Parowan Valley Potting Communities: Examining Technological Style in Fremont Snake Valley Corrugated Pottery

Scott M. Ure

A thesis submitted to the faculty of
Brigham Young University
in partial fulfillment of the requirements for the degree of
Master of Arts

James R. Allison, Chair
John E. Clark
Michael T. Searcy
Lane D. Richens

Department of Anthropology

Brigham Young University

July 2013

ABSTRACT

Parowan Valley Potting Communities: Examining Technological Style in Fremont Snake Valley Corrugated Pottery

Scott M. Ure
Department of Anthropology, BYU
Master of Arts

Defining the Fremont archaeological culture has challenged archaeologists for decades. There is still considerable debate about the origins of the Fremont, their eventual demise, their genetic relationship to modern Native American tribes, and myriad other issues. In nearly a century of Fremont research, socio-political, economic, and religious complexity remain elusive subjects. Examining technological style, the manifestation of socially influenced choices during each step of production as a means of passive communication is one useful avenue to examine Fremont material culture to uncover the social patterns they may, or may not contain. I examine whether or not technological style in Fremont Snake Valley corrugated pottery hold traces of social identity produced by Fremont potters living in the Parowan Valley, Utah.

Keywords: Native Americans, Utah, Fremont, Parowan Valley, Snake Valley Corrugated Ceramics

ACKNOWLEDGEMENTS

There are many people who have helped me during my graduate school years, but I am most grateful to my wife, Anne, for her years of patience, love, and support. I would never have been able to finish this thesis without her constant strength and willingness to sacrifice. I am also grateful to my son, Ethan, whose inquisitive mind has been an inspiration and a reminder to always ask for a child's perspective. He also reminded me that any problem can be solved with Legos. I am also thankful for my father and mother, Spencer and Doris, who have enthusiastically supported me on my journey. I am so grateful for all that they sacrificed to provide me with an excellent education. Little did they know that my digging in the garden for buried toys would lead to a career in archaeology. I would also like to thank all of my siblings, Bob, Suzanne, and James for their support and interest in my many stories about ancient pieces of broken artifacts. I am also grateful for my in-laws, Elmer and Sue, with their years of interest and support during my graduate studies. In addition, I am grateful for the love and friendship from my wife's siblings, Kristen, John, Jamie, and Kim, as well as their spouses.

I owe my beginnings in archaeology to several people, including Joel Janetski, Rich Talbot, and Lane Richens. I would never have found archaeology without them, and I am grateful for all of the time and patience they spent listening, teaching, and mentoring. I am especially grateful for the field experiences while working with Rich and Lane for the Office of Public Archaeology. The practical training I received from them is priceless. Another person I would like to thank is Chris Watkins. He spent numerous hours discussing a variety of thesis topics that eventually led me to ceramics in the Parowan Valley and has been a great friend and brother. Mike Searcy has likewise been a great friend and mentor for many years, as well as served on my thesis committee. I am grateful to Mike for his enthusiasm and energy to keep me going during the last hours of writing my thesis.

There are also many people who helped me complete my thesis in a variety of ways. I am especially thankful for Justin Dyer who is a true genius with statistics. His help running some of the complex statistics was life-saving. I am also especially thankful for Deanne and Ray Matheny and their help copy editing, friendship, support. Several students, including Haylie Ferguson, Dan King, and Stephen Freemen spent hours processing Snake Valley Corrugated pottery. I never would have finished my analysis without them, and Ryan Saltzgiver provided extremely helpful copy editing.

I would also like to thank my thesis committee, Jim Allison, John Clark, Mike Searcy, and Lane Richens, for taking an interest in my work and providing helpful ideas, critique, and support. I also am thankful for the Department of Anthropology supporting my graduate work, both financially and academically. Evie Forsyth deserves my heartfelt gratitude for the many, many, times she has watched my back. There is no doubt that I would never have finished my thesis without her help. Paul Stavast, director at the Museum of Peoples and Cultures, as well as his staff, were also extremely helpful. I am also grateful to Glenna Nielsen and Michelle Knoll, at the Natural History Museum of Utah, for allowing me to access to their Fremont pottery. Finally, I would like to thank the Department of Anthropology, the Charles Redd Center, BYU Graduate Studies, the Grace Elizabeth Shallit Memorial Student Grants, the Warren Van Pelt Student Grants, and the Archaeometry Laboratory at the Missouri Research Reactor subsidized grant (NSF #0802757) for generous funding to complete my research.

TABLE OF CONTENTS

LIST OF FIGURES

Chapter 4

Chapter 5

Chapter 6

Chapter 7

Unless noted otherwise, all figures were produced by the author.

LIST OF TABLES

1 Introduction

This thesis reports the results and interpretations from my detailed analysis of Fremont Snake Valley Corrugated pottery. My analysis involves extensive measurements for each specimen, neutron activation analysis for tracing chemical elements, and application of robust statiscal models to reveal trends. The dataset was recovered from four Fremont prehistoric sites (Figure 1): Paragonah (42IN43), Parowan (42IN100), Summit/Evans Mound (42IN40), and Mud Springs (42IN218). The first three sites are located in a geographic region of Iron County, Utah, known as the Parowan Valley. Mud Springs is a Fremont site located approximately 12 miles west of the Parowan Valley and is contemporaneous with the other three sites. The Parowan Valley is located on the east central side of Iron County and contains numerous alluvial fans eroding from streams flowing westward out of the Hurricane Cliffs (Figure 2). The Fremont inhabited the Parowan Valley for centuries (ca. A.D. 900–1300), and at their zenith they grew a variety of crops, including maize, beans, and squash. They also constructed large sedentary villages composed of numerous sub-surface and surface dwellings. Some later structures exhibited “room-block” style construction reminiscent of those built by the Ancestral Puebloans to the south.

The large villages in the Parowan Valley constituted what was arguably one of the most heavily populated Fremont regions along the Wasatch Front as evinced by reports from early Euroamerican explorers and settlers who noted the remains of numerous mounds (some accretional) scattered across the valley (Janetski 1997). This was verified through several

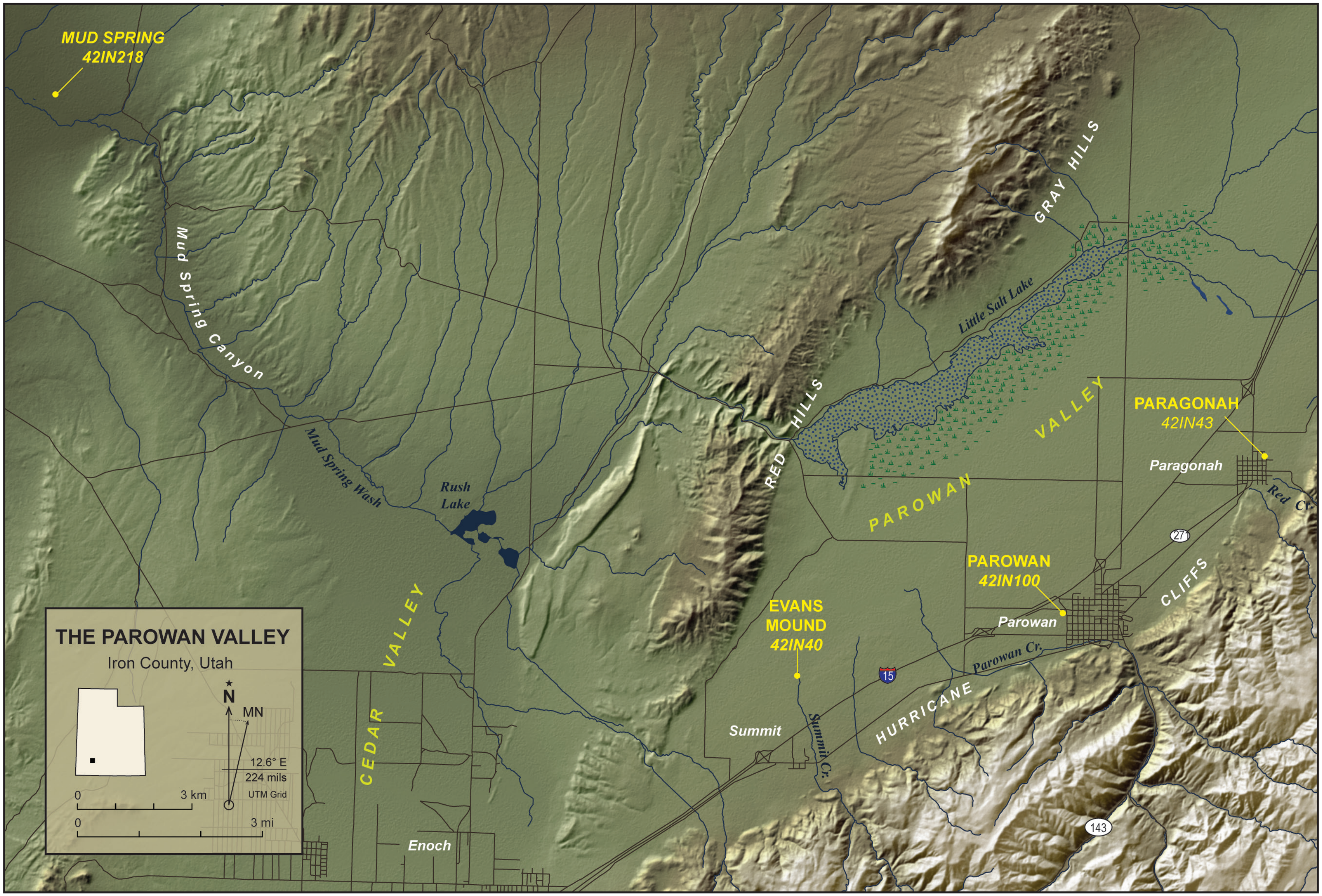


Figure 1. Map of the Parowan Valley showing modern towns (white), the location of Fremont village sites (yellow), and the physiographic boundaries discussed in this thesis.

Figure 2. Photograph of Evans Mound (bare patch in the middle of the photo) and the Hurricane Cliffs to the east. This photo shows the range of elevations, physiography, and environment in the Parowan Valley.

excavations by a variety of individuals such as, Edward Palmer, Henry Montgomery, and Neil Judd. Several universities also excavated the Fremont mounds in the Parowan Valley, including the University of California at Los Angeles (UCLA), the University of Utah (U of U), and Southern Utah University (SUU).

Defining the Problem

The Fremont living in the relatively large communities located in resource rich valleys of the Wasatch Front experienced a complex and diverse social environment. There is little research, however, that tries to substantiate this assumed social complexity; consequently, there is a generally lopsided perception of the Fremont in past research. In a recent article, James Allison (2008a:77) states that Fremont definitions have typically focused too heavily on subsistence and settlement patterns and not enough on examining social factors. This has, in part, created an "identity crisis" resulting in a loose definition of the Fremont as an unbounded conglomeration built almost entirely around their behavioral responses to extrasomatic factors (see Binford 1962; Madsen and Simms 1998; White 1959). As a consequence, the transformative capacity and social complexity of Fremont communities has been generally dismissed.

The prevailing view of the Fremont is summarized by Dorothy Sammons-Lohse (1981:130) when she wrote, "there is no indication that Fremont sites were planned in any way. Although even among very small Anasazi settlements there is consistency in the placement of surface and subterranean structures and refuse middens, there is no such consistency in Fremont sites." In addition Sammons-Lohse (1981:134) wrote, "there is no indication of [Fremont] community organization above the household level." Defining the Fremont in any consistent and formal way continues to challenge archaeologists today. There is still considerable debate and uncertainty about the origins of the Fremont, their eventual demise, their genetic relationship to modern Native American tribes, and myriad of other issues (O'Rourke et al. 1999).

Addressing these issues requires examining the Fremont from different perspectives, and the Fremont villages in the Parowan Valley are an excellent place to address these issues. The Paragonah, Parowan, and Summit sites contain rich and complex arcaheological pasts; however, little has been published about results from the excavations in the Parowan Valley. Although my thesis focuses on analyzing Snake Valley Corrugated pottery, a secondary goal is to provide a basic synthesis of the results from some of the more prominent archaeological work done in the Parowan Valley. This provides background information critical to my arguments listed below, and disseminates more details about several of the most important, yet under-published, Fremont villages in the Fremont cultural area.

Research Design

My thesis focuses on expanding what is currently known about Snake Valley Corrugated pottery through an extensive examination of technological style ("low physical or contextual visibility; subtle differences in ceramic forming techniques, etc." [Peeples 2011:15]) in Snake Valley Corrugated pottery. My main goal is to add to what is known about Fremont social complexity through an examination of intra- and inter-village interaction among Fremont potters in the Parowan Valley. I propose the following research questions that address this goal: 1) to what degree do technological aspects of style vary in Fremont Snake Valley Corrugated ceramics, and 2) do these attributes represent shared contexts of learning and social identities?

I make the assumption that material culture, specifically ceramics, can convey information about a producer's numerous and intertwined social identities. I specifically address the following assumed social identities: communities of practice and village membership (Lave and Wenger 1991). My assumptions are based on the foundation of publications from numerous scholars who have argued that individuals (agents) do exist in the archaeological record, and they are actively engaged in defining and reinventing their social environment (structure) through the manipulation of resources (see Barrett 1981; Giddens 1984; Ortner 1984; Bourdieu 1990; Cowgill 2000; Pauketat 2003; Sewell 2005; Lyons and Clark 2008; Cordell and Habicht-Mauche 2012). For example, John Barrett (1981:206) states that, "material culture in all its forms—artifact production and use, settlement location, food selection, burial mode and so on—is the result of actions [by individuals] which are both articulated through social relationships, and are also the means by which those social relationships are constructed." Timothy Pauketat (2003:82) similarly writes that artifacts, specifically pottery, can transmit messages of social identity by noting that "gender, ethnicity, cosmology, and political allegiances are routinely negotiated in the contexts of pottery production, use, and discard."

I also assume, based on previous research by others (Carr 1995; Clark 2001; Peeples 2011), that homogeneity in the less visible (passive) characteristics of hand-produced goods may vary in proportion to the amount of direct social interaction between producers, as opposed to more visible (active) attributes that are easily manipulated to mimic association or even disassociation. As Matthew Peeples (2011:173) argues, "strong patterns of similarity in such low visibility technological attributes may provide important indicators of shared contexts of learning." I argue that Peeples statement also holds true for shared social identities (see also Dietler and Herbich 1998; Gosselain 1998, 2000; Herbich 1987; Peelo 2011; Sassman and Rudolphi 2001; Stark et al. 1998). Based on the above assumptions, I propose the following premises:

1. Snake Valley Corrugated pottery contains technological style with some degree of variation.
2. Snake Valley Corrugated sherds should display high degrees of standardization and homogeneity between contemporaneous villages located in close proximity to one another.
3. A high degree of homogeneity in the results from measurments of technological style may indicate that potters producing these vessels shared similar contexts of learning, as well as affiliations with potting communities, and shared village membership.

Based on these premises, I formulated the following hypotheses to address my research questions:

1. If aspects of technological style in SVC pottery have moderate degrees of homogeneity and standardization (based on measures, observations, chemistry, and statistical results), then potters making SVC pottery might have had some degree of social interaction with each other, as well as had similar shared contexts of learning.
2. If SVC pottery from one specific village within the Parowan Valley exhibits moderately high homogeneity, suggesting shared contexts of learning among village potters, then these individuals might have belonged to a village-based community of potters, and they might have shared village membership.
3. If SVC pottery from multiple villages within the Parowan Valley exhibit moderately high homogeneity, suggesting shared contexts of learning among the potters in the Parowan Valley, then these individuals might have belonged to a multi-village, valley-wide community of potters.

Thesis Organization

My thesis is organized into eight chapters and four appendices that address the purpose and research questions stated earlier. Following the introduction chapter, Chapter 2 synthesizes major themes in Fremont research past and present. Chapter 3 includes background information and definitions for the Fremont, Chapter 4 introduces the Parowan Valley physiography, and Chapter 5 outlines archaeological research conducted there. Chapter 6 discusses the examined dataset, sampling strategy, the 35 to 56 discrete measurements taken per sherd, and the Neutron Activation Analysis performed on a sample of 200 Snake Valley Corrugated sherds from my dataset. In Chapter 6 I also outline the statistical methods and theories used for interpretation and conclusions. Chapter 7 presents the specific results from the analysis, and Chapter 8 offers interpretations and conclusions that address the research questions and overall thesis statement. Unless otherwise specfied, all figures are my own work including maps, photographs, drawings, etc.

Scope, Scale, and Limitations

My thesis is narrow in scope by focusing strictly on the passive, repetitive, and habitual construction methods left by Parowan Valley potters in Snake Valley Corrugated pottery. This cermaic type does exhibit some active stylistic attributes (Figure 3), although vessels displaying these are very few in number and are consequently not within the scope of the thesis. Some of these active stylistic attributes include a variety of incisions, indentations, and motifs noted in uncorrugated vessel coils. These designs resemble those found on Fremont Snake Valley Black-on-gray and Ivie Creek Black-on-white painted bowls (see Figures 22 and 23 in Chapter 3). Chemical analyses and metric measurements (see Chapter 6 for more information about methods) were strictly limited to Snake Valley Corrugated pottery and did not include any other Fremont ceramic types or wares.

Figure 3. Photograph of a Snake Valley Corrugated jar found at the Paragonah Site (42IN43). Note the uncorrugated coils and incised motifs that are similar to design elements found on Fremont painted bowls.

My thesis only includes data from four Fremont sites in and around the Parowan Valley. These sites represent only a small portion of the total range of Snake Valley Corrugated pottery. There are numerous other Fremont sites outside the Parowan Valley where Snake Valley Corrugated pottery has been recovered, such as at Five Finger Ridge (42SV1686), Baker Village (26WP63), Wolf Village (42UT273), South Temple (42SL285), Provo Mounds, and many others. Examining Snake Valley Corrugated sherds from a wider context would enhance research in Fremont ceramic production organization, exchange, technological trade, and Fremont social organziation in general.

Summary of conclusions

At a minimum, my thesis offers new information about Snake Valley Corrugated vessel production and the Fremont potters who produced them. More specifically, I have determined through measures of technological style, that Snake Valley pottery from across all three villages in the Parowan Valley exhibits increased degrees of standardization and homogeneity. This conclusion is based on metric measures, observations, chemistry, and statistical results suggesting shared contexts of learning between potters at the Paragonah, Summit, and Parowan sites. Although some pottery construction techniques vary, others, such as the angle of idention, as well as raw clays and tempers used to manufacture Snake Valley Corrugated pottery, are consistent across all three Parowan Valley Fremont sites. I propose that these similarities in technological style of Snake Valley Corrugated pottery are evidence for a interconnected, valley-wide, community of potters that shared a sense of identity and community larger than the household level. These potters likely interacted with each other frequently and shared a common pottery production tradition passed down from generation to generation.

2 | Fremont Research Past and Present: A Broad Perspective

Early Fremont Researchers

Some of the earliest individuals to formally document Fremont material culture were surgeons, geographers, botanists, and antiquarians. The first formal explorations of Fremont sites were performed by Dr. Henry Yarrow and Mark Severance during the 1872 U.S. geographical and geological survey of Utah (Severance 1872; Wheeler 1889). Both Severance and Yarrow mention excavating at mounds in or near the towns of Provo, Paragonah, and Beaver. While at Paragonah, Severance (1872:55) noted, "a congregation of mounds four or five hundred in number, and covering an area of at least fifty acres." Yarrow and Severance recognized similarities between the cultural remains recovered from mounds in Provo with those at Paragonah (Gunnerson 1969; Severance 1872).

Other researchers, including Edward Palmer, Henry Montgomery, and Don Maguire, were also early "Fremont" researchers who noted convincing connections between artifacts at Fremont sites and those found in the American Southwest. Edward Palmer (Figure 4), a British-trained botanist and member of the Bureau of American Ethnology Mound Exploration Division, spent from 1875–1877 collecting plants and insects, and excavating Fremont mounds in Utah (Brown 1967). In a paper published regarding artifacts found in mounds near modern-day Payson, Utah, Palmer (1877:171) wrote, "It may be asked, 'Who were the Ancient People of Utah?' From the evidence left behind in their ruined dwellings, they appear to belong to the

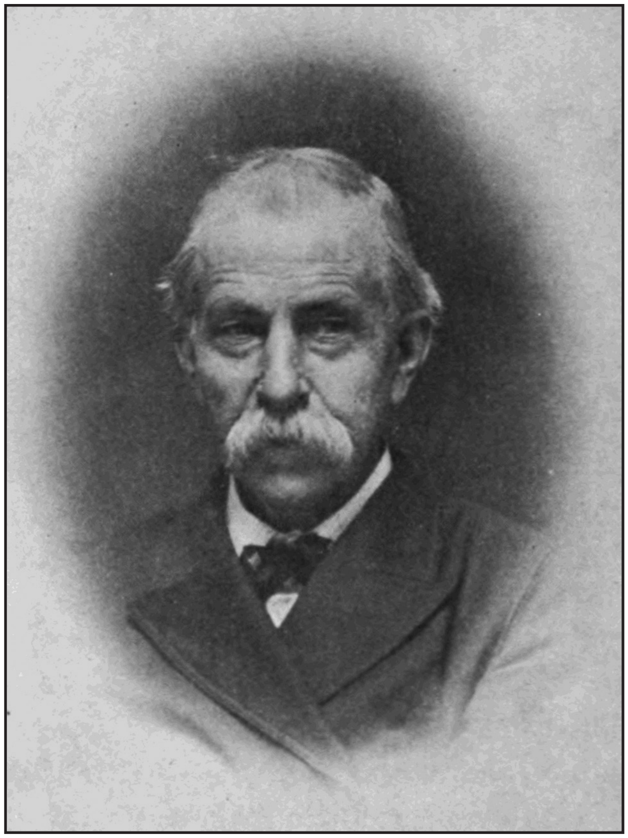


Figure 4. Photograph of Edward Palmer (Safford 1911:342).

same class of Indians as the Moquis of Arizona." Palmer (1876, cited in Fowler and Matley 1968:23) continues the same theme in earlier writings saying, "The people of this particular locality . . . were judged to most resemble the Moquis and Pimos; certainly they must be classified with Pueblo tribes, and the quality of the pottery and its ornamentation points directly to the Indians just named as their descendants."

Several years after Palmer, in the early 1890s, Henry Montgomery (Figure 5) surveyed and excavated at numerous Fremont sites in the following Utah counties: Juab, Tooele, Salt Lake, Emery, Utah, and Millard. Montgomery was a professor at the University of Utah at the time, and the notes he kept during his expeditions were meticulous for his day (see Montgomery 1894). The results from his excavations in Paragonah, and at the site he called "ancient Mason City" which he said was located at the base of Mount Nebo in Juab Valley, provide extremely

Figure 5. Photograph of Henry Montgomery (left) excavating a structure in Paragonah, Utah, in 1893 (Montgomery 1894:304).

valuable information about Fremont sites prior to modern disturbances (Montgomery 1894:299). During his work in northern and central Utah, Montgomery made an interesting observation that holds important value for today's challenges with defining the Fremont:

> When I think of the labor, care, and intelligence that must have been bestowed upon the construction of their buildings, as well as the manufacture of their excellent pottery, their ornaments and implements, I am surprised that the remains of their works occurring in widely separated districts should differ so little. A remarkably close union must, without doubt, have existed amongst the ancient people whose monuments are the subject of this writing. (Montgomery 1894:306)

At the conclusion of his report, Montgomery surmises that the prehistoric people living to the east in the "cliffs" and those in the west in the "valleys" were one in the same. In this instance, based on his travels, it seems very likely that he was comparing Fremont sites on the Colorado Plateau with those out in the Great Basin. Montgomery (1894:342) continues:

> From the preceding account of my explorations in Utah the reader will, doubtless, experience little difficulty, if any, in reaching the conclusion that the human beings who formerly

Figure 6. Photograph of Dominick "Don" Maguire. Photo courtesy of the Utah State Historical Society 2004, no. 17213.

> occupied the valleys of this region were of the same race as those who occupied the cliffs and peaks, and that the date of the occupation of the one must have been the same, or nearly the same, as that of the other. The cliff dwellers and valley residents were contemporary, or nearly so . . . . The similarity is indeed most striking . . . . That they belong to the same people cannot for a moment be questioned. A person has but to glance at them to feel sure of this.

This is perhaps, in today's terms, oversimplified, but nonetheless pertinent to the current debate regarding how to define the Fremont.

In 1892, at the same time as Montgomery was working in Utah, Dominick "Don" Maguire excavated at several Fremont sites along the Wasatch Front (Figure 6), as head of the Department of Ethnology for the Utah World's Fair Commission for the 1893 Chicago World's Fair (Neilson 2011) . He started excavating mounds at Willard, Utah, where he noted the presence of 43 separate mounds. He noted similarities in the material remains between these excavations and the Ancestral Puebloans in the American Southwest. Maguire (1894:105) writes, "As the plow made the first furrow we found that the mound was the work of the old lost race, whose remains are so abundantly scattered over Utah and Arizona." After leaving Willard, Maguire worked in several other locations, including at mound sites in Provo, Payson, and Paragonah (both Maguire and Montgomery's projects overlapped each other) located in the Parowan Valley. Maguire also spent time photographing Fremont sites in Nine Mile Canyon.

Neil Judd

Following in the footsteps of Palmer, Montgomery, and Maguire (Figure 7), Neil Judd excavated at various mound sites along the Wasatch front in 1915 (Judd 1917, 1919, 1926). Judd was the first formally trained archaeologist to work in the state of Utah (Janetski and Talbot 2000a). He was interested in examining whether these mound sites were in any way related to the "ancient habitations south and east of the Rio Colorado" (Judd 1915:1). Judd explains that, "A cursory examination only of the mounds at Beaver sufficed to establish a cultural kinship between them and recognized Pueblo ruins elsewhere" (Judd 1915:1). As with Palmer, Montgomery, and Maguire, Judd noted connections between the Mound Builders to the north and the pueblos in the southwest. In Judd's (1926:152) description of the cultural origins of the mounds at Beaver and Paragonah, he wrote:

> That culture may have originated within the drainage of the Rio San Juan, or it may have come into being on the northern and western borders of the Great Interior Basin. But it is Puebloan in fact; it is definitely and directly related to those pre-Pueblo and Pueblo cultures represented by the prehistoric ruins of northern Arizona, New Mexico, and Colorado.

Judd noted several similarities between the Fremont and Ancestral Puebloans, but specifically in the adobe-walled surface architecture at Paragonah and Beaver, and in the painted bowls and corrugated jars which he wrote were, "unquestionably Puebloan" (Judd 1926:26).

Figure 7. Neil Judd reconstructing a pot at the National Museum of Natural History. Photo courtesy of the Smithsonian Institution Archives, no. SIA2009-4254 and 778.

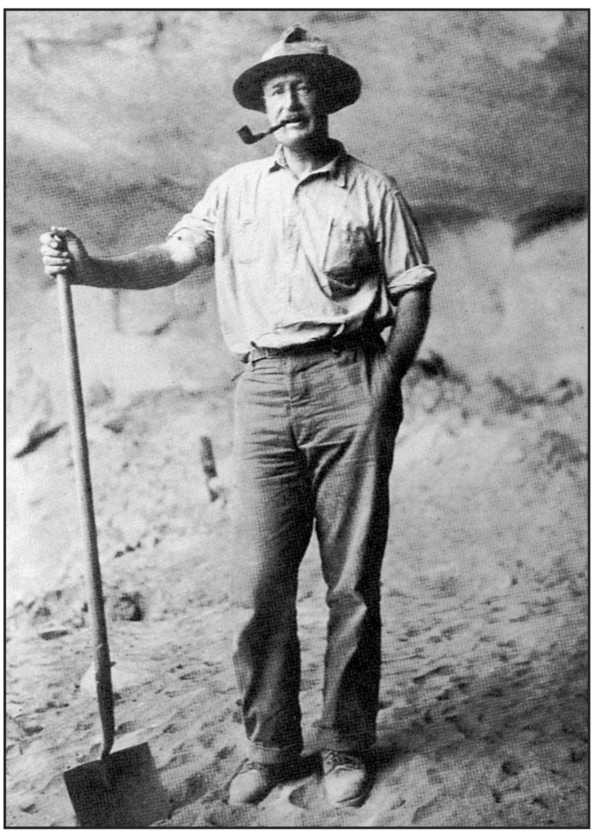


Figure 8. Alfred V. Kidder (ca. 1925) at the White House ruins, Canyon de Chelly. Original photograph in Elliott 1995:43.

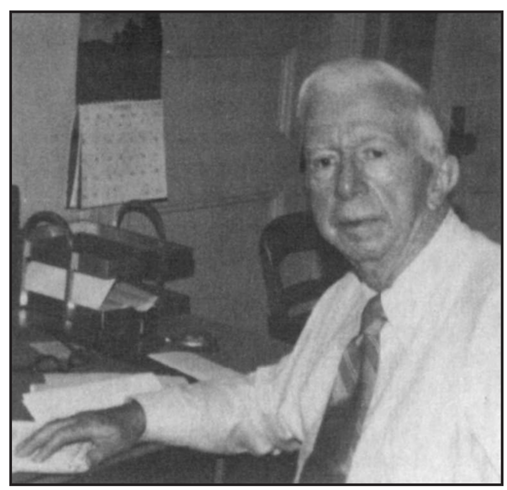


Figure 9. Noel Morss. Original photograph in Brew 1982:344.

Noel Morss

Alfred Kidder formally identified the Fremont as occupying the "northern peripheral area of the Southwest" which was a concept accepted by the academic community during the 1927 Pecos Conference (Kidder 1924, 1927) (Figure 8). Noel Morss, a Boston lawyer by profession, was the first to use the term "Fremont culture" to identify the prehistoric producers of artifacts he recovered along the Fremont and Muddy Rivers of central Utah during the Claflin-Emerson expedition (Figure 9). Morss (1931:78) believed that the "originality shown in many details of their culture makes it difficult to think of the Fremonters as merely a backward southwestern tribe." John Brew (1982:344) wrote in Morss's *American Antiquity* memoriam, "He [Morss] presented us with the first useful reports on the area which we in the 'Southwest' call, egocentrically, the 'Northern Periphery'." It is in these statements, but especially the one from Brew, that one can sense a slight schism that eventually splits the Fremont from Southwestern archaeological scholarship. This division is specifically seen in how the Northern Periphery was conceptually split: Morss (1931) designated the farmers on the eastern Colorado Plateau as Fremont, and Judd (1926) labeled the farmers out in the western Great Basin as Puebloan (Watkins 2006:14). Morss, however, still viewed the Fremont as closely related to Basketmaker groups in the south (Janetski and Talbot 2000a).

Julian Steward

Julian Steward supported the Northern Periphery label (Figure 10), albeit in a somewhat different way. He suggested a perspective that differed from the division seen in the Judd and Morss designations. Steward (1937, 1955) categorized the immediate nomadic post-Fremont hunter/gatherers in the Great Basin as the Athabaskan-speaking Promontory Culture, and the Fremont horticulturalists as part of the Northern Periphery of the American Southwest (Madsen

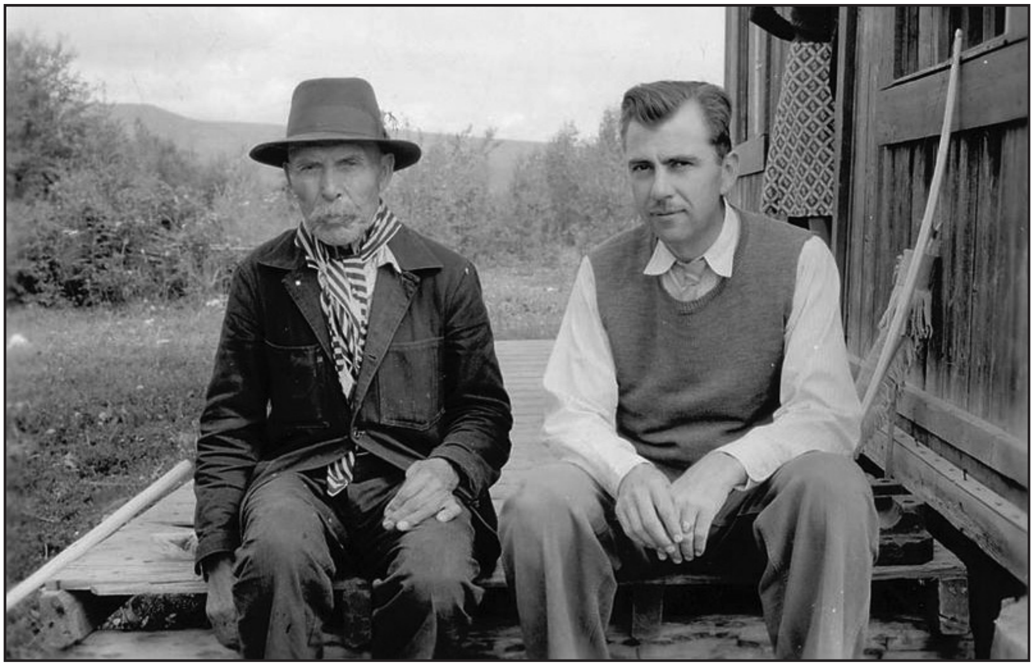


Figure 10. Julian Steward (right) with an unidentified Native American man. Photo courtesy of the National Anthropological Archives, Smithsonian Institution INV 02871300.

and Simms 1998). Steward (1941) did note, however, that there was little contact between the Northern Periphery and the Ancestral Puebloans to the south.

Resolving the Fremont/Promontory question as first suggested by Steward (1937) was a continual issue of interest for scholars studying the Fremont. Mel Aikens (1966) disagreed with Steward's conclusions that the Fremont and Promontory cultures were distinct peoples. He argued instead that the Promontory culture was simply a Fremont variant. Jack Rudy (1953:169) agreed, stating that Steward's two separate cultures were actually one group practicing a flexible and varied subsistence strategy of primarily hunting and gathering, combined with some limited horticulture. Rudy took his argument further, however, stating that the "Northern Periphery" label applied by Southwestern archeologists marginalized Utah's prehistoric peoples' varied and unique past. Steward (1955), however, continued to believe that prehistoric peoples living in western Utah should be considered part of the Northern Periphery, although not entirely. Steward (1955:89) wrote, "If western Utah is properly classifiable with the Anasazi or Pueblo

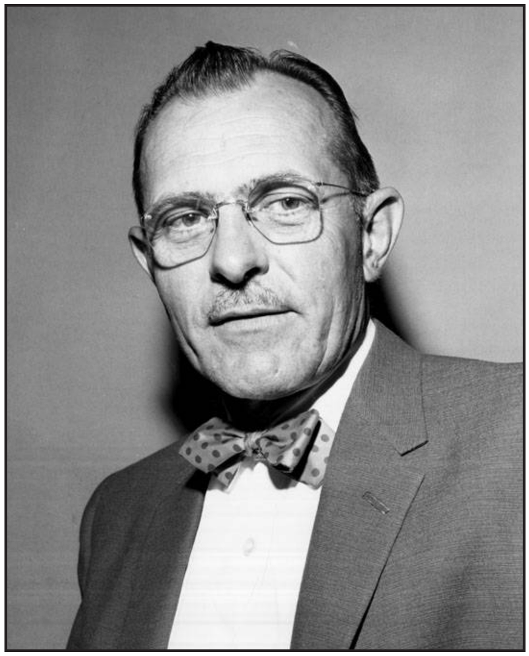


Figure 11. Jesse Jennings in 1959. Photo courtesy of the Utah State Historical Society 2004, no. 51955.

tradition, it is obviously marginal in that it borrowed some but not all diagnostic features from the climax area [American Southwest].”

Jesse Jennings

Although Steward continued to support the Northern Periphery concept, Jesse Jennings (Figure 11) supported Rudy’s argument to discard the Northern Periphery designation. Jennings and Edward Norbeck (1955:7) wrote that, “rather than being peripheral to, and culturally dependent upon the Southwest, the Great Basin antedates and may be the cultural forebear of the cultures lumped together as Pueblo.” Jennings suggested the term *Puebloid* be dropped, and that the prehistoric farmers in the western Great Basin be labeled the “Sevier Fremont” and those on the eastern Colorado Plateau be called “Fremont” (Jennings et al. 1956:104; Wormington 1955). As Jennings (1956:103) wrote, “The whole region of the Northern Periphery has been frequently dismissed, up to the present time (Steward 1955) as a subordinate, late and diluted

Anasazi manifestation. We feel that this is not an accurate picture of the culture." He also argued that the term "Fremont" be used only for the prehistoric farmers north of the Ancestral Puebloans in the Southwest (Jennings 1956). As Janetski and Talbot (2000a:6) write, "Jennings clearly recognized strong Southwestern influences in Fremont strategies and material culture but maintained that these were diffused traits and denied genetic connections."

Fremont geographical variants remained the primary focus for nearly a decade, but the results brought mixed reactions. Under the guidance of Jennings, Richard Ambler (1966, 1967) and John Marwitt (1970) attempted to expand the number of Fremont sub-groups from two to five: Uinta, San Rafael, Parowan, Sevier, and Great Salt Lake. They based these groupings mainly on material culture traits and settlement patterns (Janetski and Talbot 2000a). Both encountered significant obstacles when they perceived very few similarities in the material culture to connect these proposed Fremont sub-groups to one another. Marwitt (1970:136) concluded that, "the entire area representing the extent of Fremont culture is considered here an areal tradition taxonomically equivalent to Anasazi." This conclusion was challenged by both Melvin Aikens (1972) and later by David Madsen (1979). Aikens (1972:64) specifically argued that the Fremont had been treated by previous scholars (specifically Ambler and Marwitt) as one homogenous entity, and no one had examined the possibility that the Fremont had separate "regional histories."

David Madsen

Madsen furthered what Rudy, Jennnings, and others started, which was to split the Fremont from the American Southwest research (Madsen 1979, 1980). They moved beyond this, however, by suggesting that the Fremont did not have cultural coherence. As Madsen (1980:10) writes, "A formal definition of Fremont is still not necessary for me . . . it is probably impossible to define a unitary Fremont." Madsen's (1979, 1980, 1982) viewpoint was especially evident in his multiple counters to Michael Berry's (1972, 1974) argument that the Fremont followed a maize-dependent agricultural farming strategy that was supplemented with wild resources similar to the Ancestral Puebloan's in the American Southwest. Madsen (1979:714), however, proposed the following: "It is my thesis that (in some Fremont areas at least) corn agriculture may have been a relatively minor element in the subsistence system and that it was collecting which supported settled village existence." Madsen (1979) based this assumption on his work at Backhoe Village (42SV662), located in the Sevier Valley, where he collected an abundance of cattail pollen from mano and metate grinding surfaces, as well as from structural floors. He concluded that Fremont sedentism could be based on wild resources (such as cattail), as opposed to maize, and suggested that previous Fremont subsistence research was predisposed towards maize.

During the late 1970s and early 1980s, archaeologists continued to pursue the elusive Fremont by refining cultural trait lists, examination of origin theories, and speculating about the Fremont abandonment. Madsen and Simms (1998) explain, however, that many Fremont researchers were simply spinning their wheels during this time. They write that, "while everyone agreed that there was some phenomenon that could be labeled 'Fremont,' few could agree on what it was" (Madsen and Simms 1998:274). In 1982, Madsen suggested a new Fremont subsistence model based on environmental and behavioral influences. Janetski and Talbot (2000a:5) discussed Madsen's Fremont subsistence model writing, "After explaining why trait-based variant schemes had failed to provide a broadly useful definition of Fremont [he] constructed a variant model based on differences in subsistence economy." Madsen argued that little attention had been paid to prehistoric subsistence issues and posited that prehistoric peoples in the Great Basin practiced a wide spectrum of food procurement. Madsen (1982:218) wrote:

> It is now apparent that, despite the relative uniformity in tools and other artifact types, subsistence and settlement modes ranged from sedentary groups dependent on both domesticated and locally procured wild resources, to sedentary groups dependant primarily on local wild resources, to nomadic groups dependent on resources from a variety of ecological zones.

This new model, combined with Madsen's argument that sedentism was attainable via wild resources (Madsen and Lindsay 1977), significantly influenced Fremont studies, and attempts to connect the Fremont to the American Southwest were mostly dismissed. Prehistoric cultures in Utah would be viewed for decades through the environmental and behavioristic lenses of hunter/gatherer subsistence models.

Steven Simms

In the late 1980s and early 1990s, Steven Simms advanced the concept of Fremont cultural variability. Instead of trying to define more trait lists, Simms followed Madsen (1980, 1982) by arguing that the Fremont could not be considered a unified cultural group. Janetski and Talbot (2000a:6) explain that Simms, "cautions that categories of boundedness hinder understanding of such important processes as interactions, affiliations and change." Both Madsen and Simms (1998) have argued that there is simply too much variability in Fremont material culture to recognize them as an autonomous cultural group, and that there is no single trait that is visible across the Fremont region that can tie these communities, hamlets, and camp sites together. Madsen and Simms (1998:259) state that "while there is unity in the Fremont pattern in some respects, there is also a degree of variation that makes it impossible to define the Fremont in any but the most trivial and indefensible manner."

Simms (1986, 1990, 1994a, 1994b) also employed a behavioralist model similar to Madsen's that focused on unifying the Fremont based on subsistence strategies as understood through the lens of adaptive diversity (Upham 1984). An individual's behavior is the foundation for Fremont "adaptive diversity" that results in a narrowly defined perspective of the Fremont (Madsen 1986, 1989; Madsen and Simms 1998). The theory of adaptive diversity suggests that a single individual was not confined to one particular lifestyle, but instead, enjoyed a "behavioral plasticity" in which he or she could switch subsistence strategies at any time. Sedentary farmers could completely abandon farming and adopt a mobile hunting and gathering strategy, or the other way around (Madsen and Simms 1998:275). Simms (1986, 1990) argued that the Fremont should be considered an unbounded population which included full-time farmers, full-time foragers, part-time farmers/foragers, farmers that switched to full-time foraging, and foragers who switched to full-time farming.

Fremont Research at Brigham Young University

In the early1980s, Joel Janetski, Jim Wilde, Richard Talbot, and Lane Richens approached the Fremont from a new perspective: combining subsistence models from Great Basin archaeology with theoretical models from the American Southwest. In recent years, these scholars, as well as a new group including Jim Allison and Christopher Watkins, continue to find Fremont connections to the American Southwest. This theme of returning the Fremont to the Southwest, but incorporating Great Basin approaches instead of abandoning them, is evident in the literature (Janetski and Talbot 2000b; Janetski 2002; Janetski et al. 2011; Janetski 2008; Talbot 2008). For example, in a book chapter titled *Fremont Farmers: The Search for Context*, Talbot's (2000:275–276) proposal to "reintegrate Fremont studies with those to the south . . . and to consider the Fremont tradition within the broader social and economic context of the Greater Southwest" invigorated the discussion to re-examine the Fremont from new Southwestern perspectives. Another important call to reintegrate the Fremont into the Southwest came from Jim Allison's recent article "Human Ecology and Social Theory in Utah Archaeology." As mentioned previously, Allison argued that Fremont definitions have typically focused too heavily on subsistence and settlement patterns and not enough on examining social factors. Allison (2008:77) writes:

> By combining ecological and social perspectives, Southwestern archaeologists have been highly successful at documenting and explaining dynamic patterns of social change. I see

> ample evidence that the Fremont also had a dynamic social history, but it has gone largely unremarked as archaeologists have focused too narrowly on human ecology.

Allison suggests, applying social theories used to study Southwestern farmerscan help examine a variety of new topics mostly dismissed in Fremont studies.

Watkins's Four Turning Points in Fremont Research

Christopher Watkins (2006) explains that Fremont studies have experienced four turning points that have significantly influenced Fremont studies today. These four points warrant restating here. I argue that these four events have created what I term the "Fremont Identity Crisis" that continues to impact Fremont research. Watkins argues that the first turning point was Jenning's rejection of the Fremont as part of the northern periphery of the American Southwest. This decision significantly impacted future Fremont studies as most of his students who continued Fremont research perpetuated this research direction. As Watkins (2006:16) explains, "While Rudy (1953) was the first to refute the Northern Periphery, it was Jennings who would hold the ears of future generations of archaeologists."

Watkins argues that the second turning point was Madsen's appointment as the Utah State Archaeologist and his significant influence in promoting subsistence modeling in Fremont research. Madsen's position, along with his prolific publishing, created a centrum around which much of Utah archaeology revolved, and this was substantially increased when Jennings retired in 1986. According to Watkins (2006), Madsen's conclusions from the Backhoe Village excavation that the Fremont were mostly foragers of wild resources, combined with the weakening link between the Fremont and the Ancestral Puebloans in the estimation of archaeologists, significantly influenced Fremont research for decades.

The third turning point was the University of Utah's "potent post-Jennings research perspective" (Watkins 2006:17) with the arrival of James O'Connell in 1978. After Jenning's retirement in 1986, research at the University of Utah focused heavily on hunter-gatherer studies which was a topic in vogue during the apogee of the processual movement. During this time, under the auspices of O'Connell and others, the Department of Anthropology at the University of Utah adjusted its emphases to "archaeology, genetics, behavioral ecology, demography, hunter-gatherers, and evolutionary approaches to human behavior," which are still the areas of focus today (Department of Anthropology, University of Utah website 2013). Watkins (2006:18) writes that:

> Post-Jennings University of Utah affiliates initially had little interest in the Fremont, but successive generations of students became interested and attempted to apply the larger Great Basin hunter-gather tradition learned from their mentors—mentors who were primarily concerned with the biological perspective of human behavioral ecology (Broughton and O'Connell 1999; Hawkes et al. 1997).

This created an interesting situation where students were trained in hunter-gatherer theories and methods were applying this training to a prehistoric people possessing numerous characteristics of sedentary farmers similar to those in the American Southwest (Watkins 2006:18). The origins for the "Fremont Identity Crisis" seem clear: the majority of Fremont studies today are heavily influenced by professional archaeologists trained in a tradition that places significant emphasis on subsistence studies from a hunter-gatherer perspective.

Although Watkins alludes to, but does not define a fourth turning point, I submit that the Clear Creek Canyon Archaeological Project (CCCAP) was another turning point. Janetski and Talbot (2000a:7) write that one of the goals for the CCCAP project was to "recast the Fremont tradition as an aspect of the larger Southwestern farming pattern that bulged northward crossing the Colorado and Virgin rivers, endured for several centuries and then pulled back." The extensive, complete excavation of Five Finger Ridge from this perspective, and the exploration of numerous other Fremont sites in Clear Creek Canyon turned Fremont research back to it's roots in the American Southwest. The CCCAP revived an old perspective from which researchers could reexamine the

Fremont through a Southwestern perspective and reconnect to earlier ideas about Fremont origins (Talbot et al. 1998, 1999, 2000a, 2000b). From Janetski and Talbot's approach during the CCCAP, Fremont research at BYU has continued to reconnect the Fremont to the Puebloan farmers of the American Southwest.

3 | Defining the Fremont

Introduction

In this chapter I outline two different definitions of the Fremont which have created disagreement among Fremont scholars. These opposing viewpoints have created what I call the "Fremont Identity Crisis." I also provide a basic definition for the Fremont that outlines the general cultural boundaries, subsistence, architecture, and artifacts used to differentiate the Fremont from other formative groups in the Great Basin and American Southwest. I conclude with a brief discussion of Fremont social organization and trade.

Scales of Analysis

The previous chapter outlined varying viewpoints on a variety of issues regarding past Fremont research. The last several decades of research have resulted in two different perspectives that vary by scales of analysis (Watkins 2006). Madsen (1989) argues that defining the Fremont is impossible and suggests researchers use a microsystemic behavioral approach, instead of making large-scale generalizations. The adoption of the microsystemic behavioral approach, however, poses several problems that have significantly affected Fremont studies. As Janetski and Talbot (2000a:6) write, "It is becoming clear that the closer we look at human behavior, the more variability we see." In addition, Robert Bettinger (1993:43–44) states that this micro perspective generates a "bewildering variation on every scale in every dimension."

Janetski (2002) and Talbot (2000a) suggest defining the Fremont from a perspective stated by Steadman Upham et al. (1994:210) and Janetski and Talbot (2000a:7) which is to "assume cultural and adaptive heterogeneity . . . [and] search for how and why material patterning across relatively large geographical areas happened at all." Among human populations, it is safe to expect behavioral heterogeneity. Behavioral variation should be considered a constant where people often change their behaviors (when social structures allow) based on a variety of subtle and incalculable factors. Patterned human behavior should, therefore, be considered the focus of our attention (Binford 1988; Janetski and Talbot 2000a).

Examining prehistoric cultures requires a balanced approach at varying scales to avoid extremes in either direction. Too much "micro" creates tunnel vision, but too much "macro" creates false relationships. At the resolution Madsen and Simms suggest, patterns in Fremont material culture will not be visible, nor would they be in any other group (Watkins 2006). The "micro" and "macro" approaches, however, are not mutually exclusive and should be employed prudently based on the research questions and scales of analysis. James Brown and T. Douglas Price (1985:440) write:

> The macrosystemic, social aggregate approach is easier to operationalize in the analysis and interpretation of archaeological data. Archaeological sites are more easily conceived of as resides of entire groups. In the microsystemic, or molecular, approach, however, a better accommodation of human behavior appears possible. Thus, some trade-off between the two approaches is necessary. Archaeological data are more conformable to a macrosystemic perspective while behavioral expectations are better met in the molecular framework.

Following Brown and Price (1985) and Talbot et al. (2000), this thesis pursues two different complementary scales of analysis. As stated in Chapter 1, my analyses focus on expanding what is currently known about Snake Valley Corrugated pottery through an extensive examination of passive (low-visiblity) technological style in Snake Valley Corrugated (SVC) pottery. The goal is to increase what is known about Fremont social complexity through an examination of intra- and inter-village interaction among Fremont potters in the Parowan Valley. Examining both micro and macro details, combined with social theory and robust statistical models, will result in a more complete picture of SVC vessels and the Fremont potters who produced them. In this thesis I follow a new perspective of the Fremont outlined by Janetski et al. (2011:47): "the Fremont is a tribal culture defined in time and space by an interaction sphere recognizable, and spatially defined, by a unique style." This style, as mentioned by Janetski et al. (2011), is visible in a variety of characteristics that show both homogeneity and heterogeneity. This can cause considerable confusion in defining what is Fremont. In general, this "unique Fremont style" is visible in the Fremont settlement boundaries, subsistence strategies, architecture, material culture, social complexity, external and internal relations, and social organization.

Boundaries

The term "Fremont" was first used by Morss (1931) to provide a label for the producers of artifacts he observed near Torrey, Utah, along the banks of the Fremont River (Simms 2008). As mentioned, others had recognized these ancient farmers, but had never named them formally (see Chapter 2). The Fremont inhabited most of Utah, parts of extreme eastern and southern Nevada, and northwest Colorado. The Fremont cultural area spans the divide between the Eastern Great Basin and the Northern Colorado Plateau (Figure 12). Talbot (2000a:276) writes:

> This land is one of sharp contrasts. The Plateau is dry, often barren, rugged country bisected by occasional rivers and streams feeding the Green and Colorado Rivers. The basin is primarily high desert country with broad expanses of sparsely vegetated terrain broken up by north-south trending mountain ranges. A transition zone between these two generally arid areas stands in marked contrast. High mountain ranges and verdant valleys are home to abundant plant and animal life, and the lower elevations are ideal for agriculture. . . . Fremont residential sites are most common in these transition zones.

The Fremont inhabited many of these transition zones from approximately A.D. 300 to A.D. 1400 (Janetski 2002; Talbot 2000a). The most populated areas were located along the north-south trending Wasatch Range (often referred to as the Wasatch Front) that divides the Great Basin from the Colorado Plateau. This region is where many Fremont villages in the Parowan, Sevier,

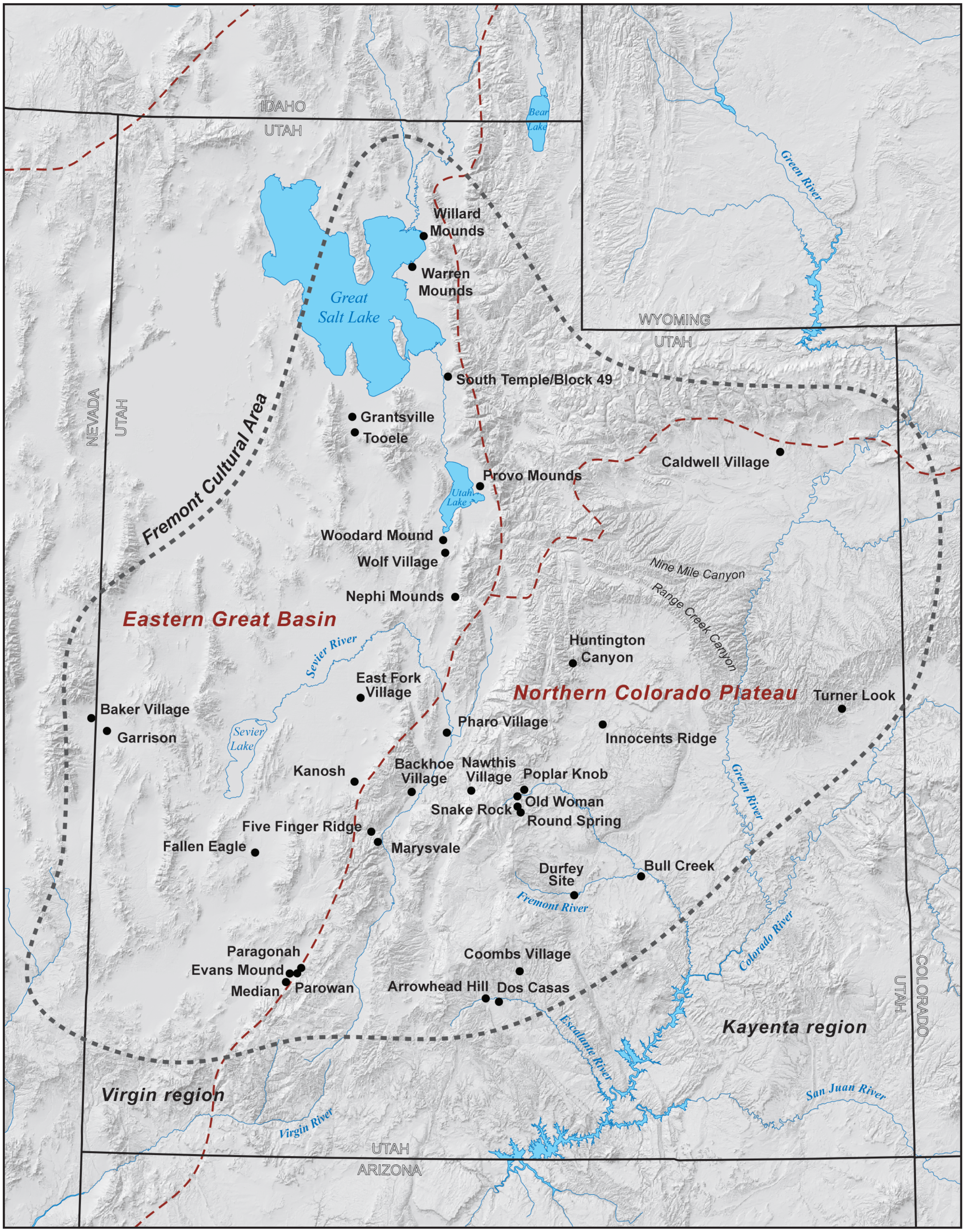


Figure 12. Map of the Fremont cultural area with plots of prominent Fremont sites and boundaries for the Eastern Great Basin and Northern Colorado Plateau.

Utah, and Salt Lake Valleys developed. It is not surprising that many modern Utah communities were also constructed directly on top of Fremont villages along the Wasatch Front. As Simms (2008:190) eloquently explains:

> The heartland of Fremont village life is strung along the mountains, forming the eastern rim of the Great Basin. Virtually every town traversed today by Interstate 15 from Cedar City to Brigham City has Fremont village sites. The locations chosen for farming by the Utah pioneers were the same places chosen by the Fremont—where mountain streams debauch onto the alluvial fans and spread their way to the valley floors, and where streams meandered along broad floodplains.

The only evidence of any Fremont presence south of the Colorado or Virgin Rivers are fewer than 10 Fremont sherds found in the Kayenta and Virgin regions. The southern boundary between the Fremont and the Ancestral Puebloans in the Kayenta and Virgin regions generally follows the Grand Staircase/Escalante escarpment to the south. To the east, the boundary follows the southern foothills of Boulder Mountain and the northern foothills of the Henry mountains, and then moves out across the San Rafael Desert where it eventually crosses into Colorado (see Figure 12). To the west, the boundary runs just south of the Parowan Valley near Cedar City, then travels south of the Escalante Desert, and finally out into Nevada. Interestingly, although there is no evidence of the Fremont south of these regions, the Ancestral Puebloans did venture northward, establishing outposts among the Fremont in places such as Coombs Village and in the Escalante Valley. There is no question that the Fremont were interacted with the Ancestral Puebloans living in the Kayenta and Virgin regions. Exchange of goods and ideas is readily visible in the Fremont adoption of corrugation techniques and the physical presence of both painted and grayware varieties of Ancestral Puebloan pottery (although in extremely small percentages) at Fremont sites (Richens 2000; Talbot and Richens 1993).

The northern Fremont boundary is generally considered to include the northern tip of the Great Salt Lake, past the Bear River marshes, and up along the Bear River. Several large mound sites were located along the northeastern shore of the Great Salt Lake, including Willard and Warren Mounds (Simms 2008). Robert Butler (1986) argues that the Fremont pushed upward into Southern Idaho, based on the recovery of basketry remnants and grayware pottery considered Fremont (Butler 1981, 1983). Further east, the Uinta Basin provides a generally accepted northeastern boundary, although a number of Fremont sites—the Texas Creek Site and numerous Fremont sites in the Douglas Creek area—were recorded in extreme northwest Colorado (Bandy and Baer 2011; Baker 1997, 1998a, 1998b; Creasman and Scott 1987; Loosle and Knoll 2003; Spangler 1995), extending the Fremont range eastward.

Subsistence

The Fremont diet comprised a mixture of both domesticated crops (maize, beans, and squash) and foraged resources (Talbot 2000a). As mentioned earlier, Michael Berry (1972, 1974) argues that the Fremont relied heavily on maize and used wild resources to supplement shortfalls. Madsen (1982) counters that the Fremont living in the Eastern Great Basin were foragers relying specifically on marshlands, while the Fremont in the Colorado Plateau were primarily farmers (Madsen and Lindsay 1977; Talbot 2000a). Simms (1986) argued, based on concepts from adaptive diversity, for the presence of at least three coexisting subsistence systems: full-time farmers supplementing diets with localized foraging, part-time farmers switching to full-time foraging as needed, and full-time farmers and full-time foragers coexisting in the same region (Talbot 2000a).

The Fremont were generally horticulturists with diets comprised of maize, beans, and squash, but they also took advantage of wild resources, both in times of plenty and in seasons of shortfall. This is evident in both the macro- and micro-floral and faunal remains recovered from many sites throughout the Fremont cultural region. By the Fremont zenith (ca. A.D. 900–1100), however, many Fremont villages show evidence of a heavy investment in farming (Berry 1972, 1974). Simms (2008:187) writes, “After A.D. 900, the landscape became a sea of farmers. People gathered into villages, hamlets, and farmsteads as they had never done before.”

Architecture

Talbot (2000a:278) explains that "The Fremont tradition is characterized by well-developed pithouses, surface adobe or masonry storage units, occasional adobe or jacal surface houses, integrative structures, and smaller specialized features" (Figure 13). There are several variants for each architectural category, and these structures can be both temporally and spatially sensitive. In general, Fremont habitation structures are roughly the same size, averaging approximately 12–17 m^2 (Richards et al. 2013), with a few notable exceptions of larger pithouses and surface dwellings often constructed near communal areas and structures. Storage structures and secondary pit structures are the smallest architectural features among the Fremont.

Pithouses are the primary Fremont residence and are usually either circular or quadrilateral in shape, although Talbot (2000b) notes the presence of rarer D-shaped pithouses as well. Circular pithouses are often larger than quadrilateral style and also date earlier. Pithouses are semi-subterranean and often have one or two ventshafts; some pithouses were constructed without any vent shafts. Pithouse interiors typically have a central hearth, vertical structural posts, subfloor storage pits, wall niches, and deflector stones. Floors are usually made of compacted bare dirt; although, some are plastered with adobe (see Figure 13). Pithouses are usually large enough to accommodate several adults performing daily tasks simultaneously (Talbot 2000b:136).

In contrast to pithouses, secondary pit structures were much smaller in size and were likely used as isolation houses for birthing or menstruation, or for visitors (Talbot 2000b). These small, shallow structures typically only have a small central hearth (often just an ephemeral thermal feature), and a few postholes to support a meager wooden frame. These structures were temporary in nature and roofed by branches, willows, and other covering materials.

Storage structures/granaries were typically thick-walled surface structures found mostly at later Fremont sites (Talbot 2000b). These structures are usually rectangular in shape and made with vertical free-standing adobe or rock-masonry walls and sometimes with slab-lined floors.

a

b

Figure 13. Fremont architecture: a) Fremont adobe surface and pit structures at Baker Village, eastern Nevada. Note the central structure in the middle (photo courtesy of the Office of Public Archaeology, BYU); b) Fremont slab-lined pit structure at Dos Casas, southeast Utah (photo courtesy of the 2002 Brigham Young University Archaeological Field School).

Figure 14. Adobe surface structure at Wolf Village (42UT273). Note the attached smaller adobe storage room in the foreground. Photo courtesy of the 2011 Brigham Young University Archaeological Field School.

Some storage structures had dividing walls which split the interior storage space in half (Talbot 2000b). In some cases, such as at Wolf Village (42UT273), storage units were attached to the side of adobe surface houses (Figure 14). Storage structures were either entered through the roof or through a doorway in the wall (Talbot 2000b).

Surface houses are somewhat rare and found only at later Fremont sites. They generally have a little bit wider range in size compared to Fremont pithouses, averaging 11–21 m^2 (Richards et al. 2013). These surface houses have similar interior features to pithouses: central hearths, vertical posts, subfloor storage pits, and wall niches. The free-standing walls are made of coursed adobe, jacal, or masonry and often have an attached storage room as seen in the surface house at Wolf Village (see Figure 14). Surface houses are often located in close proximity to central structures and contain concentrations of unusual artifacts (pendants, beads, figurines, and burials), as well as unique architectural features (Ure and Stauffer 2010). A notable example is the central structure at Five Finger Ridge. It was built in close proximity to several other unusual structures, such as Pithouse 57 which is the largest structure at Five Finger Ridge (31 m^2), and contained two contemporary hearths and numerous unusual artifacts (Talbot 2000b). Structure 1 at Wolf Village is also located immediately next to an enormous communal structure designated Structure 2 (Figure 15). This is the largest known excavated Fremont structure at ca. 850 $ft.^2$ (79 m^2), or about 4 to 5 times larger than a typical Fremont pithouse. Although Structure 2 is a semi-subterranean pit structure (as opposed to central structures that are built on the surface), it is nonetheless communal in function, based on numerous factors including it's massive size, unique construction, unusual floor features, and cardinal alignment (Allison et al. 2012). It is very possible that Structure 2 at Wolf Village may be a Fremont proto-kiva (Richards et al. 2013).

Central Structures

Central structures (Figure 16) are "always among the largest—usually the largest—formal structure at a site, often dwarfing pit and surface houses, which may be only half its size" (Talbot 2000b:147). These structures are some of the best evidence for Fremont communal public architecture (see also Allison et al. 2012). Nearly all central structures are built above ground and constructed with unusual methods not typically visible in habitation structures. Fremont central structures have centrally located hearths that are much larger than those in pithouses, and they are generally oriented north/south and contain unusual artifacts. Central structures also often exhibit evidence of ritual closure. In some Fremont villages, such as at Five Finger Ridge and Paragonah, central structures were associated with oversized pithouses, one or two other surface structures, and a plaza area. This complex of structures may represent a center of power within the Fremont village. They may have been a place where community leaders, religious persons, and other influential individuals organized and directed community life or performed rituals (Ure and Stauffer 2010). It seems likely that Fremont central structures also

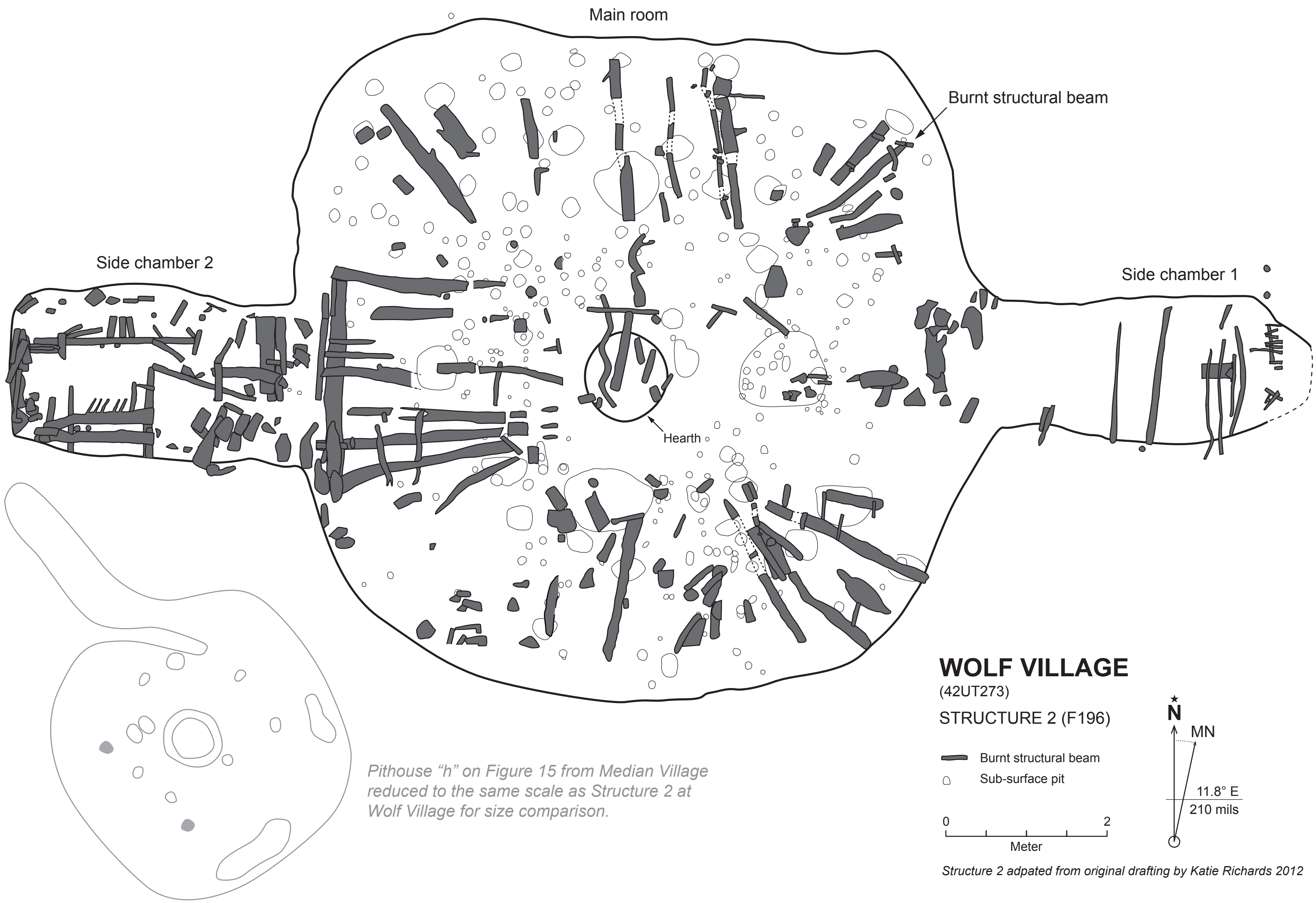


Figure 15. Plan map of Structure 2 from Wolf Village (42UT273) compared to an average sized pithouse from Median Village (42IN124). Map courtesy of the 2012 BYU Archaeological Field School at Wolf Village.

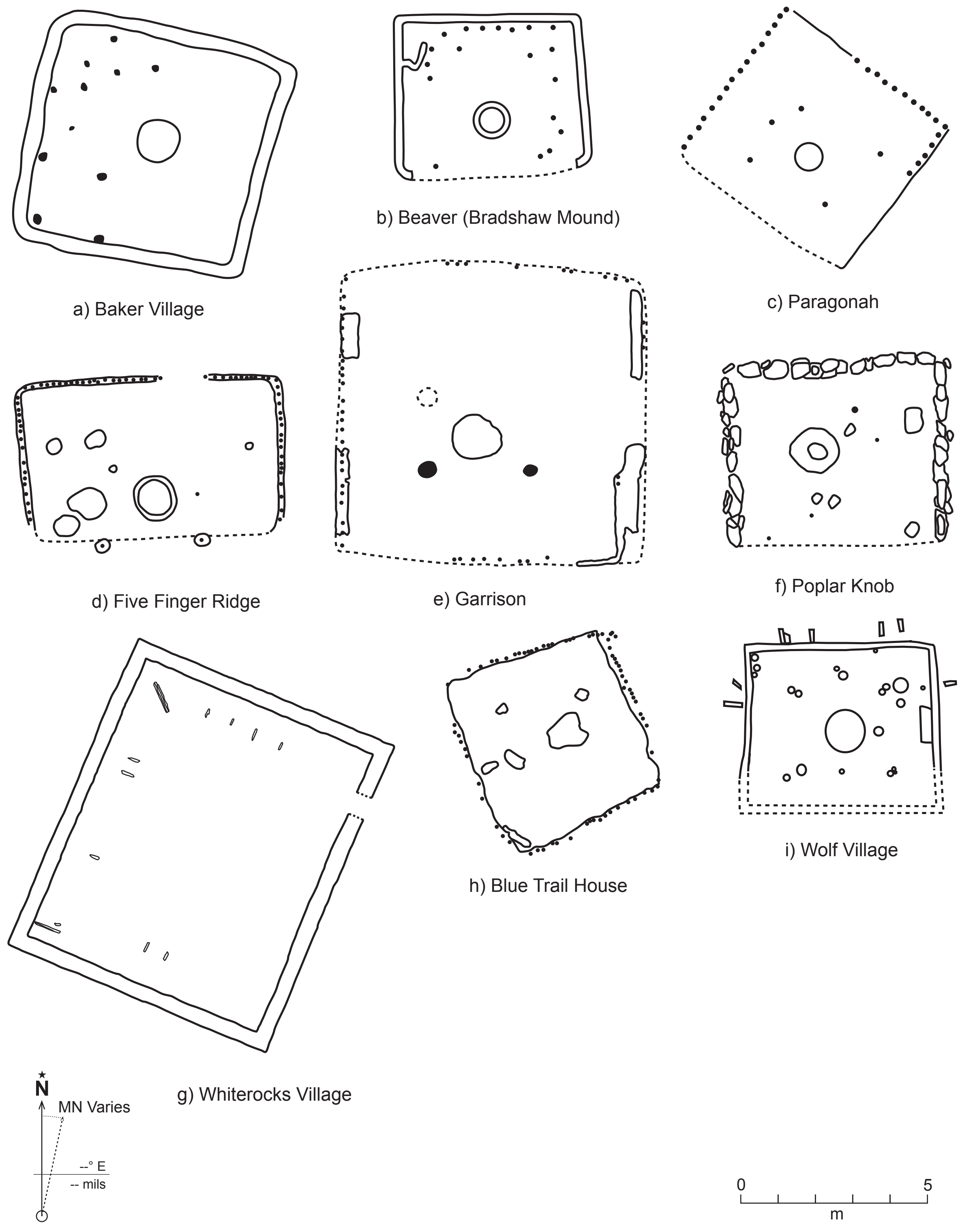


Figure 16. Select Fremont central structures: a) Baker Village (Wilde and Soper 1999:Figure 7); b) Beaver (Judd 1926:Figure 5); c) Paragonah (Judd 1919:Plate 1); d) Five Finger Ridge (Talbot et al. 2000b:Figure 2.39); e) Garrison (Taylor 1954:Figure 13); f) Poplar Knob (Taylor 1957:Figure 32); g) Whiterocks Village (Shields 1967:Figure 6); h) Blue Trail House (Quinn et al. 1991:Figure 3.2.18); and i) Wolf Village. Redrafted by the author from original drawings.

functioned as communal centers, places to gather (both formally and informally), sing, dance, or hold community events. Fremont central structures may have also been places for community members to meet informally to discuss the news, gossip, and stories of the day. Whatever the function, these buildings likely served as the anchors for Fremont villages in varying capacities (Ure and Stauffer 2010).

Material Culture

Simms (2008:187) writes that "The Fremont was a culture—there were some broad, unifying themes in the rock art, ceramic design, basketry, architecture, and the use of space." As Simms suggests, the Fremont are recognized archaeologically by several characteristics: a unusual moccasin style which is made from a deer hock with the dew claws still attached and left on the moccasin sole (Aikens and Madsen 1986:159) (Figure 17); a single, or split rod-and-bundle basketry technique (Adovasio 1977:68) (Figure 18); ornamental items made from turquoise likely imported from Arizona, New Mexico, and Nevada (Figure 19); beads made from marine shell found along the California and Baja Gulf coasts (Janetski 2002); beads made from lignite found locally in Utah; unique clay figurines (Jennings and Norbeck 1955) (Figure 20); and rock art depicting trapezoidal anthropomorphs (Figure 21).

The Fremont are also recognized by their distinctive, igneous tempered, utilitarian pottery, as well as their black-on-gray (Snake Valley) or black-on-white (Ivie Creek) painted bowls (Figures 22–23). In addition, some Fremont ceramic vessels exhibit an unusual surface manipulation described as "coffee-bean appliqué" (Figure 24). Corrugated vessels (Figure 25) emerge in the Fremont ceramic tradition by approximately A.D. 1050. Nearly all corrugated sherds are of the Snake Valley variety, although there are a few Sevier corrugated types as well. The production of Fremont corrugated vessels represents a significant change in Fremont ceramic production technology. Fremont potters traditionally coiled their gray ware vessels by overlapping the coils

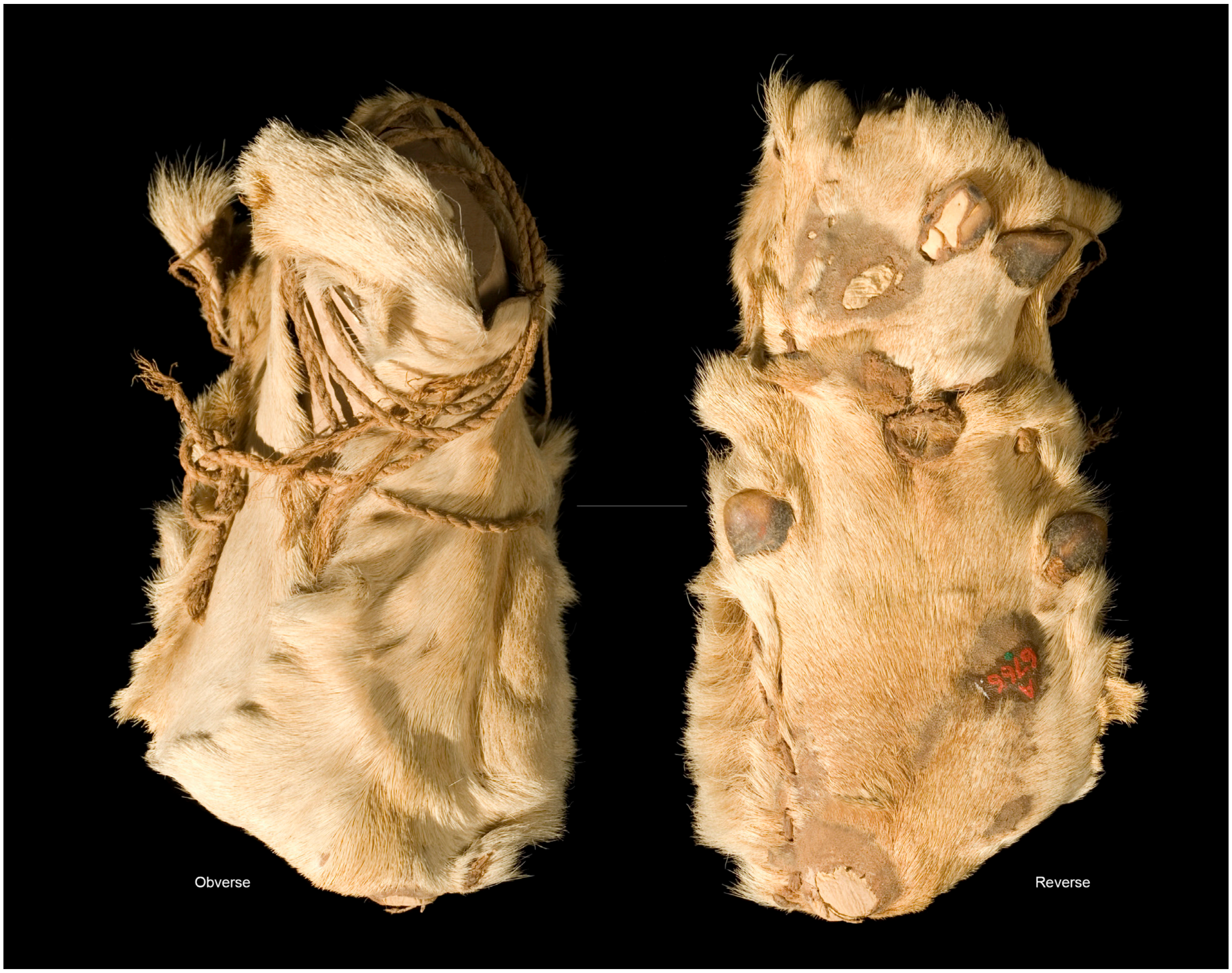


Figure 17. Fremont style moccasin. Note the attached dew claws on the sole of the moccasin. Photo provided to Joel C. Janetski, courtesy of the Peabody Museum, Harvard University.

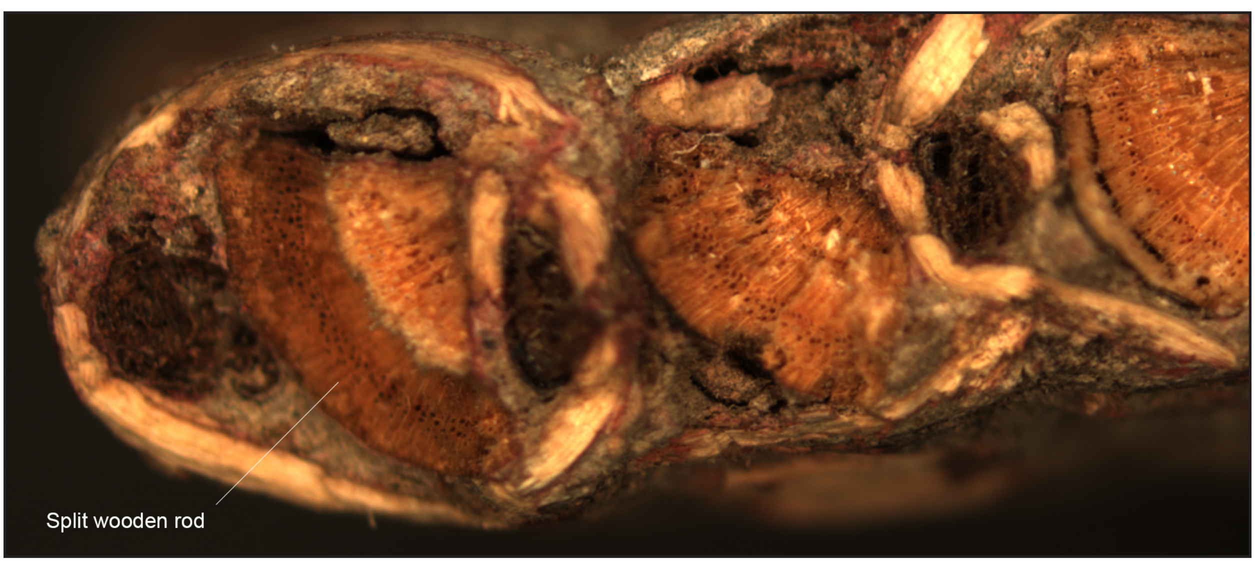


Figure 18. Microscopic image of a Fremont basket constructed with the split rod-and-bundle technique.

Figure 19. Fremont ornamental items made from imported and local materials: a) turquoise pendants from Baker Village (26WP63); b) turquoise pendants from Five Finger Ridge (42SV1686); c) lignite beads from Wolf Village (42UT273); d) *Ollivella dama* and e) *Olivella biplicata* shell beads recovered from Wolf Village (42UT273).

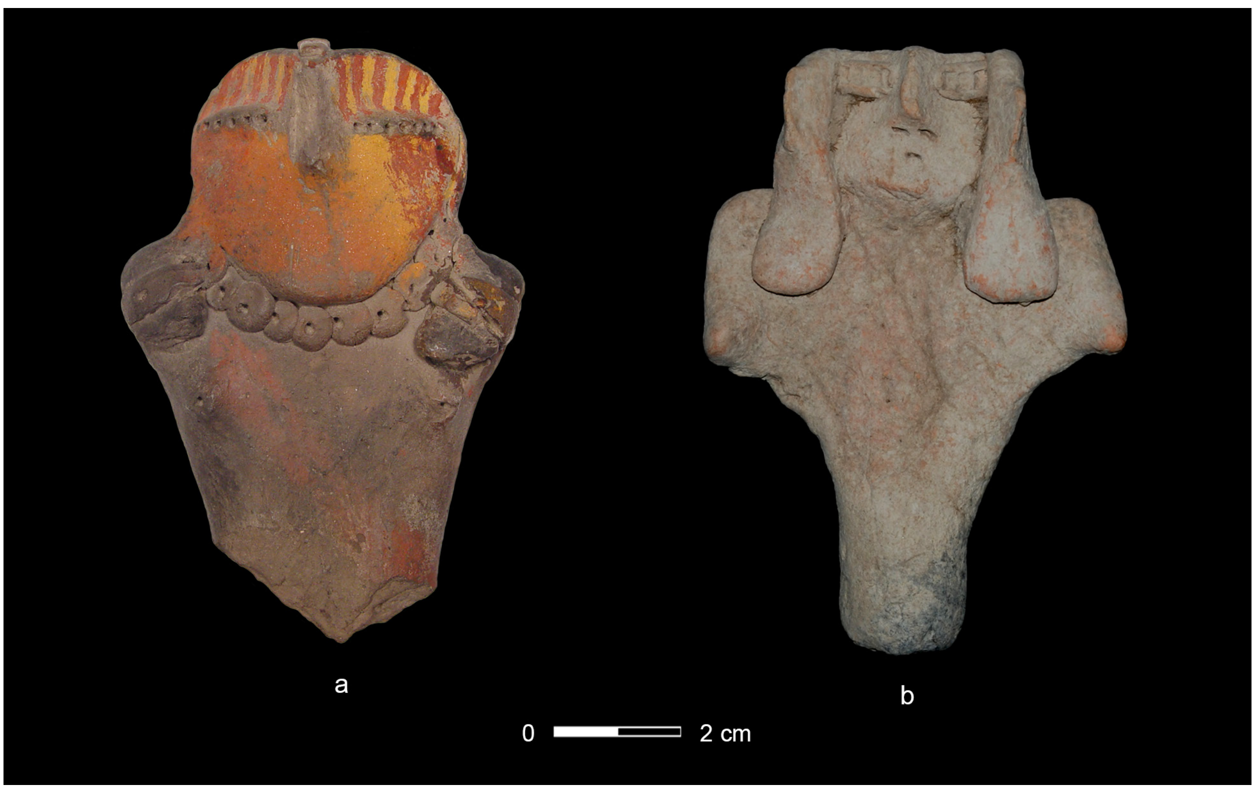


Figure 20. Fremont figurines: a) painted figurine from Nine Mile Canyon (photo taken by the author); b) figurine from Wolf Village (photo courtesy of the 2011 Brigham Young University Archaeological Field School.

Figure 21. Fremont rock art in Escalante Canyon, Utah.

Figure 22. Selection of Snake Valley Black-on-gray painted bowls.

Figure 23. Selection of Fremont Ivie Creek Black-on-white bowls.

on the inside (Geib 1996). They likely produced the vessels on a platform, or *puki*, coiling from the base to the rim in order to achieve an interior overlap. To accommodate indentations required for corrugation, coils were overlapped on the outside, creating the distinctive "clapboard" surface required to produce a corrugated surface. In the Mesa Verde region, the transition from plain to corrugated ware is visible in a progression from plain, to neck-banded, to neck-corrugated, and finally to corrugated coils. This same progression is not, however, evident in the Fremont ceramic tradition. In the short span of a generation or two, a ceramic tradition that changed little in several hundred years, was altered to accommodate a new surface modification. There is no question that Parowan Valley potters not only adopted corrugation, they eventually adapted this technology for their own.

Figure 24. Fremont pitcher with the "coffee-bean appliqué" spiralling around the neck and wrapping around the vessel shoulder. Photo provided by Joel Janetski, courtesy of the Utah State University Eastern Prehistoric Museum.

Social Complexity

Regarding Fremont social complexity, Janetski and Talbot (2000b) cite Robert Wenke (1990) who suggests the following four areas of research for examining ancient social complexity: 1) architecture, 2) mortuary practices, 3) settlement patterns, and 4) technology. For this discussion, I focus only on mortuary practices and architecture. Burial patterns often, although not always, provide insight into both the indivual's social status and the beliefs of those burying

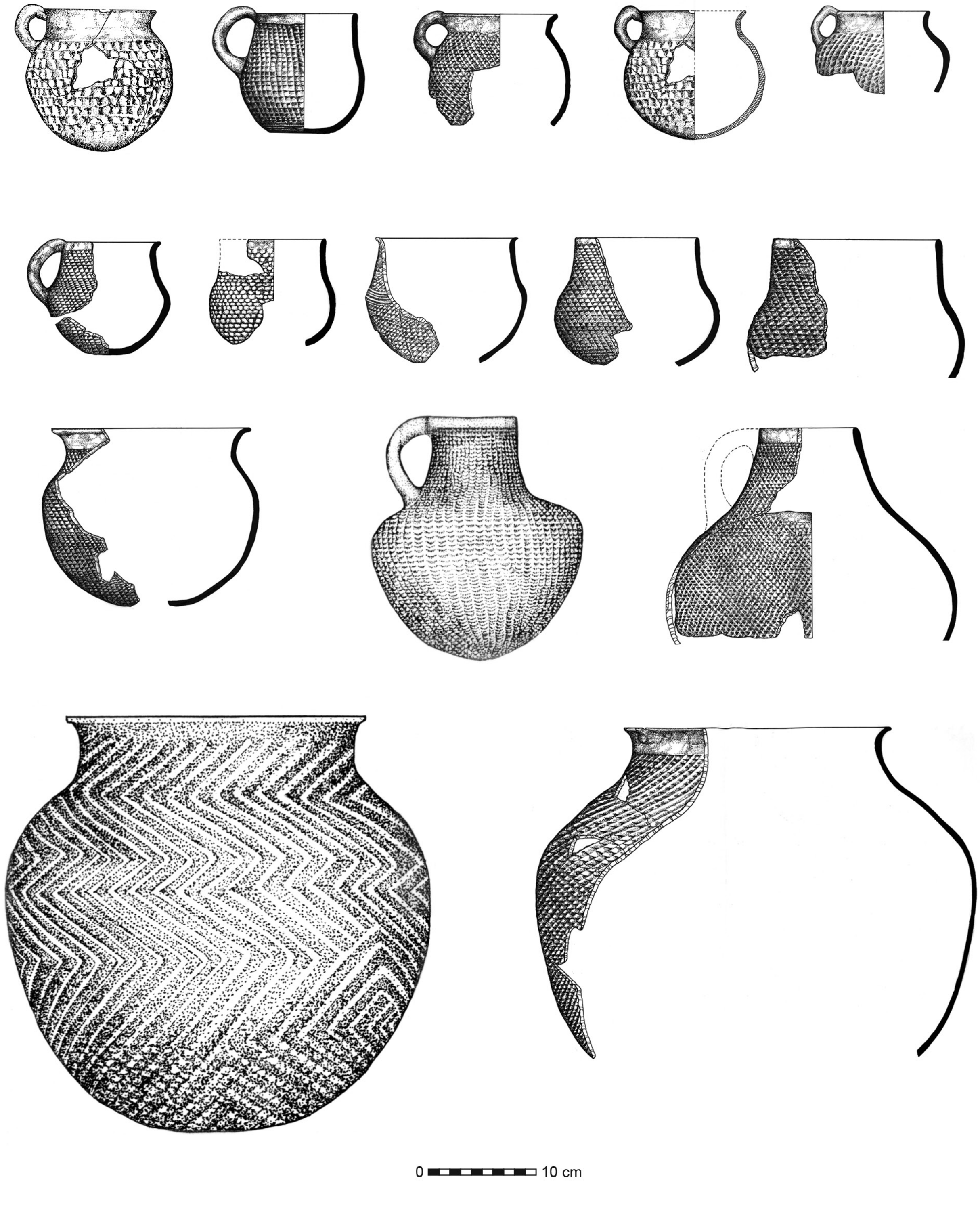


Figure 25. Snake Valley, Sevier, and Paragonah corrugated vessels recovered from Five Finger Ridge (42SV1686). Compilation adapted from numerous original drawings by Tula Rose (Talbot et al. 2000b).

the dead (Wenke 1990; Janetski and Talbot 2000b). The variation in burial goods, and the degree of complexity in how an individual was buried, can suggest ascribed or achieved social status (Janetski and Talbot 2000b; Renfrew and Bahn 1990). As Janetski and Talbot (2000b:250) explain, "Burial data can provide information on both horizontal and vertical complexity, with burial goods often a reflection of the status of an individual during life."

Architecture can also provide important information about social complexity in ancient societies. Wenke (1990:287) writes, "architectural variability reflects economic, social, and political differentiation within the community." Pronounced variation in structure sizes and the presence of associated public architecture often suggest social stratification. In general, egalitarian societies build habitations that are approximately the same size and contain similar furnishings; stratified societies exhibit increasing degrees of variability in house sizes and variation in the quality and number of associated goods (Janetski and Talbot 2000b). Evidence in the Fremont culture area for variations in structure size is most clearly visible at Five Finger Ridge, Paragonah, and Wolf Village (Richards et al. 2013).

Unusual Fremont Mortuary Practices and Social Complexity

Evidence for Fremont social complexity is scant, at best, but the most evidence comes from a few clues found in several unusual Fremont burials from Skyhouse in Nine Mile Canyon (Gillian 1955), Huntington Canyon (Montgomery and Montgomery 1993), Paragonah (Davis 1956), and Evans Mound (Pecotte 1982). All of these burials were more elaborate than typical Fremont burials and included grave goods uncommon within Fremont mortuary practices. Of these notable burials, three are male and one is female. The three males were buried under house floors and the one female was buried in a slab-lined cist (Janetski et al. 2000). These burials contained intentionally broken ceramic vessels, figurines and miniature ceramic vessels arranged on a bench, squash and corn cob remnants, and carefully arranged projectile points and groundstone (Janetski et al. 2000).

Pecotte (1982) writes that the grave goods recovered from Burial 1 at Evans Mound contained the remains of an entire Great Horned Owl (*Bubo virginianus*) with its head positioned facing the buried man's face. The right side of the man's skull was covered with corrugated sherds, and he was lying on a fibrous mat. He was also buried with nine black-billed magpie (*Pica hudsonia*) skulls in and around his waist and under his back. It is possible that these skulls were part of some type of belt. He was also buried with a quartz crystal, a finely-crafted bone weaving tool, five finished chalcedony bifaces, a bone whistle, and eight ceramic vessels placed just above the burial on the floor surface of the pithouse in which he was buried. In a corner of the same pithouse, an inverted metate was found with seven Parowan Basal-notched points laid out point-to-base and side-to-side.

John Gillian (1955:17–18) provides the following details for the remains of 25–30 year old female found at Sky House in Nine Mile Canyon. This woman was buried in a cist next to an oval adobe and stone structure located on a table rock approximately 365 Ft. above the valley floor. The cist was built on the native rock surface with stone and adobe walls measuring 2 Ft. tall and 5 Ft. long. She was wrapped in a rabbit skin robe and laid on corn cobs, squash rinds, seeds, and willows. Funerary goods included stone and adobe balls and two broken clay figurines. No pottery was found with the burial. These items are typical of other Fremont burials, especially those in the Parowan Valley. What makes this burial unusual is the adobe/stone cist in which she was buried, as well as the extreme internment location.

Comparing these elaborate burials with the often expeditious burials typically found among the Fremont suggests these individuals described above may have held some position of high status or recognition. Frank Davis (1956:87) observed that Burial 2, Mound B at Paragonah was likely "a person of some importance in the ceremonial life of the community…[who] was a priest or other religious official." Davis offers this conclusion based on bird and weasel skins found in the burial which are similar to ritualistic clothing worn by Puebloan people (Janetski et al. 2000). Walter Dodd and D. Lynn Cozzens (1982:105) support this idea, writing that the two male burials found at Paragonah and Evans Mound represent "differential status among the Fremont…[and] imply some form of specialization, possibly ritualistic or ideological." Janetski et al. (2000) also support Dodd and Cozzens, and Davis, stating that elaborate Fremont burials in the Parowan Valley, at Huntington Canyon, and at Sky House represent differential social statuses among the Fremont. What type of status is speculative; however, these individuals may have represented shaman or headmen. These elaborate burials clearly differ from the common Fremont mortuary practice, and at a minimum, reflect a complexity in Fremont social structure including the possibility of both men and women attaining importance in their communities.

Fremont Architectural Variability and Social Complexity

Evidence of Fremont social complexity is also present in several unique Fremont structures mentioned earlier. Central structures, neighboring large surfaces houses, and oversized pithouses at several Fremont village sites provide convincing evidence for architectural variability, which is a characteristic Wenke argues represents social stratification. According to Talbot (2000b:139), these structures (specifically surface houses) offer interesting insights into Fremont social organization:

> A more telling aspect of surface house use is its co-occurance with pithouses, yet rarity and often singularity at some larger sites. Closely guarded storage rooms and the unique construction differentiate the inhabitants of such structures from pithouse residents, suggesting these structures may have housed village leaders, or at least individuals with some degree of prestige.

At Five Finger Ridge (Figure 26), the 37 recorded pithouses averaged 12.4 m^2 in size. Pithouse 57, considered inhabited during the height of occupation at Five Finger Ridge, measured about

2.5 times larger than the average pithouse at 31.6 m^2 (Janetski and Talbot 2000b). The interior was unusual, containing double-hearths, and Pithouse 57 was located in a saddle between the eastern and western halves of the village. Traveling from one side of Five Finger Ridge to the other required passing by this large structure. Clement Meighan (1958) recorded a large habitation at Paragonah (Structure 20) that measured 37.1 m^2 or over twice the size of the average from 27 other pithouses excavated there.

The presence of public architecture at Fremont villages suggests architectural variability and possible social organization. Janetski and Talbot (2000b:251) provide a basic definition for public architecture as, "any feature evidencing greater than nuclear family cooperation in construction, maintenance, and/or use." Michael Adler and Richard Wilshusen (1990:133) define social integrative facilities or public architecture as, "structures or prepared spaces that are socially acknowledged as a context for integration of individuals above the household level." Conflict, tension, and competition are often prevalent as populations aggregate together with others not in their immediate family group. Communal and ritual spaces can help bind the community together and provide mechanisms to alleviate tensions that arise as people aggregate. Public structures can also "define and confine, include and exclude . . . social behaviors and social groupings" (Hegmon 1989:7), creating more stratification and social complexity. Public structures are generally differentiated from common dwellings and storage units by their larger sizes, associated ritual items, unique construction techniques, and placement within a community (Adler 1989; Adler and Wilshusen 1990; Hegmon 1989).

There are several large structures at various Fremont sites that fit the definition of public architecture suggesting some higher degree of social organization than simple egalitarianism. Structure 2 at Wolf Village is currently the best known example (see Figure 15). It is the largest known excavated Fremont structure, measuring 79 m^2 (850 $ft.^2$). It could easily have accommodated a group of 30 to 40 people during a communal event. Structure 24 and Pithouse

57 at Five Finger Ridge also fit the above stated definitions for public architecture (see Figure 26). Janetski and Talbot (2000b:252) write that, "while the daily use [for these two structures] might have been by a nuclear family, construction and the greater maintenance requirements likely necessitated the efforts of a larger residential group . . . or group of laborers." A non-comprehensive list of Fremont sites with central structures include Poplar Knob, Beaver Mounds, Baker Village, Paragonah Mounds, Garrison Site, Huntington Site, Blue Trail House, Five Finger Ridge, Whiterocks Village, and Wolf Village. Two other structures located at Evans Mounds and Turner Overlook may also fit into the Central Structure category, but not enough information is known about both to make any determination.

Janetski and Talbot (2000b) also suggest that more attention needs to be paid to Fremont irrigation systems as evidence for social organization and stratification (Talbot and Richens 2006; Metcalfe and Larrabee 1985; Sharrock and Marwitt 1967; Ambler 1966; Marwitt 1973).

External and Internal Interactions

As Janetski (2000) explains, the Fremont did not live on an island in isolation from everyone else around them. There is no question that the Fremont interacted via trade networks with the Ancestral Puebloans to the south and the Native Americans living in California and in the western Great Basin (Bennyhoff and Hughes 1987; Hughes and Bennyhoff 1986). The Fremont also traded amongst themselves locally and regionally as seen in the distribution of various types of Fremont pottery moving from one village to the next (Watkins 2006).

Marine Shell and Turquoise

Items traded into the Fremont region from long distances included marine shell, turquoise, and Ancestral Puebloan pottery. Marine shell (*Olivella, O. biplicata, O. baetica, O. dama, Haliotis,* and *Dentalium*) was imported into the Fremont region from the Pacific coast, the Gulf of Cortez,

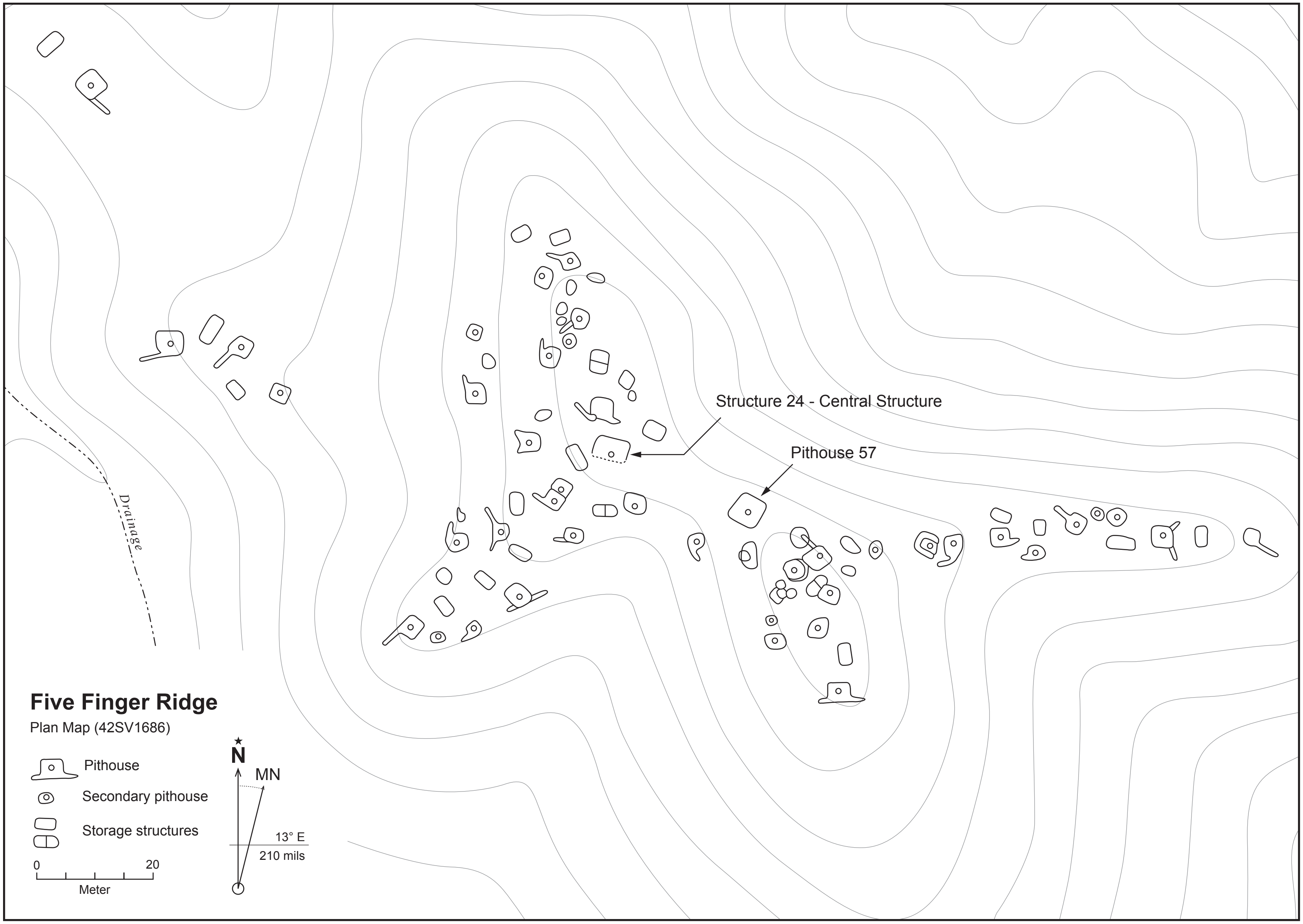


Figure 26. Map of Five Finger Ridge (42SV1686). Note the location and size of Pithouse 57. Adapted from Janetski et al. 2000:Figure 2.1.

and less frequently from the Northwest coast via trade networks that likely followed major river drainages (Janetski 2000). Turquoise is present at some Fremont sites, but is usually rare. Five Finger Ridge, however, is one exception. Excavations there recovered 53 pieces of turquoise from 21 separate pithouses. Neutron Activation Analysis performed on six turquoise items recovered from Five Finger Ridge exhibited chemical similarities to turquoise artifacts found at Chacoan and Hohokam sites (Janetski 2000; Talbot et al. 2000). Garman Harbottle and Phil Weigand (1992) determined that turquoise in Utah was imported from locations in Nevada, California, Arizona, Colorado, and New Mexico. There are currently no known turquoise sources in Utah.

Ancestral Puebloan Pottery at Fremont Sites

Puebloan pottery has been found across most of the Fremont regions, including a few sherds in the Salt Lake Valley as well as a few out in the Uinta Basin to the northeast (Richens and Thompson 2010). Butler (1983) reports Ancestral Puebloan pottery was also traded into the Twin Falls, Idaho, region, although the evidence does not currently support this theory. Most Puebloan pottery found at Fremont sites come from the southern villages along the Colorado Plateau, especially those dated post A.D. 1000 (Ambler 1969; Geib 1996; Madsen 1975). Both Kayenta and Virgin ceramics have been recovered from numerous Fremont sites across the Colorado Plateau, including up into “Bull Valley and the upper Escalante River drainage in the Grand Staircase-Escalante National Monument” (Richens and Thompson 2010).

In the Eastern Great Basin, and along the Wasatch Front, Puebloan pottery is sparse, but especially rare at the large village sites in the Parowan Valley (Richens and Thompson 2010) Out of the tens of thousands of sherds recovered from the major villages in the Parowan Valley, only a fraction of one percent are Puebloan in origin. The majority of these are either red or white wares, with a few gray wares from the Virgin Anasazi to the south (Richens and Thompson

2010). Northern Fremont sites such as the Provo Mounds, Wolf Village, Nephi Mounds, Backhoe Village, and Five Finger Ridge had negligible amounts of Puebloan pottery.

Fremont interaction with the Ancestral Puebloans is clearly evident in the ceramics found at Fremont sites, but especially among those to the east along the Colorado Plateau. Even though the counts of Puebloan pottery are much lower in the Eastern Great Basin and along the Wasatch Front, interaction still occurred. This is especially evident in the transfer of technology visible in Fremont Snake Valley Corrugated pottery produced in the Parowan Valley (Watkins 2006; Cole 2010, 2012). Prior to approximately A.D. 1050, Fremont potters did not produce corrugated pottery; however, by A.D. 1100 ± 50 Snake Valley Corrugated pottery was traded into the Five Finger area from the Parowan Valley (Richens 2000).

Local and Regional Trade

The Fremont not only interacted with the Ancestral Puebloans to the south and the Native Americans in the Western Great Basin, they also interfaced with each other at differing levels (Janetski 2002; Janetski et al. 2011). This is especially evident in Fremont ceramic trade, as well as with other items such as obsidian and various minerals (Janetski 2002). Watkins (2006) discusses the distribution of several Fremont pottery types, showing possible production areas and the movement of mostly painted wares across the Fremont area. Plain, surface manipulated, and corrugated wares were also traded, but usually in lower numbers. Based on Watkins's analysis, he was able to generally show that Fremont painted bowls were the most widely distributed of all vessel types. Watkins shows through a variety of distribution maps that Snake Valley Black-on-gray was likely produced in the Parowan Valley and traded mostly to the north and west, although some does trickle eastward to sites on the Colorado Plateau. Snake Valley Black-on-gray totals tend to diminish or falloff as a product of increased distance from the core production area in the

Parowan Valley. This pattern suggests a down-the-line distribution pattern along the Wasatch Front with some directional trade to the east (Watkins 2006; Janetski et al. 2011).

In contrast, Watkins (2006) concludes that Ivie Creek Black-on-white (ICBW) pottery was likely produced in the area around Snake Rock Village, Pharo Village, and perhaps Round Spring, but traded directionally instead of down-the-line. Janetski et al. (2011:47) explain that, "The distribution of Ivie Creek Black-on-white ceramics . . . does not follow a discernible falloff pattern but seems concentrated in the central Fremont region." Janetski et al. (2011) suggest that the differences in distribution between the two painted wares may be based on the "Central Core Concept" as defined by Janetski and Talbot (2000b:251). This theory suggests that, "trade connections [were] reinforced by participation in a type of regional system associated with the Central Structures (such as the Hohokam ball court network)" (Janetski et al. 2011:47). Snake Valley pottery may have moved along this trade network built around these areas of public integration during trade fairs or festivals held at larger Fremont villages along the Wasatch front at specific times of the year. Janetski writes:

> The festival model is attractive for conceptualizing how the Fremont might have implemented exchange between communities and with the Anasazi or other neighbors . . . . The locations of such festivals would have depended on resource availability and could have shifted depending on the productivity of certain resources. Places such as Parowan Valley near Cedar City in south-central Utah, the Sevier River Valley in central Utah near Richfield, Utah Valley, and others, are possible choices based on ethnographic patterns, site densities, and/or resource availability. Locations such as the Baker Village site, positioned on what is considered the periphery of the Fremont area seems an especially attractive locale for festivals that could include not only Fremont but also non-farming neighbors to the west.

Many of these locations suggested by Janetski contained Fremont villages that fit the central core concept. Most of these sites contained central structures that may have provided regional hubs around which trade festivals were held and goods were exchanged.

Social Organization

Diversity in Fremont material remains was the basis for breaking the Fremont into numerous variant regional models starting in the 1960s and continuing into the 1980s (Ambler 1966, 1967; Jennings et al. 1956; Marwitt 1970). Although similarities were noted between these variant groups, none of the investigators could find enough to connect these subdivisions together into one coherent culture. Consequently, a variety of names and confusing classifications were used to define these variants. Janetski et al. (2011:48) offer a new perspective to explain how the heterogeneity in Fremont material culture can still represent a larger homogenous entity:

> We suggest that invoking a model of tribal society and testing that model using analysis of style and exchange patterns provides insights and understanding for Fremont overarching similarity and internal differentiation. Those exchanges served to link the Fremont components by maintaining social and economic relations.

This model suggests that the Fremont be treated as tribal societies as outlined in Elman Service's (1962) typology of social organization. Although Service's definitions are considered antiquated and often criticized, Janetski and Talbot (2012:5) justify using this label stating, "the term tribe is common to the literature and therefore hard to ignore." They continue by stating that the term tribe appropriately describes most societies in the American Southwest and is the focus of a great deal of previous archaeological and ethnographic research (Janetski and Talbot 2012).

Critical to considering the Fremont as consisting of tribal groups is the concept that each tribe generally maintained an "interaction sphere stylistically different" from others surrounding them (Janetski 2011:48). The Fremont maintained broad scale similarities in cultural material but had minor stylistic differences in material goods between tribes. These tribes likely exhibited different social identities in the goods they produced while still maintaining socioeconomic connections (Janetski et al. 2011; Janetski and Talbot 2012). Ian Hodder's (1982) research among tribal societies in the Baringo district of Kenya provides ethnographic insight into how tribes use material goods to maintain relationships, reduce internal conflict, and demarcate group membership. Hodder (1982) explained that among the tribes he studied, material goods expressed the social identity (group membership) of the owner and the adherence to the rules for that group. Hodder (1982:26) writes:

> Ultimately, the very livelihood and security of a family depends on support from the wider group to which one belongs. Because in the Baringo context, one's reliance on the wider group is so fundamental, it is expressed immediately and overtly in the outward signs with which one is associated—i.e. in material culture.

Hodder (1982:57) does point out, however, that some objects can cross boundaries and show little stylistic variation. At a large scale of analysis, there are similarities in Fremont material culture that fit what Hodder observed among the tribes in the Baringo district of Kenya. These include shared stylistic traits in plain ware pottery, rock art, architecture, basketry, and farming among others (Adavasio et al. 2002; Janetski et al. 2011; Talbot 2000a; Talbot et al. 2005;). It should be noted, however, that at a smaller scale, such as in the temper of plain ware ceramics, distinct differences are present between similar looking vessels. For example, although Fremont Sevier, Snake Valley, and Great Salt Lake pottery all have similar functions, shapes, and little embellishment, petrographically they are quite different. This demonstrates the importance of examining both overt and passive style when using cultural material to define social boundaries between tribal groups.

Michael Searcy and Richard Talbot (2013) explain that the Fremont should be recognized not only by a variety of shared traits in their material remains but also by "a shared heritage similar to that of tribal groups found throughout the Southwest at the time of Spanish contact." These tribal groups are recognizable and associated with regions of influence centered around hubs at large Fremont village sites in the Parowan, Sevier, and Utah Valleys, as well as in the Uinta Basin (Figure 27). These valley-based areas of influence represent "macro-regions" of aggregation within the larger Fremont cultural area. As Janetski and Talbot (2012:9) explain:

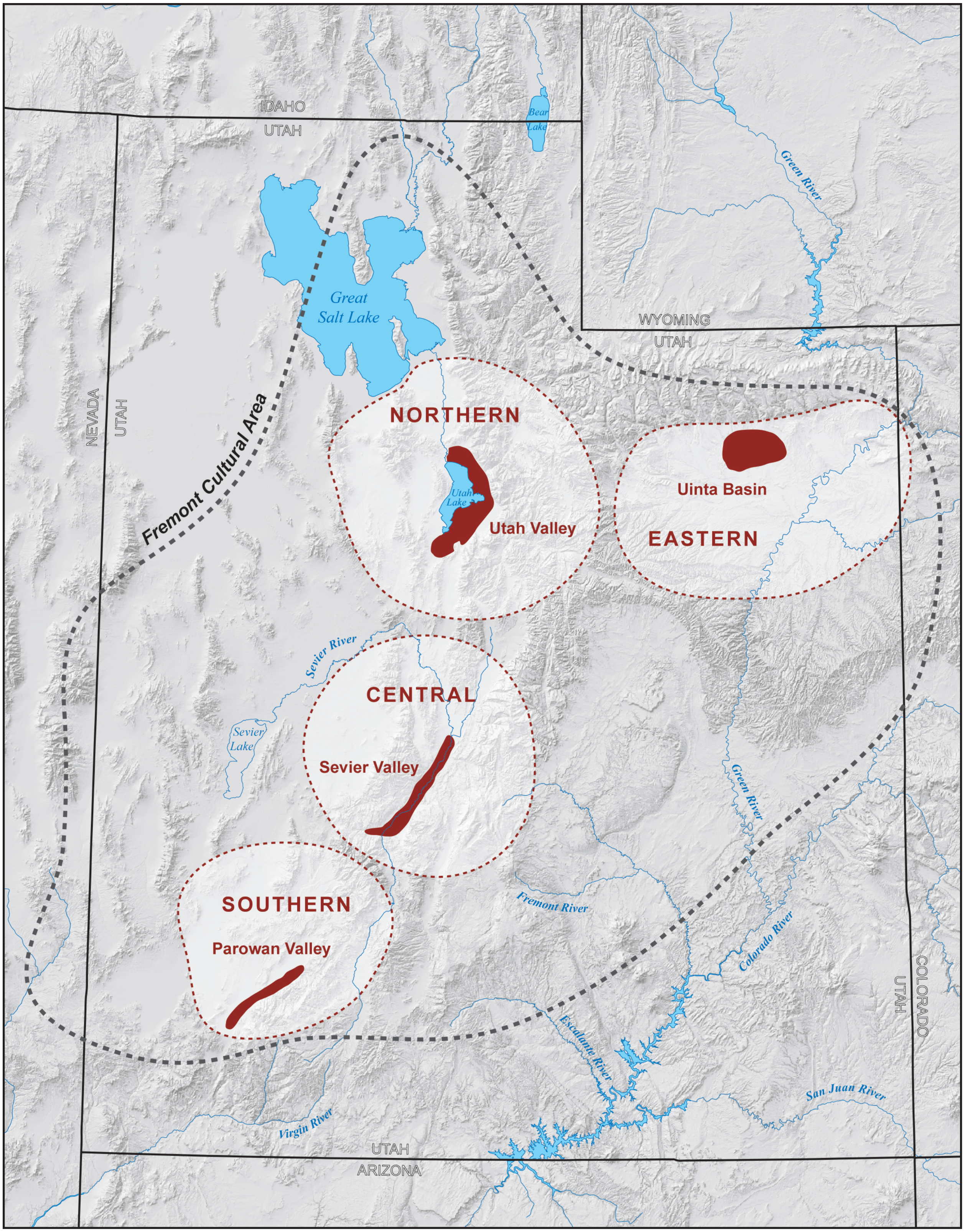


Figure 27. Fremont regions of influence in the Fremont cultural area with delineated core areas (dark red) for each region. Adapted from Janetski and Talbot 2012:Figure 4.

> We suggest these variants may simply be regional expressions of identity to set groups apart from neighbors. We expect identity to be expressed particularly in terms of active style; therefore, we should see those expressions in more visible media such as rock art, figurines, arrows, clothing, ornaments, and body adornment. However, we also expect regional variability in passive style such as in architecture and culinary ceramics to develop over time.

These four macro-regions (Northern, Eastern, Central, and Southern) share several characteristics that the Fremont repeatedly chose when establishing villages. They are located in well-watered valleys, associated with upland hunting ranges, are often near rich marshlands, and are situated on alluvial fans rich in fertile soils. This settlement pattern is very predictable, especially in the larger valleys along the Wasatch Front that contain similar resources.

In the northern Fremont region, Fremont villages were established along the eastern and southern edges of Utah Lake. The most densely populated portion of the northern Fremont region was in Utah Valley, but the Salt Lake Valley was undoubtedly heavily populated as well; however, very little has been recovered there to validate this assumption. Janetski and Talbot (2012) explain that Fremont habitation sites were located along the northeastern shores of the Great Salt Lake, and along the Weber and Lower Bear River drainages. Willard (42BO30) mound, or "The Big Village," was a large Fremont village located on Willard Creek near Ogden, Utah, that contained 70 mounds and an earthen wall surrounding the village (Simms 2008 citing Maguire 1879). It was eventually lost to the Willard Bay construction in the 1950s which used the mound material to build dikes.

In Utah Valley, the Provo mounds area was at one time a substantial Fremont community where residents took advantage of the various lacustrine, riverine, and marshland resources, as well as cultivated crops of maize, beans, and squash. The Provo River Delta contained over 100 mounds (Figure 28) that were documented by avocational archaeologists Robert and James Bee (Bee 1934–1966; Janetski 1990; Ure 2009). In various valleys south of Utah Lake, other Fremont villages dotted the landscape including Woodard Mound (42UT102), Wolf Village (42UT273), Kay's Cabin (42UT813), the Nephi Mounds (42JB2), and likely many others now lost to development.

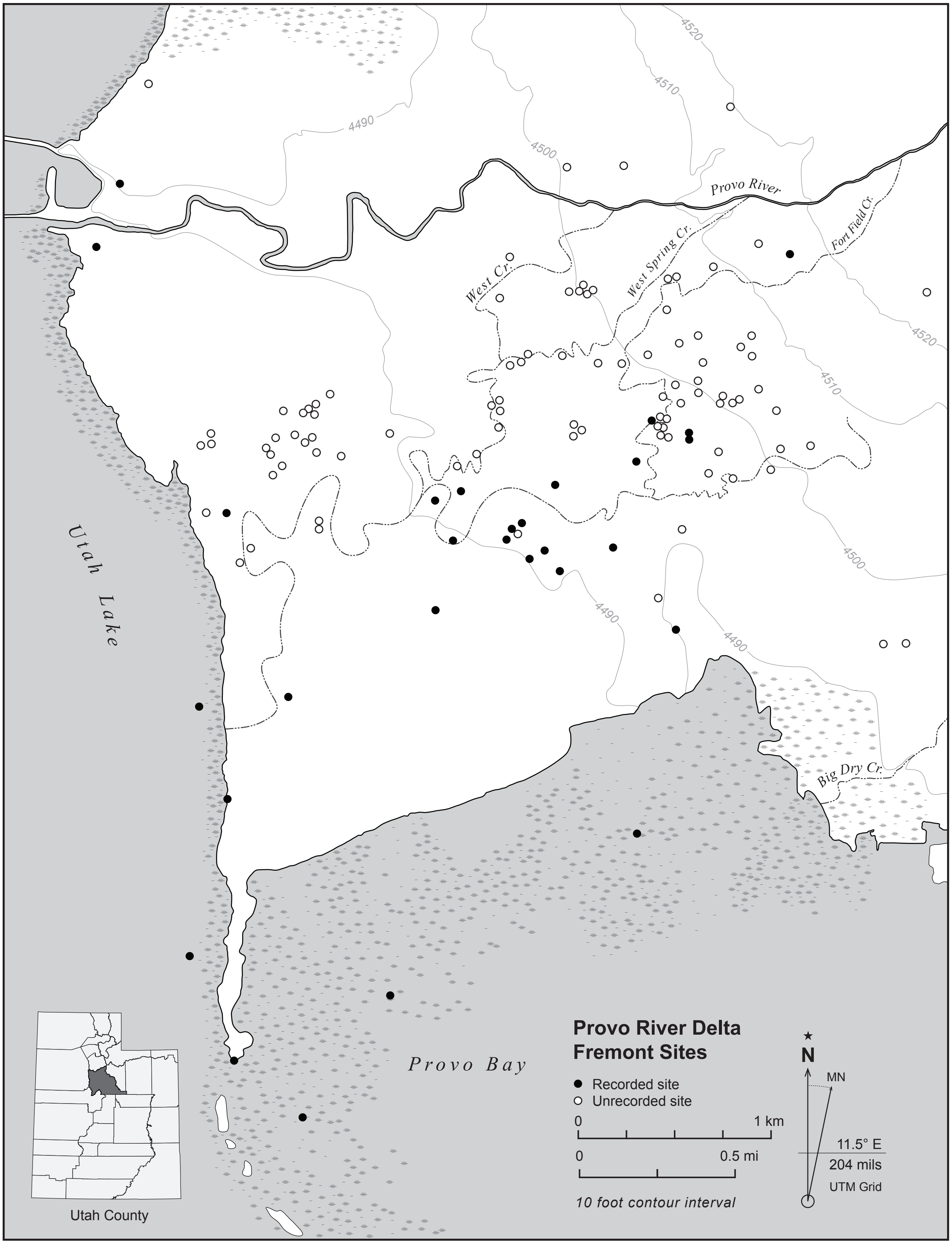


Figure 28. Recorded and unrecorded Fremont sites in the Provo River Delta. Location of unrecorded sites adapted from original map drawn by Robert and James Bee 1936–1966.

Janetski and Talbot (2012) describe the Central macro-region as including the Sevier River and its associated tributaries. The northeast-southwest trending narrow Sevier Valley constitutes the boundaries for the core of the Central macro-region. Janetski and Talbot (2012:11) write that this area may have had the highest "sum population aggregation of all the macro-regions. Sites in the core area include all of the Clear Creek Canyon sites, Backhoe Village (42SV662), and Pharo Village (42MD180). There is a possible secondary core area to the east in the Snake Rock area. Site sizes are much smaller here, but this area is thought to be the source of Ivie Creek Black-on-white bowls traded throughout the Fremont cultural area (R. Madsen 1977; Watkins 2006).

The Eastern macro-region is located to the east of the Utah and Salt Lake Valleys and is centered around a core area that includes small creeks flowing south out of the high Uintas across fertile alluvial fans in the foothills below. The Eastern macro-region includes Caldwell Village (42UN95), a Fremont village containing at least 22 pithouses, although there are several other unexcavated pithouses remaining (Ambler 1966, 1967; Marwitt 1986); Felter Hill (42DC2) which Shields (1967) observed had 27 circular depressions; and Whiterocks Village (42UN170) which had four pithouses and one rectangular adobe structure (Shields 1967). Several other Fremont small village sites were recorded by Shields (1967), including the Gilbert Site (42DC49), the Goodrich Site (42UN271), and Flattop Butte (42DC48). In addition, the Uintah River Mounds site (42UN2902), located along the edge of the Uintah River, was excavated in 1931 by Julian Steward.

The Southern macro-region core area is in the Parowan Valley, which is perhaps the best documented area of Fremont aggregation (Janetski and Talbot 2012). The Parowan Valley (see Figure 1) was home to several large villages: Paragonah (42IN43), Parowan (42IN100), Summit (42IN40), and the somewhat smaller Median Village (42IN124). Several hundred mounds represent the enormity—in comparison to other Fremont sites—of these villages, and were observed by numerous early visitors, and archaeological investigations (Berry 1972, 1974; Judd 1926; Marwitt 1970; Meighan et al. 1956; Montgomery 1894; Severance 1874). The Southern macro-region also includes a little known site in Cedar Valley to the south, sites near Beaver to the north, and a scattering of other smaller sites to the west (Berry 2005; Dames and Moore 1994; Reed and Speakman 2005). Janetski and Talbot (2012) state that little is known about the sites in the Cedar Valley and near Beaver, Utah, but suggest that both are, "somewhat united in styles of material goods including ceramics, residential architecture, gaming bones (Hall 2008), and projectile points (Woods 2009)."

Discussion

Defining the Fremont requires a balancing act between several scales of analysis. If the Fremont are examined solely at the micro scale, then the result is what Bettinger (1993:43–44) described as "bewildering variation on every scale in every dimension." On the other hand, viewing the Fremont from a broad perspective results in generalizations bordering on marginalization. Unfortunately, past Fremont research has often seen these two scales of analysis as mutually exclusive. As Brown and Price (1985:440) write, "some trade-off between the two approaches is necessary." Defining the Fremont requires applying appropriate scales of analysis while assuming "cultural and adaptive heterogeneity" (Upham et al. 1994:210) while looking for patterns across time and space. Variation in material culture and behavior should be expected when examining any human population; however, homogeneity within variation often represents increased affiliation, social complexity, and social structure. These patterns should, as both Janetski and Talbot (2000a) and Binford (1988) write, "be the focus of our attention."

This chapter provided a brief outline that examined the various characteristics used to define the Fremont. There is both variety and uniformity found in nearly every aspect of what defines the Fremont, but this does not suggest that the Fremont were an unbounded egalitarian society. As briefly outlined in this chapter, Janetski et al. (2011), Janetski and Talbot (2011), and Searcy and Talbot (2013) provide new perspectives and models that define the Fremont as a tribal societies. They suggest that the Fremont as a whole have a similar heritage with "overarching similarities" but maintain "internal differentiation" (Janetski et al. 2011) through overt expressions of identity in rock art, ceramics, and other highly-visible goods. They also argue that these Fremont tribes were connected together via exchange and social connections.

More importantly, the Fremont differentiated themselves from the Ancestral Puebloan communities to the south, especially in bordering regions, but still maintained exchange relationships across boundaries. As Searcy and Talbot (2013:31–32) write:

> We have looked to the edges of the traditional Fremont region to seek ethnic identity, and in particular to examine the nature of identity maintenance through exchange and other contacts, where the Fremont tradition can be contextualized with and contrasted to non-Fremont (us vs. them). The evidences to date imply interaction but a maintaining of social distance between Fremont horticulturalists and non-Fremont groups.

Perhaps the best example of this interaction is in the Escalante Valley where Fremont and Ancestral Puebloans lived in close proximity to each other post-A.D. 1000. Each group, however, generally maintained its own cultural identity. Almost no mixing was noted in the material culture, aside from some Fremont structures incorporating minor functional architectural elements such as slab-lined hearths and jar-shaped pits typically considered Puebloan (Talbot 2006). However, as Talbot (2006:327) explains, "I believe the Escalante Fremont devotion to an Anasazi architectural style is not completely sincere" because they did not sufficiently alter the essence of the typical Fremont pithouse. Talbot (2006:327) continues:

> Many of the Fremont Escalante region traits, and by extension those elsewhere on the northern Colorado Plateau, are unlikely to be the product of local innovation, but rather of an imitation of particular architectural traits used by the neighboring Anasazi. The cultural transmission, then, is selective or biased, with the basic Fremont social substratum as seen in most passive and active material culture styles remaining the same.

According to Janetski et al. (2012:207), there is little doubt that there was an ethnic boundary between the Fremont and the Ancestral Puebloans, even between those living in very close proximity to one another in the Escalante Valley. This ethnic boundary was considerably more defined south of the Parowan Valley. It is clear, however, that the Fremont living in the Parowan Valley were interacting with Puebloan peoples based on the adoption of several ceramic technologies, but specifically corrugating plain-ware pottery.

4 | Parowan Valley Physiography

Introduction

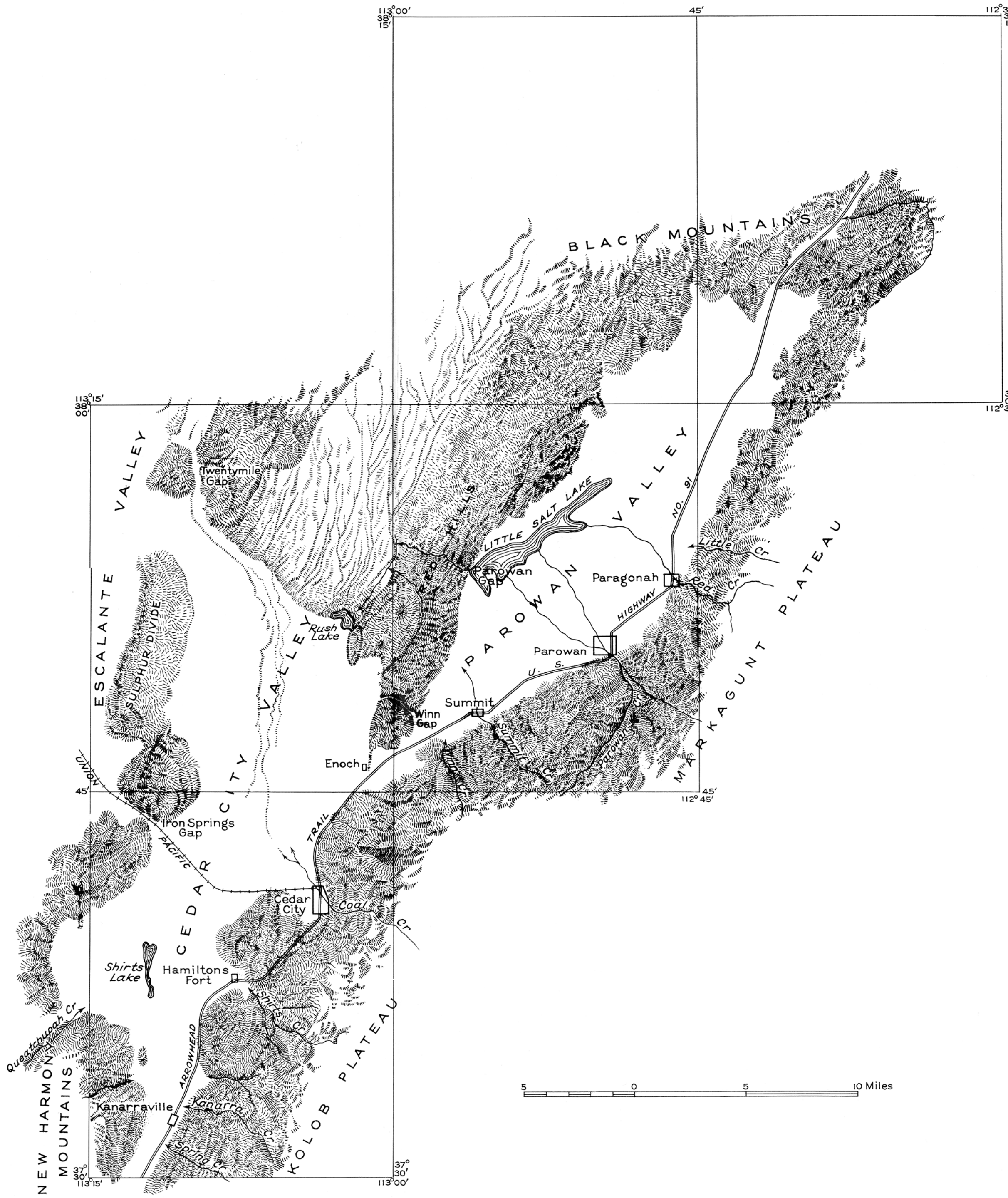
In this chapter I discuss the various physiographic characteristics of the Parowan Valley, including an overview of the geography, climate, hydrology, and geology. Fertile soils enriched with volcanic minerals and sediments, snow-fed fresh creeks flowing from the west, a generally mild climate, and accessible wild game in the foothills and highlands to the west, created an excellent location for establishing large Fremont villages in the Parowan Valley. This valley is still productive farmland today, providing the modern residents of Parowan, Paragonah, and Summit a variety of agricultural resources including irrigated hay fields, small grains, and potatoes (Utah State History: Iron County 2013). Outlining the Parowan Valley's basic physiographic features establishes the general environment and context for my thesis.

Geography

The Parowan Valley is located on the eastern side of Iron County, Utah, between the Hurricane Cliffs to the southeast and the Black Mountains to the northwest (Figure 26; see also Figure 1). The word *parowan* is derived from the Paiute words *paragoons* and *pah-o-an*, meaning "marsh people" and "bad or harmful water" which is likely referring to the Little Salt Lake nearby (Van Cott 1990a). The word *paragonah* is likewise derived from a Paiute word meaning "marshland" or "many springs" (Van Cott 1990b). The Parowan Valley is approximately 24 miles long by 7

UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

WATER SUPPLY PAPER 993 PLATE 2



SKETCH MAP SHOWING THE PRINCIPAL PHYSIOGRAPHIC FEATURES OF THE CEDAR CITY-PAROWAN VALLEY AREA, UTAH. BASE FROM PHOTO-INDEX CARDS OF THE SOIL CONSERVATION SERVICE, U. S. DEPARTMENT OF AGRICULTURE

Figure 29. Hand-drafted 1946 sketch map of the Parowan Valley and surrounding physiographic features. Original from Thomas and Taylor (1946, plate 2 supplemental map).

miles wide and runs in a northeasterly direction. It sits at an elevation of approximately 5,900 ft. above sea level and contains roughly 150 $mi.^2$ of "sloping alluvial deposits" (Weide 1973:174). The modern towns of Paragonah, Parowan, and Summit are located along the east side of Interstate 15, which runs through the valley. Cedar Valley lies to the southwest, with the Rush Lakes just on the western side of the Red and Gray Hills. The remnants of the Little Salt Lake are located to the northwest, against the Gray Hills.

Climate

Gardiner Dalley's (1972a) palynological findings suggest that the Parowan Valley was more moist prehistorically, but also experienced a decline in moisture levels during the final periods of Fremont occupation post A.D. 1200. The modern Parowan Valley climate is considered arid to semi-arid. Temperature ranges in the Parowan Valley are based on data from Cedar City which is only 14 miles further south. Current summers tend to be cool, winters mild, spring and fall are generally comfortable, and southwestern prevailing winds frequently blow through the Parowan Valley (Gregory 1950; Weide 1973). Summer days above 90° F are uncommon as are winter days below 0° F; however, summers can bring daily temperature maximum fluctuations of 40° F (Eisinger 1998). In an average year there are typically 144 frost free days in the valley, although frost can arrive as early as September 5th in some years and last into early July (Gregory 1950). The average frost-free range is from May 15th to October 4th (Weide 1973).

Annual precipitation records from the United States Weather Bureau for Parowan City (Thomas and Taylor 1946) for years 1891–1939, and from the Utah Climate Center (2013) for years 1952–2010 for the City of Summit, Utah, show an average rainfall total of 11.2 in. per year, with a range from 5.30–20.8 in. Figure 26 visually represents the average annual rainfall totals in the Parowan Valley from 1891–2010, with a dashed line representing the 10-in. threshold suggested by Randy Creswell and Franklin Martin (1993) to be the minimum amount of rainfall required for dry-

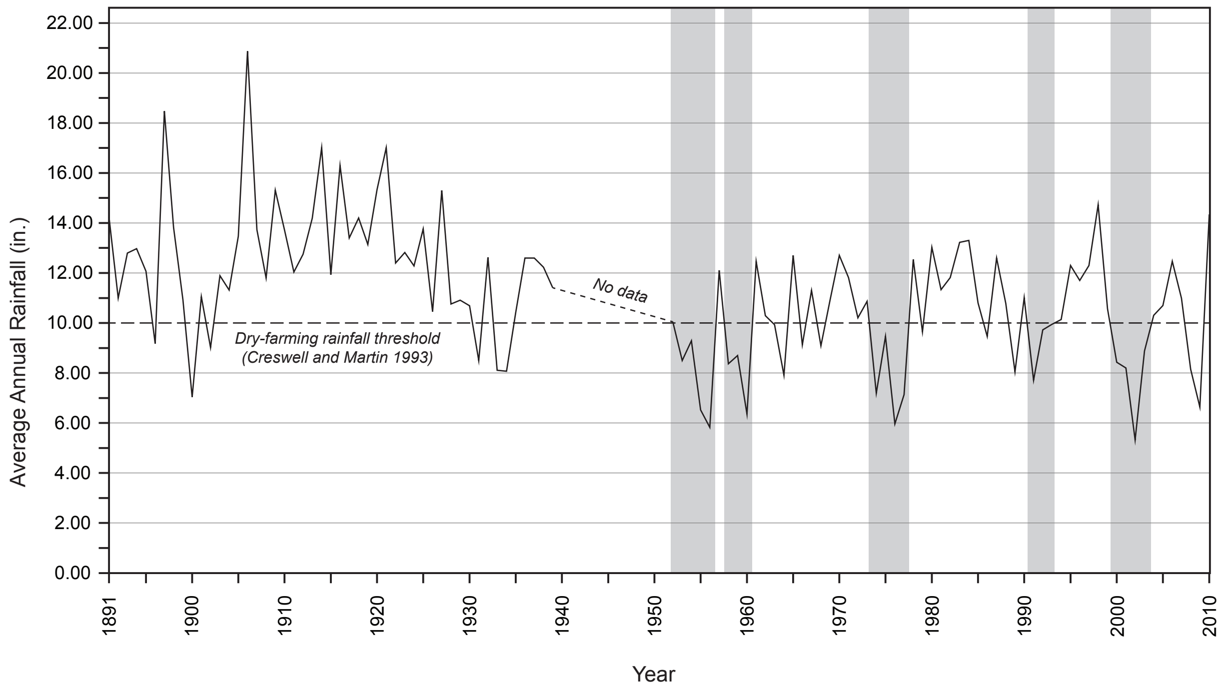


Figure 30. Annual precipitation in the Parowan Valley from 1891–2010. Results gathered from the Summit and Parowan collection stations (Thomas and Taylor 1946; Utah Climate Center 2013). The long dashed-line represents the 10 in. rainfall threshold required for dry-farming crops (Creswell and Martin 1993). Gray bands depict three or more years of rainfall below 10 in.

farming maize. During this 121 year period, approximately 33 years fall under this threshold, with five separate episodes of at least three years or more years with rainfall under 10 inches annually (depicted as gray bars in Figure 26). Rainfall totals along the east side of the Parowan Valley, against the Hurricane Cliffs, tend to be somewhat higher than the rest of the valley (Weide 1973). The driest month of the year is in June. Thunderstorms in July and August often bring additional moisture to the valley.

Hydrology

Thomas and Taylor (1946:4) describe the Cedar and Parowan Valleys as, "among the most important agricultural areas in southern Utah" based on perennial creeks flowing from the high mountains plateaus to the east. These creeks—Red Creek, Parowan Creek, and Summit Creek (from north to south), discharge into the valley providing a steady supply of irrigation water for modern farmers working their fields today. Thomas and Taylor (1946:6) observed, "Precipitation received as snow on the higher altitudes tributary to the adjacent valleys . . . is an important factor in the amount of water available to recharge the ground water in the valleys." These same creeks undoubtedly provided the Fremont living in the Parowan Valley with ample water for their crops planted in the fertile alluvium deposited in the valley at the end of these creeks. In general, maize cultivation using dry-farming techniques requires approximately 10 in. of rainfall in a given year (Creswell and Franklin 1993:8). As mentioned earlier, the eastern side of the Parowan Valley received more rainfall than the rest of the valley. The eastern side of the valley is also where the heavier, more fertile alluvial deposits are concentrated. It is not a coincidence that many Fremont villages were also located on the eastern side of the Parowan Valley.

Although the climatic data presented here is based on modern records, it seems highly probable that Fremont farmers growing crops in the Parowan Valley relied on water from these perennial streams flowing into the valley as opposed to solely from rainfall for dry farming. Fields could have easily been irrigated by flooding via informal ditches and/or hand-watering, although archaeological evidence of even crude Fremont irrigation systems is sparse. Talbot and Richens (2006) state that there is evidence of Fremont irrigation in the Uinta Basin as early as A.D. 300; Metcalfe and Larrabee (1985) report similar irrigation ditches in Gooseberry Valley. Evidence of formally constructed trenches have also been found at Nephi (Sharrock and Marwitt 1967), Caldwell Village (Ambler 1966) and at Median Village (Marwitt 1973), but none of these ditches are connected to modern or ancient stream channels, and there is no evidence of any associated catchment systems or cisterns. Without more evidence, we can only make the assumption that at least some of these features were use for irrigation purposes. The precipitation data suggests, however, that the highly erratic rainfalls in the Parowan Valley make agriculture without irrigation very unfavorable (Gregory 1950).

Geology

The Parowan Valley is bounded by the rocky Hurricane Cliffs to the east, the Red and Gray Hills to the west, and the Black Mountains to the north. Exposed rocks in the valley range from the Permian to the Recent Age, with the older rocks located in the mountains to the east and west, and the more recent rocks filling the valley floor (Thomas and Taylor 1946). The Hurricane Cliffs are a significant geological formation as they are the intersection between the Great Basin and the Colorado Plateau, as is Iron Mountain east of Paragonah. Gregory (1950:119) describes the Hurricane Cliffs as, "a fault escarpment associated with the upturned beds of an anticlinal fold . . . the line that separates the agricultural settlements from the uninhabited grazing lands." In addition, he explains that the Hurricane Cliffs mark the eastern boundary of the "flat-lying Mesozoic and Tertiary sediments and lavas that characterize the High Plateaus of central Utah" (Gregory 1950:119) where the remnants of the Wasatch and Brian Head formations are still visible. The Parowan Valley itself is geologically designated as a graben, or "drop-down fault block," based on the visible presence of normal vertical and horizontal displacement faults along the east and west edges (Weide 1973:176).

Extrusive igneous rocks in the Parowan Valley are generally basalts and rhyolites as noted along the Hurricane Cliffs between Paragonah and Cedar City. Acidic volcanic rocks such as rhyolite, trachyte, latite, dacite, andesite, and assorted pyroclastics are generally observed along the plateaus surrounding the Parowan Valley (Thomas and Taylor 1946). Table 1 provides a list of the numerous other minerals that are present in Iron County and likely in the Parowan Valley. The presence of biotite, quartz, and Andesine/Albite (both types of plagioclase feldspar) are of special interest for this thesis because these are minerals found specifically in Snake Valley pottery. Bullock (1981) notes that the source for all of these minerals is Iron Peak, located northeast of Paragonah up Little Creek Canyon. The likelihood of rocks and sediments with these minerals eroding down Iron Peak and into Little Creek seems high, making it a good place to look for

Table 1. Minerals Recorded in Iron County, Utah (Bullock 1981)

Actinolite	Cinnabar	Mercury
Albite	Cryptocrystalline Quartz	Metastrengite
Analcite	Damourite	Mimetite
Andesine	Descloizite	Mottramite
Anhydrite	Diopside	Niter
Annabergite	Ferrimolybdite	Opal
Apatite	Flourite	Orthoclase
Argentite	Galena	Pyrite
Augite	Garnet	Pyrolusite
Autunite	Geothite	Pyromorphite
Azurite	Gold	Quartz
Barite	Gypsum	Rhodochrosite
Biotite	Hematite	Rockbridgeite
Carnotite	Limonite	Siderite
Cerargyrite	Magnetite	Sulfer
Chlorite	Malachite	Sylvanite

the source raw materials used to produce Snake Valley pottery. Basalt outcrops are visible near Paragonah, Summit, and Parowan; they are found on the northern end of the Parowan Valley and are also scattered across the Gray and Red Hills to the west. The Paragonah basalt is comprised of dense olivine crystals (Weide 1973) and measures about a square mile long. It is sourced to a cinder cone further to the southeast up a narrow canyon (Thomas and Taylor 1946).

Alluvium constitutes the great majority of the fill in the Parowan Valley. These are gently sloping alluvial deposits, often with considerable depth, typical of intermontane basin valleys. Thomas and Taylor (1946:37) explain that, “these deposits include many highly permeable beds that constitute the principal source of ground water in both Cedar City and Parowan Valleys.” The alluvial fans that cover the eastern edge near the archaeological sites of Parowan, Paragonah, and Summit are composed of, “landslide breccia and colluvium deposited in thick cones . . . at the base of the Hurricane Cliffs," and "alluvium and fanglomerate material deposited in a series of coalesced fans from Paragonah, Parowan, and Summit creeks" (Weide 1973:176). These alluvial deposits contain a range of eroded materials varying from rough, angular blocks at the stream mouths, to fine-grained sands near the alluvial fan terminus (Weide 1973). The alluvial fans also contain fertile soils rich with minerals and nutrients that erode down from weathered volcanic rocks at higher elevations, as observed in other similar valley environments (Lee et al. 2006:740). Thomas and Taylor (1946:1) describe the development of these alluvial fans, writing:

> Streams issuing from canyons in the mountains become sluggish as they reach these intermontane areas, their waters disappear by evaporation or downward percolation, and the sediments which they carry are deposited to form extensive, gently sloping alluvial fans. Adjacent fans merge with each other to form broad, smooth, alluvial slopes which everywhere surround the mountain ranges . . . . Cedar City and Parowan Valleys are basins of this type.

The majority of the Parowan Valley is covered with Sierozem soils which are described as "dense, compacted, and hard" and generally occur in "alluvial fans, outwash, flood plains, and in valley bottoms" (Weide 1973:186). These soils are typically derived from, "sandstone, limestone, quartzite-rich conglomerate, and extrusive igneous rocks such as basalt or rhyolite" (Weide 1973:186). In addition, lacustrine sediments, produced from the evaporation and replenishing of water at the Little Salt Lake, generated lake flats comprised of clays, silts, sand, and salts from the dessication process (Thomas and Taylor 1946).

Flora and Fauna

The Parowan Valley is teeming with a variety of plant and animals species. Ecologically, the Parowan Valley is considered part of the Upper Sonoran Life Zone, which ranges from 4,000 to 6,500 Ft. in elevation (Gregory 1950). Sage, shadescale, and greasewood are the dominate floral species in the Parowan Valley, but pinyon pine, Utah Juniper, service berry, cliff rose, squaw berry, mountain mahogany, chokecherry, manzanita, buck brush, and rabbit brush grow in the lower reaches of the Markagunt Plateau east of the Hurricane Cliffs (Gregory 1950). Some of these plant species (especially those producing edible seeds and berries) were collected and consumed by the Fremont, as well as later indigenous groups, such as the Paiute, who also lived in the area centuries later. These edible plants were likely collected and eaten by the Mormon settlers as well. A variety of trees species grow in the valley bottoms, including cottonwood, box elder, birch, and willow (Gregory 1950). Grasses and wild flowering annuals also grow across the Parowan Valley; yucca, mesquite, and cacti, in a variety of types, grow along the Hurricane Cliffs. Vegetation to the east of the Parowan Valley, at higher elevations above the Hurricane Cliffs, transitions from pinyon-juniper to spruce, aspen, and wildflowers (Berry 1972:2; Weide 1973:183).

Fauna in the Parowan Valley, and surrounding elevations, are similar to those found in many other parts of southern Utah. Mule deer are the dominant species in and around the Parowan Valley (Gregory 1950:15–16), but other species include black bears, elk, bobcats, mountain lions, coyotes, foxes, badgers, weasels, porcupines, and weasels. Weide (1973:188) notes that antelope and mountain sheep are no longer found in the Parowan Valley, but archaeological excavations at Evans Mound indicates a large population of both species near the Parowan Valley. Rabbits and hares, as well as marmots (in the high country to the east), ground and tree squirrels, and a variety of other rodents live throughout the area. A variety of birds also inhabit the area, but of special interest to Fremont subsistence questions are the presence of sage hens, grouse, quail at lower elevations, and waterfowl near the Little Salt Lake. A few toads, snakes, and turtles inhabit wetland areas, and trout are present in the colder creeks, streams, and lakes in the higher elevations of the mountains to the east of the Parowan Valley.

Discussion

The Parowan Valley is physiographically diverse. The uplands and mountains to the east provided a variety of resources, as well as watered the Parowan Valley below with small streams full of snow melt. These uplands offered the Fremont a variety of important resources, such as large game, timber, and edible plants the Fremont typically harvested. The Parowan Valley itself contained fertile volcanic alluvial sediments offering Fremont farmers excellent agricultural soils for growing crops. Geologically, the Parowan Valley contains a variety of minerals and clays used to support a growing ceramic trade centered around the villages at Paragonah and Summit.

5 | Exploration and Archaeological History of the Parowan Valley

Introduction

In this chapter I describe the early exploration and major archaeological undertakings in the Parowan Valley, including excavations at Parowan (42IN100), Summit/Evans Mound (42IN40), Paragonah (42IN43), and the Mud Springs Site (42IN218) located on the north end of Mud Springs Canyon to the northwest of the Parowan Valley. This synthesized discussion of the archaeological history of the Parowan Valley provides important background information previosuly published only in bits-and-pieces.

The Parowan Valley was the epicenter of Fremont research from the 1950s into the early 1980s. Marwitt (1973:5) explains that by the 1970s the Parowan Valley had "probably been the scene of more [Fremont] archaeological activity of varying quality than any other part of Utah." Although Median Village (42IN124) is a prominent Fremont village located in the Parowan Valley, it is not contemporaneous with the larger village sites to the north (Marwitt 1973:8) based on radiocarbon dates provided by Marwitt (1973). The ceramic assemblage reflects this earlier date, containing only 5 (0.13 percent) Snake Valley Corrugated sherds out of a total of 12,794 (Madsen 1973:57). The lack of corrugated ceramics, and an earlier occupation at Median Village, excluded this early Fremont site from this analysis that focuses on late Fremont sites in the Parowan Valley that contain Snake Valley Corrugated pottery. The smaller Fremont campsites and habitation sites scattered throughout the Parowan Valley were excluded from my analysis so that I could focus specifically on the larger villages responsible for producing the majority of the pottery.

Early Exploration and Settlement History

The Parowan Valley was first documented in the historical record by Francisco Atanasio Domínguez and Silvestre Vélez de Escalante. These two friars, along with twelve other Spanish colonials, and two Timpanogots Utes from Utah Valley, left Santa Fe, New Mexico earlier in the summer of 1776 to embark on the now famous Domínguez-Escalante Expedition (Alexander 2007; Warner 1976 [1776]). One of their crew members, Don Bernardo Miera y Pacheco, proved extremely useful in producing maps, recommending sites for camping, and taking measurements of latitude (Alexander 2007). The two Ute guides, named Silvestre and Joaquin by the Domínguez-Escalante crew, proved invaluable and guided the expedition all the way into Utah Valley. Silvestre was the older of the two and was a leader among the Ute in Utah Valley. Joaquin was only twelve years old but stayed with the expedition for the entire trip while Silvestre remained in Utah Valley (Alexander 1995).

On October 11, 1776, the Domínguez-Escalante group traveled south from the location of the modern town of Milford, Utah through Horse Hollow and arrived approximately 11 miles north of present-day Cedar City. This stopping point is somewhere along Coal Creek in Cedar Valley, just south of Enoch, Utah. They described the area as "a beautiful valley . . . most abundant in pasturage" (Warner 1976 [1776]:74). Their journal entries also describe interactions with the indigenous population residing in the Cedar Valley, but no mention was made of Native Americans living in the Parowan Valley. This is not too surprising based on the fact that they passed just south of the Parowan Valley, rather than traveling through it. Another journal entry recorded while in Cedar Valley mentioned seeing a group of twenty women, "gathering wild plant seeds on the plain" (Warner 1976 [1776]:75). Somewhere near present day Kanarraville (about 25 mi. South of the Parowan Valley), Domínguez and Escalante (Warner 1976 [1776]:77) described a group of Native American writing that, "They had very good piñon nuts, yucca dates, and some little pouches of maize."

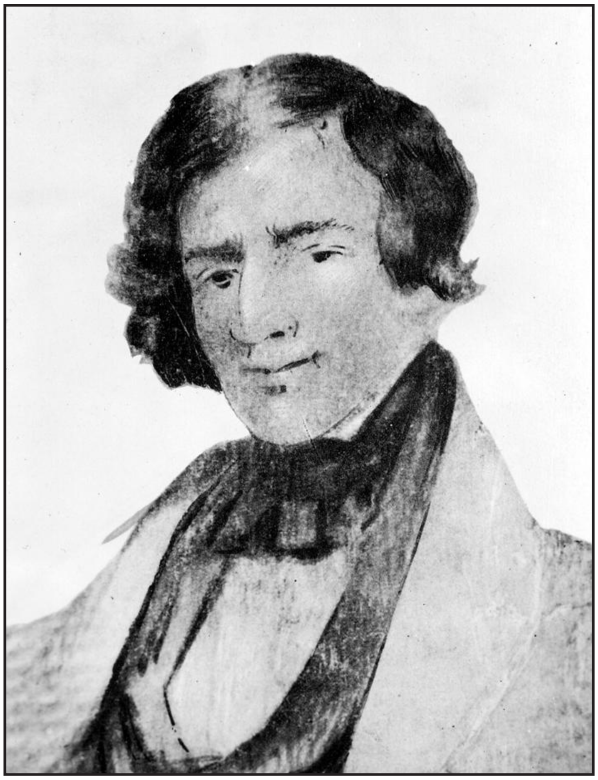


Figure 31. Drawing of Jeddiah Smith ca. 1835. Original drawing in Sullivan 1934.

Figure 32. Painting of John C. Fremont in 1856 by William S. Jewett.

During the next several decades after Domínguez and Escalante, a highly-traveled route, later named the "Old Spanish Trail," was worn into the Parowan Valley floor as part of the route to circumvent the high mountains of the Rockies to the east for journeys to destinations in the west. Trailblazer and fur hunter Jeddiah Smith (Figure 31) was the first American to cross the Sierra Nevadas into California in 1820. He traveled through the Parowan Valley during trapping expeditions to the Beaver River in 1826 and 1827 (Brooks 1977). Explorer William Wolfkill, along with his team of mountain men, Jeddiah Smith, Kit Carson, and George C. Yount (Engstrand 1965), also traveled through the Parowan Valley in 1830, paving the way for subsequent "trappers, traders, gold hunters, and adventurers in small groups and caravans to and from California" (Gregory 1950:4). In 1844, American military officer and explorer John C. Fremont (Figure 32) noted that the trail through the Parowan Valley was well-worn and accommodated troops and wagons easily (Weide 1973). Herbert Gregory (1950:4) writes that although many expeditions and explorers walked the well-worn trail through the Parowan Valley, "none of the thousands who used the Old Spanish Trail seemed to be interested in visiting 'off-trail' lands."

Scouts from the Church of Jesus Christ of Latter-day Saints surveyed the valley in the late fall of 1847, and by 1849, Parley P. Pratt suggested that the "Little Salt Lake Valley be colonized" (Gregory 1950:4). In 1850, Iron County was established and the first group of Latter-day Saints arrived in the Parowan Valley to create a mission there. George A. Smith lead a group of 119 men, 30 adult women, and 18 children to settle in present-day Parowan in 1851. This pioneer settlement included, "101 wagons . . . horses, cows, oxen, mules, dogs, cats, chickens, carpenter and blacksmithing tools, agricultural implements, seeds, and weapons for protection against the Indians" (Gregory 1950:4). Similar to the Fremont, the Latter-day saint pioneers found the alluvial deposits in the Parowan Valley highly productive for agriculture, and they irrigated their crops with water from Red Creek, Parowan Creek, and Summit Creek. They also mined iron ore from Iron Mountain and foraged for timber and feed for their livestock in the mountains to the east above the Hurricane Cliffs. The Latter-day Saints also dug a coal mine, built a saw mill, and harvested crops during their first year in the Parowan Valley. They explored the surrounding area and had several trade interactions with Paiutes, including a meeting with Chief Quinnarrah at Panguitch Lake in June of 1852 (Gregory 1950).

Other than journals detailing daily life, little information is known about any explorations in the Parowan Valley. As Gregory (1950:6) writes, "That the available records for the decades from 1851–1871 include little scientific evidence is easily understood. The physical energies and thoughts of the pioneer settlers necessarily were devoted to procuring food, shelter, and clothing." Little geological or archaeological information was noted about the Parowan Valley until Captain George M. Wheeler and Major John W. Powell surveyed through the valley during the 1870s. Both Wheeler and Powell (Figures 33 and 34) wrote copious, detailed notes about almost every

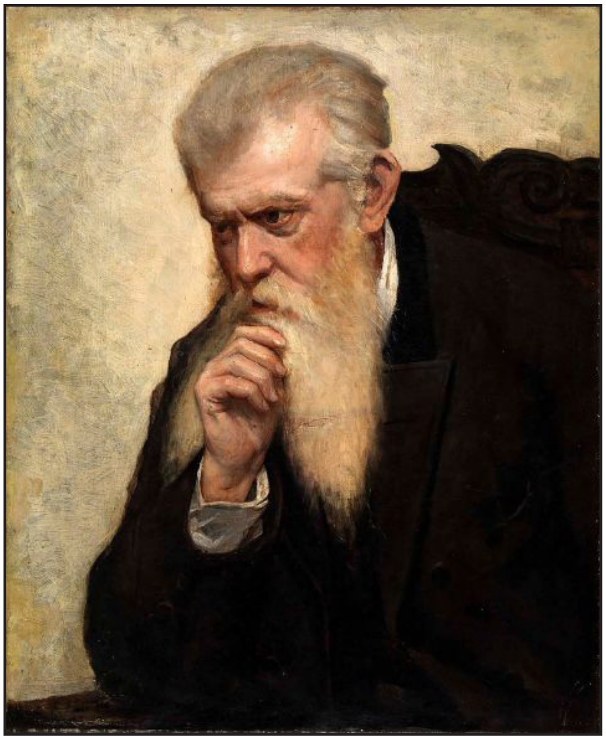


Figure 33. George M. Wheeler in ca. 1910. Painting by Alice Pike Barney.

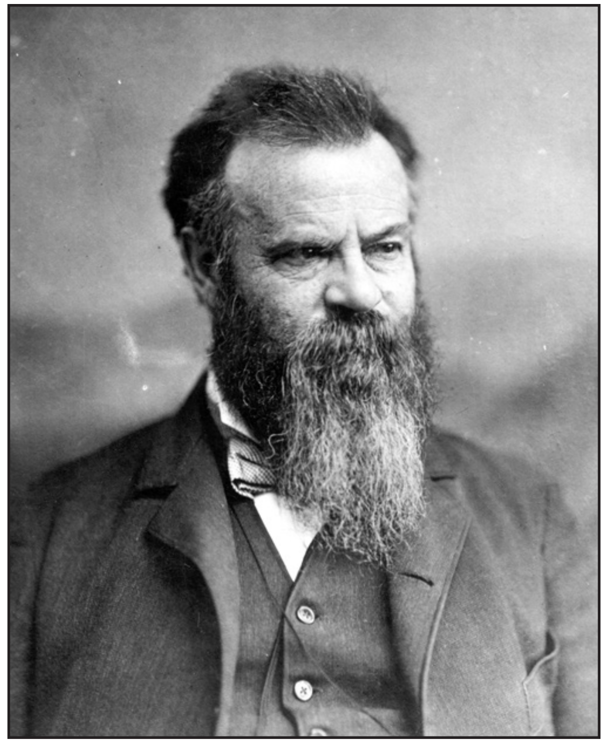


Figure 34. Photograph of John W. Powell. National Archives and Records Administration of the United States, Still Pictures Unit—Photo Citation 115-P-42.

facet of their explorations. Wheeler's documentation regarding archaeological sites encountered in Utah is extremely valuable because many of these sites were subsequently destroyed during development and expansion in the early 1900s.

Parowan Valley Archaeological History

As mentioned in Chapter 2, several early explorers spent time examining Fremont mounds located in the Parowan Valley during the decades between the 1850s and the 1890s. Reports about the hundreds of mounds spread across acres of land in the Parowan Valley offer insight into just how large these Parowan Valley Fremont villages were. Members of the 1849–1850 expedition directed by Parley P. Pratt noted in their journals various archaeological sites including those in the Parowan Valley (Janetski 1997). Brigham Young (1851:46–47) provided a fascinating and detailed description of the numerous Fremont mounds and the associated artifacts he observed near Paragonah, Utah on May 14th, 1851:

> We visited the ruins of an ancient Indian village on Red Creek, where we found quantities of broken, burnt, painted earthenware, arrow points, adobies [sic], burnt brick, a crucible, some corn grains, charred cobs, animal bones, and flint stones of various colors. The ruins were scattered over a space about two miles long and one wide. The buildings were about 120 in number, and were composed apparently of dirt lodges, the earthen roofs having been supported by timbers, which had decayed or been burned, and had fallen in, the remains thus forming mounds of an oval shape and sunken at the tip. One of the structures appeared to have been a temple or council hall, and covered about an acre of ground. Red Creek had been turned out of its natural channel to run through and water the village.

Brigham Young's description provides tantalizing clues about Fremont architecture and possible irrigation, assuming Red Creek was "turned out of its natural channel" by Fremont ingenuity instead of natural processes. The "temple or council hall" may have been the "Big Mound" excavated by Neil Judd in 1926 (see below).

The Parowan Site (42IN100)

Background

In a 1914 letter to Neil Judd, Don Maguire observed mounds near the modern city of Parowan during his visit to the Parowan Valley in 1892 (Judd 1926). Interestingly, in the early 1900s, residents of Parowan "denied all recollection of ancient mounds destroyed during cultivation of their fields" (Judd 1926:38). William Holmes (1886:291), however, noted a "remarkably fine example of a corrugated olla" recovered from near Parowan (Judd 1926:38). As Maguire suggested, a Fremont site was indeed located on the western edge of the modern town of Parowan, Utah.

The Parowan Site was first tested in 1963 and originally named the Adams-Hyatt Mound by a team from UCLA. The expedition notes suggest that UCLA was aware of the mounds as early as 1959, but they were not given permission to dig there at that time. The Parowan Site was eventually excavated by UCLA in 1964 (Arnett 1998). There is very little known about these excavations aside from what was compiled by Abraham Arnett (1998) from a handful of student field notes. Several recent BYU Master's theses also offer additional information regarding the Parowan Site (Hall 2008; Jardine 2007; Watkins 2006; Woods 2009). Unfortunately, a complete site map was never drafted during the excavations, so little is known about the site layout. Attempts have been made to piece together various student sketch maps to recreate a overall plan map for the Parowan Site. I include my draft of a plan map for the Parowan Site compiled from these same student notes (Figure 35).

As with most sites in the Parowan Valley, the Parowan Site was located near the edge of an ancient stream channel which was likely part of Parowan Creek at one time. Arnett (1998) presumes that, "Before historical agricultural practices diverted its flow, the creek passed close by the Parowan Site and emptied into the Little Salt Lake." In addition, the Parowan Site was positioned atop a broad alluvial fan that extends westward from the Parowan Canyon located to the east. According to UCLA field notes, the Parowan Site rose about 10 Ft. above ground level and measured approximately 240 by 70 Ft. or 16,800 ft.^{2} (Peck and Burkeman 1963). Researchers also noticed several smaller mounds nearby and believed that the area had not been plowed.

Architecture

The 1964 excavations uncovered three adobe granaries (Structures 1, 2, and 6) built on top of cobble and adobe foundations, as well as ten poorly preserved and incomplete pithouses (Structures 3, 4, 7, 8, 9, 10, 12, 16, 19, and 20). Arnett (1998) estimates that the pithouses averaged 10–20 ft. in diameter and 6–12 in. deep with finely constructed hearths filled with fine-grained sands. In addition, several well-constructed clay-rimmed hearths were observed both inside structures, as well as extramurally. Arnett (1998) states that four burials were recovered during the 1964 UCLA excavations. One infant and one child were recovered in the midden

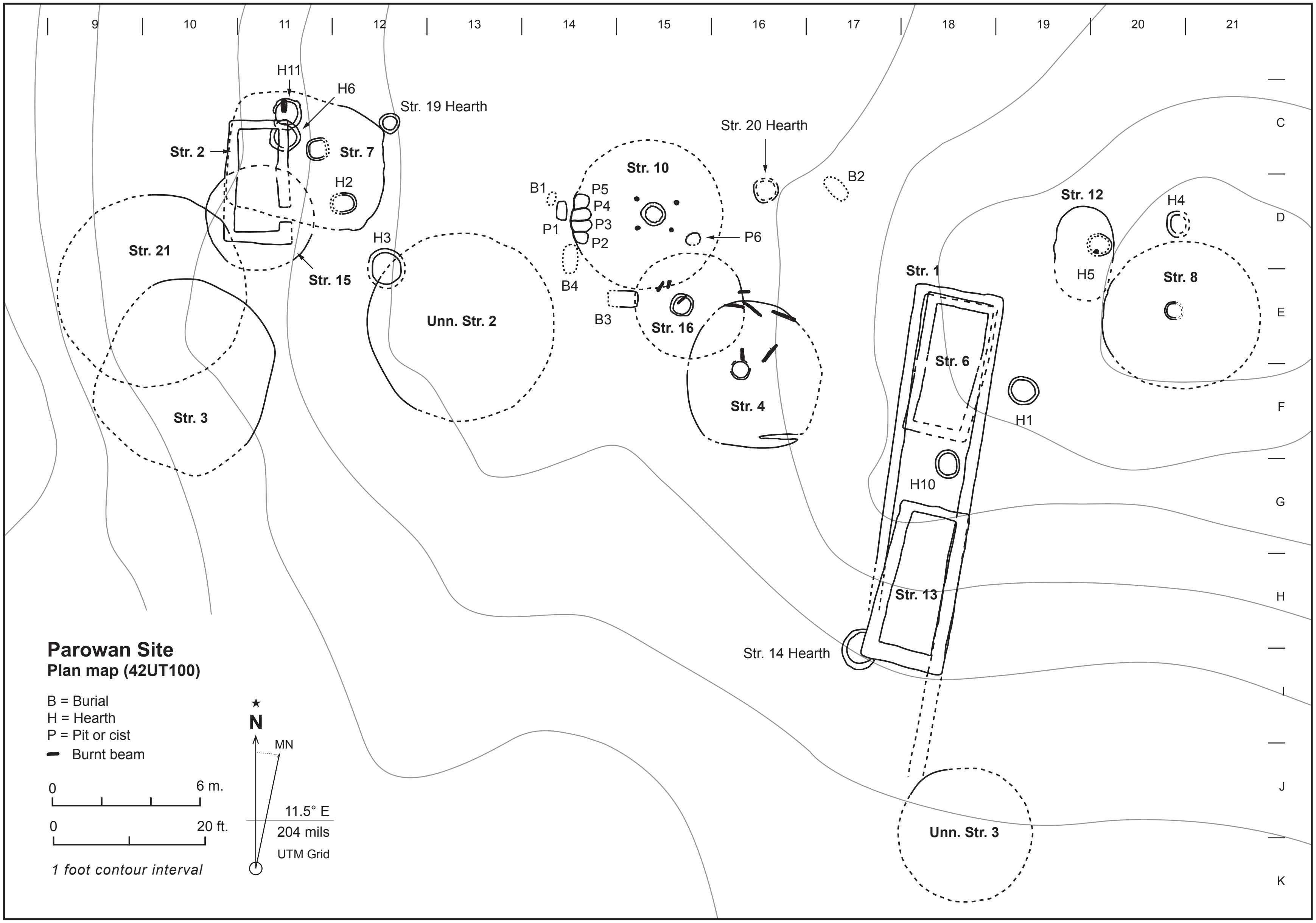


Figure 35. Plan map of the Parowan Site. Drafted from a compilation of original UCLA field sketches.

deposits, and two adults were found inside pithouses 20 and 16. No grave offerings were noted with any of the burials. One adult was sexed as female and one child was sexed as male. The other two sets of skeletal remains were too heavily decayed to determine sex.

Burials

Human remains recovered from four burials found at the Parowan Site represent numerous individuals (Owsley et al. 1998). Burial 1 (grid D14 and D16) contained skeletal remains from a four- to six-month-old infant, and single bones from two adults and one juvenile. Eight pieces of faunal bone were noted with the human remains from Burial 1. Burial 2 (grid D16 and D17) contained the skeletal remains from a 32 to 37-year-old adult male, as well as a single foot phalanx from another adult. Grave goods included ten ceramic sherds, one hammerstone, three cores, utilized and modified flakes, modified faunal bone, a corn cob, and one unmodified faunal bone. Burial 3 (grid E15) contained the remains of a 40 to 49 year-old female. Grave goods included one gaming piece, one hammerstone, one modified flake, one utilized flake, and three faunal bones. Burial 4 (grid D14 and E14) held the skeletal remains of a 4½ to 5 year-old child. The child was not buried with any items.

Douglas Owsley et al. (1998) note an additional scattering of human remains across the Parowan Site landscape at varying depths; however, none were complete, and most were represented by isolated and disarticulated skeletal elements. This scatter of human remains may be the result of modern agricultural “mound leveling” or perhaps from looting.

Artifacts

Material remains included a variety of items recorded by Arnett (1998). Clay artifacts recovered from the Parowan Site include five anthropomorphic figurines and ten clay pipe fragments. The ceramic assemblage is dominated by Snake Valley Gray wares (Table 2). Arnett (1998) reports

Table 2. Ceramic Totals from the UCLA (1963–1964) Excavations at the Parowan Site (42IN100).

Type	UCLA Total*	%
Fremont		
Snake Valley Gray	49543	79%
Snake Valley Corrugated	483	1%
Snake Valley Black-on-gray	12659	20%
Intrusive Fremont		
Sevier Gray	5	< 1%
Puebloan		
Tusayn Black-on-red	32	< 1%
Virgin Black-on-white	7	< 1%
St. George Black-on-white	1	< 1%
Total	62730	100%

* Totals are calculated from UCLA analysis provided to the Office of Public Archaeology at BYU for the Parowan Valley Archaeological Project (2013). It is difficult to ascertain just how reliable these data are, but they are the best information currently available. It is very likely that the actual remaining data today has been altered significantly from the information collected during the 1960s. Notes indicate several discarded catalog numbers, although the totals listed here include these sherds later discarded by UCLA for unknown reasons. This table does not include 3279 sherds designated by UCLA as either unidentified, not typed, or of an unknown affiliation.

that student field notes interpreted several sherds as Tusayan Black-on-red sherds, Virgin Black-on-white sherds, one St. George Black-on-white sherd, and a handful of Sevier Gray sherds. These identifications are tenuous because these sherds have not been professionally analyzed.

Aaron Woods (2009) reports that 390 projectile points were recovered from the Parowan Site, with 58 percent (n=226) made from obsidian. Projectile point types were classified by Woods (2009:44) into 11 separate types: Elko Series, Pinto Series, Humboldt, Rose Spring Corner-notched, Eastgate Expanding-stem, Rosegate, Nawthis Side-notched, Parowan Basal-notched, Bull Creek, and Desert Side-notched. Groundstone recovered includes numerous manos, metates, stone balls, polishing stones, abrading stones, and stone hatch covers. Two metate types were noted: “Utah style” which has a small trough to the side for holding the mano, and a “Nevada style” that is similar to a Utah style metate but does not have a “mano rest or depression at the closed end of the trough” (Arnett 1998:74).

Worked bone artifacts include pendants, gaming pieces, finger rings, beads, needles, awls, antler tools, and other implements used for manufacturing and processing. Hall (2008) writes that excavations at the Parowan Site recovered 418 gaming pieces. Within the total assemblage, 192 were centrally drilled, 362 were stained red, and 48 were decorated. Stone and shell ornaments include one turquoise bead and one turquoise pendant, 55 lignite beads, and 81 *Olivella* beads. Fifty-three of the *Olivella* beads are *O. dama* and 29 were *O. biplicata* (Arnett 1998; Jardine 2007).

Unworked faunal bone recovered from the Parowan Site are predominantly mule deer (MNI=55), pronghorn (MNI=20), and big horn sheep (MNI=12). Rodents, birds, rabbits and hares, and carnivores were also identified by Sara Stauffer (2012:36) but in much smaller percentages compared to artiodactyls. Stauffer (2012:36) also identified scant evidence of bison (MNI=1) and elk (MNI=1) bone. Carnivore remains from the Parowan Site include the domesticated dog (MNI=1), coyote (MNI=1), wolf (MNI=1), bobcat (MNI=1), cougar (MNI=1), American Badger (MNI=1), and black bear (MNI=1) (Stauffer 2012:40).

Chronology

The Parowan Site dates to between A.D. 1000 to 1150 based on the presence of temporally sensitive Snake Valley Corrugated and imported Tusayan Black-on-red sherds from the Ancestral Puebloans. The production of Snake Valley Corrugated pottery begins around A.D.

1050 (Richens 2000), and was most likely produced at the Paragonah Site located just north of Parowan. In addition, the possible presence of Tusayan Black-on-red at Parowan suggests an occupation date of between A.D. 1050 and 1150 (Geib 2011). Arnett (1998:77) also suggests that, "the occupation of the Parowan Site does not seem to extend beyond A.D. 1150 [based on] the lack of definitively rectangular or sub-rectangular pithouse dwellings found at the site." These types of pithouses are typically found at later Fremont occupations post A.D. 1150. Although Arnett (1998) suggests that the Parowan Site lacked late-style Fremont pithouses, Structures 3 and 7 resemble sub-rectangular shapes. In addition, adobe and masonry surface storage structures similar to Structures 1, 2, and 6, date to the later Fremont time period (Talbot 2000a, 2000b), match the other temporally sensitive evidence suggesting the Parowan Site was occupied post A.D. 1150.

The Summit Site or Evans Mound (42IN40)

Background

The Summit Site is located in the southwestern end of the Parowan Valley, approximately 1.5 miles north of the modern town of Summit, Utah. According to Berry (1972, 1974), the Summit Site has one of the largest surviving mounds (known as Evans Mound) in the Parowan Valley today. Berry (1974) writes that Evans Mound measures 300 ft. in length and 160 ft. in width and stands roughly 7 ft. above the modern ground surface. A relic channel of Summit Creek runs along the eastern edge of the current mound and would have been a valuable water source for the village. The Summit Site was strategically placed along this river channel and on top of fertile alluvial deposits to take advantage of the myriad resources this location provided agricultural endeavors. The placement of the Summit Site follows a familiar pattern similar to nearly all the other large village sites in the Parowan Valley.

Table 3. Total number of structures excavated by UCLA and the University of Utah at the Summit Site (42IN40).

Structure Type	UCLA	U of U	Total
Pithouses	14	26	40
Surface granaries	12	6	18
Use areas	0	8	8
Ramadas	1	0	1
Total	27	40	67

The Summit site was initially surveyed by K. Dixon from the University of California, Los Angeles (UCLA) in July of 1954. Dixon (1954) described Evans Mound as a, "large, long mound, containing several houses" with "other mounds in [the] field." The surveyors also noted evidence of looting and exposed adobe walls protruding from the mound. In July 1959, UCLA returned with the permission of Mr. Carl Evans (the owner and namesake for the large mound) and excavated a 5 ft.^{2} pit. The 1959 student notes record 54 in. of cultural fill below ground surface with numerous artifacts recovered from the test pit.

UCLA excavated at the Summit Site between the years of 1960–1964, although records from these excavations are sparse. The only documentation comes from mimeographed reports by McKusick (1960), Ruby and Alexander (1962), Jarvis et al. (1964), Alexander and Ruby's (1963) Great Basin Anthropological Conference report (Berry 1974; Watkins 2006), and student excavation and survey notes. Richard A. Thompson, a professor from Southern Utah University (Southern Utah State College at the time), continued excavating at Evans Mound and Median Village for several years after the UCLA work, but what little notes he kept were later lost to flood damage (Watkins 2006). Thompson later invited the University of Utah (U of U) to hold their field school excavations at Evans Mound and provided numerous resources, including valuable lab space to process artifacts recovered from the U of U field school excavations. Jesse Jennings directed three field schools at the Summit Site from 1970 to 1973 (Dodd and Cozzens 1982; Jennings 1980:xi,).

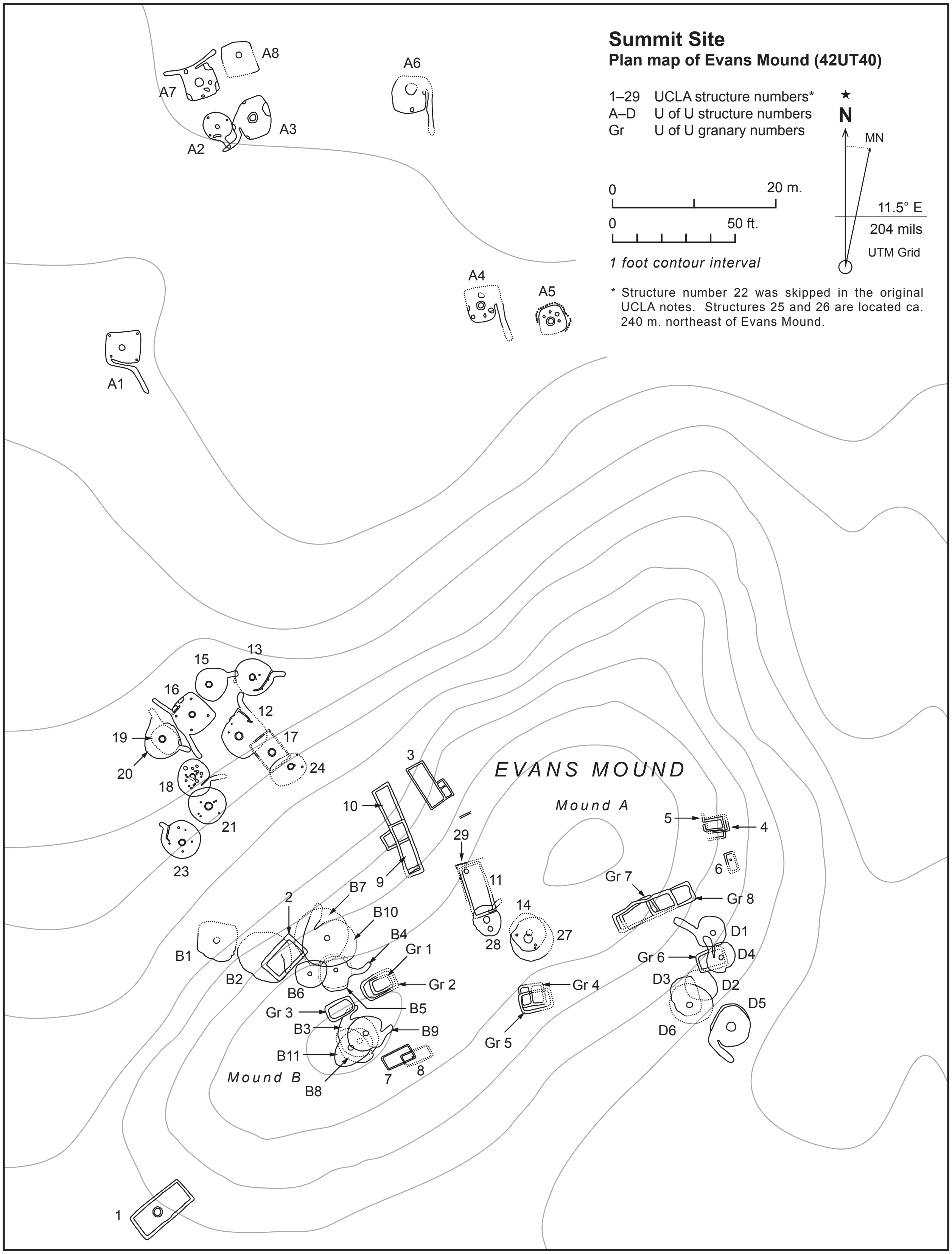


Figure 36. Map of Evans Mound at the Summit Site (42IN40). Drafted by the author from a compilation of original UCLA and U of U field sketches.

Architecture

UCLA's work at the Summit Site resulted in the excavation of 27 structures at Summit, including numerous pithouses, surface granaries, and a ramada. Excavations by the U of U (Berry 1974; Dodd and Cozzens 1982) uncovered a total of 40 structures, including pithouses, surface granaries, and use areas (Table 3). Nineteen of the pithouses were circular in shape and ranged from 10 to 18 ft. in diameter; seven were quadrilateral in shape measuring approximately 15 ft. per side (Berry 1974). Twenty-one of the 26 pithouses contained central hearths with adobe rims. Fourteen dwellings were constructed with ventilator tunnels; however, this number may actually be higher. Several structures missing vent tunnels were previously disturbed. It is possible that the vent tunnels were removed during earlier undocumented excavations in the 1960s (Berry 1974). Finally, 12 of the 26 pithouses contained adobe, jacal, and waddle and daub deflectors, or evidence of deflectors, based on the presence of posthole alignments in the structure floors.

Berry (1974) writes that the nine granaries observed at the Summit Site exhibited less structural variation than pithouses. The granaries were all likely constructed of courses of wet-laid adobe, although evidence for the coursing is not visible in every granary. The granaries measured approximately 5 to 8 ft. in width, 9 to 12 ft. in length, with wall thicknesses at a relatively thin 0.5 ft. (Berry 1974). Of particular interest is the fact that all nine granaries were oriented from southwest to northeast, which Berry (1974:27) attributes to "minimizing the effects of weathering by exposing the least amount of wall surface to prevailing southwest winds."
A total of eight use areas were noted during the four years of excavation at the Summit Site, although only one had postholes with wood post bases inside suggesting a open-walled ramada structure. Several use areas contained external clay-rimmed hearths with ash lenses (Berry 1974; Dodd and Cozzens 1982).

Burials

UCLA excavations uncovered five burials. Three burials were undisturbed and located outside structure walls, but two burials recovered from multi-room storage structures were disturbed by unknown events. Nothing more is known about these burials recovered by UCLA. U of U excavations at the Summit Site recovered 2 human burials during the final year of excavation in 1973. The first burial was recovered in Subfloor pit 1 of Pithouse A7 (this burial is also described earlier in Chapter 3). Jera Pecotte (1982) determined that the individual was an adult male, approximately 30–35 year of age, and standing 5.26 to 5.45 ft. tall. His teeth were in very good condition and his remains did not reveal any pathologies (Pecotte 1982). The remains were found in the flexed position, laying on remnants of a fibrous mat, and buried with several items very unusual in Fremont mortuary practices: a quartz crystal, a large chalcedony biface, a possible whistle, and a number of other more common items. His head was located in the south end of the burial pit, with his face turned to the southwest. A number of corrugated sherds were placed over the right side of the skull, and the remains of a Great Horned Owl (*Bubo virginianus*) were found on the left side of the adult male's skull, facing northeast toward his face, or eye-to-eye (Pecotte 1982; Watkins 2010). Pecotte (1982:117) states that, "It is probable that the skeleton was buried with an owl skin that had the wings and head attached." In addition, this individual was buried with the nine magpies (*Pica pica*) skulls and other unspecified magpie remains around his waist. Watkins (2010) surmises that these magpie remains may have been incorporated into clothing or attached to a belt, and similar to Pecotte (1982), suggests that this individual was likely a shaman buried with shamanistic paraphernalia. Reviews of Fremont burial practices by several researchers (Janetski and Talbot 2000b; Madsen and Lindsay 1977; Roberts 1991) indicate that Fremont burials typically included very few grave goods. In contrast, the items buried with this man makes his internment one of the more unusual Fremont burials ever excavated, suggesting that he held some higher degree of status within the community at Evans Mound.

Pecotte (1982:120) writes that the second burial contained the disarticulated, although complete, remains of an infant found in the upper fill of Pithouse A7. No grave goods were found associated with the burial, and according to Pecotte (1982:120), the infant was likely male. Determining sex from infant skeletal remains, however, is nearly impossible, so the sex should be consider inconclusive.

Artifacts

Artifacts recovered from the UCLA and U of U excavations included a variety of categories including ceramics, chipped stone tools, groundstone, worked bone tools, and basketry. Ceramics recovered from the UCLA and U of U field seasons totaled approximately 125,000+ sherds (Table 4). The exact totals from the UCLA excavations are based on data recorded during the 1960s, but there are some discrepancies in the dataset, as well as unidentified sherds. Aside from ceramic vessels and sherds, two clay pipes, four untempered clay figurines, and several modified sherds were listed among the unusual ceramic artifacts recovered. One modified sherd was described as a "pottery pendant" which was ground on all four sides and had a small conically drilled hole on one end (R. Madsen 1972:73). It measures 4.5 cm in length and 2 cm in width at the base.

The Snake Valley ceramic series dominates (98 percent) the entire ceramic assemblage recovered from the Summit Site. There are three primary Fremont Snake Valley ceramic types: Snake Valley Gray, Snake Valley Black-on-gray, and Snake Valley Corrugated (Dodd and Cozzens 1982; R. Madsen 1972;). Snake Valley Gray dominates the Snake Valley series (Table 4) with nearly three times the next closest ceramic type. Rex Madsen (1972:47) and Dodd and Cozzens (1982:50) note 50 identifiable intrusive ceramics found at the Summit Site,

Table 4. Ceramic Totals from the UCLA* (1960–1963) and University of Utah** (1971–1973) Excavations at the Summit Site (42IN40).

	UCLA	U of U	Total	%
Fremont				
Snake Valley Gray	79981	18934	98915	78%
Snake Valley Corrugated	8213	1361	9574	8%
Snake Valley Black-on-gray	14782	3359	18141	14%
Total	102976	23654	126630	
Intrusive Fremont				
Great Salt Lake Gray	0	4	4	4%
Sevier Gray	3	10	13	13%
Paragonah Coiled	24	48	72	74%
Ivie Creek Black-on-white	6	2	8	8%
Total	33	64	97	
Puebloan				
North Creek Black-on-gray	0	13	13	13%
North Creek Gray	0	1	1	1%
Virgin Black-on-white	13	9	22	22%
Shinarump Brown	0	4	4	4%
Dogoszhi Black-on-white	0	1	1	1%
Tsegi Orange (Red-on-orange?)	0	1	1	1%
Middleton Black-on-red (Dogoszhi style)	2	4	6	6%
Middleton Red	0	2	2	2%
Tusayan Black-on-red (Dogoszhi style)	11	6	17	17%
Unidentified Black-on-white	31	0	31	32%
Total	57	41	98	
Grand Total	103066	23759	126825	253650

* Totals are calculated from UCLA analysis provided to the Office of Public Archaeology at BYU for the Parowan Valley Archaeological Project (2013). It is difficult to ascertain just how reliable these data are, but they are the best information currently available. It is very likely that the actual remaining data today has been altered significantly from the information collected during the 1960s. Notes indicate several discarded catalog numbers, although the totals listed here include these sherds later discarded by UCLA for unknown reasons. This table does not include 3279 sherds designated by UCLA as either unidentified, not typed, or of an unknown affiliation.

** Berry 1972; Dodd and Cozzens 1982

Table 5. List of Projectile Point Type and Counts at the Summit Site as listed by Woods (2009:Table 3.2).

Type	Total	%
Elko Series	48	2%
Pinto Series	4	0%
Gypsum	4	0%
Unidentified Archaic	18	1%
Rose Spring Corner-notched	406	17%
Eastgate Expanding Stem	70	3%
Rosegate	48	2%
Nawthis Side-notched	14	1%
Parowan Basal Notched	1400	59%
Bullcreek	11	0%
Cottonwood Triangular	66	3%
Unidentified Formative	279	12%
Total	2368	100%

including three intrusive Fremont ceramic series (see Table 4). The range for these intrusive ceramics varies widely from north and northeastern Utah, down into the Virgin and Kayenta Puebloan regions of southern Utah and northern Arizona (R. Madsen 1972:94). Dodd and Cozzens (1982:50) write that, "Most of the [Puebloan] types would have been available within an area stretching no more than 75 mi. (120 km) to the southeast, south, and southwest . . . . The remaining types (Sevier, Ivie Creek, and Great Salt Lake) were typically indigenous to more distant Fremont locations, in areas well over 75 mi. (120 km) to the northeast and north."

Chipped stone tools recovered from the Summit Site included "very finely made projectile points, some drills and gravers, and rather small, but very nicely executed bifaces" (Dalley 1972c:97). Source material near the site is comprised mostly of abundant high quality chalcedony nodules washing down from Summit Creek. Dalley (1972c) surmises that obsidian found at the Summit Site was likely obtained from the Milford (ca. 40 mi. west) and Modena (ca. 55 mi. southwest) sources. The projectile point assemblage was dominated by Parowan Basal-notch points (59 percent, n=1400) which are typical at Fremont sites in the Parowan Valley (Woods 2009). Other complete and identifiable point types recovered (Table 5) include Cottonwood Triangular, Eastgate Expanding stem, Elko Series, Pinto Series, Gypsum, Rose Spring Corner-notched, Rosegate, Nawthis Side-notched, Bull Creek, and Unidentified Archaic and Formative points (Dalley 1972c; Dodd and Cozzens 1982; Woods 2009). Untyped complete points include Corner-notched, Side-notched, Single-shouldered, and Stemmed. Other stone tools include drills, gravers, stone awl, complete bifaces, burins, scrapers, complete hammerstones, choppers, and cores (Dalley 1972c; Dodd and Cozzens 1982).

Numerous groundstone artifacts were recovered from the Summit Site, although several specimens were unidentifiable. Totals listed by Wilson (1972:117) for the 1971 and 1972 seasons vary between what is written in the descriptions compared to what is listed in the provenience table; consequently, totals for each artifact type are not discussed here. Groundstone tools found at the Summit Site were constructed from a variety of source materials: Quartz sandstone, vitrophyre, rhyolite ash flow tuff, olivine basalt, quartz monzonite, and devitrified glass (obsidian with feldspar phenocrysts) (Dodd and Cozzens 1982; Wilson 1972). The following is a general list of groundstone artifacts types recovered: manos of varying types and sizes, metate fragments (only one complete trough metate was recovered), stone balls, a stone disk, polishing stones, hammerstones (non-cryptocrystalline material), abraiding stones, and other miscellaneous groundstone tools (Wilson 1972; Dodd and Cozzens 1982).

Worked bone tools recovered from the Summit Site were numerous and included a variety of awl forms, rings, counters (gaming pieces), pendants, flakers, beads, and one whistle (Dalley 1972b; Dodd and Cozzens 1982). Four hundred ninety-nine bone awls were recovered during the 1971 to 1973 excavations and categorized into 11 different descriptive classes (Dalley

1972b; Dodd and Cozzens 1982). Dodd and Cozzens (1982) also report 93 classifiable bone awl fragments from the 1971 and 1972 excavations. Seven bone tubes, 2 beads, 2 rings, and 171 whole gaming counters (gaming pieces) and 5 fragments were also recovered from the Summit Site. The majority of these exhibit a fugitive red wash on one side (Dalley 1972b; Dodd and Cozzens 1982).

Molly Hall (2008) reports that UCLA and SUU excavations recovered 646 gaming pieces, bringing the total at the Summit Site to 898 pieces. Hall (2008:56) reports that 205 of these were preforms, 649 have red staining, 378 were centrally drilled, and 91 were decorated. Hall (2008:56–57) noted what she termed as two "probable sets" of 16 pieces each; all pieces are centrally drilled and are stained red. Two examples are stained on both sides, but the majority are stained on only one side. Other worked bone artifacts include: 14 bone flakers, 36 bone scrapers, 86 scapulae tools, 266 edge worn tools, 66 bone "gouges" or "chisels", 1 flesher, 2 weaving tools, 26 "splinter knives", and 1 bone whistle.

Unworked faunal bone recovered from the Summit Site was predominantly mule deer, pronghorn, and big horn sheep. Rodents, birds, rabbits and hares, and carnivores were also identified by Stauffer (2012) but in much smaller percentages compared to artiodactyls. Stauffer (2012:36) also identified scant evidence of bison (MNI=1) and elk (MNI=1) bone from the Summit Site. The Summit Site also contained what Stauffer (2012) suggests are birds used for ritual activities (NISP=16). Species include Red-tailed Hawk, Golden Eagle, Mourning Dove, Cedar or Bohemian Waxwing, woopeckers, Northern Flicker, American Crow, American Robin, Great Horned Owl, and American Magpie.

Ornamental items recovered from the Summit Site are primarily pendants and beads made from a variety of materials. A total of 167 *Olivella* shell beads were found at the Summit Site. One hundred-fifteen were *Olivella dama*, 35 were *Olivella biplicata*, and 17 were *Olivella* sp. (Jardine 2007). A total of three pieces of turquoise were also recovered from the Paragonah Site

(Jardine 2007:39), as well as 44 bone pendants altered into triangular or trapezoidal shapes and perforated by drilling at the narrower end (Dalley 1972b; Dodd and Cozzens 1982).

Barbara Walling (1982) reported three identifiable pieces of coiled basketry from the Summit Site. She explains that all three pieces were recovered from the floors of two separate structures, and all specimens were heavily charred and fragmented, but still had enough "diagnostic elements that Adavasio (1970) suggests are important indicators of cultural sequence, especially among the Fremont" (Walling 1982:92). According to Walling (1982), the stitch types are typical of those found in the Great Basin and have Archaic origins, something others have also argued (Adavasio 1970; Adavasio et al. 2002). As Adavasio et al. (2002:25) write, "Fremont basketry, though it exhibits some internal variation, geographically and temporally, constitutes as a unit the most distinctive variety of prehistoric basketry in the entire Great Basin with the possible exception of the signature artifact of the Lovelock culture, Lovelock wickerware." They continue explaining that Fremont basketry can be readily and easily identified from the Puebloan basketry traditions to the south, as well as from any other Great Basin foraging cultures nearby. Adavasio et al. (2002:26) state that Fremont basketry may be, "confidently used as an ethnic boundary signature of their makers."

Chronology

Berry (1972:41–44) estimates that Evans Mound was occupied between A.D. 1050 to 1150 based on radiocarbon dating, archaeomagnetic dates (Shuey and Reed 1972), and temporally sensitive intrusive ceramics (mainly Tusayan Black-on-red, Middleton Red, and Middleton Black-on-red). Dodd and Cozzens (1982) argue that the Summit Site was likely not abandoned until 25 years after Berry's (1972) suggested date of A.D. 1150. Dodd and Cozzens (1982) based their abandonment date of A.D. 1175 on the increased percentage of temporally sensitive Snake Valley Corrugated pottery through time.

The Paragonah Site (42IN43)

Background

The Paragonah Site was prehistorically built on the banks of Red Creek (Paragonah Creek) which ran from the mouth of Red Creek Canyon and likely ran through the village (Meighan et al. 1956). The occupants would have had an excellent view of the Little Salt Lake to the northwest and had easy access to large, open flat lands composed of alluvial sediments conducive to farming. The modern town of Paragonah was presumably built at the southern edge of the prehistoric site, but it is highly likely that a large portion of the prehistoric village lies under the modern town today. Unfortunately, as Meighan et al. (1956:3) write, "[modern] cultivation, road construction, and years of relic collecting, has virtually destroyed the site."

Dr. Edward Palmer, from the National Museum, was the first to excavate at mounds located near Paragonah, Utah, during his Utah expeditions between 1869 and 1877 (Judd 1919). In 1872 Dr. Henry Yarrow and Mark Severance observed over 400 mounds near Paragonah as part of the U.S. geographical and geological survey of Utah (Judd 1919; Severance 1872; Wheeler 1889). While at Paragonah, Severance (1872:55) noted, "a congregation of mounds four or five hundred in number, and covering an area of at least fifty acres." In 1893 Dr. Henry Montgomery, a professor from the University of Utah, observed 100 mounds near Paragonah, as did Don Maguire who excavated there in the same year to collect artifacts for the Chicago World's Fair. Montgomery was the only one of these early researchers to publish anything regarding the surveys and excavations at Paragonah in his 1906 journal article *Prehistoric Man in Utah*.

Neil Judd (1919) first visited the Parowan Valley in 1915 and noted that only 50 mounds remained. Judd was the first formally trained archaeologist to work in Utah, and to excavate in the Parowan Valley (Janetski and Talbot 2000a). During the 1915 visit he spent one and one-half days excavating four small mounds at Paragonah. Mounds 1 and 2 contained habitation dwellings along with a scattering of artifacts (for more details see Judd 1926:36–37). Two years later, in July of 1917, Neil Judd supervised a more thorough excavation at Paragonah, during a joint expedition between the Smithsonian Institute and the University of Utah under the direction of John A. Widstoe and Dr. Levi Edgar Young.

Judd summarized what he observed during the 1917 excavations in a general way to avoid making hasty comparison between results from the Paragonah excavation and Puebloan sites in the Southwest. Judd (1919:2) generally describes the ruins of Paragonah stating:

> It must be confessed that, for the layman, there is but little of the spectacular results of the expedition. The student of history, on the other hand, will find much to hold his attention—rude dwellings of earth that seem so thoroughly adapted to their environment and vast quantities of minor antiquities, each of which is its own key to the daily activities and industries of the ancient house builders. Here was a people who came from some distant, undetermined region—a people that established a compact community, with a definite social organization, and then passed on to a new locality where another cycle in their tribal history was unfolded.

Judd published his 1917 excavation which provides valuable information about the largest mound observed at Paragonah banally known as the "Big Mound." The mound measured 225 ft. (68.6 m) in diameter and 10 ft. (3.1 m) tall at the highest point and contained numerous structures (Judd 1919).

During six years of excavation between 1954–1957 and 1959–1960 (forty years after Judd's excavations), UCLA excavated forty additional Fremont structures at the Paragonah Site. The 1954 field season was the only one published (Meighan et al. 1956), although student field notes from all five years were compiled by the BYU Parowan Valley Archaeological Project (2013), or "PVAP," organized by the Office of Public Archaeology's director, Richard Talbot. Meighan et al. (1956) noted that in those forty years the Paragonah mounds had been heavily looted and razed for agricultural purposes, but they estimate that the Paragonah Site originally had close to 320 mounds in total, based on surveys and interviews with Paragonah residents. Meighan et al. (1956:3) write that 320 mounds is not far off from the 400 mounds estimated by Yarrow and Severance in 1872, especially when outliers scattered outside the main concentration are

Table 6. Number of Structures and Types Excavated by Judd (1915–1917) and UCLA (1954–1960) at the Paragonah Site.

	Judd	UCLA	Total	%
Granaries	40	8	48	56%
Pithouses	3	30	33	38%
Surface houses	3	0	3	3%
Ramada	0	2	2	2%
Total	46	40	86	100%

included in the total. Mound diameters documented by UCLA range from 10 ft. (3.1 m) to upwards of 100 ft (30.5 m), and heights from 6 in. to 6 ft. (1.8 m). Based on some tenuous math and numerous assumptions, Meighan et al. (1956:4) suggest that the Paragonah Site population ranged between 100 to 400 persons, with a median population of ca. 250 persons.

Architecture

Judd (1919:9) describes the overall layout of the Big Mound at Paragonah noting that the "more permanent habitations in the big mound are grouped to form, roughly, three sides of a square." He explains that the open area inside the sides of the square was filled with over 6 ft. (1.8 m) of deposits, numerous exterior, open-air hearths, and multiple levels of occupational debris (Judd 1919). Judd's excavations from 1915–1917 (1926) uncovered 46 structures at the Paragonah Big Mound, although Judd (1926) notes that one-third of the mound had been previously destroyed. Meighan et al. (1956:4) write that, "this single mound no doubt contained the remains of at least 60 adobe buildings." Structure types noted by Judd (1926:9) included 40 adobe surface granaries (Judd referred to these as "court shelters"), 3 pithouses, and 3 adobe surface habitation structures (Table 6). Judd (1919, 1926) interpreted the surface granaries as small dwellings, suggesting occupants did little but sleep in these small, often narrow structures and spend most of their time outside, including cooking at exterior hearths. Meighan et al.

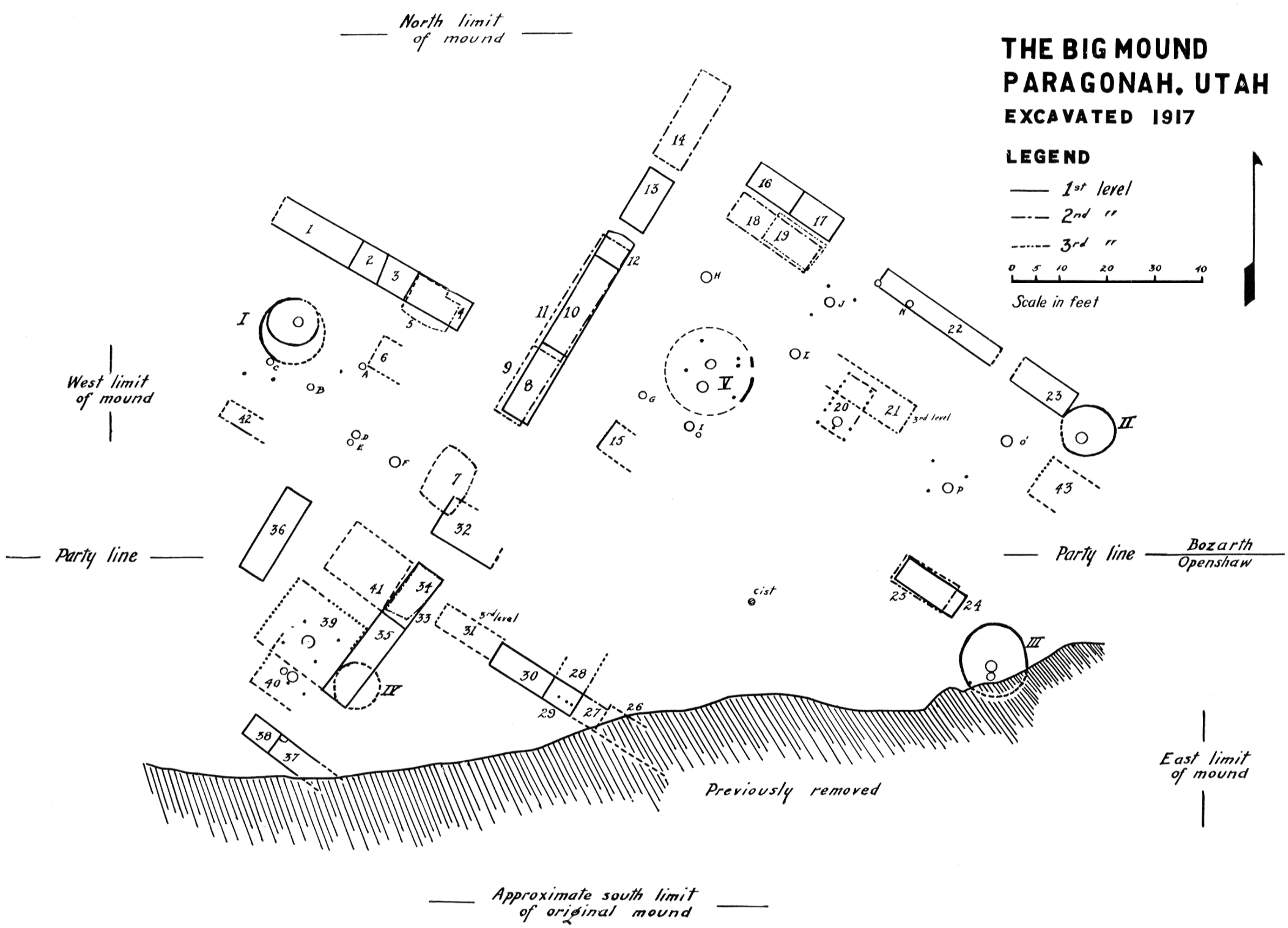


Figure 37. Map of The Big Mound excavated by Judd in 1917 (Judd 1919, plate 1)

(1956) state that Judd's interpretation is inaccurate—these structures are clearly granaries based on the lack of hearths, narrow widths, and very few domestic artifacts.

Circular pithouses excavated at Paragonah from 1915–1917 were interpreted by Judd (1919) as ceremonial rooms or kivas similar to those found among the Ancestral Puebloans. He describes these structures as circular, subterranean, or semi-subterranean. These structures were likely entered through the roof via a ladder (Judd 1919:13). All of the pithouses were lined with adobe, were likely covered with a wooden superstructure, and had centrally positioned, clay-rimmed hearths. As Judd notes, however, in "none of these chambers was anything found which would correspond to the *sipapu*, the fire screen, or the wall recesses in prehistoric kivas throughout the San Juan drainage" (Judd 1919:13). These are important characteristics indicative of Puebloan kivas but clearly missing in these pithouses at Paragonah. Although Judd (1919:14–15) states that these structures were Fremont kivas, based on their subterranean nature, the presence of a few gaming pieces, a bone pendant, and one structure with two hearths, the likelihood that these are indeed kivas is unlikely. Judd consistently describes what are now considered typical Fremont pithouse dwellings; although, in his defense, little was known about Fremont architecture at the time, while more was understood about Puebloan architecture from which Judd drew parallels.

In addition to the granaries and pithouses, Judd (1919, 1926) recorded 3 adobe surface structures. These structures were constructed above ground, were quadrilateral in shape, built with jacal walls, and contained centrally positioned, clay-rimmed hearths. Four large posts, positioned centrally around the hearth, were used to support a flat wood-beam and adobe roof. The inclosing walls, as Judd (126:71) describes, were, "vertical and consisted of a row of posts plastered with adobe mud." The largest of these structures, labeled "Room 39" by Judd (1919:11), measured 15 ft. (4.5 m) by 17 ft. (5.1 m). According to Judd (1919:11), "Room 39" contained a large, 38 in. (96 cm) diameter hearth, four large vertical posts located around the central hearth, and "small upright posts, wattled with brush or willows and plastered with mud." Judd (1919) estimates that over 30 smaller vertical posts, positioned only a few in. apart, were used to support the west wall of Room 39. This structure, along with at least two others ("Rooms 40 and 41") were likely central structures (Talbot 2000b; Ure and Stauffer 2010).

UCLA excavations from 1954–1957 and 1959–1960, recovered the remains of 40 additional structures (see Table 6), although very few details are available regarding the 1955–1957 and 1959–1960 work. The 1954 field season recovered four granaries. Three of the four granaries contained single storage rooms, while the fourth was partitioned into two rooms. A small, empty cache pit was noted in the northern room. These four structures are typical of other adobe-walled, free-standing Fremont granaries and contained a variety of cultural debris: numerous Fremont ceramic sherds, charred maize kernels and cob fragments, a few possible squash seeds, faunal bones, some mano fragments, and several broken sandstone "hatch covers." (Meighan et al. 1956:27). These granaries were constructed of adobe, with walls measuring 12–13 in. (30.4–33.0 cm) thick and well smoothed. Meighan et al. (1956:19) provide an interesting observation about the numerous granaries at Paragonah, "According to our interpretation of the site . . . the adobe structures [granaries] . . . are an innovation to handle a food surplus." Based on the volcanic alluvial sediments and the relatively continual water supply from Red Creek, growing crops in the Parowan Valley was (and still is today) often successful, as well as plentiful. Repeated plentiful harvests would have required increased storage capacity, as well as may explain the assumed comparatively larger population sizes in Parowan Valley villages.

In 1954 two pithouses were excavated by UCLA at Paragonah. One was located on Mound B (Structure 4), and the other was named the "Silo Pithouse" (Meighan et al. 1956). The Mound B pithouse was located via an exploratory trench that uncovered one corner at approximately 12 in. (30.5 cm) below the modern ground surface. The pithouse roof had been supported by four 9-in. (23 cm) posts centrally positioned around the hearth with post holes measuring 25 in.

(63.5 cm) deep (Meighan et al. 1956). A 24 in. (61 cm) tall by 9 in. (23 cm) wide adobe wall was observed in the southeast corner, and stood approximately 24 in. (61 cm) away from the exterior walls. The hearth was centrally positioned and several sets of small post holes found near the hearth were likely ladder sockets. Meighan et al. (1956:62) also described a "ramp and ditch" that ran between the exterior wall and the smaller internal wall. The Mound B pithouse contained both typical and atypical artifacts common in Fremont pithouses. A single burial pit (Burial 1) dug into the intersection between the floor and the northwest wall was also noted inside the Mound B pithouse. Details regarding this burial are discussed below.

The Silo Pithouse, according to Meighan et al. (1956), was destroyed prehistorically by fire which preserved several perishable items that do not typically survive at open sites. The pithouse was 15 $ft.^2$ (4.6 m) and 18 in. (45.7 cm) deep. The four major vertical support posts were positioned closer to the corners than in the center around the fire pit. The hearth itself measured 22 in. (56 cm) in diameter, was adobe-lined with a raised clay rim, and centrally positioned. Meighan et al. (1956) also describe a second rectangular shaped hearth located east of the main fire pit, measuring 36 by 24 in. (91.4 cm by 61 cm), and full of clean sand. Post sockets for the presumed entrance ladder were found inside the second hearth.

Student notes from the UCLA 1955–1957 and the 1959–1960 seasons at Paragonah, note the excavation of additional habitation and storage structures at Paragonah (PVAP 2013). In 1955, UCLA continued excavation at Mounds A and B, uncovering a round-shaped pithouse (Structure 17) directly below the rectangular-shaped Structure 4, as well as three other rectangular pithouses (Structures 5, 6, and 9) found west of Mound B. Another rectangular pithouse was found south of Mound B. One single granary was discovered during the 1955 excavation which was superimposed over an, "unusual square pithouse (Structure 7) with a circular annex to the north (possibly another, smaller pithouse) (PVAP 2013).

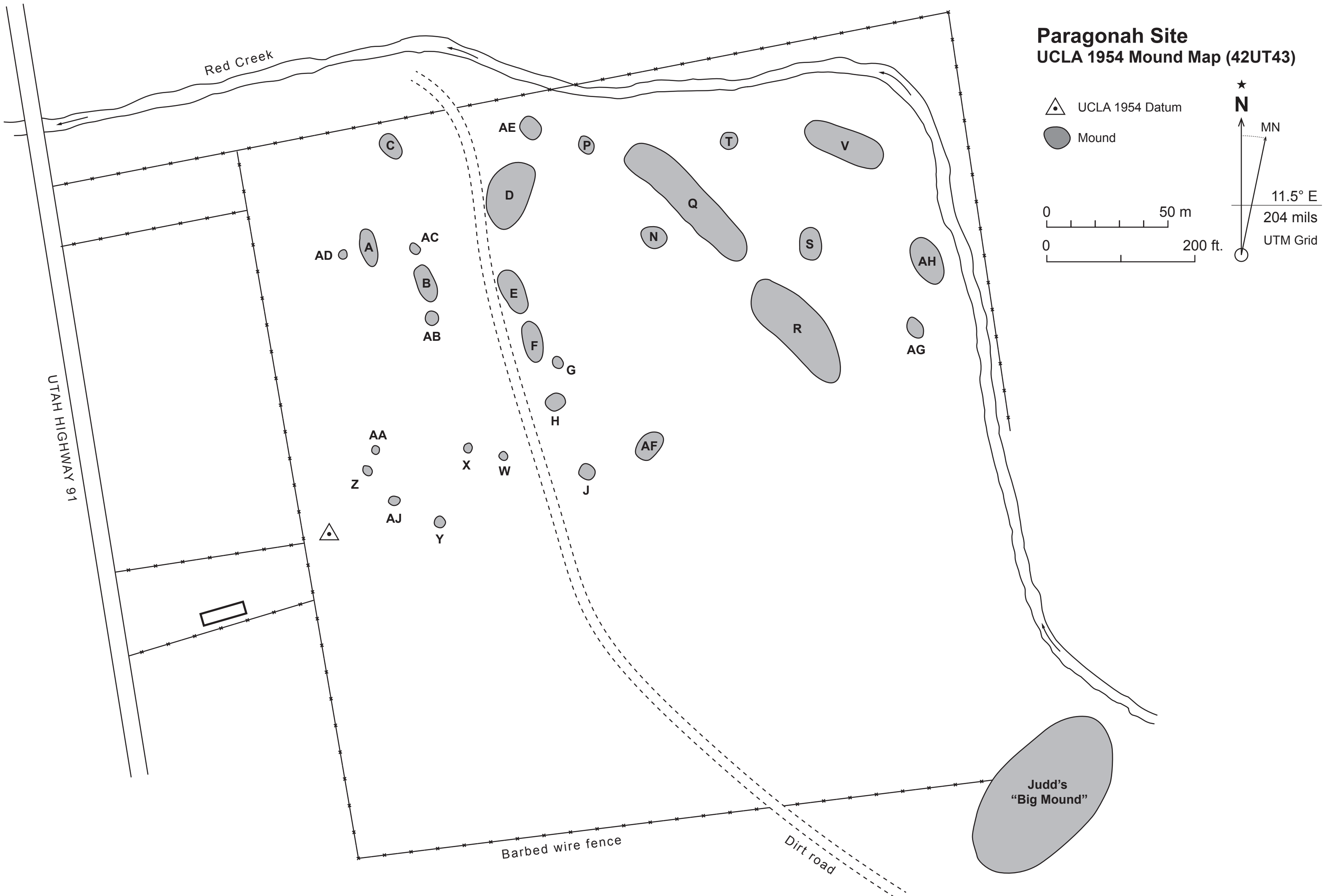


Figure 38. Map adapted from the 1954 UCLA map showing mound locations referenced during their excavations at the Paragonah Site (42IN43). Note the location of Judd's "Big Mound" in relation to UCLA documented mounds. Adaptation by author.

The 1956 UCLA excavations at Paragonah documented several more pithouses, and one square adobe surface granary. Structure 12 was the only round pithouse noted during the 1956 work. The rest of the pithouses (Structures 13–16) were rectangular-shaped and located just east of Mound B (PVAP 2013). Structures 14 and 16 stood out from the rest: Structure 14 had a "bin constructed inside the ventilator shaft" and Structure 16's ventilator walls were constructed with wattle and daub instead of lined with adobe (PVAP 2013).

UCLA excavations in 1957 uncovered six additional pithouses: Structures 19–24 (PVAP 2013). Structures 19, 21, and 24 were round pithouses. Structure 21 was built with two ventilator shafts and contained a burial (Burial 3). Structures 20, 22, and 23 were all rectangular pithouses. Structure 22 was built over Structure 24 (a round-shaped pithouse), and Structure 24 contained a burial (Burial 4). Structure 23 was found superimposed over Structure 20, both of which are rectangular pithouses, instead of the pattern where rectangular habitations typically superimpose circular-shaped dwellings.

UCLA's excavations at Paragonah in 1959 revealed four (possibly five) pithouses and one an adobe surface storage structure (McKusick 1959; PVAP 2013). Structures 27 and 30 are round pithouses, Structures 25 and 28 are rectangular-shaped, and Structure 29 is the adobe storage building constructed with a dividing wall creating two chambers. Structure 26 was initially designated a pithouse, but UCLA excavators eventually decided to call it an outside use area instead (McKusick 1959; PVAP 2013).

The 1960 UCLA field school was the last year they excavated at Paragonah. Excavations concentrated on Mounds X and Y, discovered a total of ten structures: 6 pithouses, 2 granaries, and 2 ramadas (PVAP 2013). Structures 31, 32, 35 were rectangular-shaped and found northwest of Mound X, along with a circular pithouse (Structure 36). Structure 31 contained the intact burial of a probable 5 or 6 year-old child (Burial 6). Structures 37 and 38 were found southeast of Mound Y and were identified as rectangular-shaped pithouses. In addition, two adobe surface granaries were excavated in 1960—one on Mound X, and one on Mound Y. Two open-walled, roofed, outdoor use areas (known as ramadas) were documented south of Mound X (Structures 33 and 34).

Burials

Judd's 1916 excavations at Paragonah recovered the skeletal remains from four individuals. The first was interred in a pit dug inside a structure—the remains were placed under a layer of sandstone slabs that stood ca. 8 in. (20.3 cm) above the structure floor (Judd 1926:59). A second set of human remains was exhumed outside the north wall of the same dwelling, but "no definite information was attainable as to the method of internment" (Judd 1926:59). A third burial was found in an open field, "with head to the west and knees elevated . . . below the raised knees were two fragments of the frontal [bone] of one of an infant." (Judd 1959:59). A fourth burial was noted in the same open field, but the remains were heavily damaged by farmers' plows.

Five burials were recovered during the UCLA excavation at the Paragonah Site, although remains from a sixth burial were briefly discussed in the UCLA NAGPRA documentation (Owsley et al. 1998). Burial 1 was found laying on a layer of decomposed vegetal material comprised of leaves, twigs, and grass near Structure 18. A layer of 1.5 to 3 in. (3.8 to 7.6 cm) thick clay covered the remains. Coles' (1956:121) osteological analysis noted that the remains were incomplete, but enough of the remains were available to determine that the individual was likely a young adult male who suffered from spina bifida. Grave goods included 192 ceramic sherds (not including 1 uncounted bag of ceramics), 8 projectile points, 295 faunal bones (not including 2 uncounted bags of faunal bone), 1 gaming piece, 6 vials of seeds, 3 complete corn cobs, 5 corn kernels, and 1 bag of clay.

Burial 2 was recovered during the 1954 UCLA excavation and contained the remains of a 23–26 year old male (PVAP 2013). This burial was quite elaborate compared to other

Table 7. Grave Goods Found Inside and Above Burial 2 Recovered by UCLA at the Paragonah Site (42IN43) (Meighan et al. 1956).

Item	Qty
Chipped stone	
Stone blades (quartz)	2
Scrapers (quartz, quartzite, and obsidian)	3
Manos (sandstone)	3
Hammerstones (quartzite)	2
Ceramics	
Reconstructable SVG jar (14 sherds)	1
Reconstructable SVC jar (54 sherds)	1
Boulder Gray sherd*	1
Unfired miniature clay vessel	1
Perishables (clothing)	
Remnants of a skirt or kilt	1
Cordage (trace amounts)	—
Faunal remains	
Weasel (*Mustela frenata*) skulls and phalanges	3
Bird skulls and wing bones	—
Wooden objects	
Prayer stick (impressions in clay)	4
Items above burial on pithouse floor	
Manos	9
Hammerstones	2
Large SVC jar (broken)	1
SVBG bowl (broken)	1
SVG jug (broken)	1
Antler wedge	1
Antler flaker	1
Metate fragment	1
Platform pipe (broken)	1

* Possible misidentification (Meighan et al. 1956:84).

Fremont burials. The burial pit was found against the northwest wall of the Mound A pithouse (Structure 4). The pit measured 42 in. (106.7 cm) long,18 in. (45.7) wide, and 47 in. (119.3) deep. Meighan et al. (1956:82) noted distinct “tool marks” indicative of some type of pick used to excavate the burial pit. Based on the position of the skeletal remains, the body was likely placed into the pit on its back in a flexed position. A layer of bark was placed over the corpse, as well as twigs and sticks which left impressions in the ground (Meighan et al. 1956:83). The body was then covered with a thick layer of clay measuring anywhere from 1 to 8 in. (2.5 to 20.3 cm) thick. Underneath the clay and bark layers, the skeletal remains were covered in a "very powdery dark brown dust . . . representing [the] decay of organic materials" (Meighan 1956:83). Grave goods, and an associated trash heap concentrated above the burial, contained both domestic and unusual items which are listed in Table 7 (Meighan et al 1956:63–66, 82–87). According to Meighan et al. (1956:87) the sequence of events for interning this individual were as follows: 1) the burial pit was prepared and the corpse was placed inside wearing what they presume was ceremonial clothing; 2) prayer sticks were placed with the corpse, and then the burial was sealed with wet clay; 3) household goods were intentionally destroyed on top of the sealed burial pit; and 4) the burial was filled and the house abandoned. There is no evidence, according to Meighan et al. (1956) that the dwelling was intentionally destroyed, but they (1956:87) suggest that the structure was never reoccupied, but post-collapse became a dump site for community refuse. Meighan et al. (1956:87) write that, "the man buried in the Mound B pithouse was a person of some importance in the ceremonial life of the community. We suggest that the man was a priest or other religious official, and that he was the owner of the house in which he was buried."

Very little is known about the other three burials recovered by UCLA at the Paragonah Site. According to NAGPRA documentation (Owsley et al. 1998), the nearly complete skeletal remains of an adult (35–45 year old) female were found near Structure 21. Artifacts recovered with her skeletal remains include 3 beads, a hatch cover fragment, 2 manos, and a hammerstone. The nearly complete remains of a 15–21 month old infant were found near Structure 22. This infant was likely buried on a woven mat, along with 1 projectile point, 1 bone awl, 1 mano, and 24 pieces of faunal bone. Structure 31 contained the nearly complete skeletal remains (sex unknown) of a 5 to 7 year-old juvenile (Owsley et al. 1998), but no other information is available regarding possible grave goods or other details. Various other fragmented, isolated, and disarticulated human skeletal remains were found in Structures 1, 14, 16, and 38, but sex and age (except for two bones considered adult) for these individual bones is unknown.

Artifacts

A variety of artifact types were recovered during Judd's excavations from 1915 to 1917, as well as during UCLA's six field seasons at Paragonah. The total number of ceramic sherds recovered from excavation are only available from the UCLA notes (PVAP 2013), but even these totals are incomplete (Table 8). Judd (1919) does mention generic ceramic types noted during his excavations at Paragonah. He writes that the majority of sherds were plain gray, with a few corrugated sherds. Regarding the corrugated pottery, Judd (1919:18–19) writes, "These fragments . . . are sufficient to indicate the development of the ceramic art [corrugation] among these house builders and to establish a cultural affinity between them and the ancient people south and east of the Rio Colorado." Judd (1919:19) also notes decorated jars and ollas, and the "customary black decorations over a gray interior wash were plentiful." Painted designs were described as mostly geometric patterns typical among Puebloan ceramicists, although Judd (1919:19) describes one painted design that represents an animal—something quite uncommon among Fremont painted motifs. Judd (1919:19) makes one interesting final comment regarding ceramics recovered from Paragonah:

> An examination of these Paragonah fragments discloses one peculiarity of ornamentation which is too often repeated to suggest mere accident. This is the interlineal use of red paint, superficially applied. The black decorations were painted directly upon the kaolin wash and were permanently fixed when the specimen was fired. Some of these, however, especially bowls with encircling bands, were further ornamented with red ochre and this is almost without exception was drawn between the black lines some time after the vessel had been removed from the kiln. The red paint, not being permanent, is readily removed by rubbing, but its decorative effect remains unquestioned.

Table 8. Ceramic Totals from UCLA* (1954) Excavations at the Paragonah Site (42IN43).

	Total	%
Fremont		
Snake Valley Gray	24573	61%
Snake Valley Corrugated	8874	22%
Snake Valley Black-on-gray	5315	13%
Paragonah coiled	1332	3%
Total	40094	
Intrusive Fremont		
Sevier Gray	28	90%
Sevier Corrugated	3	10%
Total	31	
Puebloan		
Virgin Black-on-white	10	14%
Boulder Gray	3	4%
Tusayan Black-on-red	11	16%
Moapa Black-on-gray	1	1%
Middleton Black-on-red	4	6%
Unidentified Black-on-white	40	58%
Total	69	
Grand total	40194	

* Totals are calculated from UCLA analysis provided to the Office of Public Archaeology at BYU for the Parowan Valley Archaeological Project (2013). It is difficult to ascertain just how reliable these data are, but they are the best information currently available. It is very likely that the actual remaining data today has been altered significantly from the information collected during the 1960s. Notes indicate several discarded catalog numbers, although the totals listed here include these sherds later discarded by UCLA for unknown reasons. This table does not include 3279 sherds designated by UCLA as either unidentified, not typed, or of an unknown affiliation.

It is not quite clear what Judd is referring to in this description because Snake Valley Black-on-gray bowls are defined as monochromatic (Marwitt 1969; Meighan et al. 1956; R. Madsen 1977) and do not include red lines painted between the black bands as described by Judd. What is more curious is his statement that this occurs "almost without exception" on these Black-on-gray bowls (Judd 1919:19). It seems that although Judd (1919) was referring to Snake Valley Black-on-gray painted bowls, his description of "interlineal" red lines is unknown in other Fremont ceramic studies. Finally Judd observed the common occurrence of a fugitive red wash applied to the exterior of several vessel forms, especially painted bowls.

Meighan et al. (1956) state that ceramics recovered from the UCLA excavations at Paragonah include all of the known Fremont types, but also suggest the presence of what they called "Paragonah Black-on-gray." They suggest that the aplastic inclusions in Paragonah Black-on-gray are different from those found in Snake Valley Black-on-gray; however, Paragonah Black-on-gray is now considered a synonym for Snake Valley Black-on-gray (R. Madsen 1977). UCLA ceramic analysts also observed a ceramic type they labeled Paragonah Coiled. R. Madsen (1977) describes Paragonah Coiled as predominately found in the Parowan Valley, but a few sherds have been found as far north as Seamons Mound (42UT271) in Provo, Utah. Intrusive ceramics (see Table 8) include several Sevier series sherds, and a handful of Puebloan sherds. The range for the intrusive Puebloan sherds varies widely from north and northeastern Utah, down into the Virgin and Kayenta Puebloan regions of southern Utah and northern Arizona. The intrusive Fremont sherds come from the Sevier region just north of the Parowan Valley.

Chipped stone tools recovered from the Paragonah Site include those typically found at other Fremont sites in the Parowan Valley: manos, metates, polishing stones, stone balls, hatch stone covers, hammerstones, and choppers. Chipped stone tools recovered from excavations at Paragonah included projectile points, drills, scrapers, utilized flakes, and "blades" (Meighan et al. 1956). Counts for stone tools are only available for the 1954 UCLA field season and do not represent the likely large assemblage recovered by both Judd's three field seasons and UCLA's five other years of excavation at Paragonah. Woods (2009), however, analyzed all of

Table 9. List of Projectile Point Type and Counts at the Paragonah Site as Listed by Woods (2009:Table 3.2).

	Total	%
Elko Series	6	2%
Rose Spring Corner-notched	28	9%
Eastgate Expanding Stem	17	5%
Rosegate	8	2%
Nawthis Side-notched	5	2%
Parowan Basal Notched	106	33%
Desert Side-notched	1	0.3%
Unidentified Formative	150	47%
Total	321	100%

the projectile points from the UCLA excavations. According to Woods (2009), Paragonah had a significantly smaller number of projectile points (n=321) compared to the Parowan and Summit sites. Regarding tool stone, a total of 163 points were made out of obsidian, while the rest (n=158) were made of a variety of cryptocrystalline cherts (Woods 2009:41). Projectile point counts by type for the Paragonah Site are listed in Table 9.

Judd's (1919:15) opening sentence regarding the "minor antiquities" recovered from the Paragonah Sites states, "In reviewing the minor antiquities exposed during the excavations of the 'big mound' the observer will, first of all, be attracted by the preponderance of bone objects." Judd (1919:15) notes that awls were especially numerous and varied significantly in size and sophistication. He writes that some of these awls, "exhibit a high degree of specialization and are really pleasing examples of aboriginal art" (Judd 1919:15). Other items noted by Judd include a variety of antler tools: punches, flaking tools, and wedges. Judd (1919:16) also noted a collection of "more or less carefully shaped objects . . . employed as dice or counters in various games and yet some of them were unquestionably adaptable to other purposes." Meighan et al. (1956) recovered 58 worked bone tools during the 1954 UCLA excavation at the Paragonah Site and these are listed in Table 10. Worked bone artifact counts from the subsequent five UCLA

Table 10. List of Worked Bone Artifacts from the 1954 UCLA Excavation at Paragonah (42IN43).

	Mound A	Mound B	Rob. Silo	Total	%
Awls	5	12	11	28	48%
Gaming piece	1	5	10	16	28%
Bone bead	1	—	—	1	2%
Bone pendant	—	8	—	8	14%
Flaker	—	3	—	3	5%
Wedge	—	2	—	2	3%
Total	7	30	21	58	

field seasons at the Paragonah Site were not published, but it is safe to assume many other worked bone artifacts were found during those field seasons.

Hall (2008) examined all of the gaming pieces from all of the UCLA excavations at Paragonah, as well as all those from Judd's work at Paragonah from 1915–1917. Artifacts from Judd's excavations are currently split between Natural History Museum of Utah at the University of Utah and the Smithsonian Institution in Washington, D.C. (Hall 2008:48). Gaming pieces recovered from the Paragonah Site total 313 pieces. Hall (2008:48) writes that, "44 are probable preforms, 122 have centrally drilled holes, 278 display hematite [fugitive red wash], and 34 have decoration present."

Unworked faunal remains recovered from the Paragonah Site represent predominantly mule deer, pronghorn, and big horn sheep; rabbits and hares (lagomorphs) are the second most abundant in the faunal record. Rodents, birds, and carnivores were also identified by Stauffer (2012) but in much smaller percentages compared to artiodactyls and lagomorphs. Stauffer (2012:36) also identified scant evidence of bison (MNI=1) and elk (MNI=2) faunal bone. Stauffer (2012:34) notes that the Paragonah Site contained the lowest number of pronghorn and big horn sheep of all the Fremont village sites in the Parowan Valley. Stauffer writes, "both Summit and Parowan assemblages have several hundred more pronghorn specimens than at

Paragonah. The artiodactyl index [for the Paragonah Site], 0.61, is the lowest of the three sites." In contrast, the Paragonah Site had the highest number of lagomorphs (MNI = 60%).

Ornamental items recovered from the Paragonah Site are primarily pendants and beads made from a variety of materials. A total of 71 *Olivella* shell beads were found at the Paragonah Site. Forty-six of these were *Olivella dama*, 13 were *Olivella biplicata*, and 12 were *Olivella* sp. (Jardine 2007). Five turquoise artifacts (4 pendants and 1 bead) were also found at the Paragonah Site during the UCLA excavations (Jardine 2007:39), as well as one lignite bead, and two unusual bone pendants made from the rib of a small mammal found in Burial 2. A total of 8 bone pendants and 1 bone bead were also recovered. It is curious that only one lignite bead was ever recovered from the nine years of excavation at the Paragonah Site by both Judd and UCLA. Examining the collections more closely would likely reveal more lignite beads which are quite typical at most Fremont sites.

Chronology

Neither Judd (1919, 1926) nor Meighan et al. (1956) are able to provide any meaningful information regarding the time frame the Paragonah Site was occupied. In general, the presence of both Snake Valley Black-on-gray and Snake Valley Corrugated pottery suggest parts of the Paragonah Site had Late Fremont occupations that post-date A.D. 1200. The Parowan Valley Archaeological Project (PVAP), however, submitted corn kernels for AMS radiocarbon dating, as well as structural beam samples for tree-ring dating that provide more precise dating information. Calibrated radiocarbon (2-sigma) dates range from A.D. 810–1280, with the height of population at between A.D. 961 and A.D. 1123 (see Table C.1. in Appendix C). Tree-ring dates taken from structures 15, 16, 30, and 31 range from A.D. 1108–1175 (see Table C.2. in Appendix C). All of these structural beams were felled between the months of March to May, except for sample UTM 117 which was dying when originally cut; consequently, the cutting month is unknown for this sample. Based on the AMS radiocarbon and tree-ring dates, Paragonah was most heavily occupied during the later Fremont period which was a time of growth and expansion across the Fremont cultural area.

Mud Springs Site (42IN218)

Background

Compared to the large Fremont village sites in the Parowan Valley, the Mud Springs Site is substantially different. The site was first recorded in 1975 by Southern Utah University. Brigham Young University's Office of Public Archaeology re-recorded the site in 1989 as part of the Wyoming-California Pipeline Company (WYCAL) project. The Office of Public Archaeology at BYU expanded the site boundaries and excavated five 50 by 50 cm tests on the site's eastern side (Berry 2005). In 1990, Dames and Moore examined the site prior to the Kern River Pipeline construction. They recorded nine features they deemed cultural, including several artifact scatters, rock concentrations, and a "rough alignment of nine boulders" (Dames and Moore 1994). In total, Dames and Moore collected 419 artifacts from both surface and sub-surface contexts at the Mud Springs Site (Berry 2005).

In 2003, the Mud Springs Site was retested by Alpine Archaeological Consultants, as part of the Kern River Expansion Project which involved installing 717 miles of 36- and 42-inch natural gas pipeline starting in Opal, Wyoming and terminating in Baker, California. The Kern River pipeline traversed Utah from north to south generally paralleling the Interstate 15 corridor (Reed et al. 2005). A portion of the pipeline intersected the Mud Springs Site boundaries, requiring additional mitigation. Berry (2005:732) writes that, "The Mud Springs Site was selected for additional investigation to provide information concerning Fremont occupation of the region traversed by the Kern 2003 Expansion Project corridor."

Berry (2005:723) states that the Mud Springs Site is located on both private and Bureau of Land Management properties on the eastern side of the Escalante Desert—artifact concentrations are located on a broad alluvial fan created by an "outwash from Mud Springs located 2.5 km to the southeast." The Mud Springs Site is approximately 24 km (15 mi.) east of the large village sites in the Parowan Valley. Berry (2005:723) describes the site as, "a large, diffuse scatter of debitage, a few flaked stone tools, ceramics, and ground stone." The site measures about 340 m southwest-northeast by 400 m northwest-southeast for a total of approximately 106,815 m^2. Establishing defined boundaries, however, has proven difficult for each survey team that has recorded the Mud Springs Site (Berry 2005). Berry (2005:770) was also unable to determine any cultural affiliation for the Mud Springs Site. The presence of nearly 400 Fremont ceramic sherds does indicate that the Fremont were either using or visiting the area. There is insufficient evidence to make any useful determination about how the Mud Springs Site was used prehistorically.

Architecture

No architecture, nor evidence for any structures, has been found at the Mud Springs Site.

Burials

No burials, nor evidence of human skeletal remains, has been found at the Mud Springs Site.

Artifacts

Berry (2005:723) describes artifacts from the Mud Springs Site consisting of obsidian and chert chipped stone tools and debitage; Snake Valley Gray, Black-on-gray, and Corrugated pottery; and mano and metate fragments found scattered across the site surface. Ceramics recovered from the Mud Springs Site are all from the Snake Valley series, aside from 1 Sevier series sherd and 4 unknown gray ware sherds. Snake Valley Gray (n=239) is the most abundant ceramic type at

Table 11. Ceramics Recovered from the Mud Springs Site (42IN218) (Berry 2003).

	Total	%
Fremont		
Snake Valley Gray	239	62%
Snake Valley Black-on-gray	44	11%
Snake Valley Corrugated	102	26%
Total	385	
Intrusive Fremont		
Sevier Gray	1	20%
Unknown gray ware	4	80%
Total	5	
Grand Total	390	

the Mud Springs Site—approximately one-third (n=102) are Snake Valley Corrugated (Table 11). Vessel forms are predominantly Snake Valley Gray jars (n=70), followed by Snake Valley Corrugated (n=23) jars. The majority of bowls (n=20) are Snake Valley Black-on-gray (Berry 2005:735).

A total of 83 chipped stone tools were found at the Mud Springs Site, including 10 projectile points, 2 drills, 51 bifaces in various stages of manufacture, 13 utilized flakes, 2 cores, and 2 scrapers (Berry 2005:751). The lack of projectile points is curious, but may be the result of decades of looting, but also surface artifact collection by the numerous survey crews that have visited the site since the 1970s (Berry 2005). Projectile point types found at the Mud Springs Site include: 1 Parowan Basal-notched, 3 Rose Spring Corner-notched, and 3 indeterminate arrow points. Dart points include: 1 Elko Corner-notched dart point, 1 Large Side-notched point, and 1 possible Humboldt point (Berry 2005:748). Over half (58%) of the formal chipped stone tools were made from obsidian, while the rest were made from of a variety of cryptocrystalline cherts. Thirty-three obsidian flakes were submitted for sourcing using geochemical analysis. All samples were sourced to Wild Horse Canyon which is located about 50 km to the northeast in the Mineral Mountains (Berry 2005:753). The one Parowan Basal-notched point is made from Wild Horse Canyon obsidian (Berry 2005:746).

Nineteen pieces of groundstone were collected from the Mud Springs Site. Berry (2005) notes that the majority were found on the surface and often fragmented and eroded. Groundstone tools included 1 complete basin metate, 1 complete unifacially flaked one-handed mano, 4 metate fragments, 2 abraders, a stone ball, and 6 miscellaneous groundstone tool fragments (Berry 2005). Tool stone types include basalt, sandstone, andesite, shale, welded tuff, and quartzite (Berry 2005).

Chronology

Based on the presence of temporally sensitive Snake Valley Corrugated pottery, the Fremont were present, at least to some degree, at the Mud Springs Site from between about A.D. 1050–1250. According to Berry (2005), one Snake Valley Gray sherd recovered from the site was subjected to thermoluminescence resulting in a date range of A.D. 1139–1355. The first half of the date range is "congruent with the known temporal span of the Fremont occupation of southwestern Utah" (Berry 2005). The later date of A.D. 1355 is a bit late for the Fremont in Utah. In general, porus pottery constructed with igneous aplastic inclusions do not date well using the thermoluminescence method. Radon loss in porus pottery constructed from igneous and volcanic geology can create disequilibrium (Aitken 1985; Kojo 1991; Meakins et al. 1979). According to Richard Roberts (1997), this often results in a "twenty percent age underestimate."

It is possible, that there was an earlier Fremont presence, but there is very little evidence to substantiate this proposal. It seems likely that the Mud Springs Site was visited, perhaps even occupied briefly, during the peak occupation of the Fremont villages in the Parowan Valley, based on the presence of 100 Snake Valley Corrugated pottery pieces. Without more directly dateable material, little more can be said about when the Fremont were present at the Mud Springs Site. More importantly, without additional details, understanding what the Fremont were doing there, and why, is limited at best.

Discussion

In this chapter I described the early exploration and major archaeological undertakings in the Parowan Valley, providing details regarding the cultural framework and background pertaining to the archaeological sites associated with the Snake Valley Corrugated pottery analyzed for this thesis. Prehistorically, the Parowan Valley was a major Fremont cultural and economic center. Very few other Fremont sites compare in complexity, size, and population, to the large villages in the Parowan Valley. The Provo Mounds on the eastern shores of Utah Lake, along the Provo River Delta, may compete in size and population; however, the Parowan Valley villages maintained strong trade networks by producing and distributing the majority of painted bowls and corrugated jars across the Fremont cultural area. This economy was likely facilitated by trade fairs that would have attracted many visitors from both Fremont and Puebloan regions alike (Janetski 2002; Janetski et al. 2011). The archaeological record shows that the Fremont villages in the Parowan Valley were trading both goods and ideas with their Ancestral Puebloan neighbors. In addition, examples of shamanism, as well as community aggregation, are present at both the Paragonah and Summit sites, based on the unusual burials, architectural variation, and community organization.

Evidence for social complexity, community aggregation, and planned community organization strengthens the inference that the Parowan Valley villages were some of the most socially complex and developed communities found among the Fremont. Although these practices are found at other Fremont sites, none can match the scale and scope observed in the archaeological record recovered from the Parowan, Paragonah, and Summit Sites. The Parowan

Site is included in this list because prehistorically it was probably similar in size and population to the Paragonah and Summit Sites. According to Talbot (personal communication 2013), the Parowan site was comparable in size to the neighboring sites to the north and south. He suggests that it was likely as large as the modern city of Parowan today. Unfortunately, very little archaeological work was undertaken at the Parowan Site before most of the mounds were removed for modern development. If, as Talbot suggests, we assume that all three sites were about the same size prehistorically, then the Fremont population in the Parowan Valley may have included a minimum of approximately 750 individuals (but possibly several times more), based on Clement Meighan et al. (1956) estimates for Paragonah. At a maximum, the Fremont population in the Parowan Valley may have topped 1500+ people during it's zenith around A.D. 1100. During this time, the Fremont villages in the Parowan Valley, especially when considered in the aggregate, were undoubtedly centers of commerce, culture, and technological advances without rival in the Fremont cultural area.

6 | Dataset, Methods, and Theory

Introduction

The previous chapters offer important background regarding Fremont research, the Fremont in general, and the Parowan Valley itself. This background information establishes the framework for my thesis, as well as disseminates more details about several of the most important, yet under-published, Fremont villages in the Fremont cultural area. My thesis, however, is primarily focused on expanding what is currently known about Snake Valley Corrugated ceramics through an extensive examination of technological style in Snake Valley Corrugated pottery. My primary goal is to enhance what is known about Fremont social complexity through an examination of intra- and inter-village interaction among Fremont potters producing Snake Valley Corrugated pottery in the Parowan Valley.

In this chapter I first provide a description of Snake Valley Corrugated pottery based on the various characteristics established by Rex Madsen (1977). I then describe 1) my dataset; 2) my sampling strategy; 3) how I analyzed the sherds; 4) what metric measurements were used; 5) a discussion of previous chemical studies on Fremont ceramics; and 6) use of Neutron Activation (NAA) on my dataset.

In the next section of this chapter, I describe the various statistical methods used to examine the results from my analyses. The statistics ranged from basic descriptive statistical methods (mean, standard deviation, coefficient of variation) used to uncover trends in the metric measures, to more complex methods, including principle component and latent profile analyses. These multivariate statistics were used to examine the more complex multi-dimensional NAA results.

The final section in this chapter outlines a variety of theoretical models that provide a framework for interpreting the results from my analysis. Specfically, practice theory provided the basic foundation for the theoretical trajectory of my thesis. This theory examines the recursive relationship between social structures and the agency of individuals. Other theories I used were technological style, social identity, shared contexts of learning, and passive style. Each of these theories provide additional concepts about how the technological style in Snake Valley Corrugated pottery may represent shared concepts of production and social identity among Fremont potters in the Parowan Valley.

Snake Valley Corrugated Pottery Defined

The primary goal for my thesis is to examine technological style and what it may represent, but a working definition of Snake Valley Corrugated pottery is an important starting point before addressing my research questions. Rex Madsen's 1977 fundamental publication entitled *Prehistoric Ceramics of the Fremont* offers the most comprehensive definition for Snake Valley Corrugated pottery to date. Madsen's publication is still widely used as a essential reference for nearly all Fremont ceramic series, types, and wares. According to R. Madsen (1977:iv), Jack Rudy (1953) was the first to formally identify the Fremont Snake Valley ceramic series which included three new types: Snake Valley Gray, Snake Valley Black-on-gray, and Snake Valley Corrugated. R. Madsen (1977) dates Snake Valley Corrugated pottery to ca. A.D. 1100–1200, although Richens (2000) suggests an earlier arrival date of about A.D. 1050, based on radiocarbon dates and provenience data recovered from the Five Finger Ridge excavation in Clear Creek Canyon.

Snake Valley Corrugated ceramics were constructed with spiral coiling and scraped interiors and then fired in a reduction atmosphere (R. Madsen 1977:9). Raw clay materials have a reddish-brown hue likely procured from either alluvial sources in the Parowan Valley, or from crushed, weathered tuffs, which provided both aplastic and plastic material (Lyneis 1992:10). Fired clays range from light to medium gray, with occasional dark gray to reddish-gray or brown colors (R. Madsen 1977:9). Aplastic inclusions are typically fine to medium angular pieces of quartz, feldspar, and biotite mica, but can also include hornblend and a variety of differentially colored ground mass inclusions (Figure 39). Aplastics range in size from 0.1 to 0.5 mm in diameter and average between 0.2–0.3 mm (R. Madsen 1977:9). Aplastic inclusions constitute approximately 40–50 percent of the vessel wall, and vessel porosity varies from 6.4–10.8 percent with a mean porosity of 8 percent (R. Madsen 1977:9).

Vessel exterior colors vary from light gray to medium gray, with some exhibiting dark gray or reddish-brown to tan colors. Some vessels exhibit firing clouds and evidence of sooting. Vessel interiors are typically well-smoothed with evidence of scraping and light polishing. Exterior finishes are corrugated. Snake Valley Corrugated vessels are not painted or slipped, although some examples have exterior fugitive red washes. Jars dominate Snake Valley Corrugated vessel forms. Corrugated bowls (usually painted on the interior) are rare. R. Madsen (1977:9) explains that Snake Valley Corrugated jars are typically "globular" in shape with "flaring necks" and "rounded bases." Rims forms are usually rounded or square, but some have out-curving lips. Snake Valley Corrugated jars range from "15–30 cm in diameter" (R. Madsen 1977:9) and were likely used for cooking and storage.

R. Madsen (1977:10) explains that Snake Valley Corrugated vessels exhibit five different corrugation techniques:

1. Unobliterated horizontal coils
2. Indented coils that created a diagonal pattern
3. A combination pattern consisting of indented and unindented coils that resemble Pueblo

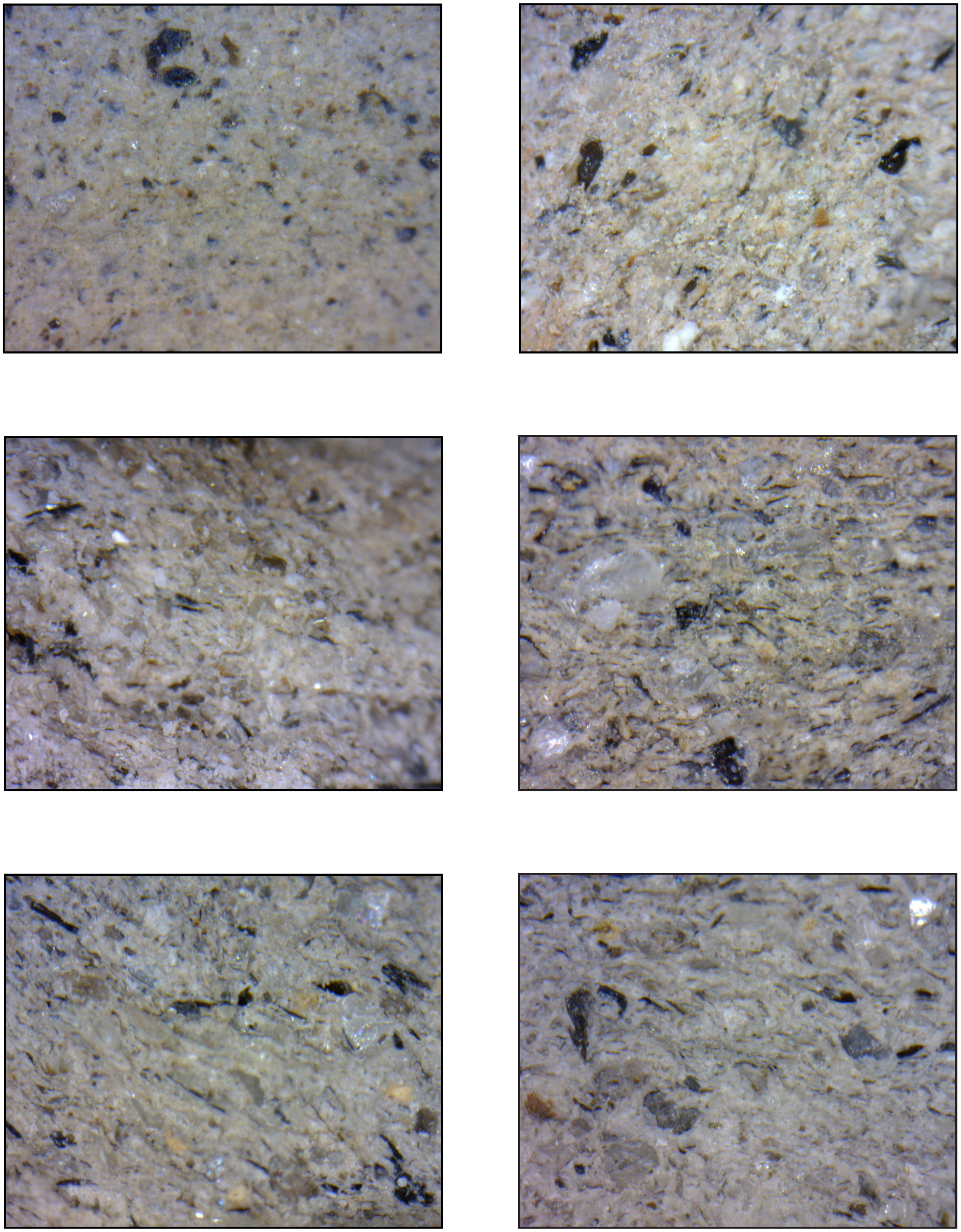


Figure 39. Micrographs of Snake Valley Corrugated rim sherds aplastic inclusions.

II corrugated decoration in the Mesa Verde region
4. Horizontally grooved coils using the fingers or a rounded stick to form a series of shallow, wide depressions
5. Diagonal grooves, sometimes with a fugitive red wash that covers the exterior

Snake Valley Corrugated ceramics are found in the highest densities in the Parowan Valley. According to Clint Cole (2010, 2012) and Watkins (2006), all Snake Valley types (Gray, Black-on-gray, and Corrugated) were produced in Fremont villages in the Parowan Valley. Similar to Cole (2010, 2012) and Watkins (2006), I assumed that all of the sherds in my dataset were made in the Parowan Valley, however, my results (see Chapter 7) now suggest that some were not produced there.

Thesis Dataset

My dataset is composed of 436 Snake Valley Corrugated sherds from three Fremont villages in the Parowan Valley, Utah (Figure 40): Parowan (42IN100), Summit (42IN40), and Paragonah (42IN43). The Natural History Museum of Utah (NHMU) at the University of Utah provided access to 32 Snake Valley Corrugated rim sherds housed in their collections. None of the body sherds were included in my analysis due to time constraints and access limitations. All 32 NHMU sherds are from the Paragonah Site (42IN43). In addition, NAA results from 10 Snake Valley Corrugated sherds recovered from the Mud Springs site (42IN218) were included in the chemical composition results (see Chapter 7). These sherds were collected during the 2003 Kern River Expansion Project and later submitted to the Missouri Research Reactor (MURR) for NAA analysis by Alan Reed and Robert Speakman (2005). The MURR staff offered the chemical analysis results to augment my dataset; however, the physical sherds were not available and are not included in the results from metric analyses performed on the other 436 sherds.

The majority (n=404) of the Snake Valley Corrugated sherds reported in this thesis are part of the Parowan Valley Archaeological Project (PVAP) directed by Richard Talbot from the Office of

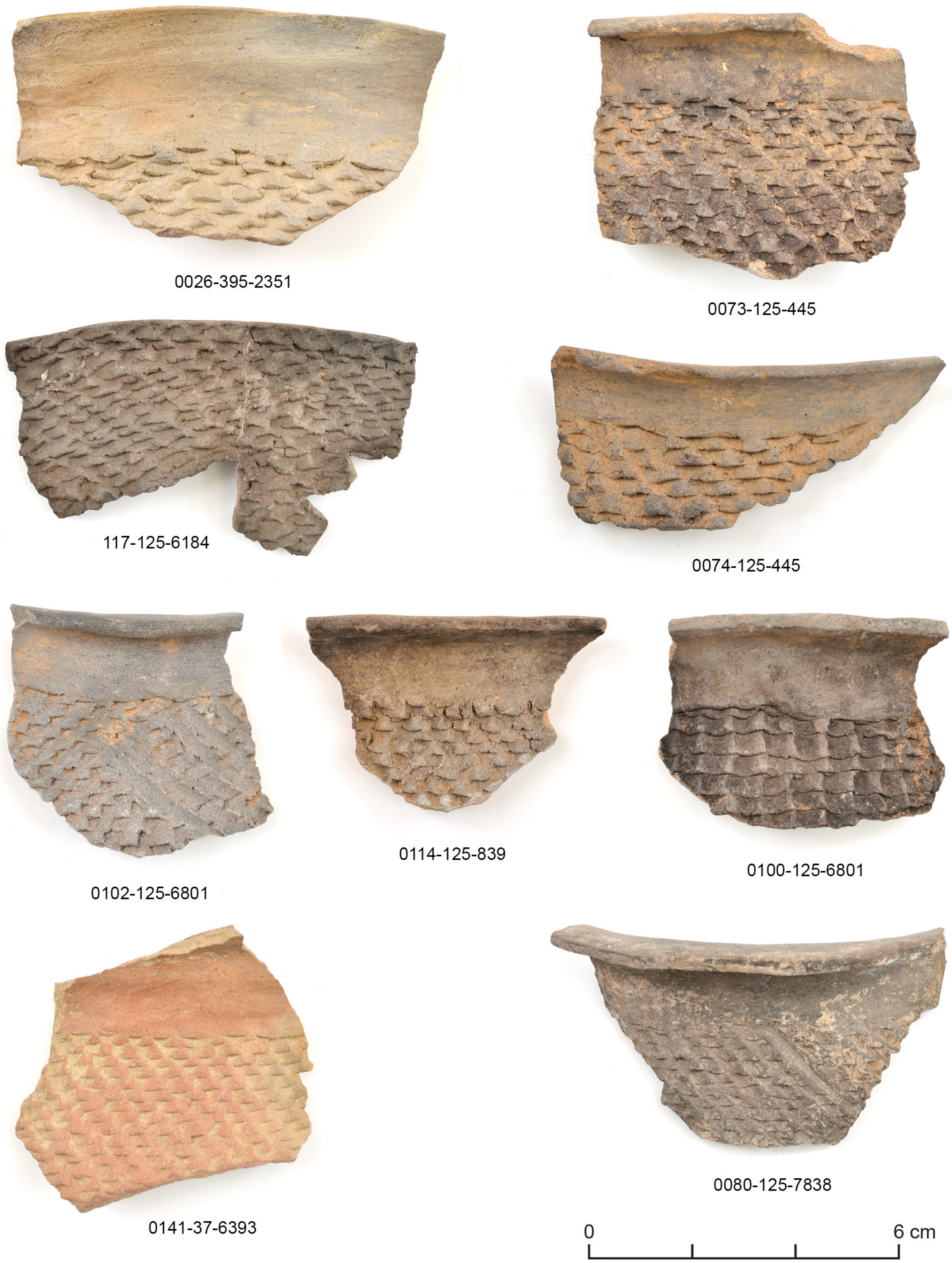


Figure 40. Photographs of select Snake Valley Corrugated rim sherds analyzed in this thesis. Photographs taken by Haylie Ferguson at request of the author.

Public Archaeology at Brigham Young University. The PVAP project was started in 1999 by Dr. Joel Janetski (BYU Department of Anthropology) and Richard Talbot as a re-examinination of the archaeological work performed by the University of California Los Angeles in the Parowan Valley during the 1950s and 1960s (PVAP 2013). The Parowan Valley Archaeological Project is an "effort to address sociopolitical and other research questions regarding the Fremont through the examination of existing collections" (PVAP 2013). The PVAP collection is currently housed at the Museum of Peoples and Cultures, although a few items remain at the Fowler Museum at UCLA.

Sampling Strategy

The total number of ceramics in the PVAP collection is presently unknown. Counts from early analysis by UCLA offer some estimates, but these numbers are incomplete and likely do not reflect the total number of ceramic sherds held in the PVAP collection today. Without a total count of Snake Valley Corrugated sherds, I was unable to create a sampling strategy based on a calculated percentage of the total assemblage. Instead, I based my sampling method on several characteristics: 1) rim presence; 2) sherd length and width; and 3) number of visible coils present. All of the Snake Valley Corrugated rim sherds in the PVAP and NHMU collections were included in my sample. In addition, sherds used for this analysis included all Snake Valley Corrugated body sherds determined to be from different vessels (based on color, and corrugation indent types and sizes), larger than 5 cm^2, and exhibiting at least three measurable coils. All sherds in the PVAP collection that met these criteria were analyzed.

Measurements

Metric data collected for each Snake Valley Corrugated sherd included anywhere from 26 to 40 discrete measurements (Table 12). Forty separate measurements were collected for rim sherds, while 26 measurements were taken for all body sherds. Calipers, metal rim diameter

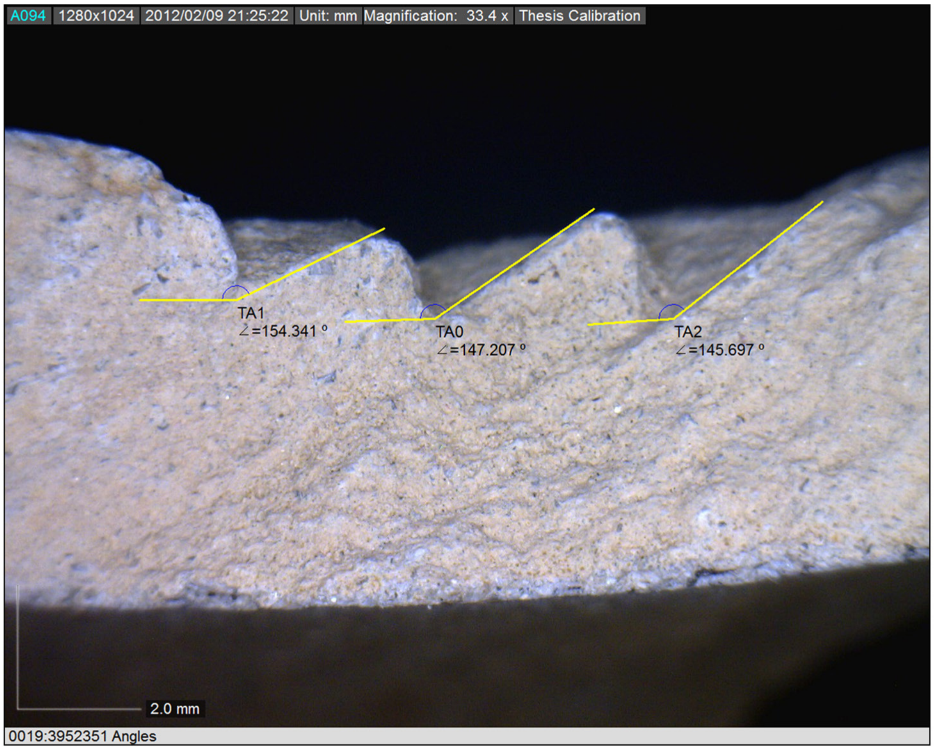
Table 12. Data Collected for each Vessel and Sherd.

Administrative	
	Site number
	Box number
	Thesis number
	Accession number
	Museum affiliation
	Artifact type (rim, body, or vessel)
	Sent for NAA
	Nip refired
Rim sherds	
	Vessel form
	Maximum orifice diameter (cm)
	Minimum orifice diameter (cm)
	Rim form
	Rim eversion (deg)
	Rim treatment
	Rim thickness: small (mm)
	Rim thickness: large (mm)
	Rim thickness: average (mm)
	Thickness at base of rim (mm)
	Uncorrugated rim height: small (mm)
	Uncorrugated rim height: large (mm)
	Uncorrugated rim height: average (mm)
	Lip form
Body sherds	
	Body thickness: small (mm)
	Body thickness: large (mm)
	Body thickness: average (mm)
	Sherd weight (gm)
	Paste munsell color
	Color name
	Sooting (presence/absence)
	Misfired
Corrugation details	
	Coil width: small (mm)
	Coil width: large (mm)
	Coil width: average (mm)
	Number of indenter per 2 cm
	Indent width: small (mm)
	Indent width: large (mm)
	Indent width: average (mm)
	Indent angle: small (deg)
	Indent angle: large (deg)
	Indent angle: average (deg)
	Indent depth: small (mm)
	Indent depth: large (mm)
	Indent depth: average (mm)
	Indent shape
	Corrugation pattern
Surfaces	
	Exterior surface treatment
	Interior surface treatment
	Scraping direction and order
	Surface deposits

gauges, a scale, metal profile gauge, etc. were used for gathering the measurements. More detailed measures were recorded using a digital microscope with scale calibration capabilities, allowing direct measurements of minute details such as indent depths and angles. Micrographs were taken at two separate magnifications to document the aplastic inclusions present in each sherd (Figure 41). Every sherds submitted for chemical analysis (a destructive process) was photographed prior to submission.

Chemical Analysis

Determining the chemical composition of the clays and aplasitc inclusions was a crucial part of examining technological style in Snake Valley Corrugated pottery; however, very few previous chemical analyses of Fremont pottery generated meaningful results to warrant repeating their methods for my analysis (see Reed and Speakman 2005 and Watkins 2006 for an exception). For example, Hendricks (1988) and Hendricks et al. (1990) analyzed 45 and 31 Fremont and Late Prehistoric sherds respectively using x-ray diffraction. The goal for both projects was to "investigate the degree of temper variability within and across the traditional Fremont typology" (Hendricks 1988). Results from these analyses suggest aplastic differences in Fremont ceramics found in Provo, Utah but especially between Fremont and Promontory pottery. In addition, Simms et al. (1997) subjected 120 ceramic sherds from the Great Salt Lake region to x-ray diffraction and compared the results to natural temper material collected around Utah Lake. Bright et al. (2005) also used x-ray diffraction to examine ceramics from Camels Back Cave located in the northwestern portion of Utah. The studies by Simms et al. (1997) and Bright et al. (2005) both concluded that sherds recovered in the Fremont area were generally manufactured with similar temper materials and do not correspond to ceramic type, or time period (Reed and Speakman 2005).



a

b

Figure 41. Micrographs of sherd 0019-395-2351 taken using a Dino-Lite Pro AM413T at 33.4x magnification: a) measurement of indent angles in degrees; and b) measurement of indent depths in millimeters.

X-ray diffraction, however, is a very poor method for examining the chemical composition of pottery because it only analyzes minerals and not their elemental constituents. Minerals are almost always altered when heated and do not compare chemically with their unheated natural counterparts. In addition, sherds fired at different temperatures may not be comparable using x-ray diffraction. Faulty results are likely when comparing fired ceramic sherds to raw materials using x-ray diffraction. In addition, the analysis from all of the x-ray diffraction mentioned above produced only semi-quantitative results which cannot be fully analyzed or integrated into other studies.

In contrast to these studies using x-ray diffraction, Watkins (2006) attempted to identify the production area of Snake Valley pottery using Inductively Coupled Plasma-Mass Spectrometry (ICP-MS) combined with distributional studies. Watkins submitted 113 ceramic sherds from the Parowan Valley, the Sevier Valley, Baker Village (located on the border of Utah and Nevada), and the South Temple site located in Salt Lake City. His chemical assays did not conclusively show that the Parowan Valley was the production area due to challenges with the bulk analysis technique he used. Watkins did, however, argue that Snake Valley ceramics were likely constructed from clays obtained in the Parowan Valley which contained similar, but still slightly different chemistry (Watkins 2006:78). Watkins' distributional models, however, show that the Parowan Valley had the highest concentration of Snake Valley pottery of all the Fremont sites included in his study, and that Snake Valley pottery was distributed or even copied throughout the Fremont culture area.

Using both Watkins (2006) chemical data, and independent chemical assays of Snake Valley ceramics using NAA, Reed and Speakman (2005) identified seven hypothetical, but chemically distinct compositional groups from Snake Valley sherds collected throughout the Fremont region. According to the authors, a significant amount of one particular grouping was visible at all the sites within their project area. They state that "Ceramics with the Group 7 materials were apparently manufactured within a limited area, yet were widely exchanged" (Reed and Speakman 2005:24). They conclude that ceramics made from the Group 7 material were likely made by specialists who produced more pottery than they or their surrounding community could use (Plog 1995).

Clint Cole's (2010, 2012) work compared the clay and temper chemistry in Snake Valley ceramics from the Parowan Valley to sherds in his study area in extreme east-central Nevada. Using the results from Instrumental Neutron Activation Analysis (INAA) and cluster analysis, Cole argues that clay and temper chemistry in Snake Valley sherds found in his research area matches the clay from ceramics and natural material sources he collected in the Parowan Valley. He concludes that classic Snake Valley pottery was produced in the Parowan Valley and traded throughout the Fremont region, including as far west as eastern Nevada.

Similar to Reed and Speakman (2005) and Cole (2010, 2011), NAA was used to chemically examine a sample of the sherds for my analysis. Small portions (about 1 cm^2) of 200 Snake Valley Corrugated rim sherds from my dataset were removed by staff at the Archaeometry Laboratory at the Research Reactor Center of the University of Missouri (MURR). A report of their results is provided in Appendix A. Hector Neff and Donna Glowacki (2002:4) write that, "The basic purpose of characterizing archaeological pottery by INAA [NAA] . . . is to identify sources or source zones where raw materials were procured and ceramics were produced." In addition, according to Michael Glascock (2012), NAA "offers sensitivities that are superior to those attainable by other methods, on the order of parts per billion or better." Neutron Activation Analysis performed at the MURR resulted in chemical levels for 33 different elements (measured in parts-per-million or ppm) for each of the 200 samples submitted. Table 13 lists all of the elements observed in the 200 Snake Valley Corrugated sherds submitted to the MURR.

Neutron Activation Analysis requires a nuclear reactor to provide neutrons that irradiate samples. Neff and Glowacki (2002:3) explain the technical process writing:

Table 13. List of Chemical Elements Collected during NAA.

Element		Element		Element	
Arsenic	As	Europium	Eu	Zinc	Zn
Lanthanum	La	Iron	Fe	Zirconium	Zr
Lutetium	Lu	Hafnium	Hf	Aluminum	Al
Neodymium	Nd	Nickel*	Ni	Barium	Ba
Samarium	Sm	Rubidium	Rb	Calcium	Ca
Uranium	U	Antimony	Sb	Dysprosium	Dy
Ytterbium	Yb	Scandium	Sc	Potassium	K
Cerium	Ce	Strontium	Sr	Manganese	Mn
Cobalt	Co	Tantalum	Ta	Sodium	Na
Chromium	Cr	Terbium	Tb	Titanium	Ti
Cesium	Cs	Thorium	Th	Vanadium	V

* Nickel (Ni) was below detection limits and exclude from analysis (Ferguson and Glascock 2013).

> When a reactor is running, fission of uranium-235 atoms in fuel elements in the reactor core produce neutrons, which may interact in various ways with samples placed in or near the core. Thermal (slow) neutrons then to combine with nuclei of the various elements in the sample to form radioactive nuclei (radioactive isotopes). The radioactive nuclei decay with characteristic half-lives, giving off gamma rays in the process. Different radioactive nuclei emit gamma rays of differing energies when they decay, so the number of radioactive nuclei of a given type in a sample can be determined from the number of decay events counted at a given energy. Because the number of radioactive nuclei of some elements formed by irradiation of a sample is proportional to the number of atoms of that element in the sample, the concentrations of various elements can be determined by counting decay events at different gamma-ray energies.

A range of gamma-rays emissions are collected for each decaying sample using a high-purity germanium detector (Neff and Glowacki 2002). A brief synopsis of the conditions and procedures used by the MURR are listed in Table 14. Figure 42 diagrams the Neutron capture process outlined by Michael Glascock (2013).

Neff and Glowacki (2002:5) explain an important point regarding NAA results from ceramics writing, “Although raw materials are invariably moved some distance from procurement

Table 14. MURR Analytical Conditions and Procedures (Neff and Glowacki 2002:Table 1.1).

Short irradiation time	5 seconds
Short irradiation flux	8 x 10^{13} n/cm^2/s
Decay time before first count	25 minutes
Count time for first count	720 seconds
Standards for pottery, first count	SRM-1633a (coal fly ash); SRM-688 (basalt rock for Ca); Ohio Red Clay (quality control)
Elements from short irradiation	Al, Ba, Ca, Dy, K, Mn, Na, Ti, V
Long irradiation time	24 hours
Long irradiation flux	5 x 10^{13} n/cm^2/s
Decay time before second count	1 week
Count time for second count	2000 seconds
Standards for pottery, second count	SRM-1633a (coal fly ash); Ohio Red Clay (quality control) SRM-278 (quality control)
Elements from second count	As, La, Lu, Nd, Sm, U, Yb
Decay time before third count	3–4 weeks after second count
Count time for third count	2.78 hours (10,000 seconds)
Elements from third count	Ce, Co, Cr, Cs, Eu, Fe, Hf, Ni, Rb, Sb, Sc, Sr, Ta, Tb, Th, Zn, Zr

location to manufacturing location, least-cost consideration dictates that the distances involved will not be great." This statement is based on Dean Arnold's (1985) body of ethnographic and ethnoarchaeological data that suggest that potters generally do not travel great distances to procure raw clays and tempering material. Based on Arnold's (1985) data, we can assume that Fremont potters did not travel far beyond the Parowan Valley to collect raw materials for producing their pottery. Based on Arnold's assumption, and using the results from my methods, I was able to successfully examine the variation in the technological style of Snake Valley Corrugated pottery.

Statistical Methods

An essential part of my examining my data involed using robust statistical methods. As stated earlier, my research questions are based on an assumption that homogeneity in

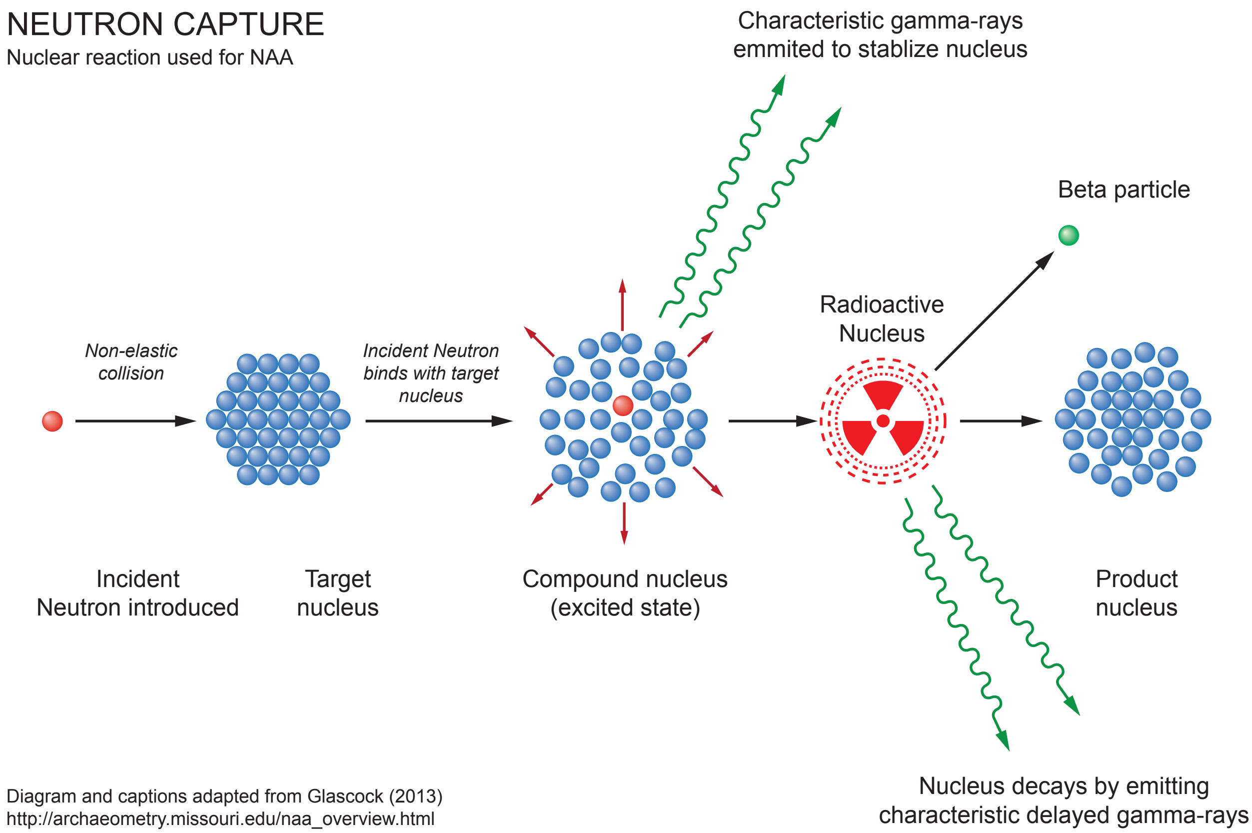


Figure 42. Diagram of the Neutron capture process used in the nuclear reaction for NAA studies. Concepts and captions adapted from Glascock (2013).

technological style of hand-produced goods often varies in proportion to the amount of direct social interaction between producers. Consequnetly, using statisical methods that examine degrees of standardization, or homogeneity, in ceramic vessel technological style help address my research questions. Calculating the degree of standardization requires collecting appropriate metric data including, but not limited to, mean, standard deviation, coefficient of variation, range, and many others depending upon the scope of analysis. Cathy Costin (1995:622) defines standardization within ceramic vessels as the "homogeneity in ceramic materials, vessel shape, and/or decoration." Most prehistoric ceramic assemblages, even those exhibiting higher degrees of standardization, will exhibit some level of variation. The question, then, is to what degree were prehistoric goods standardized, rather than whether standardization is present or absent.

For my analysis, the mean, standard deviation, and coefficient of variation were calculated for a variety of measurements to help evaluate levels of variation or homogeneity. The standard deviation provided a relatively simple measure of variability and dispersion. The lower the standard deviation, the closer, on average, the results were to the mean, while the opposite indicated measurements which were, on average, further from the mean. Stephen Shennan (2004:44) writes, however, that "The problem with the standard deviation as a measure of dispersion is that is it not all that robust." In most cases, extreme values in the dataset will inflate the level of dispersion; therefore, the coefficient of variation is a more appropriate measure for studying degrees of standardization (Searcy 2011:124). Extreme outliers, however, can still negatively influence the coefficient of variation, but in general the coefficient of variation is more robust than a simple measure of deviation.

Coefficient of Variation

William Longacre et al. (1988:103) write that the coefficient of variation is the best measure of standardization because it, "describes relative variation by expressing the standard deviation as a percentage of the mean, thereby removing scale effects." Additionally, the coefficient of variation is reliable even when examining smaller sample sizes (Eerkens and Bettinger 2001:499). Mathematically dividing the standard deviation by the sample mean and multiplying the result by 100 provides the coefficient of variation expressed as a percentage. In general, a lower coefficient of variation suggests a higher degree of standardization. Jelmer Eerkens and Robert Bettinger (2001:497–498) have found that, on average, specialists who produced goods manually, without molds or other aids can achieve a coefficient of variation value of between 2.5 to 4.5 (Eerkens 2000). They also note that the coefficient of variation results at or below 1.7 percent represent the use of measures or templates during the production process. Ethnoarchaeological data collected from specialized potters in San Nicolas, Phillipines, support these results (Longacre et al. 1988; Longacre 1999). Longacre (1999:53) writes that the CV is a very useful statistical tool for examining variabilty in ceramic assemblages. He explains that it helped them determine that specialized potters at San Nicolas, Phillipines, were able to produce pottery that varied between 3 to 4 percent. It should be noted, however, that these results from CV analysis may vary depending on whether the manufacturing process is reductive or additive.

Principal Component Analysis

Principal component analysis (PCA) is a "multivariate technique for transforming a set of related (correlated) variables into a set of unrelated (uncorrelated) variables that account for the decreasing proportions of the variation of the original observations" (Landeau and Everitt 2004:279). In simpler terms, PCA is an exploratory tool to reduce complex, multivariate datasets into a more manageable and understandable number of variables. Sabine Landeau and Brian Everitt (2004:282) explain that, "If the first few of the derived variables (the *principal components*) . . . account for a large proportion of the total variance of the observed variables, they can be used both to provide a convenient summary of the data and to simplify the subsequent analyses." Hector Neff (2002) explains datasets with more than three variables are impossible to display graphically in their entirety. One of the more powerful results, however, from PCA is the ability to graphically plot principal components using bivariate scatter plots, which "assists in understanding the structure of the data" (Landeau and Everitt 2004:282).

Principal component analysis is a common statistical method used for examining the results from chemical analysis such as NAA (Bishop and Neff 1989). PCA is especially useful for ceramic provenience studies because it has the ability to uncover group structures and relationships within the first few principal components (Neff 2002:21). Ferguson and Glascock (2013) explain that PCA offers the ability to, "identify distinct homogeneous groups within the analytical database." This is particularly important for identifying which sources were accessed for ceramic production by which potting groups.

Mixture Modeling: Latent Profile Analysis

Latent Profile Analysis (LPA) is a statistical method developed in the 1800s used to identify different groups within a multivariate population (Goodman 2002). LPA is a, "method [that] determines whether patterns . . . are indicative of varying groups within a sample (Dyer 2009:23). The goal of LPA, as explained by Dyer (2009:23), is to determine if the multi-dimensional dataset is actually a "mixture of several distributions, each representing differing groups." Dyer (2009:24) also explains that LPA

> should not be confused with exploratory factor analysis. While exploratory factor analysis determines if there are certain items that group together, latent class analysis determines what groupings of individual responses exist. Another distinction between the two is that exploratory factor analyses describe responses as a continuous latent variable. In contrast, latent class analysis describes the data in terms of a single latent multinomial variable.
>
> Latent class analysis is also distinct from cluster analysis. Latent class analysis is model based and examines hypotheses concerning the number of "classes" that exist. Further, by using probabilistic categorization, the classification of [variables] into classes integrates the uncertainty about class membership (i.e., classification error). Predictors of class membership are also easily integrated into the model and provide information about the number of classes.

An important aspect to using LPA is identifying and examining the appropriate number of classes, but this is not an automatic process. Dyer (2009:26) writes that, "Researchers must specify . . . a varying number of classes and then examine various model aspects to determine the number of classes." This is typically performed using "goodness-of-fit" methods such as the Bayesian information criterion (BIC) or the information-based criteria (IC).

Although not traditionally used for ceramic studies, LPA offers a new and useful method for examining the multivariate chemical results returned from NAA. Specifically, LPA's ability to probabilistically categorize variables into classes which takes into account classification errors, as stated by Dyer (2009), makes LPA a powerful tool for accurately determining chemical groupings from NAA results of ceramics.

Theoretical Models

Technological Style

There are many steps to producing pottery. These typically include gathering raw materials, processing the clay and temper material (if not included in the clay), constructing/decorating, and finally firing the vessel. Technological style refers to the manifestation of socially influenced choices during each of these steps of production as a means of passive and active communication. Andre Leroi-Gourham (1945) described technological style as the *chaine opératoire* or the "operational sequence." Schlanger (2005) elaborates, explaining that the *chaine opératoire* is the "range of processes by which naturally occurring raw materials are selected, shaped, and transformed into usable cultural products." Each step in the production process is informed by *habitus* and social structure, resulting in artifacts which reflect human social activity and identity. These artifacts can, in theory, be read hermeneutically by applying current observations and recognizing biases to interpret meaning. This process can provide useful interpretations about the steps and actions, and social the influences behind those actions, used to create the artifact in question.

Social Identity

Mark Varien and James Potter (2008:15) state that, "the construction of social identities is one of the most universal of human goals, and many of the choices that agents make relate to defining and negotiating their identities." In her chapter entitled *Exploring Social Identities through Archaeological Data from the Southwest*, Linda Cordell (2008:145) defines social identity as, "the ways people identify themselves in relation to their membership in diverse social groups." She explains that individuals can have multiple nested and mutable identities through time according to their particular circumstances and choice. Examples of these intersecting and cross-cutting identities include membership in a household, gender, clan, community association, kin-group, professional guild, etc.

Identities are often visible in the material goods individuals manufacture because personal tastes, technological choices (e.g., how to produce and decorate pottery), and accepted practices reflect the producers social identity. Varien and Potter (2008:16) explain that the goods they produce are, "a large constituent of any individual's decision-making and behavioral repertoire."

Shared Context of Learning

A shared context of learning is defined as the process of formal or informal learning from family members, friends, and relatives during the production of hand-made goods (Dietler and Herbich 1998). This includes learning from a community of artisans, or guilds, such as the potting communities observed among the Luo potters of western Kenya, and the Kalinga potters in the Phillipines. Among the Luo, "potters tend to live grouped in various network-clusters of homesteads . . . [called] potter communities" (Dietler and Herbich 1998:250). Crown (2001:451) writes that examining shared contexts of learning addresses, "understanding how individuals become skilled practitioners through access to knowledge, technology, terminology, and motors habits, with a particular emphasis on how learning occurs through participation in activity within social contexts."

Numerous ethnographic studies from the Pima show that women were the main pottery producers (Crown 2001). Females were largely responsible for all the aspects of pottery making, including raw material gathering, vessel forming, firing, and decorating (Mills and Crown 1995). Girls in the American Southwest typically learned pottery making from their mothers, grandmothers, aunts, or other female relatives or community members at an early age. Crown (2001:464) writes:

> As documented by DeBoer (1990), Greenfield (1984, 2000), and Wallaert-Petre (2001) learning crafts occurs in a social context that may demand conservatism or encourage creativity and innovation. From these studies, it appears that when transmission is carefully guided by a skilled teacher, there tends to be less variation in the finished products. When transmission involves less direction and more trial-and-error, there tends to be greater variation in the finished products.

Examining shared contexts of learning focuses specifically on how social contexts influence pottery production. More importantly, however, is the degree of variation in technological style that may represent similar shared contexts of learning between villages, or even potting groups within the same community.

Practice Theory

Practice theory is constructed around the concepts of *habitus* associated with sociologist Pierre Bourdieu's (1977, 1990, 1998) theory of practice, and the theory of structuration developed by sociologist Anthony Giddens (1979, 1984). In short, practice theory examines the recursive relationship between social structures and the agency of individuals. Allison (2008:60) explains that, "practice theorists attempt to explain how the actions of knowledgeable human agents are influenced by the structural properties of their societies while the same actions reproduce and modify the structures." Additionally, George Cowgill (2000:51) states that practice theory focuses on how human agents are influenced by their social structure, but they are not necessarily "mechanically determined" to do so. Sherry Ortner (1984:150) argues, however, that "the degrees to which actors really do simply enact norms because 'that was the way of our ancestors' may be unduly undervalued."

Structure

Giddens (1984:377) defines structure as, "rules and resources, recursively implicated in the reproduction of social systems. Structures exist only as memory traces, the organic basis of human knowledgeability, and as instantiated in action." To decipher this definition, William Sewell (1992:6) states that rules are composed of "conventions, recipes, scenarios, principles of action, and habits of speech and gesture." Rules, however, are not always formally constructed. Rules can also be unspoken, informal, and unconscious assumptions and presuppositions. Sewell (1992:6) explains that in this sense rules should really be considered schemas defined as "procedures, rules of etiquette, aesthetic norms, recipes for group action," and contradictions of "female and male, nature and culture, public and private . . . ."

In his definition of structure, Giddens states that in addition to rules, structures also comprise resources. In *Central Problems in Social Theory* (1979:92) Giddens explains that resources are "the media whereby transformative capacity is employed as power in the routine course of social interaction." Resources are therefore human and non-human products or "media" that provide the means whereby an individual can influence others. Sewell (1992:9) explains that human resources are the less tangible personal characteristics including, "strength, dexterity, knowledge, and emotional commitments." Knowledge is an especially important resource that allows agents the ability to maintain, multiply, and control more resources. Sewell (1992:9–10) defines non-human resources as objects that are both, "animate or inanimate, naturally occurring or manufactured, that can be used to enhance or maintain power." Non-human resources are especially important to archaeologists because they constitute the material record from which we derive interpretation. Inevitably, some acquire more goods or skills (both human and non-human) than others, thus creating an uneven distribution; however, all members of society have some access to both types of resources. Sewell (1992:10) writes, "indeed, part of what it means to conceive of human beings as agents is to conceive of them as empowered by access to resources of one kind or another."

If we re-examine Giddens's (1984:377) definition, he states that structures, "exist only as memory traces" and are therefore "virtual." They do not exist in tangible form except as ideas in the human mind that are "instantiated in action" or put into practice by human agents (Sewell 1992:6). Tangible, real-world objects are resources that partially constitute structure; however, they are clearly not "virtual" as described by Giddens, nor do they exist as "memory traces" of those that use them. Pottery, tools, structures, monuments, and many others items are certainly not incorporeal. Inclusion of human resources as virtual aspects of structure is thus confusing. Sewell (1992:10) writes that, "by definition, human bodies, like any other material objects, cannot be virtual." He continues by arguing that all resources must be considered actual instead of virtual which leads Sewell to conclude that "structure refers only to rules and schemas, not to resources, and that resources should be thought of as an effect of structures" (1992:11). Structures according to Sewell, are therefore dual in nature, comprised of virtual schemas and rules, and tangible resources. The relationship between the two is also recursive: schemas are the result of resources, and resources result from schemas. Sewell (1992:13) argues that, "if resources are instantiations or embodiments of schemas, they therefore inculcate and justify the schemas as well." He continues, "resources . . . are read like texts, to recover the cultural schemas they instantiate." This hermeneutic move offers the ability to uncover the social identities wrapped into the resources produced by knowledgeable agents.

Agency

Varien and Potter (2008:6) define agency as, "the choices made by people as they take action, often as they attempt to realize specific goals." In addition they write that, "it is through agency . . . that people signal and define who they are (and who they are not)" (2008:15). It is through agency, then, that individuals express their social identities through active choice. Human beings have an intrinsic capacity for agency, but the form it takes fluctuates due to its recursive relationship with structure. Individuals are both empowered and constrained by their structures, thus sometimes limiting opportunities to make choices. Agency is therefore always considered structured agency (Varien and Potter 2008:9).

More important to my thesis, however, are the unconscious choices made through *habitus* which represent “durable dispositions—ways of being, tendencies, propensities, inclinations” (Bordieu 1977:72). These non-reflexive actions are heavily defined by structure and are often referred to as practice (Bordieu 1990:80–97). They can represent unintended expressions of social identity at a fundamental level. Potter and Varien (2008:7) explain however, that “it is an extreme and indefensible position to argue that action structured by one’s habitus is devoid of choice, of the possibility of acting differently.”

Agency can therefore be considered the intentional and conscious choices that influence actions, whereas practice or habitus refers to the unintended, unconscious, and routine actions, or “what people do” (Hegmon 2003:220). Agency, however, can relate to more than single individuals acting by themselves. Agency can also be expressed collectively. Varien and Potter (2008:8) write that, “agency is fundamentally relational, and it can entail acting in concert with others, including acting with others [or] against others.” They continue writing, “the relational character of agency means that expressions of human agency are always communicative acts in which an individual’s actions are coordinated with, and sometimes opposed to, the actions of others (Varien and Potter 2008:8).

Discussion

The main goal for my thesis is enhance what is known about Fremont social complexity in through an examination of intra- and inter-village interaction among Fremont potters in the Parowan Valley. I suggest that examining variations in technological style in Fremont Snake Valley Corrugated ceramics may help uncover shared contexts of learning and passive representations of social identity. These theoretical perspectives mentioned above provide a helpful framework for interpreting the results from my metric, chemical, and statistical analyses in an attempt to answer my research questions. As mentioned previsouly, practice theory states that agents are individuals that make specific choices to achieve goals. I assume that the Fremont potters (agents) producing Snake Valley Corrugated pottery (resources) were making these ceramic goods for a variety of reasons that are currently unknown. As Sewell (1992) explained, however, I assume that these resources empowered the potters by providing them access to valuable economic goods, as well as knowledge, placing them in a unique position to influence the social structure regulating their immediate society.

In contrast, the physical actions these potters used to produce their pottery were influenced by the current social structures established by the current recipes and conventions regarding ceramic production. I argue that these socially informed steps of production, or technological style, can be observed using a variety of analytical and statistical methods, including those listed earlier. I argue that the repetitive steps used to produce Snake Valley Corrugated pottery were influenced by *habitus,* which is the production process practiced by enculturated potters and visible in technological style. This is important because these actions informed by *habitus* represent passive displays of social identity at the most basic level, as well as might provide insight into Gidden's version of social structure among the Fremont potters living in the Parowan Valley. This information can, consequently, help increase our understanding of interaction among Fremont potters producing Snake Valley Corrugated pottery in the Parowan Valley.

7 | Analytical Results

Introduction

This chapter provides the results from my analysis of Snake Valley Corrugated pottery from three Fremont village sites in the Parowan Valley, and one Fremont artifact scatter located approximately 10 miles west of these three sites. In this chapter, I first discuss the results from the NAA analysis including a synthesis of the report provided by the MURR written by Jeffery Ferguson and Dr. Michael Glascock (see Appendix A). I also provide results from the latent profile analysis performed on the NAA by Dr. Justin Dyer from the School of Family Life at Brigham Young University. These two statistical methods offer valuable insight regarding raw material procurement practiced by Fremont potters. The second half of this chapter discusses the statistical results from my metric measurements for each sherd included in this dataset. The compete list of measures are provided in Chapter 6. These measures were taken in an attempt to uncover minute details pertaining to technological style that may show similarities of variation between potters producing Snake Valley Corrugated pottery.

The analysis performed resulted in important information about the chemical composition and technological style associated with Snake Valley Corrugated sherds. The results discussed below show evidence for the presence of 5–9, but likely 5 or 6, chemically distinct raw material sources inside the Parowan Valley and at least one more outside. The statistical results show that several characteristics can be statistically correlated to a specific sites inside the Parowan Valley. These are important details that hint at potting communities sharing resources, but also expressing social identities in the overt technological styles found in the rim forms, lip forms, corrugation patterns, and possibly in certain thickness just below vessel rims. The following sections provide my results in more detail.

Results from Principle Component Analysis

The main goal for analyzing the results from NAA is to identify homogenous groups within the multivariate dataset. Ferguson and Glascock (2013:3) state that, "Based on the provenance postulate of Weigand et al. (1977), different chemical groups may be assumed to represent geographically restricted sources." I assume, based on this postulate, that the MURR chemical groups identified by analyzing the NAA results represent these "geographically restricted sources." A total of 33 elements were detected from the sherds I submitted to the MURR for NAA analysis. Nickel (Ni) was considered below the proper detection limits (something common with North American ceramics) and was consequently removed from my results. Ferguson and Glascock (2013:3) also explain that high calcium levels can "dilute" the levels of other elements, so all samples were adjusted to compensate for high calcium concentrations. The total dataset included the 200 Snake Valley Corrugated sherds I submitted, and the MURR also included sherds from Clint Cole and from Alan Reed, for a total of 377 sherds (Table 15). The MURR analysis calculated ten different compositional groups and one unassigned category from the total dataset (Table 16). Three class sizes were created based on the results: small (2–5 samples), medium (13–19 samples), and large (38–170 samples).

Small Groups

The small class identified by Ferguson and Glascock (2013) includes MURR compositional groups 1,2,4,5, and 10 and was made of Snake Valley Gray and Snake Valley Corrugated

Table 15. Sherd Types and Totals by MURR Submittee.

	Types							
Submittee	Brown	FB	FCB	Plain	SVG	SVBG	SVC	Total
Cole	16	7	5	8	19	—	5	60
Reed	—	—	—	—	65	19	33	117
Ure	—	—	—	—	—	—	200	200
Total	16	7	5	8	84	19	238	377

Brown = brown ware; FB = Fingernail incised brown ware ; FBC = Fingernail incised false corrugated brown ware; Plain = plainware; SVBG = Snake Valley Black-on-gray; SVC = Snake Valley Corrugated; SVG = Snake Valley Gray

Table 16. MURR Composition Groups Counts by Group noted by Ferguson and Glascock (2013).

	Compositional Group											
Type	1	2	3	4	5	6	7	8	9	10	Unas	Total
Brown	—	1	15	—	—	—	—	—	—	—	—	16
FB	—	1	6	—	—	—	—	—	—	—	—	7
FCB	—	—	4	—	—	—	—	—	—	—	1	5
Plain	—	—	8	—	—	—	—	—	—	—	—	8
SVBG	—	—	—	1	—	1	8	—	5	—	4	19
SVC	1	—	—	—	3	11	20	19	147	—	37	238
SVG	3	1	5	4	—	1	29	—	18	2	21	84
Total	4	3	38	5	3	13	57	19	170	2	62	377

Brown = brown ware; FB = Fingernail brown ware ; FBC = Fingernail brown ware corrugated; Plain = plainware; SVBG = Snake Valley Black-on-gray; SVC = Snake Valley Corrugated; SVG = Snake Valley Gray

pottery, as well as two sherds of brown ware from Clint Cole's (2012) analysis. Ferguson and Glascock (2013:7) explain that, "Small groups like these are difficult to interpret—they may represent unique highly localized recipes, unique raw materials, or possibly multiple sherds from a single vessel." Figure 43 is a bivariate plot provided by the Ferguson and Glascock (2013) displaying the relationship of the small groups to all of the other groups. Sherd URE067, from the Paragonah Site (42IN43), was the only sherd from my dataset that plotted in the small class size. This sherd plotted in Group 1 which was identified as having high concentrations of

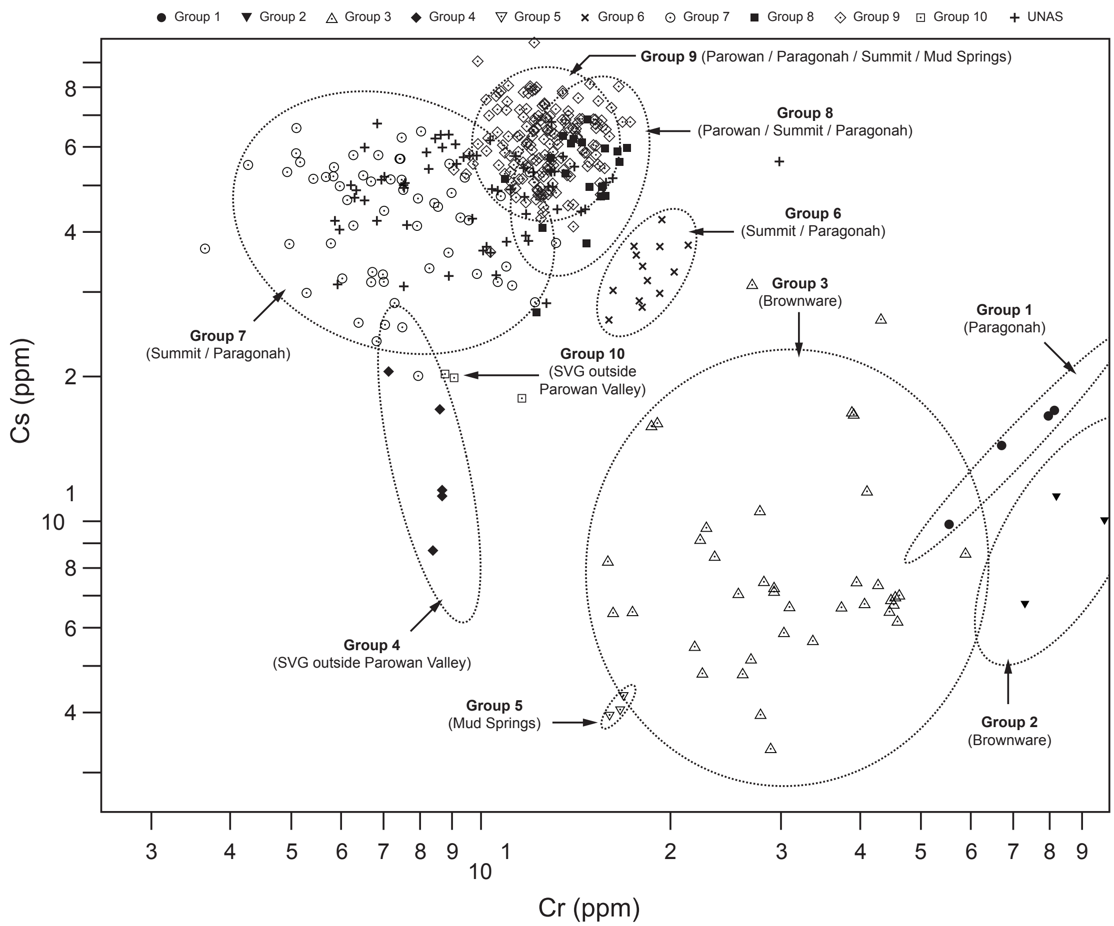


Figure 43. Bivariate plot of chromium and cesium showing all of the MURR compositional groups. The ellipses represent 90 percent confidence levels for membership in the groups.

chromium but reduced cerium (Ferguson and Glascock 2013). Group 2 includes samples from three different sites and is chemically identified as having high levels of chromium and reduced tantalum (Ferguson and Glascock 2013). Groups 4 and 5 are separated when levels of Chromium and Ytterbium are compared. Groups 2, 4, 5, and 10 include only Snake Valley Gray ware.

Medium Groups

The medium class was defined by Ferguson and Glascock (2013) as including MURR compositional Groups 6 (n=13) and 8 (n=19). They (2013:10) explain that “these medium groups may indicate small production recipes at each of these sites, but that is difficult to

Table 17. Counts* of Assigned** MURR Compositional Groups by Site from PCA.

	Groups						
Site	1	5	6	7	8	9	Total
Parowan	—	—	—	—	4	2	7
Summit	—	—	9	14	4	64	91
Paragonah	1	—	4	10	11	65	91
Mud Springs	—	3	—	—	—	14	17
Total	1	3	13	24	19	145	205

* Includes only Snake Valley Series sherds from the four sites examined in my thesis
** A total of 51 sherds from were not assigned groups by the MURR

Table 18. Percentage* of Assigned** MURR Compositional Groups by Site from PCA.

	Groups					
Site	1	5	6	7	8	9
Parowan	—	—	—	—	21	1
Summit	—	—	70	59	21	44
Paragonah	100	—	30	41	58	45
Mud Springs	—	100	—	—	—	10
Percent	100	100	100	100	100	100

* Includes only Snake Valley Series sherds from the four sites examined in my thesis
** A total of 51 sherds from were not assigned groups by the MURR

demonstrate without a better link with the raw materials or without more samples from surrounding sites." Sherds from Group 6 are associated with both Summit (42IN40) and Paragonah (42IN43), although the sample is quite small (Tables 17 and 18). Group 8 is represented equally at Parowan and Summit, but 30 percent higher at Paragonah. According to Ferguson and Glascock (2013:10), group 8 is almost entirely composed of Snake Valley Corrugated sherds and may represent a late Fremont clay recipe used at Paragonah. Figures 43 and 44 show all of the MURR compositional groups in bivariate space. These plots of chromium and cesium, as well as plots of ytterbium and lanthanum in Figure 44, were chosen by Ferguson

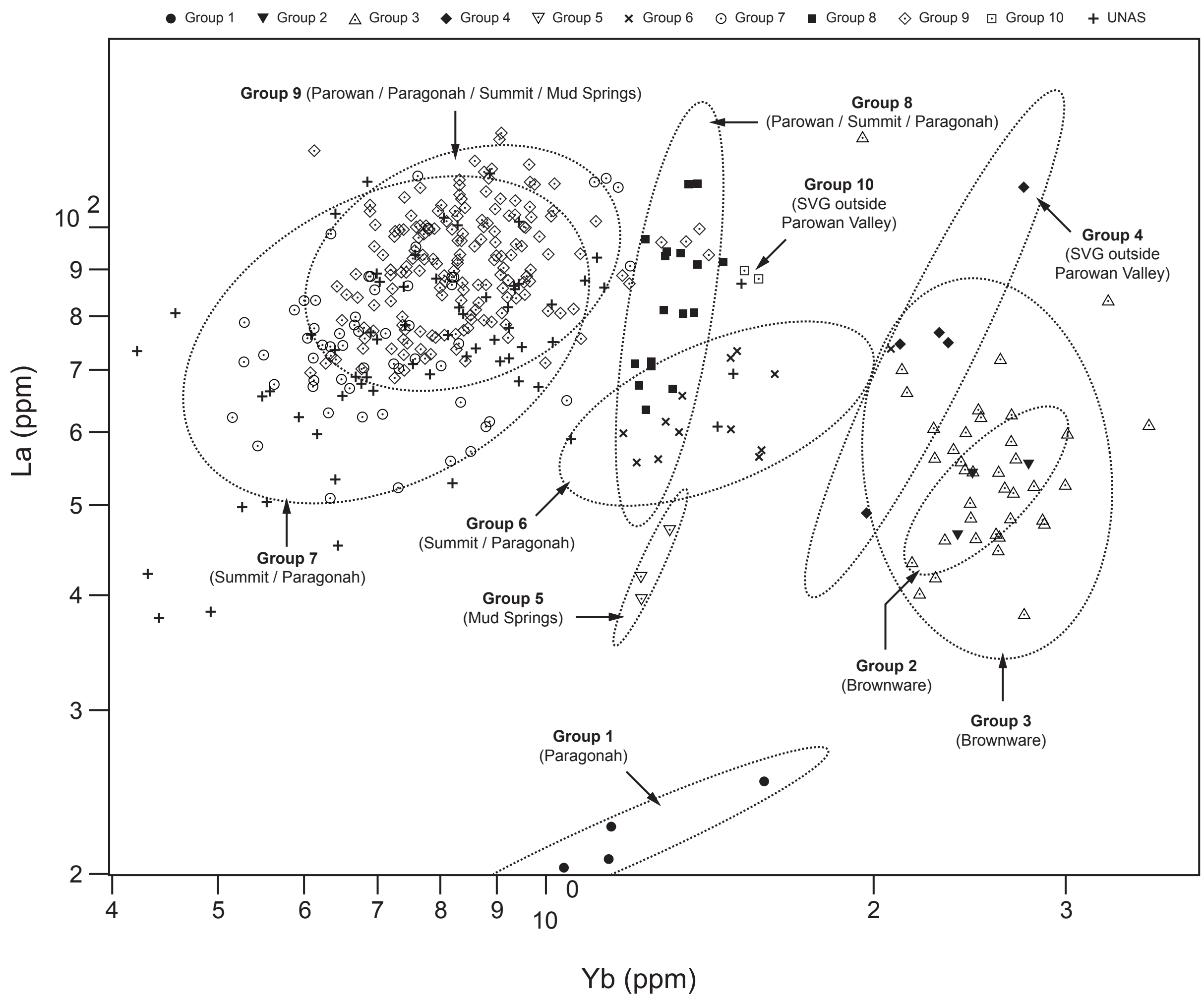


Figure 44. Bivariate plot of ytterbium and lanthanum showing all of the MURR compositional groups. The ellipses represent 90 percent confidence levels for membership in the groups.

and Glascock (2013) because they show the best separation between the compositional groups discussed in their analysis of the NAA results.

Large Groups

Three large groups (Groups 3, 7, and 9) were noted by Ferguson and Glascock (2013). Group 3 (n=38) is largely composed of Late Prehistoric Brown Ware submitted by Cole (2012), although 5 Snake Valley Gray sherds also fit into this group. Groups 7 and 9 are quite complex and have little separation in bivariate plots. Ferguson and Glascock (2013:11) state that, “The

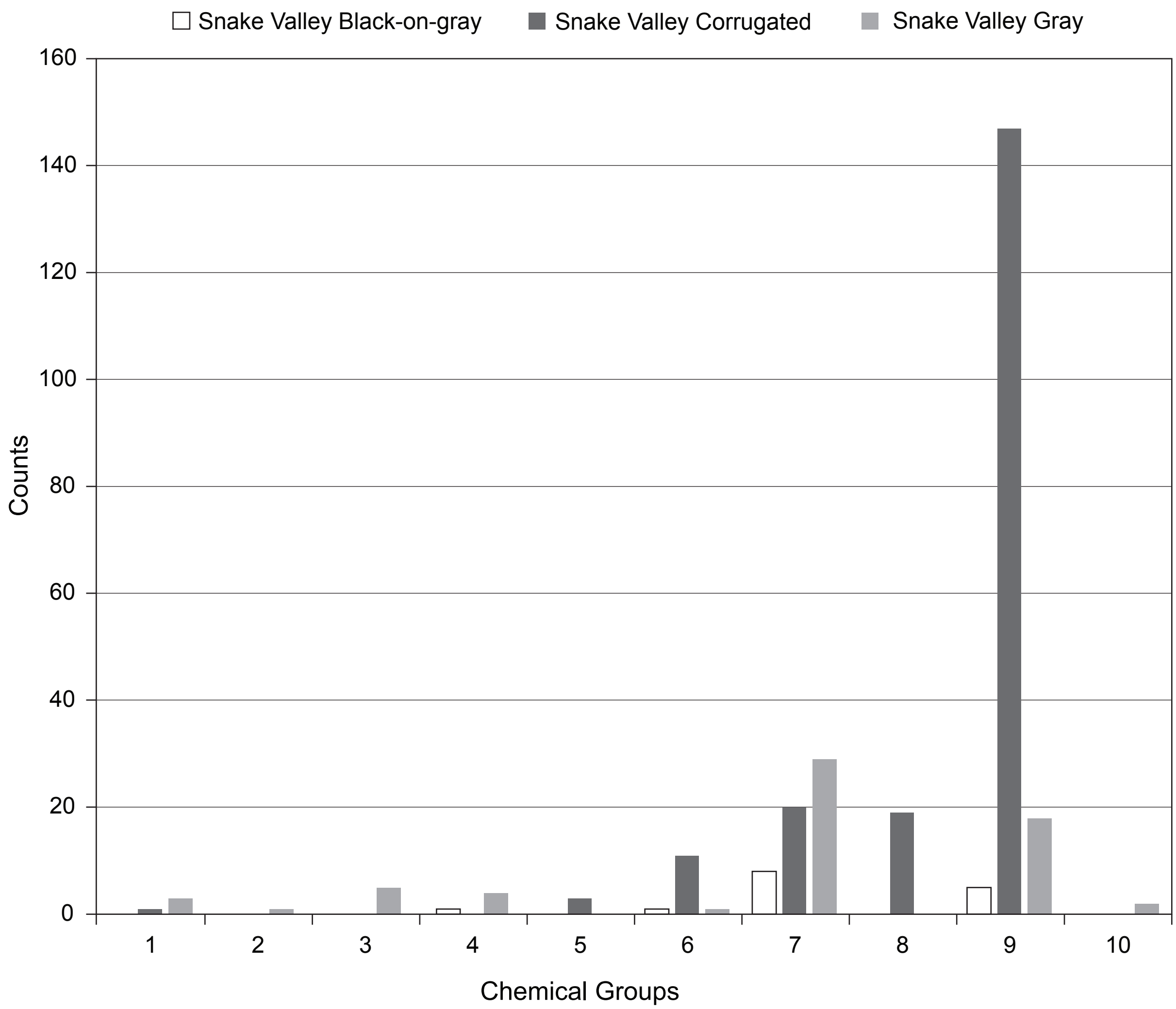


Figure 45. Graph showing counts of Fremont ceramic types by MURR compositional groups.

two groups seem to show pretty similar distributions by site, but Group 7 does have a much higher percentage of Snake Valley Gray relative to Snake Valley Corrugated when compared to Group 9." Figures 43 and 44 show the intersection of Groups 7 and 9, suggesting that they are chemically similar when comparing these elements; however, they may show increased separation when comparing two of the other 33 variables recorded.

Figure 45 shows the distribution of chemical groups by Fremont ceramic type (brown wares were excluded) analyzed by Ferguson and Glascock (2013). From the samples examined by the MURR, only 62 (16 percent) did not fit into any of the ten chemical groups; however, these unassigned sherds are fit best with Groups 7 and 9. The majority (61 percent) of Snake Valley Corrugated sherds fall into compositional Group 9 which may suggest that Snake Valley Corrugated pottery was produced from different clays and tempers compared to the Snake Valley Gray and Snake Valley Black-on-gray vessels. Ferguson and Glascock (2013:11) write that, "The majority of the unassigned samples along with all the members of Groups 7 and 9 could be considered as one generalized group representing the dominant Snake Valley Corrugated production for the area." In general, Ferguson and Glascock (2013) conclude that the Summit Site and the Paragonah Site have chemically similar Snake Valley series ceramics, but they do note that the Parowan Site is visibly different. This, however, may reflect the small sample size (n=6) from the Parowan assemblage. Ferguson and Glascock (2013:12) conclude their report stating that, "The large groups contain the majority of the Snake Valley types, but Groups 8 and 9 have a higher proportion of corrugated versus gray ware when compared to Group 7. The lack a of clear distinction between the assemblages from the main sites in this study are not surprising given the close proximity of the sites." The lack of distinction between these chemical groups may also represent either homogenous geology in the Parowan Valley, or Fremont potters living in the Parowan Valley may have all accessed similar raw material sources. This analysis does show that Snake Valley Corrugated pottery was produced from different raw materials compared to Snake Valley Gray and Snake Valley Black-on-gray vessels. This difference may show, based on the fact that Snake Valley Corrugated pottery is temporally sensitive, that raw materials used to produce the Snake Valley series may have changed over time.

Results from Latent Profile Analysis

Latent Profile Analysis (LPA) was used as an alternate method for examining the NAA results provided by the MURR laboratory. Dr. Justin Dyer, from the School of Family Life at Brigham Young University, performed the LPA using the statistical application Latent GOLD made by Statistical Innovations. In contrast to the PCA provided by the MURR, Dr. Dyer ran LPA on NAA results only from the 200 Snake Valley Corrugated sherds I submitted to the MURR, as well on the chemical results from the 22 Snake Valley Corrugated sherds recovered from the Mud Springs Site. The LPA results identified six classes (chemical groups) in the Snake Valley Corrugated sherds submitted. As mentioned previously, an important aspect to using LPA is identifying and examining the appropriate number of classes using a goodness-of-fit model. A Bayesian information criterion (BIC) method was used to determine the best number of classes represented in the dataset (Figure 46). The BIC curve shows that adding a second class improves the fit over a single class, and adding a third further improves the "goodness-of-fit". At between 6 and 7 classes the improvement is minimal, and between 9 and 10 classes the fit actually decreases. Figure 46 shows that around 6 classes the fit is not improving significantly. In addition, classification error rates, which are used to "measure misclassification rates and . . . correct estimates of proportions for misclassification" (Berzofsky et al. 2008), were extremely low, suggesting that LPA classified each sherd into an appropriate group with extremely low misclassification (Figure 47). LPA uses mixture modeling classification error methods based on "posterior class membership probabilities" (Vermunt and Magidson 2005:61–62).

Results from LPA analysis show that pottery from the four sites in my dataset share six distinct classes (Table 19). Based on these results, Class 1 is mostly associated with the Summit Site (56 percent), followed by Paragonah (33 percent), while Mud Springs (11 percent) represents only a small portion of Class 1. Interestingly, the Parowan site is not represented in Class 1. This is likely due to the very small sample size submitted for analysis. Class 2 is mainly composed of sherds from the Paragonah Site (59 percent) and the Summit Site (38 percent), while sherds from the Parowan Site represent only 3 percent of Class 2. Class 3 is similar to Classes 1 and 2 with the Paragonah Site representing 58 percent, the Summit Site at 42 percent, and nothing from the Parowan Site. Classes 4 and 5 are almost evenly represented

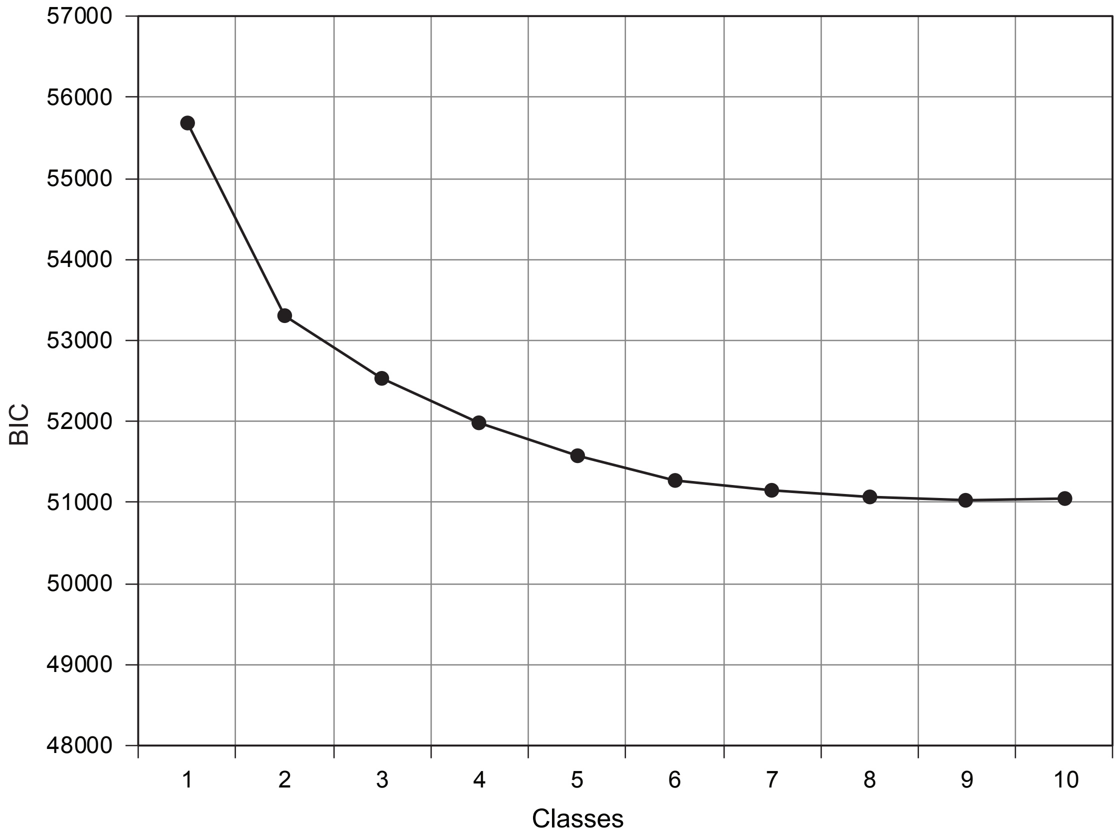


Figure 46. Bayesian information criterion graph showing the "goodness-of-fit" for each additional proposed class.

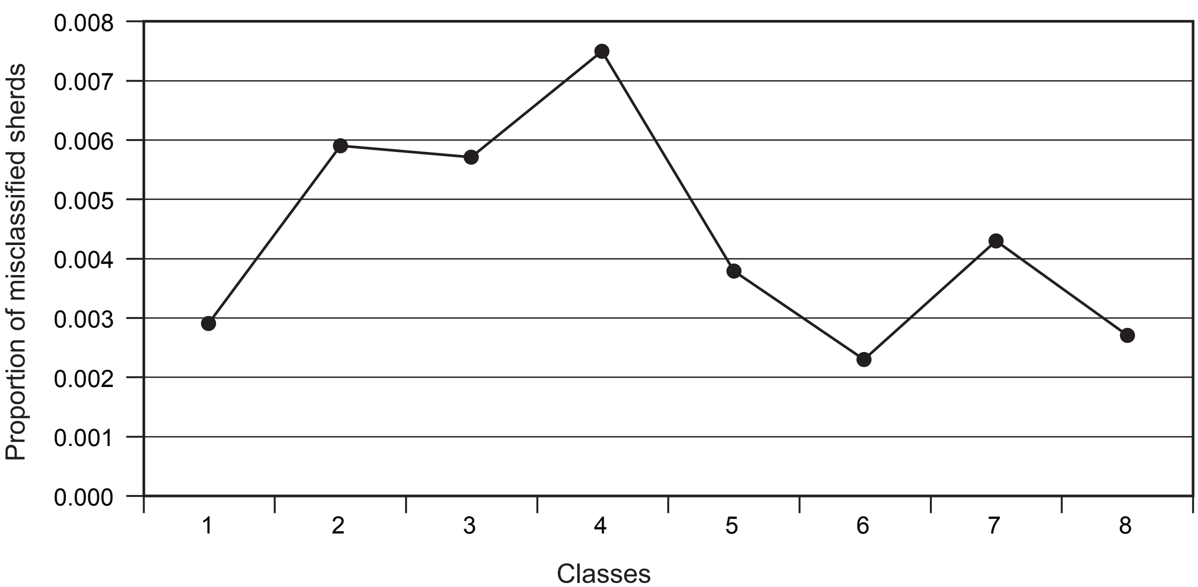


Figure 47. Classification error graph from the LPA analysis based on "posterior class membership probabilities" (Vermunt and Magidson 2005:61–62). Results show the proportion of sherds misclassified for each class.

Table 19. Classification Results from LPA Analysis.

	LPA class					
Site	1	2	3	4	5	6
Parowan	0	3	0	13	0	0
Summit	56	38	42	47	50	0
Paragonah	33	60	58	40	50	40
Mud Springs	10	0	0	0	0	60
Percent	100	100	100	100	100	100

Table 20. LPA Scores and Associated P-values from all Six Classes.

	Class 1		Class 2		Class 3		Class 4		Class 5		Class 6	
Site	Score	p-val.	Score	p-val.	Score	p-val.	Score	p-val.	Score	p-val.	Score	p-val.
Parowan	-2.484	0.448	1.642	0.336	-0.906	0.791	2.608	0.121	-0.862	0.801	0.003	0.999
Summit	0.605	0.646	0.435	0.743	1.168	0.481	0.180	0.892	1.284	0.439	-3.671	0.263
Paragonah	-0.585	0.623	0.223	0.852	0.824	0.596	-0.639	0.594	0.621	0.690	-0.444	0.793
Mud Springs	2.464	0.139	-2.299	0.483	-1.087	0.751	-2.148	0.512	-1.043	0.761	4.112	**0.036**

by sherds from the Paragonah site and the Summit Site, while the Parowan Site (13 percent) is moderately associated with Class 4. Class 6 is the most interesting of all the classes. Sherds from the Mud Springs site represent 60 percent of the chemical classification for Class 6, followed by the Paragonah Site at 40 percent. Sherds from the Mud Springs site are strongly associated with Class 6 based on “effect coding” results generated by LPA to calculate group membership (Vermunt and Magidson 2005:61–62). Effect coding returned a *p-value* of 0.03, which suggests that the association between Class 6 and Mud Springs is statistically significant.

Comparing only the 5 classes related to pottery recovered from the Parowan Valley shows a great deal of chemical variation. Comparing Classes 1 and 2, however, shows some similarities. Figure 48 visually displays the comparison of chemical elements between Classes 1 and 2, and although the magnitude differs, the trends are quite similar. Table 20 shows that Class 1 is mainly associated with the Summit site (56 percent), while Class 2 is most composed of sherds

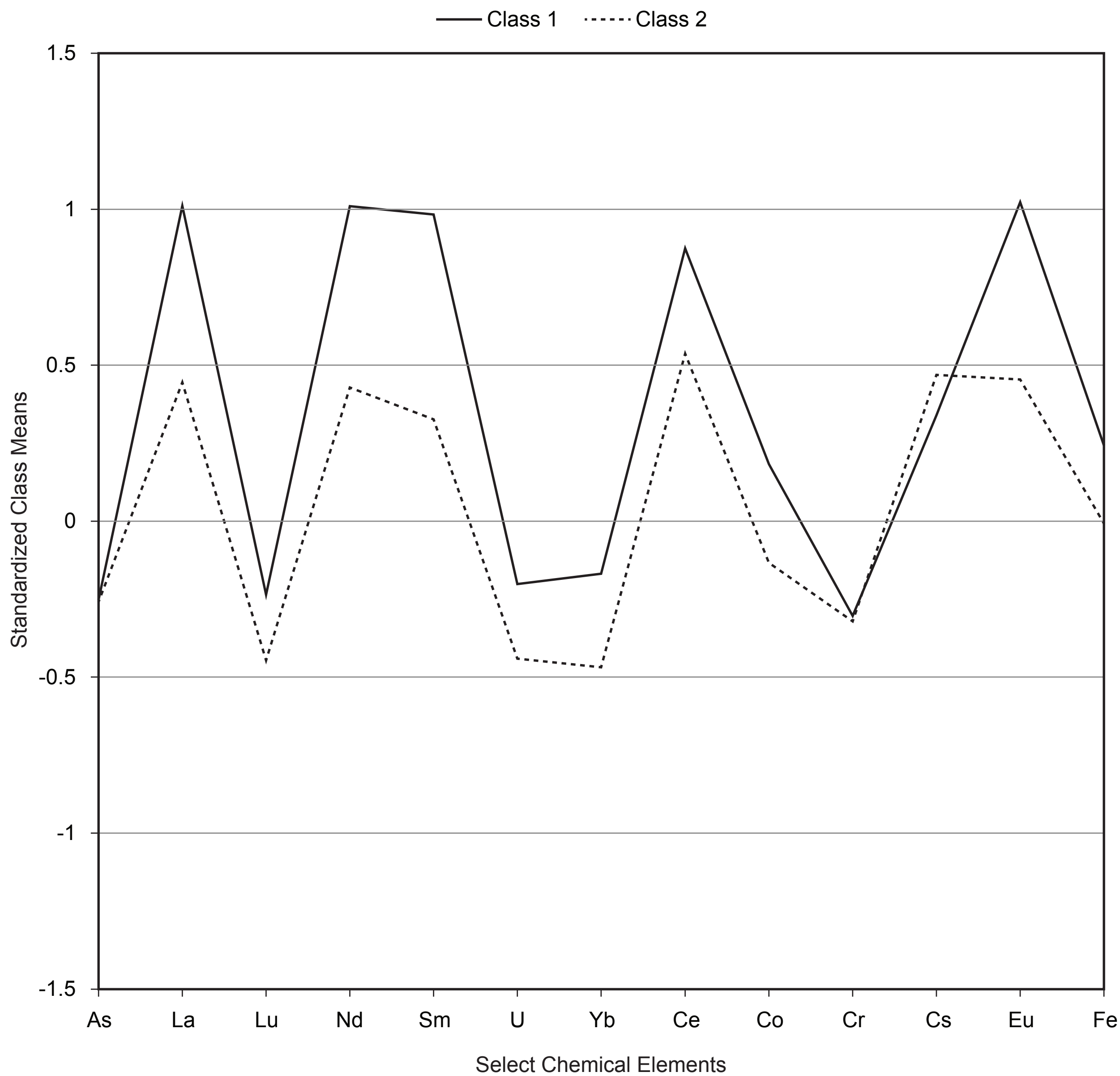


Figure 48. Profile plot of LPA for Classes 1 and 2. The zero line represents the global mean.

from Paragonah (59 percent). Interestingly, both sites have approximately 30 to 40 percent of the opposite class. When combined, 89 percent of the Class 1 sherds were recovered from either Paragonah or Summit, and 96 percent of the Class 2 sherds were found at both sites. These classes were not noted in Snake Valley Corrugated sherds recovered from either the Parowan or Mud Springs sites.

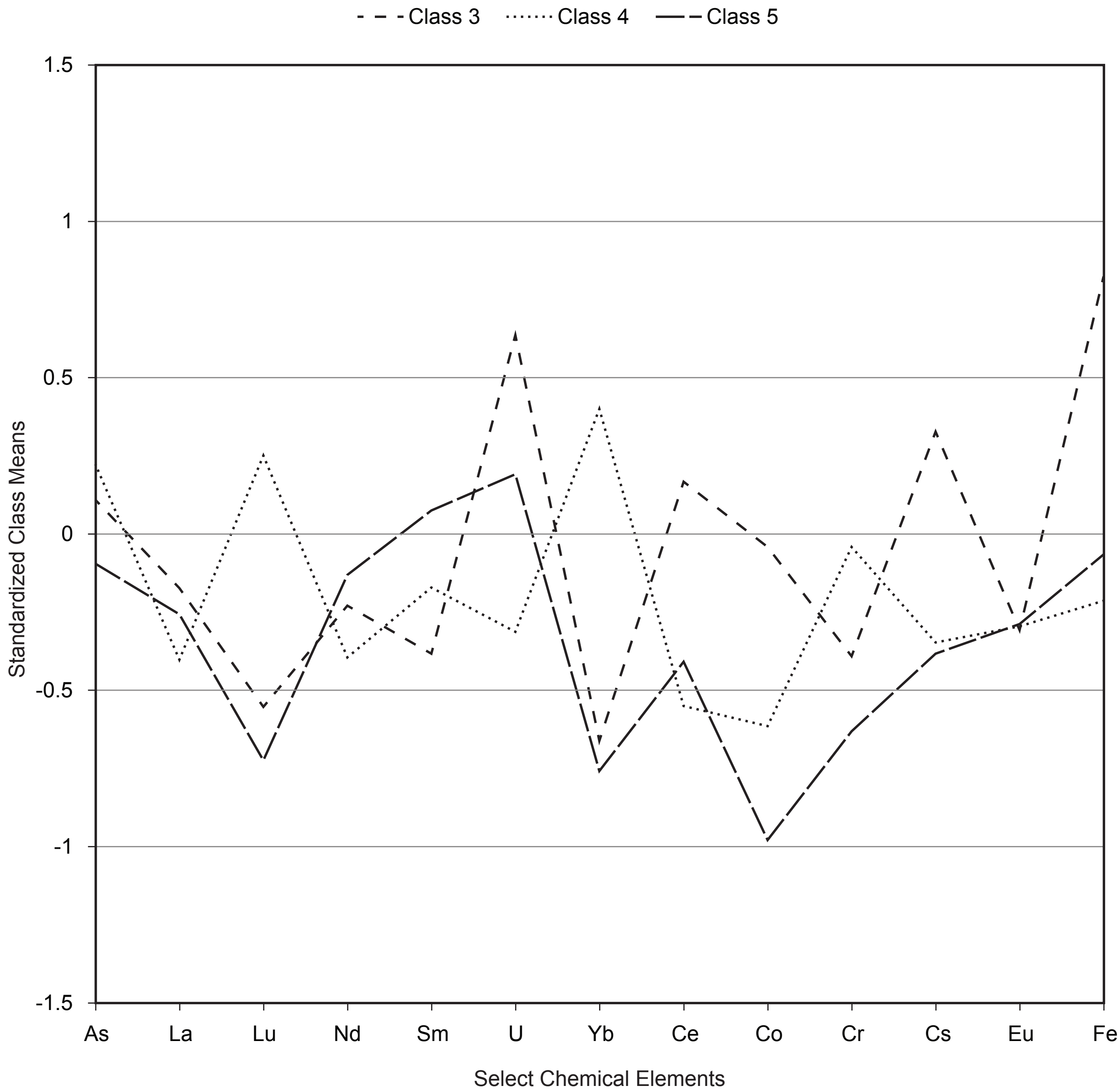


Figure 49. Profile plot of LPA results for Classes 3–5. The zero line represents the global mean.

This data suggest that pottery found at the two largest villages in the Parowan Valley were, in part, made of raw materials from these two chemically similar sources. Classes 3, 4 and 5, however, suggest something different. All three classes are composed of sherds from the Summit and Paragonah. Class 4 also includes a few sherds from Parowan (13 percent). Chemically, Classes 3–5 are significantly different from each other (Figure 49), and the results in Table 19 show that pottery found at Summit and Paragonah were made of raw materials from all three sources.

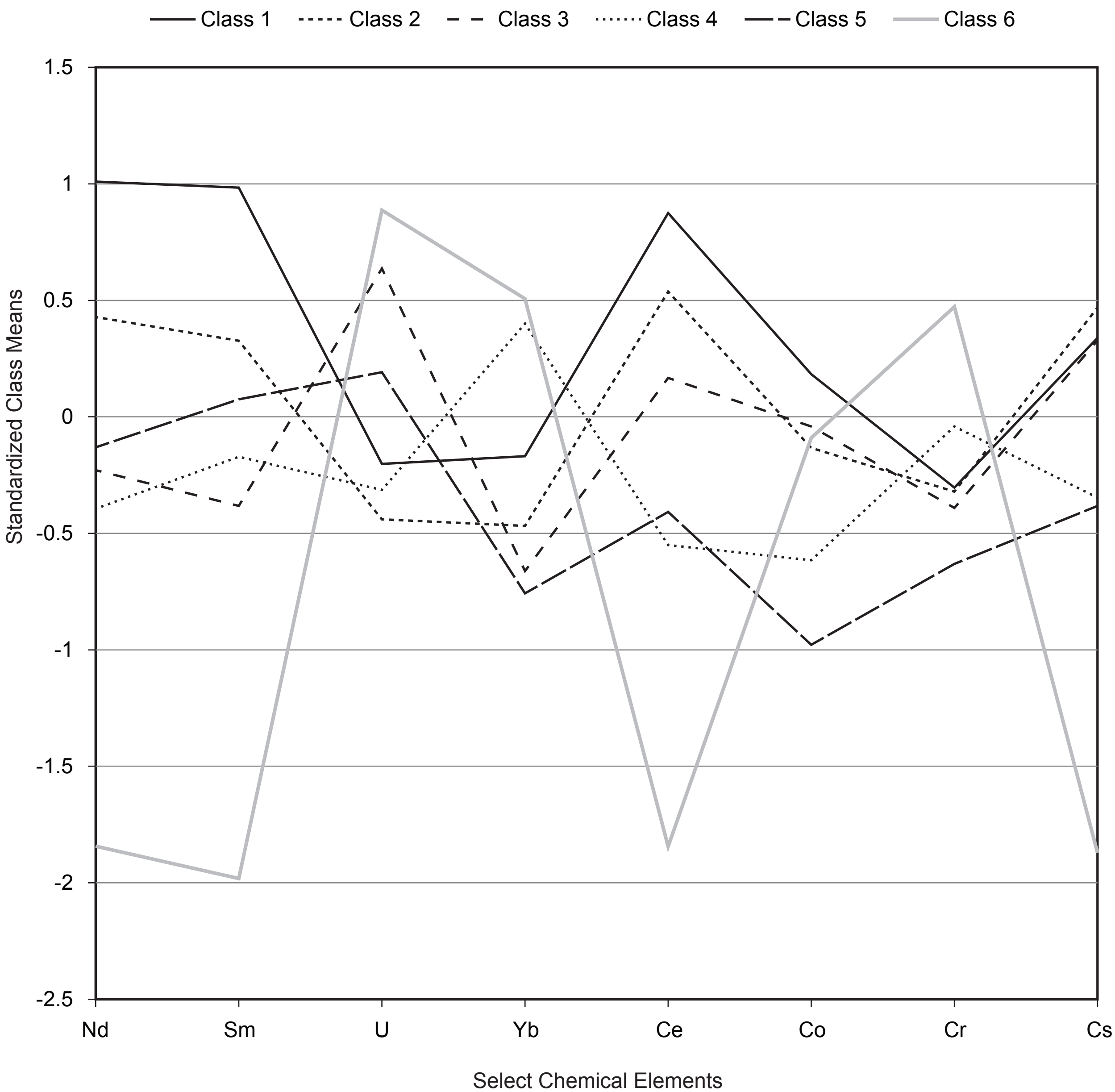


Figure 50. Profile plot of LPA results. Note the significant difference between Class 6 (light gray line) and Classes 1–5. The zero line represents the global mean.

There are noticeable difference in the chemical composition of the first five classes. Variation between Classes 1–5, however, is minimal compared to the differences between Class 6 and the other five (Figure 50). As noted earlier, there is a statistically significant likelihood (p-value = 0.04) that Snake Valley sherds found at Mud Springs were produced outside the Parowan Valley (see Table 20). Chemically, Class 6, compared to Classes 1–5, contains differing levels of Neodymium (nearly 2 standard deviations below the mean), Samarium (2 standard deviations below the mean), Uranium (1 deviation above the mean), Cerium (nearly 2 standard deviations below the mean), and Cesium (at almost 2 standard deviations below the mean). Chromium levels in Class 6 are somewhat different from Classes 1–5, but only averaged one-half standard deviation above the mean. Based on the chemical composition for sherds found in Class 6, as compared to those in Classes 1–5, the data show a distinct difference, suggesting that these sherds were not made from raw materials found in the Parowan Valley. This suggests, then, that the Snake Valley Corrugated sherds recovered from the Mud Springs Site were not produced with the same raw materials used to make Snake Valley Corrugated pottery at Fremont sites in the Parowan Valley. It is currently unclear where these Snake Valley Corrugated sherds were produced. Raw geologic samples from surrounding areas are needed to determine the production source for Class 6, but a good place to start might be village sites near Mud Springs.

Rim Sherd Measurement Results

A total of 13 measurements were recorded for each rim sherd in the dataset. These include measures for the:

1. Orifice diameter
2. Rim eversion
3. Rim form
4. Rim treatment
5. Rim thickness
6. Height of uncorrugated portion below the rim
7. Thickness at the rim base
8. Thickness two centimeters below the rim

Orifice Diameter

Richens' (2000) analysis of orifice diameters, measured from ceramic vessels found at the Five Finger Ridge excavations, resulted in the identification of several vessel class sizes: miniature (2–6 cm), small (7–12 cm), medium (13–19 cm), large (20–25 cm), and very large

(26+ cm). Due to the "paucity" of whole or reconstructed Fremont vessels, multi-modal distributions of rim sherd orifice diameters were used to define vessel class sizes (Richens 2000:56). According to Richens (2000:56), "Several ceramic studies . . . have demonstrated that formal-functional classes of vessels can be derived by using rim sherds in the absence of complete vessels." These include studies by Braun 1980, Shaprio 1984, and others.

Richens (2000) argues, based on a variety of ethnographic, archaeological, and sherd residue studies, that miniature vessels were likely used to hold small items such as seeds, paints, and other semi-solid goods. Small vessels were made for cooking 1 to 2 servings (Richens 2000:59). They may have also been used to store a variety of non-food items such as personal affects. Medium ceramic vessels were the most common size class recovered from the Five Finger Ridge excavations. Forty percent were sooted, suggesting medium vessels were commonly used for cooking food. Large jars were probably used for storage, water collection, and cooking for medium sized groups of people (Richens 2000; Braun 1980). Ceramic vessels in the large class had the capacity to provide about 30 servings (Turner and Lofgren 1966:127). These containers were capable of serving large groups of people, or they may have been used to store large volumes of water or other goods (Braun 1980).

The Snake Valley Corrugated sherds I examined included representatives from each of these classes observed by Richens (2000). The majority of the sherds come from jars (n=339, 97 percent), followed by bowls (n=11, 3 percent), and one pitcher sherd. Only two sherds fit the miniature size. Due to the small number, these sherds were combined with the small class size. Rim sherds from all of the Parowan Valley sites in my dataset total 51 within the small range, 52 in the medium size, 28 in the large category, and 26 in the very large range (Table 21). The majority of vessels are in the small (32 percent) and medium classes (33 percent). The large, and very large classes represent approximately 35 percent of the total assemblage.

Table 21. Vessel Size Counts by Site.

	Site			
Vessel size	Summit	Paragonah	Total	Percent
Small	26	25	51	32
Medium	35	17	52	33
Large	19	9	28	18
Very Large	11	15	26	17
Median	23	16	40	
Total	91	66	157	

Table 22. Vessel Size Percentages by Site.

	Site	
Vessel size	Summit	Paragonah
Small	21	14
Medium	39	26
Large	29	38
Very Large	12	23
Percent	100	100

Percentages in Table 22 show differences in the vessel size counts between Summit and Paragonah. The largest differences are in the medium and very large vessel classes. As mentioned above, medium sized vessels were used primarily for cooking meals for small groups of people, and are, therefore, equally represented at all sites. In contrast, large, and very large pottery, was used hold large quantities of food, water, or other goods. They may have also been used to cook for large groups of people.

Vessel size counts based on 5 LPA classes (excludes LPA class 6 due to small sample size) are documented Table 23. Percentages in Table 24 show that small vessels associated with LPA classes 1 and 4 are identical at 41 percent. These are thirteen percent higher than the next closest classes, LPA 2 and 3. Medium pots are represented somewhat equally across all three LPA classes, but Large vessels fit mostly with LPA classes 2 and 5. Very large vessels are more associated with LPA classes 2,3, and 5.

Table 23. Vessel Size Counts by LPA Class.

	LPA class						
Vessel class	1	2	3	4	5	Total	Percent
Small	19	8	5	7	3	42	34
Medium	14	8	6	5	4	37	30
Large	5	7	3	3	4	22	18
Very Large	8	6	4	2	3	23	19
Median	8	7	4	4	4	30	
Total	46	29	18	17	14	124	

Table 24. Vessel Size Percentages by LPA Class.

	LPA class				
Vessel class	1	2	3	4	5
Small	41	28	28	41	21
Medium	30	28	33	29	29
Large	11	24	17	18	29
Very Large	17	21	22	12	21
Percent	100	100	100	100	100

Pearson Chi-Square analysis comparing vessel class size to site returned a value of 6.624 (p-value = 0.85), suggesting that vessel class size are not statistically related to either the Summit or Paragonah site, although a larger sample size may improve this relationship. The Pearson Chi-Square result (9.902) comparing vessel class size to LPA class also did not show a relationship between these two variables (p-value = 0.872). Both the Parowan and Mud Springs sites were not included in the analysis due to the very low sample sizes from both sites, and were consequently removed from any other analysis below.

Rim Eversion

Forty-four percent (n=71) of all the Snake Valley Corrugated rims in my dataset do not exhibit any eversion, and are generally evenly spread across the 5 LPA Classes (Tables 25 and 26). LPA Class 3 exhibits a moderately higher percentage (8 percent higher than the next

Table 25. Rim Eversion Counts by LPA Class.

Rim eversion	LPA classes 1	2	3	4	5	Total	Percent
1 to 20	4	3	2	0	2	11	9
21 to 40	14	8	1	6	5	34	27
41 to 60	4	3	2	1	2	12	10
61 to 80	2	1	3	1	1	8	6
81 to 100	1	0	0	1	0	2	2
None	22	14	10	8	6	60	47
Median	4	3	2	1	2	12	
Total	47	29	18	17	16	127	

Table 26. Rim Eversion Percentages by LPA Class.

Rim eversion	LPA classes 1	2	3	4	5
1 to 20	9	10	11	0	13
21 to 40	30	28	6	36	31
41 to 60	9	10	11	6	13
61 to 80	4	3	17	6	6
81 to 100	2	0	0	6	0
None	47	48	56	47	38
Percent	100	100	100	100	100

closest) than the other classes. A total of 36 percent of LPA Class 4 rims have 21–40 degrees of eversion, which is 6 percent more than the next closest LPA class. Rims with 41 to 60 degrees of eversion are spread somewhat evenly across all 5 LPA classes, while 17 percent of LPA Class 3 rims have 61–80 degrees of eversion. Comparing rim eversion by site shows a significant difference between the Summit site and Paragonah with rim sherds that do not have any eversion (Tables 27 and 28). Paragonah has 11 percent more vessels with no rim eversion compared to the Summit site. Mann-Whitney U tests between site, LPA Class, and rim eversion were not statistically significant.

Table 27. Rim Eversion Counts by Site.

	Site			
Rim eversion	Summit	Paragonah	Total	Percent
1 to 20	11	6	17	11
21 to 40	28	15	43	27
41 to 60	14	5	19	12
61 to 80	4	5	9	6
81 to 100	0	2	2	1
None	37	33	70	44
Median	13	6	18	
Total	94	66	160	

Table 28. Percentage of Rim Eversion by Site.

	Site	
Rim eversion	Summit	Paragonah
1 to 20	12	9
21 to 40	30	23
41 to 60	15	8
61 to 80	4	8
81 to 100	0	3
None	39	50
Percent	100	100

Rim form

The highest percentage (39 percent) or rim forms are vertical in shape, followed by J-curved rim forms (18 percent), and both C-curve and J-vertical rim shapes at 11 percent (Figure 51 and Table 29). Rim forms most abundant at the Summit site are the V-vertical at 37 percent and the C-curve at 16 percent (Table 30). At the Paragonah site, vertical rim forms represent 41 percent and J-curve rims compose 27 percent of the total. Percentages for both vertical and J-curve rim forms are higher than those at Summit, and J-curve rims total more than double those at Summit. Tables 31 and 32 show that vertical rim forms also have the highest percentage, by a wide margin, in all LPA classes.

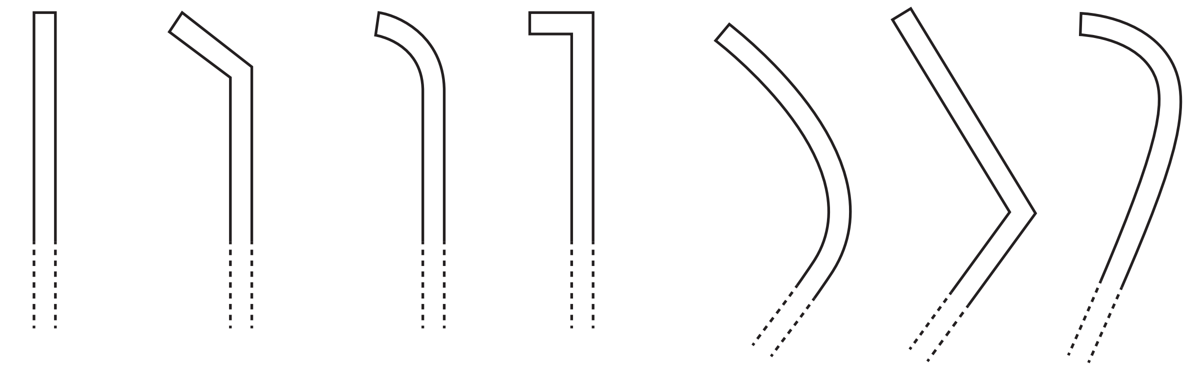


Figure 51. Diagram of rim forms observed during analysis.

Table 29. Rim Form Counts by Site.

	Site			
Rim form	Summit	Paragonah	Total	Percent
C-curve	15	3	18	11
V-curve	2	1	3	2
Vertical	35	27	62	39
L-vertical	3	5	8	5
V-vertical	9	1	10	6
Bowl	5	4	9	6
Irregular	1	2	3	2
J-vertical	13	5	18	11
J-curve	11	18	29	18
Median	9	4	10	
Total	94	66	160	

Table 30. Rim Form Percentages by Site.

	Site	
Rim form	Summit	Paragonah
C-curve	16	5
V-curve	2	2
Vertical	37	41
L-vertical	3	8
V-vertical	10	2
Bowl	5	6
Irregular	1	3
J-vertical	14	8
J-curve	12	27
Percent	100	100

The Pearson Chi-Square measure (17.594) between rim form and site was very insightful, suggesting a statistically significant relationship with a p-value of 0.02 and a minimum expected count of 1.24. The same measure between LPA classes and rim forms resulted in a Pearson Chi-square measure of 22.784 with a p-value of 0.88. The minimum expected count of 0.25 is well below the recommended count of 1, suggesting that there is no statistically measurable relationship between rim form and LPA class.

Table 31. Rim Form Counts by LPA Class.

	LPA class						
Rim Form	1	2	3	4	5	Total	Percent
C-curve	3	3	1	2	2	11	9
V-curve	1	0	1	0	0	2	2
Vertical	20	9	8	7	5	49	39
L-vertical	2	1	1	1	0	5	4
V-vertical	3	1	0	1	0	5	4
Bowl	2	5	2	0	0	9	7
Irregular	1	1	1	0	0	3	2
J-vertical	6	3	0	3	3	15	12
J-curve	9	6	4	3	6	28	22
Median	3	3	1	2	1	9	
Total	47	29	18	17	16	127	

Table 32. Rim Form Percentages by LPA Class.

	LPA class				
Rim Form	1	2	3	4	5
C-curve	6	10	6	12	13
V-curve	2	0	6	0	0
Vertical	43	31	44	41	31
L-vertical	4	3	6	6	0
V-vertical	6	3	0	6	0
Bowl	4	17	11	0	0
Irregular	2	3	6	0	0
J-vertical	13	10	0	18	19
J-curve	19	21	22	18	38
Percent	100	100	100	100	100

Rim Treatment

The majority (91 percent) of the rims I analyzed are undecorated, which is not surprising, given the fact that Snake Valley Corrugated vessels are utilitarian wares. One sherd has incising

Table 33. Lip Form Counts by Site.

	Site			
Lip form	Summit	Paragonah	Total	Percent
Pointed	9	2	11	7
Rounded point	23	7	30	19
Semi flat	15	11	26	16
Flat	2	5	7	4
Exterior bevel	7	3	10	6
Round	25	28	53	33
Exterior round	12	10	22	14
Median	12	7	22	
Total	93	66	159	

Table 34. Lip Form Percentages by Site.

	Site	
Lip form	Summit	Paragonah
Pointed	10	3
Rounded point	25	11
Semi flat	16	17
Flat	2	8
Exterior bevel	8	5
Round	27	42
Exterior round	13	15
Percent	100	100

and three exhibit coils left unobliterated but not corrugated. These coils are located along the vessel neck, an area on Snake Valley Corrugated vessels that is typically left undecorated. Rim lip forms are mostly round (33 percent), or round with a slight taper towards the tip (19 percent), while the other forms (exterior bevel, exterior and interior round, flat, pointed, and semi-flat) make up the rest of the rim lip forms in varying smaller percentages (Tables 33 and 34; Figure 52). Table 34 shows the comparison of rim lip forms by site. Paragonah has almost double the percentage of rounded lip forms, as opposed to Summit; however, Summit has nearly double the percentage of rounded point rim lip forms. Comparing lip forms to LPA Classes has similar

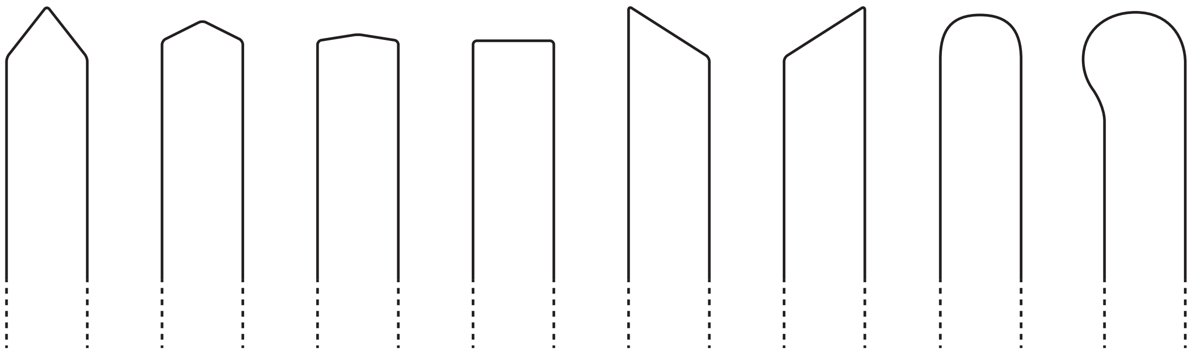


Figure 52. Stylized diagram of lip forms noted during analysis.

Table 35. Lip Form Counts by LPA Class.

	LPA class						
Lip form	1	2	3	4	5	Total	Percent
Pointed	2	2	1	1	4	10	8
Rounded point	7	6	1	5	2	21	17
Semi flat	7	6	4	0	2	19	15
Flat	2	1	1	3	0	7	6
Exterior bevel	2	2	1	0	0	5	4
Round	19	10	7	4	7	47	37
Exterior round	8	2	3	4	1	18	14
Median	5	2	2	4	2	18	
Total	47	29	18	17	16	127	

Table 36. Lip Form Percentages by LPA Class.

	LPA class				
Lip form	1	2	3	4	5
Pointed	4	7	6	6	25
Rounded point	15	21	6	29	13
Semi flat	15	21	22	0	13
Flat	4	3	6	18	0
Exterior bevel	4	7	6	0	0
Round	40	34	39	24	44
Exterior round	17	7	17	24	6
Percent	100	100	100	100	100

Table 37. Select Statistical Measures from SVC Rim Sherds from all Site Combined.

Measure	Mean	SD	CV (%)	Min.	Max.
Rim thickness (mm)	3.6	0.9	26	1.5	7.2
Height of uncorrugated (mm)	16.0	6.5	41	2.9	40.0
Thickness at base of rim (mm)	4.5	0.8	18	2.6	7.0
Rim thickness 2 cm below rim base (mm)	5.4	1.0	18	3.1	8.5

SD = Standard deviation; CV = Coefficient of variation

results to those from comparing lip forms to sites. The rounded style is the dominant lip form at 37 percent of the total (Tables 35 and 36). Rounded rim lip forms are also the dominate style for all 5 LPA classes, with Classes 1 and 3 having approximately 40 percent of the total.

The Pearson Chi-Square measure (12.62) between rim lip form and site returned a p-value of 0.04 with a minimum expected value of 2.91. This result suggests a statistically significant relationship between rim lip forms and the associated site. In this case, rounded rim lip forms show a strong association with the Paragonah site, but rounded point rim lip styles have a strong connection to the Summit site. Results comparing rim lip forms to LPA classes did not return any useful results to suggest a relationship between these two variables.

Rim Thickness

Rim thicknesses average 3.6 mm with a range of 5.7 mm and a CV value of 26 percent (Table 37; Figure 53). The uncorrugated height below the rim, but before the corrugated section, has a mean height of 16 mm with a substantially wide range of over 37 mm, suggesting a great deal of variation which is reflected in the higher CV value than the rest of the rim measurements (Figure 54). Rim thickness at the base of the rim averaged 4.5 mm and ranged 7 mm. Rim thicknesses 2 cm below the rim have a mean thickness of 5.4 mm with a range of 8.5 mm. Both of these measures have the lowest CV values of all the rim measures at 18 percent each.

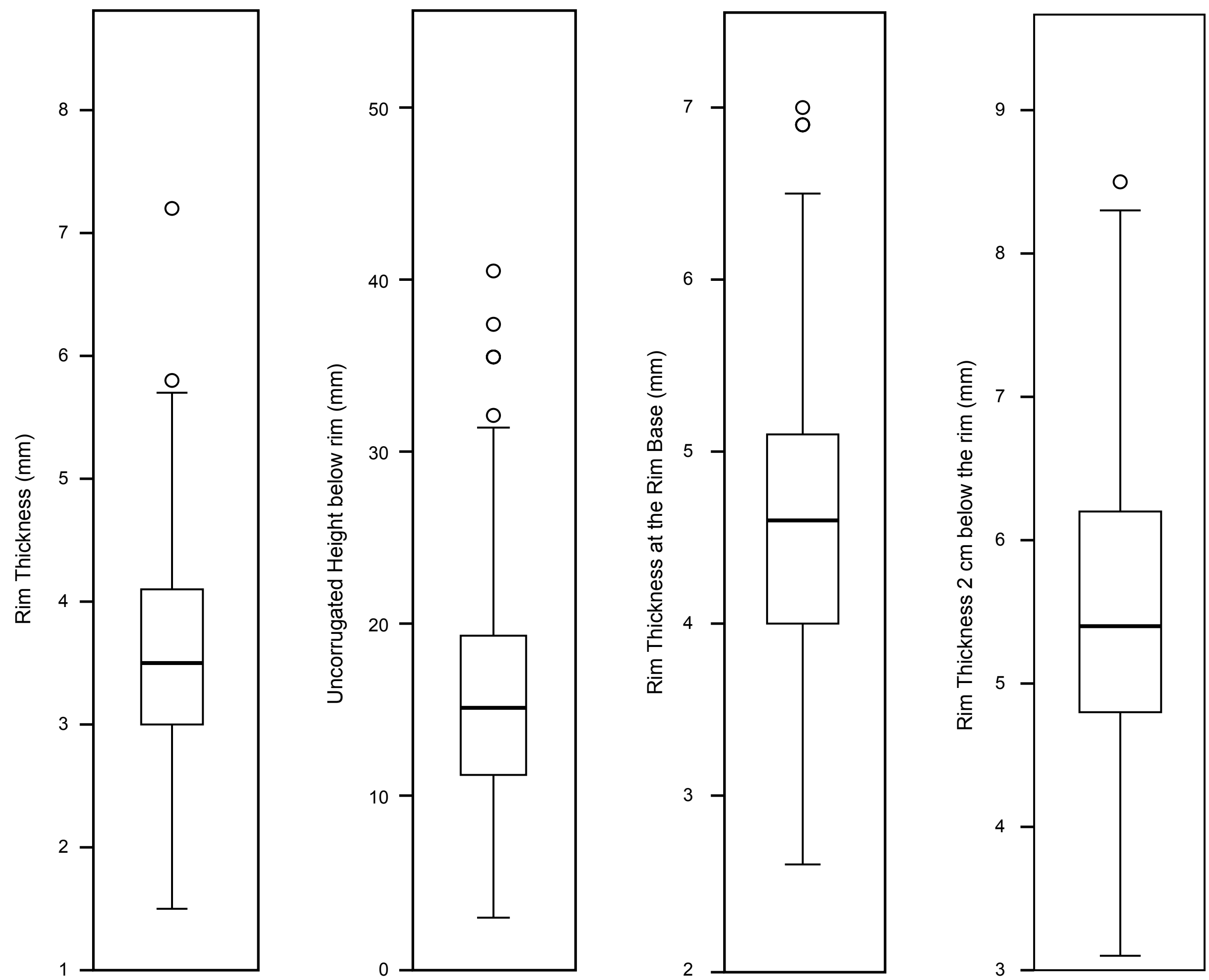


Figure 53. Box plots of rim sherd metric measures.

Figure 54. Photo of Snake Valley Corrugated sherds with uncorrugated sections below the rim.

Table 38. Rim Thickness Counts by Site.

	Site			
Rim thickness (mm)	Summit	Paragonah	Total	Percent
1–3	21	13	34	22
3–5	63	41	104	67
5–7+	6	11	17	11
Median	21	13	34	
Total	90	65	155	

Table 39. Rim Thickness Percentages by Site.

	Site	
Rim thickness (mm)	Summit	Paragonah
1–3	23	20
3–5	70	63
5–7+	7	17
Percent	100	100

Comparing rim thickness to sites using arbitrary class sizes of thin (1 to 3 mm), medium (3 to 5 mm), and thick (5 to 7+ mm) show that the majority of rims fit the medium size at both Paragonah and Summit (Tables 38 and 39). Interestingly, Paragonah has 10 percent more rims sherds in the "thicker" size than Summit, which corroborates the early data showing that very large Snake Valley Corrugated vessels are more associated with the Paragonah site than with Summit. Comparing LPA classes to rim thicknesses returns similar results as those comparing rim thickness to site (Tables 40 and 41). Sherds with medium rim thickness are the most dominant across all 5 LPA classes. Thin rim thicknesses are most associated with LPA class 5 at 44 percent, which is 9 percent higher than the next closest. A Mann-Whitney U test by site returned a p-value of 0.05, suggesting a statistically significant relationship between rim thicknesses and sites. In this case, both the Summit and Paragonah sites have high percentages of medium (3–5 mm) thick rims. Mann-Whitney U tests by LPA class returned values that are not statistically significant.

Table 40. Rim Thickness Counts by LPA class.

	LPA class						
Rim thickness (mm)	1	2	3	4	5	Total	Percent
1–3	10	3	4	6	7	30	24
3–5	33	22	13	7	8	83	65
5–7+	4	4	1	4	1	14	11
Median	7	3.5	3.5	5	6	30	
Total	47	29	18	17	16	127	

Table 41. Rim Thickness Percentages by LPA class.

	LPA class				
Rim thickness (mm)	1	2	3	4	5
1–3	21	10	22	35	44
3–5	70	76	72	41	50
5–7+	9	14	6	24	6
Percent	100	100	100	100	100

Table 42. Uncorrugated Rim Height Counts by Site.

	Site			
Size ranges (mm)	Summit	Paragonah	Total	Percent
5–10	16	10	26	16
11–15	41	21	62	39
16–20	24	13	37	23
21–25	7	12	19	12
26–30	3	5	8	5
31–40	2	4	6	4
Median	12	11	23	
Total	93	65	158	

Height of uncorrugated portion below the rim

Comparing the height of the uncorrugated portion below the rim to the Paragonah and Summit sites (using 5 cm ranges) shows that the majority (39 percent) fit into the 11–15 cm class (Table 42). In addition, percentages are relatively equal across each of the uncorrugated height

Table 43. Uncorrugated Rim Height Percentages by Site.

	Site	
Size ranges (mm)	Summit	Paragonah
5–10	17	15
11–15	44	32
16–20	26	20
21–25	8	18
26–30	3	8
31–40	2	6
Percent	100	100

Table 44. Uncorrugated Rim Height Counts by LPA Classes.

	LPA class						
Size ranges	1	2	3	4	5	Total	Percent
5–10	10	3	2	3	3	21	17
11–15	17	13	7	5	7	49	40
16–20	7	4	2	8	3	24	20
21–25	6	6	3	0	1	16	13
26–30	4	1	0	0	1	6	5
31–40	2	1	2	1	0	6	5
Median	6	3	2	3	3	19	
Total	46	28	16	17	15	122	

Table 45. Uncorrugated Rim Height Percentages by LPA Classes.

	LPA class				
Size ranges	1	2	3	4	5
5–10	37	46	44	29	47
11–15	15	14	13	47	20
16–20	13	21	19	0	7
21–25	9	4	0	0	7
26–30	4	4	13	6	0
31–40	22	11	13	18	20
Percent	100	100	100	100	100

Table 46. Counts of Thickness at the Rim Base by Site.

	Site			
Size class (mm)	Summit	Paragonah	Total	Percent
2.0–2.9	1	1	2	1
3.0–3.9	15	19	34	21
4.0–4.9	50	25	75	47
5.0–5.9	23	17	40	25
6.0–6.9	5	3	8	5
Median	15	17	34	
Total	94	65	159	

classes, but the Summit site does have 12 percent more sherds in the 11–15 cm range, compared to Paragonah (Table 43). Comparing LPA classes to the uncorrugated portion below the rim shows that the 5–10 cm range dominates all of the LPA classes (Tables 44 and 45). In the LPA class 4, however, the 11–15 range stands out from the others with 47 percent of the total in that class, compared to the much lower percentages in the other LPA classes. The next closest to LPA 4 in the 11–15 range is LPA class 5 which is 27 percent lower. LPA class 3 also shows a higher percentage in the 26–30 range at 13 percent, which is more than double the next highest percentage in LPA class 4. A Mann-Whitney U test by site returned a p-value of 0.05, suggesting a statistically significant relationship between the uncorrugated rim height and sites. Differences are visible between the Summit and Paragonah sites at the 11–15 (Summit +12 percent), 16–20 (Summit +6 percent), and 21–25 (Paragonah +10 percent) size classes. Mann-Whitney U test results by LPA class were not statistically significant.

Thickness at the rim base

Comparing the size ranges for the thickness at the rim base shows that the 4.0 to 4.9 mm range has the largest percentage at 47 percent (Table 46). The next largest range, 5.0 to 5.9 mm, is 25 percent and considerably less than the 4.0 to 4.9 mm range. Table 47 displays results of the

Table 47. Percentages of Thickness at the Rim Base by Site.

	Site	
Size class (mm)	Summit	Paragonah
2.0–2.9	1	2
3.0–3.9	16	29
4.0–4.9	53	38
5.0–5.9	24	26
6.0–6.9	5	5
Percent	100	100

Table 48. Counts of Thickness at the Rim Base by LPA Class.

	LPA class						
Size class (mm)	1	2	3	4	5	Total	Percent
2.0–2.9	0	1	2	0	1	4	3
3.0–3.9	11	7	6	5	2	31	25
4.0–4.9	24	13	8	6	10	61	48
5.0–5.9	10	6	1	5	3	25	20
6.0–6.9	2	2	0	1	0	5	4
Median	6	4	3	5	3	25	
Total	47	29	17	17	16	126	

Table 49. Percentages of Thickness at the Rim Base by LPA Class.

	LPA class				
Size class (mm)	1	2	3	4	5
2.0–2.9	0	3	12	0	6
3.0–3.9	23	24	35	29	13
4.0–4.9	51	45	47	35	63
5.0–5.9	21	21	6	29	19
6.0–6.9	4	7	0	6	0
Percent	100	100	100	100	100

Table 50. Counts of Rim Thickness 2 cm below the Rim by Site.

	Site			
Size class	Summit	Paragonah	Total	Percent
3.0 to 3.9 mm	6	1	7	4
4.0 to 4.9 mm	24	20	44	28
5.0 to 5.9 mm	44	20	64	40
6.0 to 6.9 mm	15	15	30	19
7.0 to 7.9 mm	4	7	11	7
8.0 to 8.9 mm	1	3	4	3
Median	11	11	21	
Total	94	66	160	

percentages of thickness at the rim base by site. The 4.0 to 4.9 mm range has the highest percentage for both the Summit and Paragonah sites, but the Summit site has 15 percent more in the same size range. Tables 48 and 49 show the results from comparing the counts and percentages of thickness at the rim base by LPA class. Similar to comparing these variables by site, the comparison of LPA classes shows that the 4.0 to 4.9 mm range has the largest percentages of the LPA classes. Class 5, in particular, stands out among the others. The 4.0 to 4.9 mm range holds 63 percent of the total for Class 5 which is 11 percent higher than the next highest percentage in the same range in Class 1. Mann-Whitney U test results by site and LPA were not statistically significant.

Thickness two centimeters below the rim

Comparing the size ranges for thickness 2 cm below the rim base shows that the 5.0 to 5.9 mm range has the largest percentage at 40 percent (Table 50). The next largest range, 4.0 to 4.9 mm, is 28 percent and considerably less than the 5.0 to 5.9 mm range. Table 51 displays results of the percentages of the thickness 2 cm below at the rim by site. The 5.0 to 5.9 mm range has the highest percentage at the Summit site with 44 percent from that size range, compared to the Paragonah site with only 20 percent coming from that same 5.0 to 5.9 mm range. Tables 52 and

Table 51. Percentages of Rim Thickness 2 cm below the Rim by Site.

	Site	
Size class	Summit	Paragonah
3.0 to 3.9 mm	6	2
4.0 to 4.9 mm	26	30
5.0 to 5.9 mm	47	30
6.0 to 6.9 mm	16	23
7.0 to 7.9 mm	4	11
8.0 to 8.9 mm	1	5
Total	100	100

Table 52. Counts of Rim Thickness 2 cm below the Rim by LPA Class.

	LPA class						
Size class	1	2	3	4	5	Total	Percent
3.0 to 3.9	3	0	0	2	1	6	5
4.0 to 4.9	12	10	6	3	2	33	26
5.0 to 5.9	16	10	8	6	9	49	39
6.0 to 6.9	12	6	2	4	0	24	19
7.0 to 7.9	2	2	2	1	4	11	9
8.0 to 8.9	2	1	0	1	0	4	3
Median	3	2	2	3	2	18	
Total	47	29	18	17	16	127	

Table 53. Percentages of Rim Thickness 2 cm below the Rim by LPA Class.

	LPA class				
Size class	1	2	3	4	5
3.0 to 3.9	6	0	0	12	6
4.0 to 4.9	26	34	33	18	13
5.0 to 5.9	34	34	44	35	56
6.0 to 6.9	26	21	11	24	0
7.0 to 7.9	4	7	11	6	25
8.0 to 8.9	4	3	0	6	0
Total	100	100	100	100	100

53 show the results from comparing the counts and percentages of thickness 2 cm below the rim by LPA class. Comparing LPA classes shows that the 5.0 to 5.9 mm range has the largest percentages from all of the LPA classes. The 5.0 to 5.9 mm range in Class 5 has 56 percent of the total for Class 5 which is 12 percent higher than the next highest percentage in the same range in Class 3. Mann-Whitney U test results by site and LPA class were not statistically significant.

Recorded Measurements for All Sherds

A number of different measurements were recorded for all of the 436 rim and body sherds from the Parowan, Paragonah, and Summit sites combined. These measures include:

1. Vessel wall thickness
2. Coil width
3. Number of indents per 2 cm
4. Indent width
5. Indent depth
6. Indent angle
7. Indent shape
8. Corrugation pattern
9. Paste color
10. Miscellaneous surface treatments or manipulation

Statistical results from the metric measurements calculated from Snake Valley Corrugated rim and body sherds from all three sites resulted in hints of standardization (Table 54; Figures 55 and 56). Examining each site separately, using the same measures, did not drastically alter the results. The average vessel wall thickness for body sherds from all sites is 5.4 mm with a range of 7.3 mm and a CV calculation of 18 percent. Coil widths averaged 3.7 mm with a range of 6.6 mm, and a CV of 26 percent. Mann-Whitney U test results by site and LPA were not statistically significant. The average number of indents within a 2 cm length varied from between 1 to 6 indents with an average of 2.6 indents per 2 centimeters. Indent widths averaged 5.1 mm with a CV of 27 percent, and depths averaged 1.1 mm with a similar CV value to indent widths. In contrast, indent angles were the most standardized measurement for the entire dataset with a CV

Table 54. Select Statistical Measures from SVC Rim and Body Sherds from all Site Combined.

Measure	Mean	SD	CV (%)	Min.	Max.
Rim thickness (mm)	3.6	0.9	26	1.5	7.2
Height of uncorrugated (mm)	16.0	6.5	41	2.9	40.0
Thickness at base of rim (mm)	4.5	0.8	18	2.6	7.0
Rim thickness 2 cm below rim base (mm)	5.4	1.0	18	3.1	8.5
Body thickness (mm)	5.4	0.9	18	1.2	8.5
Coil width (mm)	3.7	0.9	26	1.3	7.9
Number of indents per 2 cm	2.5	0.7	27	1.0	6.0
Indent width (mm)	5.1	1.4	27	2.0	12.0
Indent depth (mm)	1.0	0.4	39	0.3	2.8
Indent angle (deg)	**154**	**14.5**	**9**	**7**	**177**

SD = Standard deviation; CV = Coefficient of variation

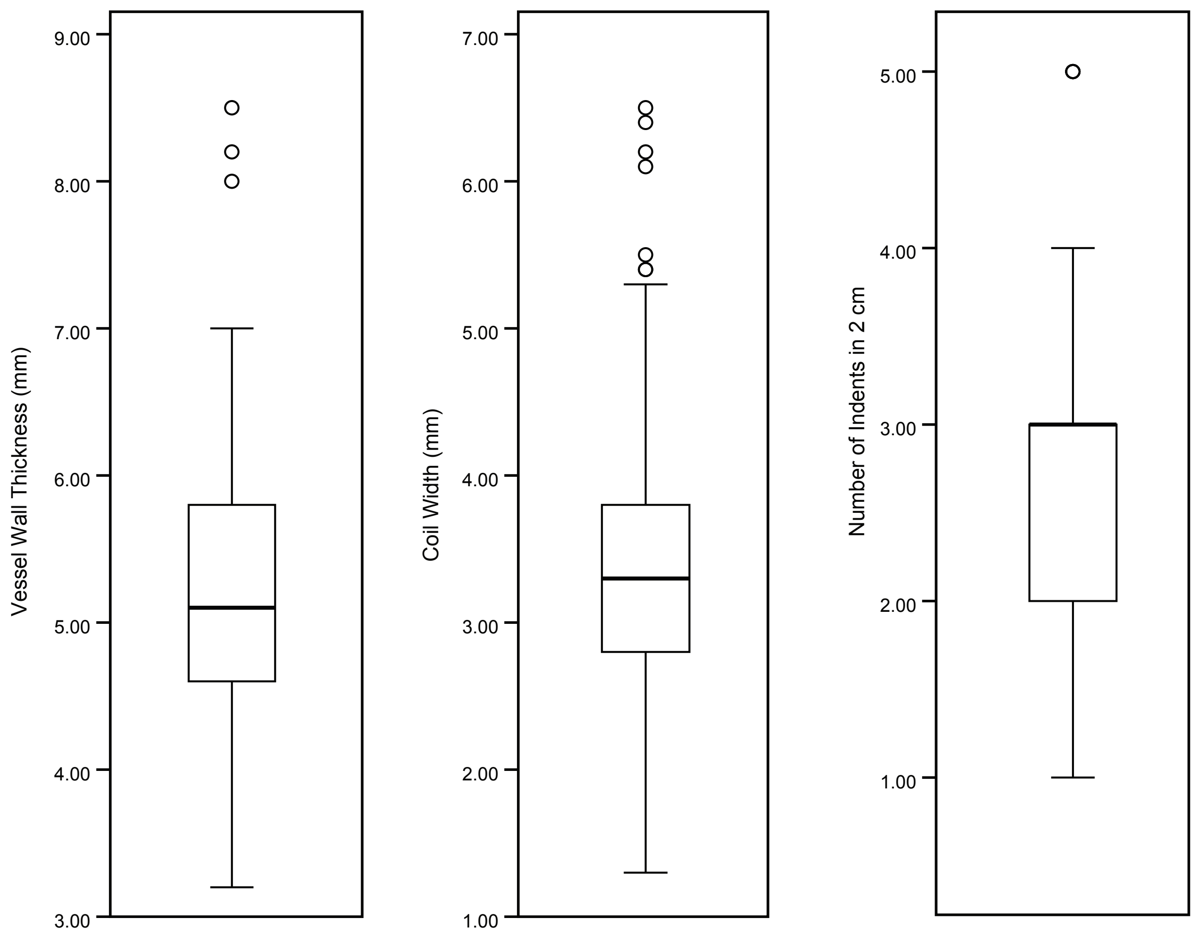


Figure 55. Box plots of body sherd metric measures.

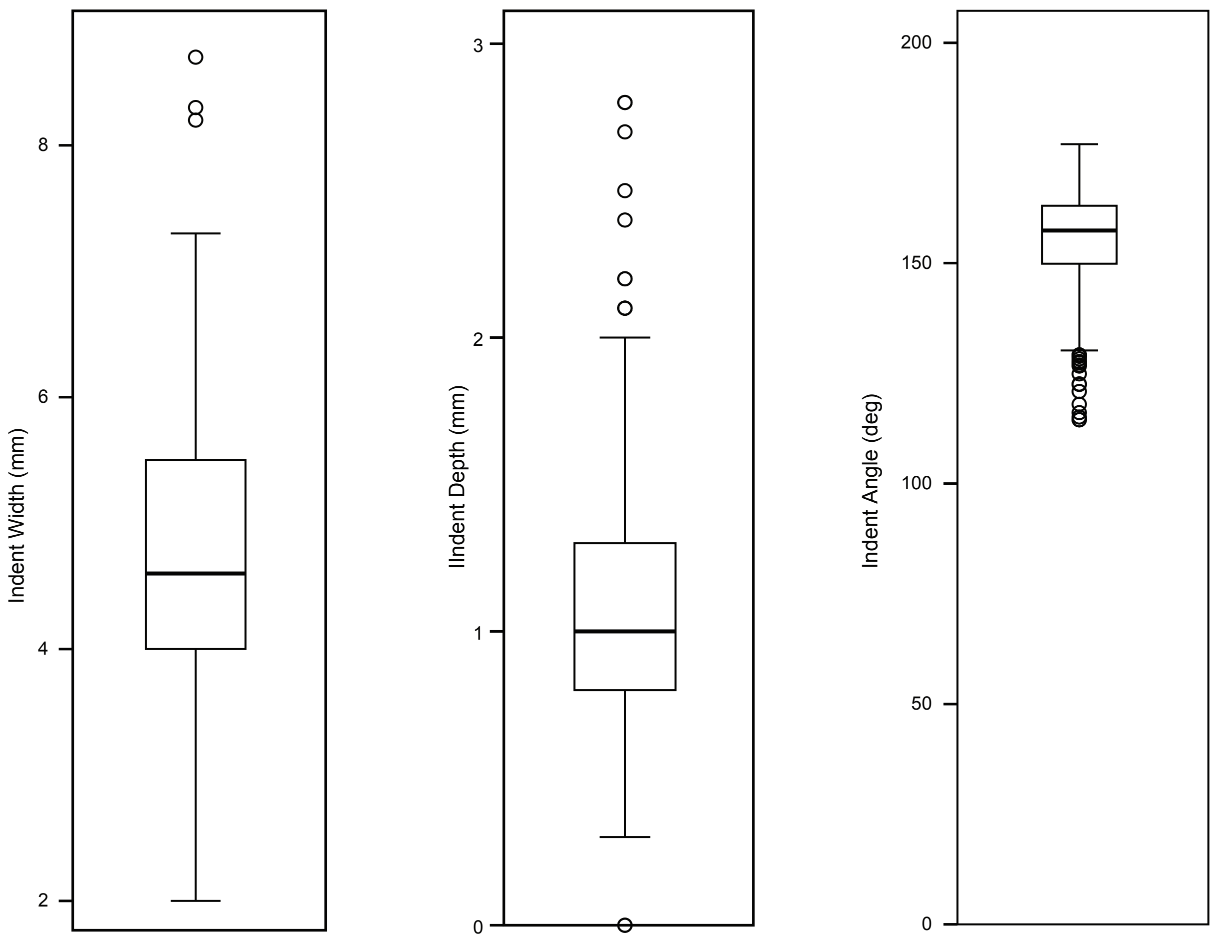


Figure 56. Box plots of body sherd metric measures (cont.).

value of 9 percent. This is a low enough percentage to suggest that the angle at which potters created the indents for Snake Valley Corrugated pottery was highly standardized across all three Parowan Valley sites included in this analysis.

Indent shapes were mostly triangular (86 percent), while the rest of the indent shapes are either rectangular/square or scalloped in shape. Corrugation patterns observed during analysis included stacked, offset, shifting, and a variety of irregular configurations (Figure 57). Fifty-percent (n=217) of the 436 sherds exhibit an offset corrugation pattern which is visible in sherds across all of the Parowan Valley sites discussed in this analysis (Table 55). The "shifting" pattern roughly represents 42 percent (n=179) of the total corrugation pattern types. A few sherds (n=13) have a stacked pattern, while a few others have irregular designs that do not fit the

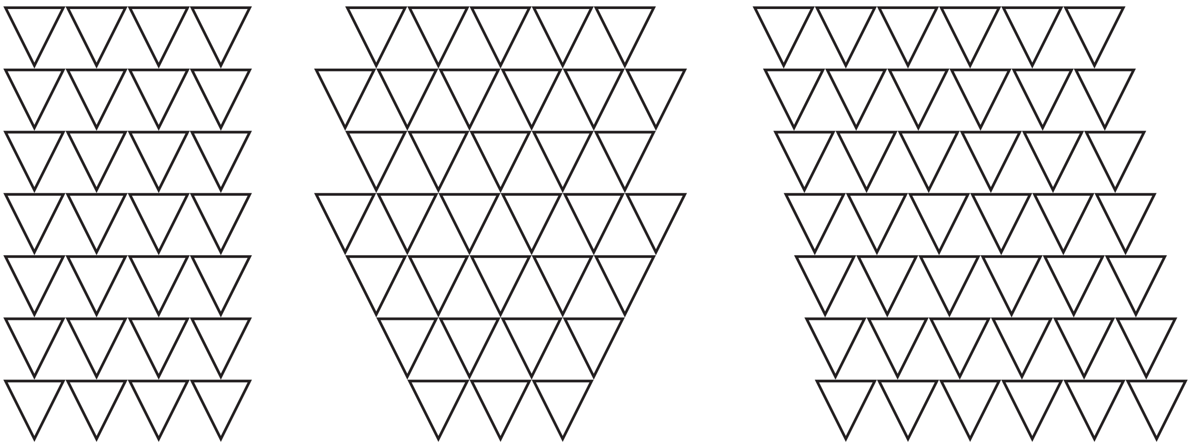


Figure 57. Corrugation patterns observed during analysis.

Table 55. Corrugation Pattern Counts by Site.

	Site			
Corrugation pattern	Summit	Paragonah	Total	Percent
Offset	184	25	209	50
Shifting	90	84	174	42
Irregular	16	6	22	5
Stacked	4	8	12	3
Median	53	17	98	
Total	294	123	417	

main three indentation patterns (Table 56). Tables 57 and 58 show the results from comparing corrugation patterns to LPA classes. The "shifting" pattern is the most dominant of all patterns in all of the LPA classes, with class 5 having 85 percent of the total sherds coming from this pattern. The other LPA classes have similar results with the "shifting" pattern.

Examining corrugation pattern percentages by site shows that 63 percent of the total assemblage at the Summit site was of the "offset" style. In contrast, 68 percent of the sherds from the Paragonah site were of the "shifting" style. The Pearson Chi-square result of 68.433 with a p-value of 0.000 (minimum expected count = 3.54) is statistically significant. This result

Table 56. Corrugation Pattern Percentages by Site.

	Site	
Corrugation pattern	Summit	Paragonah
Irregular	5	5
Offset	63	20
Shifting	31	68
Stacked	1	7
Total	100	100

Table 57. Corrugation Pattern Counts by LPA class.

	LPA class					
Corrugation pattern	1	2	3	4	5	Percent
Irregular	1	4	1	1	0	7
Offset	13	11	6	4	4	38
Shifting	41	38	22	20	22	143
Stacked	6	1	0	0	0	7
Median	6	4	3	4	4	
Total	61	54	29	25	26	195

Table 58. Corrugation Pattern Percentages by LPA class.

	LPA class				
Corrugation pattern	1	2	3	4	5
Irregular	2	7	3	4	0
Offset	21	20	21	16	15
Shifting	67	70	76	80	85
Stacked	10	2	0	0	0
Percent	100	100	100	100	100

suggests that there is a significant relationship between the corrugation pattern on Snake Valley Corrugated sherds and the site where they were likely produced. Comparing corrugation patterns to LPA classes did not show any correlations between the two variables.

Paste colors were also noted for each sherd and the results represent a wide array of colors from reds and grays to whites and blacks, as well as browns and a number of hues in between.

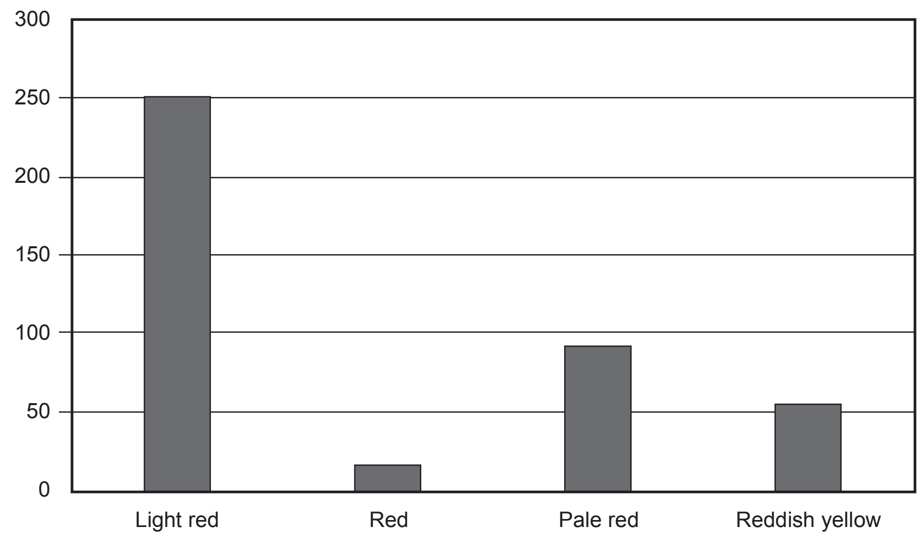


Figure 58. Graph showing refired sherd counts by Munsell color name.

Small segments from each sherd were removed or “nipped” and refired to oxidize the iron and remove carbon impurities in the paste. This is especially useful for grouping sherds by comparing differences and similarities in refired color and chemical compositional groups. Four distinct color groups were observed after refiring nips from each sherd (Figure 58). Groups were designated using the Munsell charts as: 1) light red (2.5YR 7/6), 2) red (10R 5/8), 3) pale red (10R 7/4), 4) and reddish yellow (5YR 6/6). Tables 59 and 60 show that the light red paste color (2.5YR 7/6) is the more prominent paste color at both Summit and Paragonah (n=252). These four color groups also compare favorably with the LPA studies discussed earlier that show 6 chemical groups (Tables 60 and 61). One of these LPA classes is not found within the Parowan Valley, leaving five representing the raw material sources procured by potters from the Paragonah, Summit, and Parowan sites. Categorizing the refired nips by color is a subjective process and the results should be take with caution; however, I would argue that the pale red group could be considered two groups that are difficult to parse out with the human eye. If this is the case, these refired nips would match the number of chemical groups found using LPA analysis; however, the Pearson Chi-square results that compared site and LPA class to refired paste color did not show any strong correlations.

Table 59. Paste Color Counts by Site.

	Site			
Paste color	Summit	Paragonah	Total	Percent
Light red	176	70	246	60
Pale red	72	21	93	23
Red	15	2	17	4
Reddish yellow	39	16	55	13
Median	56	19	74	
Total	302	109	411	

Table 60. Paste Color Percentages by Site.

	Site	
Paste color	Summit	Paragonah
Light red	58	64
Pale red	24	19
Red	5	2
Reddish yellow	13	15
Total	100	100

Table 61. Paste Color Counts by LPA.

	LPA						
Paste color	1	2	3	4	5	Total	Percent
Light red	37	32	21	15	21	126	64
Pale red	15	13	1	5	2	36	18
Red	1	2	0	1	0	4	2
Reddish yellow	8	8	7	4	3	30	15
Median	8	8	3	4	3	33	
Percent	61	55	29	25	26	196	

Table 62. Paste Color Percentages by LPA.

	LPA				
Paste color	1	2	3	4	5
Light red	61	58	72	60	81
Pale red	25	24	3	20	8
Red	2	4	0	4	0
Reddish yellow	13	15	24	16	12
Percent	100	100	100	100	100

Miscellaneous surface treatments, other than corrugation, recorded during my analysis included any exterior surface manipulations (uncorrugated coils, incised designs, etc.) or deposits; any vessel interior modifications; and any methods used to alter interior surfaces (scraping, smoothing, polishing, etc.). Results from the surface treatment analysis show that 56 (12 percent) sherds have polished corrugated surfaces, meaning that the exterior corrugated surface was manipulated, either intentionally or through use, resulting in a moderately smoothed surface. In addition, 211 (48 percent) sherds show signs of simple smoothing that reduces the rough exterior surface left by the corrugation process. As with the polished surfaces, it is unclear whether vessel exteriors were intentionally smoothed or were made smooth through continual use. In addition, 20 (4 percent) sherds have uncorrugated coils, and only six (1 percent) sherds have incised patterns that match those found on Fremont painted bowls. Two reconstructed Snake Valley Corrugated jars, however, were decorated with extensive incised patterns and uncorrugated coils, but these are the only two, along with the six documented sherds. Three sherds (<1 percent) have false corrugated surfaces, which is an attempt to mimic true corrugation, but is actually a technique where coils are fully obliterated and small shapes are poked into the exterior surface. Surface deposits on both the interior and exterior include a red ochre wash typical on many Fremont ceramic vessels, organic residues, and soot. Twenty-seven sherds exhibit evidence of red ochre wash, 9 have organic residues, and forty-seven have sooting from cooking fires.

Snake Valley Corrugated vessel interiors were either smoothed, scraped, or polished. Some of the interiors were only lightly smoothed, or the coils were simply obliterated with no further surface processing. A total of 244 (56 percent) sherds have simply smoothed interior surfaces, while 136 (31 percent) show that the interiors were scraped smooth with a tool, possibly with a sherd. Sixty-seven (15 percent) sherds have evidence that the inside walls were polished, and only 8 show that they were largely left at the stage where the coils were obliterated, but no further surface manipulation was used. Finally, for scraped interiors, some sherds still had scrape marks visible in the vessel walls. These marks were noted and ranked according to overlap patterns. Simple horizontal scrape marks paralleling the rim were noted on 42 percent of the scraped interior sherds, while only two sherds were noted with just vertical scrape marks. In cases where multiple scrapes are noted, the pattern seems to be a horizontal stroke first, followed by either one or two diagonal scrapes. In cases where the diagonal stroke is first, it is usually followed by an opposite diagonal scape, and sometimes a horizontal one, but very rarely by a vertical stroke.

Discussion

Results from my analysis provide information regarding the chemical composition and technological style of Snake Valley Corrugated pottery. Specifically, these results address both of my research questions which focus on the degree of variation in technological style in Snake Valley Corrugated pottery, and whether the degree of variation provided insight about shared contexts of learning and social identities among the potters in the Parowan Valley. The results suggest that Snake Valley pottery, from across all three villages in the Parowan Valley, exhibit moderately increased homogeneity. My analysis of Snake Valley Corrugated pottery at the Summit and Paragonah sites also suggests that some distinctions were made in a few overt or active aspects of technological style: rim form, lip form, and corrugation pattern.

Variation in technological style

I argue that the noted variations in technological style represents social identity at the village level, and I submit that these are likely potting communities and the existence of the variation provides evidence for shared contexts of learning. Table 63 includes results from all of the Pearson Chi Square statistical analysis showing the three categories (in bold) that have statistically significant p-values to argue for variation and technological style in Snake Valley

Table 63. Comparison of all Pearson Chi Square Results.

Variables by site	Pearson Chi Square	DF	MEC	p-value
Vessel size	6.624	3	10.93	0.85
Rim form	**17.594**	**8**	**1.24**	**0.02**
Lip form	**12.62**	**6**	**2.91**	**0.04**
Corrugation pattern	**68.433**	**3**	**3.54**	**0.00**
Paste color	3.299	3	4.51	0.34
Variables by LPA class				
Vessel size	5.881	12	2.48	0.92
Rim form	22.784	32	0.25	0.88
Lip form	26.713	24	0.63	0.31
Corrugation pattern	15.274	12	0.90	0.22
Paste color	13.459	12	0.51	0.33

DF = Degrees of freedom; MEC = Minimum expected count

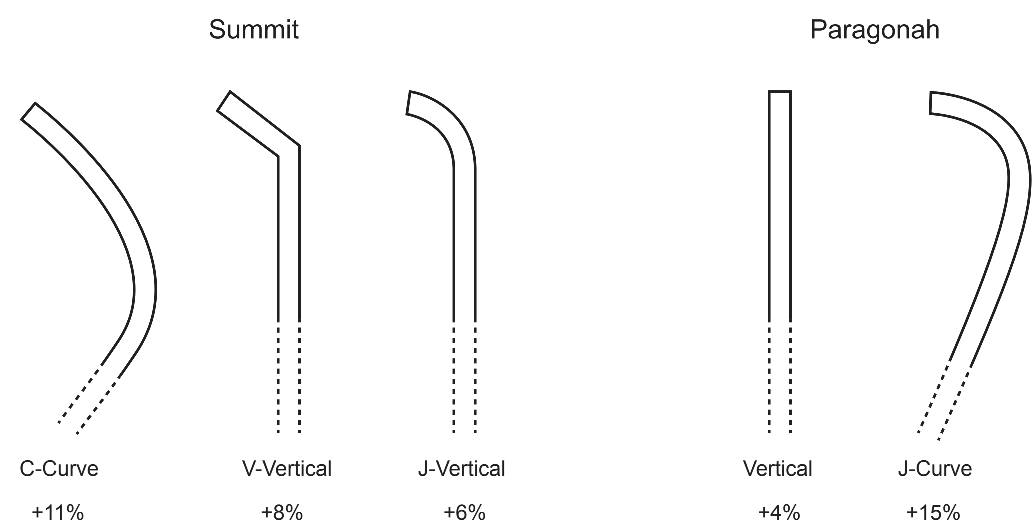


Figure 59. Rim form variation by site. Percentages indicate an increase above the corresponding rim form of the opposing site.

Corrugated pottery found at the Summit and Paragonah sites. Rim form analysis shows that potters at Summit used C-curve, V-vertical, and J-vertical rim forms; however, at Paragonah, the vertical and the J-curve rim forms were more dominant (Figure 59). Rim lip form analysis suggests that Summit potters preferred using the pointed and rounded point lip forms, while

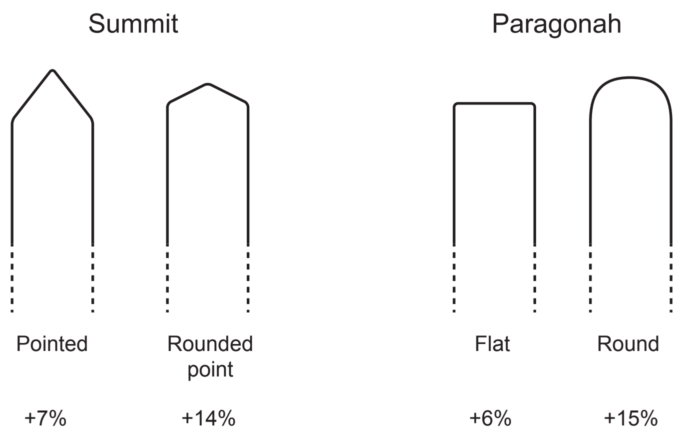


Figure 60. Rim lip form variation by site. Percentages indicate an increase above the corresponding rim lip form of the opposing site.

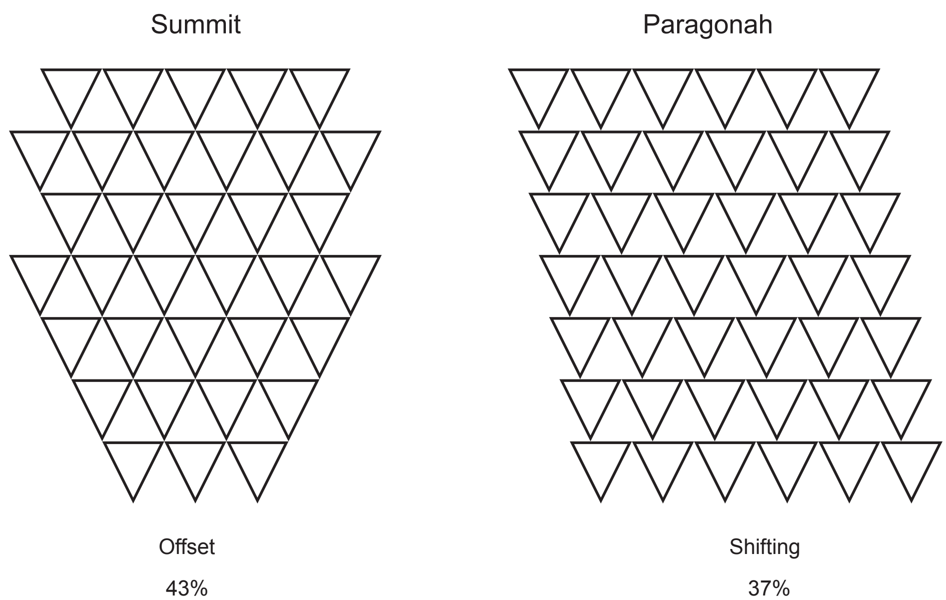


Figure 61. Corrugation variation by site. Percentages indicate an increase above the corresponding rim lip form of the opposing site.

potters at Paragonah preferred flat or round lip forms (Figure 60). Results from statistical analysis show that Potters at the Summit site overwhelmingly chose to use offset corrugation patterns on vessel exteriors, while Paragonah potters used shifting corrugation patterns for their Snake Valley Corrugated vessel surfaces (Figure 61). These conclusions are based on the assumption that the pottery found at these sites was likely produced there, although a small percentage were likely traded between sites as well.

In addition to the Pearson Chi Square analysis, I also ran Mann-Whitney U tests on the metric variables in my dataset (Table 64). Results from rim thickness measures by site returned a p-value of 0.05, suggesting a statistically significant relationship between rim thicknesses and sites. In this case, both the Summit and Paragonah sites have high percentages of medium (3–5 mm) thick rims. Results from uncorrugated rim portions by site returned a p-value of 0.05, suggesting a statistically significant relationship between the uncorrugated rim height and sites. Differences are visible between the Summit and Paragonah sites at the 11–15 (Summit +12 percent), 16–20 (Summit +6 percent), and 21–25 (Paragonah +10 percent) size classes. Mann-Whitney U test results by LPA class were are not statistically significant. Finally, coil widths compared to the sites in my analysis returned a p-value of 0.00. This is evident in the variation at the 2–3 mm size where Paragonah has 16 percent more sherds in this category (Table 65). In the 4–5 mm range, Summit has 11 percent more sherds than Paragonah.

Similarities in technological style

Although there are a few examples of distinct variations in technological style, my results also suggest moderately increased levels of homogeneity in Snake Valley Corrugated pottery across all sites in the Parowan Valley. Figure 62 is a series of box plots from a select number of measurements showing the general similarities between sherds from the Summit and Paragonah sites. In some cases the medians vary, although only several millimeters in difference in most of the cases. Figures 63 and 64 show the comparison between the same six measures graphed in Figure 62 as they compare to LPA classes. In these examples, subtle shifts are visible between the means from each LPA class, but the differences are mostly minimal.

I suggest that these similarities, along with noted moderately higher homogeneity (e.g. indent angle), in technological style are evidence for an interconnected, valley-wide, community of potters that shared a valley-wide level of identity and community. I presume that these similarities come from potters at Summit and Paragonah frequently interacting with each other

Table 64. Comparison of all Mann-Whitney U Test Results.

Test variables by Site	Mann-Whitney U	z-score	p-value
Rim thickness	**2539.0**	**-2.0**	**0.05**
Uncorrugated height below rim	**2487.5**	**-1.9**	**0.05**
Rim thickness at the base	2664.0	-1.3	0.20
Rim thickness 2 cm below rim	2625.0	-1.4	0.16
Rim eversion	2891.0	-0.6	0.51
Body thickness	2720.0	-1.1	0.28
Coil width	**1982.0**	**-3.5**	**0.00**
Indent width	2659.5	-1.3	0.19
Indent depth	2393.0	-2.1	0.33
Indent angle	2719.5	-0.7	0.45
Test variables by LPA class			
Rim thickness	729.5	-0.1	0.90
Uncorrugated height below rim	671.0	-0.6	0.56
Rim thickness at the base	607.0	-1.3	0.18
Rim thickness 2 cm below rim	710.0	-0.3	0.75
Rim eversion	597.0	-1.0	0.33
Body thickness	1325.0	-1.5	0.12
Coil width	1468.0	-0.6	0.57
Indent width	1368.0	-1.3	0.19
Indent depth	1317.0	-1.3	0.19
Indent angle	1303.0	-1.7	0.09

Table 65. Coil Width Percentages by Site.

	Sites	
Size ranges	Summit	Paragonah
1–2 mm	1	3
2–3 mm	11	26
3–4 mm	48	48
4–5 mm	27	16
5–6 mm	8	6
6–7 mm	4	1
7–8 mm	1	0
Percent	100	100

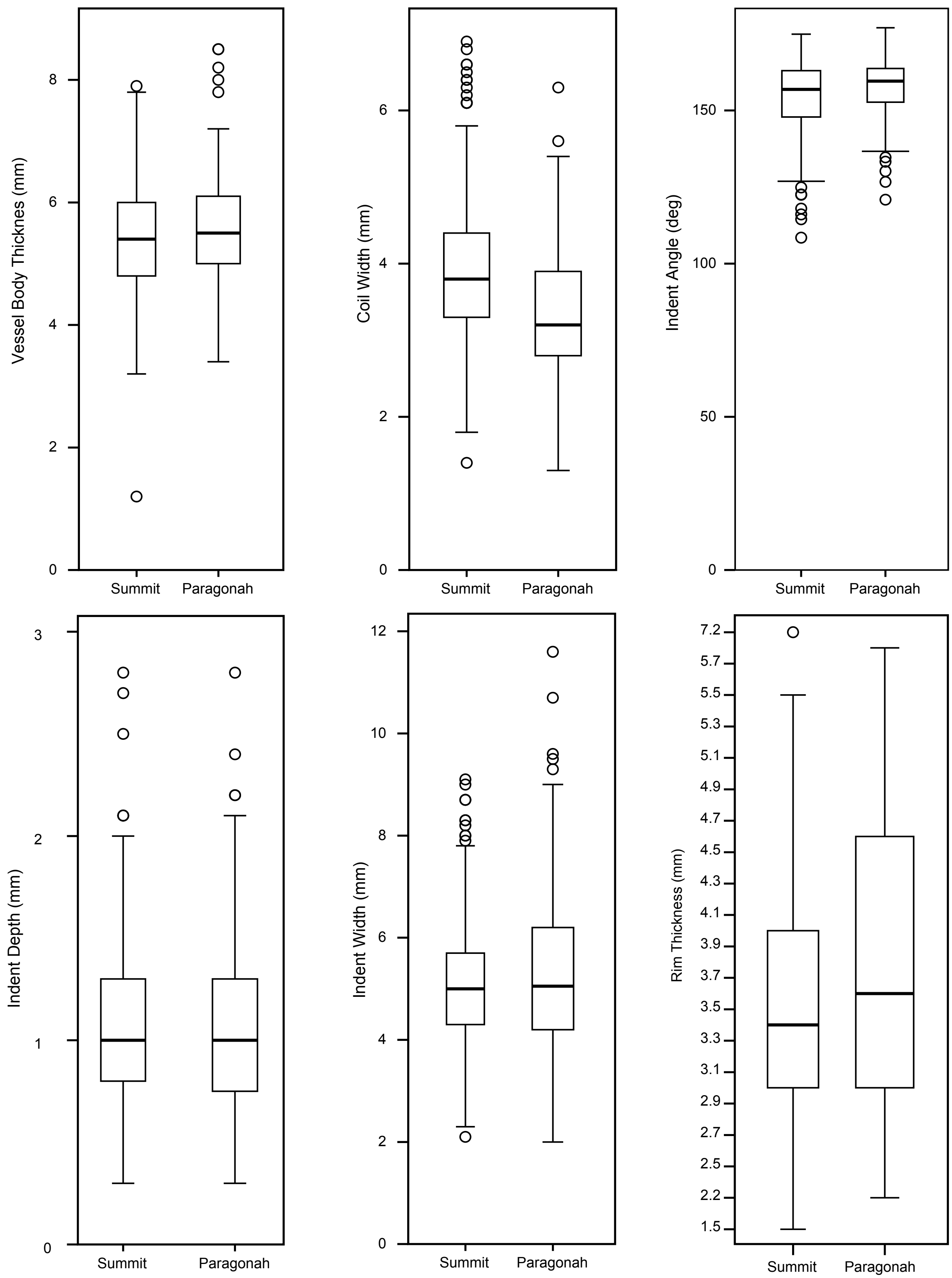


Figure 62. Box plots showing the general similarities in measurements between Summit and Paragonah.

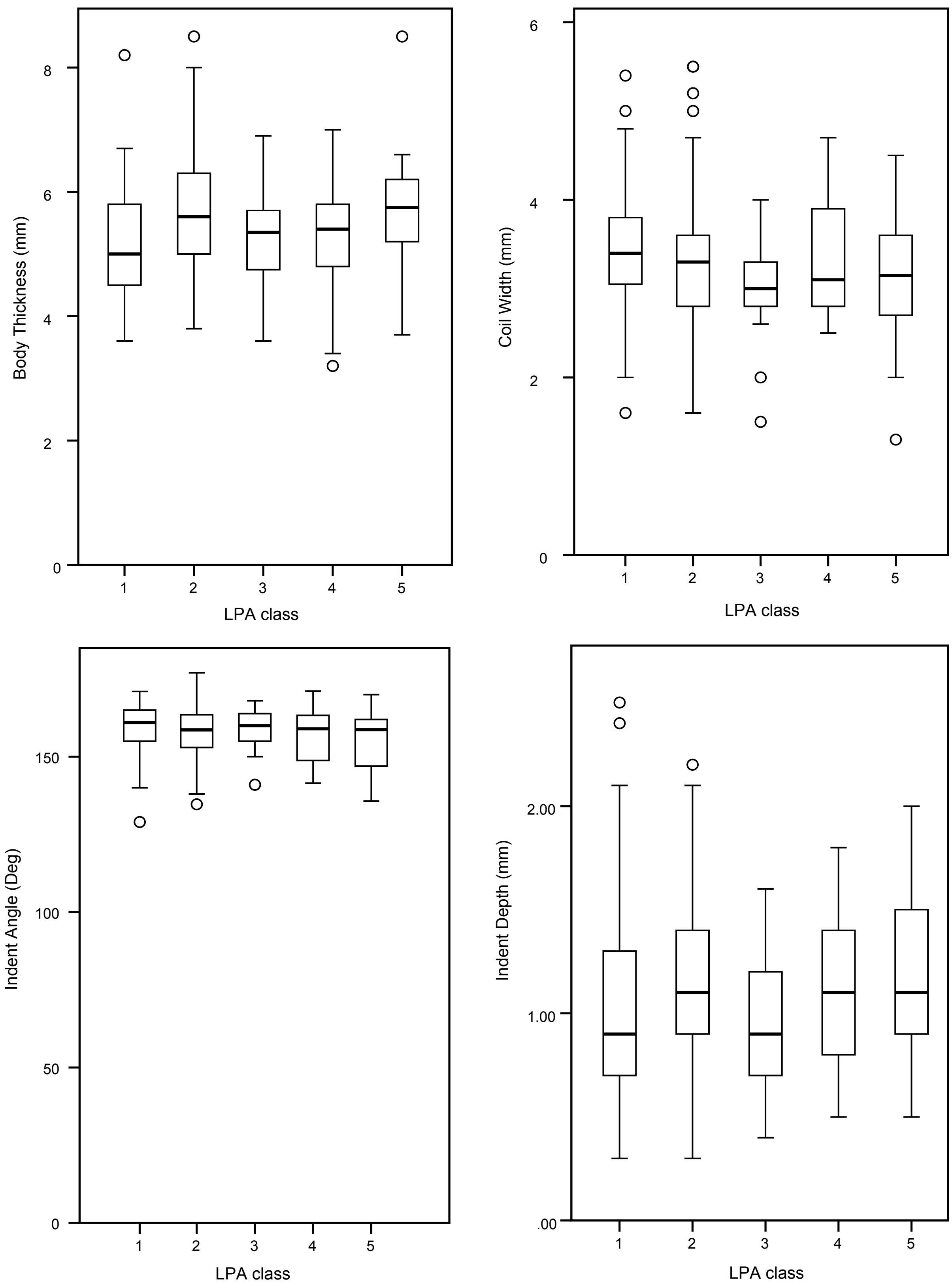


Figure 63. Box plots showing the general similarities in measurements between LPA classes.

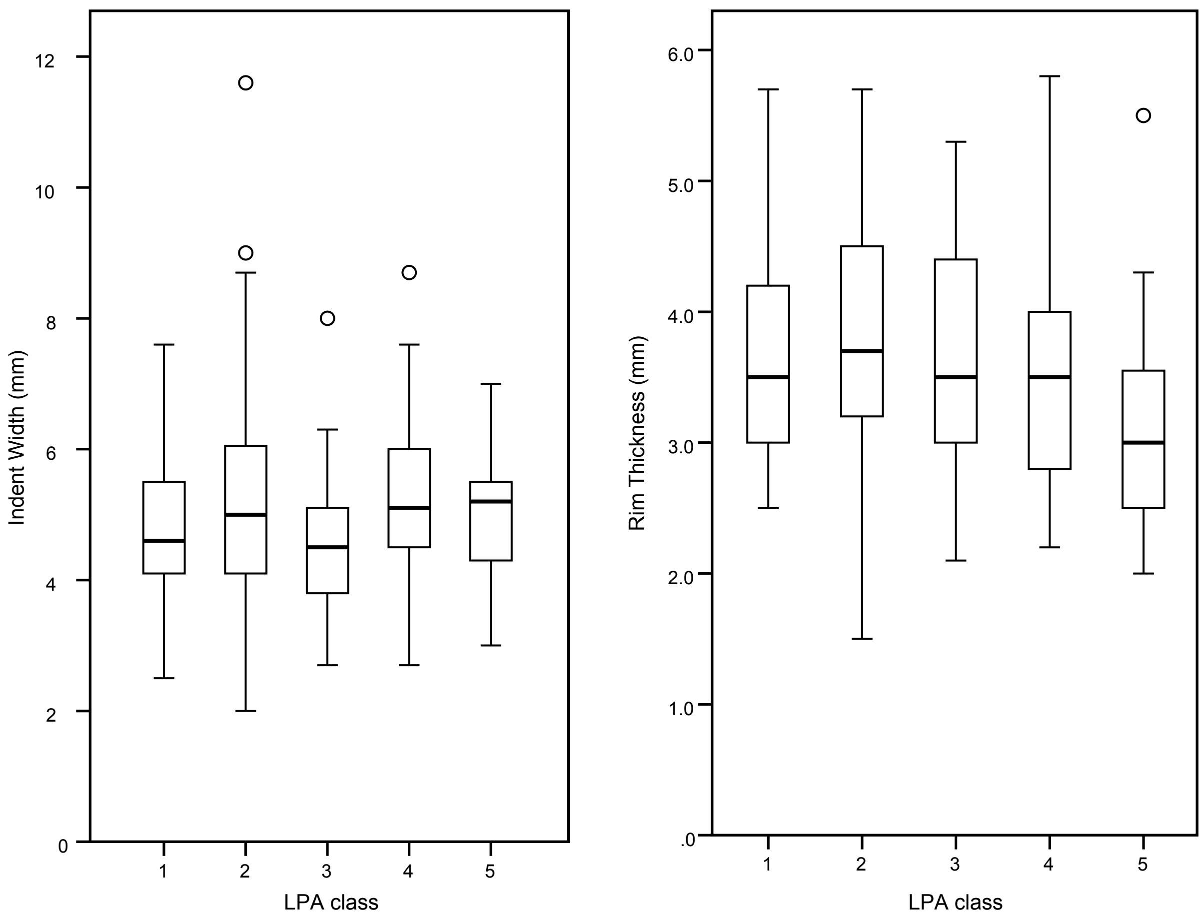


Figure 64. Box plots showing the general similarities in measurements between Summit and Paragonah.

and sharing a common pottery production tradition passed down from generation to generation.

The NAA results, combined with the PCA and LPA analysis, also offer valuable insight regarding raw material procurement practices by Fremont potters and show that Snake Valley pottery was chemically quite similar, but enough variation is present to identify compositional classes. This is not surprising given the close proximity of Fremont communities in the Parowan Valley and the presumed high degree of interactions between potters from all three villages.

The chemical data, combined with the measurement results, have uncovered minute details in Snake Valley Corrugated pottery that emphasize technological style as a means for finding patterns. These passive acts of habitus reveal important information about at least two levels of social identity, village and valley-wide membership, among Fremont potters in the Parowan Valley.

8 Conclusions

My thesis has focused on expanding what is currently known about Snake Valley Corrugated pottery through an extensive examination of technological style. In addition, I provided a synthesis of the Fremont in the Parowan Valley that has never been fully combined into one publication. My main goal, however, was to improve what is known about Fremont social complexity through an examination of intra- and inter-village interaction among Fremont potters in the Parowan Valley based on similarities or variation in technological style. I proposed the following research questions to achieve this goal: 1) to what degree do technological aspects of style vary in Fremont Snake Valley Corrugated ceramics, and 2) do these attributes represent shared contexts of learning and social identities?

In answer to Research Question 1, I argue that Snake Valley pottery from the Summit and Paragonah sites had both moderately high homogeneity, as well as statistically measurable variation. Rim forms, lip forms, corrugation patterns, rim thicknesses, uncorrugated heights below the rim, and coil widths varied between both sites, but results from other measurements (angle of indentation, body thickness, indent depth, indent width, and several others) suggest a high degree of consistency. In answer to Research Question 2, I suggest that the similarities in the technological style of Snake Valley Corrugated pottery offer hints, at one level, for an interconnected, valley-wide, community of potters that shared a sense of identity and community larger than the household level. These potters likely interacted with each other and shared a common pottery production tradition passed down from generation to generation. In contrast, I submit that the variations noted in rim forms, lip forms, and corrugation patterns between the Summit and Paragonah sites represent different expressions of technological style in Snake Valley Corrugated pottery. These differences likely represent expressions of village affiliation, and I also think that they suggest the presence of different potting communities and shared contexts of learning between the Summit and Paragonah sites.

Premises

The premises I outlined in the introduction were generally substantiated by the results from my analysis in Chapter 7. I used these premises to establish hypotheses that addressed my research questions. Premise 1 stated that, by definition, Snake Valley Corrugated pottery contains technological style with some degree of variation. Premise 2 stated that Snake Valley Corrugated sherds should display moderately high homogeneity between contemporaneous villages located in close proximity to one another. Certain characteristics, such as the angle of indention used to make the corrugated surface, do exhibit some homogeneity. Premise 3 proposed that homogeneity in measures of technological style may indicate that potters producing these vessels shared similar contexts of learning, as well as shared affiliations with potting communities and village membership.

My results offer hints that certain aspects of Snake Valley pottery do exhibit moderately high homogeneity across sites and chemical groups which may represent a valley-wide affiliation between potters. My analysis of Snake Valley Corrugated pottery at the Summit and Paragonah sites also shows variation between a few overt or active aspects of technological style, including rim form, lip form, and corrugation pattern. Although Snake Valley Corrugated vessels were utilitarian gray wares, they also conveyed important information through these more overt uses of technological style. These more visible characteristics may signal differences in production practices between potting communities, thus suggesting differing shared contexts of learning at the village scale.

Hypotheses

Based on these premises, I formulated the following hypotheses to address my research questions which are: 1) to what degree do technological aspects of style vary in Fremont Snake Valley Corrugated ceramics, and 2) do these attributes represent shared contexts of learning and social identities? The results from my analyses provided insightful information to begin addressing these questions.

Hypothesis 1

Hypothesis 1 states: *If aspects of technological style in SVC pottery have moderate degrees of homogeneity and standardization (based on measures, observations, chemistry, and statistical results), then potters making SVC pottery might have had some degree of social interaction with each other, as well as had similar shared contexts of learning*. My results provide hints that may confirm this hypothesis, but more analysis and a larger dataset, are required to fully establish its validity. Measurements and statistical results from several characteristics moderate levels homogeneity and standardization.

Hypothesis 2

Hypothesis 2 states: *If SVC pottery from one specific village within the Parowan Valley exhibits moderately high homogeneity, suggesting shared contexts of learning among village potters, then these individuals might have belonged to a village-based community of potters, and they might have shared village membership*. My results suggest that a few measures (e.g. indentation angle) exhibited moderately high levels of homogeneity among all of the Parowan Valley sites, and may represent a valley-wide community of potters, instead of a village scale level of identity. In contrast, several examples of variations in technological style may represent examples of social identity at the village level, and I submit that these are likely potting communities and evidence for shared contexts of learning. For example, differences in rim form shapes, rim lip forms, and corrugation patterns between the Summit and Paragonah sites might suggest that these potters were using technological style to differentiate their pottery from other pottery produced in the neighboring village.

Hypothesis 3

Hypothesis 3 states: *If SVC pottery from multiple villages within the Parowan Valley exhibit moderately high homogeneity, suggesting shared contexts of learning among the potters in the Parowan Valley, then these individuals might have belonged to a multi-village, valley-wide community of potters*. Based on my results, but especially the moderately high homogeneity in several measured characteristics of technological style, this hypothesis is plausible. The similarities in the chemical elements noted in the neutron activation analysis add a possible line of evidence connecting Fremont potters in the large villages in the Parowan Valley together. One could also interpret the chemical similarities in the sherds analyzed from Parowan, Paragonah, and the Summit Site as simply representing the presumed geological homogeneity of the Parowan Valley; however, is the geology really that similar?

This question expands beyond the scope and limitations of this thesis, but a few observations from my brief geologic description for the Parowan Valley help address this question. Thomas and Taylor (1946) noted over 48 different rock types in Iron County alone (Figure 65). Of particular interest is the fact that the Parowan Valley contains numerous basalt outcrops. These basalt outcrops ring the Parowan Valley, and Paragonah is located near the largest outcrop which measures approximately one square mile long (Thomas and Taylor 1946; Weide 1973). This is particularly interesting because no Snake Valley pottery of any variety is made with basalt; however, Fremont Sevier pottery, produced approximately 100 miles north, is tempered with several different varieties of basalt (R. Madsen 1977). In addition, Thomas and Taylor (1946)

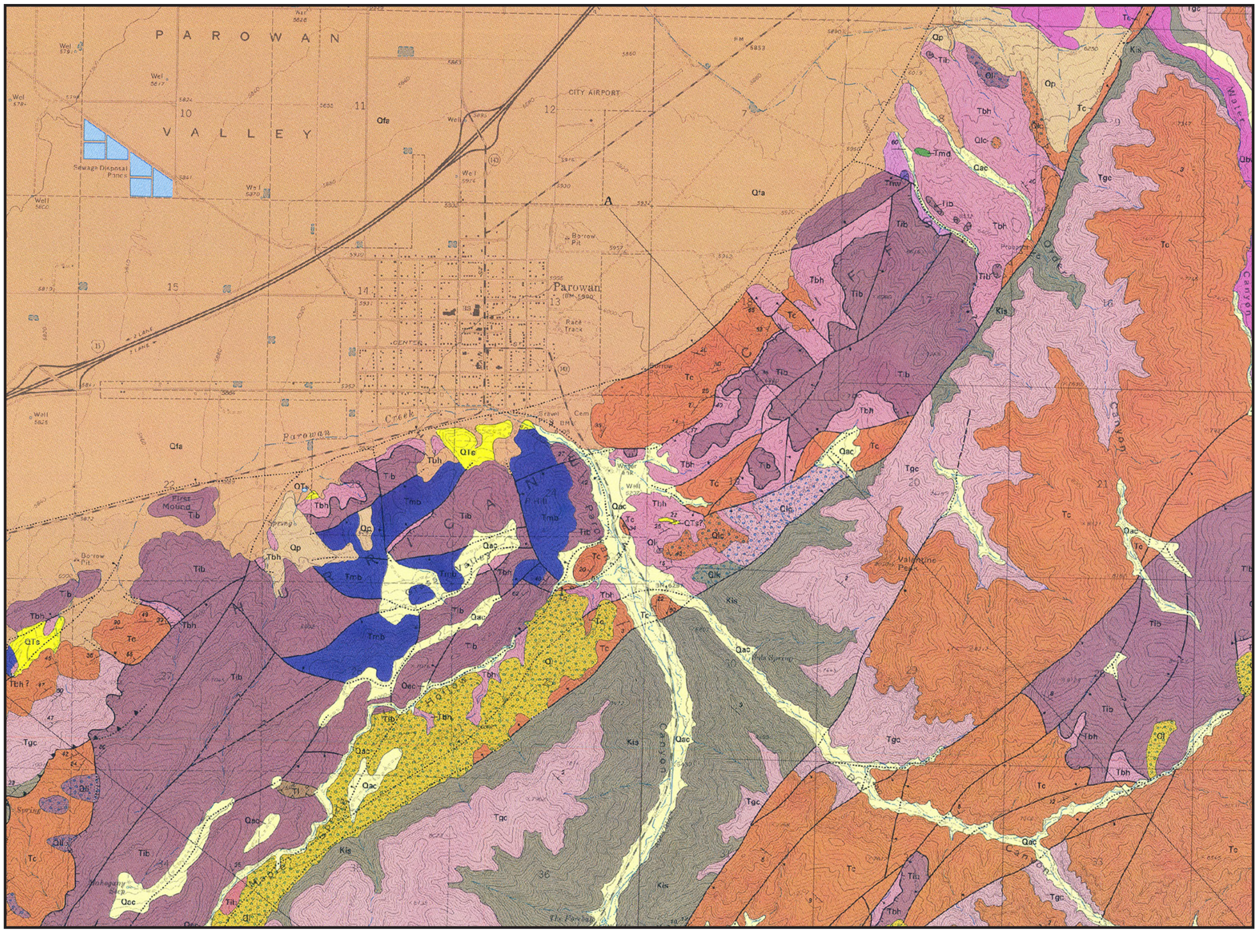


Figure 65. Geologic map of the modern town of Parowan, in the Parowan Valley, Utah.

documented rhyolite, trachyte, latite, dacite, andesite, and other assorted pyroclastics along the Hurricane Cliffs to the east. None of these rocks, however, were used for constructing Snake Valley pottery despite their presence in the Parowan Valley. Based on the geologic information from Thomas and Taylor (1946), it seems that the geology in the Parowan Valley should be considered more heterogenous than homogenous.

Interpretations

I have assumed, throughout this thesis, that technological style in ceramics conveys information about the producers social identities, and I specifically assumed that Parowan Valley potters belonged to communities of practice, at least within their home villages. As stated in the introduction, homogeneity in the technological style of hand-produced goods is assumed to vary in proportion to the amount of direct social interaction among producers. I argue that this is true for shared social identities as well. Based on the results from my analysis, the actions of the Parowan Valley potters are indeed visible in the archaeological record, and their actions, as suggested by practice theory, certainly would have defined and redefined their social environment through the manufacture of Snake Valley Corrugated pottery.

My thesis is one example of how examining the technological style of artifacts, such as those examined in Snake Valley Corrugated pottery, offers important insights overlooked at larger scales of analysis. This does not mean, however, that examining artifacts from a micro-systematic approach alone is the solution. When possible, examining artifacts from both small and large scales offers a better perspective. My goal for this thesis was to determine just how much variation existed in the small details of technological style found in Snake Valley Corrugated pottery. In addition, I wanted to know whether these details provided insight about how potters in the Parowan Valley were expressing social identities and shared contexts of learning.

I suggest that my results show both minor variation, as well as similarities, in the technological style of Snake Valley Corrugated pottery. This conclusion is based on metric measures, observations, chemistry, and statistical results suggesting shared contexts of learning between potters at the Paragonah, Summit, and Parowan sites. Although, some construction techniques vary, others, such as the angle of indention (9 percent CV), as well as raw clays and tempers used to manufacture Snake Valley Corrugated pottery, are generally consistent across all three Parowan Valley Fremont sites. I propose that these similarities in technological style are evidence for a interconnected, valley-wide, community of potters that shared a sense of identity and community larger than the household level. These potters likely interacted with each other frequently and shared a common pottery production tradition passed down from generation to generation.

Variations in technological style noted in my dataset, however, may represent expressions of social identity at the village level as well. I submit that these variations could represent village-scale differences in technological style, social identity, potting communities, and shared contexts of learning. For example, variations in rim form shapes, rim lip forms, and corrugation patterns between the Summit and Paragonah sites provide good evidence that these potters were using technological style to differentiate their pottery from vessels produced by other potters in the Parowan Valley.

Based on this interpretation, potters in the Parowan Valley might have had several interrelated social identities at both village and valley-wide scales. This conclusion seems, as first glance, to increase the Fremont identity crisis, but social identity theory, as well as other theories, offer support for this idea. This concept of multiple and intertwined identities is something not uncommon when referring to an individual's social identity (Cordell 2008). Individuals can, and often do have, multiple and nested identities depending on the situation. Examples include village membership, gender, kin-group, professional guild, clan, etc. I suggest, based on social identity theory, that Fremont potters might have had interconnected circles of social identity at the village level, as well as among the other villages in the Parowan Valley. This may be one explanation for why the pottery in my dataset exhibits evidence of both similarities among some measures, as well as variation among others.

Identities are sometimes visible in the material goods individuals manufacture because personal tastes and technological style may, at times, influence a producer's social identity. This thesis focused specifically on the unconscious actions or *habitus* related to the production of material goods. The gestures and procedures used to produce Snake Valley Corrugated pottery are "captured" in the final ceramic piece and contain valuable information about technological style used by the potter. As Sewell (1992:136) writes, artifacts "[can be] read like texts, to recover the cultural schemas they instantiate." This hermeneutic translation offers the ability to uncover the social identities wrapped into the resources produced by knowledgeable and skilled individuals. In this thesis, the potters producing ceramic vessels were the agents, and the pottery they made were the resources they produced and exchanged in a Fremont economy. The daily repetitive motions used to produce the specific raw material and form the pots were heavily influenced by *habitus*—the creative process enculturated into each potter through observation, imitation, and repetition at a young age. Ethnographic studies (Bartlett 1934; Crown 2001, 2007) show that these techniques can be passed down from generation to generation, but in a variety of ways depending upon the culture. Crown (2001) writes:

> Ethnographic and historic records from the American Southwest indicate that pottery production was traditionally learned when females were children among the Southwestern Puebloan and Piman-speaking groups. Ethnographic accounts indicate that, historically, Pueblo girls learned to make pottery largely by observation and imitation of their mothers, aunts, grandmothers, or other adult females (Bunzel 1972; Fowler 1977; Hill 1982139; John Steiner 1975 Stanislawski and Stanislawski 1978).

Based on these ethnographic analogies from the American Southwest, it is possible that Fremont potters might have been women, and they likely taught their daughters how to produce pottery using a tradition passed from mother to daughter over the centuries. As Crown writes, "[puebloan] ethnographic sources indicate that girls began to learn to make pottery at about the age of five and generally were expected to have all of the knowledge to run their own households (including producing acceptable pots) by the age of fifteen" (Figure 66 and 67). Crudely made vessels found in an archaeological context may be evidence of young Fremont potters practicing pottery-making, or perhaps elderly potters with diminishing skill. These crudely made pieces show less control and skill than other examples, especially in the indentation patterns and shapes (Figure 68). Although not specifically part of this thesis, what could be interpreted as the gestures of a young or elderly potter is evident in some Fremont painted wares (Figure 69).

Figure 66. Young Puebloan girl Nampeyo (ca. 1904) painting pottery. Original photograph taken by Carl Moon. Miriam and Ira D. Wallach Division of Art, Prints, and Photography, Digital ID #417707, Record ID #243694.

Figure 67. Zuni woman creating a ceramic vessel using the coil and scape technique. Original photo taken by Edward Curtis.

Figure 68. Select Snake Valley Corrugated sherds perhaps exhibiting poor execution. These may be the results of younger Fremont potters learning to make corrugated pottery, or elderly potters with diminishing skills levels. Photographs taken by Haylie Ferguson at request of the author.

Conclusions

My thesis focused on expanding what is currently known about Snake Valley Corrugated pottery through an extensive examination of technological style in Snake Valley Corrugated pottery. Another important part of my thesis was to increase what is known about Fremont social complexity through an examination of intra- and inter-village interaction among Fremont potters in the Parowan Valley. There was little evidence to show inter-village interaction between potters due to a lack of resolution and detail. Parowan Valley potters, however, were likely part of a larger potting community spanning all three sites, suggesting interaction and possible

Figure 69. Two Parowan Valley Snake Valley Black-on-gray bowl sherds exhibiting poor execution. These may be the results of younger Fremont potters making painted pottery or elderly potters with diminished skill levels.

kinship ties between potters from each village. I propose that a shared context of learning is the mechanism that perpetuated the homogeneity visible in the technological style of Snake Valley Corrugated pottery presented in this thesis. Hegmon et al. (2000) explain that technological style is generally learned through "close interaction among producers and/or through hands on instruction . . . technological styles are not easily copied, a conclusion that has powerful implications for archaeology." Applying this idea to Fremont potters in the Parowan Valley may confirm that the homogeneity visible in the various aspects of technological style suggests that potters from the Paragonah, Parowan, and Summit sites closely interacted with one another and shared similar contexts of learning.

In addition to expanding current definitions of Snake Valley Corrugated pottery, and examining the degree in which potters in the Parowan Valley may have interacted, this thesis also provided a consolidated review of the Fremont living in the Parowan Valley. Although student notes and a few reports provide important information, there was no synthesis available for the archaeological sites, general landscape, and environment for the Parowan Valley in one location. This thesis offers an important step toward consolidating data left in storage for decades.

As mentioned in Chapter 1, the Fremont living in the Parowan Valley experienced a complex and diverse social environment. There is little research, however, that tries to substantiate this assumed social complexity; consequently, there is currently a generally lopsided perception of the Fremont in past research. The prevailing view of the Fremont was summarized by Sammons-Lohse (1981:130) when she wrote that "there is no indication of [Fremont] community organization above the household level." My thesis, however, suggests otherwise. Other scholars, including Joel Janetski (2002), Richard Talbot (2000a), Lane Richens (2000), and recently James Allison (2008a) and Christopher Watkins (2006), are likewise successfully studying Fremont social complexity by combining research models from Great Basin archaeology with theoretical approaches from American Southwestern archaeological research.

Following these examples, my examination of technological style in Snake Valley Corrugated pottery attempted to identify expression of social identity and shared contexts of learning. This approach, along with other methods and theories, both old and new, will offer the opportunity for the material remains the Fremont left behind to tell us more about who these people were, where they came from, and why they left. As Hodder (1982) suggested, artifacts can be read like texts to reveal both the individuals and the social environment that controlled the technological style embedded in the varied steps and techniques used to make them. In this context, the ceramic vessels the Parowan Valley potters produced contain "readable" information about a Fremont people living in a dynamic social, economic, and interactive environment (Sewell 1992).

My thesis is just one example of how examining Fremont socio-cultural issues is possible. As the Fremont are studied from additional perspectives, but especially those used in American Southwestern archaeology, I submit that we will begin to see a more vibrant, diverse, but cohesive Fremont people. In essence, we can begin unraveling the Fremont "identity crisis" and recognize their important place in the prehistory of not only the Parowan Valley, but also in the Greater American Southwest.

References

Adovasio, James M., David R. Pedler, and Jeff S. Illingworth

1970 The Origin, Development and Distribution of Western Archaic Textiles. *Tebiwa* 13(2):140. Pocatello.

2002 Fremont Basketry. *Utah Archaeology* 15(1): 5–26.

Adler, Michael A.

1989 Ritual Facilities and Social Integration in Nonranked Socities. In *The Architecture of Social Integration in Prehistoric Pueblos*, edited by William D. Lipe and Michelle Hegmon, pp.35–52. Occasional Paper No. 1. Crow Canyon Archaeological Center Cortez, Colorado.

Adler, Michael A., and Richard H. Wilshusen

1990 Large-Scale Integrative Facilities in Tribal Societies: Cross-Cultural and Southwestern US Examples. *World Archaeology* 22(2): 133–146.

Aikens, Melvin

1966 Fremont-Promontory-Plains Relationships in Northern Utah. *Anthropological Papers No. 82*. University of Utah, Salt Lake City.

1972 Fremont Culture: Restatement of some Problems. *American Antiquity* 37:61-66.

Aitken, Martin J.

1985 *Thermoluminescence Dating*. Academic Press, London.

Alexander, Thomas G. (editor)

2007 *Utah: The Right Place*. Gibbs Smith Publishers, Layton, Utah.

Allison, James R.

2008a Human Ecology and Social Theory in Utah Archaeology. *Utah Archaeology* 21(1):57–78.

2008b Exchanging Identities: Early Pueblo I Red Ware Exchange and Identity North of the San Juan River. In *The Social Construction of Communities: Agency, Structure, and Identity in the Prehispanic Southwest*, edited by Mark D. Varien and James M. Potter, pp. 41–68. AltaMira Press, Lanham, Maryland.

2010 Animas La Plata Project: Volume XIV—Ceramic Studies. *SWCA Anthropological Research Papers No. 10*. SWCA Environmental Consultants.

Allison, James R., Lindsay D. Johansson, and Scott M. Ure

2012 *Communal Architecture in the Fremont World*. Paper presented at the 33rd Great Basin Anthropological Association Conference. State Line, Nevada.

Ambler, J. Richard

1969 The Temporal Span of the Fremont. *Southwestern Lore*, Vol. 34, No. 4, pp. 107–117. Boulder, Colorado.

1966 Caldwell Village. *Anthropological Papers No. 84*. University of Utah, Salt Lake City.

1967 Caldwell Village and Fremont Prehistory. Unpublished Ph.D. dissertation, Department of Anthropology, University of Colorado, Boulder.

Arnett, Abraham

1998 The Parowan Site and Mortonson's Site: A Preliminary Summary. Utah Archaeology 11(1):69–78.

Arnold, Dean E.

1985 *Ceramic Theory and Culture Process*. Cambridge University Press, New York.

Arnold, Dean E. and A. L. Nieves

1992 Factors Affecting Standardization. In *Ceramic Production and Distribution: An Integrated Approach*, edited by George J. Bey III and Christopher A. Pool, pp. 93–113. Westview Press, Boulder.

Bandy, Matthew S. and Sarah Baer

2011 Fremont on the Fringe of the Great Basin: A Study of the Formative Occupation of the Piceance Basin, Northwestern Colorado. Paper presented at the 32nd Biannual Great Basin Anthropological Conference. Layton, Utah.

Baker, Steven G.

1997 Fremont Archaeology on the Douglas Creek Arch, Rio Blanco County, Colorado: Granaries and Rock Art in Shavetail Basin. Centuries Research, Inc., Montrose, Colorado. Submitted to Bureau of Land Management White River Resource Area, Meeker, Colorado.

1998a Fremont Archaeology on the Douglas Creek Arch, Rio Blanco County, Colorado: The Rim Rock Promontory Hamlet (5RB2792). Centuries Research, Inc., Montrose, Colorado. Submitted to Bureau of Land Management White River Resource Area, Meeker, Colorado.

1998b Fremont Archaeology on the Douglas Creek Arch, Rio Blanco County, Colorado: The Sky Aerie Promontory Charnel Site (5RB104). Centuries Research, Inc., Montrose, Colorado. Submitted to Bureau of Land Management White River Resource Area, Meeker, Colorado.

Barrett, John C.

1981 Aspects of the Iron Age in Atlantic Scotland: A Case Study in the Problems of Archaeological Interpretation. *Proceedings of the Society of Antiquaries of Scotland*, vol. 111, pp. 205–219.

Bee, Robert G. and James W. Bee
1934–1966 Archaeological Collections, Utah County, Utah. Notes and Ms. on file, Museum of Peoples and Cultures, Brigham Young University, Provo, Utah.

Berry, Claudia F.
2005 The Mud Springs Site (42IN218). In *Kern River 2003 Expansion Project, Utah: Prehistoric Excavated Sites and Discoveries, Part 3*, Vol. III, edited by Alan D. Reed, Matthew T. Seddon, and Heather K. Stettler, pp. 723–780. Submitted to the Federal Energy Regulatory Commission, Southwest Region, FERC Docket No. CP01-422-000.

Berry, Michael S.
1972 The Evans Site. Special Report (limited distribution), Department of Anthropology, University of Utah, Salt Lake City.
1974 The Evans Mound: Cultural Adaptation in Southwestern Utah. Unpublished Master's thesis, Department of Anthropology, University of Utah, Salt Lake City.

Berzofsky, Marcus, Paul Biemer, and William Kalsbeek
2008 A Brief History of Classification Error Models. Proceedings of the 2008 Survey Research Methods Section, American Statistical Association. pp. 3667–3673.

Bettinger, Robert
1993 Doing Great Basin Archaeology Recently: Coping with Variability. *Journal of Archaeological Reasearch* 1:43–66.

Binford, Lewis R.
1962 Archaeology as Anthropology. *American Antiquity* 28(2):217–225.
1988 Science to Seance, or Processual to "Post-Processual" Archaeology. In *Debating Archaeology*, edited by Lewis Binford, pp. 27–40. Academic Press, New York.

Bishop, Ronald L. And Hector Neff
1989 Multivariate Analysis of Compositional Data in Archaeology. In *Archaeological Chemisty IV*, edited by Ralph O. Allen, pp.57–86. American Chemistry Society, Washington, D.C.

Bourdieu, Pierre
1977 *Outline of a Theory of Practice*. Cambridge University Press, Cambridge.
1990 *The Logic of Practice*. Stanford University Press, Stanford, California.
1998 *Practical Reason: On the Theory of Action*. Stanford University Press, Stanford, California.

Braun, David P.
1980 Appendix I: Experimental Interpretation of Ceramic Vessel Use on the Basis of Rim and Neck Formal Attributes. In *The Navajo Project: Archaeological Investigations, Page to Phoenix 500 kV Southern Transmission Line*, edited by Donald C. Fiero,

Robert W. Munson, Martha T. McClain, Suzanne M. Wilson, and Anne H. Zier, pp. 171–231. Research Papers II. Museum of Northern Arizona, Flagsstaff.

Bright, Jason, Steven R. Simms, and Andrew Ugan
2005 Ceramics from Camels Back Cave and Mobility in Farmer-Forager Systems in the Eastern Great Basin. *Anthropological Papers No. 125*. University of Utah, Salt Lake City.

Brew, John O.
1982 Noel Morss, 1904–1981. American Antiquity 47(2):344–345.

Brooks, George R. (editor)
1977 *The Southwest expedition of Jedediah S. Smith: His Personal Account of the Journey to California, 1826–1827*. Arthur H. Clark Company, Glendale, California.

Broughton, Jack M. and James F. O'Connell
1999 On Evolutionary Ecology, Selectionist Archaeology and Behavioral Archaeology. *American Antiquity* 64:153–165.

Brown, James A. and T. Douglas Price
1985 Complex Hunter-Gatherers: Retrospect and Prospect. In *Prehistoric Hunters and Gatherers: The Emergence of Cultural Complexity*, edited by T. Douglas Price and James A. Brown, pp.435–442. Academic Press, New York.

Brown, F. Martin
1967 Dr. Edward Palmer's Collecting Localities in Southern Utah and Northwestern Arizona. *Journal of the Lepidopterists' Society* 21(2):129–134.

Butler, B. Robert
1981 When did the Shoshoni Begin to Occupy Southern Idaho?: Essays on Late Prehistoric Cultural Remains from the Upper Snake and Salmon River Country. I*Occasional Papers of the Idaho Museum of Natural History*, No. 32. Idaho State University, Pocatello.
1983 The Quest for the Historic Fremont, and, A guide to the Prehistoric Pottery of Southern Idaho. *Occasional Papers of the Idaho Museum of Natural History*, No. 33. Idaho State University, Pocatello.
1986 Prehistory of the Snake and Salmon River Area. In *Great Basin*, edited by Warren L. D'Azevedo, pp. 127–134. Handbook of North American Indians, vol. 11, William C. Sturtevant, general editor. Smithsonian Institution, Washington, D.C.

Carr, Christopher
1995 A Unified Middle-Range Theory of Artifact Design. In *Style, Society, and Person: Archaeological and Ethnological Perspectives*, edited by C. Carr and J.E. Neitzel, pp. 171–258. Plenum Press, New York.

Cole, Clint

2010 *The Fremont Frontier in North Meadow Valley Wash, Eastern Nevada: An Examination of Ceramics Using Instrumental Neutron Activation Analysis*. Paper presented at the 32nd Biannual Great Basin Anthropological Conference. Layton, Utah.

2012 Prehistoric Archaeology and the Fremont Frontier at North Meadow Valley Wash, Eastern Nevada. Unpublished Ph.D. dissertation, Department of Anthropology, University of California, Davis.

Cordell, Linda S. and Judith A. Habicht-Mauche

2012 Practice Theory and Social Dynamics among Prehispanic and Colonial Communities in the American Southwest. In *Potters and Communities of Practice: Glaze Paint and Polychrome Pottery in the American Southwest*, A.D. 1250–1700, edited by Linda S. Cordell and Judith A. Habicht-Mauche, pp. 1–7. The University of Arizona Press, Tucson.

Costin, Cathy L. and Melissa B. Hagstrum

1995 Standardization, Labor Investment, Skill, and the Organization of Ceramic Production in Late Prehispanic Highland Peru. *American Antiquity* 60(4):619–639.

Clark, Jeffrey J.

2001 Tracking Prehistoric Migrations: Pueblo Settlers among the Tonto Basin Hohokam. *Anthropological Papers No. 65*. University of Arizona Press, Tucson.

Coles, Norman E.

1956 Observations on two Skeletons from Paragonah. In *Archaeological Investigations in Iron County, Utah*, pp. 119–127, by Meighan, Clement W., Norman E.Coles, Frank D. Davis, Geraldine M. Greenwood, William H. Harrison, and E. Heath MacBain. Anthropological Papers No. 25. Department of Anthropology, Univeristy of Utah.

Cowgill, George L.

2000 Rationality and Contexts in Agency Theory. In *Agency in Archaeology*, edited by Marcia A. Dobres and John E. Robb, pp. 51–60. Routledge, London and New York.

Creasman, Steven D., and Linda S. Scott

1987 Texas Creek Overlook: Evidence For Late Fremont (Post A.D. 1200) Occupation In Northwest Colorado. *Southwestern Lore* 53:1–16.

Creswell, Randy and Franklin W. Martin

1993 Dryland Farming Techniques: Crops and Techniques for Arid Regions. *ECHO Technical Note*. Electronic document, http://www.echocommunity.org/?page=ECHO_Technical_Notes, accessed January 29, 2013.

Crown, Patricia L.
1995 The Production of Salado Polychromes in the American Southwest. In Ceramic Production in the American Southwest, edited by Barbara J. Mills and Patricia L. Crown, pp. 1–29. The University of Arizona Press, Tucson.
1999 Socialization in American Southwest Pottery Decoration. In *Pottery and People: A Dynamic Interaction*, edited by James M. Skibo and Gary M. Feinman, pp. 25–43. University of Utah Press, Salt Lake City.
2001 Learning to Make Pottery in the Prehistoric Southwest. *Journal of Anthropological Research* 57(4):451–469.

Dalley, Gardiner F.
1972a Palynology of the Evans Mound Site Deposits. In *The Evans Site*, by Michael S. Berry, pp. 187–194. Special report, University of Utah, Department of Anthropology, Salt Lake City.
1972b Worked Bone. In *The Evans Site*, by Michael S. Berry, pp. 119–143. Special report, University of Utah, Department of Anthropology, Salt Lake City.
1972c Worked Stone. In *The Evans Site*, by Michael S. Berry, pp. 97–108. Special report, University of Utah, Department of Anthropology, Salt Lake City.

Dames and Moore
1994 Kern River Pipeline Cultural Resources Data Recovery Report: Utah. Prepared by Dames and Moore, Las Vegas, Nevada. Prepared for Kern River Gas Transmission Company, Salt Lake City, Utah. Submitted to the Bureau of Land Management, Salt Lake City.

Davis, Frank D.
1956 A Pit House at Mound B. In *Archaeological Excavations in Iron County, Utah*, edited by Clement W. Meighan, Norman E. Coles, Frank D. Davis, Geraldine M. Greenwood, William M. Harrison, and E. Heath McBain, pp. 60–87. Anthropological Papers No. 25. University of Utah, Salt Lake City.

DeBoer, Warran R.
1990 Interaction, Imitation, and Communication as Expressed in Style: The Ucayali Experience, in *The Uses of Style in Archaeology*, edited by Margaret W. Conkey and Christine A. Hastorf pp. 82–104. Cambridge University Press, Cambridge.

Dietler, Michael and Ian Herbich
1998 Habitus, Techniques, Style: An Integrated Approach to the Social Understanding of Material Culture and Boundaries. In *The Archaeology of Social Boundaries*, edited by Miriam T. Stark, pp. 232–263. Smithsonian Press, Washington D.C.

Dixon, K.
1954 Evans Mound Survey Notes. Manuscript on file, Office of Public Archaeology, Brigham Young University.

Dodd, Walter A., Jr. and D. Lynn Cozzens
1982 Final Year Excavations at the Evans Mound Site. *Anthropological Papers No. 106*. University of Utah, Salt Lake City.

Dyer, W. Justin
2009 Investigating the Various Ways Parental Incarceration Affects Children: An Application of Mixture Regression. Unpublished Ph.D. dissertation, Department of Human and Community Development, University of Illinois at Urbana-Champaign, Urbana.

Eerkens, Jelmer W.
2000 Practice Makes within 5% of Perfect: Visual Perception, Motor Skills, and Memory in Artifact Variation. *Current Anthropology* 41(4):663–668.

Eerkens, Jelmer W. and Robert L. Bettinger
2001 Techniques for Assessing Standardization in Artifact Assemblages: Can We Scale Material Variability. *American Antiquity* 66(3):493–504.

Eisinger, Chris
1998 A Summary of the Geology and Hydrogeology of the Cedar Valley Drainage Basin, Iron County, Utah. Utah Geological Survey Open-file Report 360. Utah Department of Natural Resources.

Elliott, Melinda
1995 *Great Excavations: Tales of Early Southwestern Archaeology, 1888–1939*. School of American Research Press, Santa Fe.

Engstrand, Iris W.
1965 *William Wolfskill, 1798–1866: Frontier Trapper to California Ranchero*. Arthur H. Clark Company, Glendale, California.

Fowler, Don D. and John F. Matley
1968 The Palmer Collection from Southwestern Utah, 1875, Miscellaneous Paper No. 20. In *Miscellaneous Collected Papers 19–24*, pp. 17–42. Anthropological Papers No. 99. University of Utah, Salt Lake City.

Ferguson, Jeffrey R. and Michael D. Glascock
2013 *Neutron Activation Analysis of Ceramics (URE001-200) from the Parowan Valley, South-Central Utah*. Submitted to Scott M. Ure. Manuscript on file, Department of Anthropology, Brigham Young University.

Geib, Phil R.
2011 *Forager and Farmers of the Northern Kayenta Region*. The University of Utah Press, Salt Lake City.

Giddens, Anthony
1979 *Central Problems in Social Theory: Action, Structure and Contradiction in Social Analysis.* MacMillan Press, London.
1984 *The Constitution of Society: Outline of the Theory of Structuration*. Polity Press, Cambridge.

Gillin, John
1955 Archaeological Investigations in Nine Mile Canyon, Utah: A Re-publication. Reprinted. *Anthropological Papers No. 21*, University of Utah, Salt Lake City. Originally published 1938, *Bulletin of the University of Utah Vol. 28, No. 11*. Publications of the Department of Sociology and Anthropology, University of Utah, Salt Lake City.

Glascock, Michael D.
2012 Overview of Neutron Activation. Electronic document, http://archaeometry.missouri.edu/naa_overview.html, accessed December 14, 2012.

Goodman, Leo A.
2002 Latent Class Analysis: The Empirical Study of Latent Types, Latent Variables, and Latent Structures. In *Applied Latent Class Analysis*, edited by Jacques A. Hagenaars and Allan L. McCucheon. Cambridge University Press, Cambridge.

Gosselain, Olivier P.
1998 Social and Technical Identity in a Clay Crystal Ball. In *The Archaeology of Social Boundaries*, edited by M.T. Stark, pp. 78–106. Smithsonian Institution Press, Washington, D.C.
2000 Materializating Identities: An African Perspective. *Journal of Archaeological Method and Theory* 7:187–217.

Greenfield, Patricia M..
1984 A Theory of the Teacher in the Learning Activities of Everyday Life, in *Everyday Cognition*, edited by Barbara Rogoff and Jean Lave, pp. 117–138. Harvard University Press, Cambridge.
2000 School of American Research Annual Report, p. 8. Santa Fe.

Gregory, Herbert E.
1950 Geology of Eastern Iron County, Utah. *Utah Geological and Minerological Survey Bulletin No. 37*. The College of Mines and Minerals Industries, University of Utah, Salt Lake City.

Gunnerson, James H.
1969 T*he Fremont Culture: A Study in Culture Dynamics on the Northern Anasazi Frontier*. Papers of the Peabody Museum of Archaeology and Ethnology Vol. 59, No. 2. Harvard University, Cambridge.

Hall, Molly J.
2008 Parowan Valley Gaming Pieces and Insights into Fremont Social Organization. Unpublished MA thesis, Department of Anthropology, Brigham Young University, Provo.

Harbottle, Garman and Phil C. Weigand
1992 Turquoise in Pre-Columbian America. *Scientific American* 266(2):78–85.

Hawkes, Kristen J., James F. O'Connell, and L. Rogers
1997 The Behavioral Ecology of Modern Hunter-Gatherers and Human Evolution. *Trends in Ecology and Evolution* 12:29.

Hegmon, Michelle
1998 Technology, Style, and Social Practices: Archaeological Approaches. In *The Archaeology of Social Boundaries*, edited by Miriam T. Stark, pp.264–279. Smithsonian Press, Washington D.C.

Hegmon, Michelle, Margaret C. Nelson, and Mark J. Ennes
2000 Corrugated Pottery, Technological Style, and Population Movement in the Mimbres Region of the American Southwest. *Journal of Anthropological Research* 57(2):217–240.

Hendricks, Joseph D.
1988 X-Ray Diffraction Analysis of Formative and Late Prehistoric Pottery from the Eastern Great Basin Area. Unpublished MA thesis, Department of Anthropology, Brigham Young University, Provo.

Hendricks, Joseph D., Donald Forsyth, and Chun Jung
1990 X-ray Diffraction Analysis of some Formative and Late Prehistoric Pottery from Utah. In *Hunter-Gatherer Pottery from the Far West*, edited by Joanne M. Mack. Nevada State Museum Anthropological Papers 23:29–52, Carson City.

Herbich, Ingrid
1987 Learning Patterns, Potter Interaction and Ceramic Style among the Luo of Kenya. *African Archaeological Review* 5:139–204.

Hodder, Ian
1982 *Symbols in Action: Ethnoarchaeological Studies of Material Culture* Cambridge University Press, Cambridge.

Holmes, Willam H.
1886 *Pottery of the Ancient Pueblos*. Fourth Annual Report, Smithsonian Instituton, Bureau of Ethnology, Washington D.C.

Janetski, Joel C.
1990 Wetlands in Utah Valley Prehistory. In *Wetland Adaptations in the Great Basin*. Museum of Peoples and Cultures Occasional Paper No. 1, Brigham Young University, Provo.
1997 150 Years of Utah Archaeology. *Utah Historical Quarterly* 65:100–133.
2000 Fremont External Relations. In *Clear Creek Canyon Archaeological Project: Results and Synthesis* by Joel C. Janetski, Richard K. Talbot, Deborah E. Newman, Lane D. Richens, James D. Wilde, Shane A. Baker, and Scott E. Billat, pp. 231–240. Museum of Peoples and Cultures Occasional Papers No. 7. Brigham Young University, Provo.
2002 Trade in Fremont Society: Contexts and Contrasts. *Journal of Anthropological Archaeology*, 21:344–370.
2008 Trends and Such in Utah Archaeology—A Personal View. Utah Archaeology 21(1):15–26.

Janetski, Joel C., Cady B. Jardine, and Christopher N. Watkins
2011 Interaction and Exchange in Fremont Society. In *Perspectives on Prehistoric Trade and Exchange in California and the Great Basin,* edited by Richard E. Hughes, pp. 22–54. University of Utah Press, Salt Lake City.

Janetski, Joel C., Lane D. Richens, and Richard K. Talbot
2012 Fremont-Anasazi Boundary Maintenance and Permeability in the Escalante Drainage. In *Meetings at the Margins: Prehistoric Cultural Interactions in the Intermountain West*, edited by David Rhode, pp. 191–210. The University of Utah Press, Salt Lake City.

Janetski, Joel C. and Richard K. Talbot
2000a Project Overview and Context. In *Clear Creek Canyon Archaeological Project: Results and Synthesis* by Joel C. Janetski, Richard K. Talbot, Deborah E. Newman, Lane D. Richens, James D. Wilde, Shane A. Baker, and Scott E. Billat, pp. 1–7. Museum of Peoples and Cultures Occasional Papers No. 7. Brigham Young University, Provo.
2000b Fremont Social and Community Organization. In *Clear Creek Canyon Archaeological Project: Results and Synthesis* by Joel C. Janetski, Richard K. Talbot, Deborah E. Newman, Lane D. Richens, James D. Wilde, Shane A. Baker, and Scott E. Billat, pp. 247–262. Museum of Peoples and Cultures Occasional Papers No. 7. Brigham Young University, Provo.
2011 Fremont Social Organization: A Southwestern Perspective. In *Archaeology for All Times: Papers in Honor of Don. D. Fowler*, edited by Nancy J. Parezo, Joel C. Janetski, and James Snead. University of Utah Press, Salt Lake City (in Press).

Jardine, Cady B.
2007 Fremont Finery: Exchange and Distribution of Turquoise and Olivella Ornaments in the Parowan Valley and Beyond. Unpublished M.A. thesis, Department of Anthropology, Brigham Young University, Provo.

Jarvis, Julie, Richard Lisenby, and Charles Sivero
l964 1964 Excavations at Summit, Utah: A Progress Report. Ms. on file, Department of Anthropology, University of California at Los Angeles, Los Angeles.

Jennings, Jesse D.
1980 Foreword. In *Final Year Excavations at the Evans Mound Site*, by Walter A. Dodd Jr. and D. Lynn Cozzens, pp. xi. Anthropological Papers No. 106, University of Utah, Salt Lake City.

Jennings, Jesse D. (editor)
1956 The American Southwest: A Problem in Cultural Isolation. In *Seminars in Archaeology, 1955*, edited by Robert Wauchope, pp. 59–127. SAA Memoirs No. 11. Memoirs of the Society for American Archaeology

Jennings, Jesse D. and Edward Norbeck
1955 Great Basin Prehistory: A Review. *American Antiquity* 21(1):1–11.

Jennings, Jesse D., Erik K. Reed, James B. Griffin, J. Charles Kelley, Clement W. Meighan, Stanley Stubbs, Joe B. Wheat, and Dee C. Taylor
1955 The American Southwest: A Problem in Cultural Isolation, In *Seminars in Archaeology*, edited by R. Wauchope, pp. 59–127. SAA Memoirs No. 11. Society for American Archaeology, Washington, D.C.

Judd, Neil M.
1917 Evidence of Circular Kivas in Western Utah Ruins. *American Anthropologist* 19(1):34–40.
1919 Archaeological Investigations at Paragonah, Utah. *Smithsonian Institution Miscellaneous Collections* 70(3):1–22, Washington, D.C.
1926 Archaeological Observations North of the Rio Colorado. *Bureau of American Ethnology Bulletin* 82, Washington, D.C.

Kidder, Alfred V.
1924 *An Introduction to the Study of Southwestern Archaeology with a Preliminary Account of the Excavations at Pecos*, Yale University Press, New Haven, CT.
1927 Southwestern Archaeology Conference. *Science* 66:489–491.

Kojo, Yasushi
1991 The Reliability of Thermoluminescence Dating: A Pilot Experiment. *Geoarchaeology* 6(4):367–374.

Landeau, Sabine and Brian S. Everitt
2004 *A Handbook of Statistical Analyses using SPSS*. Chapman and Hall/CRC, New York.

Lave, Jean and Etienne Wenger
1991 *Situated Learning: Legitimate Peripheral Participation*. University of Cambridge Press, Cambridge.

Lee, Charlotte T., Shripad Tuljapurkar, and Peter M. Vitousek
2006 Risky Business: Temporal and Spatial Variation in Preindustrial Dryland Agriculture. *Human Ecology* 34(6):739–763.

Leroi-Gourham, Andre
1945 *Evolution et Techniques: Milieu et Techniques*. Albin Michel, Paris.

Lindauer, Owen
1988 A Study of Vessel Form and Painted Designs to Explore Regional Interaction fo the Sedentary Period Hohokam. Ph.D. dissertation, Department of Anthropology, Arizona State University, Tempe.

Longacre, William A.
1999 Standardization and Specialization: What's the Link? In *Pottery and People*, edited by James M. Skibo and Gary M. Feinman, pp. 44–58. University of Utah Press, Salt Lake City.

Longacre, William A., Kenneth L. Kvamme, and M. Kobayashi
1988 Southwestern Pottery Standardization: An Ethnoarchaeological View from the Phillipines. *Kiva* 53(2):101–112.

Loosle, Byron and Michelle Knoll
2003 Fremont Numic Transitions. Paper presented at the Rocky Mountain Anthropological Conference. Estes Park, Colorado.

Lyneis, Margaret M.
1992 *The Grain of Formative Ceramic Variablity in West Central and Southwestern Utah*. Paper presented at the 23rd Biennial Great Basin Anthropological Conference, Boise, Idaho.
1994 Kern River Pipeline Cultural Resources Data Recovery Report: Utah, Volume I, Research Context and Data Analysis. Submitted to Kern River Gas Transmission Company. Copies available from Dames and Moore Inc., Las Vegas.

Madsen, David B.
1973 Ceramics. In *Median Village and Fremont Culture Regional Variation*, by John P. Marwitt, pp. 54–75. Anthropological Papers, No. 95. University of Utah, Salt Lake City.
1975 *Three Fremont Sites in Emery County, Utah*. Antiquities Section Selected Papers Vol. I, No. 1. Utah State Historical Society, Salt Lake City.
1979 The Fremont and the Sevier: Defining Prehistoric Agriculturalists North of the Anasazi. *American Antiquity* 44:711–722.

1980 Fremont/Sevier Subsistence. In *Fremont Perspectives*, edited by David B. Madsen, pp. 25–34. Antiquities Section Selected Papers Vol. VII, No. 16. Utah State Historical Society, Salt Lake City.
1982 Get it Where the Gettin's Good: A Variable Model of Great Basin Subsistence and Settlement Based on Data from the Eastern Great Basin. In *Man and Environment in the Great Basin*, edited by David B. Madsen and James F. O'Connell, pp. 207–226. SAA Papers No. 2. Society for American Archaeology, Washington, D.C.
1986 Prehistoric Ceramics. In *Great Basin*, edited by Warren L. D'Azevedo, pp. 206–214. Handbook of North American Indians, vol. 11, William C. Sturtevant, general editor. Smithsonian Institution, Washington, D.C.
1989 *Exploring the Fremont*. Occasional Publication No. 8. Utah Museum of Natural History, University of Utah, Salt Lake City.

Madsen, David and La Mar W. Lindsay
1977 *Backhoe Village*. Antiquities Section Selected Papers, Vol. IV, No. 12, Utah State Historical Society, Salt Lake City, Utah.

Madsen, David B. and Steven R. Simms
1998 The Fremont Complex: A Behavioral Perspective. *Journal of World Prehistory* 12(3):255 – 336.

Madsen, Rex E.
1972 Evans Mound Ceramics. In *The Evans Site*, by Michael S. Berry, pp. 45–96. Special Report (limited distribution), Department of Anthropology, University of Utah, Salt Lake City.

Madsen, Rex E. (editor)
1977 Prehistoric Ceramics of the Fremont. *Museum of Northern Arizona Ceramics Series No. 6*. Museum of Northern Arizona. Flagstaff, Arizona.

Maguire, Don
1894 Report of the Department of Ethnology, Utah World's Fair Commission to E.A. McDaniel, Secretary, Utah World's Fair Commission, Salt Lake City, Utah.

Marwitt, John P.
1969 Pharo Village. *Anthropological Papers, No. 91.* University of Utah, Salt Lake City.
1973 Median Village and Fremont Culture Regional Variation. *Anthropological Papers, No. 95.* University of Utah, Salt Lake City.
1986 Fremont Cultures. In *Great Basin*, edited by Warren L. D'Azevedo, pp. 161–172. Handbook of North American Indians, vol. 11, William C. Sturtevant, general editor. Smithsonian Institution, Washington, D.C.

McKusick, Marshall B.
1959 Expedition Reports, 1959 Archaeological Field School, UCLA. Ms. on file, University of California at Los Angeles, Department of Anthropology, Los Angeles.

1960 Expedition Reports, 1960 Archaeological Field School, UCLA. Ms. on file, University of California at Los Angeles, Department of Anthropology, Los Angeles.

Meakins, R.L., B.L. Dickens, and J.C. Kelly
1979 Gamma Ray Analysis of K, U and Th for Dose-rate Estimation in Thermoluminescent Dating. *Archaeometry* 21(1):79–86.

Meighan, Clement W., Norman E.Coles, Frank D. Davis, Geraldine M. Greenwood, William H. Harrison, and E. Heath MacBain
1956 Archaeological Investigations in Iron County, Utah. Anthropological Papers No. 25. Department of Anthropology, Univeristy of Utah.

Meskell, Lynn, and Robert W. Preucel
2007 Identities. In *A Companion to Social Archaoelogy*, edited by Lynn Meskell and Robert W. Preucel, pp. 121–141. Blackwell Publishing, Oxford.

Metcalfe, Duncan and Lisa Larrabee
1985 Fremont Irrigation: Evidence from Gooseberry Valley. Journal of California and Great Basin Anthropology 7:244–253.

Mills, Barbara J.
1999 Ceramics and Social Contexts of Food Consumption in the Northern Southwest. In *Pottery and People: A Dynamic Interaction*, edited by James M. Skibo and Gary M. Feinman, pp. 99–114. University of Utah Press, Salt Lake City, Utah.

Mills, Barbara J.
1995 Ceramic Production in the American Southwest: An Introduction, in *Ceramic Production in the American Southwest*, edited by Barbara J. Mills and Patricia L. Crown, pp. 1–29. University of Arizona Press, Tucson.

Montgomery, Henry
1894 Prehistoric Man in Utah. *The Archaeologist* 2(8):227–234; 298–306; 335–342.

Montgomery, Keith R. and Jacki A. Montgomery
1993 Utah Department of Transportation State Route-31 Huntington Canyon Project: Archaeological Excavations at Sites 42EM2109 and 42EM2095, Emery County, Utah.

Morss, Noel
1931 The Ancient Culture of the Fremont River in Utah. *Papers of the Peabody Museum of American Archaeology and Ethnology* 12(2), Cambridge.

Neff, Hector
2002 Quantitative Techniques for Analyzing Ceramic Compositional Data. In *Ceramic Production and Circulation in the Greater Southwest: Source Determination by INAA and Complimentary Mineralogical Investigations*, edited by Donna M. Glowacki

and Hector Neff, pp. 15–36. Monograph 44. The Costen Institute of Archaeology, University of California, Los Angeles.

Neff, Hector and Donna M. Glowacki (editors)
2002 Ceramic Source Determination by Instrument Neutron Activation Analysis in the American Southwest. In *Ceramic Production and Circulation in the Greater Southwest: Source Determination by INAA and Complimentary Mineralogical Investigations*, edited by Donna M. Glowacki and Hector Neff, pp. 1–14. Monograph 44. The Costen Institute of Archaeology, University of California, Los Angeles.

Neilson, Reid L.
2011 *Exhibiting Mormonism: The Latter-day Saints and the 1893 Chicago World's Fair*. Oxford University Press, New York.

O'Rourke, Dennis H., Ryan L. Parr, and Shawn W. Carlyle
1999 Molecular Genetic Variation in Prehistoric Inhabitants of the Eastern Great Basin. In *Prehistoric Lifeways in the Great Basin Wetlands: Bioarchaeological Reconstruction and Interpretation*, edited by Brian E. Hemphill and Clark Spencer Larsen, pp. 84–102. University of Utah Press, Salt Lake City.

Owsley, Douglas H., D. Hunt, L. Jantz, R. Kardash, C. Clark, Wendy Teeter, and Mercedes Duque
1998 Examination of the UCLA Skeletal Collection and Rancho La Brea. Manuscript on file, Department of Anthropology, University of California Los Angeles, Los Angeles.

Palmer, Edward
1877 A Review of the Published Statements Regarding the Mounds at Payson, Utah, with an Account of their Structure and Origin. *Proceedings of the Davenport Academy of Natural Sciences*, 2(2):167–172.

Parowan Valley Archaeological Project (PVAP)
2013 Original unpublished notes and data from the UCLA excavations in the Parowan Valley. Manuscript on file, Office of Public Archaeology, Brigham Young University, Provo, Utah.

Pauketat, Timothy R.
2003 Practice and History in Archaeology: An Emerging Paradigm. *Anthropological Theory* 1(1):73–98.

Pecotte, Jera K.
1982 Appendix: Human Skeletal Remains. In *Final Year of Excavations at the Evans Mound Site*, by Walter A. Dodd, pp. 117–127. Anthropological Papers 12, University of Utah, Salt Lake City.

Peelo, Sarah

2011 Pottery-Making in Spanish California: Creating Multi-scalar Social Identity through Daily Practice. *American Antiquity* 76(4):642–666.

Peck, Joel S. and Walter Burkeman

1963 Adams-Hyatt Mound, Preliminary Statement. Ms. on file, Fowler Museum of Cultural History, University of California Los Angeles.

Peeples, Matthew

2011 Ceramic Technological Variation and Social Change across the Pueblo III to Pueblo IV Transition. Paper presented at the 76th Annual Meeting for the Society for American Archaeology, Sacramento, California.

Plog, Stephen E.

1995 Paradigms and Pottery: The Analysis of Production and Exchange in the American Southwest. In *Ceramic Production in the American Southwest*, edited by Barbara J. Mills and Patricia L. Crown, pp. 30–62. The University of Arizona Press, Tucson.

Powell, John W.

1873 Explorations of the Colorado River of the West and its Tributaries Explored in the Years 1869, 1870, and 1871, under the direction of the Secretary of the Smithsonian Institution, Washington, D.C.

Powell, Shirley

2002 Late Pueblo II-Pueblo III in Kayenta Branch Prehistory. In Prehistoric Culture Change on the Colorado Plateau: Ten Thousand Years on Black Mesa, edited by Shirley Powell and Francis E. Smiley, 121–158. University of Arizona Press, Tucson.

Quinn, Allen G., B.J. Gundy, and J. Glenn

1991 *Phase III Data Recovery in the I-70 Project Study Area, Emery and Sevier Counties, Utah*. Cultural Resource Management Program, University of Pittsburgh. Submitted to the Utah Department of Transportation, Engineering Services Agreement 89-1772. Copies available at the Utah Department of Transportation, Salt Lake City.

Reed, Alan D., Matthew T. Seddon, and Heather K. Stettler (editors)

2005 *Kern River 2003 Expansion Project, Utah: Prehistoric Excavated Sites and Discoveries, Part 3*, Vol. III. Submitted to the Federal Energy Regulatory Commission, Southwest Region, FERC Docket No. CP01-422-000.

Reed, Alan D. and Robert J. Speakman

2005 Instrumental Neutron Activation Analysis of Snake Valley Series Ceramic Artifacts from southwestern Utah. *Utah Archaeology* 18(1):7–32.

Renfrew, Colin and Paul Bahn

1990 *Archaeology, Theories, and Practice*. Thomas and Hudson, New York

Richens, Lane D.
2000 Ceramics. In *Excavations at Five Finger Ridge, Clear Creek Canyon, Central Utah* by Richard K. Talbot, Lane D. Richens, James D. Wilde, Joel C. Janetcki, and Deborah E. Newman. Museum of Peoples and Cultures Occasional Papers No. 5. Brigham Young University, Provo.

Richards, Katie R., James R. Allison, Richard K. Talbot, Scott M. Ure, and Lindsay Johansson
2013 Household Variation, Public Architecture, and the Organziation of Fremont Communities. Paper presented at the 78th Annual Meeting for the Society for American Archaeology, Honolulu, Hawaii.

Roberts, Heidi
1991 A Comparative Analysis of Human Skeletal Remains from Parowan Fremont, Virgin Anasazi, and Kayenta Archaeological Sites. Unpublished Master's thesis, Department of Anthropology, University of Nevada, Las Vegas.

Roberts, Richard G.
1997 Luminescence Dating in Archaeology: From Origins to Optical. *Radiation Measurements* 27(5–6):819–892.

Ruby, Jay W. and Wayne Alexander
1962 Preliminary Report of Excavations at Evans Mound (In-40) Summit, Utah. Ms. on file, Department of Anthropology, University of California at Los Angeles. Los Angeles.

Rudy, Jack
1953 Archeological Survey of Western Utah. *Anthropological Papers No. 12*, University of Utah, Salt Lake City.

Safford, William E.
1911 Edward Palmer. *The Popular Science Monthly* 78:341–354.

Sammons-Lohse, Dorothy
1981 Households and Communities. In *Bull Creek*, edited by Jesse D. Jennings and Dorothy Sammons-Lohse, pp. 111–135. Anthropological Papers No. 105, University of Utah, Salt Lake City.

Sassman, Kenneth E. and Wictoria Rudolphi
2001 Communities of Practice in the Early Ceramic Traditions of the American Southeast. *Journal of Anthropological Research* 57:407–425.

Searcy, Michael T.
2011 *The Life Giving Stone*. The University of Arizona Press, Tucson.

Searcy, Michael T. and Richard K. Talbot
2013 Late Fremont Cultural Identities and Borderland Processes. Manuscript under review.

Service, Elman R.
1962 Primitive Social Organization; An Evolutionary Perspective. 1st edition. Random House, New York.

Severance, Mark S.
1874 Preliminary Ethnological Report. In *George M. Wheeler, Progress Report upon Geographical and Geological Explorations and Surveys West of the One Hundredth Meridian, in 1872*, pp. 55–56. Appendix F. Washington.

Sewell, William H.
1992 A Theory of Structure: Duality, Agency, and Transformation. *American Journal of Sociology* 1:1–29.

Schlanger, Nathan
2005 Chaine Opératoire. In *Archaeology the Key Concepts*, edited by Colin Renfrew and Paul Bahn. Routledge, London.

Shaprio, Gary
1984 Ceramic Vessels, Site Permanence, and Group Size: A Mississippian Example. *American Antiquity* 49:696–712.

Sharrock, Floyd W. and John P. Marwitt
1967 Excavations at Nephi, Utah, 1965–1966. *Anthropological Papers No. 88*. University of Utah, Salt Lake City.

Shennan, Stephen
2004 *Quantifying Archaeology*. Edinburgh University Press, Edinburgh.

Shields, Wayne F.
1967 1966 Excavations: Uinta Basin. In *Miscellaneous Collected Papers 15–18*, edited by Jesse D. Jennings, pp. 1–31. Anthropological Papers No. 89. University of Utah, Salt Lake City.

Shuey, Ralph T. and Ronald Reed
1972 Archeomagnetism of Evans Mound. In *The Evans Site*, by Michael S. Berry. Special Report, University of Utah Department of Anthropology, Salt Lake City.

Simms, Steven R.
1986 New Evidence for Fremont Adaptive Diversity. *Journal of California and Great Basin Anthropology* 8(2):204–216.
1990 Fremont Transitions. *Utah Archaeology* 1990 3(1):1–18.
1994a Farmers and Foragers in the Late Holocene Eastern Great Basin. Paper presented at the 24th Great Basin Anthropological Conference in Elko, Nevada.

1994b Chasing the Will-o'-the Wisp of Social Order: Implications for the Study of Fremont Adaptive Diversity. Paper presented at the 24th Great Basin Anthropological Conference in Elko, Nevada.

2008 *Ancient Peoples of the Great Basin and Colorado Plateau*. Left Coast Press, Walnut Creek, California.

Simms, Steven R., Andrew Ugan, and Jason R. Bright
1997 Plain-ware Ceramics and Residential Mobility: A Case Study from the Great Basin. *Journal of Archaeological Science* 24:779–792.

Spangler, Jerry D.
1995 Paradigms and Perspectives: A Class I Overview of Cultural Resources in the Uinta Basin and Tavaputs Plateau. Manuscript on file, Bureau of Land Management, Vernal, Utah.

Stark, Barbara L.
1995 Analysis of Specialization and Standardization. In *Ceramic Production in the American Southwest*, edited by Barbara J. Mills and Patricia L. Crown, pp.231–280. The University of Arizona Press, Tucson.

Stark, Miriam T., Mark D. Elson and Jeffrey J. Clark
1998 Social Boundaries and Technical Choices in Tonto Basin Prehistory. In *The Archaeology of Social Boundaries*, edited by M.T. Stark, pp. 208–231. Smithsonian Institution Press, Washington, D.C.

Stauffer, Sara E.
2012 Parowan Fremont Faunal Exploitation: Resource Depression or Feasting? Unpublished MA thesis, Department of Anthropology, Brigham Young University, Provo.

Steward, Julian H.
1937 Ancient Caves of the Salt Lake Region. *Smithsonian Bureau of American Ethnology Bulletin* No. 116. Washington D. C.
1941 *Archaeological Reconaissance of Southern Utah*. Anthropological Papers No. 18, Bureau of American Ethnology Bulletin No. 128:277–356.
1955 Review of Archaeological Survey of Western Utah. *American Antiquity* 21(1):88–89.

Sullivan, Maurice
1934 *The Travels of Jeddiah Smith*. The Fine Arts Press, Santa Ana, California.

Talbot, Richard K.
2000a Fremont Farmers: The Search for Context. In *The Archaeology of Regional Interaction: Religion, Warfare, and Exchange across the American Southwest and Beyond*, edited by Michelle Hegmon, pp. 275-293. University Press of Colorado, Boulder.

2000b Fremont Architecture. In Clear Creek Canyon Archaeological Project: Results and Synthesis, edited by Joel C. Janetski, Richard K. Talbot, Deborah E. Newman, Lane D. Richens, and James D. Wilde, pp. 131–184. *Museum of Peoples and Cultures Occasional Papers No. 7*. Brigham Young University, Provo.

Talbot, Richard K. and Lane D. Richens
1993 Archaeological Investigations at Richfield and Vicinity. Draft Report. *Museum of Peoples and Cultures Technical Series No. 92-4*. Brigham Yong University, Provo.
1996 Steinaker Gap: An Early Fremont Farmstead. *Museum of Peoples and Cultures Occasional Papers No. 2*. Brigham Young University, Provo.

Talbot, Richard K., Lane D. Richens, James D. Wilde, Joel C. Janetski, and Deborah E. Newman
1998 Archaeological Surveys and Limited Excavations, Clear Creek Canyon, Central Utah. *Museum of Peoples and Cultures Occasional Papers No. 3*. Brigham Young University, Provo.
1999 Excavations of Icicle Bench, Radford Roost, and Lott's Farm, Clear Creek Canyon, Central Utah. *Museum of Peoples and Cultures Occasional Papers No. 4*. Brigham Young University, Provo.
2000a Clear Creek Canyon Archaeological Project: Results and Synthesis. *Museum of Peoples and Cultures Occasional Papers No. 7*. Brigham Young University, Provo.
2000b Excavations at Five Finger Ridge, Clear Creek Canyon, Central Utah. *Museum of Peoples and Cultures Occasional Papers No. 5*. Brigham Young University, Provo.

Talbot, Richard K., Shane A. Baker, and Joel C. Janetski
2005 Project Synthesis: Archaeology in Capitol Reef National Park. In *Life on the Edge: Archaeology in Capitol Reef National Park*, by J.C. Janetski, L. Kreutzer, R.K. Talbot, L.D. Richens, and S.A. Baker, pp. 351-407. Museum of Peoples and Cultures Occasional Papers No. 11. Brigham Young University, Provo.

Taylor, Dee C.
1954 The Garrison Site: A Report of Archaeological Excavations in Snake Valley, Nevada—Utah. *Anthropological Papers No. 16*. University of Utah, Salt Lake City.
1957 Two Fremont Sites and Their Position in Southwestern Prehistory. *Anthropological Papers No. 29*. University of Utah, Salt Lake City.

Toll, H. Wolcott
1990 A Reassessment of Chaco Cylinder Jars. In *Clues to the Past: Papers in Honor of William Sund*t, edited by David Kirkpatrick, pp. 273–298. Archaeological Society of New Mexico, Albuquerque

Thomas, H.E. and G.H. Taylor
1946 Geology and Ground-Water Resources of Cedar City and Parowan Valleys, Iron County, Utah. Geological Survey Water-Supply Paper 993. United States Department of the Interior.

Turner, Christy G. II and Laurel Lofgren
1996 Household Size of Prehistoric Western Pueblo Indians. *Southwestern Journal of Anthropology* 22:117–132.

Upham, Steadman
1984 Adaptive Diversity and Southwestern Abandonment. *Journal of Anthropological Research* 40:235–255.

Upham, Steadman, Patricia L. Crown, and Stephen E. Plog
1994 Alliance Formation and Cultural Identity in the Southwest. In *Themes in Southwestern Prehistory*, edited by G. J. Gumerman, pp. 183–210. School of American Research, Santa Fe.

Ure, Scott M.
2009 The Social Side of Subsistence: Examining Food Choice at the Seamons Mound Site (42UT271) using Sociocultural Perspectives. *Utah Archaeology* 22(1):75–100.
2011 *Fremont Pottery Standardization: A Preliminary Examination of Fremont Painted Bowls and their Degree of Standardized Morphological Characteristics*. Paper presented at the 76th Annual Meeting for the Society for American Archaeology, Sacramento, California.

Ure, Scott M. and Sara Stauffer
2010 *The Function of the Central Structure in Fremont Community Organization*. Paper presented at the 32nd Great Basin Anthropoloical Conference. Layton, Utah.

Utah Climate Center
2013 Monthly Precipitation Totals for Summit, Utah 1951–2012. Electronic document, http://climate.usurf.usu.edu/index.php, accessed on January 28, 2013.

Utah State Historical Society
2004 Photograph of Don Maguire. Utah State Historical Society Classified Photo Collection #17213. Electronic image, http://content.lib.utah.edu/cdm/ref/collection/USHS_Class/id/2591, accessed on January 21, 2013.

Utah State History
2013 Iron County History. Electronic document, http://www.ilovehistory.utah.gov/place/counties/iron.html, accessed March 14, 2013.

Varien, Mark D. and James M. Potter
2008 The Social Production of Communities: Structure, Agency, and Identity. In *The Social Construction of Communities: Agency, Structure, and Identity in the Prehispanic Southwest*, edited by Mark D. Varien and James M. Potter, pp. 1–18. AltaMira Press, Lanham, Maryland.

Vermunt, Jeroen and Jay Magidson
2005 *Technical Guide for Latent GOLD 4.0: Basic and Advanced*. Statistical Innovations Inc., Belmont, Massachusetts.

Wallaert-Pêtre, Hélène
2001 Learning How to Make the Right Pots: Apprenticeship Strategies and Material Culture, a Case Study in Handmade Pottery from Cameroon. *Journal of Anthropological Research* 57(4): 471–493.

Walling, Barbara A.
1982 Basketry. In *Final Year Excavations at the Evans Mound Site*, by Walter A. Dodd, Walter A., Jr. and D. Lynn Cozzens, pp. 92–94. Anthropological Papers No. 106. University of Utah, Salt Lake City.

Warner, Ted J. (editor)
1976 [1776] *The Domínguez-Escalante Journal: Their Expedition through Colorado, Utah, Arizona, and New Mexico in 1776*. Translated by Fray Angelico Chavez. 1976 facsimile ed. Brigham Young University Press, Provo.

Watkins, Christopher N.
2006 Parowan Pottery and Fremont Complexity: Late Formative Ceramic Production and Exchange. Unpublished M.A. thesis, Department of Anthropology, Brigham Young University, Provo.
2010 The Fremont Bird Cult. Paper presented at the 32nd Great Basin Anthropoloical Conference. Layton, Utah.

Weide, David L.
1973 The Geology and Geography of the Parowan and Cedar Valley Region, Iron County, Utah. In *Median Village and Fremont Culture Regional Variation*, by John P. Marwitt, pp. 173–193. Anthropological Papers No. 95. University of Utah, Salt Lake City.

Weigand, Phil C., Garman Harbottle, and Edward V. Sayre
1977 Turquoise sources and source analysis: Mesoamerica and the southwestern U.S.A. In *Exchange Systems in Prehistory*, edited by T. K. Earle and J. E. Ericson, pp. 15–34. Academic Press, New York.

Wenke, Robert J.
1990 *Patterns in Prehistory, Mankind's First Three Million Years*. 3rd ed. Oxford University Press, New York.

Wheeler, George M.
1889 *Report of the United States Geographical Surveys West of the 100th Meridian*, Vol. 1. Washington, D.C.

White, Leslie A.
1959 *The Evolution of Culture*. McGraw-Hill Book Company, New York.

Wilson, Curtis
1972 Ground stone. In *The Evans Site*, by Michael S. Berry, pp. 109–118. Special Report (limited distribution), Department of Anthropology, University of Utah, Salt Lake City.

Woods, Aaron R.
2009 Distribution, function, and value of Parowan Valley projectile points. Unpublished MA thesis, Department of Anthropology, Brigham Young University, Provo.

Wormington, H. Marie
1955 A Reappraisal of the Fremont Culture. *Proceedings of the Denver Museum of Natural History 1*. Denver.

Young, Brigham
1851 History of Brigham Young. In *Historians Office History of the Church, 1839-circa 1882: 1851 January 6–December 29*, pp. 46–47. Church History Library, The Church of Jesus Christ of Latter-day Saints, Salt Lake City, Utah. LDS Church Archives, Salt Lake City.

Appendix A

Neutron Activation Analysis Report

Neutron Activation Analysis of Ceramics (URE001-200) from the

Parowan Valley, South-Central Utah

Report Prepared by:

Jeffrey R. Ferguson and Michael D. Glascock
Archaeometry Laboratory
Research Reactor Center
University of Missouri
Columbia, MO 65211

Report Prepared For:
Scott Ure
Department of Anthropology
Brigham Young University
Provo, UT 84602

April 1, 2013

Introduction

This report describes the preparation, analysis, and interpretation of 200 pottery samples from three sites in the Parowan Valley, Utah. The goals of the research are to examine expressions of social identity in the production of Snake Valley Corrugated (SVC) ceramics. The interpretation has included 60 samples of SVC and brownware submitted by Clint Cole (CRC001-060) and 117 samples of Snake Valley Grayware and SVC submitted by Alan Reed (ADR009-120). Sample IDs and some basic descriptive information for all samples are provided in tables A.3 and A.4.

We have identified ten compositional groups ranging in size from 2 to 170 samples. The following report details the development and statistical justification for the compositional groups as well as the distributions of the compositional groups by site and ceramic type.

Sample Preparation

Pottery samples were prepared for NAA using procedures standard at MURR. Fragments of about 1cm^2 were removed from each sample and abraded using a silicon carbide burr in order to remove glaze, slip, paint, and adhering soil, thereby reducing the risk of measuring contamination. The samples were washed in deionized water and allowed to dry in the laboratory. Once dry, the individual sherds were ground to powder in an agate mortar to homogenize the samples. Archival samples were retained from each sherd (when possible) for future research.

Two analytical samples were prepared from each source specimen. Portions of approximately 150 mg of powder were weighed into clean high-density polyethylene vials used for short irradiations at MURR. At the same time, 200 mg of each sample was weighed into high-purity quartz vials used for long irradiations. Individual sample weights were recorded to the nearest 0.01 mg using an analytical balance. Both vials were sealed prior to irradiation. Along with the unknown samples, Standards made from National Institute of Standards and Technology (NIST) certified standard reference materials of SRM-1633b (coal fly ash) and SRM-688 (basalt rock) were similarly prepared, as were quality control samples (e.g., standards treated as unknowns) of SRM-278 (obsidian rock) and Ohio Red Clay (a standard developed for in-house applications).

Irradiation and Gamma-Ray Spectroscopy

Neutron activation analysis of ceramics at MURR, which consists of two irradiations and a total of three gamma counts, constitutes a superset of the procedures used at most other NAA laboratories (Glascock 1992; Neff 1992, 2000). As discussed in detail by Glascock (1992), a short irradiation is carried out through the pneumatic tube irradiation system. Samples in the polyvials are sequentially irradiated, two at a time, for five seconds by a neutron flux of 8 x 1013 n cm-2 s-1 The 720-second count yields gamma spectra containing peaks for nine short-lived elements aluminum (Al), barium (Ba), calcium (Ca), dysprosium (Dy), potassium (K), manganese (Mn), sodium (Na), titanium (Ti), and vanadium (V). The samples are encapsulated in quartz vials and are subjected to a 24–hour irradiation at a neutron flux of 5 x 1013 n cm-2 s-1. This long irradiation is analogous to the single irradiation utilized at most other laboratories. After the long irradiation, samples decay for seven days, and then are counted for 1,800 seconds (the “middle count”) on a high-resolution germanium detector coupled to an automatic sample changer. The middle count yields determinations of seven medium half-life elements, namely arsenic (As), lanthanum (La), lutetium (Lu), neodymium (Nd), samarium (Sm), uranium (U), and ytterbium (Yb). After an additional three- or four-week decay, a final count of 8,500 seconds is carried out on each sample. The latter measurement yields the following 17 long half-life elements: cerium (Ce), cobalt (Co), chromium (Cr), cesium (Cs), europium (Eu), iron (Fe), hafnium (Hf), nickel (Ni), rubidium (Rb), antimony (Sb), scandium (Sc), strontium (Sr), tantalum (Ta), terbium (Tb), thorium (Th), zinc (Zn), and zirconium (Zr). The element concentration data from the three measurements are tabulated in parts per million.

Interpreting Chemical Data

The analyses at MURR, described above, produced elemental concentration values for 33 elements in most of the analyzed samples. Data for Ni in all samples were below detection limits (as is the norm for most New World ceramics) and was removed from consideration during the statistical analysis. Calcium levels were found to be high enough (most samples between 1 and 5%) to justify a calcium correction of the dataset. Because calcium has the potential to affect (dilute) the concentrations of other elements in the analysis, all samples were mathematically corrected to compensate for any possible calcium included effects (the data were examined before and after calcium correction and the results were similar). The following mathematical correction was used as it has been proven to be effective in other calcium-rich datasets (Cogswell et al. 1998:64; Steponaitis et al. 1988):

$$e' = \frac{10^6 e}{10^6 - 2.5c}$$

where e' is the corrected concentration of a given element in ppm, e is the measured concentration of that element in ppm, and c is the concentration of elemental calcium in ppm. After the calcium correction, calcium was generally removed from the statistical analyses. Statistical analysis was subsequently carried out on base-10 logarithms of concentrations on the remaining 31 elements.

Use of log concentrations rather than raw data compensates for differences in magnitude between the major elements, such as calcium, on one hand and trace elements, such as the rare earth or lanthanide elements (REEs). Transformation to base-10 logarithms also yields a more normal distribution for many trace elements.

The interpretation of compositional data obtained from the analysis of archaeological materials is discussed in detail elsewhere (e.g., Baxter and Buck 2000; Bieber et al. 1976; Bishop and Neff 1989; Glascock 1992; Harbottle 1976; Neff 2000) and will only be summarized here. The main goal of data analysis is to identify distinct homogeneous groups within the analytical database. Based on the provenance postulate of Weigand *et al*. (1977), different chemical groups may be assumed to represent geographically restricted sources. For lithic materials such as obsidian, basalt, and cryptocrystalline silicates (e.g., chert, flint, or jasper), raw material samples are frequently collected from known outcrops or secondary deposits and the compositional data obtained on the samples is used to define the source localities or boundaries. The locations of sources can also be inferred by comparing unknown specimens (i.e., ceramic artifacts) to knowns (i.e., clay samples) or by indirect methods such as the "criterion of abundance" (Bishop *et al*. 1992) or by arguments based on geological and sedimentological characteristics (e.g., Steponaitis *et al*. 1996). The ubiquity of ceramic raw materials usually makes it impossible to sample all potential "sources" intensively enough to create groups of knowns to which unknowns can be compared. Lithic sources tend to be more localized and compositionally homogeneous in the case of obsidian or compositionally heterogeneous as is the case for most cherts.

Compositional groups can be viewed as "centers of mass" in the compositional hyperspace described by the measured elemental data. Groups are characterized by the locations of their centroids and the unique relationships (i.e., correlations) between the elements. Decisions about whether to assign a specimen to a particular compositional group are based on the overall probability that the measured concentrations for the specimen could have been obtained from that group.

Initial hypotheses about source-related subgroups in the compositional data can be derived from non-compositional information (e.g., archaeological context, decorative attributes, etc.) or from application of various pattern-recognition technique to the multivariate chemical data. Some of the pattern recognition techniques that have been used to investigate archaeological data sets are cluster analysis (CA), principal components analysis (PCA), and discriminant analysis (DA). Each of the techniques has its own advantages and disadvantages which may depend upon the types and quantity of data available for interpretation.

The variables (measured elements) in archaeological and geological data sets are often correlated and frequently large in number. This makes handling and interpreting patterns within the data difficult. Therefore, it is often useful to transform the original variables into a smaller set of uncorrelated variables in order to make data interpretation easier. Of the above-mentioned pattern recognition techniques, PCA is a technique that transforms from the data from the original correlated variables into uncorrelated variables most easily.

PCA creates a new set of reference axes arranged in decreasing order of variance subsumed. The individual PCs are linear combinations of the original variables. The data can be displayed on combinations of the new axes, just as they can be displayed on the original elemental concentration axes. PCA can be used in a pure pattern-recognition mode, i.e., to search for subgroups in an undifferentiated data set, or in a more evaluative mode, i.e., to assess the coherence of hypothetical groups suggested by other criteria. Generally, compositional differences between specimens can be expected to be larger for specimens in different groups than for specimens in the same group, and this implies that groups should be detectable as distinct areas of high point density on plots of the first few components. It is well known that PCA of chemical data is scale dependent (Mardia *et al*. 1979), and analyses tend to be dominated by those elements or isotopes for which the concentrations are relatively large. This is yet another reason for the log transformation of the data.

One frequently exploited strength of PCA, discussed by Baxter (1992), Baxter and Buck (2000z), and Neff (1994, 2002), is that it can be applied as a simultaneous R- and Q-mode technique, with both variables (elements) and objects (individual analyzed samples) displayed on the same set of principal component reference axes. A plot using the first two principal components as axes is usually the best possible two-dimensional representation of the correlation or variance-covariance structure within the data set. Small angles between the vectors from the origin to variable coordinates indicate strong positive correlation; angles at 90 degrees indicate no correlation; and angles close to 180 degrees indicate strong negative correlation. Likewise, a plot of sample coordinates on these same axes will be the best two-dimensional representation of Euclidean relations among the samples in log-concentration space (if the PCA was based on the variance-covariance matrix) or standardized log-concentration space (if the PCA was based on the correlation matrix). Displaying both objects and variables on the same plot makes it possible to observe the contributions of specific elements to group separation and to the distinctive shapes of the various groups. Such a plot is commonly referred to as a "biplot" in reference to the simultaneous plotting of objects and variables. The variable inter-relationships inferred from a biplot can be verified directly by inspecting bivariate elemental concentration plots (note that a bivariate plot of elemental concentrations is not a biplot).

Whether a group can be discriminated easily from other groups can be evaluated visually in two dimensions or statistically in multiple dimensions. A metric known as the Mahalanobis distance (or generalized distance) makes it possible to describe the separation between groups or between individual samples and groups on multiple dimensions. The Mahalanobis distance of a specimen from a group centroid (Bieber *et al*. 1976, Bishop and Neff 1989) is defined by:

$$D^2_{y,X} = [y - \overline{X}]^t I_x [y - \overline{X}]$$

where y is the 1 x m array of logged elemental concentrations for the specimen of interest, X is the n x m data matrix of logged concentrations for the group to which the point is being compared with $\overline{X}$ being it 1 x m centroid, and I_x is the inverse of the m x m variance-covariance matrix of group X. Because Mahalanobis distance takes into account variances and covariances in the multivariate group it is analogous to expressing distance from a univariate mean in standard deviation units. Like standard deviation units, Mahalanobis distances can be converted into probabilities of group membership for individual specimens. For relatively small sample sizes, it is appropriate to base probabilities on Hotelling's T^2, which is the multivariate extension of the univariate Student's t.

When group sizes are small, Mahalanobis distance-based probabilities can fluctuate dramatically depending upon whether or not each specimen is assumed to be a member of the group to which it is being compared. Harbottle (1976) calls this phenomenon "stretchability" in reference to the tendency of an included specimen to stretch the group in the direction of its own location in elemental concentration space. This problem can be circumvented by cross-validation, that is, by removing each specimen from its presumed group before calculating its own probability of membership (Baxter 1994; Leese and Main 1994). This is a conservative approach to group evaluation that may sometimes exclude true group members.

Small sample and group sizes place further constraints on the use of Mahalanobis distance: with more elements than samples, the group variance-covariance matrix is singular thus rendering calculation of I_x (and D^2 itself) impossible. Therefore, the dimensionality of the groups must somehow be reduced. One approach would be to eliminate elements considered irrelevant or redundant. The problem with this approach is that the investigator's preconceptions about which elements should be discriminate may not be valid. It also squanders the main advantage of multielement analysis, namely the capability to measure a large number of elements. An alternative approach is to calculate Mahalanobis distances with the scores on principal components extracted from the variance-covariance or correlation matrix for the complete data set. This approach entails only the assumption, entirely reasonable in light of the above discussion of PCA, that most group-separating differences should be visible on the first several PCs. Unless a data set is extremely complex, containing numerous distinct groups, using enough components to subsume at least 90% of the total variance in the data can be generally assumed to yield Mahalanobis distances that approximate Mahalanobis distances in full elemental concentration space.

Lastly, Mahalanobis distance calculations are also quite useful for handling missing data (Sayre 1975). When many specimens are analyzed for a large number of elements, it is almost certain that a few element concentrations will be missed for some of the specimens. This occurs most frequently when the concentration for an element is near the detection limit. Rather than eliminate the specimen or the element from consideration, it is possible to substitute a missing value by replacing it with a value that minimizes the Mahalanobis distance for the specimen from the group centroid. Thus, those few specimens which are missing a single concentration value can still be used in group calculations.

Results

Regional Compositional Group Structure

We conducted a Euclidian distance search of the entire MURR database in order to identify related samples previously identified. This resulted in matches with the samples submitted by Clint Cole and Alan Reed. These related datasets were included with the new samples and all reinterpreted as a single regional dataset. Each compositional groups is briefly described below before a more detailed discussion of the patterns. The groups fall into three main groups: small (2–5 samples), medium (13–19 samples), and large (38–170 samples) and they are presented in these categories.

Small Groups

The small groups include Groups 1, 2, 4, 5, and 10. Most of the groups include only SVC/G but Group 2 does include 2 brownware samples. Only Groups 5 and 10 include samples from only one site. Small groups like these are difficult to interpret—they may represent unique highly localized recipes, unique raw materials, or possibly multiple sherds from a single vessel. Figure 1 is a plot of all of the compositional groups and unassigned samples (except for the one outlier), and the samples in the small groups are individually labeled.

Group 1 includes one new sample from Paragonah Village along with two samples from MD974 and one from 42WS2434. The samples all exhibit elevated concentrations of chromium

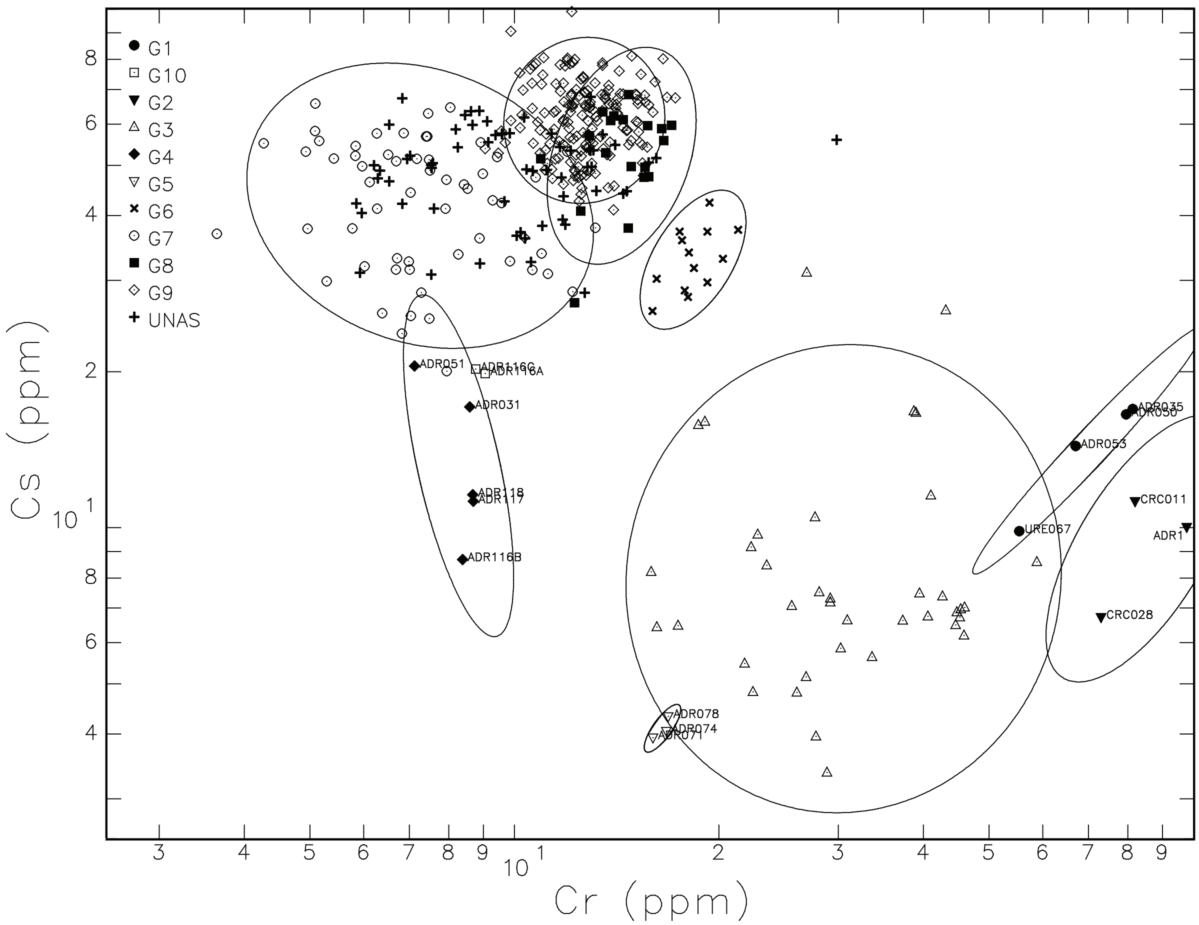


Figure A.1. Bivariate plot of chromium and cesium showing all of the compositional groups. The samples from the five small groups are individually labeled. The ellipses represent 90% confidence levels for membership in the groups.

and reduced cerium. Group 2 includes three samples, all from different sites, that exhibit elevated concentrations of chromium and reduced tantalum. Groups 4 and 5 are separated in a plot of Chromium and Ytterbium, and as with Group 2, Groups 4 and 5, and 10 include only Snake Valley Grayware (SVG) (including SVC). Group 10 includes a pair of samples from 42BE1988.

Medium Groups

There are two medium-sized groups (n=19 and n=13). Both of these groups are exclusively from the two main sites sampled in this study (including a few earlier samples from Evans Mound) and a

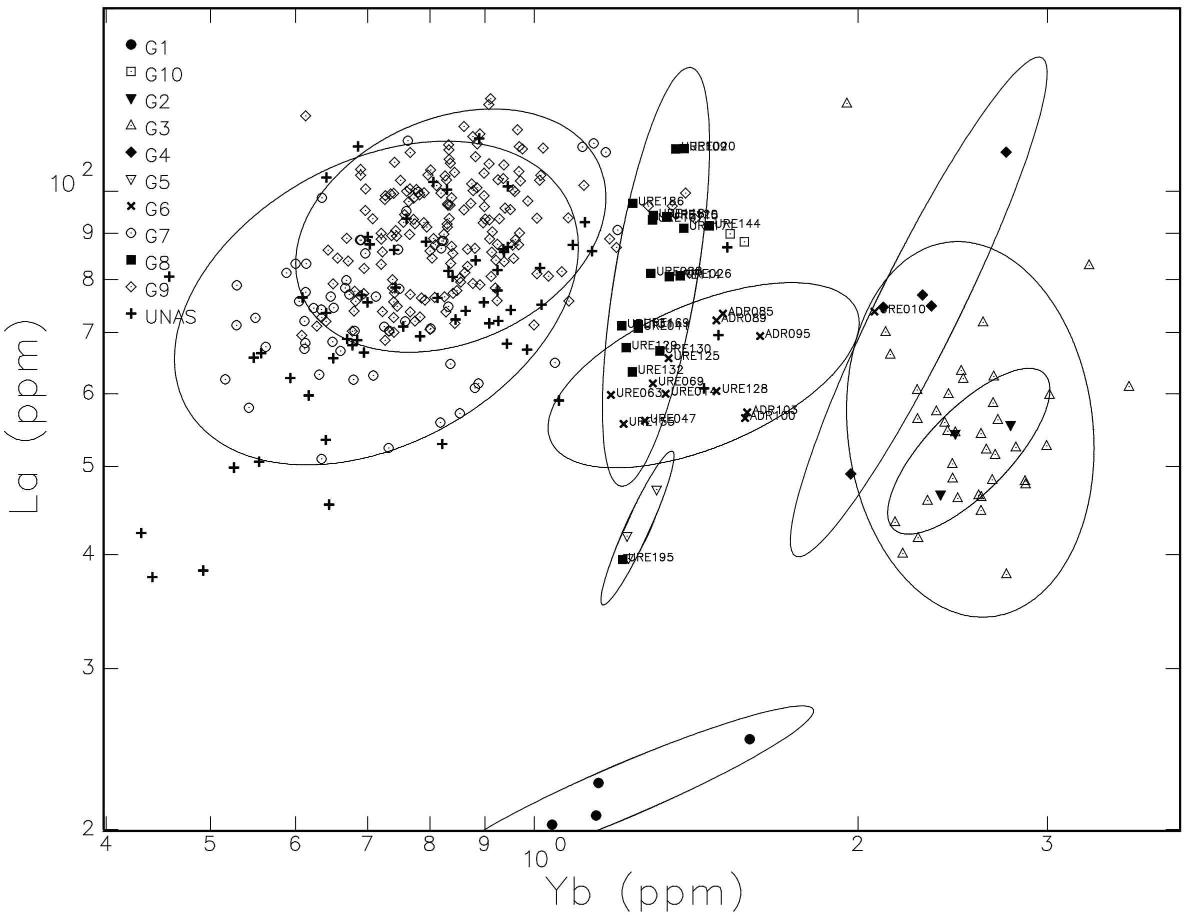


Figure A.2. Bivariate plot of ytterbium and lanthanum showing all of the compositional groups. The samples from the two medium-sized groups are individually labeled. The ellipses represent 90% confidence levels for membership in the groups.

few samples from 42IN100. Group 6 is mostly from Evans Mound while Group 8 is mostly from Paragonah and is exclusively SVC. Group 8 may represent a later recipe. These medium groups may indicate small production recipes at each of these sites, but that is difficult to demonstrate without a better link with the raw materials or without more samples from surrounding sites. Figure 2 is a plot featuring the two medium-sized groups.

Large Groups

There are three large groups. Group 3 is mostly brownware samples submitted by Cole and a few SVG submitted by Reed. While the brownwares are not the focus of your research this group does illustrate the reasonable separation by type. Group 3 separates well according to principal component 1. The remaining two large groups (Groups 7 and 9) are a little more difficult to separate. These groups were formed from a large concentration of samples that show little separation in bivariate plots. An attempt was made to use hierarchical cluster analysis to identify some separation among these samples. Two main groups were identified and then repeatedly modified using group membership probabilities based on Mahalanobis distance calculations. The separation between Groups 7 and 9 are difficult to observe in a single bivariate plot (although there is some separation visible in Figure 1), but the statistical separation is clearly shown in the group membership probabilities shown in Appendix 2. The two groups seem to show pretty similar distributions by site, but Group 7 does have a much higher percentage of SVG relative to SVC when compared to Group 9. Perhaps Group 7 represents predominantly earlier production from the same basic clays.

Unassigned Samples

All unassigned samples account for only 16.5 percent (n=62, plus 1 outlier) of the total 376 ceramic samples. This is a fairly small number, with many datasets typically exhibiting 25-30 percent unassigned. Most of the unassigned samples appear similar to the two largest groups (7 and 9). The majority of the unassigned samples along with all the members of Groups 7 and 9 could be considered as one generalized group representing the dominant SVC production for the area.

Site/Type Patterns

Overall, the two main sites samples in this new study are quite similar what examining differences by compositional group. Both Evans Mound and Paragonah have similar percentages of the major groups, suggesting a similar production/procurement system. The small sample from Parowan village appears quite distinct, with twice as many samples from Group 8 as Group 9,

Table A.1. Distribution of Compositional Groups by Ceramic Type.

	Compositional Group											
Type	1	2	3	4	5	6	7	8	9	10	Unassigned	Total
Brown	–	1	15	–	–	–	–	–	–	–		16
FB	–	1	6	–	–	–	–	–	–	–		7
FCB	–		4	–	–	–	–	–	–	–	1	5
PLAIN	–	–	8	–	–	–	–	–	–	–	–	8
SVBG	–	–		1		1	8	–	5	–	4	19
SVC	1	–	–		3	11	20	19	147	–	37	238
SVG	3	1	5	4		1	29	–	18	2	21	84
Total	4	3	38	5	3	13	57	19	170	2	62	417

but the total sample from the site is only six samples, making statistically significant conclusions difficult. Tables A.1 and A.2 show the breakdown of the compositional groups by ceramic type and site.

Conclusions

We have combined the 200 samples submitted for this project with samples from the same region previously analyzed for Clint Cole and Alan Reed for a total of nearly 400 ceramic samples. We have identified ten new compositional groups that range from small groups with just a few samples to very large groups of up to 170 samples. There are a remarkably low 16% unassigned samples.

The large groups contain the majority of the Snake Valley types, but Groups 8 and 9 have a higher proportion of corrugated versus grayware when compared to Group 7. The lack a of clear distinction between the assemblages from the main sites in this study are no surprising given the close proximity of the sites.

Table A.2. Distribution of Compositional Groups by Site.

	Compositional Group											
Site	1	2	3	4	5	6	7	8	9	10	Unassigned	Total
103-31	–	–	3	–	–	–	–	–	1	–	–	4
112-31	–	–	4	–	–	–	–	–	–	–	–	4
145a	–	–		–	–	–	–	–	–	–	–	0
42BE1988	–	1	3	3	–	–	2	–	–	2		11
42BE751	–	–	–	1	–	–	7	–	13	–	4	25
42IN100	–	–	–	–	–	–	–	4	2	–		6
42IN218	–	–	–	–	3	–	–		14	–	8	25
42IN40	–	–	–	–	–	9	14	4	64	–	29	120
42IN43	1	–	–	–	–	4	10	11	65	–	14	105
42MD974	2	–	–	1	–		5	–	1	–	1	10
42WS2434	1	–	1	–	–	–	8	–	–	–		10
42WS2435	–	–	–	–	–	–	4	–	–	–	1	5
53-83	–	–	1	–	–	–	–	–	–	–	1	2
61-84	–	–	1	–	–	–	–	–	–	–		1
6500-7500	–	–	3	–	–	–	–	–	1	–	1	5
68-79	–	1	1	–	–	–	–	–	–	–	1	3
68-97	–	–	1	–	–	–	–	–	–	–	–	1
72-77	–	–	3	–	–	–	–	–	–	–	–	3
73-33	–	–	1	–	–	–	–	–	–	–	–	1
73-82	–	–	1	–	–	–	–	–	–	–	–	1
89-71	–	–	1	–	–	–	–	–	–	–	–	1
A-3	–	1	–	–	–	–	–	–	–	–	–	1
Cache	–	–	–	–	–	–	1	–	–	–	–	1
PJ-11	–	–	–	–	–	–	–	–	–	–	1	1
PJ112-31	–	–	–	–	–	–	1	–	–	–	–	1
PJ-12	–	–	1	–	–	–	–	–	3	–	1	5
PJ-20	–	–		–	–	–	–	–	1	–		1
PJ-32	–	–	3	–	–	–	2	–	1	–	1	7
Sand Dune	–	–	1	–	–	–	–	–	4	–	–	5
SB-16	–	–	1	–	–	–	–	–	–	–	–	1
Serviceberry	–	–	2	–	–	–	1	–	–	–	–	3
Waterfall	–	–	6	–	–	–	2	–	–	–	–	8
Total	4	3	38	5	3	13	57	19	170	2	63	377

Acknowledgments

We acknowledge Cody Roush for his role in preparing the samples for irradiation. Partial Support for this project was provided by the a National Science Foundation grant to the Archaeometry Laboratory at MURR (BCS 1110793)

References

Baxter, Michael J.

1992 Archaeological uses of the biplot—a neglected technique? In *Computer Applications and Quantitative Methods in Archaeology, 1991*, edited by G. Lock and J. Moffett. BAR International Series S577, 141–148. Tempvs Reparatvm, Archaeological and Historical Associates, Oxford.

1994 *Exploratory Multivariate Analysis in Archaeology*. Edinburgh University Press, Edinburgh.

Baxter, M.J. and C.E. Buck

2000 Data Handling and Statistical Analysis. In *Modern Analytical Methods in Art and Archaeology*, edited by E. Ciliberto and G. Spoto, pp. 681-746. John Wiley and Sons,

Bieber, Alan M. Jr., Dorothea W. Brooks, Garman Harbottle, and Edward V. Sayre

1976 Application of multivariate techniques to analytical data on Aegean ceramics. *Archaeometry* 18:59–74.

Bishop, Ronald L. and Hector Neff

1989 Compositional data analysis in archaeology. In *Archaeological Chemistry IV*, edited by R. O. Allen, pp. 576–586. Advances in Chemistry Series 220, American Chemical Society, Washington, D.C.

Bishop, Ronald L., Robert L. Rands, and George R. Holley

1992 Ceramic compositional analysis in archaeological perspective. In *Advances in Archaeological Method and Theory*, vol. 5, pp. 275–330. Academic Press, New York.

Glascock, Michael D.

1992 Characterization of archaeological ceramics at MURR by neutron activation analysis and multivariate statistics. In *Chemical Characterization of Ceramic Pastes in Archaeology*, edited by H. Neff, pp. 11–26. Prehistory Press, Madison, WI.

Harbottle, Garman

1976 Activation analysis in archaeology. *Radiochemistry* 3:33–72. The Chemical Society, London.

Leese, Morven N. and Peter L. Main
1994 The efficient computation of unbiased Mahalanobis distances and their interpretation in archaeometry. *Archaeometry* 36:307–316.

Lynott, Mark J., Hector Neff, James E. Price, James W. Cogswell, and Michael D. Glascock
2000 Inferences about prehistoric ceramics and people in Southeast Missouri: Results of ceramic compositional analysis. American Antiquity, 65(1): 103–126.

Neff, Hector
1992 Introduction. In *Chemical Characterization of Ceramic Pastes in Archaeology*, edited by H. Neff, pp. 1–10. Prehistory Press, Madison, WI.
1994 RQ-mode principal components analysis of ceramic compositional data. *Archaeometry* 36:115–130.
2000 Neutron activation analysis for provenance determination in archaeology. In *Modern Analytical Methods in Art and Archaeology*, edited by E. Ciliberto and G. Spoto, pp. 81–134. John Wiley and Sons, Inc., New York.
2002 Quantitative techniques for analyzing ceramic compositional data. In Ceramic *Source Determination in the Greater Southwest*, edited by D. M. Glowacki and H. Neff. *Monograph 44, Cotsen Institute of Archaeology, UCLA*, Los Angeles.

Neff, Hector, Ronald L. Bishop, and Edward V. Sayre
1998 A Simulation Approach to the Problem of Tempering in Compositional Studies of Archaeological Ceramics. Journal of Archaeological Science 15:159–172.

Sayre, Edward V.
1975 Brookhaven Procedures for Statistical Analyses of Multivariate Archaeometric Data. Brookhaven National Laboratory Report BNL-23128. New York.

Steponaitis, Vincas, M. James Blackman, and Hector Neff
1996 Large-scale compositional patterns in the chemical composition of Mississippian pottery. *American Antiquity* 61:555–572.

Weigand, Phil C., Garman Harbottle, and Edward V. Sayre
1977 Turquoise sources and source analysis: Mesoamerica and the southwestern U.S.A. In *Exchange Systems in Prehistory*, edited by T. K. Earle and J. E. Ericson, pp. 15–34. Academic Press, New York.

Table A.3. Descriptive information and compositional group assignments.

ANID	Group	Site No.	Type
ADR009	7	42BE751	Snake Valley Gray
ADR010	9	42BE751	Snake Valley Gray
ADR011	unas	42BE751	Snake Valley Gray
ADR012	9	42BE751	Snake Valley Gray
ADR013	unas	42BE751	Snake Valley Gray
ADR014	7	42BE751	Snake Valley Gray
ADR015	7	42BE751	Snake Valley Gray
ADR016	7	42BE751	Snake Valley Gray
ADR017	9	42BE751	Snake Valley Corrugated
ADR018	unas	42BE751	Snake Valley Gray
ADR019	9	42BE751	Snake Valley Gray
ADR020	9	42BE751	Snake Valley Corrugated
ADR021	9	42BE751	Snake Valley Corrugated
ADR022	9	42BE751	Snake Valley Corrugated
ADR023	9	42BE751	Snake Valley Corrugated
ADR024	unas	42BE751	Snake Valley Corrugated
ADR025	9	42BE751	Snake Valley Corrugated
ADR026	9	42BE751	Snake Valley Corrugated
ADR027	9	42BE751	Snake Valley Corrugated
ADR028	9	42BE751	Snake Valley Corrugated
ADR029	9	42BE751	Snake Valley Corrugated
ADR030	7	42BE751	Snake Valley Black-on-gray
ADR031	4	42BE751	Snake Valley Black-on-gray
ADR032	7	42BE751	Snake Valley Black-on-gray
ADR033	7	42BE751	Snake Valley Black-on-gray
ADR034	7	42WS2434	Snake Valley Gray
ADR035	1	42WS2434	Snake Valley Gray
ADR036	7	42WS2434	Snake Valley Gray
ADR037	7	42WS2434	Snake Valley Gray
ADR038	7	42WS2434	Snake Valley Gray
ADR039	7	42WS2434	Snake Valley Gray
ADR040	7	42WS2434	Snake Valley Gray
ADR041	3	42WS2434	Snake Valley Gray

Table A.3. Continued.

ANID	Group	Site No.	Type
ADR042	7	42WS2434	Snake Valley Gray
ADR043	7	42WS2434	Snake Valley Gray
ADR044	7	42WS2435	Snake Valley Gray
ADR045	7	42WS2435	Snake Valley Gray
ADR046	unas	42WS2435	Snake Valley Gray
ADR047	7	42WS2435	Snake Valley Gray
ADR048	7	42WS2435	Snake Valley Gray
ADR049	7	42MD974	Snake Valley Gray
ADR050	1	42MD974	Snake Valley Gray
ADR051	4	42MD974	Snake Valley Gray
ADR052	unas	42MD974	Snake Valley Gray
ADR053	1	42MD974	Snake Valley Gray
ADR054	9	42MD974	Snake Valley Gray
ADR055	7	42MD974	Snake Valley Black-on-gray
ADR056	7	42MD974	Snake Valley Black-on-gray
ADR057	7	42MD974	Snake Valley Black-on-gray
ADR058	7	42MD974	Snake Valley Black-on-gray
ADR059	unas	42IN218	Snake Valley Gray
ADR060	9	42IN218	Snake Valley Gray
ADR061	unas	42IN218	Snake Valley Gray
ADR062	unas	42IN218	Snake Valley Gray
ADR063	9	42IN218	Snake Valley Gray
ADR064	unas	42IN218	Snake Valley Gray
ADR065	unas	42IN218	Snake Valley Gray
ADR066	unas	42IN218	Snake Valley Gray
ADR067	9	42IN218	Snake Valley Gray
ADR068	9	42IN218	Snake Valley Gray
ADR069	9	42IN218	Snake Valley Corrugated
ADR070	9	42IN218	Snake Valley Corrugated
ADR071	5	42IN218	Snake Valley Corrugated
ADR072	9	42IN218	Snake Valley Corrugated
ADR073	9	42IN218	Snake Valley Corrugated
ADR074	5	42IN218	Snake Valley Corrugated

Table A.3. Continued.

ANID	Group	Site No.	Type
ADR075	9	42IN218	Snake Valley Corrugated
ADR076	9	42IN218	Snake Valley Corrugated
ADR077	9	42IN218	Snake Valley Corrugated
ADR078	5	42IN218	Snake Valley Corrugated
ADR079	unas	42IN218	Snake Valley Black-on-gray
ADR080	9	42IN218	Snake Valley Black-on-gray
ADR081	unas	42IN218	Snake Valley Black-on-gray
ADR082	9	42IN218	Snake Valley Black-on-gray
ADR083	9	42IN218	Snake Valley Black-on-gray
ADR084	9	42IN40	Snake Valley Corrugated
ADR085	6	42IN40	Snake Valley Corrugated
ADR086	9	42IN40	Snake Valley Corrugated
ADR087	9	42IN40	Snake Valley Corrugated
ADR088	9	42IN40	Snake Valley Corrugated
ADR089	6	42IN40	Snake Valley Corrugated
ADR090	unas	42IN40	Snake Valley Corrugated
ADR091	7	42IN40	Snake Valley Corrugated
ADR092	9	42IN40	Snake Valley Corrugated
ADR093	unas	42IN40	Snake Valley Corrugated
ADR094	9	42IN40	Snake Valley Corrugated
ADR095	6	42IN40	Snake Valley Corrugated
ADR096	unas	42IN40	Snake Valley Gray
ADR097	unas	42IN40	Snake Valley Gray
ADR098	9	42IN40	Snake Valley Gray
ADR099	7	42IN40	Snake Valley Gray
ADR100	6	42IN40	Snake Valley Gray
ADR101	9	42IN40	Snake Valley Black-on-gray
ADR102	unas	42IN40	Snake Valley Black-on-gray
ADR103	6	42IN40	Snake Valley Black-on-gray
ADR104	9	42IN40	Snake Valley Gray
ADR105	7	42IN40	Snake Valley Gray
ADR106	unas	42IN40	Snake Valley Gray
ADR107	7	42IN40	Snake Valley Gray

Table A.3. Continued.

ANID	Group	Site No.	Type
ADR108	unas	42IN40	Snake Valley Gray
ADR109	unas	42IN40	Snake Valley Gray
ADR110	9	42IN40	Snake Valley Gray
ADR111	7	42IN40	Snake Valley Gray
ADR112	9	42IN40	Snake Valley Black-on-gray
ADR113	7	42IN40	Snake Valley Black-on-gray
ADR114	unas	42IN40	Snake Valley Black-on-gray
ADR115	2	42BE1988	Snake Valley Gray
ADR116A	10	42BE1988	Snake Valley Gray
ADR116B	4	42BE1988	Snake Valley Gray
ADR116C	10	42BE1988	Snake Valley Gray
ADR116D	7	42BE1988	Snake Valley Gray
ADR117	4	42BE1988	Snake Valley Gray
ADR118	4	42BE1988	Snake Valley Gray
ADR119A	3	42BE1988	Snake Valley Gray
ADR119B	3	42BE1988	Snake Valley Gray
ADR120A	3	42BE1988	Snake Valley Gray
ADR120B	7	42BE1988	Snake Valley Gray
CRC001	3	103-31	BROWN
CRC002	3	103-31	BROWN
CRC003	3	103-31	BROWN
CRC004	3	72-77	FB
CRC005	3	72-77	FB
CRC006	3	Waterfall	BROWN
CRC007	3	Waterfall	BROWN
CRC008	3	Waterfall	BROWN
CRC009	3	Sand Dune	BROWN
CRC010	3	PJ-32	FB
CRC011	2	A-3	BROWN
CRC012	3	68-79	BROWN
CRC013	3	61-84	FB
CRC014	out	PJ-12	FCB
CRC015	3	73-82	FB

Table A.3. Continued.

ANID	Group	Site No.	Type
CRC016	3	112-31	BROWN
CRC017	3	Serviceberry	FCB
CRC018	3	Serviceberry	FCB
CRC019	3	6500-7500	BROWN
CRC020	3	6500-7500	BROWN
CRC021	3	6500-7500	FCB
CRC022	3	112-31	BROWN
CRC023	3	112-31	BROWN
CRC024	3	PJ-32	BROWN
CRC025	3	53-83	FB
CRC026	3	68-97	BROWN
CRC027	3	73-33	FCB
CRC028	2	68-79	FB
CRC029	3	PJ-12	PLAIN
CRC030	3	PJ-32	PLAIN
CRC031	3	89-71	PLAIN
CRC032	3	SB-16	PLAIN
CRC033	3	112-31	PLAIN
CRC034	3	Waterfall	PLAIN
CRC035	3	Waterfall	PLAIN
CRC036	3	Waterfall	PLAIN
CRC037	7	Cache	Snake Valley Gray
CRC038	unas	68-79	Snake Valley Gray
CRC039	7	Waterfall	Snake Valley Gray
CRC040	9	6500-7500	Snake Valley Gray
CRC041	3	72-77	Snake Valley Gray
CRC042	9	Sand Dune	Snake Valley Gray
CRC043	unas	PJ-32	Snake Valley Gray
CRC044	unas	PJ-11	Snake Valley Gray
CRC045	7	PJ112-31	Snake Valley Gray
CRC046	9	PJ-12	Snake Valley Gray
CRC047	9	PJ-12	Snake Valley Gray
CRC048	7	PJ-32	Snake Valley Gray

Table A.3. Continued.

ANID	Group	Site No.	Type
CRC049	7	PJ-32	Snake Valley Gray
CRC050	7	Serviceberry	Snake Valley Gray
CRC051	9	PJ-20	Snake Valley Gray
CRC052	unas	6500-7500	Snake Valley Gray
CRC053	unas	53-83	Snake Valley Gray
CRC054	9	103-31	Snake Valley Gray
CRC055	9	Sand Dune	Snake Valley Gray
CRC056	9	Sand Dune	Snake Valley Corrugated
CRC057	9	PJ-32	Snake Valley Corrugated
CRC058	9	PJ-12	Snake Valley Corrugated
CRC059	7	Waterfall	Snake Valley Corrugated
CRC060	9	Sand Dune	Snake Valley Corrugated
CRC061		220	GEO
CRC062		219	GEO
CRC063		224	GEO
CRC064		218	GEO
CRC065		223	GEO
CRC066		222	GEO
CRC067		221	GEO
CRC068		94	GEO
CRC069		85	GEO
CRC070		58	GEO
CRC071		67	GEO
CRC072		217	GEO
CRC073		81	GEO
CRC074		204	GEO
CRC075		80	GEO
CRC076		187	GEO
CRC077		145a	GEO
CRC078		206	GEO
CRC079		60	GEO
CRC080		59	GEO
CRC081		212	GEO

Table A.3. Continued.

ANID	Group	Site No.	Type
CRC082		198	GEO
CRC083		199	GEO
CRC084		200	GEO
CRC085		65	GEO
CRC087		62	GEO
CRC088		205	GEO
CRC089		136	GEO
CRC090		153	GEO
CRC091		168	GEO
CRC092		151	GEO
CRC093		208	GEO
CRC094		184	GEO
CRC095		185	GEO
CRC096		183	GEO
CRC096		111	GEO
CRC097		122	GEO
CRC098		210	GEO
CRC099		101	GEO
CRC100		103	GEO
URE001	9	42IN40	Snake Valley Corrugated
URE002	unas	42IN40	Snake Valley Corrugated
URE003	unas	42IN40	Snake Valley Corrugated
URE004	9	42IN40	Snake Valley Corrugated
URE005	9	42IN40	Snake Valley Corrugated
URE006	9	42IN40	Snake Valley Corrugated
URE007	9	42IN40	Snake Valley Corrugated
URE008	9	42IN40	Snake Valley Corrugated
URE009	7	42IN40	Snake Valley Corrugated
URE010	6	42IN40	Snake Valley Corrugated
URE011	9	42IN40	Snake Valley Corrugated
URE012	9	42IN40	Snake Valley Corrugated
URE013	7	42IN40	Snake Valley Corrugated
URE014	6	42IN40	Snake Valley Corrugated

Table A.3. Continued.

ANID	Group	Site No.	Type
URE015	unas	42IN40	Snake Valley Corrugated
URE016	9	42IN40	Snake Valley Corrugated
URE017	7	42IN40	Snake Valley Corrugated
URE018	9	42IN40	Snake Valley Corrugated
URE019	9	42IN40	Snake Valley Corrugated
URE020	8	42IN40	Snake Valley Corrugated
URE021	unas	42IN40	Snake Valley Corrugated
URE022	9	42IN40	Snake Valley Corrugated
URE023	unas	42IN40	Snake Valley Corrugated
URE024	unas	42IN40	Snake Valley Corrugated
URE025	unas	42IN40	Snake Valley Corrugated
URE026	8	42IN40	Snake Valley Corrugated
URE027	7	42IN40	Snake Valley Corrugated
URE028	9	42IN40	Snake Valley Corrugated
URE029	9	42IN40	Snake Valley Corrugated
URE030	unas	42IN40	Snake Valley Corrugated
URE031	9	42IN40	Snake Valley Corrugated
URE032	9	42IN40	Snake Valley Corrugated
URE033	unas	42IN40	Snake Valley Corrugated
URE034	9	42IN40	Snake Valley Corrugated
URE035	9	42IN40	Snake Valley Corrugated
URE036	9	42IN40	Snake Valley Corrugated
URE037	9	42IN40	Snake Valley Corrugated
URE038	9	42IN40	Snake Valley Corrugated
URE039	9	42IN40	Snake Valley Corrugated
URE040	9	42IN40	Snake Valley Corrugated
URE041	8	42IN40	Snake Valley Corrugated
URE042	9	42IN40	Snake Valley Corrugated
URE043	9	42IN40	Snake Valley Corrugated
URE044	9	42IN40	Snake Valley Corrugated
URE045	9	42IN40	Snake Valley Corrugated
URE046	9	42IN40	Snake Valley Corrugated
URE047	6	42IN40	Snake Valley Corrugated

Table A.3. Continued.

ANID	Group	Site No.	Type
URE048	unas	42IN40	Snake Valley Corrugated
URE049	9	42IN40	Snake Valley Corrugated
URE050	9	42IN40	Snake Valley Corrugated
URE051	9	42IN40	Snake Valley Corrugated
URE052	unas	42IN40	Snake Valley Corrugated
URE053	9	42IN40	Snake Valley Corrugated
URE054	unas	42IN40	Snake Valley Corrugated
URE055	unas	42IN40	Snake Valley Corrugated
URE056	unas	42IN40	Snake Valley Corrugated
URE057	unas	42IN40	Snake Valley Corrugated
URE058	9	42IN40	Snake Valley Corrugated
URE059	9	42IN40	Snake Valley Corrugated
URE060	9	42IN40	Snake Valley Corrugated
URE061	9	42IN40	Snake Valley Corrugated
URE062	9	42IN40	Snake Valley Corrugated
URE063	6	42IN43	Snake Valley Corrugated
URE064	9	42IN43	Snake Valley Corrugated
URE065	9	42IN43	Snake Valley Corrugated
URE066	9	42IN43	Snake Valley Corrugated
URE067	1	42IN43	Snake Valley Corrugated
URE068	9	42IN43	Snake Valley Corrugated
URE069	6	42IN43	Snake Valley Corrugated
URE070	9	42IN43	Snake Valley Corrugated
URE071	unas	42IN43	Snake Valley Corrugated
URE072	9	42IN43	Snake Valley Corrugated
URE073	9	42IN43	Snake Valley Corrugated
URE074	9	42IN43	Snake Valley Corrugated
URE075	9	42IN43	Snake Valley Corrugated
URE076	9	42IN43	Snake Valley Corrugated
URE077	9	42IN43	Snake Valley Corrugated
URE078	9	42IN43	Snake Valley Corrugated
URE079	9	42IN43	Snake Valley Corrugated
URE080	9	42IN43	Snake Valley Corrugated

Table A.3. Continued.

ANID	Group	Site No.	Type
URE081	9	42IN43	Snake Valley Corrugated
URE082	7	42IN43	Snake Valley Corrugated
URE083	7	42IN43	Snake Valley Corrugated
URE084	9	42IN43	Snake Valley Corrugated
URE085	7	42IN43	Snake Valley Corrugated
URE086	9	42IN43	Snake Valley Corrugated
URE087	9	42IN43	Snake Valley Corrugated
URE088	8	42IN43	Snake Valley Corrugated
URE089	9	42IN43	Snake Valley Corrugated
URE090	7	42IN43	Snake Valley Corrugated
URE091	unas	42IN43	Snake Valley Corrugated
URE092	9	42IN43	Snake Valley Corrugated
URE093	9	42IN43	Snake Valley Corrugated
URE094	9	42IN43	Snake Valley Corrugated
URE095	9	42IN43	Snake Valley Corrugated
URE096	9	42IN43	Snake Valley Corrugated
URE097	9	42IN43	Snake Valley Corrugated
URE098	7	42IN43	Snake Valley Corrugated
URE099	unas	42IN43	Snake Valley Corrugated
URE100	9	42IN43	Snake Valley Corrugated
URE101	9	42IN43	Snake Valley Corrugated
URE102	9	42IN43	Snake Valley Corrugated
URE103	9	42IN43	Snake Valley Corrugated
URE104	9	42IN43	Snake Valley Corrugated
URE105	9	42IN43	Snake Valley Corrugated
URE106	9	42IN43	Snake Valley Corrugated
URE107	8	42IN43	Snake Valley Corrugated
URE108	9	42IN43	Snake Valley Corrugated
URE109	8	42IN43	Snake Valley Corrugated
URE110	unas	42IN43	Snake Valley Corrugated
URE111	unas	42IN43	Snake Valley Corrugated
URE112	9	42IN43	Snake Valley Corrugated
URE113	unas	42IN43	Snake Valley Corrugated

Table A.3. Continued.

ANID	Group	Site No.	Type
URE114	8	42IN43	Snake Valley Corrugated
URE115	8	42IN43	Snake Valley Corrugated
URE116	9	42IN43	Snake Valley Corrugated
URE117	unas	42IN43	Snake Valley Corrugated
URE118	8	42IN43	Snake Valley Corrugated
URE119	9	42IN43	Snake Valley Corrugated
URE120	8	42IN43	Snake Valley Corrugated
URE121	9	42IN43	Snake Valley Corrugated
URE122	unas	42IN43	Snake Valley Corrugated
URE123	9	42IN43	Snake Valley Corrugated
URE124	9	42IN43	Snake Valley Corrugated
URE125	6	42IN43	Snake Valley Corrugated
URE126	9	42IN43	Snake Valley Corrugated
URE127	9	42IN43	Snake Valley Corrugated
URE128	6	42IN43	Snake Valley Corrugated
URE129	8	42IN100	Snake Valley Corrugated
URE130	8	42IN100	Snake Valley Corrugated
URE131	8	42IN100	Snake Valley Corrugated
URE132	8	42IN100	Snake Valley Corrugated
URE133	9	42IN100	Snake Valley Corrugated
URE134	9	42IN100	Snake Valley Corrugated
URE135	9	42IN40	Snake Valley Corrugated
URE136	unas	42IN40	Snake Valley Corrugated
URE137	unas	42IN40	Snake Valley Corrugated
URE138	7	42IN40	Snake Valley Corrugated
URE139	9	42IN40	Snake Valley Corrugated
URE140	9	42IN40	Snake Valley Corrugated
URE141	9	42IN40	Snake Valley Corrugated
URE142	unas	42IN40	Snake Valley Corrugated
URE143	7	42IN40	Snake Valley Corrugated
URE144	8	42IN40	Snake Valley Corrugated
URE145	9	42IN40	Snake Valley Corrugated
URE146	9	42IN40	Snake Valley Corrugated

Table A.3. Continued.

ANID	Group	Site No.	Type
URE147	9	42IN40	Snake Valley Corrugated
URE148	9	42IN40	Snake Valley Corrugated
URE149	9	42IN40	Snake Valley Corrugated
URE150	9	42IN40	Snake Valley Corrugated
URE151	9	42IN40	Snake Valley Corrugated
URE152	9	42IN40	Snake Valley Corrugated
URE153	9	42IN40	Snake Valley Corrugated
URE154	9	42IN40	Snake Valley Corrugated
URE155	6	42IN40	Snake Valley Corrugated
URE156	9	42IN40	Snake Valley Corrugated
URE157	7	42IN40	Snake Valley Corrugated
URE158	7	42IN40	Snake Valley Corrugated
URE159	9	42IN40	Snake Valley Corrugated
URE160	unas	42IN40	Snake Valley Corrugated
URE161	unas	42IN40	Snake Valley Corrugated
URE162	7	42IN43	Snake Valley Corrugated
URE163	7	42IN43	Snake Valley Corrugated
URE164	9	42IN43	Snake Valley Corrugated
URE165	9	42IN43	Snake Valley Corrugated
URE166	9	42IN43	Snake Valley Corrugated
URE167	9	42IN43	Snake Valley Corrugated
URE168	7	42IN43	Snake Valley Corrugated
URE169	8	42IN43	Snake Valley Corrugated
URE170	9	42IN43	Snake Valley Corrugated
URE171	8	42IN43	Snake Valley Corrugated
URE172	9	42IN43	Snake Valley Corrugated
URE173	9	42IN43	Snake Valley Corrugated
URE174	9	42IN43	Snake Valley Corrugated
URE175	9	42IN43	Snake Valley Corrugated
URE176	9	42IN43	Snake Valley Corrugated
URE177	9	42IN43	Snake Valley Corrugated
URE178	9	42IN43	Snake Valley Corrugated
URE179	7	42IN43	Snake Valley Corrugated

Table A.3. Continued.

ANID	Group	Site No.	Type
URE180	9	42IN43	Snake Valley Corrugated
URE181	unas	42IN43	Snake Valley Corrugated
URE182	unas	42IN43	Snake Valley Corrugated
URE183	9	42IN43	Snake Valley Corrugated
URE184	unas	42IN43	Snake Valley Corrugated
URE185	unas	42IN43	Snake Valley Corrugated
URE186	8	42IN43	Snake Valley Corrugated
URE187	9	42IN43	Snake Valley Corrugated
URE188	9	42IN43	Snake Valley Corrugated
URE189	9	42IN43	Snake Valley Corrugated
URE190	9	42IN43	Snake Valley Corrugated
URE191	9	42IN43	Snake Valley Corrugated
URE192	9	42IN43	Snake Valley Corrugated
URE193	9	42IN43	Snake Valley Corrugated
URE194	9	42IN43	Snake Valley Corrugated
URE195	8	42IN43	Snake Valley Corrugated
URE196	7	42IN43	Snake Valley Corrugated
URE197	9	42IN43	Snake Valley Corrugated
URE198	9	42IN43	Snake Valley Corrugated
URE199	unas	42IN43	Snake Valley Corrugated
URE200	unas	42IN43	Snake Valley Corrugated

Table A.4. Membership Probabilities (%) for the Sample Using Mahalanobis Distance.

ANID	*G7	*G9	**Best Group
Group 7			
ADR009	45.806	0.000	G7
ADR014	11.022	0.000	G7
ADR015	72.022	0.000	G7
ADR016	38.647	0.000	G7
ADR030	95.913	0.000	G7
ADR032	79.357	0.000	G7
ADR033	92.330	0.000	G7
ADR034	11.252	0.000	G7
ADR036	77.964	0.000	G7
ADR037	94.102	0.000	G7
ADR038	55.673	0.000	G7
ADR039	49.955	0.000	G7
ADR040	98.405	0.000	G7
ADR042	93.356	0.000	G7
ADR043	53.552	0.000	G7
ADR044	95.362	0.000	G7
ADR045	87.254	0.000	G7
ADR047	7.350	0.000	G7
ADR048	75.271	0.000	G7
ADR049	56.659	0.000	G7
ADR055	48.433	0.000	G7
ADR056	9.223	0.000	G7
ADR057	32.996	0.000	G7
ADR058	24.793	0.000	G7
ADR091	3.826	0.000	G7
ADR099	57.851	0.000	G7
ADR105	77.203	0.000	G7
ADR107	10.805	0.000	G7
ADR111	9.384	0.000	G7
ADR113	60.624	0.000	G7
ADR116D	27.145	0.000	G7
ADR120B	34.875	0.000	G7
CRC037	42.585	0.000	G7
CRC039	7.753	0.000	G7
CRC045	7.025	0.000	G7
CRC048	23.968	0.000	G7

Table A.4. Continued.

ANID	*G7	*G9	**Best Group
CRC049	9.183	0.000	G7
CRC050	6.826	0.000	G7
CRC059	52.087	0.000	G7
URE009	3.068	0.000	G7
URE013	16.559	0.000	G7
URE017	58.406	0.000	G7
URE027	98.030	0.000	G7
URE082	32.056	0.000	G7
URE083	85.071	0.000	G7
URE085	74.679	0.000	G7
URE090	93.230	0.000	G7
URE098	11.494	0.000	G7
URE138	72.289	0.000	G7
URE143	58.956	0.000	G7
URE157	39.514	0.001	G7
URE158	60.004	0.000	G7
URE162	29.077	0.000	G7
URE163	81.072	0.000	G7
URE168	50.729	0.000	G7
URE179	36.010	0.000	G7
URE196	91.734	0.000	G7
Group 9			
ADR010	0.000	15.298	G9
ADR012	0.000	10.767	G9
ADR017	0.016	62.270	G9
ADR019	0.000	1.548	G9
ADR020	0.001	4.459	G9
ADR021	0.000	48.475	G9
ADR022	0.000	15.271	G9
ADR023	0.000	5.942	G9
ADR025	0.000	57.453	G9
ADR026	0.000	10.580	G9
ADR027	0.000	48.721	G9
ADR028	0.035	11.730	G9
ADR029	0.039	89.010	G9
ADR054	0.002	83.144	G9
ADR060	0.000	96.456	G9
ADR063	0.018	18.745	G9

Table A.4. Continued.

ANID	*G7	*G9	**Best Group
ADR067	0.000	75.105	G9
ADR068	0.000	54.390	G9
ADR069	0.002	89.759	G9
ADR070	0.000	43.097	G9
ADR072	0.000	61.518	G9
ADR073	0.000	63.074	G9
ADR075	0.000	58.873	G9
ADR076	0.000	65.282	G9
ADR077	0.000	9.798	G9
ADR080	0.000	6.021	G9
ADR082	0.000	80.087	G9
ADR083	0.000	82.978	G9
ADR084	0.004	99.926	G9
ADR086	0.002	69.413	G9
ADR087	0.018	47.791	G9
ADR088	0.002	38.678	G9
ADR092	0.000	55.419	G9
ADR094	0.000	54.068	G9
ADR098	0.000	2.264	G9
ADR101	0.000	42.922	G9
ADR104	0.001	29.591	G9
ADR110	0.000	11.171	G9
ADR112	0.000	7.687	G9
CRC040	0.000	5.204	G9
CRC042	0.000	11.130	G9
CRC046	0.001	24.423	G9
CRC047	0.000	3.242	G9
CRC051	0.005	56.389	G9
CRC054	0.288	9.120	G9
CRC055	0.000	10.698	G9
CRC056	0.000	77.427	G9
CRC057	0.004	17.553	G9
CRC058	0.000	1.124	G9
CRC060	0.000	2.509	G9
URE001	0.000	33.566	G9
URE004	0.000	12.202	G9
URE005	0.000	96.798	G9
URE006	0.004	9.039	G9

Table A.4. Continued.

ANID	*G7	*G9	**Best Group
URE007	0.001	78.144	G9
URE008	0.000	97.051	G9
URE011	0.022	17.574	G9
URE012	0.000	73.728	G9
URE016	0.095	37.174	G9
URE018	0.000	30.811	G9
URE019	0.000	78.814	G9
URE022	0.000	8.739	G9
URE028	0.004	90.904	G9
URE029	0.000	91.374	G9
URE031	0.000	74.884	G9
URE032	0.000	16.629	G9
URE034	0.020	75.518	G9
URE035	0.000	70.030	G9
URE036	0.000	98.362	G9
URE037	0.000	32.764	G9
URE038	0.002	90.477	G9
URE039	0.000	19.232	G9
URE040	0.000	40.384	G9
URE042	0.018	83.051	G9
URE043	0.001	63.564	G9
URE044	1.975	46.159	G9
URE045	0.203	15.826	G9
URE046	0.000	72.565	G9
URE049	0.019	0.106	G9
URE050	0.000	98.982	G9
URE051	0.000	6.859	G9
URE053	0.000	11.578	G9
URE058	0.000	37.492	G9
URE059	2.564	30.792	G9
URE060	0.207	9.673	G9
URE061	0.000	54.310	G9
URE062	0.000	76.669	G9
URE064	0.001	16.762	G9
URE065	0.001	98.569	G9
URE066	0.000	76.952	G9
URE068	0.000	46.878	G9
URE070	0.000	9.206	G9
URE072	0.018	6.818	G9

Table A.4. Continued.

ANID	*G7	*G9	**Best Group
URE073	0.002	12.051	G9
URE074	0.000	18.382	G9
URE075	0.000	12.728	G9
URE076	0.000	55.832	G9
URE077	0.006	88.583	G9
URE078	0.077	92.771	G9
URE079	0.001	95.491	G9
URE080	0.000	2.313	G9
URE081	0.005	77.361	G9
URE084	0.002	48.768	G9
URE086	0.000	82.824	G9
URE087	0.000	97.166	G9
URE089	0.000	21.072	G9
URE092	0.000	54.032	G9
URE093	0.002	79.783	G9
URE094	0.000	78.975	G9
URE095	0.000	34.197	G9
URE096	0.006	88.816	G9
URE097	0.000	53.035	G9
URE100	0.143	99.739	G9
URE101	0.000	66.819	G9
URE102	0.082	93.836	G9
URE103	0.002	97.001	G9
URE104	0.008	67.737	G9
URE105	0.000	19.355	G9
URE106	0.016	95.869	G9
URE108	0.003	46.753	G9
URE112	0.002	54.936	G9
URE116	0.568	58.297	G9
URE119	0.002	14.249	G9
URE121	0.023	97.504	G9
URE123	0.004	65.658	G9
URE124	0.000	5.245	G9
URE126	0.627	38.007	G9
URE127	0.001	37.198	G9
URE133	0.000	4.430	G9
URE134	0.118	21.478	G9
URE135	0.001	6.305	G9
URE139	0.016	99.290	G9

Table A.4. Continued.

ANID	*G7	*G9	**Best Group
URE140	0.000	38.133	G9
URE141	0.009	19.940	G9
URE145	0.041	99.547	G9
URE146	0.249	73.462	G9
URE147	0.000	7.412	G9
URE148	0.001	24.629	G9
URE149	0.099	6.701	G9
URE150	0.074	97.253	G9
URE151	0.001	88.696	G9
URE152	0.000	16.584	G9
URE153	0.000	53.710	G9
URE154	0.000	80.680	G9
URE156	0.001	7.744	G9
URE159	0.000	42.921	G9
URE164	0.000	32.917	G9
URE165	0.014	98.321	G9
URE166	0.004	46.894	G9
URE167	0.014	95.977	G9
URE170	0.000	87.621	G9
URE172	0.001	94.621	G9
URE173	0.001	6.792	G9
URE174	0.000	96.391	G9
URE175	0.001	55.400	G9
URE176	0.000	36.262	G9
URE177	0.002	95.607	G9
URE178	0.104	42.047	G9
URE180	0.001	99.220	G9
URE183	0.000	30.796	G9
URE187	0.001	79.550	G9
URE188	0.001	99.893	G9
URE189	0.018	74.017	G9
URE190	0.000	94.410	G9
URE191	0.000	7.492	G9
URE192	0.006	55.590	G9
URE193	0.011	40.689	G9
URE194	0.000	44.207	G9
URE197	0.000	45.708	G9
URE198	0.003	87.326	G9

Table A.4. Continued.

ANID	*G7	*G9	**Best Group
Group 1			
ADR035	0.000	0.000	–
ADR050	0.000	0.000	–
ADR053	0.000	0.000	–
URE067	0.000	0.000	–
Group 10			
ADR116A	0.003	0.000	G7
ADR116C	0.001	0.000	–
Group 2			
ADR115	0.000	0.000	–
CRC011	0.000	0.000	–
CRC028	0.000	0.000	–
Group 3			
ADR041	0.000	0.000	–
ADR119A	0.000	0.000	–
ADR119B	0.000	0.000	–
ADR120A	0.000	0.000	–
CRC001	0.000	0.000	–
CRC002	0.000	0.000	–
CRC003	0.000	0.000	–
CRC004	0.000	0.000	–
CRC005	0.000	0.000	–
CRC006	0.000	0.000	–
CRC007	0.000	0.000	–
CRC008	0.000	0.000	–
CRC009	0.000	0.000	–
CRC010	0.000	0.000	–
CRC012	0.000	0.000	–
CRC013	0.000	0.000	–
CRC015	0.000	0.000	–
CRC016	0.000	0.000	–
CRC017	0.000	0.000	–
CRC018	0.000	0.000	–
CRC019	0.000	0.000	–
CRC020	0.000	0.000	–
CRC021	0.000	0.000	–

Table A.4. Continued.

ANID	*G7	*G9	**Best Group
CRC022	0.000	0.000	–
CRC023	0.000	0.000	–
CRC024	0.000	0.000	–
CRC025	0.000	0.000	–
CRC026	0.000	0.000	–
CRC027	0.000	0.000	–
CRC029	0.000	0.000	–
CRC030	0.000	0.000	–
CRC031	0.000	0.000	–
CRC032	0.000	0.000	–
CRC033	0.000	0.000	–
CRC034	0.000	0.000	–
CRC035	0.000	0.000	–
CRC036	0.000	0.000	–
CRC041	0.000	0.000	–
Group 5			
ADR071	0.000	0.000	–
ADR074	0.000	0.000	–
ADR078	0.000	0.000	–
Group 6			
ADR085	0.000	0.000	–
ADR089	0.000	0.000	–
ADR095	0.001	0.000	–
ADR100	0.000	0.000	–
ADR103	0.000	0.000	–
URE010	0.001	0.000	–
URE014	0.000	0.000	–
URE047	0.000	0.000	–
URE063	0.000	0.000	–
URE069	0.000	0.000	–
URE125	0.000	0.000	–
URE128	0.000	0.000	–
URE155	0.000	0.000	–
Group 8			
URE020	0.001	1.933	G9
URE026	0.000	0.135	G9

Table A.4. Continued.

ANID	*G7	*G9	**Best Group
URE041	2.623	0.076	G7
URE088	0.080	0.554	G9
URE107	6.680	8.066	G9
URE109	6.489	0.000	G7
URE114	0.083	0.001	G7
URE115	9.004	34.034	G9
URE118	3.057	6.433	G9
URE120	0.000	0.329	G9
URE129	0.080	0.006	G7
URE130	0.000	0.000	–
URE131	7.363	0.006	G7
URE132	0.002	0.000	G7
URE144	4.473	3.742	G7
URE169	0.030	0.213	G9
URE171	0.000	6.488	G9
URE186	0.778	61.680	G9
URE195	0.000	0.000	–
Unassigned			
ADR011	0.009	0.000	G7
ADR013	0.000	0.000	–
ADR018	0.001	0.000	–
ADR024	0.000	0.000	–
ADR046	0.000	0.000	–
ADR052	0.014	0.003	G7
ADR059	0.006	0.000	G7
ADR061	0.003	0.000	G7
ADR062	0.056	0.000	G7
ADR064	0.728	0.000	G7
ADR065	1.673	0.000	G7
ADR066	1.900	0.000	G7
ADR079	0.000	0.017	G9
ADR081	0.001	0.707	G9
ADR090	0.049	1.109	G9
ADR093	0.833	0.000	G7
ADR096	0.001	0.000	G7
ADR097	0.000	0.000	–
ADR102	1.960	0.000	G7

Table A.4. Continued.

ANID	*G7	*G9	**Best Group
ADR106	37.089	0.049	G7
ADR108	0.000	0.000	–
ADR109	4.186	0.001	G7
ADR114	0.295	0.000	G7
CRC038	0.046	0.001	G7
CRC043	0.000	0.000	–
CRC044	0.003	0.013	G9
CRC052	0.217	0.000	G7
CRC053	19.887	0.418	G7
URE002	0.308	0.085	G7
URE003	0.051	0.039	G7
URE015	0.000	0.000	–
URE021	0.012	8.921	G9
URE023	2.305	15.690	G9
URE024	2.605	0.000	G7
URE025	0.157	0.000	G7
URE030	0.000	0.000	–
URE033	12.797	2.104	G7
URE048	2.103	42.509	G9
URE052	0.000	0.000	–
URE054	1.646	0.370	G7
URE055	0.972	0.117	G7
URE056	0.000	0.000	–
URE057	0.001	0.000	G7
URE071	0.088	0.000	G7
URE091	0.860	17.769	G9
URE099	0.001	1.338	G9
URE110	5.035	18.076	G9
URE111	0.000	0.000	–
URE113	0.000	0.009	G9
URE117	0.311	0.000	G7
URE122	0.224	0.000	G7
URE136	0.336	0.235	G7
URE137	1.353	7.648	G9
URE142	0.573	0.020	G7
URE160	0.000	0.000	–
URE161	0.013	0.020	G9
URE181	0.001	0.000	–

Table A.4. Continued.

ANID	*G7	*G9	**Best Group
URE182	0.289	0.116	G7
URE184	10.937	72.268	G9
URE185	0.181	0.330	G9
URE199	0.010	6.778	G9
URE200	0.073	40.941	G9

* Results are based on the following variables: Ca, Sc, V, Cr, Mn, Fe, Co, Zn, Rb, Sr, Zr, Cs, Ba, La, Ce, Nd, Sm, Eu, Tb, Dy, Yb, Lu, Hf, Ta, Th

** Best Group is based on highest membership probability > 0.001%

Appendix B

Results from Latent Profile Analysis

Analysis performed by Dr. W. Justin Dyer
School of Family Life
Brigham Young University

Table B.1. Probable Means for Each Chemical Cluster from Latent Profile Analysis.

	Cluster1	Cluster2	Cluster3	Cluster4	Cluster5	Cluster6
Overall indicators	0.289	0.287	0.140	0.135	0.127	0.023
Arsenic						
2.259–7.279	0.500	0.295	0.068	0.023	0.046	0.068
7.323–9.024	0.296	0.482	0.067	0.022	0.133	—
9.035–11.74	0.203	0.367	0.158	0.114	0.136	0.023
11.77–14.97	0.222	0.156	0.178	0.200	0.244	—
15.07–29.37	0.227	0.136	0.227	0.318	0.068	0.023
Lanthanum						
25.11–72.22	—	—	0.205	0.455	0.227	0.114
72.36–82.74	—	0.268	0.399	0.133	0.200	—
83.18–90.32	0.045	0.682	0.068	0.068	0.137	—
90.59–99.39	0.542	0.369	0.022	0.022	0.044	—
99.50–117.7	0.860	0.117	—	—	0.023	—
Lutetium						
0.0294–0.0684	0.046	0.227	0.319	—	0.409	—
0.0686–0.0824	0.252	0.415	0.178	0.022	0.133	—
0.0830–0.0978	0.442	0.358	0.089	0.067	0.045	—
0.0983–0.125	0.372	0.397	0.069	0.116	0.047	—
0.128–0.229	0.333	0.045	0.044	0.467	—	0.111
Neodymium						
19.18–55.46	—	—	0.273	0.409	0.204	0.114
55.47–64.33	—	0.268	0.377	0.178	0.178	0
64.41–69.86	0.091	0.704	0.023	0.068	0.114	0
70.04–76.31	0.430	0.437	0.022	0.022	0.089	0
76.34–90.57	0.929	0.026	—	—	0.046	0
Samarium						
3.944–9.781	—	0.001	0.386	0.318	0.181	0.114
9.790–11.07	—	0.422	0.267	0.178	0.133	—
11.09–11.94	0.023	0.727	0.046	0.136	0.069	—
11.95–12.97	0.561	0.284	—	0.022	0.133	—
13.00–16.53	0.864	0.000	—	0.023	0.114	—
Uranium						
0–1.541	0.318	0.341	0.046	0.159	0.114	0.023
1.552–1.806	0.254	0.390	0.044	0.178	0.133	—

Table B.1. Continued.

	Cluster1	Cluster2	Cluster3	Cluster4	Cluster5	Cluster6
1.814–2.012	0.318	0.386	0.114	0.114	0.068	—
2.017–2.387	0.308	0.227	0.177	0.2	0.066	0.022
2.402–4.455	0.248	0.093	0.318	0.023	0.250	0.068
Yterbium						
0.431–0.726	0.046	0.273	0.251	—	0.431	—
0.727–0.803	0.208	0.347	0.356	—	0.089	—
0.805–0.900	0.522	0.298	0.090	0.023	0.068	—
0.908–1.077	0.309	0.513	—	0.156	0.022	—
1.086–2.071	0.364	—	—	0.5	0.023	0.114
Cerium						
47.16–161.8	—	—	0.046	0.455	0.386	0.114
162.3–189.8	0.022	0.355	0.289	0.222	0.111	—
189.9–212.4	0.260	0.422	0.227	0.000	0.091	—
212.5–230.4	0.486	0.359	0.111	—	0.044	—
230.7–310.4	0.680	0.298	0.022	—	—	—
Cobalt						
2.044–3.708	—	0.023	0.023	0.409	0.523	0.023
3.742–4.176	0.154	0.248	0.222	0.200	0.111	0.067
4.177–4.532	0.115	0.749	0.136	—	—	—
4.533–4.870	0.464	0.314	0.156	0.067	—	—
4.871–6.950	0.714	0.104	0.159	—	—	0.023
Chromium						
5.293–10.61	0.045	0.136	0.25	—	0.568	—
10.63–12.07	0.373	0.494	0.111	0.022	0.000	—
12.07–12.93	0.455	0.297	0.135	0.068	0.023	0.023
12.93–14.70	0.423	0.311	0.112	0.111	0.044	—
14.73–55.35	0.146	0.195	0.091	0.477	—	0.091
Cesium						
3.940–44.61	0.045	0.114	0.046	0.341	0.341	0.114
45.59–54.80	0.287	0.224	0.178	0.2	0.111	—
54.85–60.72	0.432	0.182	0.160	0.091	0.136	—
60.76–67.72	0.333	0.401	0.199	0.022	0.044	—
68.04–98.94	0.348	0.516	0.114	0.023	—	—

Table B.1. Continued.

	Cluster1	Cluster2	Cluster3	Cluster4	Cluster5	Cluster6
Europium						
0.766–1.800	—	—	0.319	0.318	0.250	0.114
1.805–2.063	—	0.223	0.354	0.200	0.223	—
2.068–2.240	0.046	0.682	0.023	0.159	0.091	—
2.243–2.402	0.473	0.505	—	—	0.022	—
2.403–2.892	0.930	0.024	—	—	0.046	—
Iron						
2e+004–3e+004	0.180	0.320	—	0.273	0.114	0.114
3e+004–3e+004	0.290	0.333	—	0.178	0.2	—
3e+004–3e+004	0.281	0.356	0.045	0.114	0.204	—
3e+004–3e+004	0.354	0.313	0.178	0.044	0.111	—
3e+004–4e+004	0.341	0.114	0.477	0.068	—	—
Hafnium						
2.833–8.717	0.136	0.205	0.001	0.205	0.340	0.114
8.743–9.601	0.222	0.377	0.022	0.222	0.156	—
9.618–10.17	0.212	0.357	0.226	0.137	0.068	—
10.18–10.92	0.199	0.335	0.289	0.111	0.067	—
10.93–14.47	0.680	0.161	0.159	—	—	—
Nickel						
0–0	0.113	0.181	0.091	0.295	0.251	0.069
10.25–28.27	0.244	0.333	0.067	0.133	0.200	0.022
28.36–33.42	0.317	0.297	0.182	0.114	0.068	0.023
33.60–39.13	0.319	0.349	0.154	0.111	0.067	—
39.35–80.68	0.453	0.274	0.205	0.023	0.046	—
Rubidium						
58.04–70.29	0.353	0.180	0.245	0.178	0.022	0.022
70.36–74.01	0.341	0.250	0.159	0.182	0.046	0.023
74.04–77.63	0.42	0.269	0.067	0.156	0.089	—
77.64–80.47	0.195	0.457	0.116	0.116	0.093	0.023
80.55–95.87	0.134	0.289	0.11	0.044	0.378	0.044
Antimony						
0.0468–0.236	0.387	0.432	0.091	—	0.091	—
0.240–0.270	0.532	0.312	0.089	0.022	0.045	—

Table B.1. Continued.

	Cluster1	Cluster2	Cluster3	Cluster4	Cluster5	Cluster6
0.274–0.305	0.258	0.355	0.114	0.023	0.250	—
0.306–0.368	0.156	0.179	0.266	0.133	0.2	0.067
0.369–3.503	0.112	0.161	0.137	0.500	0.045	0.046
Scandium						
3.633–6.355	—	0.251	0.340	0.068	0.250	0.091
6.365–6.891	0.089	0.355	0.244	0.111	0.2	—
6.894–7.358	0.157	0.456	0.068	0.227	0.091	—
7.364–7.920	0.498	0.236	0.044	0.133	0.089	—
7.942–9.451	0.703	0.139	—	0.136	—	0.023
Strontium						
80.13–148.9	0.091	0.273	0.137	0.227	0.250	0.023
149.6–172.2	0.198	0.203	0.243	0.133	0.178	0.044
172.3–184.5	0.146	0.286	0.182	0.204	0.159	0.023
185.0–210.8	0.334	0.444	0.089	0.089	0.045	—
211.5–338.1	0.679	0.230	0.046	0.023	—	0.023
Tantalum						
0.715–1.859	0.296	0.501	0.022	0.068	—	0.114
1.861–2.179	0.496	0.304	0.067	0.133	—	—
2.180–2.489	0.316	0.275	0.091	0.273	0.045	—
2.514–2.841	0.222	0.311	0.311	0.133	0.022	—
2.855–4.140	0.114	0.045	0.205	0.068	0.568	—
Terbium						
0.349–0.638	—	0.160	0.590	—	0.159	0.091
0.641–0.763	0.001	0.658	0.091	0.068	0.159	0.023
0.768–0.851	0.384	0.416	0.022	0.111	0.067	—
0.852–0.967	0.421	0.202	—	0.267	0.111	—
0.973–1.655	0.636	0.000	—	0.227	0.136	—
Thorium						
7.743–34.80	0.068	0.182	0.023	0.568	0.046	0.114
34.82–36.82	0.408	0.437	0.067	0.022	0.066	—
36.82–38.39	0.341	0.456	0.113	0.068	0.023	—
38.40–41.36	0.509	0.247	0.178	0.022	0.044	—
41.48–47.37	0.114	0.114	0.318	—	0.455	—

Table B.1. Continued.

	Cluster1	Cluster2	Cluster3	Cluster4	Cluster5	Cluster6
Zinc						
44.91–73.49	—	0.159	0.001	0.227	0.522	0.091
74.33–81.67	0.131	0.27	0.243	0.267	0.089	—
81.69–86.82	0.158	0.478	0.25	0.114	0.000	—
86.99–92.73	0.387	0.324	0.2	0.067	—	0.022
93.15–135.5	0.772	0.205	—	—	0.023	—
Zirconium						
73.01–174.2	0.023	0.091	0.046	0.205	0.523	0.114
174.9–198.9	0.089	0.356	0.2	0.267	0.089	—
199.1–212.5	0.273	0.365	0.272	0.091	—	—
212.9–237.0	0.319	0.437	0.111	0.111	0.022	—
237.3–321.6	0.747	0.184	0.068	—	—	—
Aluminum						
6e+004–1e+005	0.159	0.295	0.023	0.409	—	0.114
1e+005–1e+005	0.354	0.447	0.044	0.133	0.022	—
1e+005–1e+005	0.340	0.342	0.136	0.091	0.091	—
1e+005–1e+005	0.341	0.237	0.156	—	0.267	—
1e+005–1e+005	0.250	0.114	0.341	0.046	0.25	—
Barium						
542.6–958.5	0.046	—	0.023	0.5	0.318	0.114
959.2–1150	0.267	0.178	0.178	0.133	0.245	—
1158–1287	0.317	0.434	0.158	0.046	0.046	—
1288–1400	0.466	0.423	0.111	—	—	—
1400–2036	0.348	0.402	0.227	—	0.023	—
Calcium						
1954–9322	0.160	0.158	0.273	—	0.409	—
9489–1e+004	0.384	0.261	0.199	—	0.156	—
1e+004–2e+004	0.296	0.432	0.137	0.068	0.068	—
2e+004–3e+004	0.422	0.444	0.089	0.045	—	—
3e+004–1e+005	0.180	0.139	—	0.568	—	0.114
Dysprosium						
1.439–2.749	0.023	0.160	0.568	—	0.159	0.091
2.763–3.220	0.111	0.622	0.111	0.045	0.089	0.022

Table B.1. Continued.

	Cluster1	Cluster2	Cluster3	Cluster4	Cluster5	Cluster6
3.230–3.558	0.407	0.389	0.023	0.068	0.114	—
3.559–4.185	0.408	0.237	—	0.222	0.134	—
4.200–6.800	0.500	0.023	—	0.341	0.136	—
Potassium						
2e+004–2e+004	0.364	0.023	0.159	0.364	0.023	0.068
2e+004–3e+004	0.398	0.268	0.111	0.178	—	0.044
3e+004–3e+004	0.327	0.355	0.160	0.068	0.090	—
3e+004–3e+004	0.243	0.358	0.222	0.044	0.134	—
3e+004–4e+004	0.114	0.432	0.044	0.023	0.387	—
Manganese						
89.38–119.6	0.159	0.068	0.228	—	0.545	—
120.9–130.8	0.355	0.357	0.132	0.089	0.067	—
130.8–139.9	0.408	0.365	0.114	0.091	0.023	—
140.1–148.7	0.421	0.290	0.089	0.200	—	—
148.7–347.9	0.099	0.356	0.136	0.296	—	0.114
Sodium						
1168–3620	0.339	0.161	0.182	0.205	—	0.114
3622–4035	0.365	0.191	0.178	0.156	0.111	—
4044–4353	0.431	0.297	0.182	0.068	0.023	—
4364–4896	0.178	0.334	0.110	0.156	0.222	—
4902–8542	0.134	0.456	0.046	0.091	0.272	—
Titanium						
2149–3624	0.114	0.045	0.046	0.159	0.522	0.114
3625–4046	0.289	0.222	0.178	0.267	0.045	—
4051–4360	0.408	0.252	0.203	0.114	0.023	—
4360–4619	0.354	0.424	0.111	0.067	0.045	—
4620–5623	0.281	0.492	0.159	0.068	—	—
Vanadium						
15.22–29.51	0.248	0.184	0.114	0.091	0.363	—
29.73–33.23	0.133	0.333	0.267	0.089	0.156	0.022
33.38–35.90	0.290	0.333	0.133	0.178	0.067	—
35.99–38.05	0.386	0.434	0.067	0.114	—	—
38.14–72.26	0.394	0.152	0.114	0.205	0.046	0.091

Appendix C

Radiocarbon and Tree Ring Dates from Archaeological Sites in the Parowan Valley, Utah

Table C.1. Radiocarbon Dates from Archaeological Sites in the Parowan Valley.Dates Provided by the Office of Public Archaeology at BYU (PVAP 2013).

Site	Provenience	Sample No.	Conventional Date	Calibrated Date (2σ)	Material Tested	Reference
Summit (42IN40)	Structure 12	PRI-07-58-395-4712	970±20 B.P.	A.D. 1010–1060; A.D. 1070–1160	Corn cob	PVAP 2013
	Structure 1	PRI-07-58-283-3101	965±20 B.P.	A.D. 1010–1060; A.D. 1070–1160	Corn cob	PVAP 2013
	Structure 18	PRI-07-58-509-3236	945±20 B.P.	A.D. 1020–1160	Corn cob	PVAP 2013
	Structure 3	PRI-07-58-365-2814	990±20 B.P.	A.D. 990–1050; A.D. 1080–1150	Corn cob	PVAP 2013
	Pit Dwelling A7	UGa-2713	1825±60 B.P.	A.D. 59–346; A.D. 373–376	Unknown	Dodd, 1982
	Structure 14	GX-1549	1295±90 B.P.	A.D. 596–900; A.D. 918–965	Charcoal	Marwitt, 1970
	Pit Dwelling B2	RL-237	1190±90 B.P.	A.D. 615–1025	Unknown	Dodd, 1982
	Pit Dwelling A1	RL-236	1050±90 B.P.	A.D. 780–1210	Wood	Dodd, 1982
	Pit Dwelling 1	GX-2405	940±90 B.P.	A.D. 895–1255	Unknown	Berry 1972
	Pit Dwelling 11	GX-2407	870±90 B.P.	A.D. 920–1290	Charred Beam	Berry 1972
	Grid 17-A-23	GX-1550	855±90 B.P.	A.D. 1016–1289	Charred corn cobs	Marwitt, 1970
	Pit Dwelling 3	GX-2404	830±80 B.P.	A.D. 1025–1325	Charred Beam	Berry 1972
	Pit Dwelling 2	GX-2406	775±90 B.P.	A.D. 1048–1344	Charred Beam	Berry 1972
	Pit Dwelling 6	GX-2403	595±90 B.P.	A.D. 1248–1428	Charred Beam	Berry 1972
	Structure 2	GaK-2114	1050±90 B.P.	A.D. 774–1185	Charred wood	Marwitt, 1970
	Structure 8	GaK-2115	1020±90 B.P.	A.D. 782–789; A.D. 810–847; A.D. 855–1215	Charred wood	Marwitt, 1970
	Structure 9	GaK-2116	990±100 B.P.	A.D. 784–787; A.D. 825–841; A.D. 862–1259	Charred wood	Marwitt, 1970
	Structure 9	GaK-2117	500±80 B.P.	A.D. 1291–1523; A.D. 1572–1629	Charred wood	Marwitt, 1970
Paragonah (42IN43)	Structure 38	Beta-171936	1120±40 B.P.	A.D. 810–840; 860–1000	Charred corn cobs	PVAP 2013
	Structure 19	Beta-171932	1040±40 B.P.	A.D. 910–920; 960–1030	Charred corn cobs and kernels	PVAP 2013
	Structure 13	Beta-171928	1030±40 B.P.	A.D. 960–1040	Charred corn cobs and kernels	PVAP 2013
	Structure 15	Beta-171930	990±60 B.P.	A.D. 960–1180	Charred corn cobs	PVAP 2013

Table C.1. Continued.

Site	Provenience	Sample No.	Conventional Date	Calibrated Date (2σ)	Material Tested	Reference
Paragonah (42IN43) cont.	Structure 27	Beta-171934	970±40 B.P.	A.D. 1000–1170	Charred corn cobs	PVAP 2013
	Structure 8	Beta-171925	960±40 B.P.	A.D. 1000–1180	Charred corn cobs	PVAP 2013
	Structure 12	Beta-171927	960±40 B.P.	A.D. 1000–1180	Charred corn kernels	PVAP 2013
	Structure 28	Beta-171935	940±40 B.P.	A.D. 1010–1190	Charred corn cobs	PVAP 2013
	Structure 14	Beta-171929	920±60 B.P.	A.D. 970–1280	Corn cobs	PVAP 2013
	Structure 22	Beta-171933	920±40 B.P.	A.D. 1020–1210	Charred corn cobs	PVAP 2013
	Structure 17	Beta-171931	910±40 B.P.	A.D. 1020–1220	Charred corn cobs and kernels	PVAP 2013
	Structure 10	Beta-171926	900±90 B.P.	A.D. 980–1280	Charred corn cobs	PVAP 2013
Parowan (42IN100)	Structure 8	GX-1547	1005±80 B.P.	A.D. 878–1218	Charred wood	Marwitt, 1970
	Structure 10	PRI-07-58-433-9688	1005±20 B.P.	A.D. 980–1050 and A.D. 1100–1120	Corn cob	PVAP 2013
	Structure 4	PRI-07-58-433-9646	990±20 B.P.	A.D. 990–1050 and A.D. 1080–1150	Corn cob	PVAP 2013
	Structure 7	PRI-07-58-433-7825	985±20 B.P.	A.D. 990–1050 and A.D. 1080–1160	Corn cob	PVAP 2013
	Structure 12	PRI-07-58-433-8266	960±20 B.P.	A.D. 1020–1060 and A.D. 1070–1160	Corn cob	PVAP 2013
	Feature 2 (E16)	GX-1548	700±80 B.P.	A.D. 1178–1413	Charcoal	Marwitt, 1970
42IN2262	Burial	Beta-222448	990±40 B.P.	A.D. 990–1160	Bone collagen extraction	PVAP 2013

Table C.2. Tree-Ring Dates from Archaeological Sites in the Parowan Valley. Dates Provided by the Office of Public Archaeology at BYU (PVAP 2013).

Site	Structure	Date	Sample No.	Reference
Paragonah (42IN43)	Structure 15	A.D. 1157 (tree dying when felled)	UTM 117	PVAP 2013
	Structure 15	March–May A.D. 1168	UTM 118	PVAP 2013
	Structure 15	May A.D. 1174–March A.D. 1175	UTM 119	PVAP 2013
	Structure 16	Unknown number of years after A.D. 1108	UTM 120	PVAP 2013
	Structure 30	May A.D. 1108	UTM 122	PVAP 2013
	Structure 30	May A.D. 1108	UTM 123	PVAP 2013
	Structure 31	May A.D. 1137–March A.D. 1138	UTM 124	PVAP 2013

Appendix D

Chemical Counts

Table D.1. Counts in PPM by Chemical for Each Ceramic Sherd in this Analysis (As–Rb).

Id No.	As	La	Lu	Nd	Sm	U	Yb	Ce	Co	Cr	Cs	Eu	Fe	Hf	Ni	Rb
001	10.371	92.429	0.107	70.326	11.205	1.713	0.790	213.878	4.423	13.473	77.927	2.135	32242.8	10.596	46.70	80.42
002	12.677	84.021	0.078	66.877	11.901	1.391	0.882	179.679	4.805	12.982	49.621	2.097	32184.2	10.168	26.01	68.06
003	14.146	86.329	0.088	66.936	12.124	1.250	0.936	184.986	4.816	12.796	49.557	2.105	32296.9	10.265	29.76	67.14
004	15.108	93.287	0.068	69.739	12.081	1.806	0.708	219.444	5.220	11.138	57.455	2.153	33660.4	12.571	39.13	63.06
005	13.708	87.418	0.055	66.593	11.590	2.217	0.809	181.409	4.509	11.506	63.627	2.170	30542.9	11.006	34.65	74.17
006	8.848	83.392	0.067	63.072	10.871	1.622	0.836	177.616	4.478	11.113	53.478	2.021	28344.3	10.177	26.87	71.00
007	14.955	93.290	0.089	71.534	11.842	1.895	0.928	205.276	4.590	12.167	64.812	2.264	28366.4	10.210	40.84	69.32
008	10.074	97.426	0.092	71.837	11.916	1.972	0.764	274.190	4.648	15.202	60.475	2.323	26691.3	9.256	28.27	74.14
009	12.206	78.347	0.046	63.138	12.094	1.656	0.667	157.979	3.059	7.944	20.039	1.985	27109.0	8.327	0.00	70.14
010	15.210	73.849	0.191	59.047	11.263	2.327	2.071	139.722	3.279	15.961	26.162	1.863	25718.0	9.063	14.31	62.89
011	5.713	96.559	0.082	75.108	12.335	0.955	0.832	178.992	5.003	10.912	58.459	2.388	29214.0	9.456	33.95	72.13
012	6.176	117.737	0.107	84.693	13.986	2.934	0.860	251.292	5.020	13.390	56.742	2.655	27166.5	11.052	34.56	75.77
013	8.301	86.357	0.080	69.198	12.507	2.387	0.747	160.844	3.418	9.429	51.882	2.011	29306.3	8.526	22.73	89.08
014	8.982	60.016	0.165	50.131	9.781	1.731	1.324	127.299	3.211	19.359	42.322	1.782	28061.9	10.217	0.00	85.63
015	21.319	49.788	0.029	39.318	6.439	3.809	0.525	130.591	3.486	8.250	54.100	1.227	27329.1	6.711	28.36	75.52
016	7.140	96.396	0.135	79.831	13.222	1.996	1.343	220.272	4.871	14.729	54.797	2.243	28201.2	9.357	45.54	73.14
017	9.224	68.427	0.054	54.811	10.552	2.795	0.649	137.621	2.744	6.689	31.472	1.735	26748.4	8.362	0.00	81.56
018	10.104	83.180	0.089	61.293	10.160	2.085	0.721	217.313	4.315	10.752	78.504	2.006	30980.2	10.376	31.16	80.32
019	5.263	112.411	0.090	82.601	13.382	1.473	0.832	264.939	4.870	12.810	57.107	2.544	27309.0	8.511	32.97	74.10
020	13.231	111.373	0.145	86.550	15.743	1.837	1.378	205.520	4.160	10.933	51.482	2.626	27238.1	9.040	47.21	68.28
021	29.366	85.780	0.087	64.597	11.428	1.896	0.937	185.064	3.861	14.638	44.533	1.987	28701.2	9.601	38.58	62.15
022	7.580	100.404	0.091	74.408	12.969	0.848	0.956	246.895	4.064	13.998	41.026	2.461	25444.5	7.900	34.84	66.88
023	9.436	111.916	0.075	85.352	14.741	1.919	0.686	234.539	4.983	11.337	57.504	2.469	32536.7	11.280	33.11	71.29

Table D.1. Continued.

Id No.	As	La	Lu	Nd	Sm	U	Yb	Ce	Co	Cr	Cs	Eu	Fe	Hf	Ni	Rb
024	15.073	86.228	0.061	68.162	11.870	0.805	0.740	186.299	3.926	10.571	32.528	1.986	28466.9	8.854	22.10	68.80
025	11.903	52.865	0.066	41.425	7.496	3.150	0.821	133.771	3.235	9.583	57.494	1.403	25007.4	7.508	33.60	86.63
026	6.748	80.794	0.138	59.359	10.320	0.843	1.367	143.892	3.780	12.515	40.819	2.102	23119.6	6.784	0.00	65.23
027	11.834	88.433	0.053	73.977	13.714	0.000	0.690	182.114	2.729	6.715	33.093	2.179	28175.0	9.410	0.00	79.58
028	6.759	112.685	0.087	82.087	13.463	1.756	0.885	248.270	5.036	12.929	55.721	2.500	26995.4	9.215	26.47	71.04
029	7.428	86.026	0.073	65.972	10.533	2.007	0.800	198.967	3.708	10.819	60.556	2.099	24401.2	8.676	24.45	77.47
030	9.460	59.727	0.085	46.773	7.819	2.121	0.617	130.390	6.211	6.834	67.296	1.570	34531.1	9.869	29.42	68.32
031	3.915	111.268	0.104	82.673	13.460	1.877	0.975	299.806	4.552	12.066	56.630	2.601	25393.6	9.910	20.62	69.89
032	2.826	111.562	0.121	83.794	13.594	1.884	1.019	287.988	4.872	12.962	56.562	2.566	25545.4	11.872	34.94	74.04
033	5.517	72.363	0.082	57.120	9.840	1.982	0.845	170.735	3.581	9.106	60.722	1.810	27655.9	9.015	24.23	80.23
034	7.503	93.500	0.118	74.088	12.963	1.954	1.075	236.187	4.628	14.623	58.395	2.309	26799.8	10.326	26.58	81.35
035	4.595	114.800	0.082	87.755	13.628	1.204	0.877	254.007	4.812	11.800	54.851	2.508	26367.3	9.493	42.72	69.80
036	9.876	99.688	0.082	78.107	12.631	1.378	0.790	212.379	5.017	10.964	71.680	2.365	29292.9	11.626	0.00	73.29
037	3.286	111.921	0.096	83.350	13.663	2.021	0.969	310.408	4.591	11.813	61.190	2.892	24634.0	8.127	41.97	79.76
038	5.814	111.026	0.094	81.219	13.249	2.230	0.833	248.518	4.944	12.752	54.886	2.521	26691.7	9.414	24.51	71.98
039	6.333	93.479	0.088	70.035	11.833	2.112	1.006	236.235	4.495	11.179	50.472	2.230	25269.7	9.901	37.04	70.96
040	9.325	102.792	0.110	77.800	12.449	2.056	1.012	210.069	4.149	12.585	62.462	2.327	26760.6	11.644	32.02	68.17
041	15.200	70.818	0.128	52.592	9.751	2.022	1.249	148.505	4.041	13.630	52.852	1.777	25834.1	8.001	22.81	71.94
042	17.668	100.901	0.063	74.567	12.805	1.922	0.884	230.075	4.956	10.302	69.785	2.403	29033.6	10.249	44.47	70.89
043	4.059	108.387	0.079	80.315	12.999	1.911	0.834	237.711	4.883	11.637	55.675	2.465	26865.2	8.628	36.86	72.33
044	7.323	96.328	0.123	76.906	13.229	1.249	1.276	230.894	5.110	15.427	54.745	2.324	28751.5	9.903	38.00	75.90
045	5.858	99.600	0.143	80.515	13.605	2.321	1.383	240.365	4.969	15.302	55.355	2.313	28501.0	10.934	39.64	72.24
046	9.024	89.738	0.093	70.815	11.640	2.299	0.824	276.405	4.007	11.512	71.812	2.229	26018.3	9.433	27.28	79.38

Table D.1. Continued.

Id No.	As	La	Lu	Nd	Sm	U	Yb	Ce	Co	Cr	Cs	Eu	Fe	Hf	Ni	Rb
047	15.972	56.052	0.120	45.355	9.297	2.316	1.267	117.520	2.991	17.637	35.811	1.666	26043.7	9.140	0.00	75.10
048	8.662	74.120	0.100	62.630	10.655	1.899	0.951	193.193	4.302	10.325	61.804	1.998	27982.1	9.456	34.77	77.68
049	9.335	86.241	0.068	66.458	11.559	2.119	0.643	221.465	4.255	10.337	36.292	1.872	28807.8	9.519	47.66	62.75
050	4.403	110.301	0.084	82.043	13.091	2.597	0.767	232.097	4.533	12.188	78.958	2.505	28269.0	10.508	30.80	80.55
051	12.922	73.837	0.062	54.684	9.169	2.100	0.722	152.135	3.783	13.011	58.829	1.739	28055.0	8.558	24.18	74.10
052	11.203	53.400	0.064	40.563	6.678	2.495	0.640	119.081	3.813	12.947	67.716	1.392	27169.7	7.287	36.64	83.49
053	7.416	72.760	0.066	55.356	9.238	2.019	0.740	209.416	4.943	17.252	67.450	1.861	32106.4	10.595	38.86	78.90
054	9.765	93.289	0.067	67.880	12.415	0.285	0.760	217.312	4.069	10.984	38.167	2.063	29120.6	10.110	42.50	66.44
055	11.712	69.363	0.073	54.062	9.930	1.915	0.783	166.966	4.696	8.623	63.563	1.907	30001.6	9.460	0.00	80.88
056	5.312	71.063	0.117	60.654	10.528	1.298	0.755	161.782	5.166	7.611	41.208	2.056	32299.9	11.201	29.15	64.41
057	7.017	76.922	0.071	60.648	10.789	1.541	0.691	166.819	5.592	8.673	59.815	2.072	32585.2	10.596	0.00	71.66
058	6.940	95.269	0.066	69.774	10.958	1.247	0.696	228.108	4.290	11.670	78.088	2.182	25099.3	9.770	34.57	83.02
059	7.384	93.328	0.147	69.037	12.702	1.039	1.411	200.501	4.837	13.831	52.213	2.304	26590.3	9.446	45.68	74.50
060	16.645	105.167	0.104	77.365	14.610	2.569	0.968	220.867	4.505	14.678	58.447	2.519	33985.0	12.237	38.02	72.83
061	14.049	77.382	0.054	55.457	9.790	2.862	0.741	224.413	4.309	10.193	59.084	1.873	31175.9	10.769	35.03	72.98
062	12.618	73.949	0.067	53.820	8.782	2.477	0.680	197.250	4.072	9.562	58.210	1.718	32370.0	10.307	29.46	72.38
063	14.973	59.825	0.128	46.623	9.132	2.296	1.178	117.848	3.552	16.195	30.185	1.805	19681.2	6.989	31.14	70.91
064	7.177	116.812	0.089	85.727	14.269	1.706	0.964	291.610	4.150	14.100	64.390	2.704	26643.6	11.299	56.78	78.28
065	13.133	87.403	0.097	64.408	11.377	1.422	0.967	197.806	4.430	13.444	68.399	2.155	29745.3	11.692	37.35	75.19
066	10.505	72.067	0.074	55.868	9.845	2.148	0.775	177.812	4.784	10.181	75.359	1.941	30369.7	12.160	48.75	81.28
067	19.343	25.111	0.229	19.177	3.944	2.333	1.586	47.156	6.950	55.352	9.840	0.767	25586.8	2.833	27.02	71.09
068	5.845	100.607	0.079	75.443	12.021	1.801	0.766	193.647	4.258	12.901	65.466	2.377	24609.2	8.936	29.09	87.34
069	21.385	61.592	0.151	46.167	9.854	2.038	1.289	129.058	2.945	20.265	32.988	1.800	26174.2	10.007	0.00	72.28
070	8.336	101.475	0.092	77.349	12.015	2.123	0.811	189.808	4.282	12.928	66.207	2.373	25329.1	10.428	0.00	85.34

Table D.1. Continued.

Id No.	As	La	Lu	Nd	Sm	U	Yb	Ce	Co	Cr	Cs	Eu	Fe	Hf	Ni	Rb
071	9.779	73.932	0.076	58.687	11.242	2.646	0.863	150.431	2.809	7.538	30.758	1.914	28113.3	10.069	28.43	83.10
072	8.645	86.821	0.110	67.174	12.997	1.927	1.192	220.128	4.120	10.258	62.558	2.251	27042.5	9.301	25.48	83.08
073	12.355	71.418	0.098	52.061	9.346	2.317	1.000	160.173	4.846	16.558	80.234	1.931	26319.9	8.717	36.95	80.58
074	7.147	100.626	0.077	74.836	11.860	1.627	0.697	189.053	4.209	11.987	60.582	2.341	24382.7	8.016	33.27	82.89
075	17.428	73.800	0.066	55.292	9.649	3.093	0.767	230.023	3.635	9.465	52.793	1.812	32349.2	10.920	19.50	76.92
076	11.353	82.741	0.067	59.804	10.113	2.549	0.867	212.472	4.681	15.363	74.898	2.014	31410.7	10.247	39.38	85.23
077	16.203	102.820	0.076	76.550	13.473	2.617	0.751	214.431	4.763	12.733	64.924	2.664	28955.0	10.354	46.97	75.78
078	16.691	101.873	0.090	76.341	13.328	1.932	0.875	218.124	4.910	12.160	65.436	2.617	29006.0	10.087	36.53	76.71
079	11.742	86.618	0.099	63.998	11.074	2.093	0.881	236.289	4.350	14.451	68.587	2.212	26900.5	10.466	0.00	78.43
080	13.671	84.510	0.061	61.725	10.127	1.733	0.656	204.520	4.829	12.093	63.336	1.787	32143.6	11.126	44.13	65.46
081	14.684	98.320	0.098	71.989	13.032	1.699	0.772	207.201	4.700	12.040	58.919	2.542	28453.6	10.163	31.83	73.60
082	8.945	88.449	0.087	68.987	12.331	1.126	0.689	183.334	4.249	10.745	47.376	2.131	27696.4	9.766	38.26	82.49
083	13.252	79.892	0.070	64.330	12.209	2.408	0.669	164.606	2.766	6.018	31.939	2.002	27764.8	8.860	0.00	82.54
084	25.490	75.682	0.068	57.207	9.458	2.250	0.740	196.225	3.941	14.020	45.587	1.756	32008.0	9.672	47.53	67.07
085	12.743	99.802	0.082	75.612	14.695	2.609	0.780	209.652	3.395	8.884	36.179	2.415	29498.0	10.488	39.95	80.55
086	5.547	87.530	0.120	66.596	10.798	0.693	0.924	189.916	4.544	14.860	55.827	2.285	25148.0	8.243	31.19	76.95
087	11.137	87.311	0.072	66.240	11.340	1.827	0.955	195.438	4.693	11.964	79.674	2.226	30196.7	11.679	38.26	79.11
088	15.299	81.265	0.142	59.536	11.305	2.094	1.283	165.382	3.954	17.027	59.696	2.081	29138.7	10.081	33.81	75.65
089	6.500	93.401	0.097	65.818	11.488	1.313	0.833	213.991	4.618	12.450	42.648	2.365	23363.3	7.738	36.67	71.40
090	13.706	81.389	0.057	65.754	12.416	1.746	0.588	165.044	2.716	6.988	32.612	2.039	27951.1	9.759	27.72	81.99
091	12.644	77.874	0.109	63.421	11.830	2.480	0.924	189.980	3.929	11.728	47.312	2.050	27448.3	8.758	37.13	75.13
092	14.390	68.683	0.061	53.094	8.268	4.057	0.727	186.412	4.037	10.909	52.786	1.651	30686.0	10.081	32.73	75.71
093	15.189	77.087	0.063	55.473	9.535	3.419	0.767	208.247	4.111	11.354	49.105	1.737	30292.4	9.746	24.17	68.02

Table D.1. Continued.

Id No.	As	La	Lu	Nd	Sm	U	Yb	Ce	Co	Cr	Cs	Eu	Fe	Hf	Ni	Rb
094	10.164	80.033	0.093	61.746	9.824	1.865	0.738	224.717	4.673	12.275	79.993	1.975	29768.5	11.486	0.00	85.52
095	17.639	72.826	0.157	54.341	8.994	2.771	0.783	183.120	4.177	14.200	62.710	1.743	31449.6	10.509	41.12	78.03
096	8.883	99.500	0.076	74.493	12.814	2.333	0.740	230.712	4.579	11.008	74.710	2.350	29938.6	11.279	40.97	74.44
097	16.875	92.512	0.068	71.995	11.092	4.455	0.756	197.148	4.948	11.434	63.244	2.025	36748.0	13.111	42.87	64.54
098	8.155	68.203	0.057	57.883	10.748	2.002	0.612	139.334	2.044	5.293	29.877	1.791	24303.1	8.578	10.25	90.83
099	12.797	114.246	0.098	90.566	15.072	1.053	0.888	234.245	4.489	12.095	53.333	2.509	30076.9	11.287	24.86	58.04
100	8.797	90.323	0.073	67.650	11.742	2.625	0.914	206.859	4.742	12.071	78.486	2.240	30315.0	10.210	57.58	78.63
101	23.524	70.625	0.079	52.308	8.779	2.609	0.800	172.578	4.127	13.157	48.226	1.707	32072.3	10.640	31.42	69.38
102	10.416	102.869	0.070	78.188	13.344	2.027	0.829	235.590	5.188	13.475	78.723	2.600	30866.3	11.178	32.63	77.34
103	15.977	96.184	0.092	70.044	12.282	1.978	0.899	242.857	4.544	12.635	73.754	2.405	30883.5	11.818	22.17	75.67
104	17.822	81.459	0.113	63.510	10.772	2.077	0.862	205.234	4.463	11.046	80.671	2.097	28726.2	10.222	27.07	73.53
105	7.710	88.530	0.083	65.726	11.372	1.748	0.961	274.057	4.330	15.147	68.358	2.303	27848.0	9.658	30.90	80.42
106	16.143	97.043	0.069	74.178	12.514	2.098	0.873	238.228	4.532	11.802	71.948	2.393	30650.6	11.471	18.49	77.09
107	9.365	93.055	0.132	73.102	12.918	1.600	1.288	229.186	5.305	14.449	61.225	2.345	29480.2	9.801	28.60	73.39
108	10.445	89.709	0.080	67.350	11.658	1.843	0.766	255.668	4.401	15.554	68.288	2.349	28203.4	9.887	0.00	80.17
109	10.403	111.292	0.110	86.580	16.528	1.869	1.354	236.062	4.208	14.699	37.844	2.688	33450.0	12.407	32.48	68.38
110	14.571	92.499	0.133	74.137	13.162	1.213	1.115	209.892	4.709	12.875	53.578	2.277	30504.0	9.837	35.84	76.75
111	16.185	60.831	0.158	47.281	8.053	2.381	1.438	117.155	3.522	29.815	55.957	1.562	27337.8	9.486	0.00	76.89
112	8.049	83.876	0.065	64.060	10.697	1.496	0.671	213.836	4.188	14.115	65.480	2.083	25669.0	9.111	33.72	76.08
113	19.185	50.563	0.049	38.310	6.886	2.637	0.555	134.755	3.538	9.659	42.544	1.390	27232.3	8.416	0.00	74.01
114	10.704	80.624	0.155	63.372	11.490	1.871	1.335	182.131	3.896	16.582	55.825	2.076	28260.0	10.634	18.71	78.82
115	7.841	93.636	0.130	74.232	13.134	1.297	1.329	220.886	5.349	14.011	62.182	2.345	29888.5	10.302	26.93	74.81
116	5.442	93.018	0.079	67.213	11.786	1.377	0.908	217.797	4.738	12.222	56.269	2.371	27828.8	8.871	39.86	70.58

Table D.1. Continued.

Id No.	As	La	Lu	Nd	Sm	U	Yb	Ce	Co	Cr	Cs	Eu	Fe	Hf	Ni	Rb
117	11.439	58.971	0.169	47.387	8.559	1.719	1.054	130.562	4.165	16.174	51.583	1.609	26855.3	8.744	0.00	79.76
118	6.661	94.080	0.153	73.998	13.273	2.199	1.290	256.318	5.090	13.489	63.405	2.340	29149.3	10.345	0.00	71.08
119	16.232	73.780	0.072	57.300	9.114	1.945	0.828	199.319	4.477	12.327	52.342	1.867	28768.5	9.769	0.00	80.18
120	7.551	93.826	0.137	76.505	13.330	1.952	1.328	235.509	4.721	14.740	68.427	2.462	24237.6	8.271	48.26	84.03
121	8.657	85.498	0.096	67.808	11.160	1.552	0.840	193.816	4.549	10.549	76.590	2.154	30741.9	11.802	28.19	76.44
122	7.539	75.553	0.080	63.887	11.244	2.097	0.898	178.078	5.539	9.149	55.323	2.056	33139.7	10.672	30.76	68.08
123	9.508	84.440	0.102	66.970	10.878	1.802	0.956	231.854	4.524	15.185	66.823	2.192	27368.5	10.676	29.88	77.63
124	19.215	70.268	0.165	54.946	8.649	2.176	0.677	175.922	4.073	13.685	52.423	1.694	31843.1	9.927	28.97	68.98
125	15.513	65.646	0.132	52.517	9.159	1.414	1.333	133.502	3.287	18.063	33.937	1.764	22653.3	7.563	0.00	73.68
126	14.925	81.231	0.131	63.204	11.379	1.973	1.006	174.296	4.115	14.170	63.095	2.081	29289.2	10.196	31.85	72.83
127	18.424	97.598	0.078	76.426	13.071	2.172	0.986	203.403	5.058	12.538	73.280	2.533	31629.9	12.181	34.08	74.20
128	10.505	60.413	0.187	47.619	9.163	1.814	1.477	120.254	3.037	18.375	31.682	1.631	24447.9	8.591	0.00	70.36
129	18.292	67.424	0.111	53.406	9.759	1.838	1.217	162.298	3.424	15.511	47.425	1.822	26367.4	9.442	34.12	74.82
130	20.345	66.845	0.171	51.839	9.940	1.731	1.308	153.331	3.445	15.563	49.560	1.775	26317.0	10.148	32.54	78.86
131	15.317	71.227	0.125	56.392	10.350	1.506	1.206	164.154	3.466	14.861	49.715	1.835	27311.7	8.966	0.00	76.68
132	14.491	63.400	0.114	50.937	9.513	1.783	1.234	147.178	3.416	15.771	47.550	1.727	25814.4	9.291	0.00	78.13
133	9.339	82.305	0.076	62.108	10.577	1.751	0.695	178.177	4.256	16.778	67.629	2.110	29955.7	10.304	0.00	80.25
134	8.347	81.650	0.103	70.281	11.989	0.952	1.060	209.547	4.120	12.018	65.360	2.244	27726.7	9.541	0.00	84.29
135	7.768	79.032	0.101	68.208	11.749	1.634	0.890	213.610	4.014	11.827	66.281	2.144	27148.6	7.837	18.96	82.26
136	3.895	89.108	0.085	74.812	11.864	1.728	0.700	174.805	4.760	10.635	48.734	2.253	29775.9	10.161	29.41	72.11
137	9.615	87.462	0.060	68.452	11.940	1.066	0.703	213.763	4.235	10.362	36.112	1.988	29193.1	9.841	25.83	66.39
138	9.814	74.512	0.067	66.741	11.467	1.355	0.623	155.500	2.603	7.012	31.442	1.954	26615.6	8.767	0.00	80.40
139	7.279	105.572	0.084	82.607	13.318	1.972	0.801	222.864	5.067	12.624	74.086	2.520	30294.8	12.077	31.53	78.32

Table D.1. Continued.

Id No.	As	La	Lu	Nd	Sm	U	Yb	Ce	Co	Cr	Cs	Eu	Fe	Hf	Ni	Rb
140	14.085	72.812	0.048	56.316	8.918	3.725	0.634	200.133	3.924	9.694	55.313	1.677	31577.7	10.903	27.42	72.95
141	9.035	80.743	0.123	67.559	12.190	2.048	1.031	216.342	4.088	13.185	62.003	2.210	27163.6	9.842	0.00	83.08
142	5.880	75.550	0.069	63.750	10.151	1.642	0.700	170.865	3.954	9.841	57.583	1.755	28544.3	10.317	35.23	72.87
143	16.241	90.697	0.157	72.616	13.221	2.132	1.195	189.425	3.495	12.182	28.512	2.212	30884.2	10.035	35.60	69.04
144	12.723	91.638	0.141	73.849	12.271	2.017	1.454	193.894	4.635	15.706	59.644	2.330	29620.3	9.990	35.45	77.64
145	7.937	96.903	0.082	77.128	12.261	2.093	0.830	214.483	4.630	11.684	69.474	2.349	28177.3	10.518	33.34	77.86
146	10.155	75.826	0.148	62.648	10.209	1.877	1.077	193.269	4.621	15.571	66.168	1.981	27437.3	9.618	23.68	79.56
147	7.225	100.492	0.093	78.266	12.596	2.911	0.777	239.755	4.787	12.829	69.687	2.461	28696.3	11.130	20.94	80.88
148	5.768	89.288	0.082	72.536	10.796	2.632	0.745	260.560	4.285	15.110	60.700	2.087	30231.7	9.933	35.72	74.25
149	12.532	91.363	0.076	73.847	12.825	2.192	0.794	214.986	5.342	10.630	64.425	2.314	32356.1	12.561	0.00	71.41
150	7.668	99.544	0.090	79.184	12.547	2.630	0.819	227.702	4.583	12.121	68.044	2.439	27853.6	9.488	24.50	78.66
151	8.510	100.023	0.057	74.591	12.019	1.945	0.761	213.505	4.275	11.795	60.764	2.166	32169.7	10.920	20.55	70.29
152	6.914	88.626	0.086	68.445	11.309	1.929	0.721	209.199	4.744	10.654	77.792	2.142	32098.8	12.990	38.47	78.21
153	8.573	109.119	0.088	78.638	13.022	1.704	0.882	272.066	4.356	15.986	63.298	2.456	28036.7	12.280	29.34	80.71
154	8.675	104.236	0.081	72.085	12.329	1.638	0.797	244.810	4.237	14.309	68.752	2.486	27228.7	11.409	42.93	82.68
155	13.683	55.627	0.156	41.669	8.927	1.767	1.211	115.687	3.438	19.236	37.218	1.668	25704.0	9.383	0.00	75.81
156	10.803	90.587	0.082	69.362	11.225	1.648	0.743	222.979	4.878	12.141	98.941	2.309	31440.3	10.918	0.00	91.59
157	9.397	64.915	0.131	47.648	9.013	1.771	1.046	139.226	3.653	11.968	53.114	1.720	26905.0	8.107	22.96	78.86
158	9.888	98.369	0.066	79.461	15.097	1.749	0.635	213.262	3.215	7.294	28.391	2.446	29856.0	9.466	0.00	74.62
159	23.465	77.243	0.062	57.119	9.418	3.248	0.694	185.906	4.323	12.535	43.948	1.777	33545.3	10.324	33.98	66.25
160	16.744	42.226	0.065	32.879	5.824	3.224	0.431	83.583	2.561	6.943	51.378	1.222	26235.0	6.678	0.00	85.43
161	14.130	85.974	0.142	68.656	12.606	1.295	1.131	187.271	4.717	14.065	54.675	2.135	27021.8	9.945	30.90	77.72
162	9.132	76.701	0.055	60.778	11.072	2.365	0.712	147.410	2.762	7.440	56.835	1.909	28670.8	8.199	0.00	95.87

Table D.1. Continued.

Id No.	As	La	Lu	Nd	Sm	U	Yb	Ce	Co	Cr	Cs	Eu	Fe	Hf	Ni	Rb
163	12.945	57.933	0.045	49.434	9.102	1.960	0.543	121.526	2.193	5.771	37.755	1.534	25915.9	8.205	0.00	90.44
164	11.740	79.539	0.119	58.549	9.527	2.215	0.854	247.972	3.991	12.909	64.569	1.950	27900.6	10.053	34.32	81.52
165	15.862	88.688	0.071	66.916	11.583	1.779	0.909	186.435	5.076	12.141	68.722	2.246	29618.9	10.737	39.52	73.35
166	4.623	90.057	0.107	67.013	11.033	1.311	0.969	208.391	4.619	11.080	63.119	2.340	25965.8	7.845	33.18	76.08
167	16.326	83.733	0.083	62.936	10.793	1.840	0.938	189.077	4.331	12.328	70.037	2.139	27671.0	9.875	23.95	72.84
168	7.377	85.517	0.067	67.212	11.942	1.019	0.697	191.472	3.434	8.430	45.913	1.992	29466.3	10.258	30.75	79.72
169	20.209	71.385	0.155	54.517	9.849	1.784	1.250	154.126	3.935	16.468	58.868	1.899	28420.8	10.176	25.87	74.10
170	10.144	97.975	0.071	72.906	12.009	1.188	0.726	212.313	4.419	12.540	52.103	2.330	27030.8	9.267	43.28	70.28
171	11.771	91.151	0.171	70.573	12.703	1.594	1.377	226.658	4.110	13.846	60.983	2.340	23979.0	8.216	37.68	78.52
172	7.945	95.510	0.085	73.065	11.947	1.784	0.950	265.005	4.415	12.689	68.998	2.350	26315.9	10.006	0.00	78.77
173	13.905	69.540	0.049	53.536	8.652	2.730	0.608	164.405	4.092	10.653	55.104	1.642	30254.4	9.875	54.15	74.89
174	12.271	96.557	0.081	72.394	11.750	1.663	0.835	203.117	4.251	13.519	53.826	2.277	26896.6	10.245	34.27	72.96
175	8.502	78.363	0.113	62.264	10.075	1.979	0.920	184.030	4.176	13.772	65.675	2.026	27721.7	9.742	24.99	80.47
176	7.417	93.200	0.110	73.351	11.223	1.964	0.772	291.181	3.924	13.967	65.596	2.345	23519.9	7.947	45.51	86.30
177	14.287	86.397	0.124	65.267	11.223	2.147	0.867	183.523	4.847	11.880	77.772	2.216	29870.5	11.624	32.93	78.04
178	15.202	84.063	0.112	64.288	11.133	1.830	0.921	189.219	4.456	13.749	69.897	2.170	29381.9	10.440	28.07	77.69
179	7.034	74.578	0.065	58.843	10.957	1.773	0.651	139.906	2.723	5.835	54.453	1.787	27444.1	8.296	24.55	91.94
180	15.073	89.999	0.077	69.856	10.971	1.391	0.720	195.354	4.449	12.258	48.943	2.070	27006.4	9.200	39.04	69.16
181	8.625	45.358	0.074	37.363	6.134	4.074	0.644	141.905	3.212	8.454	62.453	1.234	25171.3	6.799	25.59	86.28
182	8.234	87.310	0.120	69.797	12.674	1.611	1.086	213.663	3.762	9.372	57.125	2.181	25893.0	9.919	26.69	83.71
183	4.286	89.437	0.109	68.860	10.745	2.008	0.737	279.568	3.872	13.613	67.294	2.231	24094.6	7.864	26.81	85.55
184	8.239	81.751	0.085	64.425	11.148	2.012	0.832	178.272	4.203	13.068	53.413	1.993	28099.1	9.479	31.22	73.57
185	7.372	86.859	0.084	72.456	12.647	1.436	0.945	175.684	4.162	9.588	57.374	2.160	26437.0	8.494	35.75	82.99

Table D.1. Continued.

Id No.	As	La	Lu	Nd	Sm	U	Yb	Ce	Co	Cr	Cs	Eu	Fe	Hf	Ni	Rb
186	9.018	97.010	0.154	74.045	12.733	2.402	1.235	228.310	4.669	12.898	57.008	2.441	27822.4	8.970	32.61	75.11
187	18.742	70.074	0.122	54.763	8.684	3.642	0.741	174.567	4.233	13.254	60.885	1.667	30623.0	9.639	36.34	73.90
188	8.685	99.390	0.071	74.013	11.752	1.591	0.736	227.759	4.480	13.598	68.369	2.335	27301.2	9.051	31.96	77.52
189	8.223	99.974	0.113	74.792	12.547	2.305	0.959	283.149	4.987	12.688	69.290	2.491	28666.6	10.801	57.31	73.84
190	10.696	98.896	0.075	73.719	11.834	2.185	0.727	227.818	4.927	13.592	67.241	2.315	27160.1	9.554	41.84	81.24
191	8.471	85.766	0.140	69.141	11.438	1.846	0.913	239.289	4.633	12.623	57.863	2.146	23896.7	8.426	33.42	79.30
192	8.664	99.163	0.075	75.466	12.419	1.639	0.783	211.786	4.912	16.105	72.404	2.366	28172.7	10.064	36.97	78.92
193	9.640	80.659	0.096	61.925	10.238	1.705	0.912	173.673	4.459	11.974	80.485	2.068	27324.8	9.288	40.99	80.09
194	11.698	106.892	0.087	80.526	12.684	2.474	0.937	222.495	4.101	11.861	54.539	2.409	26020.7	9.836	33.89	69.90
195	10.148	39.514	0.128	35.560	6.024	1.343	1.208	81.882	3.117	12.257	27.158	1.380	16643.3	4.455	31.23	69.86
196	12.679	95.169	0.111	77.096	14.190	3.410	0.760	201.145	3.576	8.267	33.675	2.334	28614.9	10.752	44.95	76.14
197	13.969	84.535	0.096	64.536	10.168	2.678	0.803	192.430	4.856	15.692	54.160	1.932	31252.6	11.366	33.90	69.03
198	8.878	88.826	0.068	69.255	10.854	1.919	0.669	224.832	4.355	10.613	72.010	2.132	28680.5	10.383	28.64	79.70
199	17.847	67.039	0.114	52.942	8.579	2.801	0.984	183.326	3.650	13.197	44.608	1.625	28553.8	8.544	31.47	68.43
200	12.616	81.949	0.109	69.053	12.276	3.564	0.924	218.022	3.950	11.668	54.190	2.150	27361.8	10.132	32.47	79.07

Table D.2. Counts in PPM by Chemical for Each Ceramic Sherd in this Analysis (Sb–V).

Id	Sb	Sc	Sr	Ta	Tb	Th	Zn	Zr	Al	Ba	Ca	Dy	K	Mn	Na	Ti	V
001	0.264	6.852	146.22	2.403	0.604	38.833	88.95	194.26	136742.5	1257.2	8591.1	2.5	24844.4	127.8	4748.1	4732.1	32.7
002	3.503	7.301	83.41	2.792	0.993	37.908	83.30	192.21	136721.0	977.1	12034.9	4.1	19820.0	179.8	6410.6	4642.4	33.5
003	3.030	7.365	80.13	2.732	0.911	37.688	76.30	183.05	138483.5	998.1	12923.3	3.9	20939.9	178.1	6007.6	3965.5	28.9
004	0.275	9.451	204.39	2.713	0.876	39.161	117.26	240.05	135124.0	1141.4	10560.2	3.2	20732.1	131.5	4338.3	4406.5	32.4
005	0.324	8.107	163.60	2.643	0.725	35.816	91.29	216.25	130539.2	1221.9	12388.4	3.0	27304.1	136.8	5922.0	4459.8	28.6
006	0.266	6.583	119.78	2.389	0.768	36.790	77.60	201.43	129827.1	1022.4	11834.9	3.2	25890.8	161.4	5676.4	3928.7	35.7
007	0.708	7.705	194.31	2.206	0.875	35.268	89.69	191.07	129119.8	1573.4	18191.2	3.3	24561.7	135.7	5022.1	4557.8	35.9
008	0.696	7.330	249.91	1.690	0.775	36.714	93.33	208.17	120445.7	1276.7	15433.9	3.0	29438.8	135.4	6207.2	4551.4	36.2
009	0.335	6.802	136.92	2.925	0.868	43.324	57.36	137.02	130887.4	945.0	5526.2	3.6	32918.1	113.2	5881.0	3783.6	34.5
010	0.411	7.744	165.14	2.418	1.384	28.490	79.07	183.61	111441.0	701.7	53576.8	6.8	20954.4	161.0	3684.7	3565.0	39.5
011	0.257	6.590	169.50	1.889	0.830	37.592	94.48	206.28	126443.8	1251.7	18796.2	3.6	27378.8	159.5	5122.7	4567.6	36.3
012	0.277	7.824	241.51	1.941	0.953	37.841	105.49	251.89	124967.4	1127.0	10591.5	3.9	26664.2	131.7	4287.6	4309.7	37.9
013	0.328	6.894	114.63	3.347	0.894	44.377	54.85	154.51	140588.5	949.4	3214.8	4.2	28884.4	108.6	4629.8	2843.8	28.2
014	0.420	8.170	113.66	2.568	1.020	26.834	87.19	199.72	123147.0	609.1	43887.5	5.0	25153.7	156.6	3951.5	3739.2	34.4
015	0.398	4.042	196.66	3.159	0.375	36.191	73.49	106.96	133428.9	820.1	11743.6	1.8	30160.8	96.6	5315.8	3166.5	25.1
016	0.281	8.026	140.68	1.874	1.035	39.199	90.50	208.10	122813.9	1279.2	21099.6	4.4	25766.9	146.8	4401.3	4014.0	39.8
017	0.276	6.624	173.05	2.927	0.889	44.011	56.10	137.28	131567.5	982.9	5136.3	3.4	31793.0	106.8	6171.2	3086.2	31.6
018	0.213	6.716	186.20	2.180	0.568	36.610	76.37	214.64	139682.5	1608.2	9740.6	2.5	27850.8	131.9	4528.9	4359.9	35.2
019	0.233	7.785	239.57	1.880	0.934	36.825	101.68	201.60	121145.8	1158.7	11245.2	3.5	26995.7	119.6	4343.6	4715.2	35.1
020	0.257	7.830	191.80	2.136	1.408	39.393	97.68	201.33	124742.6	1084.0	29937.3	6.0	25955.7	142.3	4316.1	3802.5	26.4
021	0.700	6.887	185.06	2.454	0.792	34.804	82.86	179.89	120155.3	1099.2	41726.8	3.4	22877.5	146.4	4298.5	4198.4	31.0
022	0.280	6.753	182.07	1.844	0.985	33.161	78.68	191.84	131106.3	1319.5	30412.3	4.2	27032.5	126.3	5177.5	4520.9	34.7
023	0.316	8.740	148.94	2.655	1.024	42.832	94.13	216.89	141216.0	1146.8	9545.9	4.2	22452.9	138.5	3610.9	4396.7	35.9
024	0.386	7.064	169.37	2.425	0.788	38.115	69.53	162.10	127707.0	1113.2	7609.2	3.1	28491.7	126.3	5569.9	4502.1	33.2

Table D.2. Continued.

Id	Sb	Sc	Sr	Ta	Tb	Th	Zn	Zr	Al	Ba	Ca	Dy	K	Mn	Na	Ti	V
025	0.221	5.664	152.68	3.173	0.622	37.623	79.33	153.11	133835.5	826.0	10925.6	2.9	33286.9	112.6	5557.4	3129.2	19.7
026	0.253	6.007	174.33	1.527	0.862	30.308	78.71	143.54	109441.4	1169.9	54133.9	4.1	29133.5	146.3	4200.1	3848.7	32.7
027	0.288	6.894	122.75	3.104	1.032	46.620	52.19	156.30	140521.5	1024.1	4133.3	4.261	28364.5	109.24	3937.5	3034.6	29.02
028	0.242	7.725	274.52	1.913	0.894	37.090	102.84	207.35	119791.8	1130.9	10805.7	3.941	25495.6	123.06	4306.9	4316.2	36.79
029	0.197	5.514	194.97	1.542	0.625	37.548	75.99	188.06	113333.4	1545.7	25559.8	2.601	27527.9	114.52	5434.4	4470.7	33.62
030	0.418	6.322	119.25	2.721	0.496	37.423	85.15	174.86	143015.3	985.2	6283.2	2.467	16062.8	217.49	2493.9	3730.5	33.89
031	0.260	7.081	229.96	1.628	0.937	36.819	88.27	213.19	118609.0	1271.0	14369.2	3.706	26641.6	114.53	4163.9	4099.3	45.04
032	0.249	7.185	305.18	1.686	0.958	36.143	93.92	278.93	117542.0	1239.7	15065.7	3.542	26200.7	118.27	4164.6	4180.3	36.40
033	0.256	6.863	184.48	3.108	0.722	38.607	77.31	173.88	129243.6	942.1	11321.4	3.527	26747.8	113.47	4420.0	4056.7	28.87
034	0.405	7.178	159.17	1.980	0.978	41.094	81.33	241.38	123596.3	1469.0	16359.9	4.076	27227.7	132.11	4532.0	3872.7	36.52
035	0.266	7.518	212.18	1.826	0.891	36.061	100.72	210.93	121038.0	1117.2	8806.8	3.722	23224.5	116.44	4467.5	4038.3	34.81
036	0.223	8.113	190.71	2.162	0.817	36.993	92.58	247.32	136769.6	1367.8	7382.9	3.407	23763.4	126.80	3775.3	4935.2	35.32
037	0.190	6.871	248.46	1.601	1.001	32.865	91.54	183.53	119452.2	1385.6	13017.3	4.027	27778.0	127.89	4973.3	4447.3	36.09
038	0.263	7.652	249.55	1.922	0.852	36.824	101.11	208.65	126339.5	1199.4	9489.1	4.018	26167.8	118.85	4242.7	4657.3	35.49
039	0.227	6.582	204.83	1.853	0.857	33.609	82.59	214.90	113987.4	1124.2	20221.6	4.272	24309.7	162.66	4323.7	3581.6	35.10
040	0.260	7.569	174.01	1.935	0.880	35.284	79.47	250.85	115804.2	1323.8	37937.9	3.714	23938.4	132.32	4142.6	4307.8	37.63
041	0.305	6.534	177.22	2.411	0.802	32.179	73.43	168.31	116879.2	954.0	35076.0	4.573	25007.1	153.84	4988.8	3808.2	34.08
042	0.234	8.035	240.27	2.283	0.876	37.335	97.85	212.05	135612.0	1399.8	7865.1	3.451	23825.0	134.94	3983.8	4587.8	34.47
043	0.249	7.639	237.73	1.847	0.817	35.574	99.65	207.24	122214.0	1126.5	10582.6	3.594	25009.2	111.25	4353.0	4473.0	37.10
044	0.274	8.198	173.16	1.888	1.060	39.240	91.58	206.50	117974.1	1569.7	20568.1	4.775	24790.7	142.95	4473.0	4008.5	42.30
045	0.230	8.108	195.50	1.816	1.105	39.669	86.32	256.96	120310.9	1721.8	23628.8	4.953	24415.4	148.41	3964.9	4215.0	44.34
046	0.248	6.745	139.49	1.674	0.797	37.424	77.86	215.36	123958.5	1357.4	10286.0	3.240	26250.6	125.85	4587.3	5623.2	37.15
047	0.518	7.540	141.45	2.363	0.967	24.895	82.45	160.70	111812.4	561.6	51832.1	4.330	22675.9	122.63	4629.0	4060.1	35.43
048	0.249	6.599	128.44	2.016	0.769	36.279	83.55	224.74	125134.6	1302.7	16082.8	3.558	24475.9	145.34	4316.8	4092.0	28.83

Table D.2. Continued.

Id	Sb	Sc	Sr	Ta	Tb	Th	Zn	Zr	Al	Ba	Ca	Dy	K	Mn	Na	Ti	V
049	0.269	6.818	192.28	2.655	0.794	39.962	85.94	166.89	131715.8	1129.6	16504.8	2.835	25133.1	127.99	4048.7	3645.1	30.73
050	0.233	6.833	156.60	1.804	0.791	38.620	82.98	221.66	124323.3	1578.4	10983.6	3.250	27666.5	135.94	4185.7	4428.1	40.01
051	0.385	5.735	146.51	2.353	0.528	36.814	70.72	154.56	123529.8	957.2	13656.5	2.216	26390.9	105.30	6171.3	3507.9	29.32
052	0.296	4.672	166.18	2.459	0.378	31.462	72.24	136.00	129975.2	839.7	12485.3	1.571	27438.3	109.29	4633.8	3330.4	29.83
053	0.251	7.048	182.05	2.809	0.522	41.667	81.04	202.74	135964.6	1304.3	7460.8	2.058	24548.3	146.90	4902.2	4240.2	30.89
054	0.294	6.995	203.14	2.855	0.728	42.161	91.55	168.39	133109.0	1113.8	15090.7	2.804	25612.4	116.89	4919.7	3818.3	38.01
055	0.265	6.761	101.09	2.775	0.676	38.918	91.90	212.54	131347.8	1091.5	5285.0	2.763	25575.8	148.74	3915.9	4532.1	30.64
056	0.227	5.450	101.99	2.520	0.613	38.278	77.20	209.78	142094.3	1017.4	6731.1	2.919	19918.7	190.65	3215.4	3564.9	31.57
057	0.310	6.472	164.43	2.979	0.653	39.279	91.83	199.13	142546.9	1242.1	9590.2	2.907	20473.2	174.43	3907.2	4565.4	44.10
058	0.216	5.976	214.27	1.859	0.571	34.716	81.23	218.40	122026.1	1666.2	20704.7	2.551	31209.4	133.42	4076.6	4619.0	36.78
059	0.246	7.797	159.49	1.964	0.982	35.135	88.16	199.28	115707.7	1641.1	36486.4	4.609	28116.1	147.24	4372.0	4068.7	37.95
060	0.471	9.141	116.85	3.314	1.092	42.327	87.71	249.45	140809.4	1099.1	11271.5	4.795	19648.7	133.54	5657.3	4095.5	33.14
061	0.328	6.236	166.61	2.891	0.539	44.971	82.68	203.16	139821.7	1378.7	7907.8	2.663	26777.8	116.85	3802.1	4661.6	31.40
062	0.248	5.800	174.21	2.924	0.419	43.778	82.29	192.27	143353.4	1251.2	7484.5	2.208	25768.3	113.53	4044.4	4050.9	25.68
063	0.871	5.807	144.57	1.627	0.827	19.664	58.19	154.69	96503.6	818.5	49321.8	4.045	25848.8	176.67	4462.4	3724.0	31.39
064	0.204	7.157	165.63	1.858	0.832	41.478	80.47	269.70	120625.1	1359.3	15272.1	3.555	28500.8	128.22	3823.5	4755.3	47.35
065	0.340	7.782	144.53	2.661	0.737	36.570	86.99	230.15	128148.2	1344.0	18831.3	3.336	25752.3	135.70	4416.8	4350.5	35.30
066	0.357	7.570	164.74	2.612	0.597	35.086	89.31	260.68	130527.0	1400.4	10227.3	2.903	29313.9	136.61	4181.3	5119.1	31.22
067	1.079	7.969	249.90	0.715	0.454	7.743	88.12	73.01	55603.5	568.8	132756.6	2.748	23314.5	347.94	1168.3	3015.8	72.26
068	0.185	6.067	160.03	1.296	0.695	38.387	65.81	193.67	116766.5	1585.0	19011.7	2.797	32879.2	126.31	4980.3	4715.9	39.06
069	0.470	7.666	185.07	2.423	0.966	25.261	66.90	176.84	108661.2	591.3	64052.3	4.405	20899.3	144.31	3656.7	3841.0	40.25
070	0.203	6.242	126.21	1.328	0.647	37.953	65.71	252.78	112807.7	1471.1	20756.7	2.818	35117.6	125.73	4933.8	4652.4	37.22
071	0.314	6.505	119.75	3.605	0.837	43.362	47.02	161.12	133699.9	1828.9	8484.8	3.637	29178.5	133.83	4972.0	3360.9	32.86
072	0.281	7.842	162.78	2.489	0.962	39.683	92.54	215.12	127193.7	1255.0	17809.8	4.469	31453.4	126.25	4452.9	3926.8	24.08

Table D.2. Continued.

Id	Sb	Sc	Sr	Ta	Tb	Th	Zn	Zr	Al	Ba	Ca	Dy	K	Mn	Na	Ti	V
073	2.163	7.410	181.69	1.931	0.648	32.124	75.79	174.24	117643.8	1271.7	33003.8	3.220	27742.9	173.02	4702.6	4429.0	36.64
074	0.196	5.959	138.90	1.336	0.619	37.432	66.70	182.32	112054.8	1634.0	23718.5	2.945	34326.8	123.81	6193.1	4619.8	37.87
075	0.342	6.005	153.98	3.450	0.559	45.127	81.21	192.33	144103.2	1077.6	6072.7	2.422	27294.6	110.78	3797.0	3714.4	26.78
076	0.299	6.615	127.83	2.420	0.563	36.871	79.75	204.88	131792.3	1451.0	10275.1	2.407	27993.5	134.20	4104.6	4674.1	39.65
077	0.256	7.942	234.81	2.390	0.911	37.671	98.06	224.40	128769.8	1356.0	11269.5	3.468	27650.3	127.74	3806.9	4285.2	26.97
078	0.298	7.917	189.90	2.338	0.814	36.730	102.10	228.01	130004.7	1391.0	13106.2	3.527	27949.9	125.42	4225.4	3964.0	30.26
079	0.224	7.226	161.91	1.880	0.738	37.160	78.08	241.75	123667.5	1369.6	10566.6	3.337	30859.2	144.49	4279.3	4327.6	36.77
080	0.496	6.628	254.70	2.759	0.528	42.934	90.82	216.24	133367.5	1240.8	18636.5	2.603	21552.4	132.57	3320.7	3938.9	33.19
081	0.269	7.758	222.64	2.358	0.811	35.747	91.76	220.27	128596.8	1394.4	14184.2	3.649	26239.1	128.53	3910.2	4400.0	28.98
082	0.298	7.579	127.53	3.271	0.793	43.424	91.95	185.06	126200.6	1062.2	10589.9	3.247	30184.9	126.65	4997.0	4089.2	36.60
083	0.320	6.355	123.02	3.654	0.816	45.990	61.92	144.71	139613.9	959.2	5392.0	3.559	28993.4	121.49	4585.1	2929.9	22.05
084	0.779	6.470	181.91	2.896	0.576	43.156	82.13	168.77	129613.5	1230.4	17311.8	2.787	24148.3	110.23	4179.4	3986.3	27.54
085	0.227	7.521	147.93	3.131	1.075	44.079	60.74	187.13	139246.9	1140.2	8285.0	4.644	26797.8	125.22	3888.5	4429.1	29.90
086	0.180	6.574	253.96	1.429	0.722	33.770	86.21	193.66	110526.5	1287.8	34396.7	3.308	28444.7	144.75	4746.9	4592.5	35.45
087	0.318	8.225	176.12	2.534	0.729	36.924	93.38	232.13	133680.9	1280.1	13372.8	3.407	24860.8	139.89	3620.2	4705.8	30.77
088	1.767	8.510	154.01	2.742	0.948	32.747	77.81	197.18	119552.2	824.2	35837.3	4.466	20881.6	164.12	2888.0	4625.5	36.02
089	0.224	6.788	182.76	1.449	0.744	31.063	83.86	186.56	103520.3	1377.8	23614.7	3.147	27300.1	137.95	7246.6	3698.3	36.85
090	0.296	6.459	149.56	3.646	0.893	46.997	60.44	194.15	134664.8	979.8	4958.0	3.437	25966.4	113.17	4720.7	2439.9	33.44
091	0.230	7.281	136.73	2.720	0.854	38.014	83.32	172.17	124469.1	1286.4	11453.6	3.815	28707.0	122.13	4647.1	3306.3	25.75
092	0.315	5.488	161.48	2.798	0.427	41.645	80.78	187.52	130304.7	1423.6	11228.8	2.098	27124.6	103.70	4265.8	4045.7	31.10
093	0.281	5.981	209.20	2.594	0.505	42.639	89.91	177.58	126831.1	1286.5	15312.4	2.322	27505.6	120.91	4045.5	4179.0	32.63
094	0.847	6.505	163.79	2.008	0.519	36.013	77.75	243.04	124122.1	1496.6	13925.8	2.047	28642.1	143.48	4270.7	4945.8	34.97
095	0.339	6.365	167.15	2.839	0.550	41.863	76.07	202.16	137684.5	1137.5	12636.2	2.340	25363.0	127.90	3596.0	3967.5	33.23

Table D.2. Continued.

Id	Sb	Sc	Sr	Ta	Tb	Th	Zn	Zr	Al	Ba	Ca	Dy	K	Mn	Na	Ti	V
096	0.277	8.021	168.65	2.376	0.768	38.866	85.40	237.33	129883.5	1285.2	10471.0	3.529	24001.3	139.08	3505.7	4911.2	28.64
097	0.358	7.375	130.69	2.914	0.638	41.051	91.47	251.33	142918.6	1307.5	6111.8	2.678	19536.4	128.71	2950.1	5253.6	42.84
098	0.288	5.488	125.54	3.967	0.701	45.916	45.38	132.37	128386.0	873.2	3905.5	3.130	28853.4	99.10	5407.9	2500.4	30.25
099	0.233	8.744	220.42	2.514	0.994	38.706	99.39	237.52	128571.9	987.1	19211.4	3.926	19189.8	109.26	3888.5	3754.3	35.87
100	0.240	8.320	197.93	2.653	0.757	37.733	94.69	212.48	131868.2	1267.9	12313.8	3.502	23704.4	142.28	3566.1	4050.9	33.50
101	0.366	6.319	174.99	2.638	0.562	40.956	82.54	217.72	127895.4	1246.8	11411.9	2.256	23354.8	109.13	3956.7	4074.0	33.99
102	0.254	8.077	242.54	2.381	0.863	37.930	101.55	257.40	130910.1	1489.3	12647.3	3.533	22647.0	148.69	3607.1	4662.3	39.52
103	0.269	8.584	201.22	2.659	0.786	40.245	97.60	247.56	132610.9	1197.5	9120.2	3.298	23499.3	128.52	3668.6	4321.8	28.36
104	0.258	7.727	195.09	2.252	0.728	36.783	89.79	210.97	126582.0	1281.6	16297.8	2.843	20869.2	131.30	3462.7	4701.7	35.04
105	0.209	7.275	189.95	1.787	0.804	38.398	81.13	232.57	121391.6	1354.5	11381.8	3.186	27279.5	132.94	4119.8	4539.0	27.53
106	0.270	8.511	250.59	2.616	0.791	39.612	98.76	240.19	130079.5	1199.2	8872.3	3.362	22232.7	130.78	3633.3	4493.0	28.27
107	0.269	8.213	159.59	2.149	1.076	38.999	93.15	242.84	124953.6	2035.9	18955.1	4.536	23786.1	131.91	3697.3	4185.6	37.76
108	0.253	7.398	213.25	1.853	0.773	39.261	84.37	228.77	121879.1	1317.2	9597.4	3.515	25510.5	132.31	4438.0	4475.9	27.38
109	0.459	9.326	102.87	3.180	1.655	42.904	77.48	231.27	142120.7	955.8	12722.8	6.333	18275.2	124.56	3038.9	4364.0	38.67
110	0.334	8.517	192.54	2.841	1.054	43.914	97.82	198.46	131202.8	1376.8	18586.2	4.406	25519.5	135.11	5815.3	3351.3	25.34
111	0.522	7.019	338.13	1.879	0.696	29.472	73.20	221.75	103486.2	958.5	60977.6	3.270	21016.9	127.54	2903.0	3732.4	50.57
112	0.223	6.658	192.17	1.761	0.703	37.488	85.09	195.51	118552.8	1361.7	13356.1	2.986	28476.2	122.11	5082.2	4232.2	38.02
113	0.324	4.876	164.15	3.033	0.419	41.923	65.40	157.85	129829.0	1191.2	8536.1	2.310	29036.7	101.60	5410.4	2623.4	19.12
114	0.466	8.306	210.78	2.384	1.117	32.844	77.37	225.65	116431.8	802.1	36122.9	4.398	19589.2	164.25	3520.0	4127.9	40.06
115	0.254	8.350	177.69	2.151	1.086	38.809	93.95	240.74	126492.8	1881.5	18943.8	4.490	24231.2	145.78	4126.4	4022.5	33.14
116	0.222	6.817	226.07	1.822	0.867	36.576	96.68	214.82	120294.7	1339.5	25527.8	3.604	23383.2	132.76	4004.1	4086.4	36.58
117	0.493	7.074	173.04	2.882	0.802	34.414	83.17	177.07	121348.7	700.0	22403.6	3.287	25514.4	135.00	5348.9	3667.1	26.19
118	0.265	8.168	150.95	2.079	1.044	38.765	91.58	237.03	123278.5	2026.1	19526.6	4.763	23110.9	128.52	3439.6	4239.2	35.26

Table D.2. Continued.

Id	Sb	Sc	Sr	Ta	Tb	Th	Zn	Zr	Al	Ba	Ca	Dy	K	Mn	Na	Ti	V
119	0.255	6.094	190.07	2.007	0.599	33.667	83.70	208.49	119191.7	1715.8	21526.0	2.579	26716.7	140.06	4538.5	3875.3	36.98
120	0.279	6.864	187.25	1.799	1.102	35.996	108.40	193.37	113908.1	1168.8	17831.8	4.932	29836.3	141.71	5255.5	4664.9	37.04
121	0.233	7.897	196.13	2.724	0.754	38.752	92.73	262.51	131715.0	1318.5	13520.2	3.164	24059.5	149.03	3503.9	4977.1	35.35
122	0.294	7.083	123.92	3.192	0.775	43.616	89.07	233.84	144002.8	1016.5	7254.5	3.230	17467.5	179.44	2554.0	3746.5	29.73
123	0.221	7.234	220.43	1.827	0.718	37.252	82.70	247.63	121745.5	1377.2	9798.6	3.486	26816.3	142.42	4246.6	4420.2	39.64
124	0.329	6.277	174.59	2.668	0.556	40.549	81.45	198.20	131365.7	1307.8	12166.4	2.529	22644.8	116.16	3589.1	4374.7	34.04
125	0.343	6.528	183.67	1.594	0.936	24.306	71.67	167.79	88393.6	973.4	56184.1	4.424	21023.9	159.08	3713.9	3445.0	39.33
126	0.636	8.160	181.19	2.625	0.930	34.388	92.06	219.25	125536.1	1022.5	31716.4	3.907	20059.4	145.99	3166.9	4690.7	34.11
127	0.269	8.451	288.98	2.613	0.904	38.182	112.60	255.84	132229.2	1883.9	15030.8	3.456	22692.8	146.07	3332.8	5065.0	34.42
128	0.463	6.946	150.10	2.028	1.008	25.174	62.77	202.62	97399.0	854.2	59563.1	4.669	20713.8	148.38	3356.2	3754.8	37.32
129	0.350	7.029	168.68	2.362	0.863	31.624	81.69	183.29	112257.3	891.8	40653.4	4.327	22650.8	130.67	3384.6	4217.6	34.61
130	0.374	7.100	182.57	2.441	1.065	31.953	81.67	217.09	116001.7	797.4	36359.0	3.839	22706.0	134.29	3941.7	3625.7	30.65
131	0.368	7.117	174.24	2.484	0.953	33.360	78.26	179.43	119935.9	875.3	35764.6	4.489	24910.8	146.29	3412.8	4071.2	37.19
132	0.321	6.875	147.96	2.387	0.922	30.779	88.50	176.48	113020.4	807.2	38579.2	3.977	23025.1	140.05	4058.9	4412.6	33.38
133	0.305	7.545	200.53	2.317	0.636	33.175	96.41	207.12	122405.7	1194.7	29022.1	2.613	25148.9	147.33	4251.3	4823.8	32.58
134	0.298	7.101	160.39	2.291	0.914	38.650	90.61	178.72	121229.0	1551.5	14266.0	3.913	28393.7	122.87	4648.1	4154.6	31.76
135	0.301	7.005	180.70	2.280	0.864	37.721	85.80	178.18	122633.6	1638.7	14857.5	3.598	28287.4	129.60	4723.1	3900.3	31.76
136	0.284	5.877	185.03	1.861	0.736	42.378	88.59	234.03	122027.1	1431.7	9162.8	3.401	23787.6	159.35	3646.0	4564.8	45.29
137	0.296	6.892	257.10	2.742	0.752	41.661	88.72	197.30	127681.3	1158.2	15453.8	2.956	25527.4	128.95	4165.0	3624.8	26.70
138	0.306	5.850	138.20	3.380	0.753	44.861	57.25	145.61	138793.2	996.9	4714.5	3.562	30511.6	113.38	5094.9	3069.3	32.62
139	0.302	7.920	215.16	2.415	0.895	38.769	98.11	275.68	131782.5	1331.2	8820.4	3.672	23827.6	142.25	3695.3	4440.6	34.11
140	0.286	5.501	174.62	2.799	0.514	44.465	86.17	215.69	133988.5	1291.2	6629.3	2.177	25503.1	114.67	4848.4	4779.6	24.29
141	0.314	6.971	175.86	2.232	0.915	38.279	84.86	202.98	124050.3	1686.0	14786.7	4.022	28255.2	122.87	4838.1	3657.3	28.06
142	0.278	6.550	317.43	3.025	0.641	43.325	84.71	172.46	129566.7	963.8	22013.6	2.496	24359.2	127.05	3705.2	3559.6	24.94

Table D.2. Continued.

Id	Sb	Sc	Sr	Ta	Tb	Th	Zn	Zr	Al	Ba	Ca	Dy	K	Mn	Na	Ti	V
143	0.451	8.350	153.80	3.152	1.298	40.648	75.61	170.70	128282.6	731.1	12796.7	6.044	23495.2	126.58	4880.1	3735.6	38.14
144	0.322	7.956	187.88	2.540	0.996	37.699	91.31	217.99	120563.2	1019.4	31215.7	4.377	23843.9	146.89	3711.9	4072.1	28.61
145	0.251	7.713	217.72	2.092	0.796	37.980	103.54	247.00	124853.2	1331.0	10054.6	3.173	25024.3	141.13	4102.4	4307.8	37.03
146	0.283	7.434	167.97	2.143	0.803	35.719	81.79	201.15	118612.0	1223.4	25398.5	3.598	26513.3	168.13	4752.9	4720.5	34.14
147	0.230	7.692	198.78	2.046	0.851	38.108	104.60	257.88	122707.7	1365.3	20375.2	2.458	25976.4	127.32	3734.3	5056.2	38.48
148	0.323	6.258	188.05	1.888	0.629	41.676	76.61	218.28	124544.2	1366.6	9321.5	3.375	26433.5	141.73	4294.4	4587.0	37.47
149	0.270	9.067	190.14	2.686	0.988	39.393	117.75	247.58	135852.3	1362.8	10696.8	4.185	21647.1	145.14	3239.0	4384.5	42.72
150	0.247	7.505	175.09	1.894	0.815	38.036	91.26	238.21	123936.3	1315.9	8945.1	3.498	25841.9	137.86	4188.1	4494.8	41.26
151	0.364	7.084	146.57	2.572	0.783	41.359	86.01	221.19	139950.0	1185.9	11786.0	3.020	24677.1	118.20	3884.1	4586.3	33.39
152	0.251	6.564	116.07	2.415	0.666	37.343	83.20	274.38	142461.1	1374.8	6874.4	2.725	26086.7	142.38	3499.6	5453.3	36.06
153	0.250	7.396	188.49	1.850	0.828	39.829	84.75	281.15	119707.9	1276.9	17013.3	2.994	29759.8	160.47	4382.1	5085.2	43.52
154	0.275	7.458	193.98	1.977	0.719	37.533	83.72	250.27	123228.8	1239.7	8863.8	3.096	29171.8	133.65	4605.7	5232.8	34.50
155	0.488	7.502	151.01	2.472	0.948	24.408	68.35	189.85	107645.2	646.8	54515.9	4.126	24741.8	167.22	4363.6	4492.0	28.59
156	0.259	6.894	172.21	2.179	0.732	36.639	86.82	227.56	138206.6	1954.4	10569.3	3.014	29586.9	140.75	3740.2	5364.5	41.73
157	0.321	6.801	187.76	3.155	0.789	37.070	80.22	167.56	122029.0	756.4	28602.1	3.768	28516.2	143.55	4695.2	2891.2	29.51
158	0.307	7.589	182.75	2.966	1.141	45.823	62.39	168.30	140812.0	1095.8	5207.2	4.284	28141.8	114.91	4577.6	3760.9	29.06
159	0.331	6.990	150.87	2.972	0.563	43.073	90.76	185.91	139383.9	940.1	10159.0	2.316	26434.4	113.66	3878.7	4864.8	32.80
160	0.258	3.633	204.73	3.507	0.349	34.346	67.39	120.10	129102.0	664.5	1954.0	1.439	33270.5	89.38	5048.8	2547.6	16.70
161	0.336	7.682	223.45	2.968	1.051	40.293	85.20	200.37	126613.9	876.9	17654.8	4.747	26857.9	124.21	4182.4	3387.2	23.90
162	0.284	6.699	159.00	3.956	0.758	46.407	57.49	131.53	134806.6	747.8	4795.1	3.212	32193.7	114.41	5357.0	2381.1	19.26
163	0.319	6.007	135.30	4.140	0.669	44.735	51.49	138.65	137646.5	776.6	5547.8	2.455	30717.5	114.11	4896.2	2782.8	24.82
164	0.306	5.937	162.80	1.723	0.624	37.560	74.33	202.87	123626.9	1187.9	11897.2	2.240	33671.0	121.35	4464.6	4318.1	37.71
165	0.287	8.022	204.03	2.529	0.759	37.050	95.45	231.75	132736.2	1327.9	13361.3	3.072	27388.9	158.60	5129.0	4526.8	35.33

Table D.2. Continued.

Id	Sb	Sc	Sr	Ta	Tb	Th	Zn	Zr	Al	Ba	Ca	Dy	K	Mn	Na	Ti	V
166	0.235	6.673	241.13	1.695	0.768	34.325	89.80	181.93	114328.8	1228.6	26128.2	3.358	28376.8	126.00	4148.3	4368.0	31.95
167	0.297	7.329	207.74	2.111	0.756	36.072	78.81	207.83	126606.5	1352.3	25920.7	3.375	26238.4	149.88	4063.3	4532.7	30.79
168	0.302	6.716	182.21	3.089	0.780	44.482	72.33	188.84	143598.5	1050.0	13220.1	3.458	26869.2	119.26	3681.8	3342.5	35.79
169	0.587	8.027	148.51	2.659	0.893	32.245	72.82	206.03	125333.8	842.8	33553.0	4.069	22877.8	165.85	3101.8	3822.3	39.01
170	0.303	7.079	176.42	2.054	0.829	34.990	77.44	208.64	120583.3	1405.6	20207.8	3.485	32145.2	143.00	6557.0	3996.5	31.16
171	0.226	6.913	181.67	1.824	1.076	35.530	91.42	172.14	121717.5	1033.1	31312.0	5.579	29611.6	137.88	4139.4	4386.8	31.97
172	0.258	7.128	200.80	1.815	0.796	36.818	79.68	237.42	120487.6	1206.2	15322.7	3.165	28905.1	146.36	4035.3	4959.2	41.56
173	0.331	5.875	172.38	2.556	0.570	42.896	82.19	198.89	135324.5	1422.7	7803.7	2.007	26849.7	105.49	4152.7	4300.4	30.00
174	0.369	7.021	173.79	2.073	0.736	34.029	81.05	211.52	123625.1	1454.3	18813.4	2.984	33420.3	136.10	8542.4	5126.8	36.07
175	0.310	7.029	155.44	1.841	0.678	32.615	69.94	215.61	115442.8	1169.8	37806.5	3.021	26180.4	155.98	3614.6	3897.5	38.05
176	0.217	5.710	176.34	1.205	0.661	39.427	66.21	193.84	111680.0	1257.3	17242.1	2.750	32758.6	123.29	4790.9	5102.5	40.44
177	0.316	8.162	179.87	2.641	0.794	36.665	93.40	249.33	134257.0	1185.1	14068.8	3.162	25949.9	151.41	3622.3	4756.7	35.62
178	0.393	8.104	183.01	2.641	0.872	35.054	87.41	224.09	127322.3	964.8	24757.5	3.662	22965.7	185.87	3289.4	4311.6	30.59
179	0.281	6.393	147.92	3.848	0.725	44.743	59.11	134.70	126915.1	784.2	4871.4	3.131	31327.6	112.30	5956.5	2158.1	15.22
180	0.530	5.931	201.96	1.768	0.673	38.065	82.20	202.77	121687.0	1403.2	17134.8	2.696	28684.4	132.04	5747.4	4827.9	37.58
181	0.296	4.344	162.13	2.778	0.391	36.292	64.06	127.71	132392.9	841.8	11572.0	2.130	33158.4	115.16	4723.5	3177.1	25.02
182	0.220	6.959	172.29	2.855	0.988	41.695	74.44	194.87	132961.5	1005.1	11162.3	5.392	30067.2	115.67	4655.1	3394.1	26.20
183	0.213	5.648	142.76	1.328	0.593	38.472	65.19	175.85	122763.9	1444.3	13197.8	2.823	33213.8	137.50	4675.1	4956.2	33.43
184	0.300	7.027	180.58	2.739	0.791	36.929	75.48	190.57	131046.5	1117.2	25181.0	3.262	24281.7	152.29	3754.5	4534.5	31.74
185	0.202	7.068	176.33	2.950	0.955	41.257	80.22	172.31	132734.6	1072.4	10608.4	4.154	29072.5	114.22	4649.8	3178.8	26.02
186	0.324	7.475	211.50	1.985	1.011	34.942	86.81	208.75	127425.0	1667.1	30324.9	4.457	29837.9	140.19	4278.8	4310.5	37.38
187	0.383	6.177	159.82	2.735	0.554	40.473	76.46	183.69	140475.4	1149.7	12254.7	2.486	26559.7	127.20	3719.6	4474.9	35.46
188	0.282	6.859	197.96	1.991	0.730	35.764	84.65	204.49	122659.9	1395.9	18597.9	2.957	29729.9	145.73	5933.2	4033.7	37.98
189	0.269	7.879	212.12	2.426	0.846	39.003	96.53	227.93	138995.0	1264.0	12083.2	3.434	26428.2	151.47	3326.0	4783.3	35.46

Table D.2. Continued.

Id	Sb	Sc	Sr	Ta	Tb	Th	Zn	Zr	Al	Ba	Ca	Dy	K	Mn	Na	Ti	V
190	0.266	6.997	195.11	2.011	0.728	35.337	82.46	208.18	125879.4	1417.0	12002.6	2.964	28619.9	151.98	5424.7	4250.3	33.23
191	0.388	6.262	218.16	1.490	0.847	35.696	105.97	208.51	116750.0	1509.8	22572.7	3.732	28117.5	153.63	4372.0	4779.3	37.60
192	0.284	7.397	175.42	2.140	0.840	35.238	91.16	227.79	133740.1	1442.8	10218.1	3.603	25243.9	153.24	3963.8	5076.9	43.13
193	0.288	7.577	175.36	2.210	0.712	35.903	89.32	205.04	125451.7	1368.9	24803.8	2.905	26763.4	168.45	3686.3	4843.1	30.43
194	0.428	7.086	215.40	2.001	0.858	36.172	80.51	217.19	119826.8	1422.3	32466.3	3.808	26827.6	163.72	4947.5	4449.5	41.01
195	0.344	4.409	160.33	1.050	0.711	15.427	44.91	123.02	74977.7	744.7	91014.7	3.171	23867.9	236.68	3560.8	3083.2	32.22
196	0.289	7.364	154.34	3.031	1.123	43.226	61.12	219.22	141285.8	1031.3	7489.3	4.361	28236.1	125.63	3945.6	4360.2	38.16
197	0.370	6.526	171.32	2.452	0.646	39.585	83.73	209.49	129364.9	1441.6	15916.8	2.347	28564.0	177.97	5644.9	4419.4	42.97
198	0.231	6.860	229.43	2.386	0.688	39.693	84.72	216.51	136543.5	1289.0	8641.6	3.163	28861.3	143.98	4254.3	4370.2	31.82
199	0.318	5.993	173.86	2.455	0.688	34.825	75.34	155.29	126118.0	1143.9	23293.8	3.080	23918.6	131.04	4642.8	3520.8	34.64
200	0.249	7.295	180.51	2.755	0.894	39.312	85.53	215.48	128693.9	1267.4	13085.9	3.971	29915.2	133.74	4661.0	4182.1	25.58