gatherers seek out resources using a cost-benefit framework (Moore and Keene 2014), and is based on the assumption that humans will search for food containing the most caloric value, using the least amount of energy and time possible. This will provide them the greatest advantage and would be a behavior that maximizes individual fitness and would therefore be selected for.

Under optimal foraging theory, the diet-breadth model assumes that foragers will hunt for all animal resources at once, and once an animal is found and the forager decides to pursue it, the handling time is now unavailable for searching (Smith 1983). Foraging can be divided into two parts: the time spent searching for prey and the time spent in pursuit, capture, and eating of the prey (Macarthur and Pianka 1966; Smith 1983; Winterhalder and Smith 1981). When a forager happens upon prey, they must choose to pursue the prey or continue hunting for other prey (Winterhalder and Smith 1981). In a fine-grained environment, a forager will happen upon prey randomly, in proportion to the foraging area. The opposite of a fine-grained environment is a patchy environment, one in which prey is distributed diversely across the landscape (Macarthur and Pianka 1966). The prey is ranked based on its profit, which includes the net energy obtained per handling time (Smith 1983). An optimal diet occurs when different types of prey are added in descending rank until the calories per unit is maximized (Smith 1983). When access to high-ranked prey varies or is limited, changes in diet will occur.

The diet-breadth model demonstrates that a forager determines what resource to exploit based on the quality and quantity of the resource and the cost it takes procuring it. The main goal of the forager is to maximize their energy return rate (Kelly 1995). The time spent procuring a particular resource means that other resources are unable to be harvested during that time. The forager decides that the opportunity cost to a particular resource is greater than the others. A particular resource must be determined to be worth the energy and time invested that the forager may lose out on other opportunities (Kelly 1995).

Settlement and Subsistence Model for the San Bernardino Mountains

The seasonal migration theory for the inhabitants of the northern side of the San Bernardino Mountains was proposed by Altschul *et al.* (1985) for a cultural resource investigation. The theory proposes that groups occupied the lower elevation area of the Summit Valley during the winter months and migrated up the northern side of the mountain via one or more of the multiple drainage routes during the warmer months. The timing of migration was based on the time of year when the resources were available. They propose that the groups were spending the colder months at the lower elevations in the Summit Valley and were spending the warmer months at the higher elevations sites in the mountains. The map of the possible migration routes are seen in Figure 7. By migrating to areas where resources are seasonally available, the group is able to forage more efficiently and gain more access to a wider variety of resources (Binford 1981).

While occupying the higher elevation areas, the group would exploit the pinyons and acorns that were available for harvest in the fall. Altschul and colleagues proposed that a permanent settlement can only occur near a reliable freshwater source and the only known freshwater sources in the area is Deep Creek and Willow Creek (Altschul *et al.* 1985; Simpson *et al.* 1983). The water in the lower elevation area may dry up or become sparse during the intense summer months, making migration up to a year-round freshwater source during this time a necessity.

Using this seasonal pattern, the group was able to utilize over 200 different plant resources available in the different elevation zones (Altschul *et al.* 1985). The plants available in the Summit Valley include chia seeds and juniper, which were used for food and material. The yucca plant is found on the mountainside and was an important plant resource for the people in this area. The stalks were roasted in pits and were able to be stored for long periods of time. Yucca is harvested in the springtime, which is the time when the acorns and pinyons stores were likely depleted and seeds are yet to be harvested, making the yucca a very useful resource (Altschul *et al.* 1985). By foraging for seasonal resources and storing them, the group was able to maximize their foraging profits (Binford 1981). They could gather a variety of plant resources and then preserve them to subsist on during months when resources were not readily available.

There is archaeological evidence that yucca was being processed in the area by at least around 3500 BP (Sutton *et al.* 1993). Kowta (1969) proposed the theory that the large abundance of scraper planes found in this area were made specifically to process the yucca plant, providing evidence that it may have been a heavily depended on resource. Even though the climate has changed slightly over the time period that this area has been occupied, the plant resources available would not likely have changed completely. The plant resources may have moved up or down the mountainside, depending on the climate at the time, but the resources seen in the area today have likely been there since the initial occupation of the site (Altschul *et al.* 1985).

Groups residing in the region could hunt large game in both elevation zones, including deer and pronghorn in the Summit Valley area and bighorn sheep in the higher elevation areas. Small game was also hunted, including rat, rabbit, and waterfowl, as evidenced by the protein residues found on the groundstone at the Summit Valley sites (Parr *et al.* 1991; Sutton *et al.* 1993; Yohe *et al.* 1991). While on the hunt for larger, higher-ranked prey, a group could catch smaller prey if they happened upon them (Smith 1983). This would allow the group to have protein regardless if they caught a larger mammal or not. By migrating seasonally, the group was able to hunt for a wider array of mammals, possibly hunting the larger game in the area when it was available.

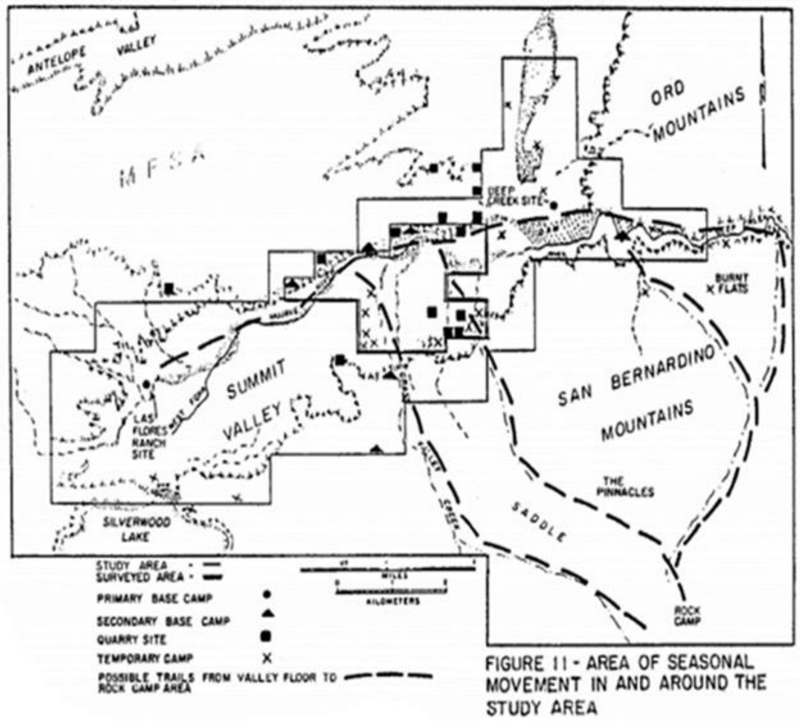

Figure 7. Seasonal Round for the San Bernardino Mountains
(Altschul *et al.* 1985: Figure 10)

<u>Deep Creek Drainage Route</u>

Although there are multiple routes that lead from the Summit Valley up to the higher elevations, the one Altschul *et al.* (1985) believe was the most likely route up the mountain is the Deep Creek Drainage route, due to the direct connection from Summit Valley to Rock Camp. Other sites that have been recorded along this route include CA-SBr-938, CA-SBr-484, CA-SBr-473, CA-SBr-444, CA-SBr-458, and CA-SBr-921. The other possible routes include the Grass Valley Creek Drainage and drainages that are located to the east of the research area. The sites located along the Deep Creek Drainage route could have been used to exploit the resources found only in that environmental zone or they could just have been items that were left behind over time by the group as they were travelling along the route.

Optimal Foraging Theory

Optimal foraging theory can be used to explain Binford's (1981) hunter-gatherer subsistence and settlement strategies model. In this model, Binford distinguishes between collectors and foragers. Collectors are logistically organized, using groups who specialize in procuring resources from distant patches, while foragers "map on" to their resources by moving seasonally and altering the size of their group. This would be done to maximize their access to resources at any given time. From an archaeological visibility perspective, Binford (1981) argues that these different organizational strategies will show specific patterns in the archaeological record: foraging group sites will consist of a base camp and the sites where they procure their resource; collectors will have additional sites, including field camps and caches where they have stored their resources.

According to Altschul *et al.* (1985), the group was migrating up and down the mountainside depending on the season. Binford (1981) argues that a foraging group will set up camps and caches in areas where resources can be exploited. The group's base camp, located in the Summit Valley, could have been the main habitation area for most of the year, with large and small mammal hunting and processing taking place (Parr *et al.* 2001, Sutton *et al.* 1993). The group set up an occupation site at Rock Camp in order to exploit resources that were only available in that area, such as acorns, as well as other resources, such as small mammals (Simpson *et al*. 1972). By setting up sites near available resource areas, the group was mapping on to sources in order to maximize their resource needs (Binford 1981). Based on ethnographic evidence (Benedict 1924), we know the group was storing resources, at least in historic times. By storing and caching resources, the group was able to lower the risk of starvation within the group.

Hypotheses

Hypothesis 1

The inhabitants of the Rock Camp Site were processing small mammals, as well as plant resources, on groundstone.

Theoretical Framework. The way in which a group processes their available resources can change due to resource availability, environmental changes, population increases and demands. One way in which a group may maximize their energy input, would be to process an available resource in the most calorically beneficial way possible (Kelly 1995; Outram 2004). By grinding up entire small mammals on groundstone, the group would be able to obtain the most nutrients from them.

I will be applying optimal foraging theory to my research to determine if animals were being processed on groundstone in order to utilize the entire body to acquire the most caloric benefit. By grinding up an entire animal, you are able to attain the maximum caloric intake possible. For groups that live in areas where resources may be limited or seasonal, exploiting the fat resources within mammals may be beneficial for the survival of that group. Fat resources can be very important if there are a lack of available carbohydrates. “In terms of energy, fat can provide 225% the number of calories compared to equal quantities of either carbohydrate or protein” (Outram 2004:74). Certain fats are essential for the human body to run properly. Fats also contain vitamins A, D, E, and K (Outram 2004). In mammals, fat is found within the bones and underneath the skin. The use of groundstone to process small animals does not take much energy output. Small game is easier to obtain compared to large game (Bettinger 2015) and using a metate and mano to process the meat may not take much effort compared to processing a large animal. Although a higher-ranked mammal would be the ideal, catching multiple smaller mammals would allow the group the nutrients they need (Outram 2004; Smith 1983; Winterhalder and Smith 1981). If the hunter happens upon a rabbit while hunting for larger prey, the hunter must decide if they are going to pass on the opportunity of capturing the rabbit and hope for larger prey. By deciding not to capture the rabbit, the hunter now risks the group going without food. Based on the archaeological evidence taken from the Summit Valley sites, the inhabitants were utilizing all possible animal resources in their area. The protein residue analysis done on the groundstone tested positive for mouse, rat, squirrel, bird, rabbit, deer, pronghorn, insects, and fish (Parr *et al.* 1991; Sutton *et al.* 1993; Yohe *et al.* 1991).

Frequent loss of energy within a group would have negatively affected that population (Winterhalder 1981). Reliable foraging strategies would be adapted by a group in order to avoid these negative impacts. Expending the least amount of energy and time possible while foraging allows a group to partake in other activities, such as tool manufacture. When a group spends less time foraging, they have more time for rest, increasing their wealth, social relationships, and raising their social status (Winterhalder 1981). A group that has an improved amount of energy has the possibility of increasing the amount of viable offspring in the group (Winterhalder 1981). The risk of starvation increases when larger, high rank prey is depended on as the larger the prey, the more difficult it is to find them (Bettinger 2015). Spending a significant amount of time foraging also leaves the group vulnerable to dangers (Winterhalder 1981).

Most of the positive protein residues on groundstone from the Summit Valley sites are small animals, including rats and rabbits. The Native inhabitants were likely using all possible animal resources available in their immediate area to maximize the rate of return from their hunting endeavors. Sutton and Gardener (2010) propose that the way in which resources were processed changed greatly during the Millingstone Horizon, possibly due to a lack of available resources. If protein resources were decreasing, grinding bones on metates would allow for the maximum amount of protein to be obtained (Yohe 1995). Or, as Sutton

(1993) suggests, individuals may had just discovered a more effective way to process mammals.

Test Implications. I will be using CIEP to determine what materials were being processed on the groundstone at the Rock Camp Site. Since the Rock Camp Site is known as an acorn processing site, it would be likely that acorns or other plant material would test positive on the groundstone (Simpson *et al*. 1972). Also, due to the large amount of groundstone found at the site and the common belief that groundstone was mainly used to process plant material, then plant residues should be highly likely. If mammal proteins outnumber the plant proteins, then we may need to expand our understanding of all the ways in which groundstone was being utilized at the Rock Camp Site. If mammal proteins are present, it shows that the group was utilizing a wide variety of resources on groundstone. If mammals were processed on groundstone, it shows that the group was maximizing their access to all available resources (Binford 1981). If there are no mammal proteins found on the groundstone during testing, then the Rock Camp Site may not have been utilized to process small mammals in this way.

Hypothesis 2

Processing small mammals on groundstone occurred at both elevations.

Theoretical Framework. We already have positive protein residues for artifacts found at three sites in Summit Valley. We need more evidence to determine if this was common practice, which is why I chose to test a comparative site located at a higher elevation. The Rock Camp Site can be compared with the Summit Valley sites due to its location on the proposed migration route as well as similar assemblages (Altschul *et al.* 1985).

Test Implications. If the Summit Valley sites are the winter base camps, as Altschul *et al.* (1985) propose, then it is likely the group was utilizing the groundstone in the same way at both elevations. If a practice is common in the lower elevation areas, then evidence of this practice may also be present at the associated higher elevation area. However, due to the difference in elevation of the two areas, the protein residue results may be different. The Summit Valley sites and the Rock Camp Site are each located in two different environmental zones (Bean and Saubel 1972), each with their own plants and mammals occupying the areas (Parr *et al.* 2001, Simpson *et al.* 1972; Sutton *et al.* 1993). Due to the presence of Black Oak trees at the Rock Camp Site, the site may have been used to process acorns (Simpson *et al.* 1972). The Summit Valley sites do not contain black oak trees and the CIEP analyses did not test positive for acorns (Parr *et al.* 1972; Sutton *et al.* 1993). If a resource can be found at both elevations, then it is likely the protein residues for that mammal will be positive. If mammals are being processed on the groundstone at Rock Camp, then I anticipate the proteins to be similar to that of the Summit Valley sites, as long as that mammal can be found at both elevations during the season of occupation. If the protein residues are not similar, the group may be utilizing different small mammal resources at each site due to differences in seasonality, availability, and elevation. If Altschul *et al.*'s (1985) seasonal round theory is valid, there should be variation in the resources procured and processed at the different elevation sites due to seasonal variation in the resources exploited. If there are no mammal proteins found on the groundstone at the Rock Camp Site, then the group could have just been processing mammals at the lower elevation sites and not the higher elevation sites, where there may have been a focus on acorn processing only.

CHAPTER FOUR

METHODS

For my research, I tested 20 groundstone artifacts for protein residues using CIEP. To determine from which site I should select samples, I first went to the South Central Coastal Information Center (SCCIC) located at California State University, Fullerton and the San Bernardino County Museum to obtain site records and supplemental information, including reports, for sites in the San Bernardino Mountains. Since the groundstone at three sites in the Summit Valley (CA-SBR-7691, CA-SBR-6179, and CA-SBR-6580) had already been tested for protein residues, I decided to focus on sites located at higher elevations. Based upon Altschul *et al.*'s (1985) settlement and subsistence theory for the San Bernardino Mountains, I chose to focus on a comparative site to those in the Summit Valley. After analyzing site records and reports, I narrowed my focus to several potential sites, which included sites located along the Deep Creek Drainage route.

After choosing my potential sites, I went to the San Bernardino County Museum to analyze the artifacts that had been excavated from the sites. I decided on the Rock Camp Site due to the large amount of research that had been done at the site, as well as the extensive groundstone artifact collection available at the museum. The reasons for not choosing the other sites were due to lack of available background and archaeological information, as well as a lack of available groundstone artifacts to test. I chose 20 artifacts from the collection using random sampling, making sure to include a variety of groundstone artifact types. A complete list of artifacts is shown in Appendix B. I chose 20 artifacts so I would have a large enough sample for my testing, which is based upon the laboratory's standards. I also collected four soil samples taken from the site to test against the artifacts associated with that soil.

Crossover Immunological Electrophoresis

The most common protein residue analysis done for archaeological purposes is crossover immunological electrophoresis, or CIEP. CIEP was originally developed by forensic scientists for criminal investigations but has become popular in archaeological analysis. CIEP is an immunological test that determines what proteins were processed on a particular artifact. The residues found on the artifact are tested against antisera in the lab to determine if that antisera is also found on the artifact. Even if the protein residue has undergone the denaturation process, biological residue has remained (Yohe *et al.* 1991). The samples are tested against the anti-sera of a variety of animals and plants. The reaction that takes place causes a precipitate to form when the antigen reacts with the antibody (Schneider 2009). The stronger the sample reacts to the anti-sera, the more closely related the sample is to that particular species. At this time, CIEP can only identify the antibody to a Family level.

The reasons why CIEP is commonly used for protein residue testing is because it is relatively affordable, it does not require expensive equipment, it is very sensitive, and multiple samples can be tested at once (Newman 1993). I was trained in CIEP under the guidance and supervision of Dr. Robert Yohe and his graduate student assistant Steve Teteak, at the California State University Bakersfield Laboratory of Archaeological Sciences.

To extract the residues from the groundstone, ammonia solution is applied to the surface using a pipette. The solution is then collected and put into a plastic vial. The vial is then put onto a rotating mixer, and once the solution is thoroughly combined, it is placed into a refrigerator. The extracted residue is placed onto agar gel next to the antisera. The gel is then placed into an electrophoresis tank and undergoes electrophoresis, which is when the gel is put into an electrical field, for about 45 minutes. During this process, the two reactants will be brought together. If there is a strong positive reaction, a white layer will occur in the middle of the two reactants. To test the weaker reactions, the gel undergoes a dying process. The gel is washed, dried, and then dyed with 0.5% Coomasie Blue R250. If a reaction is positive, a dark band will appear below the dyed sample (Newman and Julig 1989).

One of the main arguments against CIEP analysis is the possibility of protein degradation on artifacts. According to Kooyman *et al.* (1992), protein residue can actually stay on artifacts for up to 5600 years, blood residue can remain on artifacts even when protein degradation has happened. Normal biological processes that happen in the soil do not change or remove the blood residues. Also, museum procedures and curation do not necessarily remove blood residues. Kooyman *et al.* (1992) demonstrated this with their CIEP analysis on artifacts found at the Head-Smashed-In-Buffalo Jump site in Canada. They tested projectile points that dated to 4000-1750 BP. The sample included projectile points that had been cleaned and curated at a museum. The points tested positive for bison residues, which shows that blood residue can survive soil changes over 2,000 years as well as normal curation procedures.

Downs and Lowenstein (1995) did a study in order to determine if immunological analyses were a viable way to test for protein residues on artifacts. Prior to this study, the accuracy of these tests had not been properly determined. The authors did a comparison of blind tests that included controls of modern blood protein residues and archaeological residues. For the CIEP test, the results for the control specimens were all accurate and for the artifacts, 80% came back negative for protein residues. The authors believe that if blood had ever been present on the artifacts' surfaces, a large enough amount may not have survived, the proteins had degraded, or the CIEP test had failed (Downs and Lowenstein 1995). The authors believe that CIEP analysis is the most effective of the immunological techniques tested.

Even though protein residue analysis can be somewhat controversial in the archaeological field (discussed below), CIEP can be a very useful tool to add to artifact analysis (Fiedel 1996). An artifact that has undergone normal biological processes, and even curated, can be tested for protein residue analysis (Kooyman *et al.* 1992; Schneider *et al.* 2009). To provide additional evidence for the positive protein residues, associated soil samples should be taken. Testing the associated soil allows the argument for the positive protein residues to be more credible. Testing the soil samples that the artifacts were recovered from strengthens the argument that the residues found on that artifact's surface are there because that was what was being processed on its surface, rather than just being a result of soil contamination. The data obtained from protein residue analysis can be used alongside other analyses, such as the study of faunal remains or pollen analysis. Protein residue analysis allows us to expand our knowledge about the ways in which tools have been used. For instance, analysis can be done on groundstone to determine what materials were being processed on it and projectile points can be tested to determine what mammal it was used to kill. These data provide a better understanding of subsistence strategies during prehistoric times.

<u>Criticisms of Crossover Immunological Electrophoresis</u>

Protein residue analysis has been criticized by the archaeological community for several reasons, including a lack of knowledge of the analysis and the validity of the test (Craig and Collins 2002; Downs and Lowenstein 1995; Fiedel 1996; Stahl 1996). Downs and Lowenstein (1995), argue that protein degradation can occur due to biological processes during deposition. While protein degradation does occur, protein residues can still remain (Kooyman *et al.*

1992; Yohe *et al.* 1991). The CIEP test is very sensitive and can detect small amounts of protein residues (Newman 1993). Craig and Collins (2002) are critical of the current extraction methods taken during CIEP testing. Although current extractions may not work effectively for every artifact material, it has been proven to work on lithic artifacts, as shown in this research as well as others (Parr *et al.* 2001, Sutton *et al.* 1993, Yohe *et al.* 1991). Fiedel (1996) and Stahl (1996) argue that CIEP analysis should not be used as a way to identify subsistence strategies in prehistoric times because it is difficult to determine if a protein has been misidentified or not identified at all. Although there is a chance that a protein may not be identified due to contamination or degradation, the proteins that are identified help expand our knowledge of prehistoric subsistence strategies. The results of the CIEP test can be used in addition to other testing to strengthen an argument, including faunal analysis and paleobotanical analysis.

Blood is made up of cells and plasma. The plasma contains globulin and albumin blood proteins and the red blood cells contain hemoglobin. The protein amino acid chains break up into smaller peptide chains over time. The rate of protein degradation is dependent on the artifact's deposition and environmental setting. Protein residue can degrade at a faster rate in response to exposure to air, heat, sun, and water (Downs and Lowenstein 1995). Although Downs and Lowenstein (1995) warn about protein degradation, the authors also argue that CIEP analysis is the most effective of the immunological tests.

Proteins bind strongly to surfaces using short range bonds. Craig and

Collins (2002), believe that although this may aid in protein preservation, the current extraction methods for analysis are not sufficient. The ways in which protein residues will survive on artifacts depend on their material and surface area. As shown in the study done by Kooyman et al. (1992), protein residues can still survive on artifact surfaces even if protein degradation has occurred. Perhaps extracting protein residue would yield better results if the methods were re-evaluated, as Craig and Collins (2002) suggest.

Fiedel (1996) analyzed Yohe *et al.*'s (1991) use of CIEP on artifacts from the site CA-SBR-6179. Based on Yohe *et al.*'s analysis of the site, they determined groundstone was used to process rats. This was based on the presence of rat proteins on the collected groundstone, as well as the use of ethnographic information. Fiedel (1996) points out that rats did not inhabit California until after AD 1600, although there were similar species available that could have had similar proteins. Fiedel also points out that the ethnographic accounts focus on deer and rabbits as the main sources of animal protein. Neither of these mammals were found during CIEP analysis at the site. According to Fiedel, this could mean that these subsistence strategies were incorrect or had drastically changed since these ethnographies were documented or that the ethnographies themselves were wrong. Fiedel warns of using CIEP results as a way to accurately identify prehistoric subsistence strategies. Just because an artifact tested positive for blood residue does not mean that the inhabitants were using that mammal as a main source of their diet. Due to the limited amount of antisera available to test against, Fiedel believes it is difficult to determine whether a protein has been identified correctly. Since the range of available antisera is limited, Fiedel argues that using CIEP analysis for a comparative or statistical analysis would not be appropriate.

Rodents were part of the native inhabitants' diet, although rodent remains are difficult to find archaeologically (Michelsen 1967). When small animal remains are recovered from sites, they are usually viewed as being biological contaminants or non-cultural. This viewpoint does not allow for interpretation of small mammals in prehistoric diets (Sobolik 1994).When screening soil for artifacts, any mesh size greater than 1/8" will not be able to catch a large enough sample of small bones. Using soil flotation can help recover small bones more successfully. Rodent bones found during archaeological investigations are often difficult to determine whether they died naturally underground or were left there culturally. Rodent bones that are recovered are usually very fragmented, which could mean they were ground up during processing (Yohe *et al.* 1991). For their analysis, Yohe *et al.* (1991) tested a mortar and pestle for protein residues. They both tested positive for rat and mouse proteins. The manos found at the site had evidence of battering and pecking at the ends. This could be because the manos were used to crush the animals against the groundstone.

Once a small mammal dies, the remains can likely become fragmented or moved to another location via normal biological processes or animal transport. Bones that undergo normal biological processes underground are often difficult to recover and interpret archaeologically. Often, small mammal remains are unable to be correctly identified in any way that could help aid in interpretation (Stahl 1996).

Stahl (1996) believes protein residue analysis has not been properly explained to many archaeologists. There are still many archaeologists who doubt its validity, especially in regards to whether blood residues can actually survive that long in certain conditions. Stahl also cautions about making inferences about subsistence practices based on blood residue results. Analyzing the actual faunal remains can help give a better representation of how the small mammals were being used. Using CIEP analysis is a way to help identify mammal remains that researchers are unable to do by faunal analysis alone. CIEP analysis shows evidence of animal processing, which likely meant that animal was consumed by the group. It goes beyond just identifying what faunal remains were present at the site, but actually shows what mammals were being processed and eaten.

Obtaining Samples from Groundstone

Using a field kit provided by the Archaeological Laboratory at California State University, Bakersfield, I was able to obtain my samples directly from the groundstone housed at the San Bernardino County Museum. The kit included 5% ammonium hydroxide, pipettes, plastic vials, plastic weigh boats, and swabs. Using the pipette, I applied the ammonium hydroxide to the surface of the artifact over the plastic weigh boat. I then used the swab to acquire as much of the residue as I could. I concentrated on areas with apparent use-wear. Once the swab was saturated with the solution and possible protein residues, I squeezed the solution into the weigh boat. The solution was then pipetted into a labeled plastic vial. Once the residues had been obtained from all 20 artifacts, I placed the vials and their holder into a frozen cooler. The vials were kept in the freezer until I was able to return to the archaeology lab at California State University Bakersfield. I also took samples from soil samples that were excavated from the Rock Camp Site. Due to the lack of availability of all of the soil samples taken from all 21 excavation pits from the site, I was only able to obtain four. The soil samples came from Unit 12 (below 12”), Unit 14 (below 48” and below 60”), and Unit 21 (below 48”). The artifacts associated with these soil samples will have stronger evidence for the protein residues found upon their surfaces. Testing the soil samples of the associated artifacts that are being tested for protein residues strengthens the argument that the residues found on that artifact’s surface are there because that was what was being utilized on its surface, rather than just being a result of soil contamination.

Testing Samples for Protein

Once the protein samples had been extracted from the twenty groundstone artifacts, I was able to return to the Laboratory of Archaeological Sciences at California State University Bakersfield. The first step in the crossover immunological electrophoresis process was to set up the agar gels and insert the antisera and samples into the gels. I tested 20 samples taken from the groundstone at the site, as well as four associated soil samples. Each of the 24 samples got its own agar gel. The gel contains wells that are in pairs. The antisera is placed in the left well and the sample is placed in the right well. The agar gels are shown in Figure 8. The antisera and samples are placed into the wells using a pipette.

I tested each sample against 31 different antisera from various mammals and plants. A list of complete antisera that I tested for is shown in Table 9. The electrophoresis tanks are shown in Figure 9. Before the gels are placed into the tank, a buffer is added to electrophoresis chamber. The gel is then placed into the chamber, where a paper is moistened and placed into the gel directly next to the wells. The chambers are closed and an electrical current is sent through the chambers for 45 minutes. After undergoing electrophoresis, the gels are placed into a NaCl bath on a rotating mixer for four hours. Once done with the NaCl bath, the gels are pressed between blotting paper, glass, and two pound weights to extract as much liquid as possible. After being pressed for 10 minutes, the gel is put into an oven at 70 degrees Celsius for about an hour.

Once dry, the gels undergo the staining process. The staining process is shown in Figure 10. The staining process allows the positive bands between the wells to become visible. Three containers are set onto the rotating mixer: one containing the blue stain, and two others containing destain. The destain allows everything except the positive reactions to be visible. The gels stay in each container for three minutes each. Once finished staining, the gels are placed onto blotting paper to dry. After the gels are completely dry, they are able to be analyzed. To determine whether the reaction was positive or negative, you simply look for blue bands that appear between the two wells. An example of one of my positive results is shown in Figure 8. Some of the bands are difficult to see with an unaided eye, so a magnifying glass and table lamp are used. The results were then recorded in a spreadsheet.

Table 9. Antiserum Samples that were Tested Against

Animal Antiserum	**Plant Antiserum**
Ursine	Amaranthaceae
Bovine	Asteraceae
Camelidae	Camas
Feline	Capparaceae
Phasianinae	Chenopodiaceae
Cervinae	Cupressaceae
Elephantine	Lessoniaceae
Cavinnae	Lomatium
Equine	Malvaceae
Hominini	Mesquite
Leporidae	Portulacaceae
Murinae	Pinaceae
Caprinae	Acorn

Porcine	Buckeye
Triopsidae	Yucca
Salmoninae	-

(Teteak 2017)

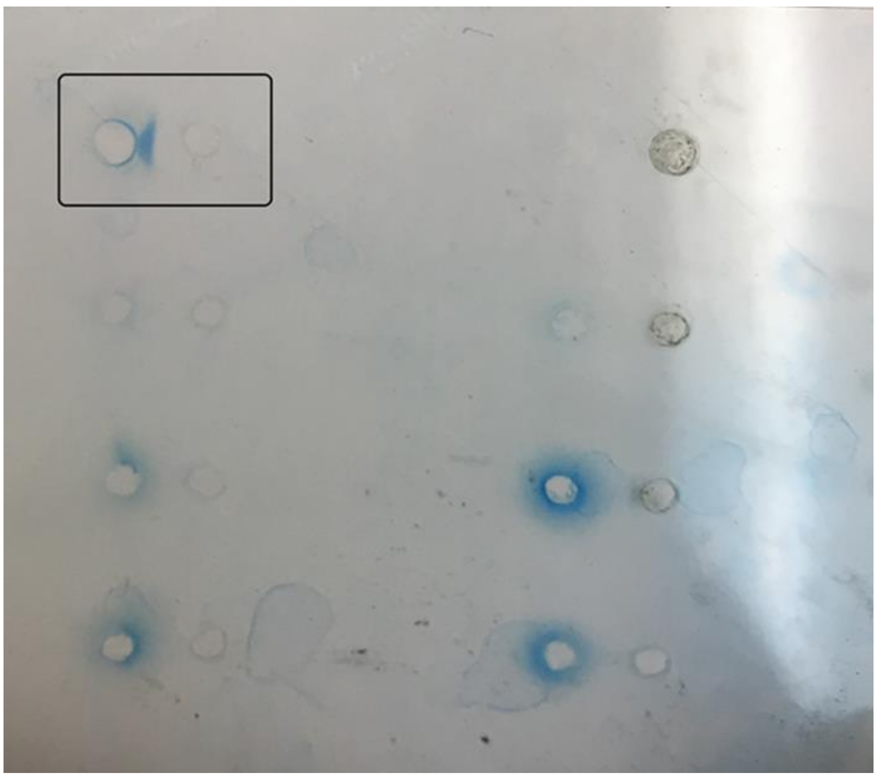

Figure 8. A Positive Reaction on the Agar Gel

Figure 9. Electrophoresis Tanks

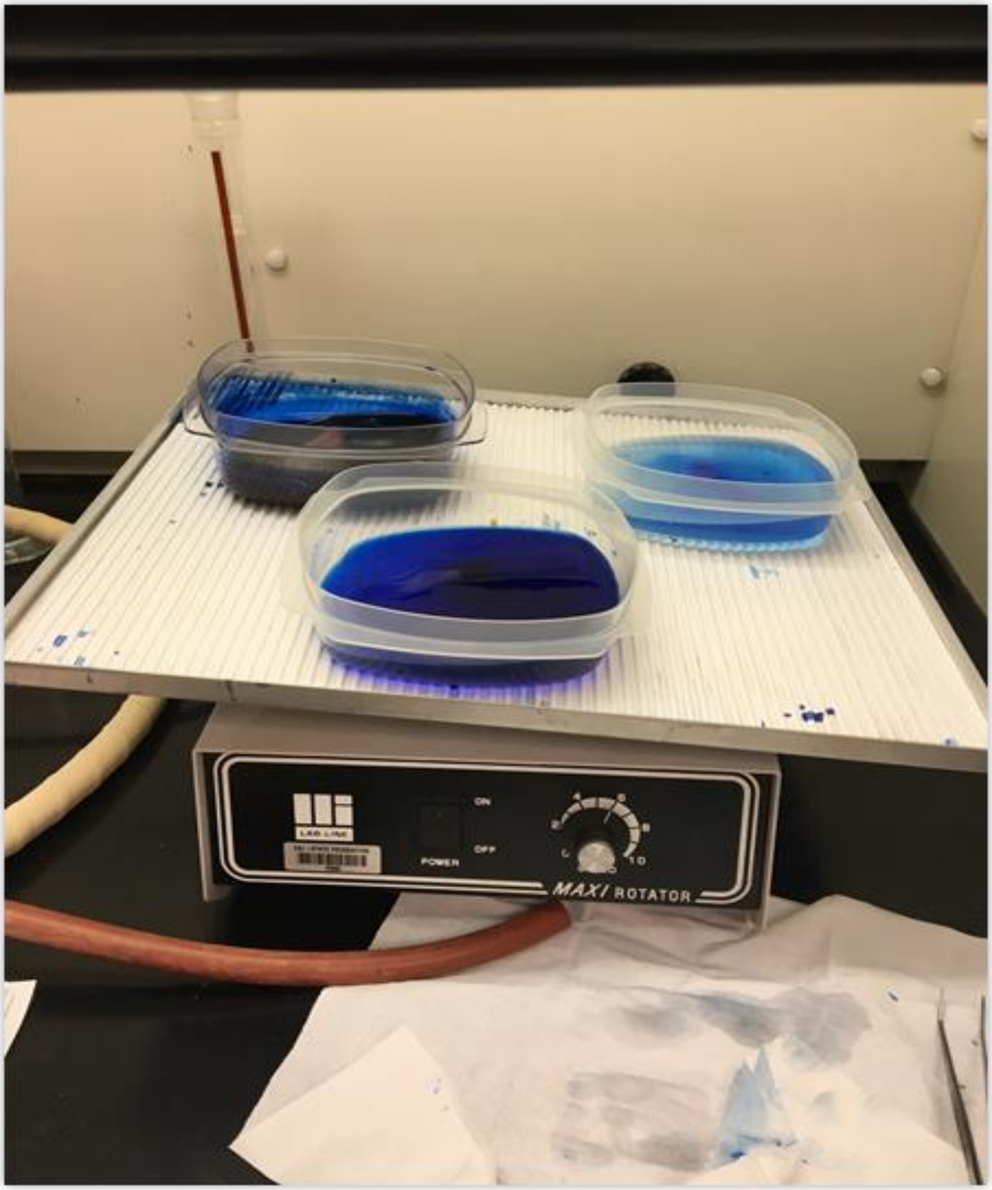

Figure 10. Gels Undergoing the Staining Process

CHAPTER FIVE

RESULTS

Fourteen of the 20 groundstone artifacts tested from the Rock Camp Site, came back positive for protein residues. The artifacts that tested positive for proteins include metates, handstones, manos, pestles, a sheller/huller, and a bush hammer. Out of the 14 artifacts that tested positive for protein residues, 12 of the artifacts were positive for rabbit. One of the artifacts, a mano (sample #12) tested positive for rat. Two artifacts, a mano and the sheller/huller, tested positive for bovine (cow). This was likely due to soil contamination from ranching activities that occurred during historic times at the Rock Camp Site. Bovine tested positive in my soil sample from the site, which negates the bovine protein residues found on the artifacts. One artifact, a pestle, tested positive for Capparaceae. Capparaceae includes beeplant, bladderpod, stinkweed, etc. This positive was weak, however. This was the only positive plant protein residue out of the entire sample of groundstone artifacts (Table 10).

I obtained soil samples from the Rock Camp Site collection at the museum. Although 21 pits were excavated from the site, only soil samples from three of those pits could be currently found in the collection. I tested four soil samples that came from three of the 21 pits found at Rock Camp: Unit 12 (below 12”), Unit 14 (below 48” and below 60”), and Unit 21 (below 48”). A table that details the artifacts recovered from the tested soils are shown in Table 11. A list containing the positive protein residues for each soil sample is shown in Table 12. A detailed description of the results of each artifact tested is presented below.

Artifact Samples

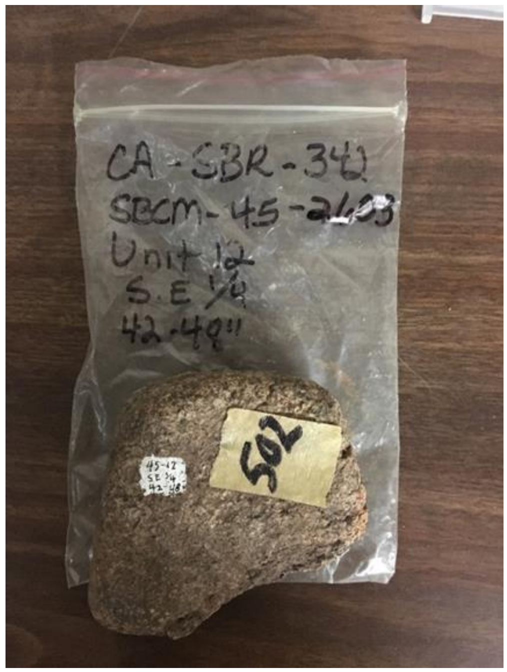

Figure 11. Artifact #1

Artifact #1 (Catalog #2603) is a metate fragment that was found in Unit 12. It was excavated from the depth of 42-48”. The metate fragment tested positive for rabbit proteins.

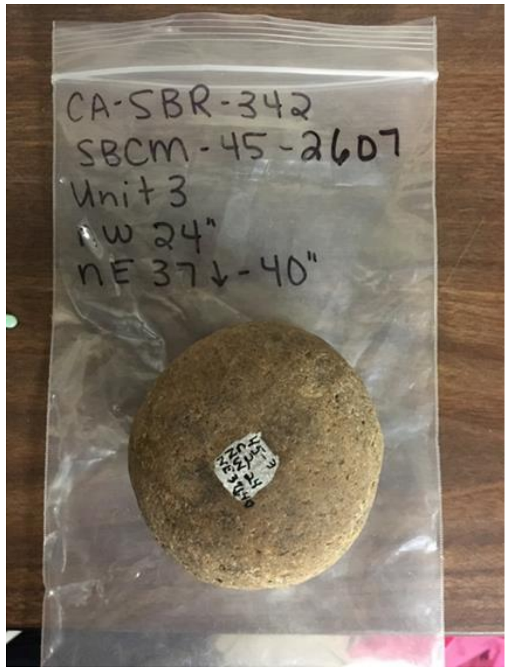

Figure 12. Artifact #2

Artifact #2 (Catalog #2607) is a handstone that was found in Unit 3 at a depth of 37-40”. The handstone tested positive for rabbit.

Figure 13. Artifact #3

Artifact #3 (Catalog #499) is a mano that was excavated from Unit 3 at the depth of 12-18”. The mano did not test positive for any protein residues- the results were negative.

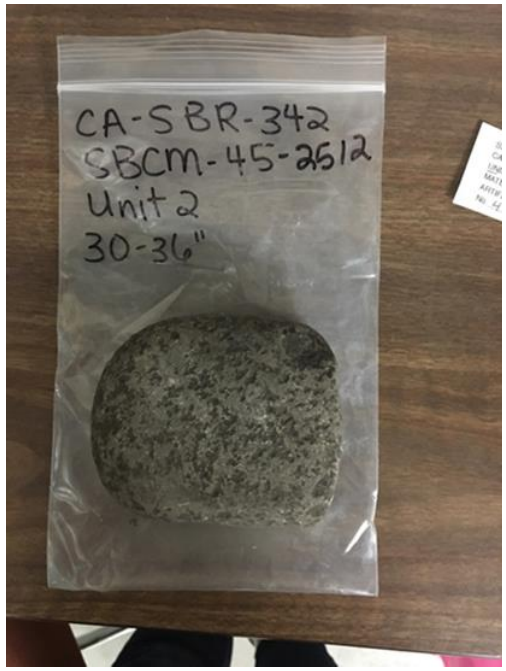

Figure 14. Artifact #4

Artifact #4 (Catalog #2512) is a mano that was excavated from Unit 2. It was located at depth of 30-36”. The mano tested positive for both rabbit and bovine (cow) residues.

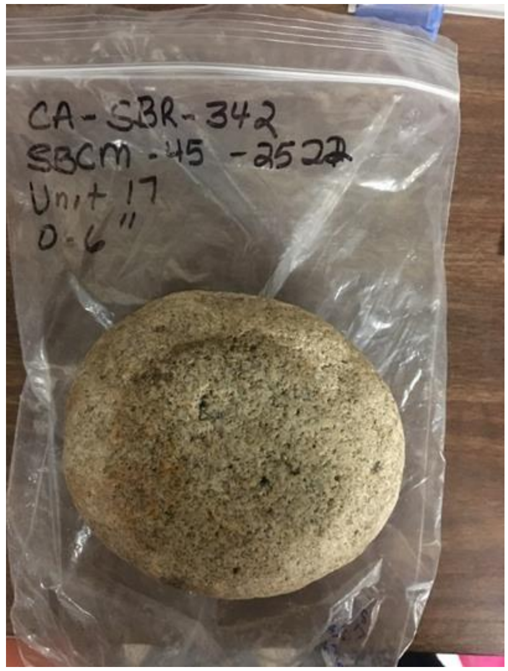

Figure 15. Artifact #5

Artifact #5 (Catalog #2522) is a possible sheller or huller. It was excavated from Unit 17 at a depth of 0-6”. The sheller/huller tested positive for bovine residues.

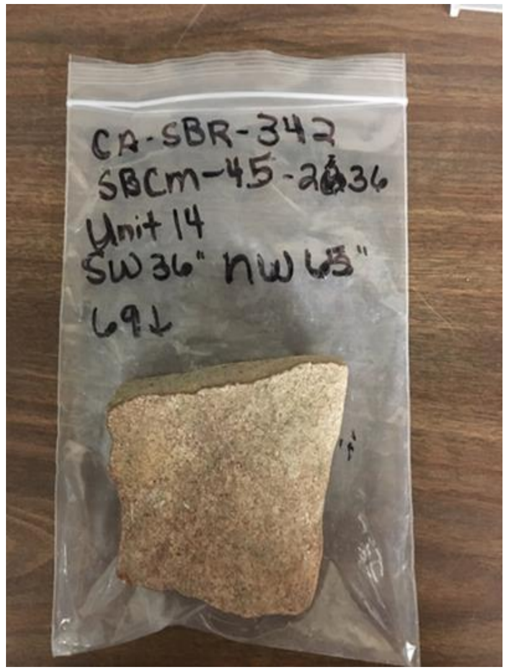

Figure 16. Artifact #6

Artifact #6 (Catalog #2636) is a metate fragment that was located in Unit 14 at a depth of below 36”. The metate tested positive for rabbit.

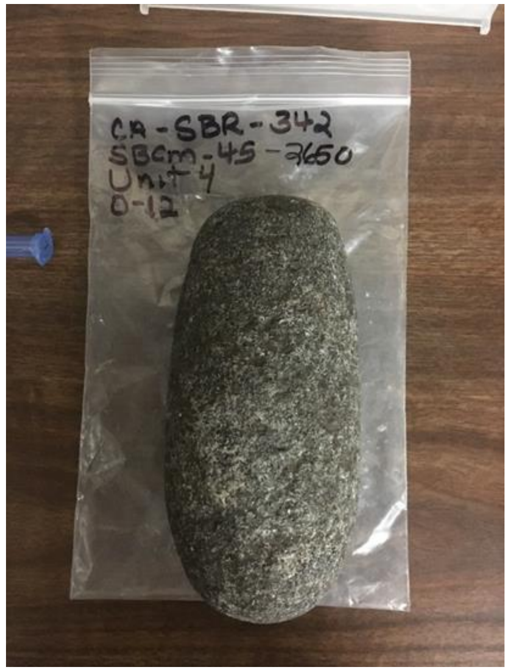

Figure 17. Artifact #7

Artifact #7 (Catalog #2650) is a pestle that was excavated from Unit 4 at a depth of 0-12". The pestle tested positive for rabbit and also had a weak positive for the plant Capparaceae.

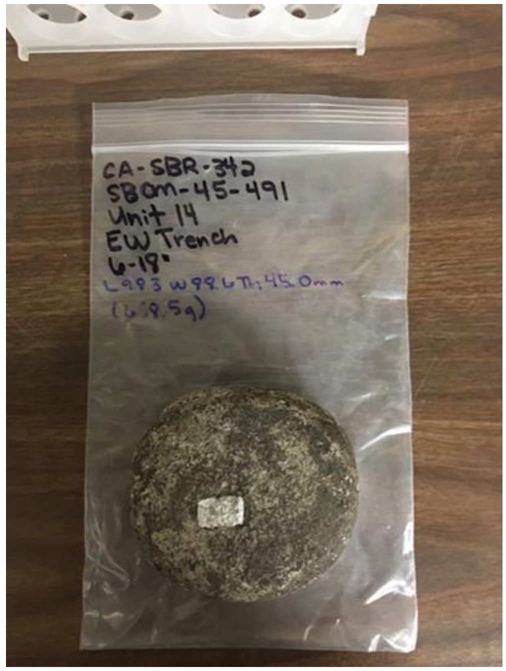

Figure 18. Artifact #8

Artifact #8 (Catalog #491) is a mano that was found in Unit 14. It was located at a depth of 6-18”. The mano tested positive for rabbit.

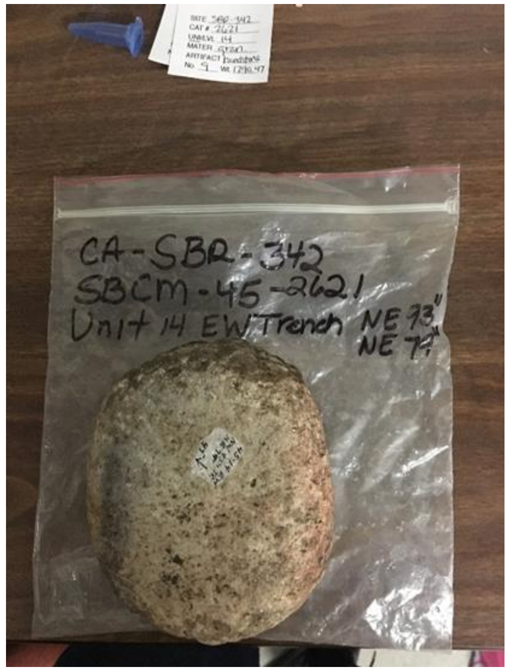

Figure 19. Artifact #9

Artifact #9 (Catalog #2621) is a handstone that was found in Unit 14 at an unknown depth. The handstone tested positive for rabbit.

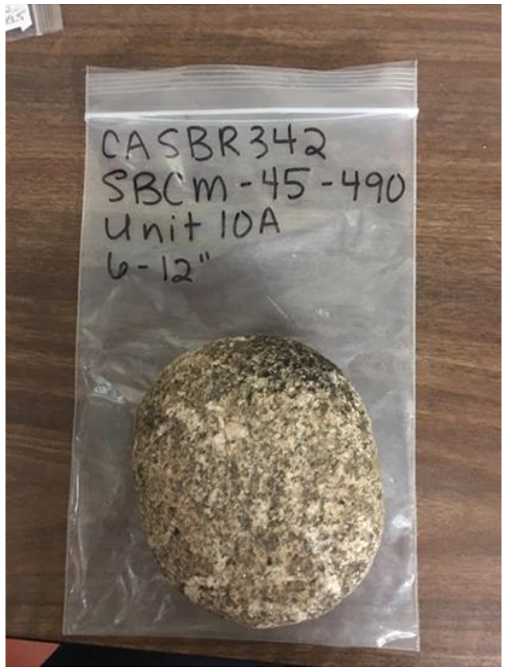

Figure 20. Artifact #10

Artifact #10 (Catalog # 490) was labeled as a bush hammer. It was found in Unit 10A at a depth of 6-12”. The bush hammer tested positive for rabbit.

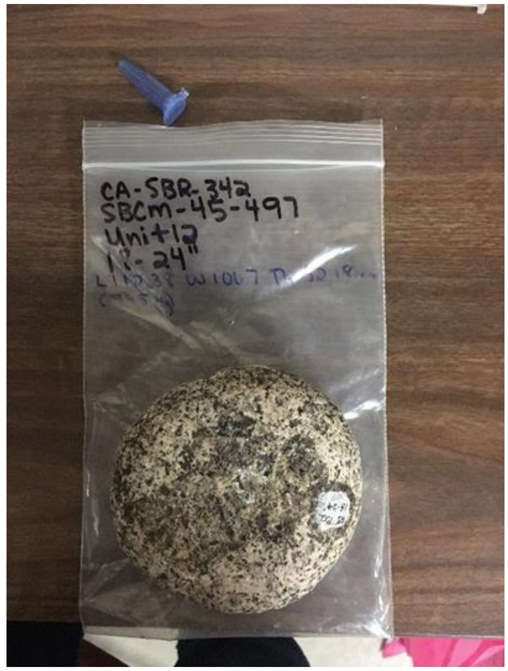

Figure 21. Artifact #11

Artifact #11 (Catalog #497) is a muller that was found in Unit 12 at a depth of 18-24”. The muller did not test positive for any protein residues- the results were negative.

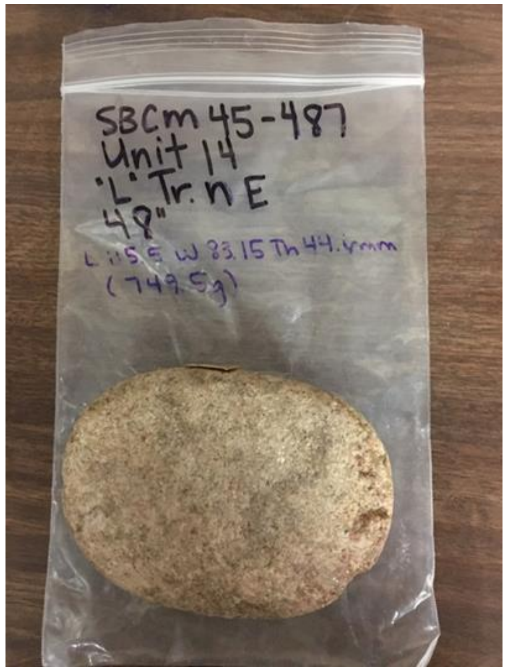

Figure 22. Artifact #12

Artifact #12 (Catalog #487) is a mano that was excavated from Unit 14 at a depth of 48”. The mano tested positive for rat proteins.

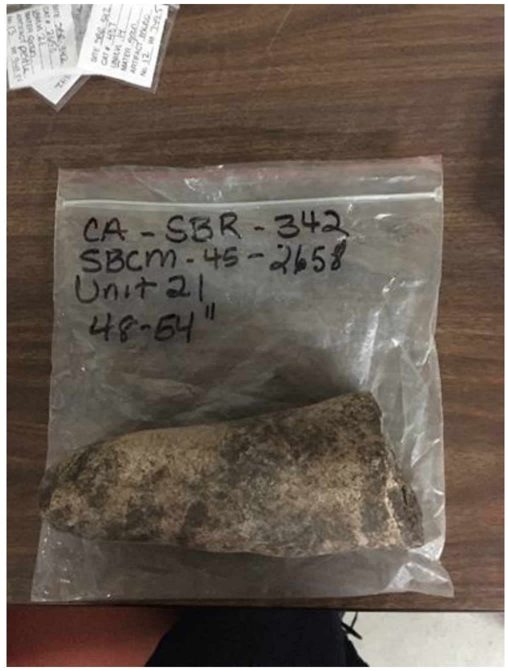

Figure 23. Artifact #13

Artifact #13 (Catalog #2658) is a pestle that was excavated from Unit 21 at the depth of 48-54”. The pestle tested positive for rabbit.

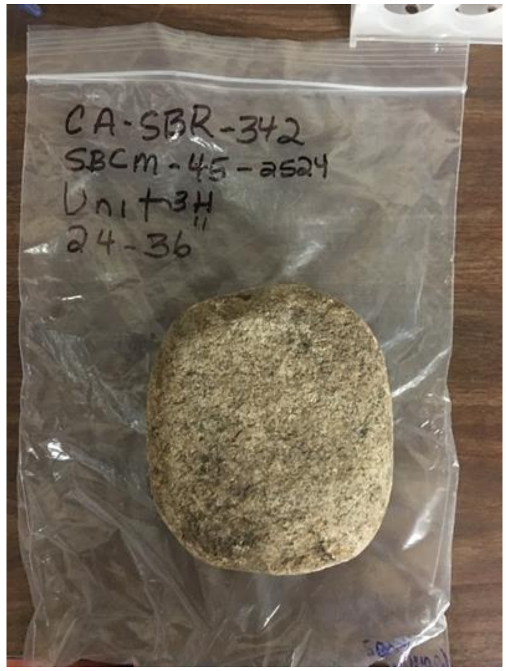

Figure 24. Artifact #14

Artifact #14 (Catalog #2524) is a handstone that was located in Unit 3H at a depth of 24-36”. The handstone tested positive for rabbit proteins.

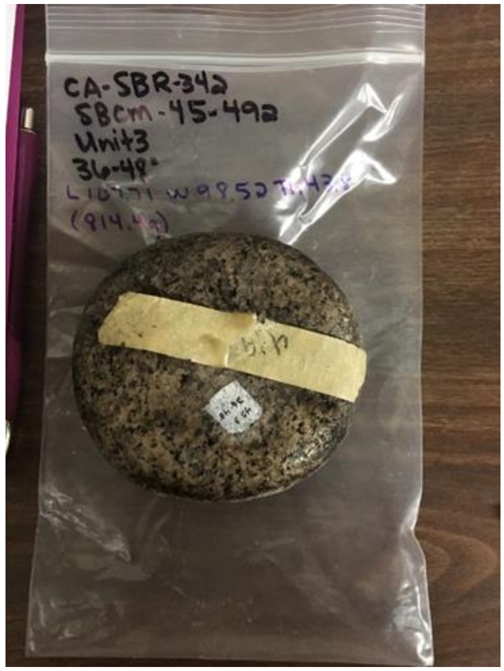

Figure 25. Artifact #15

Artifact #15 (Catalog # 492) is a mano that was excavated from Unit 3. It was located at the depth of 36-48”. The mano did not test positive for any protein residues- the results were negative.

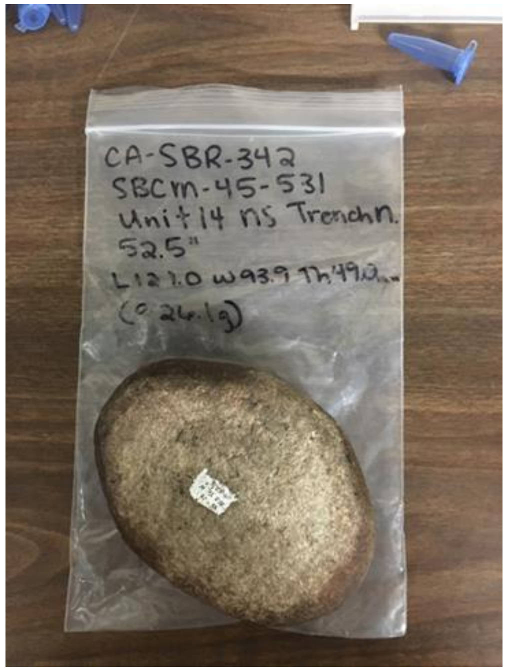

Figure 26. Artifact #16

Artifact #16 (Catalog #531) is a mano that was found in Unit 14 at a depth of 52.5”. The mano tested positive for rabbit proteins.

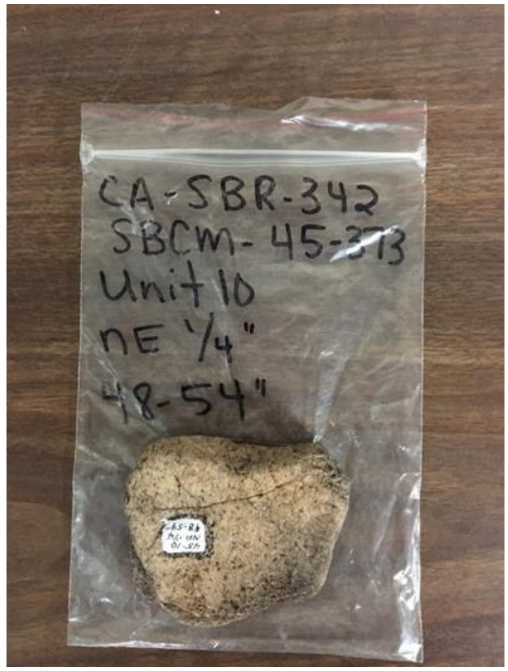

Figure 27. Artifact #17

Artifact #17 (Catalog #373) is a handstone that was excavated from Unit 10 at a depth of 48-54”. The handstone did not test positive for any protein residues- the results were negative.

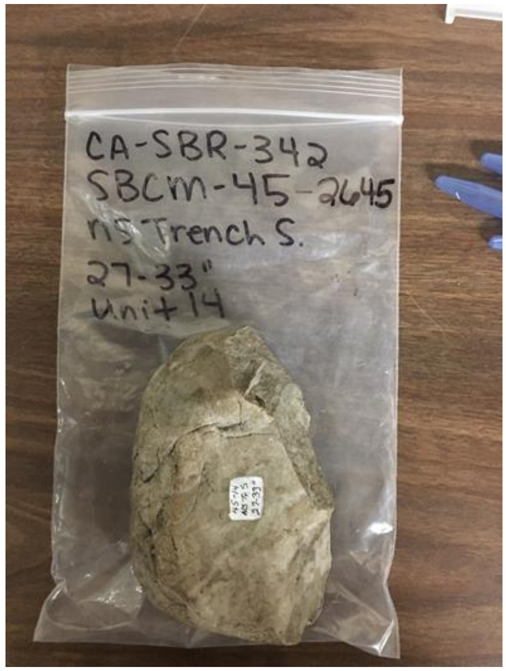

Figure 28. Artifact #18

Artifact #18 (Catalog #2645) is a metate fragment that was excavated from Unit 14 from a depth of 27-33”. The metate fragment did not test positive for any protein residues- the results were negative.

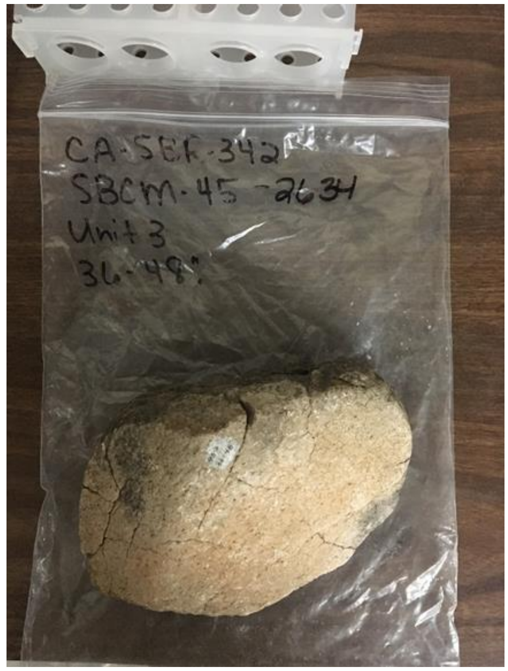

Figure 29. Artifact #19

Artifact #19 (Catalog #2634) is a metate fragment that was excavated from Unit 3 from a depth of 36-48”. The metate fragment tested positive for rabbit proteins.

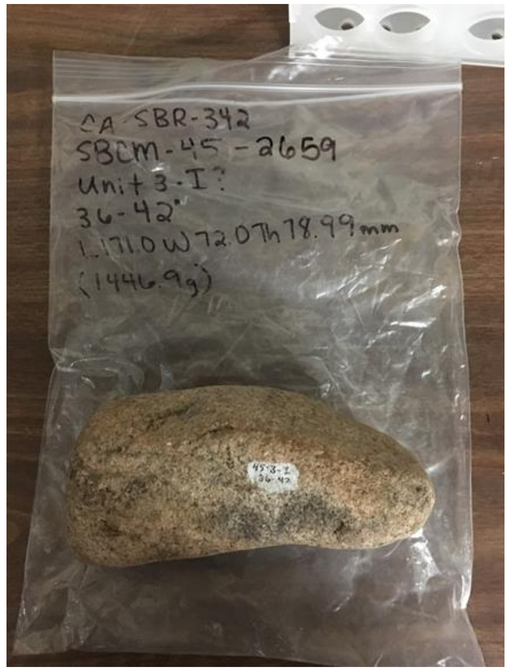

Figure 30. Artifact #20

Artifact #20 (Catalog #2659) is a pestle that was found in Unit 3I at a depth of 36-42”. The pestle did not test positive for any protein residues- the results were negative.

Soil Samples

Soil Sample #1 was originally taken from Unit 14 a depth of below 48”. The soil sample tested positive for rabbit, acorn, capparaceae, chenopodium, compositae, yucca, and loma. Contamination issues will be addressed below. Soil Sample #2 was taken from Unit 21 from a depth of below 48”. This soil sample tested positive for bovine, cedar, chenopodium, malva, mesquite, and loma. Soil Sample #3 was taken from Unit 14 at a depth of below 60”. This soil sample did not test positive for any protein residues- it was negative. Soil Sample #4 is from Unit 12 at a depth of below 12". This soil sample tested positive for bovine, chicken, buckeye, malva, yucca, and loma.

Table 10. Protein Residue Analysis Results for CA-SBR-342

ARTIFACT	**ARTIFACT #**	**RESULTS**
Metate	1	**Rabbit**
Handstone	2	**Rabbit**
Mano	3	Negative
Mano	4	**Bovine, rabbit**
Sheller/Huller	5	**Bovine**
Metate	6	**Rabbit**
Pestle	7	**Rabbit, capparaceae (weak)**
Mano	8	**Rabbit**
Handstone	9	**Rabbit**
Bush hammer	10	**Rabbit**
Muller	11	Negative
Mano	12	**Rat**
Pestle	13	**Rabbit**
Handstone	14	**Rabbit**
Mano	15	Negative

Mano	16	**Rabbit**
Handstone	17	Negative
Metate	18	Negative
Metate	19	**Rabbit**
Pestle	20	Negative

(Teteak 2017)

Table 11. Soil Samples with Corresponding Artifacts

Soil Sample #	**Artifact #**
1	12, 16
2	13
3	6, 9
4	11

Table 12. Results of Soil Analysis for CA-SBR-342

LAS #	**Prov/Inventory Code**	**Artifact**	**Results**
21	Soil Unit 14, 48”	Soil	Rabbit, acorn, capa, cheno, compo, yucca, loma

22	Soil Unit 21, 48”	Soil	Bovine, cedar, cheno, malva, mesquite, loma
23	Soil Unit 14, 60”	Soil	Negative
24	Soil Unit 12, 12”	Soil	Bovine, chicken, buckeye, malva, loma, yucca

(Teteak 2017)

Positive Protein Residues

The high percentage of positive rabbit protein found on the groundstone tested as part of this research suggests that rabbits, and possibly other small mammals, were an important part of the diet of the Native inhabitants at the Rock Camp site and were processed using groundstone. Rabbit was found on nearly every groundstone artifact type, including metates, manos, handstones, pestles, and the bush hammer. The rabbit results were likely not all due to contamination since rabbit residues were only found in one of the tested soil samples. That soil sample (#1) contained two artifacts, with only one containing rabbit proteins. That artifact (#16) cannot accurately be determined to have been used to process rabbit since its associated soil contained rabbit proteins as well. Several other artifacts tested positive for rabbit residues that had been found in context with soils that contained no rabbit proteins. This strengthens the argument that rabbit was processed at the Rock Camp Site using the groundstone.

Interestingly, out of the 20 groundstone artifacts that were tested, only one came back positive for plant residue, and it was a weak positive. The artifact that had been labeled as a sheller or huller, posited to be used in acorn processing, did not test positive for any plant residues. The sheller/huller only tested positive for bovine (cow) residue, which is likely the result of soil contamination. The artifact that had been labeled as a bush hammer also did not test positive for any plant residues. In fact, it tested positive for rabbit protein. The negative results for the protein reside on these artifacts does not mean they were not processing mammal or plant materials on these pieces of groundstone. Protein degradation can occur due to weathering or fire, which would result in the breakdown of the protein, likely causing a negative result in protein residue analysis.

Six of the groundstone artifacts were associated with the soil samples tested from the Rock Camp Site. Most of the artifacts with associated soils were unaffected by the results. Artifact #16 came back positive for rabbit. The soil associated with this artifact did as well. This means that the rabbit found on the surface of this artifact could likely be due to contamination. The other artifacts that came back positive for rabbit in that list are likely to be from the processing of rabbits on the groundstone since the soil that the artifacts are associated with came back negative for rabbit. The rat proteins found on artifact #12 also may be due to mammal processing on groundstone since the soil was negative for rat. The two positive bovine (cow) results that were found on the mano (Artifact #4) and the sheller/huller (Artifact #5) were most likely due to soil contamination. During the historic period, a ranch was at the Rock Camp Site. The bovine (cow), as well as the chicken protein found in soil sample #4, were both likely due to historic ranching activities.

CHAPTER SIX

DISCUSSION

Small Mammals on Groundstone at the Rock Camp Site

My first hypothesis is, “The inhabitants of the Rock Camp Site were processing small mammals, as well as plant resources, on groundstone.” Based on the data I was able to obtain from the protein residue analysis, I was able to determine that rabbit was likely processed on the groundstone at the site (Teteak 2017). Rat may have also been part of their subsistence based on the one positive rat protein that was found on a mano at the site. Rat was also found at the Summit Valley sites which strengthens the argument that it was part of their subsistence (Parr *et al.* 2001, Sutton *et al.* 1993, Yohe *et al.* 1991). Only one artifact tested positive for plant material, which was the pestle that was positive for capparaceae. Again, I cannot assume capparaceae was a common plant being processed on groundstone due to the presence of only one positive protein sample. Since 60% of the groundstone had a positive residue for rabbit, this suggests that the groundstone was used for processing small mammals, especially rabbits. This does not mean that the groundstone was not used for other processing, such as acorns or other plants, but that it was likely used for a variety of food processing.

The group was likely processing small mammals on groundstone in order to obtain the most caloric value available without using an abundance of energy or time (Kelly 1995; Moore and Keene 2014). If a high-ranked mammal is limited or seasonal to the area, small mammals would give the group the necessary nutrients they need (Outram 2004). The group would likely decide to pursue small mammals, including rabbits, if they were encountered during a hunt (Kelly 1995; Smith 1983; Winterhalder and Smith 1981). If a group chooses not to pursue the smaller game, the group may be at risk.

The reliance on small mammals is very beneficial to a group's subsistence strategies because small mammals can be more reliable than plants, including acorns. Plant resources can be unreliable due to environmental changes, fire, or pests (Bean 1974). Changes in the weather can affect how a plant matures and whether it will sprout. Changes in moisture levels can either cause droughts, which dries up the soil, making plant growth difficult, or an extreme amount of water, such as flooding episodes, can also cause plants to die or be carried away (Bean 1974). Wildfires, which do occur throughout this region, can wipe out the vegetation for an entire area instantly, leaving the ground barren for an unpredictable amount of time. Plants can also be eaten by other mammals who subsist on it. Parasitic plants and/or pests can also destroy a plant (Bean 1974). All of these factors can ultimately destroy important food resources that are being heavily relied upon.

In order to minimize risk associated with foraging activities, the group will exploit a variety of different resources so that if one resource is unavailable, there are others the group can rely on (Kelly 1995). If a plant resource that is relied upon becomes unavailable, the group will have to search for other ways to get their basic needs. Having a wide diet breadth allows a group to survive. Meat is valued within hunter-gatherer groups because it contains a high amount of protein. Meat also contains nine of the essential amino acids that the body cannot synthesize on its own. Other vitamins in meat include B12, iron, zinc, linoleic acid, and glucose (Kelly 1995). Fat from mammals helps aid in the body's adsorption and storage of vitamins. Mammal fat also provides twice the amount of energy as carbohydrates do (Kelly 1995).

Processing small mammals on groundstone would allow for a high-calorie source of protein, without the cost of a high energy and time-consuming hunt for larger game. Since bigger game are not as numerous, a hunter may only capture one or a few larger mammals (Bettinger 2015). The more time a hunter spends pursuing an animal, the more at risk the group is to dangers (Winterhalder and Smith 1981). A larger mammal may be more intensive and time consuming to process, while a small mammal can be killed, placed on a metate, and pound down to a paste using a mano or handstone. The grinding up of small mammals allows the entire mammal to be eaten, ensuring the most caloric benefit and providing a good course of protein (Outram 2004). Another benefit to grinding up meat is that it would allow individuals who could not chew meat the ability to eat it, including older people and young children. This was demonstrated in Adams (2014) when a Hopi elder explained that a particular mortar was used to soften meat for older individuals who did not have any teeth left.

Due to acorn processing and large mammal hunting consisting of high-energy and time-consuming processes in order to obtain the maximum benefit, grinding up entire small mammals is a more efficient source of protein and calories (Basgall 1987; Bettinger 2015). Based on ethnographic evidence, we know Native peoples of California practiced this form of subsistence, so we can assume that this was also practiced during prehistoric periods (Bean and Saubel 1972; Kroeber 1925; Michelsen 1967; Shipek 1970).

Small Mammal Processing at Both Elevations

My second hypothesis is, "Processing small mammals on groundstone occurred at both elevations." Based on previous Summit Valley research and the current research from Rock Camp, small mammals were processed using groundstone at both elevations (Parr *et al.* 1972; Sutton *et al.* 1993). Since positive protein residues were found at both elevation sites, it is likely that mammal processing on groundstone was likely a common occurrence throughout the region. To strengthen this argument, we would need to test artifacts from other sites located at the higher elevation zone, as well as sites located along the possible migration routes.

Based on the seasonal round theory, the Rock Camp Site was occupied during the warmers months of the year and was used to process acorns (Altschul *et al.* 1985; Simpson *et al.* 1972).There were no acorn residues found on the groundstone tested at Rock Camp. This does not mean acorns were never processed on the groundstone at the site, just that it was not shown in the particular sample tested. The mammal residues that were found during testing were rabbit and rat. These mammal proteins were also found at the Summit Valley sites (Parr *et al.* 1972; Sutton *et al.* 1993). Due to the similar mammals processed on groundstone at both sites, it is likely the group was using utilizing groundstone similarly at each elevation. The Rock Camp sample did not provide any additional residues than what was found at the Summit Valley sites so difference in seasonality cannot be determined. Other than the similarity between both CIEP results, there is no additional evidence for Altschul *et al.*'s (1985) seasonal round theory. The group was able to maximize their access to small game resources by exploiting rabbit at both elevations (Binford 1981).

Acorn Processing Site?

Despite the Rock Camp Site being labeled an acorn processing site, no acorns, or even pinyon residues, were found in the samples tested. While it is very likely the group occupying this site during prehistoric times were using the groundstone to process the acorns found in the area, as well as other plant material, it is also likely they were using the groundstone to process other material, such as small mammals. Based on ethnographic data, we know the Serrano were using that area to gather acorns and process them on groundstone (Benedict 1924; Simpson *et al.* 1972). It is very likely those groundstone tools that were excavated from the site were used to process acorns at some point, but the acorn and other plant material may not have shown up in my results due to protein degradation or due to my samples just not having any acorn residues on their surfaces (Downs and Lowenstein 1995). According to Wallace (1955: 223), “Mortars and pestles are regarded as being more efficient for pulverizing and grinding oily and fleshy acorns preparatory to leaching out their tannic acid content.” My samples from the Rock Camp Site were mainly manos, and my results may be indicative of specific tool utilization for grinding mammals (manos) versus grinding acorns (pestle). As tool type alone is a poor indicator of the particular material being processed (Adams 2014), additional analysis such as CIEP or paleobotanical analysis can help elucidate tool use. Certain tools can, however, be used to process a variety of materials. The mortar and pestle are regarded as efficient for acorn processing, they were also likely used to process materials when acorns were not available (Basgall 1987).

Acorns are a very good source of calories and fat. According to Baumhoff (1963), acorns contain 2265 calories per pound, which is higher than most other grains. However, acorns have less protein in comparison with grains such as wheat and barley (Basgall 1987). While there are benefits to a reliance on acorns, such as caloric value, the presence of acorn-bearing oak trees located throughout the Rock Camp Site, as well as their long preservation potential, acorns also have disadvantages.

A major disadvantage to acorns is the presence of tannic acid, a toxin. Due to acorns containing tannin, an intensive process has to be done in order to make the acorns fit for consumption. The tannic acid must be leached from the acorns before they are edible. The leaching process involves the acorns being submerged in water for weeks at a time (Basgall 1987). This process is very labor intensive and acorns are liable to rot. In order to properly leach the acorns, they must be flushed with water multiple times in order to remove the tannic acid. Cold and warm water were used during this process. In order to get the warm water, hot stones were placed in baskets filled with water. This made the process even more labor intensive. The warm water also caused some of the nutrients to be lost (Basgall 1987). According to Baumhoff (1963), this inefficient process would not allow acorns to support large populations.

A major disadvantage to a reliance on acorns is that most oak trees do not produce a significant crop every year; acorn production fluctuates yearly. For example, Black Oak (*Quercus kelloggii*) produces a significant crop about once every two years. Environmental factors also affect whether an oak tree will produce a viable crop (Basgall 1987). Extreme fluctuations in temperature, excessive moisture and wind, wildfires, and parasite infestations could negatively affect the acorn crop (Bean 1974). If there is an excess of rain during certain times, acorns can mildew. Excessive or no rainfall could also change the natural growth schedule of the plant. Flooding could cause the plant to be destroyed or die (Bean 1974).

Other disadvantages to acorns include competition from predators and storage complications. Humans were not the only ones subsisting on acorns. Animals were also relying on acorns, including deer, birds, and rodents, which meant competition for humans. Bugs can eat the inside of the acorns, causing an entire batch to become inedible. A larva infestation is able to turn the inside of the acorns into webs (Bean 1974). The oak trees must be watched so that animals or the weather will not affect the acorns. Storing acorns also has complications, including pest invasion and spoilage from excessive moisture. During long periods of low production of acorns, storing would not counterbalance the lack of available acorns (Basgall 1987).

Depending on one main food resource would not be beneficial for the group's survival, especially a resource that is so labor intensive and requires long-term storage. Goldschmidt's (1974) study done on the Hupa Tribe indicated that it took approximately 447 minutes to prepare 6 lbs. of shelled acorns. This is 164 minutes of processing time per kg. of acorns. Basgall (1987) determined the labor costs for processing 6 lbs. of acorns to be: 60 minutes to gather the acorns, 60 minutes to transport them back to camp, and 240 minutes to shell the acorns. This would equal out to be 252 minutes per kg of acorns, or 1073 calories/hour. Dependence on storage limits the group's overall mobility, which in turn would lower chances of exploiting other available resources in the area. Based on archaeological studies, a dependence on acorns had negative effects on the human body, as shown in the increased rates of mortality and an increased risk of tooth enamel damage (Basgall 1987).

Although acorns were part of the diet for inhabitants in this region, they were likely subsisting on other sources of protein as well, including small mammals (Parr *et al.* 1991; Sutton *et al.* 1993; Yohe *et al.* 1991). Due to the potential unstable nature of acorns, a reliance on other resources would allow the group to remain viable. Using small mammals as a source of calories for their diet would have given the group a better source of protein and a resource that did not require extensive processing or storage (Basgall 1987).

Comparative Analysis to Summit Valley Sites

Based upon previously obtained data from the Summit Valley sites (Parr *et al.* 2001; Sutton *et al.* 1993; Yohe *et al.* 1991), I wanted to determine whether processing small mammals was a common occurrence throughout the region, or just localized in the Summit Valley. Due to Rock Camp Site's similarity in assemblages and location in relation to the Summit Valley sites on the seasonal round, Rock Camp Site data were ideal for comparison to the Summit Valley sites (CA-SBR-7691 and CA-SBR-6580) (Altschul *et al.* 1985). The positive protein results from the Rock Camp groundstone suggests that processing small mammals on groundstone was not just localized to the Summit Valley, but also occurred at the higher elevations as well.

At CA-SBR-7691, protein residues came back positive for bird, deer, rat, squirrel, rabbit, and pronghorn. At the Siphon Site (CA-SBR-6580), positive protein residues came back for pronghorn, rat, waterfowl, rabbit, fish, and yucca. Most of the positive protein residues from these sites were from metates, while the majority of the positive protein residues from the Rock Camp site were from manos. Although there was variation in the types of animal protein found on the groundstone, all the sites had both rat and rabbit present. The differences in the results of the three data sets could be due to availability of resources, seasonality, or a larger sample size, as is the case for the Siphon Site which had 117 artifacts tested. Another difference was that both Summit Valley sites had additional artifact types tested. The Rock Camp data was focused solely on groundstone.

Based off of previous data and the data that was obtained from the protein residue analysis, processing small mammals, especially rabbits and rats, occurred at both elevation zones (Parr *et al.* 2001; Sutton *et al.* 1993, Yohe *et al.* 1991). Based on Altschul *et al.*'s (1985) seasonal round theory, the Native inhabitants were subsisting on small mammals throughout all seasons of the year. During the group's winter and fall occupation in the Summit Valley, the group could have been relying on small mammals to offset the depletion of their acorn stores. During the occupation at the Rock Camp Site in the warm months, the group could have been using the site as their main hunting and mammal processing area. Evidence for this is shown in the abundant presence of groundstone, including multiple bedrock mortars (Simpson *et al.* 1972). Rabbits may have been killed and processed at the Rock Camp Site in large numbers and then dried and taken to the lower elevation sites. Relying on small mammals at both elevation zones would have allowed the group to exploit an abundant resource that is available in both areas and requires little effort in comparison to bigger game or acorn processing (Parr *et al.* 2001; Simpson *et al.* 1972; Sutton *et al.* 1993; Yohe *et al.* 1991). The rabbits would have provided a substantial amount of protein, calcium, and essential fats, which is critical if other resources, such as acorns, are limited or not available that season (Kelly 1995; Outram 2004).

CHAPTER SEVEN

CONCLUSION

This research expanded the knowledge of what materials were being processed on groundstone. Groundstone is commonly found at sites throughout the Southern California region and beyond and it is a commonly held belief that groundstone was mainly utilized as a tool to process plant material (Sutton 1993; Yohe *et al.* 1991; Zepeda 2014). To test this assumption, using CIEP, groundstone from Rock Camp, a high elevation base camp in the San Bernardino Mountains, was analyzed for protein residues to determine what may have been processed using the groundstone. Based on other data from lower elevation sites in the region, groundstone was used not only for plant processing, but also for processing small mammals (Parr *et al.* 2001; Sutton *et al.* 1993; Yohe *et al.* 1991).

The Rock Camp Site is considered an acorn processing site, due to the extensive amount of groundstone present, including bedrock mortars, as well as numerous oak trees throughout the site. While it is likely Rock Camp was used to process acorns during harvest time, based upon the data from the current research, it was likely used as a hunting area as well. Small mammal protein residues are well represented in the 20 samples of groundstone analyzed from existing collections. Using protein residue analysis allows researchers to expand their current knowledge of what groundstone or other artifacts could have been used for or to better understand the subsistence economy of the site inhabitants.

To further this research, additional groundstone from the Rock Camp Site should be tested using CIEP analysis. It would be beneficial to test some of the bedrock mortars throughout the site since it has been proven that protein residues can be found on these features despite their being exposed to the environment (Schneider *et al.* 2009). A larger sample of each artifact type should be tested in order to see if there is a preference of which groundstone tools were used to process mammals. If possible, the faunal remains found at the site should be analyzed in order to accurately determine the MNI of each species present.

Groundstone artifacts are one of the most common artifacts found in the region. By knowing what was being processed on groundstone, it will broaden our knowledge about subsistence strategies in this region and by comparing data from seasonal occupation sites, it will help expand our knowledge regarding mobility patterns in the San Bernardino Mountains. My research enhances our current knowledge of animal processing on groundstone since there is so little current research available.

APPENDIX A

SMALL PLANTS FOUND AT THE ROCK CAMP SITE

Bush Penstemon	*Penstamon ternatus*
Squaw Root	*Perideridia gairdneri*
Wild Heliotrope	*Phacelia distans*
Phacelia	*Phacelia mohavensis*
Cream Cups	*Platystemon californicus* var. *crinitus*
Grass (knot-like heads)	*Poa* sp.
Potentilla	*Potentilla glandulosa* ssp. *reflexa*
Cinquefoil	*Potentilla gracilis* ssp. *Nuttallii*
Bracken Fern	*Pteridium aquilinum* var. *lanuginosum*
Mountain Mint	*Pycanthemum californicum*
Skullcap	*Scutellaria angustifolia*
Blue Eyed Grass	*Sisyrinchium hesperium*
Golden Rod	*Solidago californica*
Common Dandelion	*Taraxacum officinale*
Clover (2 kinds)	*Trifolium* sp.
Yellow Meadow Violet	*Viola Douglasii*
Yellow Wood Violet	*Viola lobata*
Yucca, Lord's Candle	*Yucca Whipplei*
California Fuchsia	*Zauschneria californica* ssp. *latifolia*
Rattlesnake Weed	*Euphorbia* (similar to, but not *albomarginata*)
Mountain Spurge	*Euphorbia Palmeri*
Green Gentian	*Frasera neglecta*
Parry Gilia	*Gilia Parryae*
Everlasting	*Gnaphalium microcephalum*
Mare's Tail	*Hippuris vulgaris*
Mountain Iris	*Iris Hartwegii* ssp. *australis*
Small Rush	*Juncus*
(White Gilia-type flower)	*Linanthus*
Bitterroot	*Lewisia nevadensis*
Honeysuckle	*Lonicera interrupta*
Stiff-haired Lotus	*Lotus strigosus*
Annual Lupin	*Lupinus concinnus*
Perennial Lupin	*Lupinus excubitus*
Small Blazing Star	*Mentzelia* sp.
Bigelow Monkey-flower	*Mimulus bigelovii*
Viscid Monkey-flower	*Mimulus floribundus*
Red-stemmed Mimulus	*Mimulus rubellus*
Tiny Monkey-flower	*Mimulus* sp.
Mustang Mint	*Monardella lanceolate*
Miner's Lettuce	*Montia perfoliata* var. *depressa*
Deer Grass	*Muhlenbergia ringens*

Baby Blue Eyes	*Nemophilia Menziesii* ssp. *integrifolia*
Tobacco	*Nicotiana acuminate* var. *multiflora*
Sweet Cecily	*Osmorhiza chilensis*
Panic Grass	*Panicum pacificum*
Coffee Fern	*Pellaea andromedaefolia*
Scarlet Bugler	*Penstemon centranthifolius*
Scarlet Bugler	*Penstemon* (*Eatonii*?)
Yarrow	*Achillea lanulosa*
Mountain Dandelion	*Agoseris retrorsa*
Wild Onion	*Allium fimbriatum* var. *Parryi*
Giant Ragweed	*Ambrosia* (*trifida*?)
King's Snapdragon	*Antirrhinum Kingii*
Indian Hemp	*Apocynum cannabinum* var. *glaberrimum*
Columbine	*Aquilegia formosa* var. *truncata*
Prince's Rock Cress	*Arabis* sp.
Prickly Poppy	*Argemone numita rotundata*
Milkweed	*Asclepias eriocarpa*
Narrow Leaved Milkweed	*Asclepias fascicularis*
Locoweed, Rattleweed	*Astragalus Douglasii*
Golden Stars	*Bloomeria crocea*
Mustard	*Brassica* sp.
Harvest Brodiaea	*Brodiaea coronaria*
Mariposa Lily	*Calochortus Palmeri*
Rabbit Brush	*Chrysothamus viscidiflorus*
Thistle	*Cirsium californicum*
Clarkia	*Clarkia* sp.
Bindweed	*Convolvulus*
Larkspur	*Delphinium patens* ssp. *montanum*
Milk Maid, Toothwort	*Dentaria californica*
Willow Herb	*Epilobium oreganense*
Horsetail	*Equisetum hyemale*
Blue Mantle Gilia	*Eriastrum sapphirinum*
Yerba Santa	*Eriodictyon trichocalyx*
Wild Buckwheat	*Eriogonum fasciculatum* var. *foliosum*
Filaree, Storksbill	*Erodium cicutarium*
Wallflower	*Erysimum capitatum*

(Simpson *et al.* 1972)

APPENDIX B

SAN BERNARDINO COUNTY MUSEUM LETTER

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SAN BERNARDINO COUNTY

Museum

Melissa Russo
Museum Director

Tamara Serrao-Leiva
Curator of Anthropology
San Bernardino County Museum
2024 Orange Tree Ln.
Redlands, CA 92374

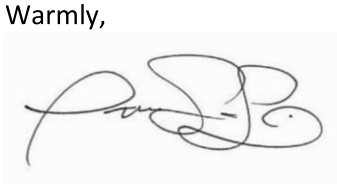
November 25, 2017

To Whom It May Concern,

This letter is to confirm that Lacy Padilla of the CSUSB Archaeology department had full permission and access to the objects and files associated with the Rock Camp Site (SBCM 45, CA-SBR-342). Earlier this year, Lacy came to the museum and conducted an extensive analysis of the ground stone collected from this site for her thesis project.

The San Bernardino County museum is an AAM-accredited institution that takes pride in the work of volunteers, interns, and researchers. Do not hesitate to contact me for further questions.

Warmly,



Tamara M. Serrao-Leiva

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