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Parowan Pottery and Fremont Complexity: Late Formative Ceramic Production and Exchange

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PAROWAN POTTERY AND FREMONT COMPLEXITY:

LATE FORMATIVE CERAMIC PRODUCTION

AND EXCHANGE

by

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GRADUATE COMMITTEE APPROVAL

of a thesis submitted by

Christopher N. Watkins

This thesis has been read by each member of the following graduate committee and by majority vote has been found to be satisfactory.

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BRIGHAM YOUNG UNIVERSITY

As chair of the candidate's graduate committee, I have read the thesis of Christopher N. Watkins in its final form and have found that (1) its Format, citations and bibliographic style are consistent and acceptable and fulfill University and department style requirements; (2) its illustrative materials including Figures, tables, and charts are in place; and (3) the final manuscript is satisfactory to the graduate committee and is ready for submission to the university library.

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ABSTRACT

PAROWAN POTTERY AND FREMONT COMPLEXITY:

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The Fremont, a Formative culture located in the Eastern Great Basin and Colorado Plateau, have been primarily studied from an ecological perspective. This research addresses issues that are not ecological, the organization of production and exchange of ceramic vessels. Following criteria suggested by Brown et al. (1990), I argue that the following need to be addressed prior to a useful discussion of intergroup trade: the source of the raw materials of the exchanged objects, the associated pattern of distribution, the relative value of the objects, and their context of manufacture, use, and consumption. I specifically address three of these issues regarding the Snake Valley pottery series, asking what is the source of Snake Valley Black-on-gray pottery, what is the distribution of Snake Valley Gray, Snake Valley Black-on-gray, and Snake Valley Corrugated, and in what context was Snake Valley Black-on-gray manufactured? These questions are approached via two data sets -- a chemical assay and a distributional analysis. I argue that Snake Valley pottery was probably produced in a restricted area, the Parowan Valley, and that production was organized as community craft specialization, though I acknowledge that more research on this topic is ultimately required.

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Chapter 1: INTRODUCTION

The Fremont, a Formative Great Basin/Colorado Plateau culture, are often perceived as simple, tribal people who settled in sparse outposts consisting of handfuls of pithouses, presumably the residences of related nuclear families (Sammons-Lohse 1981). This pattern of settlement does not apply in the well-watered valleys of the Wasatch Front (Janetski and Talbot 2000b) where early European settlers observed the remains of sprawling Fremont communities (Janetski 1997). The Fremont, particularly those living in large sedentary populations along the Wasatch Front, probably enjoyed a fair degree of social and economic complexity. With a few notable exceptions (Janetski 2002; Janetski and Talbot 2000b; Wilde and Soper 1999; Hockett 1998; Marwitt 1986; Sammons-Lohse 1981; Gunnerson 1969), Fremont studies over the last 30 years have focused principally on subsistence: what people ate and how they obtained it (Madsen 1979; Simms 1986). Questions of social organization and exchange have been largely ignored (however, see McDonald 1994 and Janetski 2002 for exceptions).

Purpose

My research addresses two of these neglected issues, asking how Fremont pottery production and exchange were organized during the Late Formative (ca. A.D. 900-1350, for a discussion of Fremont chronology see Janetski et al. 2000). James A. Brown, Richard A. Kerber, and Howard W. Winters (1990:251) identify three aspects of exchange that require systematic research prior to any useful discussion of intergroup trade: "First, the raw materials of traded objects need to be accurately sourced to develop a pattern of exchange relations (Plog 1977). Second, the relative value of objects has to be identified, and third, the objects have to be distinguished by context of manufacture, use, and consumption."

I have accepted these aspects of exchange as a framework for modeling Fremont ceramic production and exchange. Six questions are embedded in this framework. What is the source of the raw materials of the exchanged objects? What is the associated pattern of distribution? What is the relative value of the objects? And what is the context of manufacture, use, and consumption? I have formulated specific research questions within this framework to explicitly address three aspects of Fremont ceramic production and exchange. What is the source of Snake Valley Black-on-gray pottery? What is the distribution of Snake Valley Gray, Snake Valley Black-on-gray, and Snake Valley Corrugated? And in what context was Snake Valley Black-on-gray manufactured?

I do not explicitly assess the remaining portions of the framework with new data. In Chapter 5, however, I discuss relative value and the contexts of use and consumption in light of existing data. Four relevant models proposed by other researchers also bear on my research. They are explained and addressed in later chapters.

Research Questions

As indicated above, I explicitly address three of the six questions suggested by Brown et al. (1990) with new data. All of the questions are discussed in Chapter 5 in light of the data generated here and those existing previously. I discuss the questions explicitly addressed in this research in more detail below.

Sourcing – the Location of Raw Materials

I hypothesize that at least *some* Snake Valley pottery was produced in the Parowan Valley, shown in Figure 1.1 as Evans Mound, Paragonah, and Median Village. Huge ceramic assemblages have been recovered here, and they are dominated by quartz-, feldspar-, and biotite-tempered sherds (Meighan et al. 1956; Marwitt 1970; Dodd 1982; Berry 1972a, 1972b). Margaret Lyneis (1994) has argued that Snake Valley pottery was constructed of welded volcanic tuffs that had either been weathered/decomposed and/or ground to the point of workability as pottery clay.

I attempt to source the raw materials used in the construction of Snake Valley Black-on-gray. I have adopted Lyneis's hypothesis that the welded volcanic tuffs in the Parowan Valley are the source material for Snake Valley Black-on-gray pottery. The

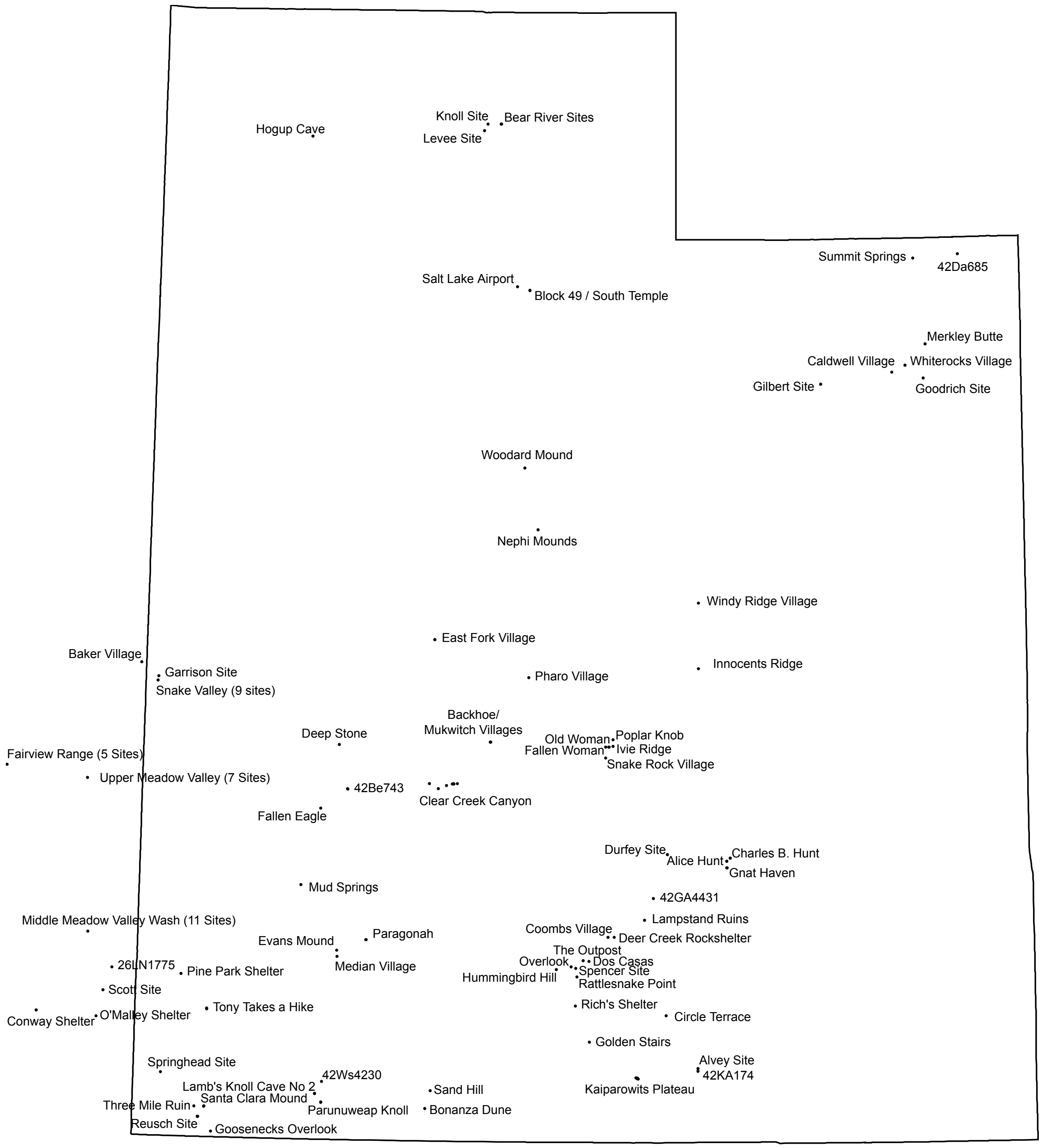

Figure 1.1. Sites Mentioned in this Thesis.

Parowan Valley has long been suspected to be the production center of most Snake Valley pottery (Madsen 1977; Lyneis 1994; Richens 1999, 2000a, 2000b; Schuster 1996; Wilde and Soper 1999). Recent excavations in the Salt Lake Valley have called this assumption into question. Substantial quantities of pottery were recovered at Block 49/South Temple (Talbot et al. 2004), and the Salt Lake Airport (Allison 2002) that appear to belong to the Snake Valley Series, or are at least close variants. I selected several sherds from the

Parowan Valley and three other Fremont villages for chemical analysis via Inductively Coupled Mass Spectrometry (ICP-MS), and then compared them to samples of volcanic tuff obtained from the Parowan Valley. If the raw material samples fall into the same compositional group as the sampled sherds, then the clays utilized in the construction of the pottery were probably derived from those tuffs.

Preliminary petrographic evidence from sherds from Baker Village (Wilde and Soper 1999; Schuster 1996; Richens 1999) and a temper and clay refiring analysis of pottery from Clear Creek Canyon (Richens 2000a, 2000b) indicate that all or most of the corrugated and painted pottery present at these sites was of non-local manufacture. Much of this corrugated and painted pottery is from the Snake Valley series, and the researchers suggest these sherds were manufactured in the Parowan Valley. I anticipated that most of the Snake Valley Black-on-gray pottery I sampled would fall into the same compositional groups as the raw material and sherd samples from the Parowan Valley, indicating probable production in that immediate region. I also expected the "non-classic" variant pottery from South Temple to fall into a different compositional group than the raw material samples and "classic" pottery samples, indicating they were produced elsewhere.

Distribution – A Pattern of Exchange Relations

If the source(s) of the pottery has been determined, I will be able to conclusively define the pattern of exchange relations for Snake Valley Black-on-gray pottery. Even if the chemical assay is inconclusive, I will still be able to suggest patterns of exchange relations based on the distributions alone. I have collected data from excavated sites that were readily available to me (i.e., University of Utah Anthropological Papers, Antiquities Section Papers, Brigham Young University Occasional Papers and Technical Series, major CRM projects, and other well-known monographs). In addition to Snake Valley Black-on-gray, I collected data on Snake Valley Gray and Snake Valley Corrugated. Although I am not explicitly identifying the source of these types, their distributions shed light on possible production areas and are relevant to this discussion.

I anticipated that (1) the area of highest distribution of Snake Valley Gray pottery would be larger than that of Snake Valley Black-on-gray or Snake Valley Corrugated, indicating that as a utility ware it was more widely produced; (2) more Snake Valley pottery would be present on the west side of the Wasatch Mountains, which were a natural prehistoric barrier (Lohse 1980; Janetski 2002); (3) Snake Valley pottery would be little represented at Virgin Anasazi sites, indicating the presence of a distinct social boundary and possibly minimal trade and interaction; (4) higher occurrence of Snake Valley pottery at relatively large Fremont sites, as suggested by Janetski (2002); and (5) fall-off of Snake Valley pottery in all directions from the Parowan Valley as a function of distance from the Parowan Valley.

Context of Manufacture

Several models have been developed to describe the organization of production. Productive arrangements proposed by van der Leeuw (1984) and Peacock (1982) are often cited. Both begin on the level of the household and build in complexity before ending somewhere around industrialization. Most small-scale societies, such as the Fremont, will invariably fall into either the household production or household industry designations. In household production, which roughly corresponds to Sahlins's (1972) Domestic Mode of Production, each household produces all the goods needed for its own consumption. In a household industry, which Schuster (1996) proposes as the likely productive arrangement of Fremont pottery (see below), at most several individuals produce goods for consumption on the extra-household level.

Allison (2000) argues that neither of these frameworks is very useful in dealing with variation in small-scale societies, where important differences in productive arrangements not visible in the above schema can exist. He gives a stronger endorsement to Costin's (1991) typology, which focuses on specialized production arrangements. These arrangements are explicitly approached through four independent parameters: intensity (the amount of time devoted to the production of a given commodity), scale (the size and composition of the unit of production), concentration (whether production units are spatially dispersed or nucleated), and context (the degree of elite sponsorship). Degree (the ratio of producers to consumers) is also discussed but is not incorporated into the typology. Costin's individual specialization roughly corresponds to the household industry discussed above; however, my research is particularly concerned with Costin's community specialization in which "autonomous individual or household-based production units" are "aggregated within a single community" (Costin 1991:4; see also Hegmon et al. 1995).

Craft specialization is generally defined by John Clark (1995:273; Clark and Parry 1990:297) as "production of alienable, durable goods for non-dependant consumption." Costin (1991:4) defines craft specialization, as "a differentiated, regularized, permanent, and perhaps institutionalized production system in which producers depend on extra-household exchange relationships at least in part for their livelihood, and consumers depend on them for the acquisition of goods they do not produce themselves." Clark argues that this definition is too restrictive, a judgment shared by both Allison (2000) and myself. Additional definitions of craft specialization have been suggested (see Cobb 1993; Stark 1992), but in this thesis I will use Clark's general definition along with Costin's concept of community craft specialization.

When the Parowan Valley Archaeological Project (see below) is complete, an analysis of pottery production in the Parowan Valley at the household level may be possible. I am limiting my study to a regional scale. Several researchers have hypothesized community craft specialization of pottery in the Parowan Valley (Schuster 1996; Richens 2000b, 1999; Lyneis 1994). Some pottery production in the Parowan Valley surely occurred given the vast quantities of Snake Valley pottery present. However, this has yet to be explicitly demonstrated nor are any of the details of production known. Given the extremely unbalanced prehistoric Southwestern ceramic exchange relationships at Chaco (Toll 1981, 1991, 2001; Toll et al. 1980) and in the

Phoenix Basin (Abbot 2000; Abbot and Love 2001; Abbot et al. 2001; Van Keuren et al. 1997), production is better shown than inferred by the presence of large quantities of pottery. If the Snake Valley Black-on-gray pottery from the Parowan Valley and the other sites in the sample fall into the same compositional groups as the raw material sources collected from the Parowan Valley, then the Parowan Valley can be identified as a place of community craft specialization.

Existing Model Evaluation

Four models pertinent to my research questions have been proposed. Each is briefly explained below and is followed by the impacts I anticipate my research will have on them. Further discussion will be included in Chapter 5, after the presentation of the data in Chapters 3 and 4.

Janetski's Trade Fair Model

After citing ethnographic analogs and archaeological evidence for the movement of goods within the Fremont and between the Fremont and surrounding peoples, Janetski (2002) argued that trade fairs/festivals were important mechanisms for the distribution of exotics at Fremont sites. When the sites in his sample are lined up from southwest to northeast, a pattern of what initially appeared to be gradual fall-off of exotics emerges. Janetski noted that this pattern was occasionally interrupted by "spikes", sudden increases in material, at the larger residential sites, which he interpreted as evidence for limited directional trade. Janetski suggests that the large sites where high quantities of exotics are present in opposition to expected fall-off could represent central places, which Renfrew (1977:85) defines as loci "for exchange activity, and more of any material passes through it (per head of population) than through a smaller settlement."

Since the Fremont probably lacked powerful leaders or centralized hierarchical political systems (Sammons-Lohse 1981; however, see Janetski and Talbot 2000b for a discussion of Fremont social complexity) these sites were probably not nodes where goods were tightly controlled. As such, Janetski argues that the sites (Baker Village, the Sevier Valley, Round Spring, and the Parowan Valley) were not places of central place redistribution or market exchange but were localities where regular gatherings were held, which were in part intended to facilitate exchange. If these localities were "central places" of significance in the Fremont area, then the large, complex sites in the Parowan Valley were among the foremost. Janetski's trade fair model will be supported if the Parowan Valley proves to have been a major production area for Snake Valley Black-on-gray pottery and if the distribution of this pottery parallels the unusually high distributions at large sites he observed for exotic items.

Schuster's Baker Village Thesis

Utilizing binocular microscope and petrographic analyses, Schuster (1996) argued that the only pottery at Baker Village (Figure 1.1) that could have been produced locally was a Fremont variant tempered only with quartz, comprising roughly 9 percent of the 1055 sherds he analyzed. Rhyolitic tuffs located approximately 10 km from Baker Village containing feldspar, quartz, and biotite were identified and were considered as possible, but not probable, source locations for "classically" tempered Snake Valley pottery. These deposits were considered unlikely raw material candidates because they were farther than Arnold's (1985) ethnographically determined maximum temper procurement distance of 7 km from Baker Village. Interestingly, Arnold specifically documents cases of volcanic tuffs being transported much farther than 7 km, a fact that could be significant in this particular case.

Unfortunately, no record of Schuster's artifact analysis can be found at the Museum of People and Cultures, making inclusion of his quartz-only pottery in this analysis difficult. By pure luck I encountered two sherds of this variant while pulling Snake Valley Black-on-gray from the collection, and I have included them in the chemical assay to test Schuster's argument. Schuster recognized that his data only weakly supported the Household Industry production of Fremont pottery (van der Leeuw 1984).

As argued above, this can be fairly safely assumed for a small-scale society like the Fremont, and rather than attempting to test this idea I have chosen to examine production at a supra-household scale. I anticipate that the Snake Valley Black-on-gray pottery at Baker Village will fall into compositional groups with Parowan Valley sherd and raw material samples, indicating that they were manufactured in the Parowan Valley. The sherds with quartz-only temper will fall into another compositional group, indicating they were produced outside of the Parowan Valley, possibly at Baker Village.

Kern River II and Anasazi Models of Ceramic Production

In a pioneering provenience study of Fremont pottery, Alan Reed (2005) attempted to apply Anasazi models of pottery production to the Fremont. His study assumed that plain and corrugated wares were primarily used for cooking, and that white and red wares (including all slipped and painted pottery) were utilized as storage and serving vessels. Breakage of vessels used for cooking would have been higher, and as such it is thought that most people would have produced their own gray and corrugated wares (Wilson and Blinman 1995). Independent household-level producers probably specialized part time in the production of time-intensive non-utility wares (Hegmon et al. 1995) which were then traded over both long and short distances (Hegmon et al. 1995; Hegmon et al. 1997; Wilson and Blinman 1995).

Reed submitted 117 sherds from the Snake Valley Series for Instrumental Neutron Activation Analysis (INAA), that were subsequently sorted into eight compositional groups. The samples were collected from sites along the Kern River Pipeline corridor, in addition to 20 sherds taken from collections generated by University of Utah excavations at Evans Mound (Berry 1972a, 1972b, 1974; Dodd 1982). These data were then used to evaluate the applicability of the Anasazi model of ceramic production in three specific ways. First, were the three types of Snake Valley ceramics (Snake Valley Gray, Snake Valley Black-on-Gray, and Snake Valley Corrugated) manufactured in the same location? Second, were Snake Valley Black-on-Gray ceramics from East Fork Village (42MD974) imported, or were they locally manufactured to imitate exotic types? And finally, were the Snake Valley types from Hunchback Shelter (42BE751) and the Mud Springs site (42IN218) produced at either the Fallen Eagle site (42BE1988) or at Evans Mound (42IN40)?

The resulting model of Fremont ceramic production is based on Reed's answers to these three questions. Reed (2005:304) argues that "INAA has conclusively demonstrated that the corrugated, plain gray, and painted types of Snake Valley Gray were produced with multiple suites of minerals, which suggests production in multiple locations." This is contrary to the Anasazi model of ceramic production, which predicts fewer locations of manufacture of painted (presumably non-utilitarian) pottery. Reed further argues that most sites are not clearly dominated by ceramics of a single compositional group, suggesting either high residential mobility or routine trade, with a lack of a clearly dominant compositional group at most sites arguing for trade.

Reed's conclusions are admittedly hamstrung by his small sample size and his failure to include raw material sources in his analysis. These constraints are primarily limitations imposed by the linear project area in which he worked. Additional assumptions I question are that each compositional group revealed represents raw materials exploited by potters at a single site, and the designation of Snake Valley Corrugated as a utility ware. The importance of Reed's study cannot be overemphasized; however the patterning (or lack thereof) in compositional groups his arguments are based on could have easily been the result of problems associated with small samples. Provenience studies of this sort are, as Reed acknowledges, cumulative by nature. My research is also hampered by too few samples. My study, however, also includes raw material samples from the Parowan Valley, a region of considerable geologic diversity. It is entirely possible that every compositional group Reed identified at Evans Mound has an origin in the Parowan Valley in the form of several ash-flow tuffs.

I anticipated that several compositional groups or subgroups would be correlated to tuffs in the Parowan Valley, thereby explaining most of the compositional diversity Reed attributes to either high residential mobility or large quantities of vessels being exchanged from multiple production loci. I also hypothesize that the Parowan Valley was a locus of craft specialization for Snake Valley Black-on-gray pottery on the community level, which is consistent with the Anasazi model of ceramic production Reed argued against.

Arnold and Harry: Models of Agricultural Marginality

Dean Arnold (1985) has presented ethnographic data indicating a correlation between ceramic specialization and agricultural/economic marginality. Concentrations of ceramic producers are usually located on lands relatively poor for agriculture. Karen Harry (2005) has challenged the applicability of this model to the prehistoric Southwest. With data from six areas where pottery specialization is known to have occurred, Harry argued that in the prehistoric Southwest agricultural marginality was not the sole or primary factor leading to the adoption of a subsistence strategy incorporating part-time ceramic specialization. In many cases, the regions where specialization developed were agriculturally as good as or better than the places where the wares were consumed. Additional factors probably playing a role in the development of community-based craft specialization include environmental unpredictability (Ford 1972), differential distribution of pottery-making resources (Allison 2000; Harry 2000), and differences in potting skills (Crown 1995).

If, as anticipated, the Parowan Valley was the location of community craft specialization (see above), Harry's critique of the Arnold model will be supported, and an additional case study will be added to those given by Harry to help determine *why* community craft specialization develops. Conformity with Harry's model would also provide additional support for Talbot's (1996) and Janetski's (2002) arguments that trends in the Fremont area generally paralleled those observed in the greater Southwest.

Thesis Organization

The title of Chapter 2, "Re-exploring the Fremont" is an allusion to the 1989 book *Exploring the Fremont* by David B. Madsen. This publication has gained wide acceptance and is considered by many to be the definitive statement on the Fremont. The behavioral perspective exemplified in *Exploring the Fremont* leaves little room for discussion at a scale beyond that of the individual. I begin Chapter 2 by briefly recapping the history of Fremont research, highlighting three turning points that directly led to the dominance of behavioral archaeology in Fremont research. My research rejects individual behavior as the sole archaeological unit of analysis. I instead, opt for the macro-scalar view suggested by Janetski and Richard Talbot (2000a). I argue that at the macro-scale, the Fremont are definable and patterns, such as the ones I hypothesize above, can be discerned from archaeological evidence. A brief summary of Fremont culture history is also presented, providing necessary context for the remaining chapters.

Chapter 3 is the presentation of the first of two data sets – the chemical assay. Included are a discussion of relevant theory, the methodology I chose to implement, and the statistical analysis of the data; the raw data are tabulated in Appendix A. Chapter 3 addresses where Snake Valley Black-on-gray was constructed and tests the hypothesis that most of the pots of this type were constructed in the Parowan Valley. I also briefly discuss the variability of temper in Snake Valley pottery, ultimately addressing whether the "classic" Snake Valley pots tempered with the angular quartz, feldspar, and biotite triad are exclusive to the Parowan Valley.

In Chapter 4, I address patterning of Fremont exchange relations expressed in the distribution of Snake Valley Gray, Snake Valley Black-on-gray, and Snake Valley Corrugated. Particular emphasis is placed on Snake Valley Black-on-gray, the type analyzed in the chemical assay. I mapped distributions with Global Information Systems (GIS) models after a review of the literature where the quantities of Snake Valley pottery at excavated Fremont sites were tabulated. The collected data are given in Appendix B.

Variable ceramic typology conventions in the reports I reviewed prompted me to suggest revisions to the Fremont ceramic typology, bringing it more closely in line with the Southwestern ware-series-type system upon which it was originally based.

Chapter 5 is my discussion of each question proposed by Brown et al. (1990) and my evaluation of the four relevant models. This discussion is followed by a synthesis, along with suggested directions for further research.

Scope and Limitations

The scale of my analysis is intentionally broad, my goal being the identification of wide-ranging patterns of Fremont activity. This is especially evident in Chapter 4, where I refrain from discussing possible relationships between individuals or interactions between small groups of Fremont sites. The discussion is, instead, limited to patterns observable across the Fremont area. Smaller-scale applications of the research questions are certainly of interest but are beyond the scope of this research.

The chemical assay and distributional analysis are limited to Snake Valley Black-on-gray and the Snake Valley Series respectively. It is my hope that further research of this nature will be applied to other types, and eventually, will lead to sufficient answers to the questions posed by Brown at al. (1990) and a model of Fremont ceramic production and exchange.

Chapter 2: RE-EXPLORING THE FREMONT

By contemporary standards of Fremont archaeology, the research questions I am addressing here are at best unconventional. With a few exceptions noted below, Fremont archaeologists have been preoccupied with behavior and subsistence, largely ignoring or explaining away questions of non-subsistence economics, social organization, exchange, and ideology. This chapter "re-explores" the Fremont and the archaeological theories that have been applied thus far to their study. This discussion will show a need in Fremont studies for the kind of broadening I suggest and will justify my application of models and theory of a non-behavioral nature.

A Brief History of Fremont Research

Antiquarians and the earliest generations of archaeologists observed similarities between material remains now called Fremont and the Puebloans of the greater Southwest. Edward Palmer (1876, cited in Fowler and Matley 1978:23) was the first to go on record with this observation, noting the Puebloan characteristics of the pottery he discovered near present-day Payson, Utah. Neil Judd (1926) confirmed the affiliation of these remains with the Southwest, a determination that was accepted by A.V. Kidder (1924a, 1924b), and corroborated by Julian Steward (1933, 1936). Kidder (1924a) coined the term "Northern Peripheral Area" to describe the prehistoric farmers of the Utah area. The Northern Periphery soon became divided into two regions – Morss (1931) designating the Colorado Plateau farmers of the east as "Fremont" after his work along the Fremont River and Judd (1926) labeling the western Great Basin farmers as "Puebloan."

In the 1950s, Jack Rudy (1953) initiated the backlash against the "Northern Periphery" designation, arguing that the label marginalized Utah cultures and obscured their unique characteristics. Despite Steward's (1955) defense of the Northern Periphery, Jesse D. Jennings and other major players in Utah archaeology supported Rudy, arguing for the abandonment of the term "Puebloan" and the adoption of "Sevier Fremont" for western farmers and the preservation of "Fremont" for the eastern manifestation (Jennings et al. 1956:103). Though Jennings acknowledged some Southwestern influence on the Fremont/Sevier Fremont, he continued to maintain that these were merely diffused traits rather than some sort of deeper seated affiliation.

Under the guidance and/or influence of Jennings, the next generation of archaeologists began to pursue a more refined definition of the Fremont, including questions of regional patterning of material culture. Marwitt (1970) and Ambler (1966a, 1966b) revisited Steward's (1933) observations of diversity, positing models of Fremont regional variation. This focus on geographic variability was relatively short lived, quickly fading in the 1970s as subsistence studies rose primarily with the work of David Madsen. Based on the University of Utah's work in the Parowan Valley, Michael Berry (1972b, 1974) first proposed a subsistence model characterizing the Fremont as settled farmers practicing a lifeway similar to the Anasazi. Armed with data primarily from Backhoe Village in the Sevier Valley, Madsen (1979, 1980, 1982; Madsen and Lindsay 1979) countered vigorously that the sedentism observed in the Fremont area could have been based on wild resource exploitation.

Madsen (1982) later developed a series of continuum models of Fremont subsistence, with maize-eating settled farmers at one extreme and highly-mobile foragers at the other. Steven R. Simms (1986, 1990) continued the paradigm of Fremont variability with his adoption of Steadman Upham's (1984) "adaptive diversity," arguing against attempts to set boundaries on behavior in favor of studies on the level of individual decision-makers. Behavioral approaches, such as those posited by Madsen and Simms, now dominate Fremont studies, though notions of trait-based variation continue to linger. Janetski and Talbot (2000a:6) conclude their discussion of Fremont research with this assessment of the current state of research: "Notions of Fremont variation have evolved significantly over the past 75 years. From bounded area models based on artifact lists, the scenario has moved to accommodating complex strategy mosaics within regions."

Three Turning Points

Three events have had particular influence on the shape of current Fremont studies. The first was Jennings's rejection of a Southwestern paradigm for Fremont studies. While Rudy (1953) was the first to refute the Northern Periphery, it was Jennings who would hold the ears of future generations of archaeologists. A faculty member has significantly molded many a graduate student, but Jennings seems to have been particularly close to the scholars in his charge. Longtime friend, former student, and colleague, C. Melvin Aikens (1994:xii), notes that all Jennings's students were engendered with "that certain blend of striving, nervous anticipation (for some verging on fear) and, ultimately, respectful affection for their mentor." Much of this was probably due to his unremitting availability to his students.

> Unlike the latter-day professor who typically schedules but a few office hours each week for student conversation and consultation, Jennings was always there, and his door was always open. A student could depend on finding him interested and ready to act directly on the concern of the moment. (Aikens 1997)

Given this degree of influence and devotion, it is not surprising that almost none of Jennings students questioned his pronouncement on the Fremont and the Southwest (for an exception see Berry 1972a, 1972b, and 1974). Jennings's (1978) discourse on the Fremont in *Prehistory of Utah and the Eastern Great Basin* proved to be particularly influential.

After Jennings, the next most prominent figure in Fremont archaeology is David B. Madsen. After completion of graduate school, Madsen quickly ascended to the position of Utah State Archaeologist, beginning a substantial research program from what Janetski and Talbot (2000:5) call an "economic perspective." I disagree with this designation because Madsen was fixated on subsistence, only one item of the ancient economy. By Rhoda Halperin's (1994) definition, Madsen's work would be considered ecological rather than economic.

The weight Madsen placed on subsistence is perhaps best typified in his first major foray into the subject, the Backhoe Village report (Madsen and Lindsay 1977). At Backhoe (Figure 1.1), Madsen discovered cattail pollen on the floor of a pithouse, and it became the basis for his argument that the Fremont were largely exploiters of wild resources. Abandonment of the Norhern Periphery by Jennings and other archaeologists 20 years previous severed or weakened ties between the Fremont and the greater Southwest, but archaeology's perception of Fremont lifeways remained otherwise essentially unchanged. At the time the Backhoe report was published, the Fremont were still generally thought of as sedentary farmers largely dependent on maize agriculture. Madsen's (1979) new direction thrust wild resource exploitation into the forefront, leading him to define the Fremont as maize-dependent agriculturalists on the Colorado Plateau, and the remaining groups in the eastern Great Basin as the more wild resource dependent Sevier.

It is somewhat curious that Madsen became such an influential player in Fremont archaeology. Jennings directly molded several generations of archaeologists in his academic position at the University of Utah. As state archaeologist, Madsen had little direct interaction with students. But like Jennings, he *did* initiate and prolifically publish an intensive research program. Madsen's influence came with these publications, and as State Archaeologist he set the tone for archaeological research in Utah. With the departure of Jennings, the State Archaeologist's office became the premiere institution for archaeological fieldwork in the Fremont area, which further expanded Madsen's already growing influence.

In concert with Madsen's subsistence emphasis, the University of Utah Department of Anthropology began to develop a potent post-Jennings research perspective of its own, the origin of which can be traced to the arrival of James F.

O'Connell in 1978. Jennings was influential until his retirement in 1980, and he continued to wield some clout until his permanent departure in 1986. After this time, the University of Utah became increasingly concerned with hunter-gatherer archaeology, a trend mirrored by contemporary processual developments in American archaeology. Under O'Connell and others, the University of Utah Department of Anthropology (2005) became a program that specialized in "genetics, behavioral ecology, demography, hunter-gatherers, and evolutionary approaches to human behavior." The emergence of these emphases is the third turning point in Fremont Archaeology. 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 (Hawkes et al. 1997; Broughton and O'Connell 1999). In other words, behavior-oriented hunter-gatherer archaeologists were strongly influencing the study of a culture where farming very clearly was a major subsistence activity.

The current state of Fremont archaeology was largely shaped by the preceding three programs and biases – Jennings' rejection of the Northern Periphery, Madsen's subsistence focus, and the University of Utah emphasizing hunter-gatherers and behavioral ecology following Jennings's retirement. By and large, the Fremont today are studied from the traditional Great Basin research tradition with primary emphasis on subsistence, by researchers trained as or by hunter-gatherer archaeologists. In stark contrast to the majority of contemporary Fremont studies are the Clear Creek Archaeological Project (Talbot et al 1998, 1999, 2000; Baker and Billat 1999; Janetski et al. 2000) and other research by Brigham Young University (BYU) personnel (most notably Talbot 1996; Janetski 2002; Wilde and Soper 1999; and Janetski et al. 2005).

The Clear Creek Archaeological Project

BYU's involvement in the Clear Creek Archaeological Project began in the early 1980s with the awarding of a contract to the Office of Public Archaeology (OPA) to assist in mitigating the construction of Interstate 70 through Clear Creek Canyon. What began as a simple excavation of a small, open habitation site soon grew into the full-scale investigation of several sites, including the near complete excavation of Five Finger Ridge, one of the largest Fremont sites ever studied in detail (Janetski 1999).

The Clear Creek Archaeological Project sought 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" (Janetski and Talbot 2000a:7). They did so not by abandoning the work of Madsen and others, but by expanding on it. Subsistence is an important question in any archaeological analysis, but myriad other questions deserve equal consideration. In approaching the Fremont from a Southwestern perspective, the writers of the Clear Creek reports did not attempt to explain away the Fremont diversity that has been known since Steward's (1933, 1936, 1955) time but, instead, argued for multiple scales of analysis, asking questions about individual variation and large-scale patterning.

I share the Southwestern perspective of Janetski et al. (2000). By cutting Fremont studies off from the Southwest, researchers have alienated themselves from one of the richest bodies of theory in archaeology. I approach the problem of Fremont pottery production and exchange with a preconceived notion that the Fremont participated in the larger Formative Southwestern system, and have attempted to utilize a range of applicable theory developed there and elsewhere. As inspired by the Clear Creek Archaeological Project, reconciliation of the Fremont to the rest of the Southwest with this type of research would constitute a fourth turning point in Fremont archaeology, allowing Fremont researchers the opportunity to add additional suites of research questions to existing behavioral and ecological emphases.

Fremont Defined

In *Exploring the Fremont*, his now classic statement on the Fremont to the public, Madsen (1989:2-3) declared that Fremont are "characterized by variation and diversity and are neither readily defined nor easily encapsulated within a single description." On the *very next page*, he advised the public that if they "stumble on an archaeological site anywhere within the [the Fremont] region and find sherds of… distinctive gray pottery, [they] have found the remains of what we have come to call the Fremont." This and other similar contradictions have muddled Fremont studies for the last several decades, with researchers indicating that the Fremont are undefinable in their variation in one breath, and identifying any group with Fremont pottery as Fremont with the next. The idea that the Fremont are special and somehow exempt from being defined reflects the isolation in which Fremont studies have developed. Madsen (1979:711) indicates that a "satisfactory and explicit definition of the Fremont has not been produced in over 50 years of research – a failure which suggests that no comprehensive entity exists." Conceptions of the Fremont today have largely stabilized into two distinct camps, which differ significantly in their scale of archaeological analysis and definitions of culture.

Scalar Perspectives

Fremont "adaptive diversity" began as an argument for the existence of a Fremont farmer-forager subsistence system consisting of three coexisting strategies: full-time horticulturalists, part-time horticulturalists, and full-time foragers (Simms 1986, 1990). Eventually, the unit of analysis of Fremont archaeology became the behavior of the individual (Madsen and Simms 1998; Madsen 1986, 1989), a micro-perspective that produces results with "bewildering variation on every scale in every dimension" (Bettinger 1993:43-44). Janetski and Talbot (2000a) cite Brown and Price's (1985), argument for a more balanced approach – and subsequently adjust the scale of their analysis to enable a description of spatial and temporal patterning at the community and regional level.

Talbot (2004:85) concedes that both methods approach Fremont history at different scales (see Lekson 1996), neither of which is correct or incorrect, though the results are not always complementary. One approach emphasizes "broad patterns of social, economic, technological, or other relationships that together form a recognizable archaeological tradition or region, and the other focuses on individual decision-making" (Gumerman and Gell-Mann 1994:13). Definite patterns of "Fremont" culture are evident at the macro-scale applied in the Clear Creek Archaeological Project. At the micro-scale espoused by Madsen and Simms, few patterns are observable in the Fremont area nor would they be obvious in any another context.

Definitions of Culture

Two principal definitions of culture are currently operating among Fremont archaeologists. The Madsen and Simms (Madsen 1989; Madsen and Simms 1998; Simms 1986, 1990) approach of adaptive diversity perceives culture as "elastic, a kind of unbounded social environment in which individuals find themselves" (Madsen 1989:23). In this universe where more traditional conceptions of culture are cast aside in favor of "complexes" of varying individual behaviors (Madsen and Simms 1998), it *is* impossible to define the Fremont, or for that matter **any** culture because at the scale of individual behavior, culture cannot be defined. Janetski and Talbot (2000a:6) suggest that "not only does 'Fremont' remain undefined, to make definitions a goal is counter productive," though the volume in which this statement is contained could be interpreted as a very long definition of at least the large villages of the Fremont Central Area. The spatial and temporal patterns that emerge with the macrosystemic approach discussed above essentially become the opposing definition of culture. Talbot (2004:85) has recently clarified the nature of these patterns, offering this *de facto* definition of culture:

> …decision-making patterns that are reflected archaeologically in larger spheres of human interaction and through time. This includes not only local economic adaptations, but also broad scale settlement and subsistence strategies and

the social and ideological realms of the Fremont, including sociopolitical and integrative systems at the household, community, and regional levels, alliance and exchange systems, etc.

The Fremont as an Archaeological Culture

In a sense, seeking a definition of the Fremont is a moot point. The dominant theoretical perspective claims it is impossible, and the dissident minority insists that doing so isn't useful. What the two factions do seem to agree on is the need for a rough definition of the Fremont as an *archaeological* culture, a "constantly recurring assemblage of artefacts which are assumed to be representative of a particular set of activities carried out at a particular time and place" (Darvill 2002:109). Madsen (1989:67) proposes that the term "Fremont" should be applied as an "umbrella" to include a diversity of human behavior. Four relatively distinct artifact classes are identified as the material manifestations of this behavior: one-rod-and-bundle basketry, the "Fremont" hock-style moccasin, distinctive trapezoidal anthropomorphs depicted in rock art and clay figurines, and distinctive grayware pottery. The umbrella concept is declared "useful" by Janetski and Talbot (2000a:7), particularly in its rejection of bounded models of regional variation. To Madsen's list of common physical objects they add architecture and socio-economic emphases.

With a macroscalar approach, general material patterns among the Formative people north of the Colorado River can be delineated. The Fremont were fairly sedentary pithouse dwellers (Talbot 2000a, 2000b) for whom maize was a major food source, though an assortment of wild food resources were also exploited (for a summary of Fremont subsistence see Janetski and Newman 2000). A distinctive style of basketry, moccasin, pottery, and art distinguish the Fremont from their neighbors (Adavasio 1986; and Madsen 1989). These fairly egalitarian people, with four known exceptions, also buried their dead without preserved objects (Madsen and Lindsay 1977; Roberts 1991; Janetski and Talbot 2000a).

The people that shared these archaeologically observable characteristics may have recognized a variety of group affiliations among themselves. They may have shared a common language, but they just as likely could have spoken a variety of distinct languages or dialects. Some may have not even recognized an affiliation between their own kin group and other prehistoric farmers with the characteristics listed above. Regardless of how Fremont groups organized themselves socially and politically, the material culture traits shared across the Fremont area are meaningful, indicating some level of commonality. The nature and meaning of this commonality are beyond the scope of this research, and I recognize that this is a difficult subject to address with archaeological evidence. I argue, however, that the subject is an important one that demands further investigation. Rather than seeing the Fremont material culture complex as some sort of indicator of a pan-Fremont identity, I interpret these shared characteristics as the material manifestation of participation in an agricultural-based regional system north of the Colorado River (Janetski and Talbot 2000a) that archaeologists have identified as "Fremont."

Behavioral Perspective Assessed

Even at the macroscale, the strength of this pattern fluctuated both temporally and spatially across the Fremont area. These fluctuations have been chalked up to variable strategies by behavioral archaeologists. Much of this variability, however, can probably be attributed to farmer-forager relationships. During the Late Fremont period, in particular, the general pattern of Fremont material culture is strongest in the Central Core Area where it also reaches its most elaborate manifestation (Talbot 2004:89-91, Janetski et al. 2000). Areas most commonly held up as examples of Fremont foraging behavior are the Great Salt Lake Marshes (Coltrain 1994; Simms 1986; Simms et al. 1991) and the deserts west of the Wasatch Mountains (Simms et al. 1997). These areas contain sites where the Fremont material pattern, defined above, is weak, where it is argued that sites with some Fremont pottery and ephemeral structures represent a "Fremont" foraging strategy.

Spielmann and Eder (1994) have examined ethnographically known forager-farmer relations and how these data might be utilized to interpret the past. They identified complex, mutually beneficial exchange systems in which food (carbohydrates for meat), commodities, and labor were bartered. Complex social relationships were also identified, often including partial assimilation of foragers into the farming culture, or perhaps the adoption of farming customs by the neighboring foraging groups. Regardless and despite the mutual benefit both groups enjoyed, farming was the lifeway with higher prestige, and the foragers often went to great pains to fit in and become more like their farming neighbors.

Four approaches to documenting and assessing prehistoric farmer-forager interactions have been suggested. The first, variable settlement pattern, presupposes an ability to distinguish between hunter-gatherer and farming sites. Technological transfer (for example the presence of pottery produced by farmers at foraging sites) is also mentioned, as is intensification or reorganization of hunting strategies in response to increased economic demand from farmer interaction. Finally, relations of dominance and subordination are discussed. Though difficult to assess in the archaeological record, the degree of hypergyny is specifically mentioned as a significant indicator of group dominance.

To the south of the Fremont, where farmer abuts farmer, a clear social boundary exists (though see Madsen 1989). Fremont and Anasazi stylistic objects, such as rock art, architecture, and pottery are markedly distinct and serve as delineators of social boundaries (Geib 1996). To the west (Coltrain 1994; Simms 1986; Simms et al. 1991; Simms et al. 1997), north, and east (Smith 1992), where farmer adjoins forager, no such boundary exists and Fremont characteristics seem to grade into those of hunter-gatherers (e.g., the presence of Fremont pottery at hunter-gatherer sites). The details of these farmer-forager relationships are beyond the scope of this research; however, it seems most likely that the foraging behavior noted among groups manifesting Fremont characteristics where farmer meets forager are likely attributable to hunting and gathering groups "cozying up" to farmers, or to marginalized former farmers continuing an attempt to participate in what was probably a social system of higher prestige (Janetski 2002).

Fremont Culture History

The Fremont horticultural strategy gradually evolved from Archaic roots at "a differential rate depending on localized environmental and cultural factors" (Talbot et al. 1998:34). In a review of data from central Utah, Janetski (1993) describes this pattern of gradual trait accumulation by the indigenous population, identifying increasing permanence and formality in residential architecture and storage features as well as the arrival of corn (200 B.C.), bows and arrows (A.D. 200), and ceramics (A.D. 500). Other artifacts include Rose Spring, Eastgate, and Elko series projectile points, hock moccasins, and one-rod-and-bundle basketry. Talbot et al. (1998) designate this period of transition from 2000-1450 B.P. as Early Fremont, noting that few sites have thus far been dated to the period. Many questions about this early period, including settlement patterns, remain unanswered for want of data.

During Middle Fremont (1450-900 B.P.) times, Talbot et al. (1998) note a uniformity of residential architecture (shallow, circular pithouses) and the development of the "typical" suite of Fremont artifact types. These include physiographically bounded ceramic types, the Utah-type metate, and distinct beads, awls, needles, figurines, and stone balls. The typical settlement pattern consisted of nuclear household inhabitation of "rancherias" (Jennings 1978), where diverse resources were exploited. Increased dependence on horticulture probably also characterized portions of the Fremont during this period. This is particularly evident along the Wasatch Front, where population increases and aggregation began about 1050 B.P. An additional important Middle Fremont change is increasing Anasazi interaction and influence.

The Late Fremont period (900-600 B.P) "represents the culmination of Fremont development" (Talbot et al 1998:35). Populations continued to rise, particularly in the "central core area" (Talbot and Wilde 1989), defined as the Great Basin-Colorado Plateau transition zone from Willard Mound (Judd 1926; Steward 1933) in the north to Summit, Utah in the south. Major Fremont settlements are also founded in the west, from Upper Meadow Valley Wash in Nevada to the northern end of the Snake Valley, and in the east from Paradox Valley to Yampa Canyon. Architectural changes included increasingly deep and quadrilateral pithouses, on-site rectangular adobe storage structures, and large jacal adobe buildings. Corrugated pottery was developed, and painted pottery became increasingly more common. Projectile point types also diversified (Holmer and Weder 1980). The Formative period began to decline between 800-750 B.P. when the settlement (and probably subsistence) strategy rapidly shifted, resulting in the abandonment of some areas and, with the exception of the Bull Creek area (Jennings and Sammons-Lohse 1981), population reduction in the others. By 600 B.P. all material hallmarks of the Fremont have disappeared.

Conclusion

In this chapter, I have briefly summarized the history of Fremont research, identifying three key turning points that have shaped contemporary Fremont studies. These turning points are: the rejection of the "Northern Periphery" concept by Jennings, Madsen's subsistence/ecological emphasis, and the rise of behavioral perspectives at the University of Utah Department of Anthropology. I also implicated the Clear Creek Archaeological project as a possible fourth turning point, as it may signal a return to consideration of the Fremont in the context of the greater Southwest. I define the Fremont as an archaeological culture consisting of archaeologically observable characteristics, and summarize their culture history.

I have some questions as to the accuracy of Janetski and Talbot's (2000a) claim that behavioral micro-perspectives and the macro-perspectives they espouse can be complementary. The kind of behavioral archaeology being applied here mostly dismisses the possibility that complex economic and social arrangements existed among the Fremont, questions a researcher with a broad outlook would explicitly test. I leave the possible reconciliation of these research positions to others, having demonstrated at least a need for the kind of inquiries I pursue in the following chapters.

Chapter 3: CHEMICAL ASSAY

Three major methods of analysis have been employed in archaeological studies of ceramic provenience: (1) trace element analysis (Glowacki and Neff 2002; Neff 2000, 1992b; Speakman and Neff 2005; Freestone 1982), (2) petrofacies characterization of sand tempered pottery (Miksa and Heidke 2001; Heidke and Miksa 2000; various others but see Abbot 2000), and (3) petrographic analysis. Sand temper is a prerequisite for application of the petrofacies model, and petrographic analysis, while extremely useful when properly applied, is probably better utilized in a provenience study as an ancillary, supplemental investigation to one of the other techniques above (Stoltman et al. 1992). Since the non-plastic components of Snake Valley and most other Fremont pottery are not sand, ceramic provenience studies in the Fremont area are best carried out via elemental assay. This chapter seeks to answer two questions. Where was Snake Valley Black-on-gray manufactured, and what is the nature of the relationship between "classic" and "non-classic" Snake Valley pottery? I anticipated that classic Snake Valley Black-on-gray was manufactured in the Parowan Valley, and that non-classic pottery was manufactured elsewhere.

Research Plan

The fundamental proposition involved in the "sourcing" of archaeological artifacts is the "provenience postulate" (Weigand et al. 1977), which conditions provenience studies on extra-source variation exceeding inter-source variation. Neff and Glowacki (2002) identify two possible applications of the provenience postulate (Figure 3.1). Like in most ceramic analyses, I have undertaken this research with Approach 2, sampling several sherds of unknown provenience and sorting them into compositional groups with pattern recognition statistics, which will then be compared to raw material samples. The second approach was undertaken with the caveat that in this specific situation, Approach 1 may eventually be applicable. If I had succeeded in tracing Snake Valley Black-on-gray pottery back to distinct geologic units of ash-flow tuff (i.e., lithic outcrops), a database of known raw material sources could have been built with which future sherd samples could have then been compared.

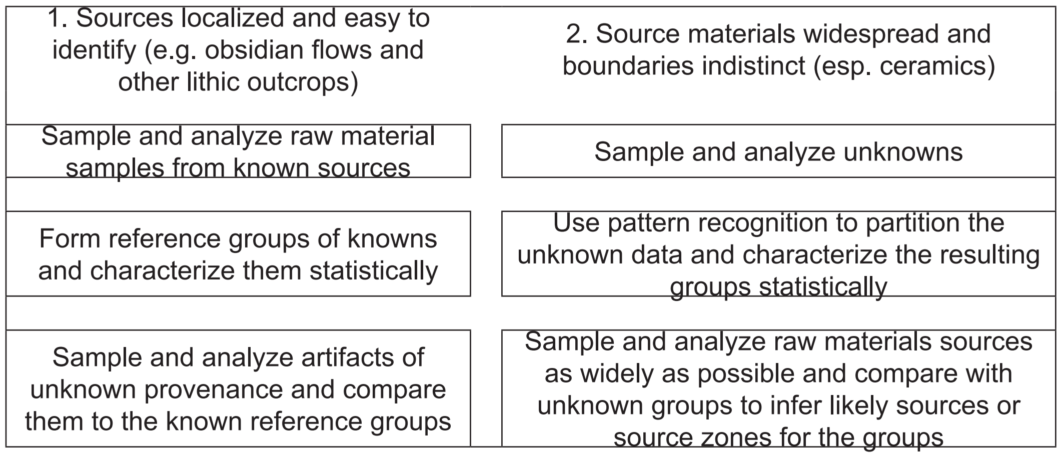

Figure 3.1. Two Approaches to Provenance Determination (from Neff and Glowacki 2002:6).

The design of this research was heavily influenced by Lyneis's (1994) hypothesis that Snake Valley pottery is constructed of decomposed/weathered volcanic tuff. I explicitly test this hypothesis by comparing my sherd samples directly to unaltered tuff samples rather than to primary clays. Approaching the problem this way is tenuous given the complex life-histories of ceramics in comparison to other archaeological material types often sourced (Neff and Glowacki 2002). In selecting *in situ* volcanic tuffs as the raw material source, I assumed a life history for Snake Valley Black-on-gray pottery of low complexity – a history of primary or "manufactured" clay (via grinding) which was not tempered nor significantly sifted or levigated prior to vessel formation and firing. I also assumed that little leaching or other digenesis occurred after the pottery was discarded.

If a pottery type could be sourced to a bounded geologic unit, it would then be a simple matter to determine the maximum production area of that type with the many detailed geologic maps available. This would be particularly useful if the multiple compositional groups revealed in Reed's (2005) study could be correlated to specific geologic units. A further possibility is the potential association of sherds with a specific geologic unit/source with a macroscopic or other relatively simple, inexpensive technique (e.g., refiring), which Abbot (2000) has argued should be a major objective in ceramic provenience studies.

Each of the sherd and raw material samples in my study has been analyzed by Inductively Coupled Plasma – Mass Spectrometry (ICP-MS) analysis. If the sherd samples from each site are chemically similar (i.e., from the same compositional group), or belong to groups demonstrated to be found in close proximity, then they were constructed in the same location. If these sherd samples then compare well chemically to a geologic unit or units in the Parowan Valley, Snake Valley Black-on-gray was primarily or perhaps exclusively produced in the Parowan Valley. The remainder of Chapter 3 details the sampling strategy I employed in the chemical assay, an explanation of the chemical assay and statistical pattern recognition methods utilized, and finally, the statistical analysis of the raw elemental data (Appendix A).

Sampling Strategy

Several lines of evidence point to the Parowan Valley as a production center for Snake Valley Pottery. Lyneis (1994) has presented data demonstrating a fall-off in the quantity of Snake Valley pottery as a function of northward distance from the Parowan Valley. As indicated above, Janetski (2002) has implicated the Parowan Valley as a possible central place where trade fair/festival gatherings regularly took place; a convenient forum in which Snake Valley pottery could have been acquired by visiting groups. Through a combination of petrographic analyses and refiring experiments, Schuster (1996) and Richens (2000a, 2000b, 1999) have both argued that the Parowan Valley was a primary source of Snake Valley pottery. The sampling strategy and methods of analysis detailed below were designed to answer this question. Was the Parowan Valley the major production center of Snake Valley Black-on-gray pottery?

I selected samples from three classes: sherd, raw material (in the form of bulk rock samples), and a few additional miscellaneous samples. The sherds are from Snake Valley Black-on-gray (and in the case of the South Temple site, some Snake Valley Gray) pots. The sherd samples were selected from the large Fremont settlements of the Parowan Valley, the hypothesized production area, and three additional large Fremont sites, Mukwitch Village, Baker Village, and the South Temple site (Figure 1.1). All remaining bulk rock and miscellaneous samples were taken from the Parowan Valley.

Sites Sampled

The sherd samples were taken from archaeological sites in the Parowan Valley and three additional sites. As the hypothesized location of Snake Valley Black-on-gray pottery production, I selected a large sherd sample and several raw material examples from the Parowan Valley for chemical analysis. I selected the other sites as representatives of large, distant sites with Snake Valley Black-on-gray pottery present in the ceramic assemblage. If the pottery at these sites is chemically similar to the sherds and raw materials in the Parowan Valley, then they were produced there and carried to the sites in which they were discarded. In the descriptions of each site below, I give particular emphasis to the Parowan Valley, the hypothesized zone of Snake Valley Black-on-gray production.

Parowan Valley

The Parowan Valley is located approximately 20 miles northeast of Cedar City in the southwestern portion of Utah, on the eastern edge of Great Basin physiographic zone; the nearby Hurricane Cliffs delineate the boundary between the Basin and the Colorado Plateau. Three perennial drainages (Red, Summit, and Parowan Creeks) once flowed into the valley but have since been diverted for modern irrigation. Shadscale and sagebrush dominate the valley vegetation. As elevation rises to the east, increasing quantities of pinyon and juniper are found, eventually transitioning to conifer and aspen communities (Berry 1972b). The Parowan Gap, a well known rock art site, and the Little Salt Lake, the likely locus of important marsh resources, are found to the west. Climate is typical of the southeastern Great Basin, and the average rainfall is 12.77 inches per year. The average frost-free period is 123 days (Berry 1972b). The major sites of the valley, Paragonah (42-IN-43), Summit/Evans Mound (42-IN-40), and Parowan (42-IN-100), occur on the valley bottom along prehistoric channels of the three perennial drainages listed above. These large sites are found within a 15 km radius of one another. As of 1970, the Parowan Valley had "probably been the scene of more [Fremont] archaeological activity of varying quality than any other part of Utah" (Marwitt 1970:5).

The early historical descriptions of the Parowan Valley sites are tantalizing in their implication of site size and complexity, the first of which came from Brigham Young in a letter dated 1851:

> We visited the ruins of an ancient Indian village on Red Creek, where we found quantities of broken, burnt, painted earthenware, arrow points, adobes, 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.

Many early historic accounts of archaeological sites should be considered suspect. In the case of the Parowan Valley, later excavations confirmed Young's description of the mounds at Paragonah (Janetski 1997:102). Young's descriptions of site size and density are intriguing. Several additional amateurs and quasi-professional archaeologists visited and worked in the Parowan Valley in the succeeding decades, and these other early descriptions compliment Young's account. Janetski (1997) has summarized much of this work, which was undertaken by the U.S. Geological Survey, Edward Palmer (on behalf of the Peabody Museum), Don Maguire, and University of Utah Professor of Natural History Henry Montgomery.

As part of the first generation of professionally trained archaeologists in Utah, Neil Judd's interpretations of the sites in and around Parowan greatly influenced future research. He worked throughout the state in the early twentieth century, spending a fair portion of that time at Paragonah. Based on observed similarities in architecture and pottery, Judd concluded that there was a strong relationship between the ruins of the Wasatch Front and the ruins of the Pueblo people of the Southwest (Judd 1926:152). His designation of the Wasatch Front culture as "Puebloid" or Puebloan continued well into the 1950s (Meighan et al. 1956).

The next major archaeological work that took place in the Parowan Valley was the 10 field seasons initiated in 1954 by Clement W. Meighan of UCLA. The 1954 excavations were summarized in a report published by the University of Utah Press (Meighan et al. 1956). The only other publication from these years is a preliminary report on the 1962 excavations (Alexander and Ruby 1963) given at the 1963 Great Basin Anthropological Conference. The major sites excavated during this period were Paragonah, Summit, and Parowan. Critical data from these excavations have lain fallow for over 40 years. BYU/OPA has been working for several years to prepare the artifacts and notes for analysis and publication as part of the Parowan Valley Archaeological Project (PVAP). My proposed research will be the first to benefit from PVAP as several sherd samples were taken from the UCLA collections.

Following the completion of work by UCLA in 1964, the late Richard A. Thompson continued excavating with Southern Utah State College (now Southern Utah University) at both Evans Mound and Median Village. The extents of these excavations is unknown and the notes, once thought to have been in possession of Michael S. Berry, are now rumored to have been destroyed or lost. Marwitt (1970) had knowledge of a partially excavated adobe storage unit exposed by Thompson at Median Village but was unaware of any details or published description. The “many years of excavation” (Dodd 1982 p.xi) conducted by Thompson yielded little in the way of publications, but his advice, assistance, and invitation prompted Jesse D. Jennings and the University of Utah field school to continue the excavations at Evans Mound.

Unlike the rest of the Parowan Valley excavations, Utah’s four field seasons at Evans Mound are well represented in the literature. The first three field seasons were published by Berry, then a University of Utah graduate student. Berry produced a subsistence model (Berry 1974), an interim report for the 1970-1971 season (Berry 1972a), and results and synthesis for the 1970-1972 field seasons (Berry 1972b). The final year’s excavation, 1973, was compiled by Walter A. Dodd, Jr., also of the University of Utah (Dodd 1982). Nearby Median Village was excavated in 1968 by University of Utah’s John P. Marwitt (1970) as part of the I-15 highway salvage project.

Mukwitch Village (Sevier Valley)

Mukwitch Village was excavated as part of I-70 mitigation undertaken by OPA (Talbot and Richens 1993) in central Utah (Figure 1.1). Though only one Fremont pithouse was uncovered during the limited testing, Talbot (1993) conducted a modern informant-based survey that identified Mukwitch Village as a small portion of a much larger Fremont settlement mostly obliterated by the development of the modern town of Richfield, Utah. Talbot’s proposed boundary for the site includes the well known Backhoe Village (Madsen and Lindsay 1977). Sevier Gray ceramics dominate at Mukwitch Village, representing 75 percent of the total assemblage. The remaining ceramics at Mukwitch consist primarily of the Snake Valley series, with some Emery series, and unclassified variant pottery also present. Mukwitch chronology is problematic. Three radiocarbon dates were obtained from the structure, ranging from 1390±70 to 1000±90 B.P. The presence of corrugated pottery on the floor and subfloor of the structure and its quadrilateral shape suggest a date late in the range of radiocarbon dates, sometime between A.D. 900 and 1050-1075.

South Temple (Salt Lake Valley)

The discovery of Fremont human remains during 1998 trenching by the Utah Transit Authority in downtown Salt Lake City prompted salvage mitigation by OPA, now known as the South Temple project (Talbot et al. 2004). These hasty excavations provide a glimpse into what was probably an extensive Fremont occupation of City Creek in the Salt Lake Valley (Figure 1.1). Seven possible structures, two ramada areas, and two very large depressions were excavated at South Temple, in addition to several extramural areas. Nine radiocarbon dates produced a weighted average date of 1008±19 BP, and a 1 Sigma probability that the dates fall between AD 1001-1025. Over 3000 sherds were recovered at South Temple, the vast majority of which are Great Salt Lake Gray. A small percentage (ca. 5%) of sherds from the Snake Valley series was also recovered. Most of the sherds appear to represent about 10 painted bowls. Petrographic and microscopic analysis indicate that much of what was called Snake Valley pottery lined up well with Madsen's (1977) definition of the type. Other sherds were thought to be from a limited, localized tradition of quartz-tempered pottery similar to Snake Valley but constructed from a distinct volcanic tuff (Lyneis 1994). I have submitted sherds from both "classically" tempered Snake Valley pottery and the quartz-tempered variant for analysis.

Baker Village

Excavated between 1990 and 1994 as a cooperative venture by personnel from BYU/OPA and the Ely District BLM office, Baker Village is the final site to be sampled in this research. Though smaller than the Parowan Valley sites, Baker Village is nonetheless extremely significant because a large portion of the settlement was completely cleared by excavators. The site is located in eastern Nevada in close proximity to the Utah-Nevada border (Figure 1.1). The site consists of at least five or six pithouses and seven above-ground storage structures carefully planned and arranged around a large Central Structure (Wilde and Soper 1999; Talbot 2000a). Radiocarbon data indicate a primary occupation of Baker Village during the mid-to-late 13th century.

A few dates from the A.D. 1000s and 1100s were also noted. Snake Valley ceramic types are the most abundant pottery in the Baker assemblage, comprising 37 percent of the typed sherd sample. Sevier Gray is the next most common ceramic type, followed by small quantities of Great Salt Lake Gray and Emery Gray. A significant number of sherds (25 %) could not be classified in the established Fremont taxonomy and are thought to be locally produced variants (Richens 1999). Schuster (1996) concurs with this hypothesis, further suggesting that the "classic" Snake Valley pottery tempered with quartz, feldspar, and mica was produced elsewhere – probably the Parowan Valley.

Objects Sampled

When possible, I selected pottery samples from dated, structural contexts. When this was not possible, I selected additional sherds that were large enough for analysis and were of the desired type. The raw material samples were taken from exposures of ash-flow tuff in Parowan Valley, the hypothesized production center of Snake Valley Black-on-gray pottery. Geologic units qualified for sampling if they (1) were near enough to the large Parowan Valley sites to have been exploited as raw material for pottery construction, and (2) contained at least the Snake Valley temper triad of quartz, feldspar, and biotite as mineral inclusions. Miscellaneous samples were objects discovered in archaeological collections from the Parowan Valley that might have been used as raw materials in pottery construction. This category includes several groundstone implements constructed from local ash-flow tuffs and a clay sample. These strategies of site selection and material sampling are discussed in greater detail below.

Sherd Sample

One hundred thirteen sherds were submitted for ICP-MS analysis. The Parowan Valley is represented by 59 Snake Valley Black-on-gray sherds: 19 from Paragonah, 20 from Parowan, and 20 from Summit (alias Evans Mound). Twenty-six sherds were taken from Mukwitch Village in the Sevier Valley: 21 Snake Valley Black-on-gray and

5 Sevier Gray. Sixteen Snake Valley Black-on-gray and 2 sherds tempered with quartz only make up the Baker Village sample, which is located in the Snake Valley. Finally, ten sherds were selected from the South Temple site in the Salt Lake Valley; six of which are classified as Snake Valley Black-on-gray and four as Snake Valley Gray (Table 3.1).

Table 3.1. South Temple Ceramic Samples.

Case No.	Sample No.	Ceramic Type	Classic/Non-Classic
21	98.237.2804.1	Snake Valley Black-on-gray	Classic
22	98.285.2438.24	Snake Valley Gray	Non-Classic
23	98.285.2422.6	Snake Valley Black-on-gray	Classic
24	98.237.2886.74	Snake Valley Gray	Classic
25	98.237.2933.3	Snake Valley Gray	Non-Classic
26	98.237.2113.1	Snake Valley Black-on-gray	Classic
27	98.285.288.23	Snake Valley Gray	Non-Classic
28	98.285.2511.8	Snake Valley Black-on-gray	Classic
29	98.237.2548.29	Snake Valley Black-on-gray	Non-Classic
30	98.237.2845.8	Snake Valley Black-on-gray	Classic

I initially only selected sherds found on the floors of dated structures. However, the preparation techniques employed in the analysis demanded a minimum sample size of 10g (see Sample Preparation below). This condition significantly limited the pool of sherds to select from, and I was unable to locate the requisite number of sherds from the desired contexts at any of the sampled sites. Samples were thus selected in two passes. In the first pass, I pulled all of the sherds from dated floor contexts that were of the appropriate size. These sherds were supplemented by sherds from a variety of contexts during a second pass, until the desired number of samples from each site was obtained. In the event that multiple sherd samples were selected from nearby proveniences, I took particular care to avoid re-sampling the same vessel. I accomplished this by carefully comparing designs, wall thickness, and form. The provenience of each sherd can be found with the raw data in Appendix A.

A different sampling strategy was employed at South Temple. Some sherds appeared to be from the Snake Valley series but departed slightly from the "classic" mineral triad of quartz, biotite, and feldspar. Four of these "Non-classic" sherds were included in the sample, along with six other "classically" tempered representatives (Table 3.1). The context of these sherds within the site varied, as it was not the primary criterion in their selection. As in the samples from the other sites, I am confident that the ten-sherd sample from South Temple represents as many different vessels.

Raw Material Sample

The Parowan Valley is an area of surprising geologic diversity (Maldonado and Williams 1993; Maldonado and Moore 1995). Following Lyneis's (1994) study, I have attempted to identify the specific welded tuffs in the Parowan Valley which mineralogically *could* match the quartz, biotite, and feldspar temper in Snake Valley Pottery. In other words, to be considered a candidate for this analysis, a welded ash-flow tuff had to contain at least feldspar and biotite. One unit without quartz was included in the sample. The units also needed to have been available (i.e. within the ethnographically determined maximum distance of 7 km for temper procurement [Arnold 1985]) to prehistoric potters living in one of the major Parowan Valley sites. Possibilities include the Harmony Hills Tuff, the Bauers Tuff Member of the Condor Canyon Formation, the Leach Canyon Formation, the Wah Wah Springs Formation, and the Lund Formation (Maldonado and Moore 1995). Ten bulk rock samples were submitted (Appendix A) from exposures around the Parowan Valley.

The Harmony Hills Tuff is a Miocene unit described as pale-pink to grayish orange pink, moderately welded, crystal rich trachyandesite to andesite ash-flow tuff (Williams 1967). Minerals include plagioclase (63 %), biotite (16 %), hornblende (9 %), quartz (7 %), pyroxcene (5 %), and trace amounts of sanidine. Local exposure of the unit is Parowan Canyon in the southwestern part of the Parowan quadrangle (Maldonado and Moore 1995). Two samples of the tuff are included in the analysis.

The Bauers Tuff Member of the Condor Canyon Formation is a resistant, light brownish-gray, densely welded, Miocene, rhyolite ash-flow tuff. Included minerals are plagioclase (55 %), sanidine (35 %), biotite (7 %), Fe-Ti oxides (3 %), and pyroxene (trace) (Anderson and Rowley 1975). The unit's exposure is immediately adjacent to the Harmony Hills Tuff in Parowan Canyon (Maldonado and Moore 1995). As with the Harmony Hills Tuff, the Bauers Tuff Member was unlikely to have been utilized as a source for Snake Valley Pottery due to its remote location and dissimilar mineralogy (i.e., high levels of sanidine and the absence of quartz). Two samples were collected and submitted for analysis.

The Oligocene epoch Leach Canyon Formation is shown locally only in a gravity slide block in Section 35, Township 34 South, Range 9 West (Maldonado and Moore 1995). The formation is grayish-orange-pink, rhyolitic, and partially welded containing plagioclase (35-45 %), quartz (25-30 %), sanidine (20-30 %), biotite (5 %), hornblende (2 %), and pyroxene (1 %) (Williams 1967; Anderson and Rowley 1975). Recent flooding had washed out the road leading to the block when I made the geologic collection, and its poorly accessible location (1,500 feet above the valley floor) discouraged me, and probably prehistoric potters, from visiting the unit. Several additional exposures of the Leach Canyon Formation are found in the Red Hills (Maldonado and Williams 1993) but are in an area poorly accessible by road. Ultimately, no samples of this unit were taken.

The Wah Wah Springs Formation is available only in a few small gravity slide blocks on the east side of the Parowan Valley (Maldonado and Moore 1995) but is found ubiquitously in Red Hills along the western edge of the Parowan Valley (Maldonado and Williams 1993). This Oligocene formation is a grayish-orange-pink, dacitic, moderately welded ash-flow tuff. Included in the tuff are plagioclase (70 %), hornblende (15 %), biotite (5 %), quartz (5 %), Fe-Ti oxides (3 %), sanidine (2 %) and pyroxene (trace) (Anderson and Rowley 1975). It is readily available in small quantities in the eastern portion of Parowan Valley near the major sites, and in much larger quantities in the Red Hills (Maldonado and Moore 1995; Maldonado and Williams 1993). I collected two samples for analysis.

The Oligocene Lund Formation is a simple cooling unit of moderately resistant, gray orange pink dacitic, ash-flow tuff containing plagioclase (69 %), hornblende (12 %), biotite (6 %), quartz (8 %), Fe-Ti oxides (3 %), sanidine (2 %), and trace amounts of pyroxene, apatite, and zircon (Anderson and Rowley 1975). The unit is present in large exposures in the Red Hills (Maldonado and Williams 1993) and two samples were obtained for analysis.

Miscellaneous Samples

Four additional samples were submitted from the Parowan Valley collection made by UCLA, including two manos made from a welded volcanic tuff and a ball constructed from a volcanic tuff. In testing these samples, I hoped to demonstrate that people of the Parowan Valley had access to the volcanic tuffs I hypothesized were the source material for Snake Valley Black-on-gray pottery. The fourth miscellaneous sample is clay containing quartz, biotite, and feldspar recovered from a Parowan Valley pithouse. This clay closely resembles Snake Valley pottery, and is probably the material from which the vessels were immediately formed. Whether the clay is decomposed tuff, a human mixed clay-temper recipe, or some other form is indeterminate.

Methodology

As explained above, sorting the samples into compositional groups first requires an assay of the elemental concentrations for both sherd and raw material samples. These values are then analyzed statistically with pattern recognition techniques to determine group membership. The specific methods I employed to obtain the chemical data and sort the samples into groups are detailed below.

Chemical Assay

During ICP-MS, samples are placed in solution by acid digestion prior to being heated to approximately 10,000°C where they form plasma. The excited atoms and ions are then measured with a quadrapole mass spectrometer, obtaining data for several elements in just minutes. The specific method employed in this analysis is four acid "near total" digestion. A prepared sample (0.25 gram) is digested with perchloric, nitric, and hydrofluoric acids to near dryness. The sample is then further digested in a small amount of hydrochloric acid. The solution is made up to a final volume of 12.5 ml with 11 percent hydrochloric acid, homogenized, and then analyzed by inductively coupled plasma-atomic emission spectrometry.

Though not the weak-acid partial digestion disparaged in the literature (Neff et al. 1996), four-acid, near-total digestion does dissolve only "nearly all elements for the majority of geological materials. Only the most refractory minerals, such as zircons, are partially dissolved using this procedure" (ALS Chemex 2004). Ideally, these data would have been combined with the Instrumental Neutron Activation Analysis (INAA) of Snake Valley pottery initiated by Reed (2005). The proprietors of the Missouri University Research Reactor (MURR), where Reed's analysis was conducted, have indicated that the data generated by these two methods are not comparable (Jeff Speakman, personal communication 2005). Even without questions of compatibility, the MURR analysis recorded different elements than the one reported here, ultimately making reconciliation of the data sets difficult, if not impossible.

Sample Preparation

I partially prepared the samples prior to sending them to ALS-Chemex, a commercial lab with an office in Reno, Nevada. Artifact samples were photographed, washed, and stripped of paint and catalog numbers with a silicon carbide burr. Bulk rock samples had their outer rind removed with a hammer and chisel. I then crushed all the samples into pieces roughly the size of a quarter. ALS Chemex further reduced the samples using a ring mill pulverizer. The pulverizer uses a tungsten carbide ring set, contaminating the samples with between 10 and 15 percent of both tungsten and cobalt.

All samples were pulverized to at least 85 percent of the ground material passing through a 75 micron screen.

Pattern Recognition

The ALS-Chemex analysis described elemental concentration values for 47 elements in the analyzed samples (Appendix A). Tungsten and Cobalt were removed from consideration in the analysis due to intentional contamination that occurred during sample preparation (see above). Barium, Chromium, Tin, Tantalum, Thallium, and Zirconium were not completely digested during sample preparation and were also omitted. Values for Tellurium and Rhenium were nearly all below detection levels, so these elements were also excluded; this left 37 elements for each analyzed sample. A sample occasionally returned a value below detection levels in some of the remaining elements. In these cases, I used the minimum detection value for that element.

The sample data were then transformulated to base-10 logarithms of concentration, partially compensating for differences in magnitude between major elements and trace elements. This conversion also yields a more normal distribution for many trace elements and is fairly standard for this type of analysis. The data were then subjected to a Principal Components Analysis (PCA), a technique that allows multivariate data to be evaluated in only a few dimensions. I identify initial groups with cluster analysis, and finally, evaluate the strength of these groups with Mahalanobis distance.

Principal Components Analysis

Principal Components Analysis (PCA) is a technique that can be used to recognize patterns (e.g., subgroups) in compositional data. A PCA generates several reference axes that are arranged in decreasing order of described variation. Samples can then be plotted by these new values, either to recognize patterns or to evaluate the coherence of hypothetical groups advised by other criteria (archaeological context, decoration, etc.).

As argued by the provenience postulate (Weigand et al. 1977), compositional variation among specimens should be larger for specimens in different groups than those in the same group. Groups should then be observable as areas of high density on plots of the first few components.

As discussed by Baxter (1992) and Neff (1994), PCA can be applied with both variables (elements) and objects (individual analyzed samples) displayed on the same set of principal component reference axes. An X-Y plot of the first two principal components is the best possible two-dimensional representation of the correlation structure in the data. The plot of object coordinates is the best two-dimensional representation of Euclidean relations among the objects in standardized log-concentration space. When combined into one figure, the resulting "biplots" can then be verified in plots of bivariate elemental concentrations. The biplots in this analysis are the variation of Baxter's (1992) type-3 biplot advocated by Neff (1994). The principal component scores in my analysis are the result of a simultaneous RQ factor analysis with variance-covariance matrix, generated with software written by Neff in GAUSS.

Grouping Procedure - Cluster Analysis

The main objectives of compositional analysis are to group like samples and associate them with production in a specific location or zone. I have selected cluster analysis to assist me in identifying potential compositional groups. Cluster analysis "requires that some measure of similarity (or distance) be calculated on the basis of the original data matrix, and then different algorithms are used to fuse cases into groups" (Duff 2002:98). Following Andrew Duff (2002.), I employed the hierarchical Ward's and average link algorithms, which enable display of aggregating, successive cases in dendrograms.

Group Evaluation - Mahalanobis Distance

A metric measurement known as Mahalanobis distance makes it possible to describe the separation between groups or between individual points and groups in multiple dimensions (Bieber et al. 1976; Bishop and Neff 1989; Neff 2001; Harbottle 1976; Sayre 1975). 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 (Speakman and Glascock 2005:2295-2296). I made the Mahalaobis distance calculations with software written by Hector Neff (1994) in GAUSS.

Statistical Analysis

The statistical analysis of the data follows the pattern outlined above. The relationships between the first three principal components are presented first with some discussion. I define some preliminary groups in the cluster analysis, and then evaluate the strength of these groups with the Mahalanobis distance measure.

Principal Components Analysis

Some grouping is evident with only a cursory view of the data. Figure 3.2 is a plot of Principal Component 1 and Principal Component 2 of all samples. All of the bulk rock samples fall well away from the vast majority of the sherd samples. The single raw material sample in the vicinity of the sherds is the lone clay sample. Snake Valley Black-on-gray pottery was clearly not made of weathered or ground up raw Parowan Valley tuff. Having demonstrated this, the bulk rock samples have no further bearing on intragroup homogeneity, and I have removed them from the analyses that follow.

I repeated the PCA without the bulk rock samples. In this iteration of the analysis, Principal Components 1 and 2 explain 33.19 and 15.02 percent of the total variance in the sample and are the best axes on which to display group membership. These components are plotted by type and site in Figure 3.3. The "Quartz Only" and Sevier Gray sherds, thought to represent local pottery production at Baker and Mukwitch Villages respectively, plot well away from the central cloud of Snake Valley Black-on-Gray pottery. The four sherds from South Temple identified as "non-classic" Snake Valley pottery also plot well away from the more traditionally tempered sherds. Interestingly, the remaining "classic" Snake Valley pottery from South Temple appears on the fringe of the primary cluster. Principal Component 3 explains 14.09 percent of the variance in the data set. The patterning of the South Temple pottery noted above is less clear in the plot of Principal Component 1 and Principal Component 3 (Figure 3.4).

Grouping Procedure - Cluster Analysis

The hierarchical relationships revealed by cluster analysis with Ward's and the Average Link algorithms are presented in Figures 3.6 and 3.7 respectively. I re-plotted the PCA with groups corresponding to the major color groups in the Ward's (Figure 3.8) and Average Link (Figure 3.9) cluster analyses, and used these as preliminary compositional groups.

Ward's algorithm generated three primary clusters. Cluster 3 contains the pottery classified as types other than Snake Valley Black-on-gray and the non-classic Snake Valley Samples. The primary point cloud is divided into two clusters (Cluster 1 and Cluster 2) split roughly along the Y-axis. The clusters overlap significantly in the plot of Principal Component 1 on Principal Component 2.

The Average Link algorithm generated eight clusters and 11 unclassified samples. Cluster 8 contains the two "quartz-only" sherds from Baker Village, and Cluster 7 contains two of the non-classic Snake Valley sherds from South Temple. Cluster 6 is limited to four of the five Sevier Gray sherds from Mukwitch Village. This leaves the primary point cloud divided into three large (Clusters 1-3) and two smaller, peripheral clusters (Clusters 4-5). The three largest clusters overlap and grade into each other on Principal Components 1 and 2.

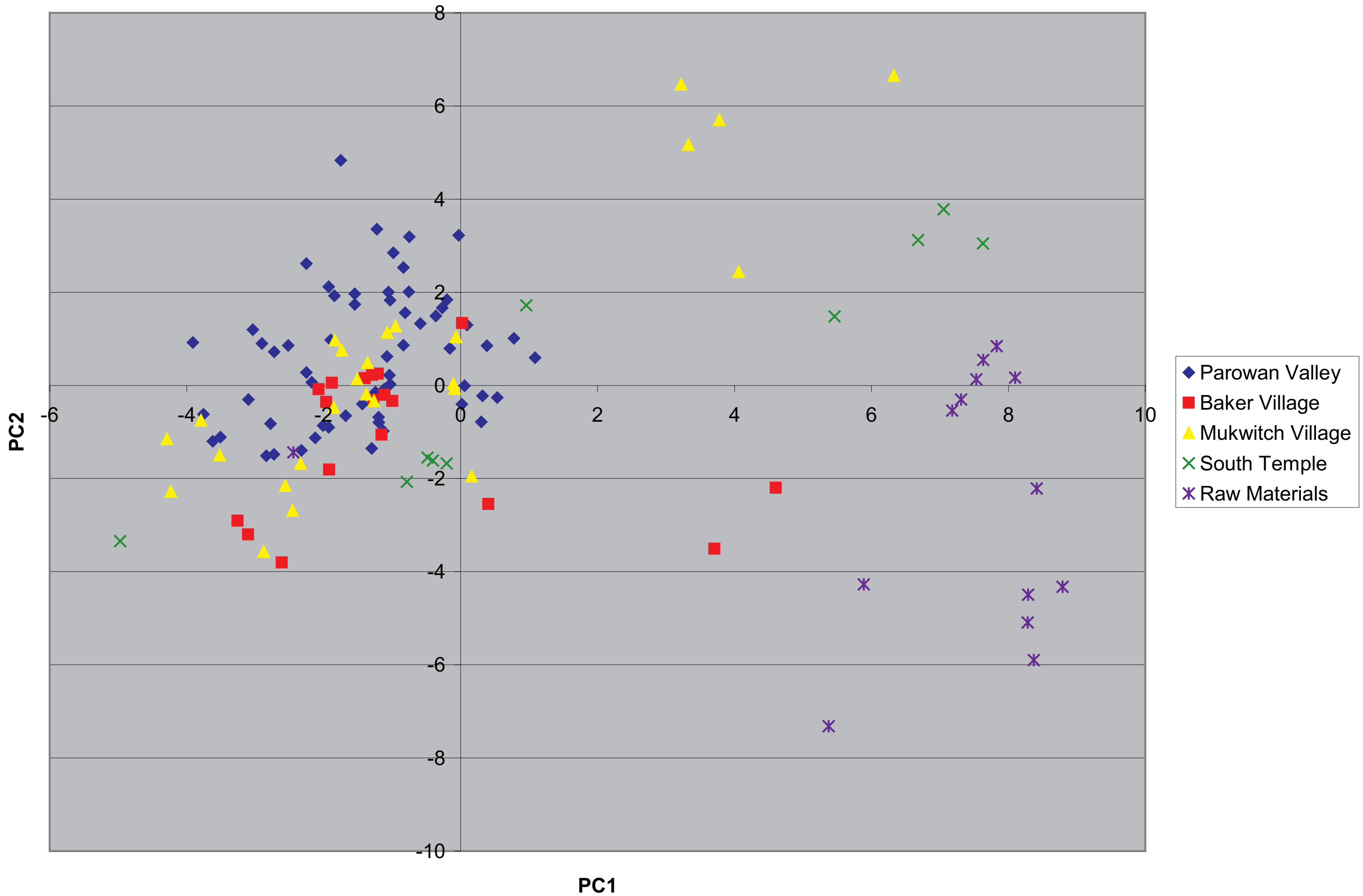

Figure 3.2. Plot of Principal Component 1 on Principal Component 2 by Site – All Samples Shown.

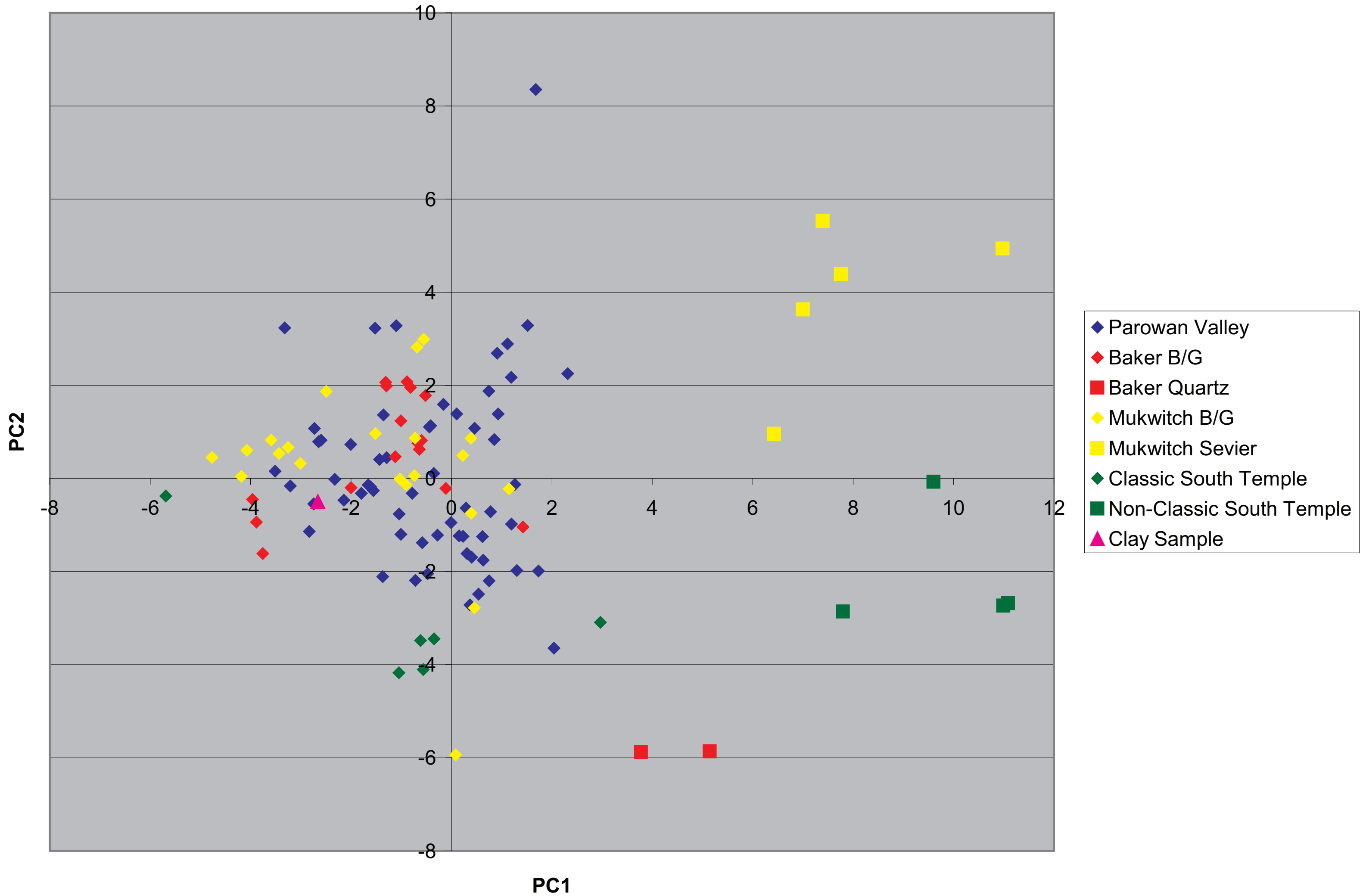

Figure 3.3. Plot of Principal Component 1 on Principal Component 2 by Site and Type – Bulk Rock Omitted.

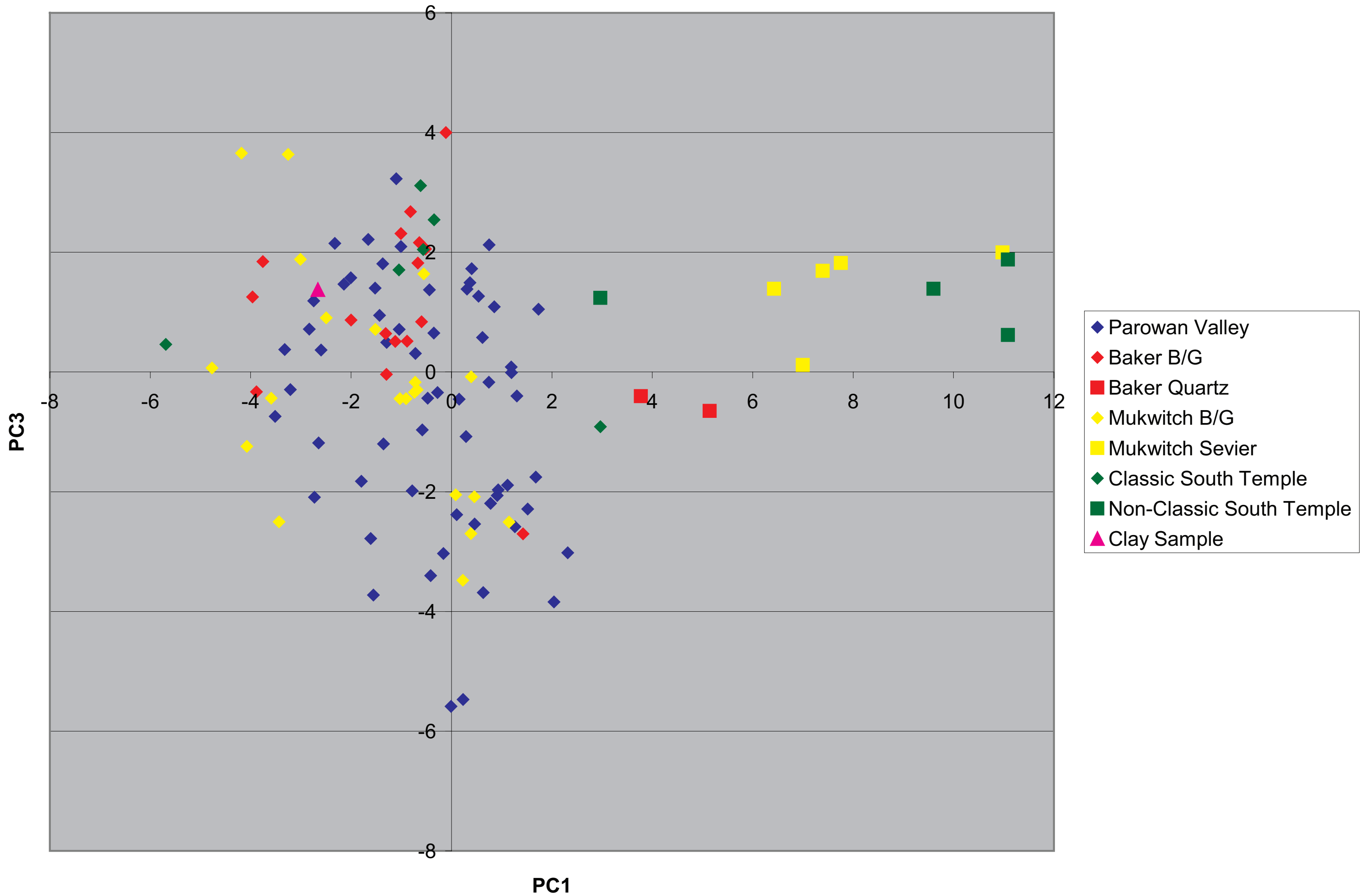

Figure 3.4. Plot of Principal Component 1 on Principal Component 3 by Site and Type – Bulk Rock Omitted.

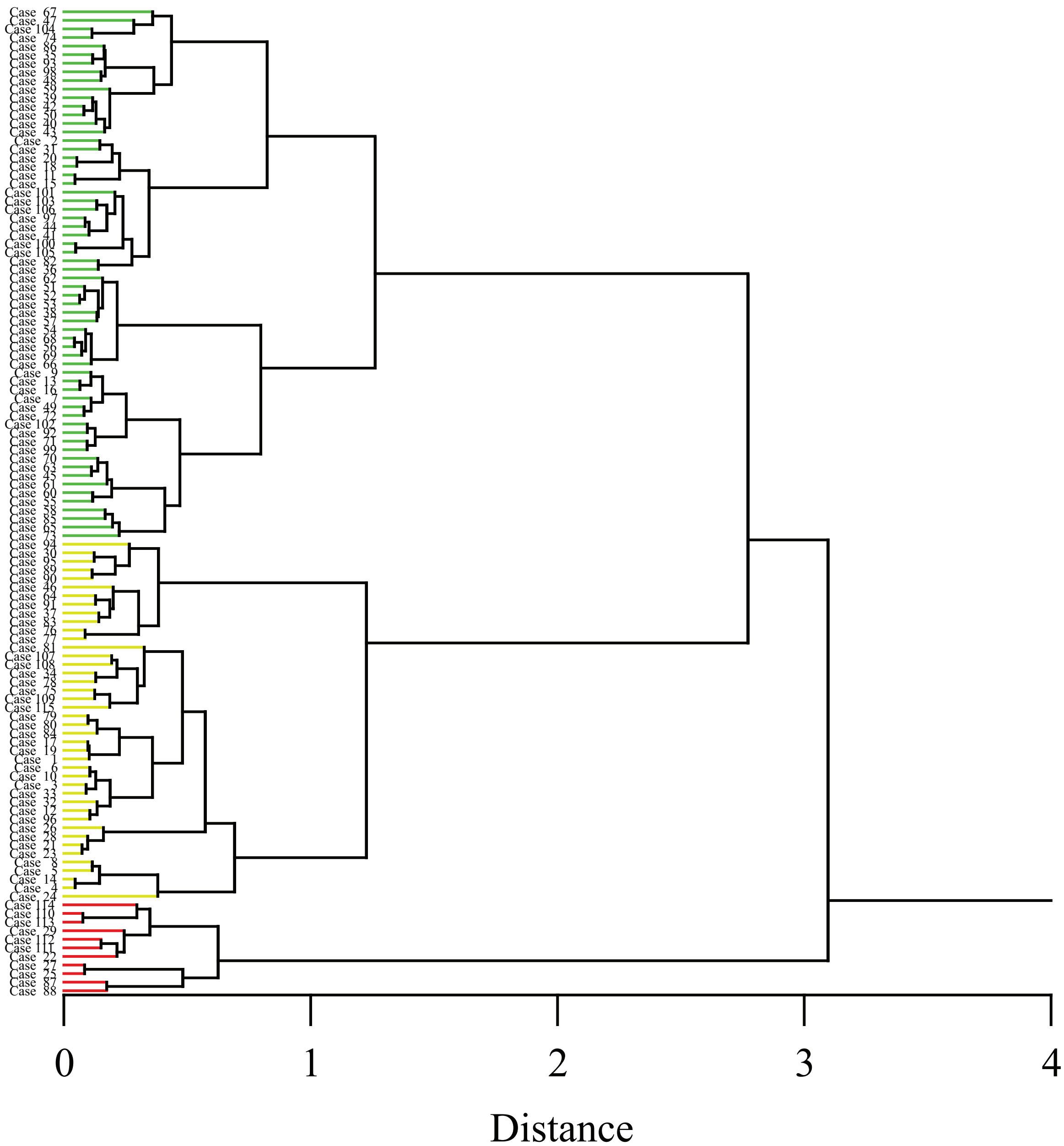

Figure 3.6. Cluster Analysis with Ward's Algorithm.

Group Evaluation - Mahalanobis Distance

I evaluated the strength of the groups suggested in the above cluster analysis with the Mahalanobis Distance metric. An initial pass (Figure 3.10) was promising, and I proceeded to eliminate samples with extremely low probabilities of group membership from consideration (P<0.1) in an attempt to produce groups. When I recalculated the Mahanalobis Distance values, however, the probabilities of group membership of the

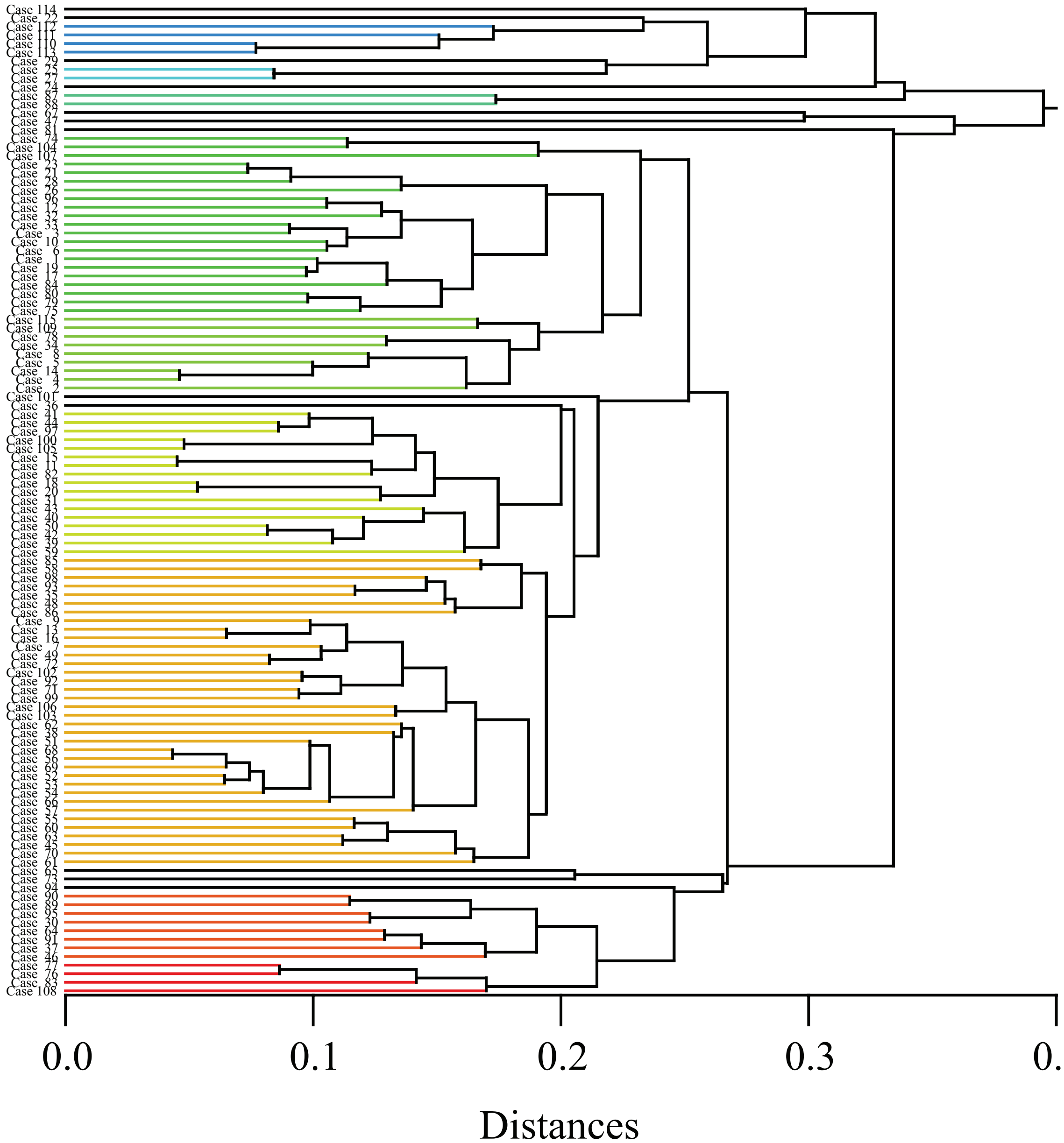

Figure 3.7. Cluster Analysis with the Average Link Algorithm.

remaining samples failed to increase. In many cases, samples that had boasted high Mahalanobis Distance values in previous group configurations returned extremely low probabilities of belonging to the group in smaller, supposedly “tighter” configurations.

There are three possible explanations for this phenomenon. First, the “near-total” digestion of the samples was inadequate, and has left chemically distinct compositional groups in the sample obscured. Second, the sherds in the sample were constructed from multiple related sources. The chemical relationship of these sources is close enough

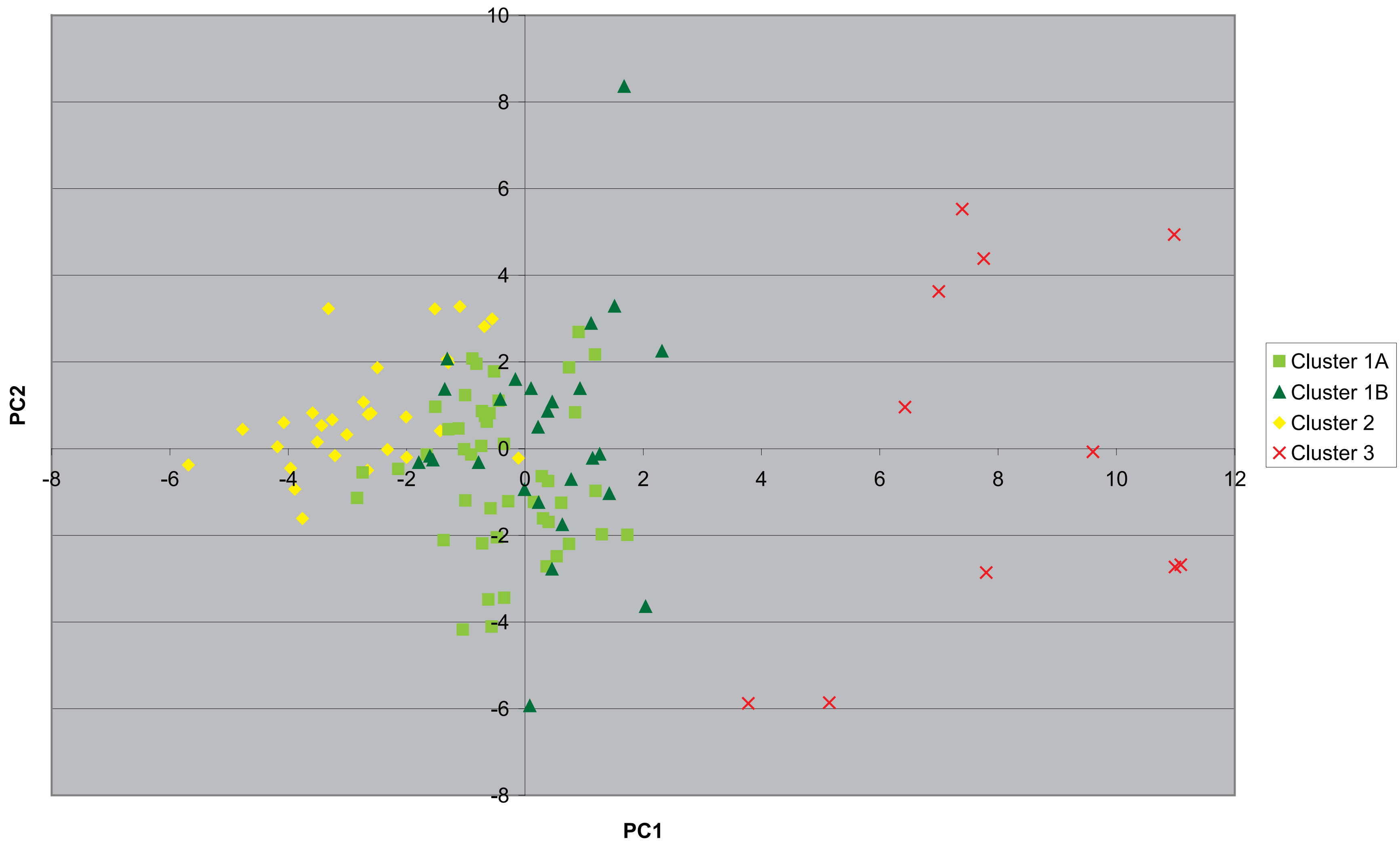

Figure 3.8. Plot of Principal Component 1 on Principal Component 2 by Ward's Clusters – Bulk Rock Omitted.

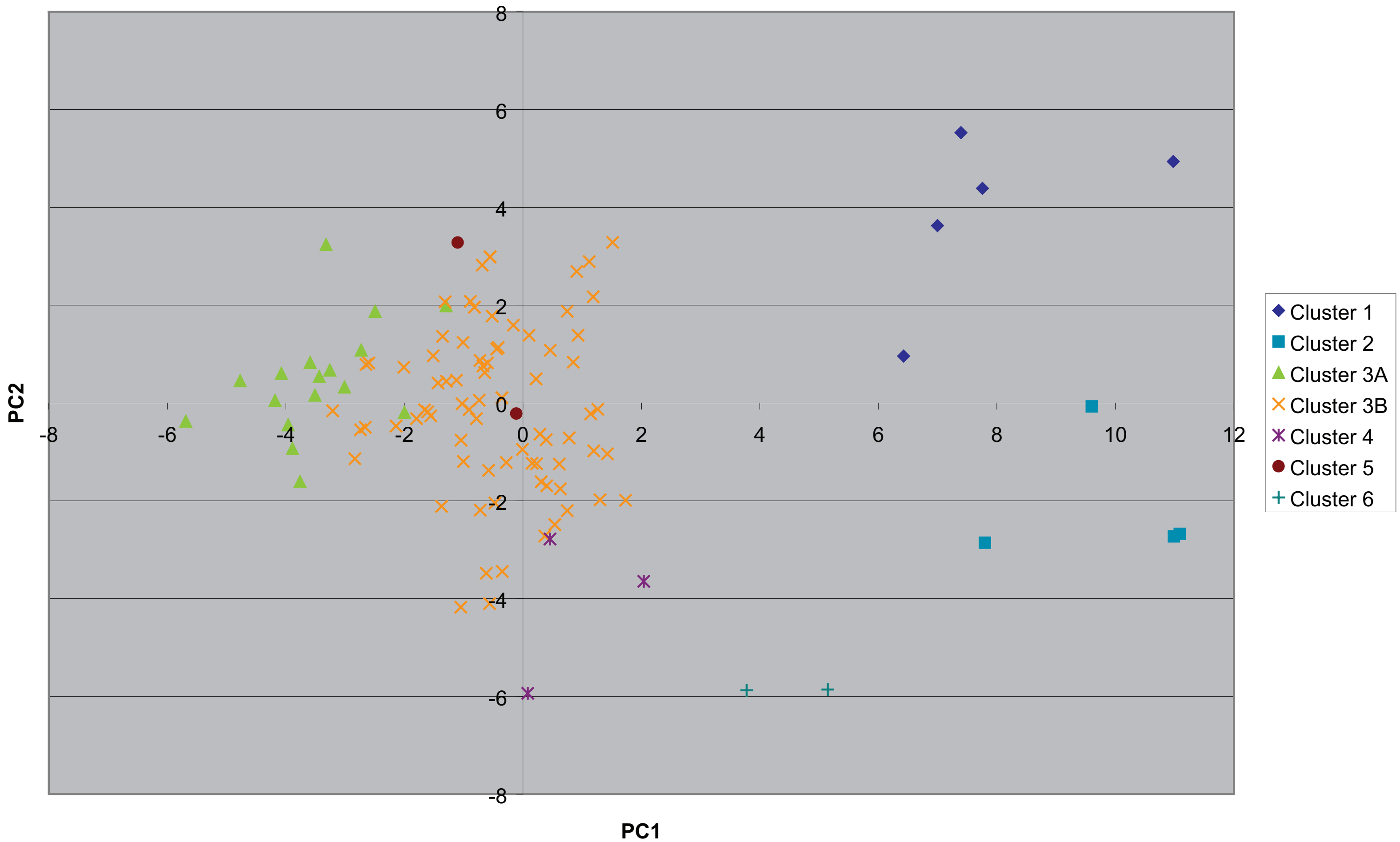

Figure 3.9. Plot of Principal Component 1 on Principal Component 2 by Average Link Clusters – Bulk Rock Omitted.

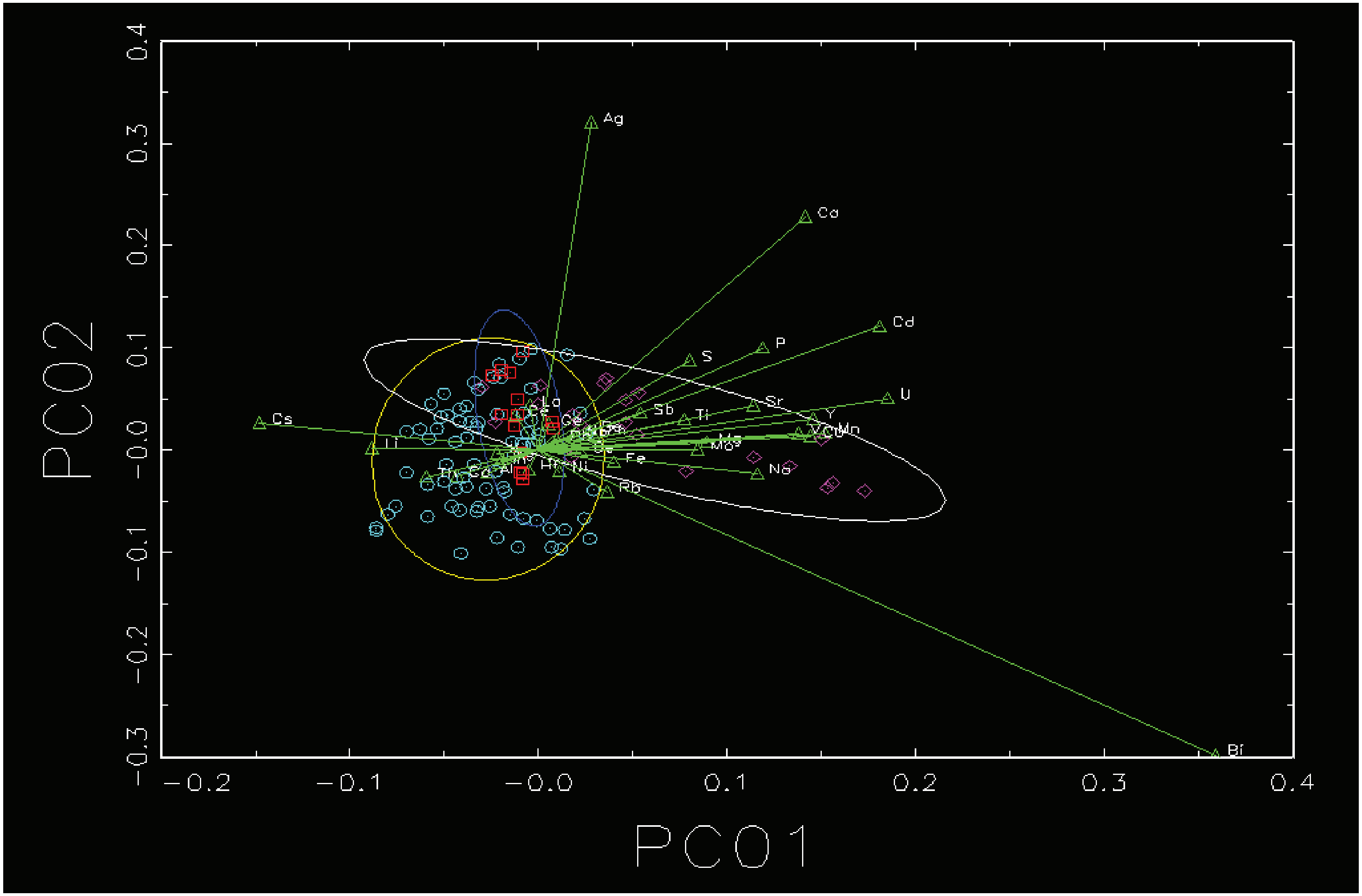

Figure 3.10. Initial Evaluation of Compositional Groups with Mahalanobis Distance Metric.

that the pottery cannot be sorted. In other words, there may be so many closely related compositional groups that they are impossible to distinguish with this sample set. Third, the source or sources of Snake Valley pottery is chemically indistinct or heterogeneous.

Summary

I subjected several Snake Valley Black-on-gray sherds from four large Fremont sites and some "non-classic" Snake Valley pottery from South Temple to ICP-MS analysis. I also submitted some raw material samples from the Parowan Valley to the same analysis. After analyzing the elemental concentrations with pattern recognition techniques, I make the following conclusions.

The Snake Valley Black-on-gray pottery in the sample was not constructed exclusively of the sampled volcanic tuff. This finding does not support Lyneis's (1994) hypothesis that Snake Valley pottery was constructed of weathered or decomposed volcanic tuff from the Parowan Valley. The similarity between the mineral inclusions in the Parowan Valley tuff units and the non-plastic portion of classic Snake Valley pottery does, however, suggest that these inclusions do contribute to the composition of the pots. Additional evidence for this is presented in Lyneis's work on pottery recovered from the first Kern River Pipeline investigation, wherein she identified increasing quantities of Fremont "variant" pottery as a function of northward distance from the Parowan Valley. These sherds appeared to share a common construction technique with Snake Valley pottery Lyneis had worked with in the Parowan Valley. They differed from classic Snake Valley pottery in their lack of the requisite mineral composition. Lyneis suggests that this variant pottery was constructed with the same technology as classic Snake Valley pottery, and that the different tuffs used in their construction led to the different mineral composition. This suggests utilization of volcanic tuffs in the construction of Snake Valley pottery and the variants identified by Lyneis, but the nature of that utilization is not currently understood.

Most of the classic Snake Valley Black-on-gray pottery sampled plots into a central point cloud on principal components. Ward's and Average Link cluster analyses suggest some divisions of this cloud in the form of overlapping clusters. These clusters, however, failed to materialize into compositional groups with believable probabilities of group membership. Assuming that the assay adequately measured the elemental variability in the samples, this indicates that most of the Snake Valley Black-on-gray sherds in the sample are related chemically, but that distinct compositional groups are not very well defined.

This central point cloud of Snake Valley Black-on-gray sherds is contrasted against those sherds thought to represent local manufacture. The latter group includes the sherds from Baker Village tempered only with quartz, the non-classic Snake Valley sherds from South Temple, and the Sevier Gray sherds from Mukwitch Village. The Baker quartz-only pottery and the non-classic Snake Valley pottery from South Temple are analogous with Lyneis's Fremont variant pottery from the Kern River Pipeline study – pottery that was manufactured like classic Snake Valley pottery, but with different raw materials. The implications of these conclusions are further discussed in the concluding chapter.

Chapter 4: A PATTERN OF EXCHANGE RELATIONS

In 1977 Rex Madsen produced maps identifying the maximum distributions of Fremont pottery types as then known, as well as "core areas" where a type dominated and was presumably produced. The intervening 28 years of research have yielded increased data and refined techniques in analysis. The data I present in this chapter enable me to develop of a pattern of exchange relations for the Snake Valley series.

In Chapter 1, I described my expectations for the distribution of Snake Valley pottery. They are that (1) the area of highest density (i.e., the "bull's-eye") of Snake Valley Gray pottery will be larger than that of Snake Valley Black-on-gray or Snake Valley Corrugated, indicating that as a utility ware it was more widely produced; (2) more Snake Valley pottery will be present on the west side of the Wasatch Mountains, which were a natural prehistoric barrier (Lohse 1980); (3) Snake Valley pottery will be little represented at Virgin Anasazi sites, indicating minimal trade and interaction; (4) there will be a higher occurrence of Snake Valley pottery at relatively large Fremont sites as suggested by Janetski (2002), and; (5) that the material will fall-off in all directions as a function of distance from the Parowan Valley (Lyneis 1994).

I approach these questions through Geographic Information Systems (GIS) density models, which enable distributions to be contoured in multiple dimensions. Distributions for all three Snake Valley types and for the Snake Valley Series collectively were determined from percentage data. I have generated an additional model for Snake Valley Black-on-gray limited to structural sites where the data is expressed as a ratio of numbers of sherds to residential structures, to explicitly test the Janetski (2002) trade fair-festival model. Prior to the presentation of this data, I discuss problems with the existing Fremont pottery typology how these problems affect the analysis. This chapter only contains the distributional models, the discussion of which follows in Chapter 5.

Fremont Pottery Classification

Fremont pottery classification is problematic. Unlike the rest of the Southwest where in-depth ceramic studies have long histories reaching back to the days of A.V. Kidder (1924), Fremont ceramic analyses have relied primarily on a single seminal work (Madsen 1977). A few additional influential studies were undertaken prior to 1970 (Rudy 1953; Madsen 1970; Lister 1961; Steward 1933, 1936). Most of the modern ceramic research efforts lie buried in gray literature or in University of Utah Anthropological Papers (Allison 2002; Lyneis 1994; Richens 2003, 2000b; Reed 2005; Geib and Lyneis 1996; Spurr 1993; Madsen 1986). Additional research (Stokes et al. 2001; Bright and Ugan 1999) on the ceramic mobility model proposed by Simms et al. (1997) has also been pursued.

Variation within Temper Groups

Variation (both perceived and genuine) lies at the heart of the confusion over Fremont ceramic classification. Fremont pottery is classified into the nine types (Madsen 1977) summarized in Table 4.1. In theory, the first characteristic by which Fremont pottery types are designated is temper, followed by the second characteristic, surface treatment. As in any taxonomy, these types are idealized categories into which less than ideal specimens are sorted. As such, the distributions discussed in this chapter are not representative of identically manufactured ceramics. Instead they depict the distribution of what has been designated as Snake Valley pottery by various analysts.

A case study illustrates some of the pitfalls involved in Fremont pottery classification. The Fallen Eagle site (Stokes et al. 2001, Figure 1.1) was excavated as part of a fiber optic line mitigation. Six thousand seven hundred and twenty-one sherds were recovered. Of these, 6523 were classified as Snake Valley Gray. The sherds were purported to have been classified following “the guidelines presented by Madsen (1977)” by identifying “temper material, temper size, wall thickness, and paste color” (Stokes et al. 2001:18).

Table 4.1. Fremont Pottery Types as per Madsen (1977).

Type Name	Temper Description	Surface Treatment	Additional References
Snake Valley Gray	Fine to medium angular particles of quartz (10-20%), feldspar (20%-30%), and biotite mica (5%-10%)	Smoothed	Lyneis 1994; Reed 2005
Snake Valley Black-on-gray	Fine to medium angular particles of quartz (10-20%), feldspar (20%-30%), and biotite mica (5%-10%)	Painted	Lyneis 1994; Reed 2005
Snake Valley Corrugated	Fine to medium angular particles of quartz (10-20%), feldspar (20%-30%), and biotite mica (5%-10%)	Corrugated	Lyneis 1994; Reed 2005
Paragonah Coiled	No Temper	Unsmoothed	Meighan et al. 1956
Sevier Gray	Medium (0.3-0.6 mm) to extremely coarse (larger than 1 mm) angular pieces of dark or gray basalt (15-40%) and quartz (0-15%) with occasional mica.	Smoothed	Richens 2000b; Madsen and Lindsey 1977; Spurr 1993
Great Salt Lake Gray	Mostly angular particles (0.1-1.0 mm) of quartz (10-30%), and mica - biotite and muscovite - (5%), with some rounded grains of sand	Smoothed	Richens 2003; Allison 2002
Unita Gray	Up to 40% angular crushed calcite (white and light pink) with occasional presence of quartz or crushed igneous rock	Smoothed	Storm 2006; Johnson and Loosle 2002
Emery Gray	Angular crushed fragments of gray basalt (20-40%) and quartz (10-25%) with occasional mica particle	Smoothed	Spurr 1993; Geib and Lyneis 1996
Ivie Creek Black-on-white	Ranges from angular crushed fragments of gray basalt (20-40%) and quartz (10-25%) to dark crushed basalt particles	Painted White Slip	Geib and Lyneis 1996; Lister 1961

Arguing that the standard Fremont typology is insufficient to distinguish locally produced pottery; the analysts also re-categorized the sherds into temper groups, reproduced in Table 4.2. In this second analysis, 6207 of 6721 sherds were placed in a "quartz-only" temper group. Since the analyses were undertaken independently, there is no way to tell how many of the sherds with quartz-only temper were classified as Snake Valley Gray. It is clear, however, that the vast majority of the sherds called Snake Valley Gray at Fallen Eagle contained quartz-only temper. The Fallen Eagle investigators (Stokes et al. 2001:18) acknowledge that "These identifications placed sherds into an idealized type, and may or may not imply a link to the traditional home ranges of a particular type." Quartz-only temper, however, is a far cry from "the guidelines presented by Madsen (1977)" for Snake Valley Gray.

Table 4.2. Temper Groups Identified at the Fallen Eagle Site.

Quartz Temper	Baked	Painted	Quartz Temper (lots of mica)	Black Temper	Feldspar Temper	Mixed Temper	Red Wash	Clay	Total
6207	250	141	42	38	32	8	2	1	6721

Following Rudy (1953), Madsen (1977:5-7) defines Snake Valley Gray as coiled, scraped, smoothed, and often burnished grayware. Temper is described as "Fine to medium angular particles of quartz (10-20%), feldspar (20%-30%), and biotite mica (5%-10%). Inclusions range from 0.1 to 0.5 mm. in diameter and average 0.2 to 0.3 mm. Tempering agents constitute 40-50% of the vessel wall." Snake Valley Black-on-gray and Snake Valley Corrugated have temper descriptions identical to Snake Valley Gray, differing only in the application of mineral paint and corrugated surface treatments respectively.

Lyneis (1994), who endorses a strict definition of Snake Valley Gray, has advocated the establishment of "Fremont Variants" which are also defined primarily on the basis of temper. These variants were observed north of the Parowan Valley along the Kern River Pipeline, and Lyneis argues that they represent the local application of Parowan Valley (i.e., Snake Valley) pottery manufacturing technology; the utilization of volcanic tuffs as source material. These sherds resembled the Parowan sherds she was familiar with (as they share a common construction method) but differed mineralogically, lacking the "classic" temper triad of quartz, feldspar, and biotite mica. One difference between the tuffs in the area where Lyneis identified the variants, and those in the Parowan Valley are the mineral inclusions. Thus the Fremont Variants, probably having been constructed from a volcanic tuff or a derivative, resemble "classic" Snake Valley Gray. Since the mineral inclusions of the tuffs are different, the non-plastic inclusions in the Fremont Variant pottery are different from those derived from Parowan Valley tuffs. Since the non-plastic pottery elements (a.k.a., temper) are not consistent with what has been defined as Snake Valley, the sherds were classified as a variant without a defined place in the typology.

Variation in temper exists in all Fremont pottery types and has been specifically discussed for Emery Gray (Spurr 1993; Geib and Lyneis 1996), Sevier Gray (Richens 2000b), Great Salt Lake Gray (Allison 2002; Richens 2003), Uinta Gray (Storm 2006; Johnson and Loosle 2002), and the Snake Valley series (Lyneis 1994). In each case the researcher argued for more in-depth compositional analyses of Fremont pottery variation, but not a revision of types. For the purposes of this analysis, I have included all pottery assigned to the Snake Valley series. This undoubtedly includes pottery which should not have been designated as Snake Valley under the strict definition I am advocating. I am unsure to what degree this will skew the distributions presented below, but I saw no solution to the problem which did not include a re-analysis of tens of thousands of pottery sherds.

Types, Series, and Wares

Most Fremont pottery is undecorated grayware and, as discussed above, temper is the primary characteristic by which type is determined. Common exceptions to the standard surface treatment are painted and corrugated vessels with Snake Valley temper (Snake Valley Black-on-gray and Snake Valley Corrugated) and slipped and painted pots with Emery temper (Ivie Creek Black-on-white). Early analysts assigned this regularly encountered pottery "type" status. As defined by Madsen (1977), Fremont pottery is classified in a two-tier system of ware and type (Figure 4.1), based first upon temper and then on surface treatment. This system has led to two glaring misconceptions.

While far from common, painted and corrugated varieties of other Fremont pottery types are now occasionally encountered. Some researchers type all Fremont corrugated pottery, regardless of temper, as Snake Valley Corrugated arguing that no other Fremont corrugated type has been formally defined (personal communication, Dee Hardy 2004). The same problem occurs when painted, unslipped pottery tempered with material other than quartz, biotite, and feldspar is encountered. Since no formal Sevier, Salt Lake, or Uinta Black-on-gray types have been defined, analysts may be tempted to classify these sherds as Snake Valley Black-on-gray. There is also a temptation to call *unslipped,* painted pottery with basalt temper Ivie Creek Black-on-white; since technically, there is no Emery Black-on-gray category in the typology.

A system limited to only two tiers also masks the relationship between types in the second tier. Looking at Figure 4.1, one might think that Snake Valley Gray and Sevier Gray are as different as Snake Valley Gray and Snake Valley Corrugated. This is not the case, as the Snake Valley types differ only in surface treatment and Snake Valley Corrugated and Sevier Gray differ in both temper and surface treatment.

A three-tier system consisting of ware, series, and type was introduced by Colton and Hargrave in 1937. Their system is still the basis for most Southwestern pottery classification. The basic unit of the system, type, is defined as "a group of pottery vessels which are alike in every important characteristic except (possibly) form" (Colton and Hargrave 1937:2). General characteristics include surface color, method of clay handling, composition of temper, composition of paint, and styles of design. A series consists of types bearing a "genetic" relationship to one another. In the case of the Fremont, the genetic relationships are "collateral developments or variations from any type" (Colton and Hargrave 1937:3). An example of this in the Fremont area is Snake Valley pottery, in which the later painted and corrugated varieties grew out of an existing grayware tradition (Madsen 1977). Finally, a ware "is a group of pottery types which has a majority of (the above) characteristics in common but that differ in others" (Colton and Hargrave 1937:2). Fremont pottery fits nicely into this type, series, ware system (Figure 4.2).

Based on color and general method of manufacture, Madsen (1977) defined three ceramic traditions (wares) in the Fremont area, Desert Gray (Rudy 1953), Promontory Gray, and Ivie Creek Black-on-white. Grant Smith (2004) argued convincingly that Promontory pottery has no Fremont affiliation (see also Janetski 1994), and as such it has been omitted from this discussion. Ivie Creek Black-on-white was never accepted as a distinct tradition, and it is now always included as part of Desert Gray Ware, which is technically defined as coil and scraped pottery tempered with a variety of igneous and sedimentary materials present throughout the duration of Fremont culture history (Madsen 1977:v-vi). My proposed three-tiered restructuring of Fremont pottery classification surmises all Fremont pottery under this single ware (Figure 4.2).

The key variable in the definition of the proposed series is temper. In general, grayware pottery predates painting, corrugation, and other surface treatments in the Fremont area. Though some chronological questions remain, it is probably safe to assume that all other surface treatments are derivatives of an original plain gray construction (i.e. collateral developments). Each of the five major temper groups, Sevier, Salt Lake, Uinta, Emery, and Snake Valley, are allotted a ceramic series into which various types can be assigned (Figure 4.2). Types in a temper series are then determined on the basis of surface treatment, the most common being plain gray, corrugated, painted (black-on-gray), and slipped and painted (black-on-white).

Many researchers (Allison 2002; Richens 2003, 2000a, 2000b, 1999; Lyneis 1994) are already using *de facto* versions of this system, and several "types" have been identified but not formally defined. Referring to the Snake Valley types as a "series" has been common in the literature for some time, and variable surface treatments (for example Snake Valley Red-on-gray discovered by Allison [2002] at the Salt Lake Airport) have been referenced without the kind of formal definition some might expect. Some of these rare, currently undefined variations are shown in red in Figure 4.2. The more commonly occurring, better understood types are shown in black.

Paragonah Coiled has been intentionally left out of this figure. It is roughly equivalent to the miniature mudware found elsewhere in the Southwest and is probably not a "type" in the same way that the others are. These crudely-made vessels are cobbled together with whatever local muds were available, and were produced in an entirely different fashion and context than most Southwestern pottery. Paragonah Coiled is

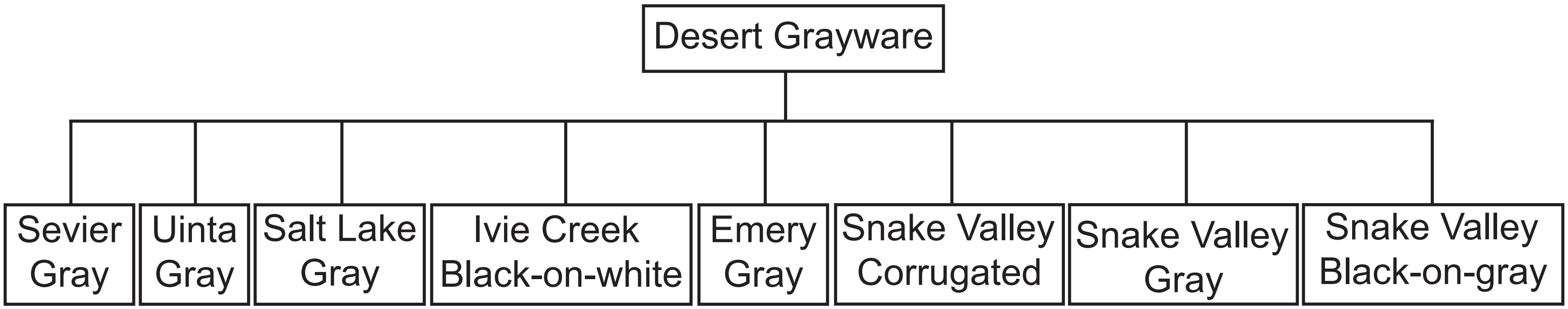

Figure 4.1. Relationships Between Fremont Pottery Types under the Current Typology.

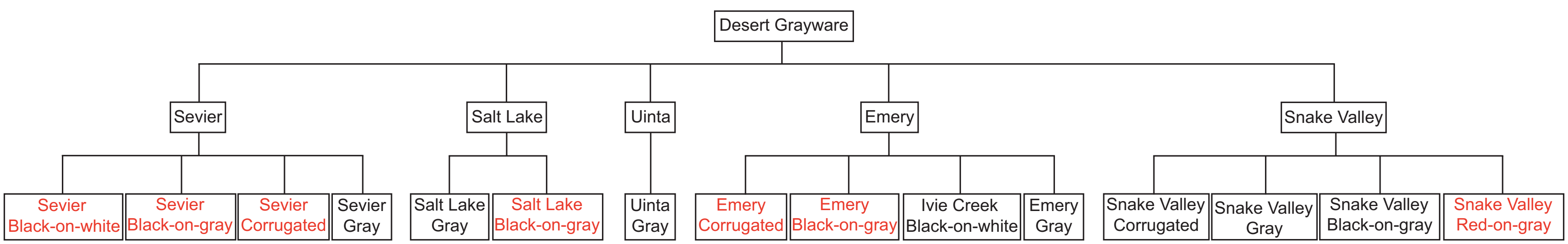

Figure 4.2. Figure 4.2. Proposed Reclassification of Fremont Pottery in a Type-Series-Ware System -- Rare Types in Red.

better characterized as the local version of a greater Southwestern mudware tradition, an interesting research topic, but not one that belongs in this analysis or typology.

Though they would not fit well into the typology, I have identified three distinct ceramic tempering "technologies" in use by the Fremont: the addition of crushed igneous rock to clay (the Sevier, Emery, and Great Salt Lake Series), the addition of crushed calcite to clay (Uinta Series), and the exploitation of volcanic tuffs as either temper or as both fabric and non-plastic inclusions (Snake Valley Series). Uinta Gray potters may have simply been using crushed calcite in the absence of available igneous rock, which then leaves two ceramic tempering technologies in the Fremont area. These common technologies indicate at some level a shared knowledge and tradition of pottery manufacture.

Despite the variation in Fremont pottery, ceramic types remain very useful constructs for archaeological analysis. If the typology is consistently followed, the utility of ceramic types will correspondingly greatly increase, allowing for more accurate discussions of distribution, exchange, and shared traditions among the Fremont.

Methodology

The data I used to generate the models presented below were collected from an extensive, but not exhaustive literature review of excavated sites. These data were transformed into ratios of type against the total ceramic assemblage (i.e., percentages), and for Snake Valley Black-on-gray as a ratio of the quantity of sherds divided by the number of residential structures. I generated the models with the Inverse Distance Weighted (IDW) algorithm, the least predictive of the available methods. The data are graphically rendered as "contour" maps depicting the density of Snake Valley pottery. The raw data are presented in Appendix B.

Data Collection

The data used to generate the distributional models were gathered in a substantial literature search of excavated and tested sites. I included the University of Utah Anthropological Papers, BYU Museum of Peoples and Cultures Occasional Paper and Technical Series, and other well-known monographs and gray literature in my review. The data fields I chose to include are the total numbers of sherds in the ceramic assemblage, quantities of each member of the Snake Valley series, an "other" Snake Valley category including oddities such as incised and corrugated/painted sherds, and the number of residential structures at each site. I also gathered dates and cultural affiliation when such information was available.

Consistent with the current standard in North American archaeology, Universal Transverse Mercator (UTM) coordinates, legal descriptions, or longitude/latitude coordinates were not given in most of the documents published in the last 20 years. When legal descriptions or longitude/latitude locations were given, I translated them into UTMs with Daniel Gustafson's on-line Graphical Locator (http://www.esg.montana.edu/gl/). Where locations were only given on a map, I approximated their locations with the same website. All UTMs are expressed as though they were in Zone 12 N. The Nevada sites were converted from UTM Zone 11 N.

This database is unfortunately far from complete. Several large residential sites such as Smoking Pipe, Nawthis Village, and the Kanosh and Willard mounds were excavated prior to the establishment of the current pottery typology or have not yet been adequately published. These sites would have been particularly useful in evaluating the Janetski trade model. Most of UCLA's Parowan Valley excavations are also not included in the sample, though they would only increase the strength of the density already apparent given the University of Utah and Meighan excavations. The relatively small number of sites in the sample (n=108) is also a problem, but there are enough cases that I believe the general trends are still be viable.

GIS Modeling

Inverse distance weighted interpolation determines cell values using a linearly weighted combination of a set of sample points. The "weight" in IDW is a function of inverse distance. IDW lets the user control the significance of known points upon the interpolated values, based upon their distance from the output point. By defining the higher power option, even more emphasis can be put onto the nearest points. Thus, nearby data will have the most influence, and the interpolated surface will have more detail. Conversely, specifying a lower power will give more influence to those of the surrounding points which are a more distant. The characteristics of the interpolated surface can also be controlled by limiting the input points for calculating each interpolated point. The input can be limited by the number of sample points to be used, or by a radius within which all points will be used in the calculation of the interpolated points (Philip and Watson 1982; Watson and Philip 1985).

Each figure was generated in ArcMAP 9.0. Interpolation was made with the IDW algorithm to the fourth power, with the data classified into nine quantiles. Though IDW is a minimal predictive method, artificial zero points were inserted near the edges of the map to keep ArcMAP from projecting high distributions into areas known to contain no Snake Valley pottery. I opted to manually smooth some of the jagged edges in the figures prior to rendering them here to increase the ease of their readability.

Distributional Models

Renfrew (1977; Renfrew and Bahn 2000) has suggested several models describing the archaeological distribution of goods (Table 4.3). Coercive power or control is a prerequisite of the Port of Trade, Colonial Enclave, Emissary Trading, and Central Place Redistribution models, the type of coercion that does not exist in small-scale societies such as the Fremont. These models can be safely dismissed as improbable models of Fremont exchange. Direct Access applies only to raw material procurement, and since the product in question is manufactured pottery, this model is also omitted from consideration in this case. The "middleman" in Freelance Trading is at least a part-time specialist. The amount of time which part-time specialists were able to devote to subsistence activities other than food procurement in the Fremont area is unknown, but the small scale of the society argues that that time was probably minimal. While some Fremont middleman exchange may have taken place, it would have been very limited, contributing minimally to the overall Fremont trade.

Table 4.3. Models of Exchange (Renfrew and Bahn 2000).

Direct Access	A group has direct access to a material source. If territorial boundaries exist between the group and the source, they may be crossed with impunity.
Reciprocity (Home Base)	One group visits another at their home base where they exchange their respective specialized products.
Reciprocity (Boundary)	Two groups meet at their common boundary for exchange purposes.
Down-the-line	Reduplicated forms of the above two interactions, in which a commodity travels across successive territories through successive exchanges.
Central Place Redistribution	A group brings some of their goods to a central place as tribute to a central person. Some of these goods are redistributed to other groups likewise bringing tribute
Central Place Market Exchange	A group brings goods to a central place where they exchange with other groups who have arrived for the same purpose. The central person is not necessarily involved in the exchange.
Freelance (Middleman) Trading	The middleman exchanges with multiple groups, but is not under their control.
Emissary Trading	A group sends an emissary, who is under their control, to other groups to exchange.
Colonial Enclave	A group sends emissaries to establish a base of operations near another group to facilitate trade.
Port of Trade	Groups send emissaries to a neutral central place for exchange.

The remaining models can be classified into two general groups, Down-the-line and Directional Trade (including Central Place Redistribution and the two reciprocity models) (Renfrew 1977). In the Down-the-line model, quantities of the exchanged good decrease as a function of distance from the source; the receivers retaining a portion of the goods prior to passing the rest to the next closest locality. Unlike Down-the-line exchange, directional traders bypass some groups resulting in an uneven distribution of goods (Figure 4.3). Both of these distributions have been suggested as applicable models of exchange in the Fremont area.

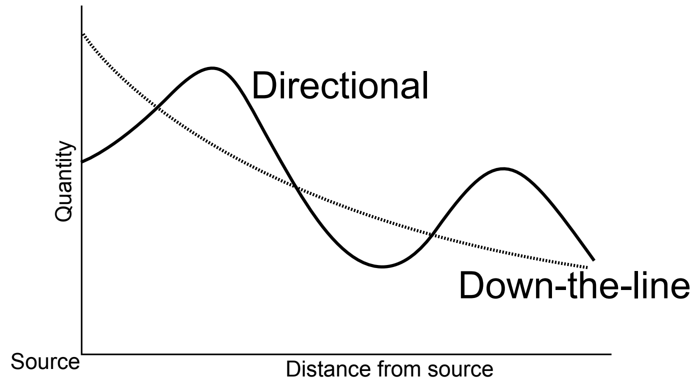

Figure 4.3. Distributions of Down-the-line and Directional Trade (Renfrew 1977).

Preliminary data generated by the Kern River Pipeline mitigation (Lyneis 1994) indicates fall-off of quantities of Snake Valley pottery north of the Parowan Valley. Ceramic assemblages at sites investigated along the pipeline corridor in the Escalante Desert just northwest of the Parowan Valley contain almost 100 percent Snake Valley ceramics. Farther north, 42BE743 presents a high percentage (45 %) of Snake Valley ceramics in addition to a healthy representation (55 %) of Fremont Variants. These variants are clearly Fremont pottery but do not fit cleanly into any existing type; they probably represent a local implementation of the Snake Valley ceramic production technology, i.e., the exploitation of volcanic tuffs (Lyneis 1994). Sites Five Finger Ridge, 42MD1002, 42MD973, and 42MD974 each exhibit increasing percentages of Sevier Gray and decreasing percentages of Snake Valley ceramics as a function of northward distance from the Parowan Valley, thus representing a fall-off gradient along the Wasatch Mountains from the probable production center.

In the case of the Fremont, the individual exchanges generating a Down-the-line distribution would have been reciprocal, consisting of logistical exchange visits to nearby settlements, prearranged meetings at territorial boundaries, or opportunistic encounter-based interactions. Down-the-line distribution north of the Parowan Valley has yet to be demonstrated. Lyneis's (1994) indicates the possibility of Down-the-line exchange, but the Kern River sample is small; some sites are represented by less than 10 sherds. The pattern has yet to be replicated with a more substantial data set. As explained previously, I am explicitly testing Lyneis's supposition, hypothesizing that she is correct and that Snake Valley pottery will gradually decrease at sites located farther and farther from the Parowan Valley.

As discussed briefly in Chapter 1, Janetski (2002) has argued that the distributions of exotic artifacts in the Fremont area indicate some Directional Trade along with Down-the-line exchange. Higher quantities of exotics are present at the larger sites along the Wasatch Front, which are argued to be evidence of trade fairs/festivals being held at central places.

The convergence of several groups at a central location is a component of Central Place Market Exchange. As defined by Renfrew and Bahn (2000), however, Central Place Market Exchange presupposes the presence of a central person who may or may not be involved in the exchange. As previously stated, the Fremont probably had no such central persons, though they may have had central places. In identifying the larger Fremont sites as possible loci for regular trade fairs or festivals, Janetski implies that these locations were central places on the Fremont landscape. If central places existed in the Fremont area, the Parowan Valley, with its impressive size and indications of high status persons and ritual behaviors would have been chief among them. An additional problem with Fremont Central Place Market Exchange is the market prerequisite. "Market" is a loaded word; conjuring images of stalls erected in open squares or along crowded thoroughfares. This sort of formal, organized marketing that is part of Central Place Market Exchange has been argued to have existed in the Hohokam area (Abbott 2003, 2001; Abbot et al. 2001), but it is unlikely to have existed among the less-nucleated Fremont.

The distribution of goods produced from trade fairs and festivals in small-scale societies such as the Fremont could be similar to the Central Place Market Exchange model. Key differences are the absence of formalized markets/marketing and central persons of importance. Other mechanisms facilitating exchange, such as gambling (Janetski 2002), probably performed a function similar to that of formal marketing in small-scale societies. This modified model warrants a modified name, and I suggest Central Place Exchange. I hypothesize that Snake Valley pottery, particularly the black-on-white, were primarily exchanged via trade fairs and festivals located at central places along with other items such as obsidian, marine shell, and turquoise (Janetski 2002). These central places will correspond to relatively large sites with high percentages/ quantities of Snake Valley pottery as compared to the surrounding sites.

Distribution of Snake Valley Pottery

The models I present in this chapter are generated from the data as percentages of the total ceramic assemblages and, in the case of Snake Valley Black-on-gray, as a ratio of residences and amount of pottery. Raw data are listed in Appendix B. Three of the figures correspond to specific ceramic types in the Snake Valley Series (Figures 4.4-4.6), and the fourth figure (Figure 4.7) depicts percentages of all Snake Valley pottery as a percentage of the total assemblage. The final map, Figure 4.8, is the distribution of Snake Valley Black-on-gray pottery at structural sites only, expressed as a ratio of the number of Snake Valley Black-on-gray sherds at a site divided by the number of residential structures at the same site. Though it presupposes structure contemporaneity, this coefficient, to an extent, measures the amount of pottery per capita at a given site. These models are discussed in Chapter 5.

Summary

Despite variation in Fremont pottery, I argue that classification is still a useful archaeological construct, but that the two-tier Fremont pottery classification system proposed by Madsen (1977) is inadequate, masking important relationships and making discussion/classification of rare surface treatments difficult. Following Colton and Hargrave (1937), I propose a three-tier classification system of Fremont pottery, which

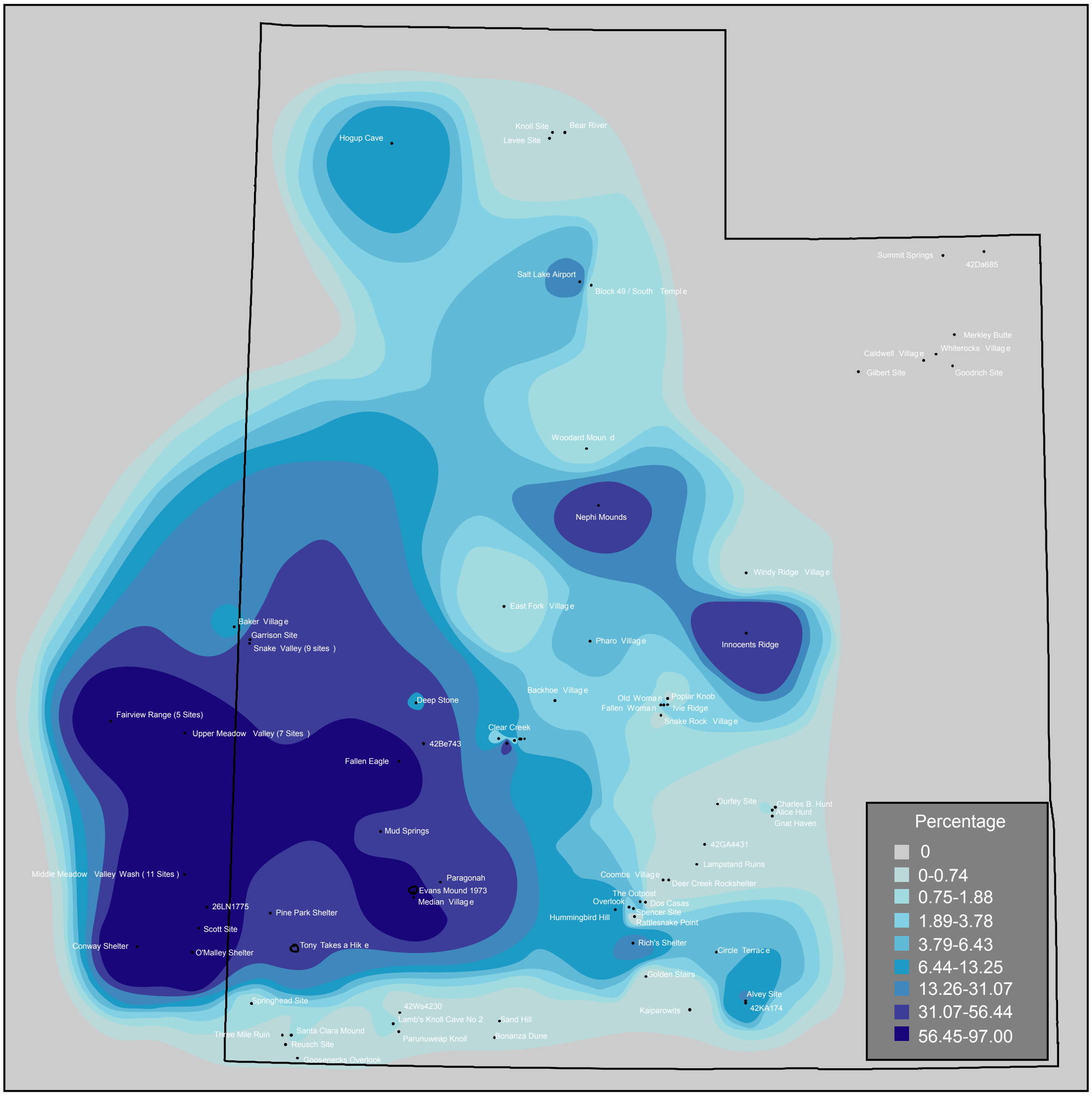

Figure 4.4. Distribution of Snake Valley Gray Pottery at all Sites as Percentages of the Total Pottery Assemblage.

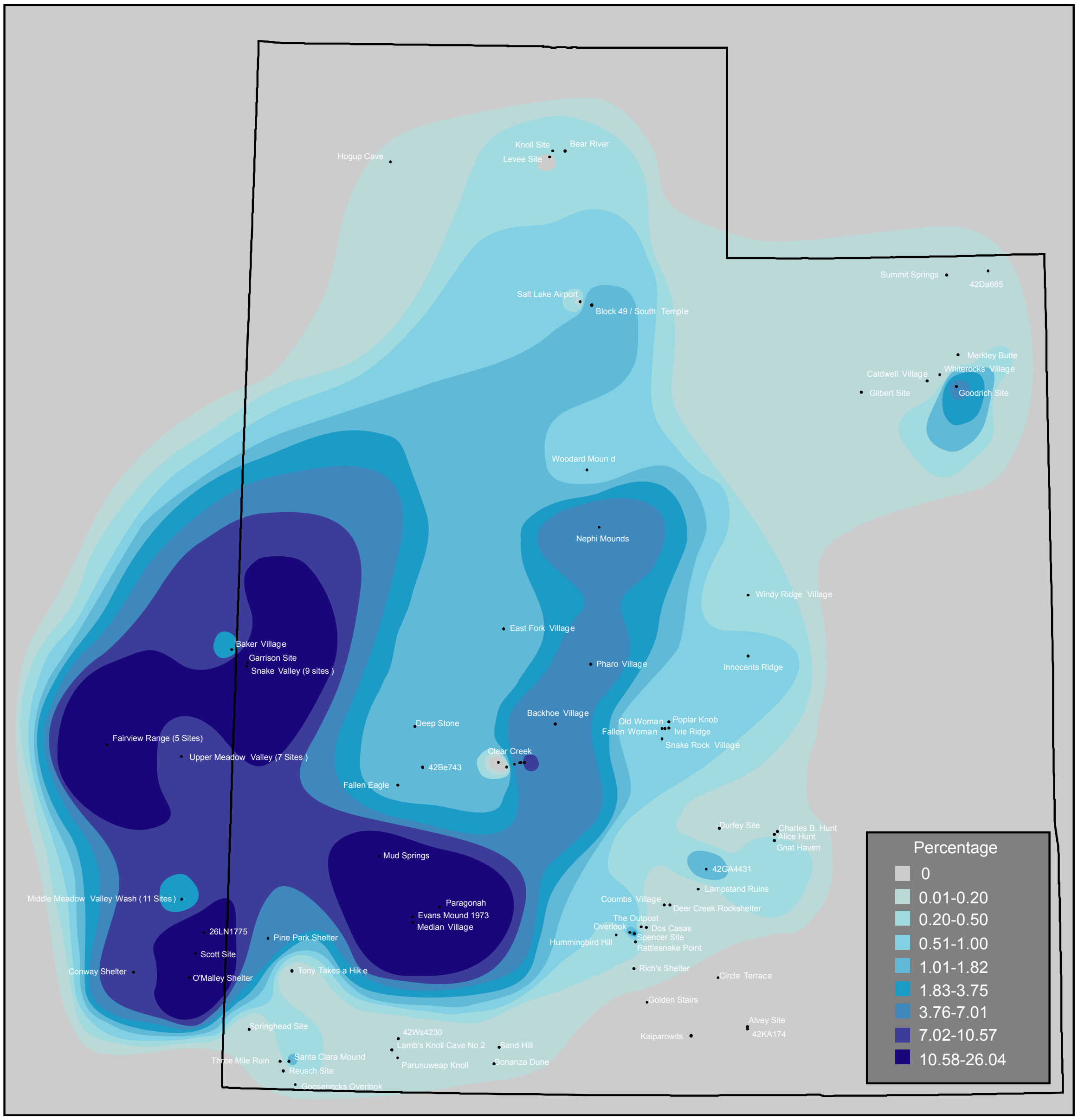

Figure 4.5. Distribution of Snake Valley Black-on-gray Pottery at all Sites as Percentages of the Total Pottery Assemblage.

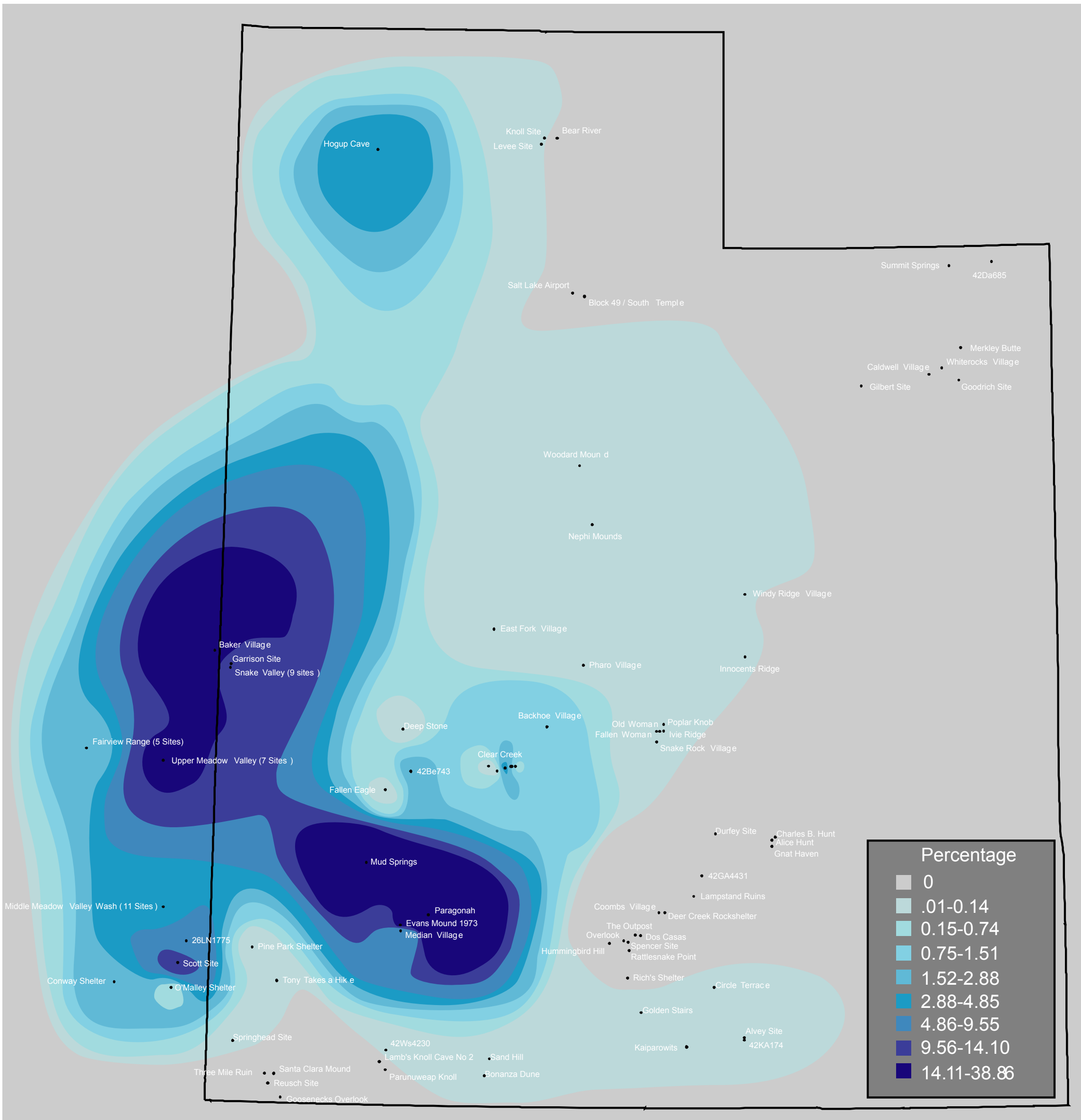

Figure 4.6. Distribution of Snake Valley Corrugated Pottery at all Sites as Percentages of the Total Pottery Assemblage.

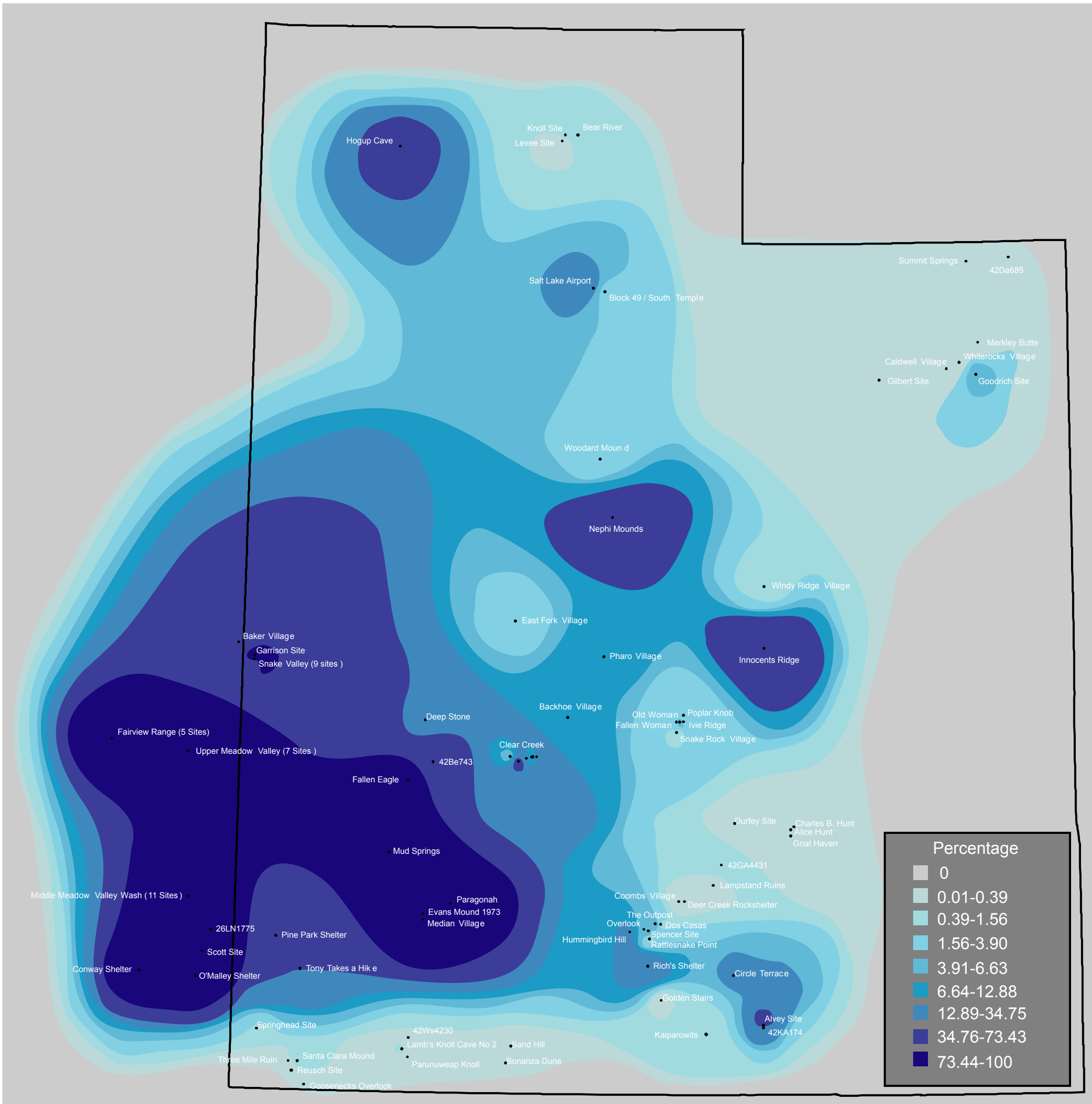

Figure 4.7. Distribution of Snake Valley Pottery at all Sites as Percentages of the Total Pottery Assemblage.

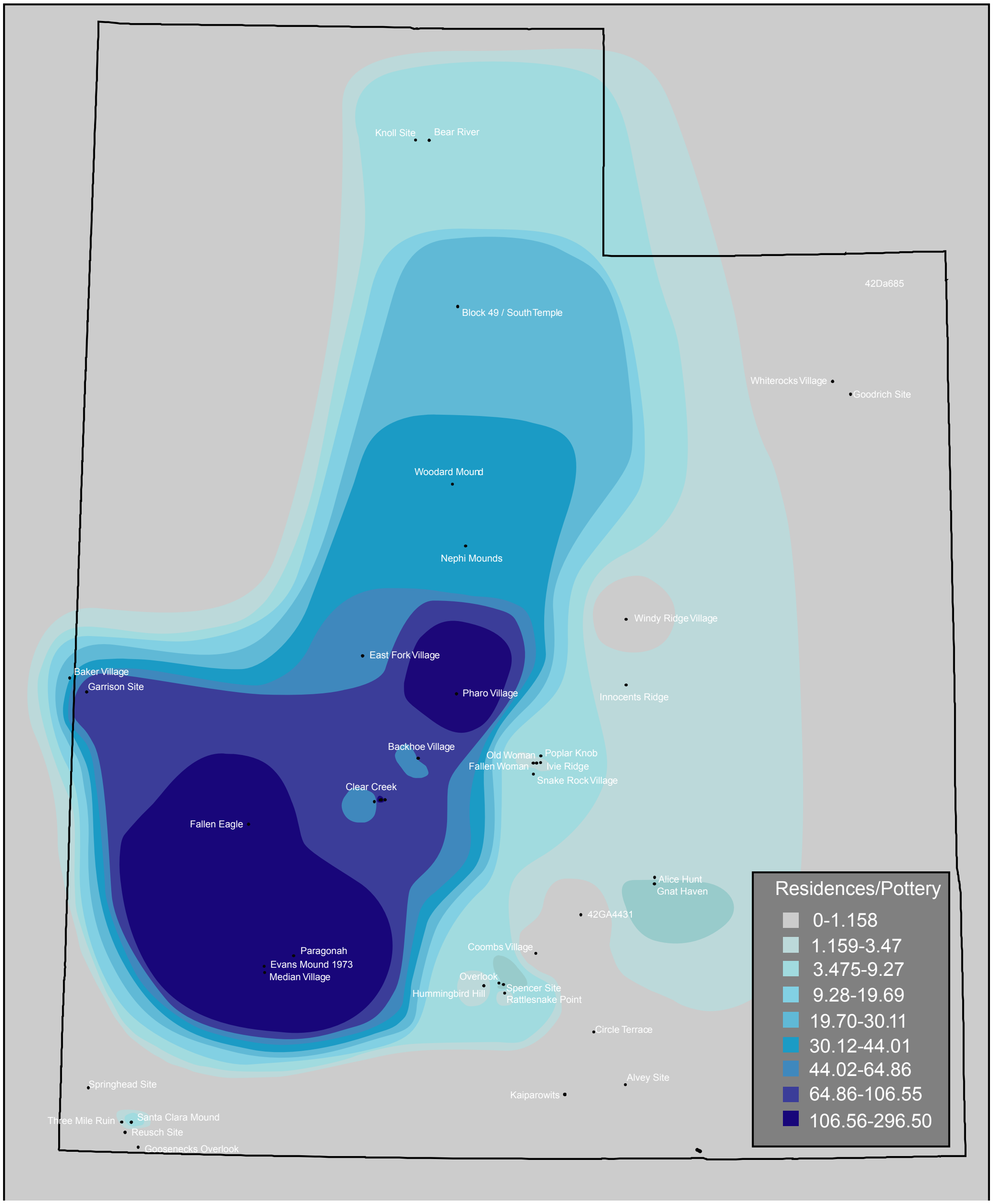

Figure 4.8. Distribution of Snake Valley Black-on-gray Pottery from Structural Sites as a Ratio of Number of Sherds Divided by Number of Residential Structures.

remedies these problems and brings consistency to Fremont pottery classification. With data collected in an extensive review of published Fremont excavations, I model the distribution of the Snake Valley Series as percentages of the total ceramic assemblage, and in the case of Snake Valley Black-on-gray, as a ratio of Snake Valley Black-on-gray pottery divided by the number of residential structures.

Chapter 5: DISCUSSION AND CONCLUSIONS

In Chapter 1, I identified several research questions within the framework presented by Brown et al. (1990) and four existing models relevant to Late Formative Fremont ceramic production and exchange. The data presented in the preceding two chapters facilitate discussion of these topics. I also briefly discuss the remaining portions of the Brown et al. framework not directly addressed by the data. I conclude the chapter with a summary and suggestions for further research.

Research Questions

The research questions discussed below address some of the criteria given by Brown et al. as prerequisites to useful discussion of intergroup trade. In previous chapters, I have presented data directly addressing three of these issues, the location of raw materials, a pattern of exchange relations, and the context of manufacture. I briefly discuss the remaining topics proposed by these authors in light of the data I have generated here and those existing in the literature: relative value and the context of use and consumption.

Location of Raw Materials

As outlined in Chapter 3, the chemical assay of Snake Valley Black-on-gray pottery enabled me to make only a few concrete conclusions. First, the Snake Valley Black-on-gray pottery in the sample was not exclusively constructed of the tuffs sampled. This was contrary to my initial expectation. Second, the classic Snake Valley Black-on-gray pottery plot into a central point cloud on principal components, and the sherds thought to represent local manufacture plot well away from this cloud.

Location of Raw Materials

Interpretation of this central point cloud is problematic, and I have suggested three possibilities. First, the “near-total” digestion of the samples was inadequate, and has left chemically distinct compositional groups in the sample obscured. Second, the sherds in the sample were constructed from multiple related sources. And third, the source or sources of Snake Valley pottery is chemically indistinct or heterogeneous. If an adequate chemical assay is assumed, then with multiple related sources or a single heterogeneous source are left as the probable explanation for the raw material for Snake Valley Black-on-gray. If the former proves to be true, then source area of Snake Valley Black-on-gray pottery is still probably going to be fairly limited. Exactly *how* limited depends on the amount of chemical variation in the relevant local geologic units. In other words, how extensive could the distribution of the related, contributing raw material sources be? Given my discussion of the variability in the geology of the Parowan Valley, I suspect that the distribution of the raw material sources would probably be somewhat limited. An additional factor to consider is the nature of the Snake Valley Black-on-gray "recipe" of construction, which is discussed further below.

The distributional evidence presented in Chapter 4 further supports the proposition that the Parowan Valley was the production center for not only Snake Valley Black-on-gray pottery, but for the entire series as strictly defined. In each of the models, the Parowan Valley was the area of highest concentration for each type in the Snake Valley series. This was particularly true of the surface manipulated types, Snake Valley Black-on-gray and Snake Valley Corrugated. The distributional data are perhaps the strongest indicator that the Parowan Valley was a production center for Snake Valley pottery.

Classic vs. Non-Classic

My hypothesis that the non-classic pottery was not made in the Parowan Valley appears to have been supported. The non-classic sherds, including the quartz-only Baker Village samples and the non-classic Snake Valley samples from South Temple, were very clearly chemically distinct from the rest of the classic sherds, indicating they were probably made in a different place. This returns us, however, to some of the definitional issues raised in Chapter 4. A more conventional analyst, such as Lyneis, would probably never assign a sherd without mica to the Snake Valley Series. Others, such as Bright at Fallen Eagle (Stokes et al. 2001) do not hesitate to designate sherds with only angular quartz temper as Snake Valley. It might be argued that on some level, it does not matter which type a sherd is assigned so long as the analyst explicitly explains the criteria used in the analysis. However, if consistency in the typology is to be maintained, pottery that appears similar to the Snake Valley Series but lacks the complete temper triad should probably *not* be designated as such; and it rather should be allocated to a "Fremont Variant" (Lyneis 1994) category or other equivalent.

Distribution – A Pattern of Exchange Relations

In Chapter 1, I laid out my expectations for the distribution of Snake Valley pottery. They are that (1) the "heart" (i.e., the area of highest concentration) of Snake Valley Gray pottery will be larger than those of either Snake Valley Black-on-gray or Snake Valley Corrugated indicating that as a utility ware it was more widely produced (2) more Snake Valley pottery will be present on the west side of the Wasatch Mountains, which were a natural prehistoric barrier (Lohse 1980, Janetski 2002) (3) Snake Valley pottery will be little represented at Virgin Anasazi sites, indicating minimal trade and interaction (4) a higher occurrence of Snake Valley pottery at relatively large Fremont sites as suggested by Janetski (2002) and (5) fall-off of Snake Valley pottery in all directions as a function of distance from the Parowan Valley (Lyneis 1994). I address each of these questions below.

The area of highest density of Snake Valley Gray pottery will be larger than that of either Snake Valley Black-on-gray or Snake Valley Corrugated.

To evaluate this hypothesis, I compared the distributional models of the three members of the Snake Valley Series, specifically the two highest percentage levels (Table 5.1) of five loose site clusters. I defined the clusters somewhat arbitrarily, as sites I considered to be relatively close to one another (Table 5.2). In clusters marked high

(Table 5.3), each site in the cluster is included in an area that falls within one of the two highest pottery distributional levels. In medium clusters, at least 50 percent of the sites fell into the upper two levels. Conversely, low clusters have more than 51 percent of the sites outside of the upper two levels. I have made one exception for the Parowan Valley. Although Median Village contains no corrugated pottery, its early date places it prior to the introduction of corrugated pottery. Despite this deficiency, the Parowan Valley retains a high ranking for Snake Valley Corrugated.

Table 5.1 Two Highest Levels of Percentage Distributions for Snake Valley Gray, Snake Valley Black-on-gray, and Snake Valley Corrugated.

Type	Highest Density (%)	Second Highest Density (%)
Snake Valley Gray	97.00-56.46	56.45-31.07
Snake Valley Black-on-gray	26.04-10.58	10.57-7.09
Snake Valley Corrugated	38.86-14.11	14.10-9.56

Table 5.2. Site Clusters for Distributional Comparison.

Cluster	Included Sites
Parowan Valley	Paragonah, Evans Mound, Median Village
Middle Meadow Valley	Middle Meadow Valley Wash (11 Sites), 26LN1775, Scott Site, Conway Shelter, O'malley Shelter
Upper Meadow Valley	Upper Meadow Valley (7 Sites), Fairview Range (5 Sites)
Snake Valley	Snake Valley (9 sites), Garrison site, Baker Village
North of Parowan Valley	Mud Springs, Fallen Eagle, 42BE743

The density of all Snake Valley pottery is high in the Parowan Valley, the suspected area of primary production. Density of Snake Valley Gray is high in each cluster except the Snake Valley, where it is medium. Densities of Snake Valley Black-on-gray and Snake Valley Corrugated are lower than Snake Valley Gray in many of the remaining clusters, confirming my prediction that Snake Valley Gray would have a larger area of highest density than the other members of the series, indicating that is had a wider zone of production than the other types. This claim is made with the caveat that several sherds that were called Snake Valley Gray, such as those from the Fallen Eagle site (Stokes et al. 2001), are not really consistent with the type definition.

Table 5.3. Comparison of Snake Valley Type Distributions by Site Cluster.

Cluster	Gray	Black-on-gray	Corrugated
Parowan Valley	High	High	High
Middle Meadow Valley	High	Medium	Low
Upper Meadow Valley	High	High	Medium
Snake Valley	Medium	Medium	High
North of Parowan Valley	High	Low	Low

More Snake Valley pottery will be present on the west side of the Wasatch Mountains, which were a natural prehistoric barrier (Lohse 1980).

As seen in Figure 4.8, the Wasatch Mountains acted as a barrier to the distribution of Snake Valley Black-on-gray. The barrier is less clear, but still observable when all sites are considered (Figures 4.4-4.7). Although relatively little Snake Valley pottery made it onto the Colorado Plateau, the pottery that is present is widely distributed, probably equaling a few vessels at most Fremont sites. Most of the Fremont sites without any Snake Valley pottery are located in the distant, relatively inaccessible Uinta Basin. This likely reflects the higher costs/logistical problems associated with transporting pottery long distances over rough terrain. This widespread distribution indicates that Snake Valley pottery was a commodity greatly desired by the Fremont and that mechanisms were in place for its dispersal.

Three important conduits connecting the Basin and the Plateau are revealed in the distributional analysis. The first of these was the Sevier Valley. As seen in Figure 4.5, the distribution of Snake Valley Black-on-gray pottery follows the valley north through Backhoe/Mukwitch Village and Pharo Village to Nephi. This pattern can also be seen in the distribution of the collective Snake Valley Series. The material probably also continued along the Wasatch proper via Beaver and Kanosh, but the ceramic data for these sites are insufficient to test this hypothesis. The second conduit is between the Sevier Valley and the Snake Rock Village cluster of residential sites. Clear eastern "bulges" of Snake Valley Black-on-gray pottery protrude into the Snake Rock area (Figures 4.5 and 4.8). Salina Canyon and Ivie Creek provide a fairly direct route between the regions and would have been a natural funnel for commerce. Most of the Ivie Creek Black-on-white pottery in the Basin may have also passed to the west along this route from the Snake Rock Village cluster. Although there is no obvious geographical route, there appears to have been significant intercourse between the inhabitants of the Upper Escalante area and the Eastern Great Basin at least during the early part of the late period, shown in each of the distributional models. This possible trade route may have been an important conduit for turquoise and/or marine shell from the Anasazi area to the Basin, as it appears that the Fremont of the Eastern Great Basin may have interacted little with the nearby Virgin Anasazi (see below).

Snake Valley pottery will be little represented at Virgin Anasazi sites indicating minimal trade and interaction.

One of the most striking distributional patterns of Snake Valley pottery is the sudden discontinuance of the material to the south and west of the areas of highest density, confirming my hypothesis. To the south this boundary corresponds to cultural affiliation, with very small percentages of Snake Valley pottery present only at those Virgin Anasazi sites immediately bordering the Fremont area, thus validating my hypothesis. Likewise, little Virgin Anasazi pottery has been recovered at Fremont sites. The vast majority of exchanged Snake Valley pottery went to other Fremont people. This pattern is supported by the distributions of all the models.

This calls into question the degree of interaction between Fremont and Virgin Anasazi groups. The lack of ceramic exchange clearly indicates the maintenance of a strong social boundary was maintained between Fremont and Virgin Anasazi groups. The nature of this social boundary, however, remains unclear. Both Lyneis (1992) and Janetski (2002) have implied that the Fremont were plugged into the Virgin Anasazi exchange network from which they obtained marine shell and turquoise. If the Fremont were getting shell and turquoise from the Virgin Anasazi, they were not offering pottery or goods contained in pottery for trade. Other goods may have been exchanged for exotics, but the ceramic type distributions shown here indicate little ceramic interaction between the Fremont and Virgin Anasazi.

The Anasazi-esque corrugation and design elements of Snake Valley pottery might be seen as evidence for intermarriage or diffusion of ceramic technology resulting from persistent or close interaction. Charmaine Thompson and James Allison (1988), however, point out that Fremont pottery design styles are much more akin to the eastern Anasazi than to the more immediate Virgin Anasazi. More intensive Anasazi-Fremont interaction has been documented on the Colorado Plateau (Aikens 1967; Lister 1961; Baer and Sauer 2002). In the west, based on the ceramic evidence, I suggest that the Fremont and Virgin Anasazi may have interacted little. Ceramics alone are not enough to adequately characterize this social boundary, and suggestions for further research on this subject are given at the end of this chapter.

There will be a higher occurrence of Snake Valley pottery at relatively large Fremont sites as suggested by Janetski (2002).

This question is addressed in my evaluation of the Janetski Trade Fair model below.

Snake Valley pottery will fall-off in all directions as a function of distance from the Parowan Valley (Lyneis 1994).

Contrary to my expectation, fall-off of Snake Valley Black-on-gray pottery from the Parowan Valley was only observable to the northeast along the Wasatch, and not in every direction. Potential eastern fall-off was probably interrupted by the Wasatch Mountains, which restricted to flow of goods to at least two places (see above). The area west of the Parowan Valley returned high distributions for most of the Snake Valley Series, indicating either very close exchange with the Parowan Valley for pottery or a production area extending into this region. The western area is difficult to evaluate since the lack of reported structural sites caused the area to drop out of the clear structural model (Figure 4.8). Structural sites do exist in the region (Personal communication, Clint

Cole 2005), and this question if left to Cole's forthcoming analysis. Finally, the strong social boundary and/or the lack of Fremont – Anasazi interaction accounts for the absence of southern fall-off from the Parowan Valley. Without regular exchange with the Virgin Anasazi, there was nowhere in the south for Snake Valley pottery to go.

Summary

Except in the distant Uinta Basin, most Fremont sites contain at least a trace of Snake Valley pottery. Only the most spatially immediate Virgin Anasazi obtained any Snake Valley pottery, and this was limited to only a few vessels. Very small quantities of Snake Valley pottery are also present in Anasazi sites on the Kaiparowits Plateau. With the exception of sherds found at Coombs Village, no Snake Valley pottery has been recovered from Kayenta contexts. The series experiences a sudden cessation to the west, where hunter-gatherers with less use for pottery lived.

The highest densities of Snake Valley pottery are present in the Parowan Valley and in eastern Nevada near the border of the Escalante Desert. The most intensive distribution of Snake Valley Black-on-gray and Snake Valley Corrugated is more restricted than Snake Valley Gray, indicating a production zone that was probably more limited. The more narrow distribution of Snake Valley Corrugated may reflect temporal differences (corrugated pottery is later) and/or low supply/demand.

An important additional aspect of the distribution of this material is how it is distributed *within* a site. Janetski (2002) has noted that many exotic materials (turquoise, marine shell, Anasazi pottery, and obsidian) are evenly distributed throughout Fremont sites and not hoarded into single features. For pottery, this distribution is difficult to quantify, but in my review of the literature I discovered no case where large amounts of Snake Valley pottery were concentrated in any one portion of a site. This is more likely due to a limited number of vessels being present and similarly deposited than differential possession of an imported resource.

Context of Manufacture

I have presented some evidence indicating that production of Snake Valley Black-on-gray pottery was largely restricted to the Parowan Valley. If this was indeed the case, the context of manufacture of this pottery type was community craft specialization. Costin's (1991) parameters for productive arrangements can only vary so much within small-scale societies (such as the Fremont). "Concentration" is likely to vary the most, "intensity" and "scale" may vary somewhat, and "context" will remain constantly low. The degree of specialization (the ratio of producers to consumers) is also likely to vary (Allison 2000). Spielmann (2002a, 2002b) specifically applies Costin's variables to sites of community craft specialization in small-scale societies. Generally, ritually charged or socially valued goods are created by individually skilled specialists. Aggregation of these specialists into communities is the result of large-scale demand and widespread circulation.

In the case of the Parowan Valley, "concentration" was relatively high, as producers were aggregated into a single region. Given the small-scale context of the Fremont, I have assumed that production scale was the household and that the degree of elite sponsorship (context) was low. Though there is some evidence for emerging elites in the Parowan Valley, there is no indication of centralized control or hoarded resources that sponsorship would require. "Intensity," the amount of time invested in production, was higher than that of neighboring areas because the highly burnished and painted Snake Valley Black-on-gray pottery was more time-intensive to make than undecorated pottery (see Relative Value below). "Degree," the ratio of producers to consumers is unknown, but I suspect it was probably also low. Data generated by PVAP will be able to confirm this hypothesis.

Relative Value

Determining the relative value of Snake Valley Black-on-gray is problematic. Fremont pottery, unlike other Southwestern ceramics (Hegmon et al. 1997), is almost never found in mortuary or other ritual contexts (see Janetski and Talbot 2000b for summary of Fremont mortuary practices and grave goods). Because Fremont pottery is not discovered in specialized contexts, we are left to other means to assist in determining the value of the objects. The production step measure of ceramic manufacture (Feinman et al. 1981), an ordinal index of production costs, explains that a vessel with more steps involved in its production will have a higher production cost and thus increased value. Under these criteria, Snake Valley Black-on-gray would have been more highly valued by the Fremont simply because it was painted, which requires a greater time investment than undecorated plainwares.

At Backhoe Village, Madsen and Lindsay (1977) noted that all of the non-ornamental drilled (i.e., repaired) sherds were painted, indicating that the painted vessels were either easier to repair and/or were more highly valued. A similar pattern was noted at Five Finger Ridge (Talbot et al. 2000). Louise Senior (1994) has argued that mending and curation does reflect a high value placed on objects prehistorically. While conducting the distributional analysis reported in Chapter 3, I attempted to record whether a high number of drilled sherds were Snake Valley Black-on-gray. Unfortunately, the pottery type to which the worked sherds were assigned has not been reported often enough to make for a useful analysis. Since the vast majority of Fremont painted pottery falls into two types, one of which is Snake Valley Black-on-gray, the mending of the painted pottery at Backhoe Village and other sites provides some evidence that the type was probably curated. As a painted type that was probably curated prehistorically, Snake Valley Black-on-gray pottery was more highly valued by the Fremont than plain undecorated wares. I discuss this issue further discussed in the evaluation of the Arnold/Harry models below.

Context of Use

Fremont pottery was probably used for several mundane tasks including cooking, storage, and other household functions. Beyond these, discussing Fremont pottery use quickly becomes problematic. As stated above, Fremont pottery (unlike Anasazi pottery) is almost never discovered in mortuary or other ritual contexts. The one known exception is an individual discovered in the Parowan Valley with ritual paraphernalia and eight ceramic vessels (Janetski and Talbot 2000b; Meighan et al. 1956). Hockett's (1998) interpretation of laminated levels of adobe melt and bone-rich fill as Fremont feasting at Baker Village is misguided, but activities invisible to current archaeology in which painted or corrugated pottery played a prominent role may well have occurred. Three known ceramic bird effigy vessels, one from Five Finger Ridge (Richens 2000a) and two from UCLA investigations in the Parowan Valley (Jardine 2005), hint at possible ritual use of pottery. What can be conclusively argued is that the Fremont differed from the Anasazi in both their use and consumption of ceramic vessels, the former indicated by the absence of Fremont pottery in ritual contexts (Janetski and Talbot 2000b) and the latter by the general lack of Fremont whole vessels.

Fremont corrugated pottery has yet to be established as principally utilitarian as seems to be the case with similarly manipulated Anasazi vessels. Sooting data from Five Finger Ridge (Table 5.4) indicate a high percentage of sooted surface manipulated pottery, though this may be due to the pitted surface maintaining soot more so than smooth surfaces. Clint Cole (personal communication 2005) is currently addressing this issue in his Ph.D. dissertation, and further study is required in this direction. This issue is discussed further in my evaluation of the Arnold-Harry models below.

Table 5.4. Sooting Data of Jar Rims from Five Finger Ridge.

Surface Decoration	Total	Percent	Sooted	Percent
Plain	1106	88	276	24.9
Corrugated	53	4.2	20	37.7
Surface Manipulated	97	7.7	37	38.1
Total	1256	100	333	26.5

Context of Consumption

In the case of the Fremont, consumption is probably best equated with deposition. Unlike the Anasazi, who tended to deposit their trash in quasi-formal middens with probable ideological significance, the Fremont, when possible, dumped refuse in abandoned structures or in informal deposits scattered throughout a residential site (Talbot et al. 2000). Beyond this, the context of consumption of Fremont pottery is poorly understood, though I give a few suggestions for further investigation of this issue below.

Model Evaluation

The four models I discuss below not only flesh out the research questions considered above but provide further basis for discussion of Fremont ceramic production and exchange. I evaluate each model in the context of the data presented in previous chapters.

Janetski's Trade Fair Model

When I considered all of the data collected for the distributional analysis as percentages, the Nephi Mounds, Innocent's Ridge, and Pharo Village returned uncharacteristically high values for Snake Valley Gray (Figure 4.4) and the collective Snake Valley Series (Figure 4.7). Slightly higher concentrations were also apparent at the Garrison site, Humming Bird Hill, the Alvey site, the Goodrich site, and at Five Finger Ridge. None of these sites is particularly large, although, Five Finger Ridge could be considered large in the context of Clear Creek Canyon, but it remains only a medium-sized site in the context of the Wasatch Mountains or even the Sevier Valley. This could be construed as weak support for the Janetski model. However, the sites identified above are not those identified by Janetksi as central places, are not particularly large, and in most cases have only slightly higher concentrations of Snake Valley pottery than the surrounding sites. These facts, combined with the pattern revealed when the data were expressed as a ratio of Snake Valley Black-on-gray divided by number of residential structures, lead me to a much different conclusion, one not suggested in my initial research questions.

Initially, I conceived of this research as a test of Janetski's Trade Fair/Festival model. If the distribution of Snake Valley Black-on-gray pottery mirrored the one Janetski observed for exotics, then his model would be supported. Conversely, if the distribution I observed did not follow the model, then Janetski's model would not be supported. This view, however, is overly simplistic, and the differential distribution of Snake Valley Black-on-gray pottery does not negate the Janetski model, nor is it an explicit test of the same. The disparity of the distributions only indicates that the commodities were not distributed in the same manner, and beyond this I cannot adequately evaluate the trade fair/festival model proposed by Janetski.

Instead, I interpret these two artifact distributions as the material correlates of two complementary, integrative interaction spheres operating among the Fremont. The first, identified by Janetski, involved the exchange of exotic materials at central places, large village sites scattered across the Fremont landscape. Janetski argued that these gatherings facilitated exchange of at least exotics, and served to socially integrate participating groups through intermarriage, gambling, and other risk buffering behaviors.

The second, represented by the distribution of Snake Valley Black-on-gray ceramics identified in this research (Figure 4.8), was centered at a single central place, the Parowan Valley. Painted (and possible corrugated and plainware) pottery produced in this locality were exchanged in a different manner, in a regional system that complemented and cross-cut the network identified by Janetski. Snake Valley Black-on-gray pottery was primarily distributed down-the-line as a function of northward distance from the Parowan Valley. The down-the-line pattern is less clear on the Plateau or in other directions from the Parowan Valley. It is clear, however, that the pots were not distributed in the same manner as exotic material.

In this scenario, socially valued pottery manufactured in a ritually significant locality (the Parowan Valley, see below) was distributed to most Late Fremont settlements. On the Colorado Plateau, these vessels were present in small quantities.

Even fewer pots found their way to the more distant Uinta Basin. Despite the small number of vessels, some Snake Valley pottery was present at the vast majority of Late Fremont sites.

I suggest three plausible explanations for this distribution, which are not necessarily mutually exclusive. First, Snake Valley pottery operated as a sort of badge of ethnic identity among the Fremont, representing a shared affiliation or a common ideology. The paucity of Snake Valley pottery at Anasazi sites further supports this idea. Second, Snake Valley pottery became a necessary or desired part of the Fremont toolkit, required for feasts or other ritual activity. This is difficult to test, since Fremont pottery is not found in ritual contexts. There are few known ritual contexts in which we might expect to find important pottery. As previously explained, the Fremont primarily buried their dead without material objects. Unlike the Anasazi, there are no obviously ritual structures in which we would expect to find ritually important objects. Third, Snake Valley pottery represented affiliation with or a desire to associate with the Parowan Valley. The final possibility is discussed in greater detail below.

Schuster's Baker Village Thesis

Since no raw material samples from Baker Village were sampled, I cannot conclusively say whether or not the pottery with quartz-only temper was locally produced as Schuster (1996) suggested. It is radically different from the Snake Valley Black-on-gray pottery sampled from the site (Figure 3.3), indicating that these two types were constructed with different raw materials. The Snake Valley Black-on-gray pottery sampled from Baker Village appears to be chemically similar to the Snake Valley Black-on-gray pottery found in the Parowan Valley and elsewhere, however, this similarity was found not to be statistically significant. As indicated above, there is some evidence that the Parowan Valley was production center for this type, but further research is required to make a conclusive statement.

As Schuster (1996) suggests, the Household Industry model may well describe most Fremont pottery production. This may not have been the case in the Parowan Valley where the arrangement may have been craft specialization on the level of the community. Community craft specialization may also have been the production arrangement for Ivie Creek Black-on-white. Madsen (1977) identified a relatively restricted “core area” (roughly corresponding to areas of highest concentration) in the Snake Rock Village area. Intensive investigations at a more intensive scale than I attempt here are required to determine whether individual producers were specializing in pottery production more than their immediate neighbors.

Kern River II and Anasazi Models of Ceramic Production

The data I have presented contradict the findings of Reed (2005) on two counts. Reed’s assertion that Snake Valley Gray, Corrugated, and Black-on-gray were manufactured at multiple locations is based on the establishment of multiple compositional groups in his the chemical assay (Figure 5.1). Four of these compositional groups overlap and would be blurred if several unassigned sherds were not omitted from the plot. When the ellipses representing the confidence intervals of these compositional groups are removed (Figure 5.2), the central point cloud closely resembles the one I identify in Figure 3.3. Compositional Groups 5, 6, 7, and perhaps 8 (Figure 5.1) could represent either a single heterogeneous source or multiple closely related sources as I’ve argued above, rather than the distinct compositional groups indicated in the study.

Clearly, not *all* pottery assigned to the Snake Valley Series was made in the Parowan Valley. Reed’s outlying compositional groups and the non-classic Snake Valley pottery from the South Temple site testify to this, as do Lyneis’s (1994) “Fremont Variants” and the similar sounding non-classic sherds recovered from the Salt Lake Airport, Baker Village, and the Fallen Eagle and Deep Stone sites (Stokes et al. 2001). Most of these non-classic sherds are Snake Valley Gray, which was clearly produced in places other than the Parowan Valley. The Fallen Eagle site, with its more than 6000

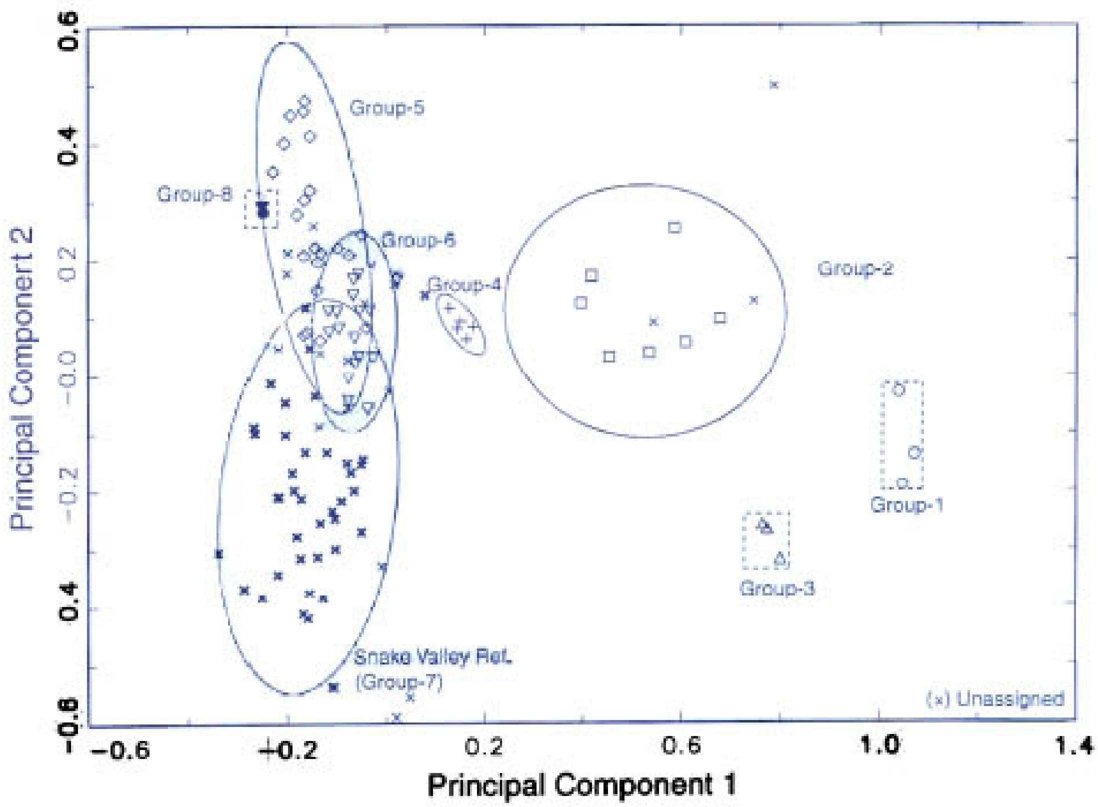

Figure 5.1. Compositional Groups from Reed (2005).

recovered Snake Valley Gray sherds, is perhaps the best example of production of Snake Valley Gray outside of the Parowan Valley. This statement is made with the caveat that most of these sherds lacked mica, and would not have been designated as Snake Valley Gray by researchers following a strict definition of Snake Valley pottery. They would instead, have, designated the sherds as Fremont Variants or at best non-classic Snake Valley Gray.

I anticipated several compositional groups or subgroups would be correlated to tuffs in the Parowan Valley. This was not conclusively demonstrated, but two significant pieces of evidence support community craft specialization in the Parowan Valley. The first is the fall-off of Snake Valley Black-on-gray pottery as a function of northern distance from the Parowan Valley and the greater quantities of Snake Valley pottery found in the Parowan Valley as opposed to neighboring regions. A third piece of evidence is

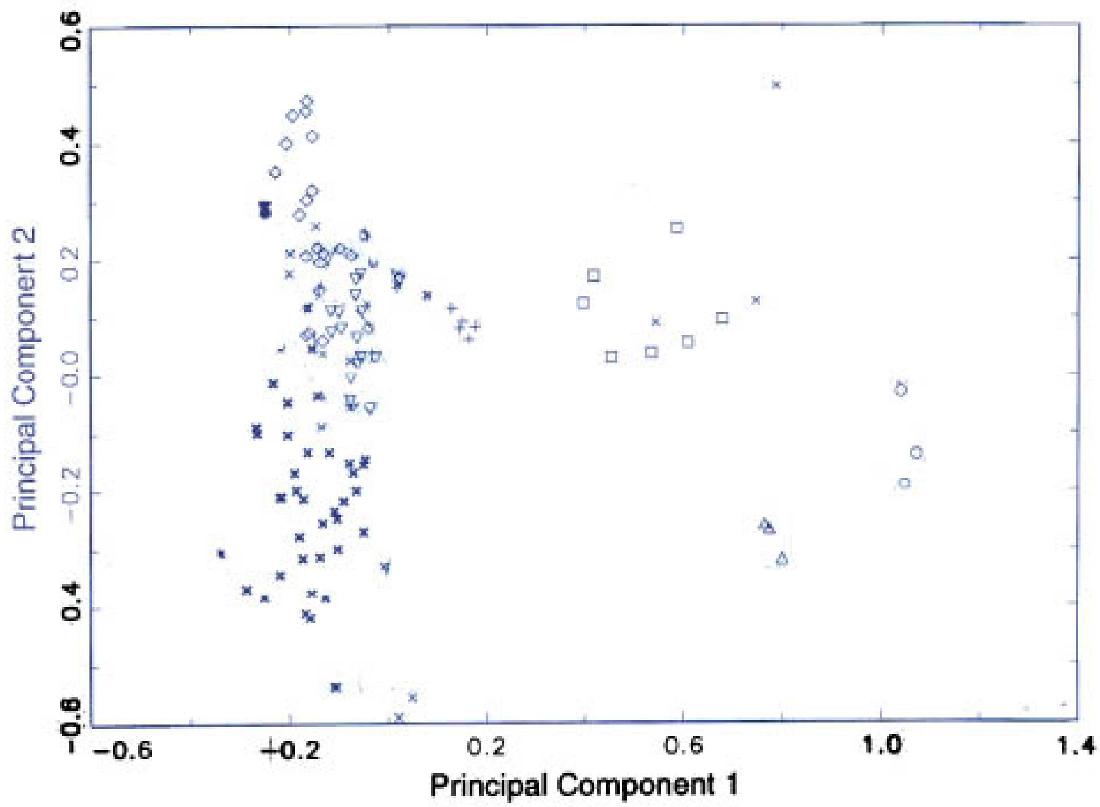

Figure 5.2. Reed (2005) Analysis With Confidence Intervals Removed.

the occurrence of the clay sample in the central point cloud of Snake Valley Black-on-gray samples, however, this piece of evidence is more tenuous than those previously mentioned. In addition, the probable existence of community craft specialization of Snake Valley Black-on-gray pottery in the Parowan Valley is consistent with the Anasazi model of ceramic production Reed argued against. These preliminary findings were consistent with my expectations, though they require further investigation.

Arnold and Harry: Models of Agricultural Marginality

Some evidence has been presented indicating that the Parowan Valley was a production center for Snake Valley Black-on-gray pottery. The possibility of community craft specialization in this region, with its three perennial streams and relatively warm climate (as compared to the rest of the Fremont area) supports Harry's (2005) critique of

Arnold's (1985) argument that ceramic specialization in peasant society is dependent on agricultural marginality. This consistency with the rest of the Southwest is an additional case of the Fremont paralleling their more southern contemporaries (Talbot 1996; Janetski 2002).

The question of *why* craft specialization may have originated in the Parowan Valley remains to be addressed. As discussed in Chapter 1, Harry identified three political/economical factors that play a role in the development of community-based specialization: environmental unpredictability (Ford 1972), differential distribution of pottery-making resources (Allison 2000; Harry 2000), and differences in potting skills (Crown 1995). Most Fremont groups were probably pushed to form relationships (expressed by trade) with neighbors as a means of buffering risk in the event of subsistence shortfalls brought on by environmental deficiencies. Community craft specialization probably did *not* develop in the majority of Fremont settlements, indicating that other factors were driving development of this productive arrangement.

As indicated by Madsen (1977), Snake Valley pottery is the finest produced in the Fremont area. The potters of the Parowan Valley were clearly skilled in their craft. Though painted and burnished pottery was sometimes constructed in the northern Fremont area, the majority was restricted to the south in places like the Parowan Valley and possibly Snake Rock Village and vicinity. The high skill of the Parowan Valley potters probably contributed to ceramic specialization in that area.

Spielmann (2002a, 2002b) alternatively argues that the need for socially valued goods and ceremonial life (specifically feasting) are the factors that create demand and drive specialization. In addition to the mending/curation and higher labor investment discussed previously, other unique properties distinguish goods that are socially valued. Objects (Helms 1988, 1993) or the raw materials used in their construction (Bradley 2000) may originate from distant, inaccessible, or symbolically-charged places. The goods may have also been elaborated through burnishing, polishing, or other decorative techniques. Burnishing is an important characteristic of the Snake Valley Series (Madsen 1977), indicating that it was probably a socially valued good, but most other Fremont pottery also exhibits a high degree of burnishing. Snake Valley Black-on-gray and possibly Snake Valley corrugated (along with Ivie Creek Black-on-white and some other rare types), however, also have decorations that grant "an aesthetic quality… beyond production for ordinary, everyday consumption" (Spielmann 2002b:197) also consistent with socially valued goods.

It is difficult to say whether feasting or other portions of Fremont ceremonial life played a significant role in the development of craft specialization in the Parowan Valley. Spielmann (2002b:202) argues that the slip color, shiny glaze decoration, and burnishing of Rio Grande Glaze ware bowls derive from their importance in ritual contexts. The bowls were large and shared common iconography, further indicating their special use possibly as part of an emerging ideological "sect" in the area. San Juan red ware bowls are similarly identified as critical to feasting activities (Spielmann 2002a). The production of San Juan Red Ware coincides with increasing aggregation in the late 700s. Unlike the large Rio Grande Glaze ware bowls, which were probably designed for serving to large groups, the relatively small and shallow red ware bowls were probably for use by individuals. Special usage is indicated by the association of large quantities of these bowls with pit structures. Spielmann specifically interprets the special usage as communal feasting in these pit structures.

These sorts of data regarding feasting are absent for the Fremont. As mentioned previously, Hockett's (1998) argument for feasting at Baker Village was based on misinterpretation of the archaeological context of the faunal assemblage; however, two important elements of feasting are known. The large numbers of people which would have gathered under Janetski's (2002) trade fair/festival model would have required large quantities of food, provided by the hosts or visitors, or a combination of both. Special socially-valued ceramic bowls (the Snake Valley Series and Ivie Creek Black-on-white) are present throughout the Fremont area. This leaves a large group of people at a single location with large quantities of food with socially-valued serving vessels. There isn't enough evidence to be sure there was feasting occurring in the Fremont area, but a number of things are consistent with it. Further research into Fremont feasting, ritual behavior, and general ideology is necessary if this is to be further understood.

The Parowan Valley was a significant place in the world of the Fremont. Compared to rest of the Fremont area, the Parowan Valley was a veritable metropolis with a population perhaps well into the hundreds (Janetski et al. 2000). In addition to its size, the Parowan Valley has produced additional evidence for emerging social complexity in the form of high status burials with extensive grave goods (Meighan et al. 1956) which are almost unknown in the rest of the Fremont area (Janetski and Talbot 2000b). These factors alone qualify the Parowan Valley as a place that would have been a special, symbolically charged and/or ritually important place in the Fremont universe. The unique status the Parowan Valley had in the past greatly enhanced the social value of commodities originating there, qualifying Snake Valley pottery, especially the painted type, as "pieces of places" (Bradley 2000) which would have been important because of their origins in the Parowan Valley.

The Spielmann (ceremonial) and Harry (political/economic) perspectives are not mutually exclusive. Social, ritual, political, and economic factors contribute to many systems of production and exchange. However Spielmann's argument more explicitly addresses specialization in the Parowan Valley. A variety of factors influenced the emergence of community craft specialization in the Parowan Valley including exchange driven by a need for social networking, the skill of the Parowan Valley potters, possible ritual implications of the pottery, and the significance of the Parowan Valley as a prominent place.

Directions for Further Research

If the raw materials utilized in the manufacture of Snake Valley pottery are to be adequately sourced, we must first determine what those raw materials actually are. In this research, I tested Lyneis's (1994) hypothesis that Snake Valley Black-on-gray pottery, both clay and temper, was derived from weathered volcanic tuffs originating in the Parowan Valley. This hypothesis was not supported, and additional possibilities need to be explored. Basic questions about this type still need to be answered. What is the process by which it was manufactured? Was the non-plastic portion of the pottery intentionally added as temper, as was likely the case with other Fremont types? Or were they included as part of another process? The remarkable consistency of paste and the triad of non-plastic elements in the classic examples of the Snake Valley Series imply that pots of this type were constructed of the same raw materials with a similar recipe.

Although it is not outside the realm of possibility, I find it extremely unlikely that potters would gather, prepare, and mix precise quantities of quartz, biotite, and feldspar to add clay as temper. I suggest that classic Snake Valley pottery was constructed of altered, ash-flow tuffs found in the Parowan Valley. Alteration is generally defined as "any change in the mineralogic composition of a rock brought about by physical or chemical means, especially by the action of hydrothermal solutions" (Jackson 1997:18). The hypothesized alteration of the Parowan Valley tuffs, I suggest here, would have included the replacement of the tuff matrix with clay *in situ* by hydrological processes, leaving the mineral inclusions observed in the tuffaceous units as inclusions in the clay These altered tuffs would differ drastically chemically from the ash-flow tuffs from which they derived; all of the material except the mineral inclusions having been completely replaced. Altered tuffs of this nature may be consistent with the heterogeneous or chemically similar sourced I hypothesized above. Clays of this kind have not been observed in the Parowan Valley, but this may be because no one has ever looked for them.

But regardless, identification of *in situ* raw materials in the Parowan Valley would be an integral part of future studies of Snake Valley pottery.

Additional understanding may come from an analysis of the biotite included within Snake Valley pottery. If the biotite varies enough chemically, it would be possible to separate it from the sherd samples and from the locally available tuffs and conduct further elemental additional assays to determine the source of the biotite. Eric Christensen, a BYU geologist working in the region, expressed his support for this idea, and he believes that the biotite would be distinct from tuff to tuff.

The other portions of the Brown et al. (1990) framework also require additional research. The precise nature of that work is beyond the scope of this thesis, but it would probably be beneficial to construct a research design addressing each of these issues in turn. Particular emphasis should be placed on the sourcing of raw materials and the distribution of other Fremont pottery types. Specialized techniques, such as spatial, statistical, and archaeometric analyses could help to answer the remaining questions, which I respectfully leave to future researchers.

Summary and Conclusion

In this research, I have examined several questions related to Fremont ceramic production and exchange during the Late Formative and have reached several conclusions. My attempt to source Snake Valley Black-on-gray pottery was not conclusive. However, I presented some evidence indicating that Snake Valley Black-on-gray pottery, and the other types in the Snake Valley Series, were produced in the Parowan Valley. Down-the-line exchange was the primary distribution of Snake Valley Black-on-gray pottery. The Wasatch Mountains were a barrier to prehistoric exchange (Lohse 1980), and Snake Valley pottery was transported across this boundary in at least three locations. Snake Valley Black-on-gray pottery was primarily possessed by Fremont groups, implying that it may have been a badge of Fremont ethnic identity and a strong social boundary, and possible limited interaction between the Fremont and the Virgin Anasazi of Southwestern Utah.

If the production of Snake Valley Black-on-gray was restricted to the Parowan Valley, production of the pots was organized on the level of community craft specialization. The distribution of Snake Valley pottery does not parallel the distribution of exotics identified by Janetski (2002). I interpret the two different distributions as evidence of complementary spheres of interaction operating among the Fremont, probably ultimately rooted in risk-buffering strategies. Contrary to the findings of Reed (2005), I argue that Fremont ceramic production more closely follows the model proposed by Wilson and Blinman (1995) for the Anasazi, with utility wares more widely manufactured than non-utility wares. Specialization in pottery production by the prehistoric inhabitants of the fertile Parowan Valley supports Harry's (2005) critique of Arnold's (1985) model of ceramic specialization.

It is my hope that this research will be some of the first of many to follow the macro-scalar research orientation suggested in the Clear Creek Archaeological Project (Janetski et al. 2000). In this research, I have focused on economic patterning at a regional scale, intending to contribute to the emerging literature of Fremont economics (Janetski 2002; Reed 2005; Janetski et al. 2000). Entire suites of research questions at a variety of scales are required to truly understand the Fremont and their internal and external relationships. I urge others to continue working at the macro-scale that we may continue to unravel the mysteries of these elusive Farmers north of the Colorado River.

APPENDIX A

Sample No.	Site	Wt.	Ag	Al	As	Ba	Be	Bi	Ca	Cd	Ce	Co	Cr	Cs	Cu	Fe	Ga	Ge	Hf	In
		kg	ppm	%	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm
125.9	Paragonah	0.02	<0.01	10.95	6.4	1270	1.85	0.02	1.26	0.04	188.5	37	21	74.7	3.2	2.58	34.7	0.19	4.2	0.052
125.316	Paragonah	0.02	0.02	8.02	13.3	940	1.48	0.06	3.51	0.06	70.5	14.4	33	37.4	4.3	2.17	29.6	0.15	3.5	0.056
125.336	Paragonah	0.02	0.02	10.7	12.2	1050	1.59	0.06	0.8	0.02	111	10.8	35	56.8	3.5	2.35	33.3	0.18	4.4	0.065
125.111	Paragonah	0.02	<0.01	9.52	13.6	1090	1.59	0.12	2.31	0.05	50.5	8.1	23	27.6	3.7	2.43	32.4	0.14	5	0.068
125	Paragonah	0.02	<0.01	10.45	13.2	1060	1.81	0.21	1.86	0.06	79.5	10.2	20	41.6	4.3	2.63	37.2	0.16	5.9	0.077
125.42	Paragonah	0.03	0.03	10.75	10	980	1.86	0.04	1.52	0.03	125.5	9.9	33	40.2	3.7	2.7	36.7	0.2	5.6	0.071
125.181	Paragonah	0.02	0.05	9.31	9.6	970	1.74	0.01	3.35	0.05	80.6	15.7	18	45.8	4.6	2.5	33.3	0.17	4.7	0.062
125.6	Paragonah	0.04	0.02	9.7	8.2	1070	1.66	0.08	1.74	0.06	81.4	8	13	44.5	4.5	2.47	32.4	0.15	4.7	0.061
125.628	Paragonah	0.03	0.03	9.53	9.2	1120	1.68	0.03	3.13	0.06	143	8.2	19	46.9	4	2.29	31	0.21	3.7	0.056
125.590	Paragonah	0.02	0.04	9.96	8	1290	1.62	0.08	1.4	0.03	147	14.2	19	47.3	3.2	2.42	31.7	0.17	3.4	0.057
125.346	Paragonah	0.03	0.05	8.05	15.4	540	1.42	0.02	4.65	0.04	65.9	7	17	24.6	5	2.12	28.8	0.14	5.3	0.055
125.899	Paragonah	0.03	0.03	11.25	11.8	960	1.52	0.04	0.92	0.03	103.5	9	13	46	3.8	2.53	35.9	0.16	4.9	0.068
125.637	Paragonah	0.02	0.07	9.79	9.5	1150	1.76	0.02	3.3	0.04	125	11.4	15	49.6	4.4	2.39	32.1	0.18	4	0.054
125.1	Paragonah	0.02	<0.01	9.95	13.1	1140	1.54	0.16	1.88	0.05	61.8	6.7	16	29.7	4.4	2.48	33.3	0.13	5.2	0.067
125.7005.A	Paragonah	0.02	0.03	8.64	17.4	600	1.42	0.02	5.04	0.04	64.4	10	16	23.5	5.1	2.18	29.1	0.14	5	0.06
125.7005.B	Paragonah	0.02	0.06	9.49	7.4	1090	1.56	0.02	3.34	0.06	116.5	11.3	25	46.4	5.4	2.4	30.8	0.18	3.9	0.059
125.6800.A	Paragonah	0.02	<0.01	10.4	8.3	1440	1.64	0.02	1.34	<0.02	138.5	47	12	65	5.5	2.65	34.7	0.16	4.1	0.058
125.6800.B	Paragonah	0.02	0.04	9.93	12	660	1.76	0.04	3.78	<0.02	72.6	17.4	16	36.8	4.8	2.67	33.5	0.16	6.2	0.075
125.6800.C	Paragonah	0.04	<0.01	11.7	8.9	1140	1.63	0.04	0.93	0.02	161.5	16.9	11	53.4	4.1	2.76	35.8	0.19	5.2	0.075
125.6800.D	Paragonah	0.02	0.04	10.2	14.4	680	1.82	0.03	3.68	0.03	78.7	16	21	42.1	5.4	2.66	33.5	0.16	6	0.066
98.237.2804.1	S. Temple	<0.02	0.07	9.65	4.3	1190	1.5	0.06	1.16	0.09	210	31.8	17	65.7	3.8	2.13	30.5	0.19	3.1	0.049
98.285.2438.24	S. Temple	0.02	0.13	7.75	6.1	990	2.95	0.15	2.99	0.2	87.3	16	40	10.8	19	3.15	24.9	0.19	8.3	0.072
98.285.2422.6	S. Temple	0.04	0.04	10.15	3.5	1250	1.56	0.07	1.1	0.07	221	15.9	11	70.3	3.7	2.28	32	0.19	3.2	0.059
98.237.2886.74	S. Temple	0.04	0.02	8.72	8.2	980	1.11	0.56	3.14	0.31	52.6	9	10	50.3	14.2	2.09	25.3	0.13	2.3	0.049
98.237.2933.3	S. Temple	0.02	0.1	7.79	3.2	1370	2.04	0.35	2.83	0.25	115	23.9	40	5.27	24.6	3.73	23.5	0.19	3.7	0.048
98.237.2113.1	S. Temple	0.02	0.06	9.43	4.6	1150	1.34	0.02	1.24	0.03	203	33.5	14	46.8	3.4	2.23	28.4	0.19	2.9	0.047
98.285.288.23	S. Temple	0.02	0.08	7.75	2.9	1410	1.9	0.5	2.8	0.21	95.4	20.8	43	4.84	22.4	4.17	23.2	0.16	3.7	0.048
98.285.2511.8	S. Temple	0.02	0.04	10.1	4	1240	1.58	0.07	1.11	0.05	215	24.5	15	66.9	4	2.26	31.3	0.2	3.1	0.049
98.237.2548.29	S. Temple	<0.02	0.03	8.23	4	1170	2.02	0.28	2.38	0.06	93	89.1	12	23.2	11.8	2.96	24.1	0.16	5.4	0.05

Sample No.	Site	Wt.	K	La	Li	Mg	Mn	Mo	Na	Nb	Ni	P	Pb	Rb	Re	S	Sb	Se	Sn	Sr	Ta
		kg	%	ppm	ppm	%	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm
125.9	Paragonah	0.02	2.33	78.9	93.2	0.66	130	0.72	0.39	20.5	18.1	620	26.5	67	0.005	<0.01	0.44	1	3.3	162	13.1
125.316	Paragonah	0.02	2.37	27.4	63.7	0.56	118	0.95	0.49	16	12.6	950	24.3	25.6	0.002	0.03	0.47	1	3.2	171.5	5.65
125.336	Paragonah	0.02	2.46	44.5	85.8	0.55	100	0.69	0.39	14	19.4	580	24.4	63	0.002	0.01	0.31	1	4.3	150.5	4.9
125.111	Paragonah	0.02	2.12	16.2	81	0.5	117	0.7	0.42	14.9	16.4	490	25.3	22	<0.002	0.01	0.33	1	4.1	157.5	3.88
125	Paragonah	0.02	2.03	29.3	94.7	0.51	121	0.82	0.37	18.2	17.8	500	28.4	32.7	0.002	0.01	0.52	2	5	151.5	4.68
125.42	Paragonah	0.03	1.78	59.8	85.3	0.87	109	0.76	0.33	15.8	21.6	450	23.6	37.6	<0.002	0.01	0.38	1	4.3	176.5	4.18
125.181	Paragonah	0.02	1.9	36.8	94.7	0.47	132	0.76	0.34	16.8	19.1	620	23.3	29.9	0.002	0.01	0.62	1	3.8	171	5.86
125.6	Paragonah	0.04	1.88	25.9	95.4	0.47	122	0.46	0.29	15.7	17.4	560	23.2	32.4	0.002	0.01	0.54	2	3.9	159.5	3.61
125.628	Paragonah	0.03	2.17	49	78.8	0.59	122	0.55	0.37	16.8	14.8	560	24.2	40.3	0.002	0.01	0.35	1	3	172.5	2.91
125.590	Paragonah	0.02	2.37	53	64.1	0.53	120	0.79	0.43	16.8	14.6	580	23.9	48.9	0.003	0.01	0.44	1	2.7	174.5	5.07
125.346	Paragonah	0.03	1.74	25.8	62.8	0.91	140	0.69	0.32	19	9.2	670	26.8	22	<0.002	0.02	0.55	1	3.8	138	3.53
125.899	Paragonah	0.03	2.48	44.1	71.8	0.67	110	0.69	0.41	13.3	18.6	430	22.8	67.9	<0.002	0.01	0.53	2	5.6	133	5.03
125.637	Paragonah	0.02	2.14	46.2	73.9	0.56	129	0.65	0.38	17.3	15	570	22.6	39.3	0.002	0.01	0.5	2	3.2	181	4.38
125.1	Paragonah	0.02	2.19	19.7	82.9	0.53	116	0.62	0.4	15.4	17	490	25.1	27.6	<0.002	0.01	0.38	1	4.3	154.5	3.54
125.7005.A	Paragonah	0.02	1.71	25.8	59.4	1.06	132	0.66	0.3	18.3	9.5	680	26.1	20.2	0.002	0.02	0.59	1	3.9	132	4.27
125.7005.B	Paragonah	0.02	1.66	53.9	70.8	0.53	130	0.72	0.35	16.2	14.7	560	25.3	39.3	0.002	0.01	0.54	2	3.2	178.5	4.38
125.6800.A	Paragonah	0.02	2.3	44.4	76.1	0.58	116	0.82	0.4	19.2	17.9	880	22.3	52.6	0.006	0.01	0.48	1	3.6	145	16.2
125.6800.B	Paragonah	0.02	1.63	30.1	89.8	0.85	142	0.63	0.28	21.4	14	1020	30.7	23.5	0.002	0.01	0.63	2	4.9	150.5	7.08
125.6800.C	Paragonah	0.04	2.16	70.9	81.3	0.72	105	0.59	0.42	16.8	20.1	650	23.1	59.2	0.002	0.01	0.43	1	4.5	165	7.07
125.6800.D	Paragonah	0.02	1.7	34.2	82	0.82	146	0.58	0.29	20.9	14.6	1320	31.7	30.3	0.003	0.01	0.58	2	4.5	152	6.25
98.237.2804.1	S. Temple	<0.02	2.55	82.6	52.7	0.67	107	0.67	0.51	17	14.3	650	20.5	67.8	0.004	0.01	0.33	1	2.4	184.5	10.55
98.285.2438.24	S. Temple	0.02	3.78	41	35	1.06	466	2.07	1.44	19.4	17.4	1580	27.9	131	0.005	0.06	0.68	2	2.9	388	2.73
98.285.2422.6	S. Temple	0.04	2.58	90.5	54.8	0.7	106	0.61	0.52	15.6	14.8	630	20.7	70.9	0.002	0.01	0.28	2	2.6	183.5	5.74
98.237.2886.74	S. Temple	0.04	3.09	23.3	60.3	0.5	443	0.66	0.9	16.5	19.6	750	29.1	71.3	0.002	0.02	0.31	1	2.7	251	3.93
98.237.2933.3	S. Temple	0.02	2.03	60.5	15.8	1.5	701	1.14	1.88	14.2	17.2	1200	28.6	98.9	0.003	0.01	0.44	2	1.6	736	3.45
98.237.2113.1	S. Temple	0.02	2.51	73	52.7	0.61	102	0.66	0.47	16.8	15.2	490	21.5	62.6	0.005	<0.01	0.27	1	2.2	185.5	11.2
98.285.288.23	S. Temple	0.02	1.95	47.8	14.8	1.52	689	1.06	1.89	13	17.2	840	27.7	68.3	0.002	0.01	0.55	1	1.5	803	2.24
98.285.2511.8	S. Temple	0.02	2.52	90.8	50.3	0.7	127	0.91	0.47	16.2	14.2	590	20	70.1	0.004	0.01	0.72	1	2.6	186.5	9.04
98.237.2548.29	S. Temple	<0.02	2.33	44.8	20	1.04	319	1.47	1.26	22.6	8.4	1360	23.4	93.3	0.011	0.01	0.3	2	2.3	561	26.5

Sample No.	Site	Wt.	Te	Th	Ti	Tl	U	V	W	Y	Zn	Zr
		kg	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	ppm
125.9	Paragonah	0.02	<0.05	33.6	0.399	0.45	0.9	36	274	6.8	81	84.2
125.316	Paragonah	0.02	<0.05	14.4	0.342	0.42	0.8	37	110	4.4	77	79
125.336	Paragonah	0.02	<0.05	31.9	0.283	0.4	0.6	26	64.8	4.5	68	81.8
125.111	Paragonah	0.02	<0.05	14.3	0.298	0.34	0.5	29	39.7	3.5	72	89.7
125	Paragonah	0.02	<0.05	22.3	0.326	0.38	0.5	31	54	4.9	76	108
125.42	Paragonah	0.03	<0.05	30.9	0.319	0.33	1	29	48.4	6.7	77	98
125.181	Paragonah	0.02	<0.05	19.5	0.334	0.36	0.9	32	96.2	5.8	73	99.5
125.6	Paragonah	0.04	<0.05	19.5	0.326	0.35	0.3	29	33.8	4.2	67	83.8
125.628	Paragonah	0.03	<0.05	23.8	0.334	0.38	0.8	31	31.9	8.8	74	92.1
125.590	Paragonah	0.02	<0.05	25.9	0.379	0.38	0.7	38	99.8	5.6	74	75.9
125.346	Paragonah	0.03	<0.05	13.8	0.288	0.35	0.7	31	36.7	6.6	49	97.1
125.899	Paragonah	0.03	<0.05	35.2	0.262	0.41	0.4	24	52.1	5.5	66	84.6
125.637	Paragonah	0.02	<0.05	22.9	0.339	0.37	0.7	33	65.6	8.4	78	94.4
125.1	Paragonah	0.02	<0.05	17.1	0.306	0.32	0.5	29	26.7	4.2	73	92.6
125.7005.A	Paragonah	0.02	<0.05	12.8	0.279	0.36	0.6	28	57.1	6.6	47	94.5
125.7005.B	Paragonah	0.02	<0.05	24.2	0.258	0.39	0.8	26	73.9	6.5	53	74.9
125.6800.A	Paragonah	0.02	<0.05	26.8	0.375	0.45	1.6	33	336	5.3	73	65.6
125.6800.B	Paragonah	0.02	<0.05	18.6	0.333	0.43	0.8	31	121	6.8	67	119.5
125.6800.C	Paragonah	0.04	<0.05	36.9	0.339	0.37	1.1	29	109.5	6.9	83	102.5
125.6800.D	Paragonah	0.02	<0.05	21.4	0.326	0.42	0.9	32	111.5	7.3	68	117
98.237.2804.1	S. Temple	<0.02	<0.05	32.6	0.34	0.48	0.4	31	250	6.2	72	58.3
98.285.2438.24	S. Temple	0.02	<0.05	20.2	0.457	0.85	5.5	82	48.2	24.4	101	276
98.285.2422.6	S. Temple	0.04	<0.05	35.3	0.36	0.47	0.4	34	117	6.4	77	61.7
98.237.2886.74	S. Temple	0.04	<0.05	20.3	0.24	0.61	0.4	38	52.1	8.8	109	32.3
98.237.2933.3	S. Temple	0.02	<0.05	17.9	0.45	0.68	2.4	97	75	19.8	80	111
98.237.2113.1	S. Temple	0.02	<0.05	32.2	0.328	0.42	0.7	31	261	5.2	70	60.7
98.285.288.23	S. Temple	0.02	<0.05	13.8	0.462	0.71	1.9	114	43.4	16.8	92	102
98.285.2511.8	S. Temple	0.02	<0.05	33.5	0.347	0.45	0.4	33	199.5	6.4	74	60
98.237.2548.29	S. Temple	<0.02	<0.05	19.2	0.403	1.18	2.9	84	690	18.8	82	168.5

Sample No.	Site	Wt.	Ag	Al	As	Ba	Be	Bi	Ca	Cd	Ce	Co	Cr	Cs	Cu	Fe	Ga	Ge	Hf	In
		kg	ppm	%	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm
98.237.2845.8	S. Temple	0.02	0.03	12.1	6.3	290	1.54	0.04	0.35	0.02	48.4	21.6	9	47.8	5.6	2.29	39.4	0.14	5.4	0.084
433.814	Parowan	0.02	0.06	9.04	13	790	1.68	0.05	3.43	0.06	58.7	15	25	52.3	5.6	2.88	33.8	0.15	5.8	0.069
433.801	Parowan	0.04	0.03	10.4	8	1000	1.33	0.05	1.06	0.02	147	9.7	13	47.9	5.5	2.53	31.4	0.15	3	0.066
433.117	Parowan	0.02	0.02	11.05	15.4	930	1.47	0.1	0.93	<0.02	155	25.9	13	45.1	3.4	2.52	36.1	0.17	5.3	0.068
433.446	Parowan	0.02	<0.01	11.45	7.2	960	1.49	0.1	0.7	<0.02	66.7	13.4	14	27.4	4.7	2.53	36.7	0.18	6	0.077
433.106	Parowan	0.03	0.16	9.11	8.2	1300	1.64	0.04	1.78	0.06	91.1	11.8	11	48.2	9.7	2.58	29.7	0.16	3.4	0.067
433.106	Parowan	0.03	0.11	7.82	14.7	860	1.14	0.04	7.12	0.09	79	12	13	25.2	6.8	1.77	22.1	0.21	3.5	0.052
433.113	Parowan	0.04	0.08	11.2	13	750	1.51	0.03	0.67	0.03	45.9	10	4	38.1	6.7	2.38	33.6	0.14	5.7	0.092
433.912	Parowan	0.03	0.08	9.55	10.8	1430	1.72	0.02	4.1	0.07	95.9	11.6	10	52.3	7.1	2.58	28.5	0.18	3.8	0.067
433.122	Parowan	0.02	0.11	9.73	24.1	720	1.89	0.1	3.32	0.05	98.6	10.4	12	26.3	7.4	2.82	32.3	0.21	7.3	0.081
433.1	Parowan	0.02	0.14	9.05	16.5	630	1.93	0.06	4.87	0.11	79.1	96.5	16	27.8	7.5	2.62	31	0.18	6.6	0.079
433.103	Parowan	0.02	0.1	9	19.2	580	1.92	0.01	4.8	0.06	83.3	14.8	15	36	7.1	2.47	30	0.18	6.3	0.079
433.110	Parowan	0.02	0.11	9.65	20.1	700	2.09	0.05	3.34	0.04	98.4	20.3	13	27.3	7.3	2.82	33.6	0.2	7.2	0.08
433.556	Parowan	0.03	0.12	9.14	14.3	610	1.8	0.17	4.85	0.08	77.9	35.1	17	30.7	6.8	2.44	27.6	0.17	6.2	0.069
433.268	Parowan	0.02	0.07	8.93	11.4	550	1.45	0.02	4.02	0.05	67.7	14.2	13	32.4	6.3	2.2	26.6	0.21	5	0.056
Parowan 1	Parowan	0.02	0.09	11.8	10.8	720	1.68	<0.01	1.15	0.03	84.9	38.9	10	44.1	6.7	2.53	32	0.23	5.5	0.072
443.166	Parowan	0.02	0.05	9.34	11.2	720	1.44	0.05	1.22	0.03	24.5	29.5	13	41.9	11.1	2.5	31.9	0.15	4.3	0.087
433.112	Parowan	0.02	0.16	11.1	22.9	510	2.72	0.52	1.12	0.06	72.9	28.8	15	22	10.5	3.7	42.2	0.23	11.4	0.114
433.969	Parowan	0.02	0.1	10.85	9.8	1080	1.56	0.08	1.92	0.05	122	25.1	15	53	9.7	2.87	30.2	0.22	3.7	0.069
433.115	Parowan	0.02	0.09	10.6	9.2	1120	1.76	<0.01	3.21	0.06	99.8	24.1	16	57.2	6.4	2.62	33.2	0.22	4.9	0.071
433.101	Parowan	0.02	0.12	9.69	15.2	590	2.12	0.05	3.39	0.05	64.9	25.7	13	34	7	2.52	30.5	0.2	6.3	0.07
283.246	Summit	0.02	0.16	9.2	9.5	1120	1.66	0.01	4.69	0.11	116.5	50.3	16	45.7	6.6	2.42	29.7	0.25	3.9	0.061
283.228	Summit	0.02	0.15	8.83	7.6	970	1.47	0.01	3.87	0.09	135.5	16.3	17	44.9	6.7	2.19	26.9	0.23	4	0.057
283.299	Summit	0.03	0.17	9.57	6.9	1300	1.52	<0.01	2.84	0.08	119	9.7	13	45	7.2	2.62	27.9	0.24	3.8	0.06
283.297	Summit	0.02	0.14	10.05	8	1240	1.43	0.01	2.08	0.07	148.5	16.6	19	46.5	7.9	2.35	28.8	0.25	3.7	0.059
333.7778.B	Summit	0.02	0.13	11.75	10.8	720	1.63	0.02	1.16	0.09	66.3	21.4	10	45.8	12	2.37	36.5	0.18	6.9	0.096
395.5730.A	Summit	0.03	0.14	9.98	7.7	1210	1.6	<0.01	2.07	0.07	179	16.4	10	53.1	7.7	2.45	29.4	0.25	3.5	0.061
395.408	Summit	0.03	0.22	10.9	12	1050	1.73	<0.01	3.01	0.15	97.5	14.2	14	60.3	7.8	3.04	33.4	0.21	5.8	0.078
283.256	Summit	0.02	0.1	11.7	12.2	900	2.12	0.02	1.18	0.07	95	26.7	12	76	8.4	2.6	33.8	0.18	5.5	0.075

Sample No.	Site	Wt.	K	La	Li	Mg	Mn	Mo	Na	Nb	Ni	P	Pb	Rb	Re	S	Sb	Se	Sn	Sr	Ta
		kg	%	ppm	ppm	%	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm
98.237.2845.8	S. Temple	0.02	2.53	22.5	75.9	0.51	103	0.75	0.44	12.2	17.8	160	35	80.5	0.004	<0.01	0.35	1	9.3	74.1	11.5
433.814	Parowan	0.02	1.75	22.7	98.9	0.39	130	0.71	0.29	17.2	18.2	1150	27.7	29.1	0.003	0.01	0.51	1	4.5	156	6.19
433.801	Parowan	0.04	3.04	45	49.9	0.48	110	0.57	0.51	12.6	18.6	720	28.1	75	0.003	0.01	0.36	2	3.4	127.5	4.15
433.117	Parowan	0.02	2.34	57.8	66.9	0.58	99	0.7	0.41	18.3	19.8	610	21.7	61.8	0.004	0.01	0.44	1	4.7	151.5	10.25
433.446	Parowan	0.02	2.3	26.9	58.6	0.67	100	0.67	0.39	16.3	15.6	380	27.7	44.4	0.005	<0.01	0.33	1	5.4	113	6.49
433.106	Parowan	0.03	2.53	29.2	59.3	0.55	113	0.58	0.47	17.8	15.4	720	22.7	42.1	<0.002	0.01	0.44	2	3.1	193.5	4.71
433.106	Parowan	0.03	2.59	44.1	44.2	0.98	153	0.49	0.42	12.2	8	1100	33.4	46.5	<0.002	0.06	0.55	2	3.1	179	4.98
433.113	Parowan	0.04	2.86	18.6	73	0.5	87	0.56	0.54	12.8	19.7	600	25.3	64.8	<0.002	0.02	0.46	2	7.2	132.5	5.73
433.912	Parowan	0.03	2.39	39.1	86.9	0.48	119	0.54	0.42	15	16	1240	23.1	40.7	<0.002	0.05	0.4	2	3.8	182.5	4.44
433.122	Parowan	0.02	1.76	40	90.9	0.81	132	1.06	0.36	20.9	17.7	1150	28.1	26.6	<0.002	0.04	1.52	2	5.5	148.5	4.77
433.1	Parowan	0.02	1.92	33.5	96.6	0.9	187	1.4	0.39	30.4	14.7	1540	30.2	26.1	0.008	0.02	0.77	2	5.5	156	32.8
433.103	Parowan	0.02	2	33.2	87.6	0.79	125	0.62	0.36	19.3	13.5	1020	27.7	35.2	<0.002	0.02	0.6	2	5.2	144.5	6.05
433.110	Parowan	0.02	1.72	41.2	98.4	0.76	127	0.72	0.41	22.5	18.4	1100	29.3	26	0.002	0.03	0.64	2	5.6	152	8.04
433.556	Parowan	0.03	2.22	31.9	63.7	0.85	116	0.82	0.39	21.8	9.6	1260	29.4	41.2	0.004	0.01	0.5	2	4.7	148	12.4
433.268	Parowan	0.02	2.09	28.9	59.9	0.81	128	0.56	0.47	16.2	14.9	830	25.2	37.9	0.002	0.02	0.53	2	4.1	147	6.03
Parowan 1	Parowan	0.02	2.67	34.5	68.5	0.66	102	0.72	0.49	17.4	16.8	710	29.9	71.6	0.004	0.02	0.48	2	5.7	132	15.15
443.166	Parowan	0.02	2.36	9.1	62.8	0.72	92	0.68	0.49	13.1	32.4	470	21.3	33.6	0.003	0.01	0.41	2	6.9	173.5	12.4
433.112	Parowan	0.02	1.03	26.9	124	0.76	118	2.35	0.36	19.6	34.5	680	34.1	16.6	0.002	0.03	3.03	2	7.9	184.5	10.75
433.969	Parowan	0.02	2.57	37.8	69.6	0.57	131	0.89	0.51	14.8	23.2	970	29	60.9	0.002	0.04	0.75	2	3.7	155	8.71
433.115	Parowan	0.02	2.38	38.2	83.7	0.57	136	0.66	0.43	19	19.2	790	21.8	43.1	0.002	0.01	0.38	2	4.6	186.5	8.27
433.101	Parowan	0.02	1.99	26.9	71.4	0.79	114	0.75	0.42	20.5	14.8	1220	28.5	38.3	0.002	0.02	0.61	2	5.3	170	9.9
283.246	Summit	0.02	2.23	53.9	67.8	0.58	127	0.81	0.5	20.6	16.5	1130	20.5	36.6	0.005	0.03	0.37	2	3.4	206	16.85
283.228	Summit	0.02	2.16	54.5	54.2	0.67	123	0.56	0.42	16.2	14	1080	25.3	41	0.002	0.02	0.37	2	2.7	190.5	5.69
283.299	Summit	0.03	2.36	53.9	68	0.59	111	0.51	0.46	15	17	900	25.3	50.1	<0.002	0.03	0.4	2	2.9	208	3.61
283.297	Summit	0.02	2.64	53.2	56.8	0.56	102	0.75	0.51	15	16.2	680	25.2	55	0.002	0.02	0.42	2	2.7	204	6.07
333.7778.B	Summit	0.02	2.67	24.6	66.2	0.44	107	0.72	0.52	15.8	19.7	620	29.6	64.6	0.002	0.02	0.33	2	8.3	115.5	10.6
395.5730.A	Summit	0.03	2.61	66.4	68.7	0.63	100	0.59	0.54	15.8	16.1	1060	23.4	58.6	<0.002	0.02	0.35	2	2.8	206	5.76
395.408	Summit	0.03	2.07	38.1	100.5	0.53	142	0.56	0.41	18	21.6	1120	28.6	45.2	0.002	0.03	0.44	2	4.8	186	5.69
283.256	Summit	0.02	2.64	33.8	72.2	0.55	101	0.73	0.52	19.4	20.4	900	28.9	71.2	0.003	0.02	0.38	2	4.9	155.5	10.6

Sample No.	Site	Wt.	Te	Th	Ti	Tl	U	V	W	Y	Zn	Zr
		kg	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	ppm
98.237.2845.8	S. Temple	0.02	<0.05	39.7	0.13	0.45	0.2	23	168	3.2	61	73.5
433.814	Parowan	0.02	<0.05	15.5	0.35	0.42	0.7	37	97.1	4.6	83	94.4
433.801	Parowan	0.04	<0.05	33.5	0.362	0.45	0.5	42	57.4	4.4	80	48.4
433.117	Parowan	0.02	<0.05	36.3	0.262	0.4	1.1	23	192.5	7.6	77	104
433.446	Parowan	0.02	<0.05	24.8	0.217	0.35	0.2	24	101.5	3.9	76	91.2
433.106	Parowan	0.03	<0.05	22.2	0.355	0.41	0.5	38	79	4.1	84	78.3
433.106	Parowan	0.03	<0.05	16.9	0.212	0.38	0.4	32	93.8	11.4	43	76.3
433.113	Parowan	0.04	<0.05	29.1	0.17	0.45	0.5	18	66.5	3.1	54	82
433.912	Parowan	0.03	<0.05	24.1	0.345	0.36	0.7	31	74.2	5.3	73	68.3
433.122	Parowan	0.02	<0.05	22	0.353	0.34	0.8	37	56.4	7.4	71	114
433.1	Parowan	0.02	<0.05	19.2	0.318	0.44	1.2	31	950	7.1	67	111.5
433.103	Parowan	0.02	<0.05	21.2	0.297	0.39	1	30	106	6.6	75	104
433.110	Parowan	0.02	<0.05	22.9	0.359	0.37	0.8	38	154	7.7	79	118.5
433.556	Parowan	0.03	<0.05	19.4	0.296	0.39	0.7	30	308	7.1	64	115
433.268	Parowan	0.02	0.05	18.2	0.269	0.41	1.1	29	113	6.6	70	83.1
Parowan 1	Parowan	0.02	<0.05	31.5	0.247	0.46	0.5	30	388	5.3	69	80.6
443.166	Parowan	0.02	<0.05	20.7	0.157	0.41	0.3	19	256	1.6	82	55.8
433.112	Parowan	0.02	<0.05	24.8	0.362	0.34	0.8	45	192.5	5.9	97	174.5
433.969	Parowan	0.02	<0.05	28.8	0.381	0.46	0.6	43	204	4.4	90	55.6
433.115	Parowan	0.02	<0.05	26.3	0.332	0.42	0.7	30	176	6.8	85	102
433.101	Parowan	0.02	<0.05	22.1	0.285	0.42	0.6	33	226	7.3	73	122
283.246	Summit	0.02	<0.05	25.7	0.32	0.4	0.5	29	470	8.8	81	84.3
283.228	Summit	0.02	<0.05	24.9	0.361	0.38	0.8	39	134.5	7.1	71	72.5
283.299	Summit	0.03	<0.05	28.2	0.341	0.38	0.6	34	60.7	5.5	82	75.6
283.297	Summit	0.02	<0.05	30.5	0.341	0.42	1.2	31	138	5.6	74	62.5
333.7778.B	Summit	0.02	<0.05	35.2	0.167	0.46	0.3	23	191	4.4	61	103
395.5730.A	Summit	0.03	<0.05	28.7	0.337	0.41	0.7	33	119.5	5.8	81	64.5
395.408	Summit	0.03	<0.05	24.9	0.395	0.42	1.3	37	93.6	5.4	89	94.4
283.256	Summit	0.02	<0.05	33.2	0.288	0.45	2.6	26	224	6.1	81	104

Sample No.	Site	Wt.	Ag	Al	As	Ba	Be	Bi	Ca	Cd	Ce	Co	Cr	Cs	Cu	Fe	Ga	Ge	Hf	In
		kg	ppm	%	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm
333.7778.A	Summit	0.02	0.16	9.96	22.7	1160	1.92	0.08	3.59	0.18	67.1	18.8	16	58.5	9.3	3.02	33.4	0.17	6.5	0.079
333.736	Summit	0.04	0.16	11.65	7.8	810	1.65	<0.01	1.16	0.09	88.9	17.1	9	56.5	10.4	2.57	35.2	0.21	4.4	0.084
283.2402.C	Summit	0.02	0.09	12.25	10.4	1030	1.83	<0.01	1.17	0.07	106.5	242	8	39.4	7.9	2.73	38.1	0.47	6.9	0.081
395.5730.B	Summit	0.02	0.15	9.12	7.9	1090	1.53	0.02	7.25	0.11	231	12.8	11	46.9	7.4	2.34	26	0.33	3.4	0.056
283.2402.A	Summit	0.03	0.05	11.45	7.9	1020	1.75	<0.01	1.19	0.07	101	15.4	6	37.7	8	2.62	37.7	0.21	6.4	0.083
283.2402.D	Summit	0.02	0.07	10.45	8.4	950	1.72	<0.01	1.61	0.03	55.2	27.6	10	39.6	6.5	2.61	35.7	0.17	6.4	0.079
Summit 1	Summit	0.03	0.14	12.15	12.6	350	2	0.01	0.93	<0.02	35.6	17.6	8	58.1	13.5	2.64	37.5	0.14	6.5	0.104
283.2402.B	Summit	0.02	0.11	9.04	5.4	1080	1.46	0.02	2.14	0.1	137.5	31.2	11	51.7	7.2	2.15	28	0.23	3.1	0.053
395.522	Summit	0.03	1.1	10.55	13.4	1380	1.54	0.08	2.05	0.02	97.1	46.9	12	50	21.7	2.7	32.2	0.21	4.5	0.049
395.498	Summit	0.02	0.16	9.97	6.5	1310	1.6	0.01	1.86	0.09	149.5	18.2	10	53.9	7.7	2.32	29.9	0.26	3.2	0.053
395.629	Summit	0.03	0.09	9.28	5.8	1160	1.59	<0.01	3.15	0.07	169	16.3	11	49.5	6.6	2.24	28.7	0.24	3.3	0.053
Summit.2387	Summit	0.04	0.05	12	8.9	1020	2.08	0.01	1.08	0.03	96	15	10	30.4	8.4	3.01	39.2	0.25	7.6	0.091
91.78.8852.1	Baker	0.03	0.09	10.8	13.4	1100	1.78	0.02	1.48	0.02	144.5	19.2	9	60.3	6.2	2.62	33.7	0.25	4.9	0.06
91.78.9828.3	Baker	0.02	0.07	10.45	10.8	1030	1.85	<0.01	2.22	0.03	124	32.1	12	55.4	6.9	2.68	33	0.2	5.1	0.057
91.78.1854.17	Baker	0.02	0.07	10.3	12.1	1280	1.84	<0.01	1	<0.02	92.5	34.8	11	52.7	7.6	2.84	34.5	0.2	4.5	0.061
91.78.9807.1	Baker	0.03	0.08	10.45	16.8	1010	2	0.35	0.79	<0.02	74.5	9.5	10	32.7	8.3	2.93	40.3	0.22	6.8	0.087
91.78.8714.6	Baker	0.04	<0.01	11.25	16.5	1180	2.01	0.12	1.01	<0.02	140.5	12.3	7	45.4	7.6	2.84	35.5	0.21	4.5	0.077
91.78.2293.2	Baker	0.04	<0.01	13.1	8.7	560	1.56	0.01	0.56	<0.02	46.6	16.8	2	24.5	9.1	2.48	39.8	0.15	5.5	0.08
91.78.6726.5	Baker	0.03	<0.01	11.5	8	500	1.45	0.02	0.63	<0.02	39.4	22.1	4	21.5	8.1	2.28	38.2	0.12	5.3	0.073
91.78.9249.25	Baker	0.02	<0.01	11.55	11	610	1.83	0.11	0.8	<0.02	69	18	10	27.8	6.9	2.54	33.9	0.16	4.8	0.086
91.78.6559.8	Baker	0.03	<0.01	11.65	17.2	1710	2.18	0.06	0.65	<0.02	140	13	9	52.5	5.5	3.01	38.2	0.17	4.3	0.082
91.78.1319.1	Baker	0.02	<0.01	11	13.8	1100	2.31	0.03	0.82	<0.02	99	26.6	7	48.8	8	2.5	35	0.18	4.3	0.081
91.78.3154.1	Baker	0.02	<0.01	11.85	14.8	1160	1.91	0.16	0.7	<0.02	129	164	7	33.7	8	2.73	39.6	0.34	4.9	<0.005
91.78.1763.1	Baker	0.02	0.04	8.63	11.4	860	1.82	0.04	5.69	0.07	80.6	13.8	12	23.8	6.3	2.25	26.9	0.16	3.8	0.061
91.78.1867.1	Baker	0.02	0.04	12.5	5.8	480	1.32	0.02	0.5	0.03	68.8	19.3	4	26	9.6	2.32	37	0.18	5.5	0.07
91.78.8847.01	Baker	0.03	0.02	11.05	13.3	1160	1.8	0.02	1.46	<0.02	148	16.4	12	56.6	5.8	2.6	33.9	0.22	4.1	0.058
91.78.1669.1	Baker	0.02	0.07	10.65	18.4	570	2.13	0.03	1.38	0.06	57.3	20.8	7	45.4	8.2	2.35	34.8	0.17	4.7	0.079
91.78.1192.5	Baker	0.02	0.12	10.05	10.1	920	1.5	0.07	2.12	0.07	85.4	19.2	7	44.1	6.2	2.38	32.8	0.2	5.9	0.068
91.78.1898.1	Baker	0.03	0.16	6.91	5.9	560	3.22	0.43	1.04	0.14	62.7	10.4	24	5.94	9.9	1.39	20.6	0.16	1.7	0.045

Sample No.	Site	Wt.	K	La	Li	Mg	Mn	Mo	Na	Nb	Ni	P	Pb	Rb	Re	S	Sb	Se	Sn	Sr	Ta
		kg	%	ppm	ppm	%	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm
333.7778.A	Summit	0.02	2.06	24	99	0.43	132	0.68	0.48	17.8	21.8	1230	28.3	35.4	0.003	0.04	0.44	2	5	171.5	7.36
333.736	Summit	0.04	2.8	43	82.5	0.51	105	0.53	0.5	12.8	26.5	440	30.3	85.4	0.002	0.01	0.38	2	6.2	134	7.06
283.2402.C	Summit	0.02	2.41	46.3	80.9	0.61	123	2.07	0.41	39.2	23.6	420	33.7	61.9	0.008	0.01	0.55	4	6.5	139	78.5
395.5730.B	Summit	0.02	2.08	94.5	70	0.6	151	0.71	0.35	14.8	13.7	1120	23.2	51.1	<0.002	0.03	0.51	2	2.5	207	4.13
283.2402.A	Summit	0.03	2.37	44.8	82.7	0.56	116	0.65	0.42	16.8	18.4	800	30.3	58.9	0.002	0.01	0.39	2	6.3	136	6.88
283.2402.D	Summit	0.02	2.25	19.4	84	0.49	116	0.9	0.4	18	18.5	470	28.4	45.9	0.003	0.01	0.44	1	6.1	138.5	10.45
Summit 1	Summit	0.03	2.37	15.8	111	0.67	93	0.95	0.43	16	30.3	250	26.5	62.2	0.002	0.01	0.73	2	10.4	155	10.15
283.2402.B	Summit	0.02	2.59	68.2	55.2	0.64	95	0.73	0.46	17.5	15.8	770	23.1	53.2	0.003	0.01	0.47	2	2.4	221	10.55
395.522	Summit	0.03	2.41	36.9	75.2	0.51	112	0.87	0.58	20.8	22.2	1190	26.6	49.4	0.005	0.02	5.23	2	290	182.5	15.8
395.498	Summit	0.02	2.85	71.3	55.1	0.64	105	0.64	0.56	17.2	15.4	1240	23.2	61.5	0.002	0.02	0.4	2	2.6	219	6.44
395.629	Summit	0.03	2.54	71.6	63.3	0.63	103	0.53	0.46	15.9	15.3	1050	23.4	50.1	0.002	0.02	0.38	2	2.6	218	5.61
Summit.2387	Summit	0.04	1.7	46.5	85.4	0.69	123	0.54	0.32	20.3	23.4	350	33	32.2	<0.002	<0.01	0.36	3	5.6	132	6.46
91.78.8852.1	Baker	0.03	2.07	59.5	89.3	0.63	117	0.58	0.44	18.8	20.7	620	24.4	54	0.002	0.01	0.44	2	4	195.5	6.72
91.78.9828.3	Baker	0.02	2.02	40.6	86.5	0.58	107	0.91	0.42	19.6	21	640	22.5	42.8	0.003	0.01	0.43	2	4	194.5	9.98
91.78.1854.17	Baker	0.02	2	31	85.1	0.48	99	0.89	0.37	19.1	23.3	660	21.8	47.2	0.003	0.01	3.95	2	4	160.5	11.05
91.78.9807.1	Baker	0.03	2.26	29.7	82.4	0.62	106	0.82	0.6	18	14.9	420	25.2	43.9	<0.002	0.01	0.44	2	5.9	145.5	4.77
91.78.8714.6	Baker	0.04	1.94	57.5	92.5	0.65	109	0.58	0.4	18	26.2	660	23.8	46.5	<0.002	0.01	0.35	2	4.4	192	4.73
91.78.2293.2	Baker	0.04	2.85	19	61.7	0.49	108	0.57	0.69	14.4	14.2	470	22.2	82.4	<0.002	0.01	0.36	2	9.5	125.5	10.95
91.78.6726.5	Baker	0.03	2.7	16.2	51.6	0.42	90	0.69	0.57	14.5	13.4	410	22.2	69.1	<0.002	0.02	0.36	2	9.1	120.5	12.25
91.78.9249.25	Baker	0.02	2.56	30	83	0.61	102	0.57	0.66	13.8	14.9	430	24.4	70.6	<0.002	0.01	0.41	2	6.4	133.5	9.28
91.78.6559.8	Baker	0.03	2.39	43.9	98.4	0.59	110	0.73	0.59	17.4	25.2	600	22.1	63.5	<0.002	0.02	0.4	3	4.4	176.5	5.68
91.78.1319.1	Baker	0.02	2.73	37.3	93.6	0.6	110	0.7	0.64	20.2	24.6	530	25.5	65.6	<0.002	0.01	0.38	3	5	183	10.55
91.78.3154.1	Baker	0.02	2.34	57.9	68.5	0.75	105	1.33	0.61	32	11.9	450	24.5	66.6	<0.002	0.01	0.39	4	5.4	158.5	55.8
91.78.1763.1	Baker	0.02	1.97	36.1	78.3	0.97	170	0.7	0.39	16.8	11.4	590	25	32.9	<0.002	0.03	0.48	2	3.4	180.5	5.24
91.78.1867.1	Baker	0.02	2.76	30.7	43.4	0.48	100	0.56	0.57	13.4	13.2	380	22.8	83.9	<0.002	0.01	0.49	2	8.1	116.5	11.1
91.78.8847.01	Baker	0.03	2.09	55.8	81.4	0.66	117	0.52	0.45	17.2	23.9	640	23.4	52.8	<0.002	0.01	0.37	3	3.4	203	6.05
91.78.1669.1	Baker	0.02	2.55	21.2	102.5	0.57	101	1.42	0.79	16	29.7	330	21.8	49.4	<0.002	0.02	1.01	2	5.7	180	8.97
91.78.1192.5	Baker	0.02	2.33	31	95.7	0.78	105	0.72	0.98	15.4	27.1	480	22	41.8	0.002	0.02	0.37	2	5.2	241	7.89
91.78.1898.1	Baker	0.03	2.73	31.3	29.1	0.38	146	1.06	1.38	15.2	9.3	1500	29.1	148.5	<0.002	0.01	0.61	2	2.4	215	3.67

Sample No.	Site	Wt.	Te	Th	Ti	Tl	U	V	W	Y	Zn	Zr
		kg	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	ppm
333.7778.A	Summit	0.02	<0.05	20.1	0.353	0.44	1.1	36	152	4.8	78	101.5
333.736	Summit	0.04	<0.05	35.9	0.265	0.47	0.3	30	122.5	4.1	68	77.8
283.2402.C	Summit	0.02	0.09	40	0.25	0.46	0.3	26	2300	4.9	76	88.8
395.5730.B	Summit	0.02	<0.05	32	0.303	0.32	0.6	30	83.5	11.2	75	73.7
283.2402.A	Summit	0.03	<0.05	40.4	0.232	0.37	0.3	27	101.5	5.2	75	85.4
283.2402.D	Summit	0.02	<0.05	25.2	0.223	0.41	0.3	27	213	3.2	72	84.4
Summit 1	Summit	0.03	<0.05	36.8	0.146	0.45	1.6	19	126	3.5	83	89.5
283.2402.B	Summit	0.02	<0.05	32.1	0.325	0.4	0.7	30	264	5.7	71	58.2
395.522	Summit	0.03	<0.05	25.3	0.358	0.42	1.1	31	421	4.6	84	76
395.498	Summit	0.02	<0.05	31	0.336	0.41	0.6	30	159	6.4	85	62.5
395.629	Summit	0.03	<0.05	29.2	0.316	0.39	0.6	31	122.5	7.3	79	68
Summit.2387	Summit	0.04	<0.05	33.3	0.323	0.33	0.5	31	86.7	6.7	90	140
91.78.8852.1	Baker	0.03	<0.05	30.4	0.374	0.41	1.2	32	134	6	82	100.5
91.78.9828.3	Baker	0.02	<0.05	27.3	0.362	0.38	1	30	237	4.9	82	92.2
91.78.1854.17	Baker	0.02	<0.05	29.2	0.362	0.39	1.8	32	261	4.5	70	69.4
91.78.9807.1	Baker	0.03	<0.05	30.7	0.273	0.41	0.8	30	50.2	5.5	67	115.5
91.78.8714.6	Baker	0.04	<0.05	29.8	0.384	0.32	1.4	33	57.3	7.1	87	110.5
91.78.2293.2	Baker	0.04	<0.05	38.4	0.146	0.27	0.5	24	126	3.6	42	83.8
91.78.6726.5	Baker	0.03	<0.05	32.7	0.137	0.41	0.6	22	189.5	3.2	40	80.8
91.78.9249.25	Baker	0.02	<0.05	29	0.221	0.37	0.5	37	153.5	6.6	49	86.1
91.78.6559.8	Baker	0.03	<0.05	31.3	0.392	0.39	2.2	34	85.7	5.5	81	66.9
91.78.1319.1	Baker	0.02	<0.05	28.8	0.273	0.43	1.6	25	217	6.6	90	100.5
91.78.3154.1	Baker	0.02	<0.05	39.4	0.268	0.24	0.5	27	1600	7.5	71	95.7
91.78.1763.1	Baker	0.02	<0.05	19	0.272	0.36	0.5	37	93.9	8.8	54	89.6
91.78.1867.1	Baker	0.02	<0.05	42.1	0.136	0.41	0.4	22	154.5	4.1	39	79.9
91.78.8847.01	Baker	0.03	<0.05	27.9	0.361	0.38	1.2	32	110.5	6.3	82	98
91.78.1669.1	Baker	0.02	<0.05	22.8	0.16	0.46	1.4	17	151.5	4.9	84	94.5
91.78.1192.5	Baker	0.02	<0.05	30.7	0.21	0.35	0.4	20	144	3.5	67	76.8
91.78.1898.1	Baker	0.03	<0.05	21	0.225	0.88	3	43	86.5	16.5	44	44.6

Sample No.	**Site**	**Wt.**	Ag	Al	As	Ba	Be	Bi	Ca	Cd	Ce	Co	Cr	Cs	Cu	Fe	Ga	Ge	Hf	In
		kg	ppm	%	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm
91.78.1673.15	Baker	0.02	0.15	6.96	5.2	510	3.26	0.14	0.91	0.04	60.9	23	23	4.84	8.8	1.43	20.4	0.15	1.6	0.047
86.005.516.39	Mukwitch	0.02	0.09	9.94	13.9	800	1.79	0.12	0.43	<0.02	55.8	21.7	7	31	10.2	2.46	37.1	0.19	6.1	0.088
86.005.543.4	Mukwitch	0.04	0.15	10.4	17.6	770	1.79	0.1	0.21	0.02	49.7	12.6	5	39	7.6	2.48	36.7	0.16	5.8	0.083
86.005.516.41	Mukwitch	<0.02	0.07	9.33	13.5	840	1.62	0.02	0.62	<0.02	36.1	62.1	11	36.1	6.1	2.53	34.9	0.15	5.9	0.066
86.005.302.13	Mukwitch	<0.02	0.11	9.52	13.8	1050	1.68	0.02	2.27	<0.02	95.2	24.7	9	34.7	5.6	2.41	31.5	0.2	4.8	0.065
86.005.455.12	Mukwitch	0.03	0.11	9.89	16.2	1040	1.7	0.06	1.84	0.03	77.6	10	10	49.9	8.1	2.47	30.6	0.19	4.5	0.06
86.005.656.7	Mukwitch	<0.02	0.1	11.25	14.4	840	1.54	0.08	0.48	0.04	70.6	18.2	9	36.6	10.6	2.61	35.3	0.21	5.8	0.082
86.005.516.18	Mukwitch	0.02	0.06	11.1	9.2	720	1.63	0.04	0.22	<0.02	45.4	20.2	7	41.1	6.1	2.61	37.9	0.18	6	0.086
86.005.631.1	Mukwitch	0.02	0.07	11.4	14.1	980	1.7	0.04	0.57	<0.02	97.5	27.1	7	41.1	6.4	2.63	35.3	0.22	5.7	0.07
86.005.671.3	Mukwitch	0.02	0.15	8.43	15.2	700	1.66	0.02	4.5	0.03	81.1	23.4	14	30.4	7.7	2.24	28.4	0.22	5.1	0.049
86.005.631.26	Mukwitch	0.03	0.07	9.91	13.2	1690	1.74	0.05	1.25	0.02	92.3	20	11	51.9	6.2	2.79	33.4	0.19	4.7	0.061
86.005.302.8	Mukwitch	0.02	0.09	10.45	15.1	1230	1.74	0.02	0.96	<0.02	99.8	13.7	9	41	5.8	2.68	34.7	0.22	5.5	0.069
86.005.516.64	Mukwitch	0.02	0.08	8.98	21.3	660	1.58	0.04	4.42	<0.02	76.3	9.5	13	27.6	5.8	2.35	30.4	0.2	6.1	0.066
86.005.226.1	Mukwitch	0.03	0.08	7.58	8.1	830	1.29	0.02	3.17	0.02	79.6	10.4	12	27.5	4.1	1.74	22.8	0.19	2.4	0.034
86.003.399.34	Mukwitch	0.03	0.12	9.57	14.8	1180	1.62	<0.01	3.11	0.02	87.8	10.6	10	70.2	6.2	2.4	31.3	0.22	4.1	0.06
86.005.797.8	Mukwitch	0.02	0.13	8.65	8.1	1420	1.61	<0.01	3.49	0.03	106	119	10	45.8	7.9	2.42	29.5	0.21	3.5	0.052
86.005.642.1	Mukwitch	0.06	0.08	10.05	24.1	1140	1.98	0.24	1.04	0.03	88.1	5.8	8	31.8	10.3	2.8	37.4	0.23	6.7	0.083
86.005.516.11	Mukwitch	0.02	0.09	8.12	22.7	530	1.58	0.05	4	0.02	67.3	6.1	12	23.6	6.4	2.14	29.5	0.2	6	0.063
86.005.763.20	Mukwitch	0.02	0.09	7.76	11.2	930	1.4	<0.01	4.39	0.02	89.5	11.8	9	28.4	5.7	1.94	25.3	0.21	3.5	0.037
86.005.262.1	Mukwitch	0.03	0.03	12.7	15	930	1.6	0.15	0.24	0.03	153	9.7	6	42.6	9.7	2.64	38.1	0.29	5.7	0.087
86.005.564.1	Mukwitch	0.02	<0.01	12.5	7.2	820	1.49	0.02	0.31	<0.02	126.5	30.2	5	45.6	5.5	2.69	38.2	0.25	6.2	0.088
86.005.516.25	Mukwitch	0.03	<0.01	11.45	20.9	1250	1.99	0.23	0.91	0.03	119	9.2	11	35.7	9.1	2.91	37.6	0.24	6.3	0.087
86.005.215.31	Mukwitch	0.03	0.02	11.35	14	760	1.5	0.36	3.26	0.09	63	18.2	35	21.3	36.2	5.42	27.6	0.22	6.6	0.087
86.005.610.21	Mukwitch	0.04	0.07	10	11.6	800	1.82	0.26	4.64	0.16	60.4	12.5	22	16.15	17.4	4.07	24.4	0.21	6.5	0.07
86.005.533.16	Mukwitch	0.04	0.03	9.32	13.5	820	2.1	0.11	3.01	0.07	78.7	10.2	19	26.2	14	3.43	24.1	0.21	6.5	0.06
86.005.104.8	Mukwitch	0.04	0.03	10.95	11.2	810	1.58	0.35	2.84	0.07	72.7	18.8	31	13.3	44.5	5.29	25.9	0.22	5.9	0.075
86.005.369.40	Mukwitch	0.02	<0.01	9.61	10	960	1.2	0.25	3.05	0.06	49.6	741	30	26.6	56.2	5.23	21.3	0.35	4.7	0.056
Sample 9	N/A	0.66	0.06	7.68	2.5	700	1.66	0.02	3.27	0.05	89.7	16.1	24	2.12	21.7	3.39	18.8	0.2	2.4	0.049
Sample 6	N/A	0.69	0.04	8.13	2.7	1040	1.66	0.01	2.62	0.06	105.5	16.6	33	2.89	33.1	2.45	22.5	0.23	2.3	0.052

Sample No.	Site	Wt.	K	La	Li	Mg	Mn	Mo	Na	Nb	Ni	P	Pb	Rb	Re	S	Sb	Se	Sn	Sr	Ta
		kg	%	ppm	ppm	%	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm
91.78.1673.15	Baker	0.02	2.76	30.9	30.3	0.38	144	1.04	1.46	17.6	9.3	280	29	143.5	0.003	0.01	0.59	2	2.4	159	7.53
86.005.516.39	Mukwitch	0.02	2.22	22.4	70.1	0.49	78	0.62	0.48	14.2	16.5	390	21.3	41	0.002	0.01	0.39	2	6.3	89	8.76
86.005.543.4	Mukwitch	0.04	2.26	17.6	66.1	0.59	80	0.44	0.43	13.7	17.5	350	22.2	47.1	<0.002	0.02	0.27	1	6.4	83.2	6.24
86.005.516.41	Mukwitch	<0.02	2.21	13	68.6	0.53	90	0.87	0.4	20.5	16.7	350	22.2	37.1	0.006	0.01	0.35	1	5.7	92.7	20.5
86.005.302.13	Mukwitch	<0.02	2.29	33	74.2	0.63	120	0.68	0.53	18.2	16.5	560	28.5	39.2	0.002	0.01	0.36	2	4.2	159.5	8.42
86.005.455.12	Mukwitch	0.03	2.29	27.9	75.8	0.41	103	0.56	0.47	16	16.4	810	24.5	47.9	<0.002	0.01	0.32	2	4.3	170.5	4.58
86.005.656.7	Mukwitch	<0.02	2.42	29.2	72.5	0.55	97	3.25	0.44	14.2	15.1	310	24.6	62.8	0.002	0.01	2.05	2	6.5	94.4	8.37
86.005.516.18	Mukwitch	0.02	2.42	17.8	72.6	0.52	85	0.54	0.45	15.2	15	300	22.6	58.9	0.002	0.01	0.37	2	6.8	85.5	9.08
86.005.631.1	Mukwitch	0.02	2.3	49.3	71.8	0.71	93	0.57	0.41	16.8	16.5	380	22.8	67	0.003	0.01	0.31	2	5.7	107.5	10.55
86.005.671.3	Mukwitch	0.02	1.84	33.9	57.2	0.87	141	0.74	0.39	20.2	11.6	820	27.1	35.1	0.002	0.02	0.51	2	4	151	8.23
86.005.631.26	Mukwitch	0.03	2.01	29.2	84.4	0.6	111	0.63	0.45	18.2	21.8	610	22.5	42.8	0.002	0.03	0.32	1	3.9	199	7.05
86.005.302.8	Mukwitch	0.02	2.23	33.4	75.1	0.65	104	0.56	0.45	16.8	19.2	540	22.2	45.9	<0.002	0.02	0.38	2	4.7	151	6.06
86.005.516.64	Mukwitch	0.02	2.03	29.3	68.3	1.02	117	0.69	0.41	20	12.7	730	26.8	28.7	<0.002	0.03	0.45	2	5.2	160.5	4.79
86.005.226.1	Mukwitch	0.03	2.52	39	38.9	0.77	145	0.42	0.61	13.8	8.6	530	19.5	46.7	<0.002	0.01	0.28	1	1.9	165.5	3.49
86.003.399.34	Mukwitch	0.03	2.01	37.2	85.7	0.49	142	0.5	0.36	17	17.9	690	25.7	43	<0.002	0.01	0.3	2	3.6	176.5	4.07
86.005.797.8	Mukwitch	0.02	2.33	41.6	70.3	0.55	116	1.47	0.42	29.9	15.4	570	23.2	39	0.013	0.02	0.35	2	2.8	204	37.8
86.005.642.1	Mukwitch	0.06	1.91	33.1	78.9	0.59	97	0.5	0.53	18.9	20.6	640	25.5	34.5	<0.002	0.03	0.48	2	5.5	127	3.69
86.005.516.11	Mukwitch	0.02	2	26	67.9	0.92	105	0.59	0.42	19.6	12.6	780	27.4	23.4	<0.002	0.02	0.42	2	5.2	149	3.77
86.005.763.20	Mukwitch	0.02	2.23	36.8	59	0.83	122	0.55	0.49	15.2	11.6	720	19.7	31.7	<0.002	0.03	0.34	2	2.5	192.5	4.24
86.005.262.1	Mukwitch	0.03	2.57	71.1	68.9	0.65	91	0.47	0.49	12.4	17.3	430	23.8	75.7	<0.002	0.02	0.42	2	6.6	102.5	5.7
86.005.564.1	Mukwitch	0.02	2.53	53.8	70.7	0.61	91	0.6	0.45	15.8	16.3	320	23.9	84.6	0.003	0.01	0.34	2	7.2	96.8	12.25
86.005.516.25	Mukwitch	0.03	2.03	42.6	76.2	0.66	101	0.52	0.55	18.6	21.5	680	25.1	43.5	<0.002	0.03	0.43	3	5.6	126.5	4.63
86.005.215.31	Mukwitch	0.03	1.41	19.5	52	1.63	302	0.91	0.83	14	43.5	1300	23.5	67.6	<0.002	0.03	0.77	3	3.1	262	1.9
86.005.610.21	Mukwitch	0.04	1.64	23.5	59.9	1.82	318	1.22	0.87	16	33.3	1200	27.8	73.9	<0.002	0.03	0.75	2	3.2	208	1.81
86.005.533.16	Mukwitch	0.04	1.97	30.7	37.5	1.48	338	1.28	1.03	14.4	16.2	1120	21.3	125.5	<0.002	0.02	0.65	2	2.8	230	1.68
86.005.104.8	Mukwitch	0.04	1.22	25.9	54.4	1.52	337	0.73	1	13.8	35.4	1300	20.9	66.3	<0.002	0.02	0.76	3	2.8	292	1.77
86.005.369.40	Mukwitch	0.02	1.8	19.9	32.9	2.25	499	5.5	1.33	83	33.5	1630	24.8	64.6	0.059	0.04	0.38	4	3.5	399	>100
Sample 9	N/A	0.66	2.94	43.1	17.8	1.4	520	0.95	2	12.2	12.8	660	21.5	128.5	<0.002	<0.01	0.39	2	1.2	473	1.5
Sample 6	N/A	0.69	3.45	50.6	14.2	0.94	259	0.58	2.42	11.1	20.3	1460	21.4	139	<0.002	<0.01	0.41	2	1.4	686	1.52

Sample No.	Site	Wt.	Te	Th	Ti	Tl	U	V	W	Y	Zn	Zr
		kg	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	ppm
91.78.1673.15	Baker	0.02	<0.05	19.5	0.24	0.8	2.5	45	206	17.4	46	44.6
86.005.516.39	Mukwitch	0.02	<0.05	26.8	0.213	0.38	0.3	22	161.5	3.9	49	103
86.005.543.4	Mukwitch	0.04	<0.05	23.9	0.24	0.42	0.4	23	78.8	3.1	48	94.1
86.005.516.41	Mukwitch	<0.02	<0.05	19.4	0.245	0.43	0.5	22	480	2.8	52	94.9
86.005.302.13	Mukwitch	<0.02	<0.05	27.7	0.286	0.4	0.7	34	197.5	5.6	70	81.5
86.005.455.12	Mukwitch	0.03	<0.05	24.8	0.312	0.4	1.1	29	69.8	5.3	60	88.7
86.005.656.7	Mukwitch	<0.02	<0.05	34.5	0.211	0.48	0.3	21	157.5	4.2	57	93.2
86.005.516.18	Mukwitch	0.02	<0.05	25.5	0.213	0.43	0.2	21	161	3.1	47	99.3
86.005.631.1	Mukwitch	0.02	<0.05	38	0.251	0.42	0.5	22	225	5.8	54	94.6
86.005.671.3	Mukwitch	0.02	<0.05	19	0.28	0.4	1.1	31	199.5	7.2	53	94.8
86.005.631.26	Mukwitch	0.03	<0.05	26.2	0.363	0.38	1.1	34	156	3.9	74	73.6
86.005.302.8	Mukwitch	0.02	<0.05	30.3	0.301	0.39	1.3	26	106	5.2	65	85.8
86.005.516.64	Mukwitch	0.02	<0.05	20.9	0.266	0.35	1.2	32	62.2	6.5	53	103
86.005.226.1	Mukwitch	0.03	<0.05	18	0.248	0.39	1	30	79.9	5.7	42	54.4
86.003.399.34	Mukwitch	0.03	<0.05	23.8	0.344	0.42	0.9	30	65.8	5.5	70	93
86.005.797.8	Mukwitch	0.02	<0.05	25.8	0.344	0.46	0.5	33	1100	5.3	66	67
86.005.642.1	Mukwitch	0.06	<0.05	27.5	0.317	0.35	0.8	30	16.4	5.9	61	120
86.005.516.11	Mukwitch	0.02	<0.05	19	0.256	0.36	1.2	32	31.3	6.1	51	99.4
86.005.763.20	Mukwitch	0.02	<0.05	19.7	0.277	0.36	0.8	30	85.5	5.4	52	71.5
86.005.262.1	Mukwitch	0.03	<0.05	44.2	0.216	0.37	0.4	21	63.8	6.1	53	102
86.005.564.1	Mukwitch	0.02	<0.05	43.4	0.229	0.46	0.3	22	254	5.4	54	105
86.005.516.25	Mukwitch	0.03	<0.05	31.6	0.354	0.35	0.9	32	50.6	6.6	69	120.5
86.005.215.31	Mukwitch	0.03	0.05	23.4	0.785	0.88	2.1	121	16.5	12.8	96	193
86.005.610.21	Mukwitch	0.04	0.05	20.9	0.541	0.72	3.4	63	11.1	10.6	83	188
86.005.533.16	Mukwitch	0.04	<0.05	23.9	0.478	0.66	4.1	62	13.6	15.2	72	206
86.005.104.8	Mukwitch	0.04	0.05	23.4	0.687	0.53	2.2	112	17.6	15.7	81	175
86.005.369.40	Mukwitch	0.02	<0.05	15.2	0.615	<0.02	2.8	136	5780	10.4	85	122
Sample 9	N/A	0.66	<0.05	20.5	0.354	0.55	3.6	105	16.2	16.9	58	61.8
Sample 6	N/A	0.69	0.05	19.9	0.418	0.52	2.8	90	24.9	18.5	59	62.5

Sample No.	Site	Wt.	K	La	Li	Mg	Mn	Mo	Na	Nb	Ni	P	Pb	Rb	Re	S	Sb	Se	Sn	Sr	Ta
		kg	%	ppm	ppm	%	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm
125.933	Paragonah	0.27	3.13	36.8	18.2	1.23	722	0.71	2.11	12.5	14	770	17	129.5	<0.002	<0.01	0.38	2	1.1	432	1.35
Sample 1	N/A	0.48	3.59	53.2	14.2	0.95	243	0.56	2.44	11.1	17.8	1410	22.4	143	<0.002	<0.01	0.38	2	1.4	694	1.21
Sample 2	N/A	0.6	4.43	68.9	17.6	0.19	240	1.71	2.69	15	1.7	260	29.5	208	<0.002	<0.01	0.94	2	1.8	287	2.88
125.932	Paragonah	0.14	3.47	44.4	25.1	1.53	619	1.3	2.25	13.7	15.9	770	23.8	145.5	<0.002	0.01	0.55	2	1.3	493	2.08
Sample 11	N/A	0.56	4.41	115	27.8	0.57	544	3.79	2.82	24.9	0.9	900	34.9	255	<0.002	0.02	1.06	3	2.4	524	1.99
Sample 10	N/A	0.61	3.24	47	19	1.44	599	1.23	2.05	15.2	12.9	670	22.9	146	0.003	<0.01	0.39	2	1.3	477	7.12
Sample 5	N/A	0.98	4.8	105.5	16	0.28	377	3.96	2.62	27.4	1.7	910	31.5	249	0.005	<0.01	0.77	3	2.3	371	15.2
Sample 4	N/A	0.47	4.63	103.5	18.7	0.45	505	4.15	2.54	24.4	1.7	800	31.2	231	<0.002	0.01	0.87	2	2.9	353	3.56
Sample 12	N/A	0.64	3.9	101	35.3	0.84	561	2.72	2.53	19.4	3.2	1160	26.5	212	<0.002	0.03	0.53	2	1.5	614	1.51
Sample 8	N/A	0.66	5.12	107.5	14.6	0.24	356	3.94	2.68	26.2	0.9	820	32.1	269	<0.002	<0.01	0.83	3	2.4	335	2.48
283.174	Paragonah	0.06	3.5	57.2	26.9	0.78	438	1.56	2.23	15	3.8	440	25.8	131.5	<0.002	0.02	0.67	2	1.7	242	2.59
Clay 1	Paragonah	0.14	2.34	40.1	87.1	0.63	113	0.38	0.38	15.4	21.7	520	19.2	53.9	<0.002	0.01	0.28	2	5.9	118.5	3.41

Sample No.	Site	Wt.	Ag	Al	As	Ba	Be	Bi	Ca	Cd	Ce	Co	Cr	Cs	Cu	Fe	Ga	Ge	Hf	In
		kg	ppm	%	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	%	ppm	ppm	ppm	ppm
125.933	Paragonah	0.27	0.04	7.28	3.4	700	1.68	<0.01	3.75	0.17	81	16.6	26	2.14	20.5	3.63	18.25	0.2	2.2	0.047
Sample 1	N/A	0.48	0.03	8.15	3.2	1030	1.56	<0.01	2.61	0.04	103.5	13.8	34	2.86	38.3	2.35	22.1	0.22	2.3	0.053
Sample 2	N/A	0.6	0.11	7.4	8.7	1250	2.08	0.06	0.85	0.05	127.5	9.1	3	6.36	5.7	1.38	17.95	0.21	5.3	0.036
125.932	Paragonah	0.14	0.04	8.26	2.8	720	1.8	<0.01	3.28	0.05	95.2	20	32	3.88	9.7	3.98	20.2	0.24	2.4	0.056
Sample 11	N/A	0.56	<0.01	8.3	7.7	1730	2.82	0.04	1.73	0.02	230	6.2	3	6.37	8.6	2.46	23	0.31	10	0.05
Sample 10	N/A	0.61	0.06	8.22	1.7	740	1.7	0.08	3.24	0.09	97	31.6	25	2.41	19.4	3.47	19.45	0.24	2.6	0.051
Sample 5	N/A	0.98	<0.01	8.09	5.5	1360	2.48	0.02	1.4	0.03	217	53.3	2	6.23	10.4	2.5	21.3	0.31	9.2	0.041
Sample 4	N/A	0.47	<0.01	7.67	5.9	1360	2.69	0.12	1.42	0.07	212	11.2	4	7.03	9.7	2.28	20.1	0.26	12.3	0.058
Sample 12	N/A	0.64	0.02	8.09	5.6	2130	2.4	<0.01	2.03	0.03	196.5	7.8	6	5.71	13	2.84	21.3	0.27	4.1	0.046
Sample 8	N/A	0.66	<0.01	8.02	5.1	1410	2.63	<0.01	1.26	0.04	223	10.8	1	6.93	9.7	2.36	21.8	0.3	9.8	0.051
283.174	Paragonah	0.06	0.03	7.48	4.5	760	2.18	0.1	1.54	0.06	94.4	8.9	9	3.47	8.8	1.42	17.75	0.17	3.1	0.028
Clay 1	Paragonah	0.14	<0.01	10.2	11	620	1.39	0.38	1.8	0.05	132.5	6.6	7	47.5	4.8	2.25	30.8	0.21	5.3	0.08

Sample No.	Site	Wt.	Te	Th	Ti	Tl	U	V	W	Y	Zn	Zr
		kg	ppm	ppm	%	ppm	ppm	ppm	ppm	ppm	ppm	ppm
125.933	Paragonah	0.27	<0.05	18	0.384	0.41	3	118	14	17.1	59	57.5
Sample 1	N/A	0.48	<0.05	20.1	0.407	0.54	2.8	87	14.3	18.4	62	62.4
Sample 2	N/A	0.6	<0.05	32.5	0.202	0.73	5.4	24	59.6	17.3	38	159.5
125.932	Paragonah	0.14	<0.05	19.7	0.436	0.79	3.1	130	35.4	20.3	67	62.2
Sample 11	N/A	0.56	<0.05	55.7	0.53	0.53	8.3	55	18.5	24.8	63	367
Sample 10	N/A	0.61	<0.05	22.5	0.37	0.69	3.7	110	170	17.2	60	68.1
Sample 5	N/A	0.98	<0.05	35.9	0.45	0.48	6.3	35	448	25	63	289
Sample 4	N/A	0.47	<0.05	41.7	0.435	0.75	7.6	32	65.9	28	61	481
Sample 12	N/A	0.64	<0.05	39.9	0.505	0.39	5.2	64	12.5	20.4	67	154.5
Sample 8	N/A	0.66	<0.05	40.4	0.464	0.56	6.8	37	31.5	25.7	61	297
283.174	Paragonah	0.06	<0.05	29.7	0.194	0.62	4.9	27	50.1	13.4	46	84.9
Clay 1	Paragonah	0.14	<0.05	34.4	0.178	0.38	0.5	18	25	6.2	68	114

APPENDIX B

Site Name	Northing	Easting	n	SVG	SVC	SVB/G	Other SV	Total SV	Reference
26LN1775	4181234	219088	233	147	13	33	0	193	Elston and Juell 1987
42Be743	4268498	334968	198	75	0	5	0	80	Lyneis 1994
42GA4431	4214730	484990	144	1	0	1	0	2	Janetski et al. 2005
42KA174	4130000	506899	72	3	0	0	0	3	Gunnerson 1957
42Md973	4341960	377756	243	2	0	1	0	3	Lyneis 1994
Alice Hunt	4233111	521067	632	1 V	0	0	0	0	Jennings and Sammons-Lohse 1981
Alvey Site	4131255	506899	549	102	0	0	0	102	Gunnerson 1957
Backhoe Village	4291511	405019	2239	64	31	127	0	222	Madsen and Lindsay 1977
Backhoe Village II	4291531	405009	14190	69	0	36	0	105	Seddon 2001
Baker Village	4331008	233802	946	73	221	56	0	350	Wilde and Soper 1999
Bear River No. 2	4595022	410368	3000	0	0	21	0	21	Aikens 1967
Bear River No. 3	4595022	410468	2061	0	0	16	0	16	Shields and Dalley 1978
Block 49	4513315	424451	2237	10	0	18	0	28	Talbot et al. 2004
Bridgette	4126483	477181	596	9	2	0	0	11	Fowler and Aikens 1963
Circle Terrace	4157227	491266	159	11	0	0	0	11	Fowler 1963
Conway Shelter	4160132	181882	297	264	8	25	0	297	Fowler et al. 1973
Coombs Village	4195725	462824	65084	3	2	0	0	5	Lister 1961
Deep Stone	4290359	330853	234	73	0	3	0	76	Seddon 2001
Dos Casas	4183865	453392	1159	8	0	0	0	8	Jordan and Talbot 2001
East Fork Village	4341860	377756	2614	70	0	68	3	141	Lyneis 1994, Reed et al. 2005
Evans Mound 1973	4189398	329454	5686	3112	994	1316	207	5629	Dodd 1982
Fairview Range (5 Sites)	4280651	167665	96	69	2	25	0	96	Fowler et al. 1973
Fallen Eagle	4259171	321730	6828	6625	0	119	0	6744	Seddon et al. 2001
Fallen Woman	4289180	463284	1604	184	0	5	0	189	Wilson and Smith 1976
Five Finger Ridge	4270314	383481	22433	287	979	690	94	2050	Talbot et al. 2000
Frei Site	4112935	264238	1840	1 V	0	1 V	0	0	Pendergast 1960

Site Name	Northing	Easting	n	SVG	SVC	SVB/G	Other SV	Total SV	Reference
Garrison Site	4324150	242171	1992	1033	185	330	0	1548	Taylor 1954
Goodrich Site	4470357	617460	153	0	0	3	0	3	Shields 1967
Goosenecks Overlook	4100637	267510	1061	0	0	1	0	1	Aikens 1965
Hogup Cave	4589208	317885	296	30	12	0	0	42	Aikens 1970
Hummingbird Hill	4179872	437336	722	101	0	2	0	103	Baer and Sauer 2002
Hunchback Shelter	4268698	334868	673	351	22	8	0	381	Reed et al. 2005
Icicle Bench	4271163	388810	1272	77	0	143	2	222	Talbot et al. 1999
Innocents Ridge	4327596	507208	959	288	0	6	0	294	Schroedl and Hogan 1975
Ivie Ridge	4289413	465247	584	8	0	3	0	11	Wilson and Smith 1976
Knoll Site	4595094	403801	715	0	0	6	0	6	Fry and Dalley 1979
Lamb's Knoll Cave No. 1	4118997	318663	113	4	0	0	0	4	Aikens 1965
Lott's Farm	4271073	386326	976	86	25	42	8	161	Talbot et al. 1999
Median Village	4186419	329628	17414	14508	5	2780	0	17293	Marwitt 1970
Middle Meadow Valley Wash (11 Sites)	4198804	207227	149	133	6	10	0	149	Fowler et al. 1973
Mud Springs	4221632	311898	389	221	102	45	6	374	Reed et al. 2005
Mudhole Pueblo	4126383	477081	782	6	0	0	0	6	Fowler and Aikens 1963
Mukwitch Village	4291611	405119	2831	185	46	160	0	391	Talbot and Richens 1993
Nephi Mounds	4395783	428354	7911	1329	4	434	31	1798	Sharrock and Marwitt 1967
North Cedars Cave	4268760	379380	79	39	0	0	0	39	Talbot et al. 1998
North Point	4229904	521175	1892	0	0	1 V, 1	0	0	Jennings and Sammons-Lohse 1981
Old Road	4289180	463184	218	0	0	2	0	2	Wilson and Smith 1976
Old Woman	4289188	461599	3340	12	0	0	0	12	Taylor 1957
O'Malley Shelter	4157205	211281	569	457	6	104	0	567	Fowler et al. 1973
Overlook	4181213	444667	1258	37	0	6	0	43	Baer and Sauer 2002
Paragonah	4194630	343895	4125	1763	1603	593	0	3959	Meighan et al 1956
Pharo Village	4323237	423851	12273	681	8	584	0	1273	Marwitt 1968

Site Name	Northing	Easting	n	SVG	SVC	SVB/G	Other SV	Total SV	Reference
Pine Park Shelter	4178068	253053	206	111	0	14	0	125	Rudy 1954
Poplar Knob	4292716	465261	2438	8	0	30	0	38	Taylor 1957
Radford Cave	4271057	386985	244	14	0	9	1	24	Talbot et al. 1998
Radford Roost	4271190	386904	4306	20	115	202	18	355	Talbot et al. 1999
Rattlesnake Point	4176220	447538	2936	37	0	0	0	37	Baer and Sauer 2002
Reusch Site	4107889	261212	2985	7	0	0	0	7	Aikens 1965
Rich's Shelter	4162006	446706	106	25	0	0	0	25	Harris 2005
Round Spring	4280585	463334	27465	102	7	340	27	476	Metcalf et al. 1993
Salt Lake Airport	4515207	418349	1262	127	0	2	3	132	Allison 2002
Santa Clara Mound	4112835	264138	52 V	1 V	0	0	0	0	Palmer 1876, Fowler and Matley 1978
Scorpio Site	4161022	265651	433	222	0	0	0	222	Reed et al. 2005
Scott Site	4170053	214675	576	422	70	84	0	576	Fowler et al. 1973
Snake Rock Village	4283751	461652	21362	0	0	113	0	113	Aikens 1967
Snake Valley (9 sites)	4322150	241871	848	350	131	133	0	614	Rudy 1953
South Temple	4513515	424451	3004	63	0	79	0	142	Talbot et al. 2004
Spencer Site	4180501	446973	713	17	0	25	0	42	Gunnerson 1957
Springhead Site	4129801	243011	195	3	0	0	0	3	Reed et al. 2005
Tewap Knoll	4126283	477201	213	1	0	0	0	1	Fowler and Aikens 1963
The Observatory	4126183	477581	558	5	1	0	0	6	Fowler and Aikens 1963
The Outpost	4183261	449911	113	8	0	0	0	8	Jordan and Talbot 2001
Three Forks Pueblo	4126353	477081	576	11	0	0	0	11	Fowler and Aikens 1963
Three Mile Ruin	4112935	259438	6314	9	0	0	0	9	Aikens 1965
Tony Takes a Hike	4160722	265701	78	14	0	0	0	14	Reed et al. 2005
Trail Mountain Shelter	4271280	375010	94	3	0	0	0	3	Talbot et al. 1998
Upper Meadow Valley (7 Sites)	4274298	207200	236	180	34	22	0	236	Fowler et al. 1973
Whiterocks Village	4476599	608654	4318	0	0	1	0	1	Shields 1967
Windy Ridge Village	4359819	507178	459	1	0	1	0	2	Madsen 1975
Woodard Mound	4426150	421900	4578	58	0	31	0	89	Richens 1983

REFERENCES

Abbott, David R. (editor)
2003 *Centuries of Decline during the Hohokam Classic Period at Pueblo Grande*. University of Arizona Press, Tucson.

Abbott, David R.
2000 *Ceramics and Community Organization Among the Hohokam*. The University of Arizona Press, Tucson.
2001 Conclusions for the GARP Ceramic Analysis. In *The Grewe Archaeological Research Project, Volume 2. Material Culture, Part I: Ceramic Studies*, edited by David R. Abbott, pp. 67-106. Anthropological Papers No. 99-1, Northland Research, Tempe, Arizona.

Abbott, David R. and Tina K. Love
2001 Chapter 7: Specialized Studies and Observations on Pottery Production, In *The Grewe Archaeological Research Project, Volume 2: Material Culture, Part I: Ceramic Studies,* edited by D. R. Abbott, pp. 141–153. Anthropological Papers No. 99-1, Northland Research, Inc. Tempe, AZ.

Abbott, David R., Susan L. Stinson, and Scott Van Keuren
2001 The Economic Implications of Hohokam Buff Ware Exchange During the Early Sedentary Period. *Kiva* 67:7-30.

Aikens, C. Melvin
1965 *Excavations in Southwest Utah*. Anthropological Papers No. 76. University of Utah Press, Salt Lake City.
1967 *Excavations at Snake Rock Village and the Bear River No. 2 Site*. Anthropological Papers No. 87. University of Utah Press, Salt Lake City.
1970 *Hogup Cave*. Anthropological Papers No. 93. University of Utah Press, Salt Lake City.
1994 Foreword. In *Accidental Archaeologist*, by Jesse D. Jennings. University of Utah Press, Salt Lake City.
1997 Biographical Memories: Jesse D. Jennings July 7, 1909 - August 13, 1997. Electronic document, http://www.nap.edu/readingroom/books/biomems/jjennings.html, accessed May 17, 2005.

Alexander, W. and J.W. Ruby
1963 *1962 Excavations at Summit, Utah: A Progress Report*. Nevada State Museum Anthropological Papers, No. 9. Carson City, Nevada.

Allison, James R.
2000 Craft Specialization and Exchange in Small-scale Societies: A Virgin Anasazi Case Study. Unpublished Ph.D. Dissertation, Department of Anthropology, Arizona State University, Tempe.

2002 *Archaeological Excavations at the Salt Lake Airport*. Research Report No. 02-23. Submitted to Salt Lake City Department of Airports. Copies available from Baseline Data, Inc., Orem, Utah.

ALS-Chemex
2004 Schedule of Services and Fees: USA and International. Electronic document, http://www.alschemex.com/services/2004_fee_schedules_pdf/ALS_Schedule_US.pdf, accessed June 21, 2005.

Ambler, J. Richard
1966a *Caldwell Village*. Anthropological Papers No. 84. University of Utah Press, Salt Lake City.
1966b *Caldwell Village and Fremont Prehistory*. Unpublished Ph.D. dissertation, Department of Anthropology, University of Colorado, Boulder.

Anderson, J.J. and P.D. Rowley
1975 Cenozoic Stratigraphy and of Southwestern High Plateaus of Utah. In *Cenozoic Geology of Southwestern High Plateaus of Utah*, by J.J. Anderson, P.D. Rowley, R.J. Fleck, and A.E.M. Nairn, pp. 1-51. Geologic Society of America Special Paper No. 160, Boulder, CO.

Arnold, Dean
1985 *Ceramic Theory and Cultural Process*. Cambridge University Press, Cambridge.

Baer, Sarah and Jacob Sauer
2002 *The BYU Escalante Drainage Project: Little Desert, Main Canyon, and Escalante Desert Areas 2002*. Museum of Peoples and Cultures Technical Series No. 02-08. Brigham Young University, Provo.

Baker, Shane A. and Scott Billat
1999 *Rock Art of Clear Creek Canyon in Central Utah*. Museum of Peoples and Cultures Occasional Papers No. 6. Brigham Young University, Provo.

Baxter, M. 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.

Bieber, A.M., D.W. Brooks, G. Harbottle, E.V. Sayre
1976 Application of Multivariate Techniques to Analytical data on Aegean Ceramics. *Archaeometry* 36:287-306.

Berry, Michael S.
1972a *Excavations at Evans Mound 1970-71: An Interim Report*. Department of Anthropology, University of Utah, Salt Lake City.
1972b *The Evans Site.* Special Report, University of Utah Department of Anthropology (limited distribution), Salt Lake City.
1974 *The Evans Mound: Cultural Adaptation in Southwestern Utah*. Master's Thesis, University of Utah Department of Anthropology, Salt Lake City.

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

Bishop, R.L. and Hector Neff
1989 Compositional data Analysis in Archaeology. In *Archaeological Chemistry IV*, edited by R.O. Allen, pp. 57-86. American Chemical Society Advances in Chemistry Series No. 220. Washington, D.C.

Bishop, R. L., R. L. Rands, and G. R. Holley
1982 Ceramic Compositional Analysis in Archaeological Perspective. In *Advances in Archaeological Method and Theory*, vol. 5, pp. 275-330. Academic Press, New York.

Bradley, Richard
2000 *An Archaeology of Natural Places*. Routledge, London.

Bright, Jason and Andrew Ugan
1999 Ceramics and Mobility: Assessing the Role of Foraging Behavior and its Implications for Culture-History. *Utah Archaeology* 12:17-30.

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., Richard A. Kerber, and Howard W. Winters
1990 Trade and the Evolution of Exchange Relations at the Beginning of the Mississippian Period. In *The Mississippian Emergence*, edited by Bruce D. Smith, pp. 251-280. Smithsonian Institution Press, Washington.

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

Clark, John E.
1995 Craft Specialization as an Archaeological Category. *Research in Economic Anthropology* 16:267-294.

Clark, John E. and William Parry
1990 Craft Specialization and Cultural Complexity. *Research in Economic Anthropology* 12:289-346.

Cobb, Charles R.
1993 Archaeological Approaches to the Political Economy of Nonstratified Societies. In *Archaeological Method and Theory, Vol. 5*, edited by Michael B. Schiffer, pp. 42-100. University of Arizona Press, Tucson.

Colton, Harold Sellers and Lyndon Lane Hargrave
1937 *Handbook of Northern Arizona Pottery Wares*. Northern Arizona Society of Science and Art, Flagstaff, Arizona.

Coltrain, Joan
1994 *The Great Salt Lake Wetlands: A Study in Prehistoric Diet*. Paper presented at the 59th meeting of the Society for American Archaeology. Anaheim, CA.

Costin, Cathy Lynne
1991 Craft Specialization: Issues in Defining, Documenting, and Explaining the Organization of Production. In *Archaeological Method and Theory* vol. 3, edited by Michael B. Schiffer, pp. 1-56. University of Arizona Press, Tucson.

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. 142-166. University of Arizona Press, Tucson.

Darvill, Timothy
2002 *Oxford Concise Dictionary of Archaeology*. Oxford University Press, Oxford.

D'Azevedo, Warren L. (editor)
1986 *Great Basin*. Handbook of North American Indians, Vol. 11, William C. Sturtevant, general editor, Smithsonian Institution, Washington, D.C.

Dodd, Walter A. jr.
1982 *Final Year Excavations at the Evans Mound Site*. Anthropological Papers, No. 106. University of Utah Press, Salt Lake City.

Duff, Andrew I.
2002 *Western Pueblo Identities: Regional Interaction, Migration, and Transformation*. University of Arizona Press, Tucson,

Elston, Robert G. and Kenneth Juell
1987 *Archaeological Investigations at Panaca Summit*. Cultural Resource Series Monograph No. 10. Nevada State Bureau of Land Management Office, Reno.

Feinman, Gary M., Steadman Upham, and Kent G. Lightfoot
1981 The Production Step Measure: An Ordinal Index of Labor Input in Ceramic Manufacture. *American Antiquity* 46:871-884.

Fowler, Don D.
1963 *1961 Excavations: Harris Wash, Utah*. Anthropological Papers No. 64. University of Utah Press, Salt Lake City.

Fowler, Don D. and C. Melvin Aikens
1963 *1961 Excavations, Kaiparowits Plateau, Utah*. Anthropological Papers No. 66. University of Utah Press, Salt Lake City.

Fowler, Don D. and John F. Matley
1978 The Palmer Collection from Southwestern Utah, 1875, Miscellaneous Papers No. 20. In *Miscellaneous Collected Papers No 19-24*, pp. 17-42. Anthropological Papers No. 66. University of Utah, Salt Lake City.

Fowler, Don D., David B. Madsen and Floyd W. Sharrock
1973 *Prehistory of Southeastern Nevada*. Desert Research Institute Publications in the Social Sciences No. 6. Reno.

Ford, Richard I.
1972 Barter, Gift or Violence: An Analysis of Tewa Inter-tribal Exchange. In *Social Exchange and Interaction*, edited by E.N. Wilemsen, pp. 21-45. Anthropological Papers of the Museum of Anthropology No. 41, University of Michigan, Ann Arbor.

Freestone, I.C.
1982 Applications and Potential of Electron Probe Micro-Analysis in Technological and Provenance Investigations of Ceramics. *Archaeometry* 24:99-116.

Fry, Gary F. and Gardiner F. Dalley
1979 *The Levee Site and the Knoll Site*. Anthropological Papers No. 100. University of Utah, Salt Lake City.

Geib, Phil R.
1996 *Glen Canyon Revisited*. Anthropological Papers, No. 119. University of Utah Press, Salt Lake City.

Geib, Phil R., Jim H. Collette, and Kimberly Spurr
2001 *Kaibabitsinungwu: An Archaeological Sample Survey of the Kaiparowits Plateau*. Grand Staircase – Escalante National Monument Special Publication No. 1. Bureau of Land Management, Salt Lake City.

Geib, Phil R. and Margaret M. Lyneis
1996 Sources of Igneous Temper for Fremont Ceramics. In *Glen Canyon Revisited* by Phil R. Geib, pp. 167-180. Anthropological Papers, No. 119. University of Utah Press, Salt Lake City.

Glowacki, Conna M. and Hector Neff
2002 *Ceramic Production and Circulation in the Greater Southwest: Source Determination by INAA and Complementary Mineralogical Investigations*. Monograph 44, The Costen Institute of Archaeology. University of California, Los Angeles.

Gummerman, George J. and Murray Gell-Mann
1994 Patterns and Perturbations in Southwestern Prehistory. In *Themes in Southwestern Prehistory*, edited by George J. Gummerman, pp. 11-31. School of American Research Press, Santa Fe.

Gunnerson, James H.
1957 *1957 Excavations, Glen Canyon Area*. Anthropological Papers No. 43. University of Utah Press, Salt Lake City.
1969 *The 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.

Halperin, Rhoda
1994 *Cultural Economies Past and Present*. University of Texas Press, Austin.

Harbottle, G.
1976 Activation Analysis in Archaeology. In *Radiochemistry 3*, edited by G.W.A. Newton, pp. 33-72. Chemical Society, London.

Harris, Deborah C.
2005 *The BYU Escalante Drainage Project: Black Hills, Escalante Flats, and Escalante Canyon 2003*. Technical Series No. 03-12. Brigham Young University Museum of Peoples and Cultures, Provo, UT.

Harry, Karen G.
2000 Community Based Craft Specialization: The West Branch Site. In *The Hohokam Village Revisited*, edited by David E. Doyel, Suzanne K. Fish, and Paul R. Fish, pp. 197-200. Southwestern and Rocky Mountain Division of the American Association for the Advancement of Science, Glenwood Springs, Colorado.

2005 Ceramic Specialization and Agricultural Marginality: Do Ethnographic Models Explain the Development of Specialized Pottery Production in the Prehistoric American Southwest? *American Antiquity* 70:295-319.

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, James R. Allison, Hector Neff, and Michael Glascock
1997 Production of San Juan Redware in the Northern Southwest: Insights into Regional Interaction in Early Puebloan Prehistory. *American Antiquity* 62:449-463.

Hegmon, Michelle, Winston Hurst, and James R. Allison
1995 Production for Local Consumption and Exchange: Comparisons of Early Red and White Ware Ceramics in the San Juan Region. 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.

Heidke, James M. and Elizabeth J. Miksa
2000 Correspondence and Discriminant Analyses of Sand and Sand Temper Compositions, Tonto Basin, Arizona. *Archaeometry* 42:273-299.

Helms, Mary
1988 *Ulysses' Sail: An Ethnographic Odyssey of Power, Knowledge, and Geographical Distance*. Princeton University Press, Princeton.
1993 *Craft and the Kingly Ideal*. University of Texas Press, Austin.

Hockett, Bryan Scott
1998 Sociopolitical Meaning of Faunal Remains from Baker Village. *American Antiquity* 63:289-302.

Holmer, Richard N. and Dennis G. Weder
1980 Common Post-Archaic Projectile Points of the Fremont Area. In *Fremont Perspectives*, edited by David B. Madsen, pp. 55-68. Antiquities Section Selected Papers Vol. VII, No. 16. Utah State Historical Society, Salt Lake City.

Jackson, Julia A.
1997 *Glossary of Geology*, fourth edition. American Geological Instituite, Alexandria Virginia.
Janetski, Joel C.
1993 The Archaic to Formative Transition North of the Anasazi: A Basketmaker Perspective. In *Anasazi Basketmaker: Papers from the 1990 Wetherill-Grand Gulch Symposium*, edited by Victoria Atkins, pp. 223-241. Cultural Resource Series No. 24. Utah Bureau of Land Management, Salt Lake City.

1994 Recent Transitions in Eastern Great Basin Prehistory: The Archaeological Record. In *Across the West*, edited by David B. Madsen and David Rhode, pp. 157-178. University of Utah Press, Salt Lake City, Utah.
1997 150 years of Utah Archaeology. *Utah Historical Quarterly 65:100-133.*
1999 *Archaeology of Clear Creek Canyon*. Popular Series No. 1. Brigham Young University Museum of Peoples and Cultures, Provo.
2002 Trade in Fremont society: contexts and contrasts. *Journal of Anthropological Archaeology* 21:344-370.

Janetski, Joel C., Lee Kreutzer, Richard K. Talbot, Lane D. Richens, and Shane A. Baker
2005 *Life on the Edge: Archaeology in Capitol Reef National Park*. Museum of Peoples and Cultures Occasional Papers No. 11. Brigham Young University, Provo.

Janetski, Joel C. and Deborah E. Newman
2000 Fremont Subsistence. In *Clear Creek Canyon Archaeological Project: Results and Synthesis* by J.C. Janetski, R.K. Talbot, D.E. Newman, L.D. Richens, J.D. Wilde, S.A. Baker, and S.E. Billat, pp. 185-200. Museum of Peoples and Cultures Occasional Papers No. 7. Brigham Young University, Provo.

Janetski, Joel C. and Richard K. Talbot
2000a Project Overview and Context. In *Clear Creek Canyon Archaeological Project: Results and Synthesis* by J.C. Janetski, R.K. Talbot, D.E. Newman, L.D. Richens, J.D. Wilde, S.A. Baker, and S.E. Billat, pp. 247-262. Museum of Peoples and Cultures Occasional Papers No. 7. Brigham Young University, Provo.
2000b Social and Community Organization. In *Clear Creek Canyon Archaeological Project: Results and Synthesis* by J.C. Janetski, R.K. Talbot, D.E. Newman, L.D. Richens, J.D. Wilde, S.A. Baker, and S.E. Billat, pp. 247-262. Museum of Peoples and Cultures Occasional Papers No. 7. Brigham Young University, Provo.

Janetski, J.C., R.K.Talbot, D.E. Newman, L.D. Richens, and J.D. Wilde
2000 *Clear Creek Canyon Archaeological Project: Results and Synthesis*. Museum of Peoples and Cultures Occasional Papers No. 7. Brigham Young University, Provo.

Jardine, Cady Brooke
2005 *Parowan Valley Archaeological Project: A Preliminary Report*. Paper presented at the Seventh Biennial Rocky Mountain Anthropological Conference.

Jennings, Jesse D.
1978 *Prehistory of Utah and the Eastern Great Basin*. Anthropological Papers No. 98. University of Utah, Salt Lake City.

Jennings, Jesse D. and Dorothy Sammons-Lohse
1981 *Bull Creek*. Anthropological Papers No. 105. University of Utah Press, Salt Lake City.

Jennings, Jesse D., E.K. Reed, J.B. Griffin, J.C. Kelley, C.W. Meighan, S. Stubbs, J.B. Wheat, and D.C. Taylor
1956 The American Southwest: A Problem in Cultural Isolation, In *Seminars in Archaeology*, 1955, edited by R. Wauchope, pp. 59-127. SAA Memoirs No. 11. Society for American Archaeology, Washington, D.C.

Johnson, Clay and Byron Loosle
2002 *Prehistoric Uinta Mountain Occupations*. Heritage Report 2-02/2002. Ashley National Forest, Vernal, Utah.

Jordan, Aaron and Richard K. Talbot
2001 *The BYU Escalante Drainage Project: Big Flat and Escalante Canyon Areas 2001*. Museum of Peoples and Cultures Technical Series No. 01-13. Brigham Young University, Provo.

Judd, Neil M.
1919 Archaeological Investigations at Paragonah, Utah. *Miscellaneous Collections* vol. 70 no. 3. Smithsonian Institution, Washington, D.C.
1926 *Archaeological Observations North of the Rio Grande*. Bureau of American Ethnology Bulletin No. 82, Smithsonian Institution, Washington, D.C.

Kidder, Alfred V.
1924 *An Introduction to the Study of Southwestern Archaeology: With a Preliminary Account of the Excavations at Pecos*. Papers of the Southwestern Expedition No. 1. Phillips Academy, Andover, Massachusetts.

Lekson, Stephen H.
1996 Scale and Process in the Southwest. In *Interpreting Southwestern Diversity: Underlying Principles and Overarching Patterns*, edited by Paul R. Fish and J. Jefferson Reid, pp. 81-86. Anthropological Research Papers No. 48, University of Arizona, Tempe.

Lister, Florence Cline
1961 Ceramics. In *The Coombs Site*, by Robert Hill Lister and Florence Cline Lister, pp. 32-90. University of Utah Occasional Papers No. 41, Vol. III, University of Utah Press, Salt Lake City, Utah.

Lyneis, Margaret M.
1992 *The Main Ridge Community at Lost City: Virgin Anasazi Architecture, Ceramics, and Burials*. Anthropological Papers No. 117. University of Utah, Salt Lake City.
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.

Lohse, Ernest S.
1980 Fremont Settlement Pattern and Architectural Variation. In *Fremont Perspectives*, edited by David B. Madsen, pp. 41-54. Antiquities Section Selected Papers No. 16, Utah State Historical Society. Salt Lake City.

Madsen , David B.
1970 Ceramics. In *Median Village and Fremont Culture Regional Variation*, by John P. Marwitt, pp. 54-75-. Anthropological Papers No. 95. University of Utah Press, Salt Lake City.
1975 *Three Fremont Sites in Emery County, Utah*. Selected Papers No. 1. Utah State Historical Society, Antiquities Section, Salt Lake City, Utah.
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 B. and Lamar W. Lindsay
1977 *Backhoe Village*. Selected Papers No. 4. Utah State Historical Society, Antiquities Section, Salt Lake City, Utah.

Madsen, David B. and Steven R. Simms
1998 The Fremont Complex: A Behavioral Perspective. *Journal of World Prehistory* 12:255-336.
Madsen, Rex E.
1977 *Prehistoric Ceramics of the Fremont*. Museum of Northern Arizona Ceramic Series No. 6. Flagstaff, Arizona.
Maldonado, Florian and Rosalie C. Moore
1995 *Geologic Map of the Parowan Quadrangle, Iron County, Utah*. United States Geological Survey, Washington D.C.

Maldonado, Florian and Van S. Williams
1993 *Geologic Map of the Parowan Gap Quadrangle, Iron County, Utah*. United Sates Geological Survey, Washington D.C.

Marwit, John P.
1968 *Pharo Village*. Anthropological Papers No. 91. University of Utah Press, Salt Lake City.
1970 *Median Village and Fremont Culture Regional Variation*. Anthropological Papers, No. 95. University of Utah Press, 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. Sturtvant, general editor. Smithsonian Institution, Washington, D.C.

McDonald, Elizabeth Kae
1994 *A Spatial and Temporal Examination of Prehistoric Interaction in the Eastern Great Basin and on the Northern Colorado Plateau*. Unpublished PhD dissertation, Department of Anthropology, University of Colorado, Boulder.

Meighan, C.W., N.E. Coles, F.D. Davis, G.M. Greenwood, W.M. Harrison, and E.H. MacBain
1956 *Archaeological Investigations in Iron County, Utah*. Anthropological Papers, No. 25. University of Utah Press, Salt Lake City.

Metcalf, M.D., K.J. Poole, K. McDonald, and A. McKibbin (editors)
1993 *Hogan Pass: Final Report on Archaeological Investigations along Forest Highway 10 (State Highway 72), Sevier County, Utah*. Metcalf Archaeological Consultants, Inc., Eagle, CO.

Miksa, Elizabeth J. and James M. Heidke
2001 It all Comes out in the Wash: Actualistic Petrofacies Modeling of Temper Provenance, Tonto Basin, Arizona, USA. *Geoarchaeology* 16:177-222.

Morss, Noel
1931 *The Ancient Culture of the Fremont River in Utah*. Papers of the Peabody Museum of American Archaeology and Ethnology Vol. 12, No. 2. Harvard University, Cambridge.

Neff, Hector
1992a Introduction. In *Chemical Characterization of Ceramic Pastes in Archaeology*, edited by Hector Neff, pp. 1-10. Prehistory Press, Madison, WI.

1992b *Chemical Characterization of Ceramic Pastes in Archaeology*. Monographs in World Archaeology No. 7. 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.

2001 Comments on 'Technological Choices in Ceramic Production'. *Archaeometry* 43:278-281.
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, Costen Institute of Archaeology, UCLA, Los Angeles.

Neff, Hector, M.D. Glascock, R.L. Bishop, and M.J. Blackman
1996 A Reassessment of the Acid-extraction Approach to Compositional Characterization of Archaeological Ceramics. *American Antiquity* 61:389-404.

Neff, Hector and Donna M. Glowacki
2002 Ceramic Source Determination by Instrumental Neutron Activation Analysis in the American Southwest. In *Ceramic Production and Circulation in the Greater Southwest: Source Determination by INAA and Complementary 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.

Peacock, D.P.S.
1982 *Pottery in the Roman World: An Ethnoarchaeological Approach*. Longman, London.

Palmer, Edward
1876 Exploration of a Mound in Utah. *American Naturalist*, Vol. 10, pp. 410-414. Cambridge.

Pendergast, David M.
1960 The Frei Site, Santa Clara, Utah. In *Miscellaneous Collected Papers*, edited by David M. Pendergast. Anthropological Paper No. 60. University of Utah Press, Salt Lake City.

Philip, G.M. and D.F. Watson
1982 A Precise Method for determining Contoured Surfaces. *Australian Petroleum Exploration Association Journal 22*:205-212.

Plog, Fred
1977 Modeling Economic Exchanges. In *Exchange Systems in Prehistory*, edited by T.K. Earle and J.E. Ericson, pp. 127-140. Academic Press, New York.
Reed, Alan D.
2005 Instrumental Neutron Activation Analysis. In *The Kern River 2003 Expansion Project*, Vol. IV Chapter 15, edited by Alan D. Reed, Matthew Seddon, and Heather Stettler, pp. 295-306. Submitted to Federal Energy Regulatory Commission, Southwest Region, Docket No. CP01-422-000.

Reed, Alan D., Matthew T. Seddon, and Heather K. Stettler
2005 *The Kern River 2003 Exxpansion Project, Utah CD Version*. Submitted to Federal Energy Regulatory Commission, Southwest Region, Docket No. CP01-422-000.

Renfrew, Colin
1977 Alternative Models for Exchange and Spatial Distribution. In *Exchange Systems in Prehistory*, edited by Timothy K. Earle and Jonathon E. Ericson, pp. 71-90. Academic Press, New York.

Renfrew, Colin and Paul Bahn
2000 *Archaeology: Theories Methods and Practice*. Thames and Hudson, New York.

Richens, Lane D.
1983 *Woodard Mound: Excavations at a Fremont Site in Goshen Valley, Utah County, Utah 1980-1981*. Unpublished Master's Thesis, Department of Anthropology, Brigham Young University, Provo.
1999 Baker Village Ceramic Analysis. In *Baker Village: Report of Excavations, 1990-1994* by James D. Wilde and Reed A. Soper. Museum of Peoples and Cultures Technical Series No. 99-12. Brigham Young University, Provo.
2000a 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.
2000b Ceramics. In *Clear Creek Canyon Archaeological Project: Results and Synthesis*, by J.C. Janetski, R.K.Talbot, D.E. Newman, L.D. Richens, and J.D. Wilde, pp. 47-66. Museum of Peoples and Cultures Occasional Papers No. 7. Brigham Young University, Provo.
2003 Prehistoric Ceramics. In *The Right Place – Fremont and Early Pioneer Archaeology in Salt Lake City* by Richard K. Talbot, Shane A. Baker, and Lane D. Richens pp. 159-186. Museum of Peoples and Cultures Technical Series No. 03-07. Brigham Young University, Provo.
2004 Ceramics. In *Archaeology in Capitol Reef National Park 1996-2000*, draft. Brigham Young University Museum of Peoples and Cultures. Provo, Utah.

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.

Rudy, Jack R.
1953 *Archaeological Survey of Western Utah*. Anthropological Papers No. 12. University of Utah, Salt Lake City.
1954 *Pine Park Shelter, Washington County, Utah*. Anthropological Papers No. 18. University of Utah Press, Salt Lake City.

Sahlins, Marshall
1972 *Stone Age Economics*. Aldine, Chicago.

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 Press, Salt Lake City.

Sayre, E.V.
1975 Brookhaven Procedures for Statistical Analyses of Multivariate Archaeometric Data. Unpublished manuscript.

Schroedl, Alan R. and Patrick F. Hogan
1975 *Innocents Ridge and the San Rafael Fremont*. Selected Papers No. 2. Utah State Historical Society, Antiquities Section, Salt Lake City, Utah.

Schuster, Lance J.
1996 Fremont Pottery Production: Ceramic Evidence from Baker Village (26Wp63), Nevada. Unpublished Master's Thesis, Department of Antropology, Brigham Young University, Provo.

Seddon, Matthew T.
2001 *Fremont Site Complexity at Backhoe Village: Results of Discovery Excavations and Data Analysis at the Utah Army National Guard Vehicle Maintenance Facility Within Backhoe Village (42SV662) in Richfield, Sevier County, Utah.* Submitted to Utah National Guard Environmental Resource Management. Copies available from SWCA, Inc. Environmental Consultants, Salt Lake City.

Senior, Louise M.
1994 The Estimation of Prehistoric Values: Cracked Pot Ideas in Archaeology. In *Expanding Archaeology*, edited by J.M. Skibo, W.H. Walker, and A.E. Neilsen, pp. 92-110. University of Utah Press, Salt Lake City.

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

Shields, Wayne F.
1967 1966 Excavations: Uinta Basin. In *Miscellaneous Collected Papers 15-18*, pp. 1-30. Anthropological Papers No. 89. University of Utah Press, Salt Lake City.

Shields, Wayne F. and Gardiner F. Dalley
1978 The Bear River No. 3 Site, Miscellaneous Papers No. 22. In *Miscellaneous Collected Papers No 19-24*, pp. 57-99. Anthropological Papers No. 66. University of Utah, 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.

Simms, Steven R., Jason R. Bright and Andrew Ugan
1997 Residential mobility and plain gray ceramics: A case study from the Great Basin. *Journal of Archaeological Science* 24:779-792.

Simms, Steven R., Carol J. Loveland, and Mark E. Stewart
1991 *Prehistoric Human Skeletal Remains and the Prehistory of the Great Salt Lake Wetlands*. Ms. On file, Department of Sociology, Social Work, and Anthropology, Utah State University, Logan.

Smith, Craig S.
1992 The Fremont: A View from Southwest Wyoming. *Utah Archaeology 1992* 1:55-75.

Smith, Grant Carlos
2004 *Promontory Ware or Promontory Gray? Revisiting the Classification Problems of Eastern Great Basin Ceramics*. Unpublished Masters thesis. Brigham Young University Department of Anthropology, Provo.

Speakman, Robert J. and Michael D. Glascock
2005 Instrumental Neutron Activation Analysis of Fremont Pottery from the Kern River Expansion Project, Utah. In *The Kern River 2003 Expansion Project*, Vol. III Appendix F, edited by Alan D. Reed, Matthew Seddon, and Heather Stettler, pp. 2291-2324. Submitted to Federal Energy Regulatory Commission, Southwest Region, Docket No. CP01-422-000.

Speakman, Robert J. and Hector Neff
2005 *Laser ablation-ICP-MS in archaeological research*. University of New Mexico Press, Albuquerque.

Spielmann, Katherine A.
2002a Communal Feasting, Ceramics, and Exchange. In *Identity, Feasting, and the Archaeology of the Greater Southwest: Proceedings of the 2002 Southwest Symposium*. Edited by Barbara J. Mills, pp. 210-232. University Press of Colorado, Boulder.
2002b Feasting, Craft Specialization, and the Ritual Mode of Production. *American Anthropologist* 104:195-207.

Spielmann, Katherine A. and James F. Eder
1994 Hunters and Farmers: Then and Now. *Annual Review of Anthropology* 23:303-323.

Spurr, Kimberly Caryn
1993 *Compositional Analysis of Temper in Emery Gray and Sevier Gray Ceramics of the Fremont Culture.*

Stark, Barbara L.
1992 Ceramic Production in Prehistoric La Mixtequilla, South Central Veracruz, Mexico. In *Ceramic Production and Distribution: An Integrated Approach,* edited by George J Bey III and Christopher A. Pool, pp. 175-204. Westview Press, Boulder, Colorado,

Steward, Julian H.
1933 *Early Inhabitants of Western Utah*, Bulletin Vol. 23(7):1-34. University of Utah Press, Salt Lake City.
1936 *Pueblo Material Culture in Western Utah*. Bulletin No. 287. Anthropological Series Vol. 1, No. 3. University of New Mexico, Albuquerque.
1955 Review of *Archaeological Survey of Western Utah*. *American Antiquity* 21:88-89.

Stokes, Wendy L., Ken Lawrence, Matthew T. Seddon, Alan Hutchinson, Jason Bright, Sonia Hutmacher, Jim Hasbargen, Joshua S. Edwards, Scott B. Edmisten, Robert Herrmann, Trevor R. Lindland, Rachael Gruis, Jo'Etta Buckhouse, Krislyn Taite, James McMillan, and Thomas Sharp
2001 The Fallen Eagle Site (42BE1988). In *History and Prehistory Along the San Pedro, Los Angeles, and Salt Lake Railroad: Results of Archaeological Investigations for the Level (3) Communications Fiber Optic Line from Salt Lake City, Utah to the Utah/Nevada Border. Volume V: Excavations at the Deep Stone Site (42Md866) and the Fallen Eagle Site (42Be1988)*, edited by Matthew T. Seddon, Wendy L. Stokes, Ken Lawrence and Krislyn Taite, pp. 153-373. Prepared by SWCA, Inc., Environmental Consultants, Salt Lake City, Utah. Submitted to Utah State Office, Bureau of Land Management.

Stoltman, James B., James H. Burton, and Jonathan Haas
1992 Chemical and Petrographic Characterizations of Ceramic Pastes: Two Perspectives on a Single Data Set. In *Chemical Characterization of Ceramic Pastes in Archaeology*, edited by Hector Neff, pp.85-92. Monographs in World Archaeology No. 7. Prehistory Press, Madison, WI.

Storm, Brian
2006 *Grayware Ceramics in Northeastern Utah: Examining the Petrographic Data*. Manuscript on file at Ashley National Forest, Vernal, Utah.

Talbot, Richard K.
1993 An Informant-based Survey of Richfield in *Archaeological Investigations at Richfield and Vicinity* by Richard K. Talbot and Lane D. Richens, Appendix E. Museum of Peoples and Cultures Technical Series No. 93-15. Brigham Young University, Provo.

1996 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. University of Colorado Press, Boulder.
2000a Fremont Architecture. In *Clear Creek Canyon Archaeological Project: Results and Synthesis*, by Janetski, J.C., R.K.Talbot, D.E. Newman, L.D. Richens, and J.D. Wilde, pp. 131-184. Museum of Peoples and Cultures Occasional Papers No. 7. Brigham Young University, Provo.
2000b Fremont Settlement Patterns and Demography. In *Clear Creek Canyon Archaeological Project: Results and Synthesis*, by Janetski, J.C., R.K.Talbot, D.E. Newman, L.D. Richens, and J.D. Wilde, pp. 201-230. Museum of Peoples and Cultures Occasional Papers No. 7. Brigham Young University, Provo.
2004 Uinta Basin Agricultural Period Dynamics. In *Fremont Farming and Mobility on the Far Northern Colorado Plateau*, by Richard K. Talbot and Lane D. Richens, pp. 77-114. Museum of Peoples and Cultures Occasional Papers No. 10. Brigham Young University, Provo.

Talbot, Richard K., Shane A. Baker, and Lane D. Richens
2004 *The Right Place – Fremont and Early Pioneer Archaeology in Salt Lake City*. Museum of Peoples and Cultures Technical Series No. 03-07. Brigham Young University, Provo.

Talbot, Richard K. and Lane D. Richens
1993 *Archaeological Investigations at Richfield and Vicinity*. Museum of Peoples and Cultures Technical Series No. 93-15. Brigham Young University, Provo.

Talbot, Richard K. and James D. Wilde
1989 Giving Form to the Formative: Shifting Settlement Patterns in the Eastern Great Basin and Northern Colorado Plateau. *Utah Archaeology 1989* 2:3-18.

Talbot, R.K., L.D. Richens, J.D. Wilde, J.C. Janetski, and D.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.
2000 *Excavations at Five Finger Ridge, Clear Creek Canyon, Central Utah*. Museum of Peoples and Cultures Occasional Papers No. 5. Brigham Young University, Provo.

Taylor, Dee Calderwood
1954 *The Garrison Site*. Anthropological Papers No. 16. University of Utah Press, Salt Lake City.
1957 *Two Fremont Site and Their Position in Southwestern Prehistory*. Anthropological Papers No. 29. University of Utah Press, Salt Lake City.

Thompson, Charmaine and James A. Allison
1988 *Symbolism and Meaning in Fremont Painted Ceramics*. Paper presented at the 21st Biannual Great Basin Anthropological Conference, Park City, Utah.

Tite, M. S.
1972 *Methods of Physical Examination in Archaeology*. Seminar Press, London.

Toll, H. Wolcott
1981 Ceramic Comparisons Concerning Redistribution in Chaco Canyon, New Mexico. In *Production and Distribution: A Ceramic Viewpoint*, edited by H. Howard and E. Morris, pp. 83-120. British Archaeological Reports No. 120. Oxford.
1991 Material Distributions and Exchange in Chaco Canyon. In *Chaco and Hohokam: Prehistoric Regional Systems in the American Southwest*, edited by Patricia L. Crown and W. James Judge, pp. 77-108. School of American Research, Santa Fe.
2001 Making and Breaking Pots in the Chaco World. *American Antiquity* 66:56-78.

Toll. H. Wolcott, Thomas C. Windes, and Peter J. McKenna
1980 Late Ceramic Patterns in Chaco Canyon: Pragmatics of Modeling Ceramic Exchange. In *Models and Methods in Regional Exchange*, edited by R.E. Fry, pp. 95-117. Society for American Archaeology Papers No. 1. Washington D.C.

University of Utah Department of Anthropology
2005 About the Department. Electronic document, http://www.anthro.utah.edu/, accessed May 21, 2005.

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

van der Leeuw, Sander E.
1984 Dust to Dust: A Transformational View of the Ceramic Cycle. In *The Many Dimensions of Pottery: Ceramics in Archaeology and Anthropology*, edited by S.E. van der Leeuw and A.C. Pritchard, pp. 707-773. Albert Egges van Giffen Institut, Universiteit van Amsterdam.

Van Keuren, Scott, Susan L. Stinson, and David R. Abbot
1997 Specialization Production of Hohokam Plain Ware Ceramics in the Lower Salt River Valley. *Kiva* 63:155-175.

Watson, D.F. and G.M. Philip
1985 A Refinement of Inverse Distance Weighted Interpolation. *Geo-Processing* 2:315-327.

Weigand, P. C., G. Harbottle, and E. 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.

White, Leslie A.
1949 The Science of Culture, a Study of Man and Civilization. Farrar, New York.

Wilde, James D. and Reed A. Soper
1999 *Baker Village: Report of Excavations, 1990-1994*. Museum of Peoples and Cultures Technical Series No. 99-12. Brigham Young University, Provo.

Williams, P.L.
1967 *Stratigraphy and Petrography of the Quichapa Group, Southwestern Utah and Southeastern Nevada*. Unpublished Ph.D. Dissertation, Department of Geology, University of Washington, Seattle.

Wilson, C. Dean, and Eric Blinman
1995 Changing Specialization of White Ware Manufacture in the Northern San Juan Region. In *Ceramic Production in the American Southwest*, edited by Barbara J. Mills and Patricia L. Crown, pp. 63-87. The University of Arizona Press, Tucson.

Wilson, Curtis J. and Howard L. Smith
1976 *Interstate Highway I-70 Salvage Archaeology*. Antiquities Section Selected Papers No. 7. Utah Division of State History, Salt Lake City.