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Fremont Finery: Exchange and Distribution of Turquoise and Olivella Ornaments in the Parowan Valley and Beyond

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FREMONT FINERY: EXCHANGE AND DISTRIBUTION OF TURQUOISE AND *OLIVELLA* ORNAMENTS IN THE PAROWAN VALLEY AND BEYOND

by

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of a thesis submitted by

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

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ABSTRACT

FREMONT FINERY: EXCHANGE AND DISTRIBUTION OF TURQUOISE AND *OLIVELLA* ORNAMENTS IN THE PAROWAN VALLEY AND BEYOND

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The Fremont tradition developed on the northern Colorado Plateau and eastern Great Basin between A.D. 1 and A.D. 1350 (Talbot 2000a). Research on exotics in the Fremont area, specifically turquoise and *Olivella* shell, has been sporadic until recently (Hughes and Bennyhoff 1986; McDonald 1994; Janetski 2002). In this thesis, I present new data on *Olivella* and turquoise artifacts found throughout the Fremont region, including the Parowan Valley sites, Nephi Mounds, and Kay's Cabin, as well as a spatial distribution of *Olivella* and turquoise in the Fremont area. I performed microprobe analysis on blue-green artifacts from Kay's Cabin and found most are turquoise, although other minerals including variscite, azurite, malachite, and possibly chrysocolla are also present. Also, various experimental methods were used to chemically characterize a turquoise artifact from Parowan Valley (see Appendix A). I analyzed over 350 *Olivella* artifacts (see Appendix B) and examined modern *Olivella* shells; therefore, I provide a discussion of the details and differences between the *O. biplicata* and *O. dama* species.

Through testing Janetski's (2002) trade fair model, I readdress the question of whether or not *Olivella* and turquoise were distributed across the Fremont region via

directional or down-the-line exchange. My research supports Janetski's model and shows that Fremont exotic exchange moved directionally, with *Olivella* and turquoise artifacts concentrated at central sites on the Fremont landscape. I also explore the possibility that the exchange of *Olivella* and turquoise to the Fremont area was conducted through different networks. It appears, based on high numbers of turquoise at certain sites and high frequencies of *Olivella* artifacts at other sites, that these ornaments were not traded together. I examine whether exotic artifacts were differentially distributed among sites in Parowan Valley and within the specific sites and I observed that *Olivella* and turquoise are most often associated with living areas.

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I am also grateful to the Museum of Peoples and Cultures for facilitating access to their collections. Staff at the Utah Natural History Museum were helpful by providing updated information for this thesis. Barbara Frank at SUU was exceptionally kind and helpful as she provided me with information on Dr. Thompson's excavations in Parowan Valley and lent me the *Olivella* artifacts from that research for this analysis. The Fowler Museum at UCLA has been generous with their loan to BYU of the Parowan Valley collection, making the bulk of my research possible. Dr. Ron Bishop at the Smithsonian Institution also enabled and allowed me the awesome opportunity to examine Parowan Valley artifacts from Neil Judd's excavations.

Finally, I specially acknowledge my family. My husband Jeffrey has been my strength and given unconditional love. Towards the end of my thesis adventure my son Jarrett has provided reason for it all. My parents Geoffrey and Susie Waldrom have supported me in many ways as I have pursued my degree. With my parents, my sisters, Lauren, Emily, Alison, and Morgan have provided encouragement and love. My grandfather, Bryan Cady, has offered enthusiasm and instilled in me devotion towards prehistoric economics.

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1 | Introduction

The Fremont tradition developed on the northern Colorado Plateau and eastern Great Basin from approximately A.D. 1 to A.D. 1350 (Talbot 2000a). Fremont archaeological collections are often rich in bone, shell, and stone ornaments – evidence that decorative objects were important. James Gunnerson (1969:155), for example, explains that "to judge by figurines and pictographs, the Fremont people valued ornaments." Exotic materials, such as turquoise and *Olivella,* were made into adornments and brought in from long distances, finally reaching Fremont sites. *Olivella* is somewhat common in Fremont contexts, whereas turquoise is rather rare. Although exotic materials are present in the archaeological record, Fremont researchers rarely investigate the role that the exchange and distribution of these important artifacts played in Fremont society (for exceptions see Hughes and Bennyhoff 1986; McDonald 1994; Janetski 2002). The patterned distribution of exotic artifacts across the Fremont landscape is indicative of the internal and external exchange relationships facilitating the acquisition of these objects.

PURPOSE

Research on artifacts exotic to the Fremont area, specifically turquoise and *Olivella* shell, has been sporadic until recently (Hughes and Bennyhoff 1986; McDonald 1994; Janetski 2002). In this thesis, I present new data on *Olivella* and turquoise artifacts found throughout the Fremont region (Figure 1.1), including the Parowan Valley sites, Nephi

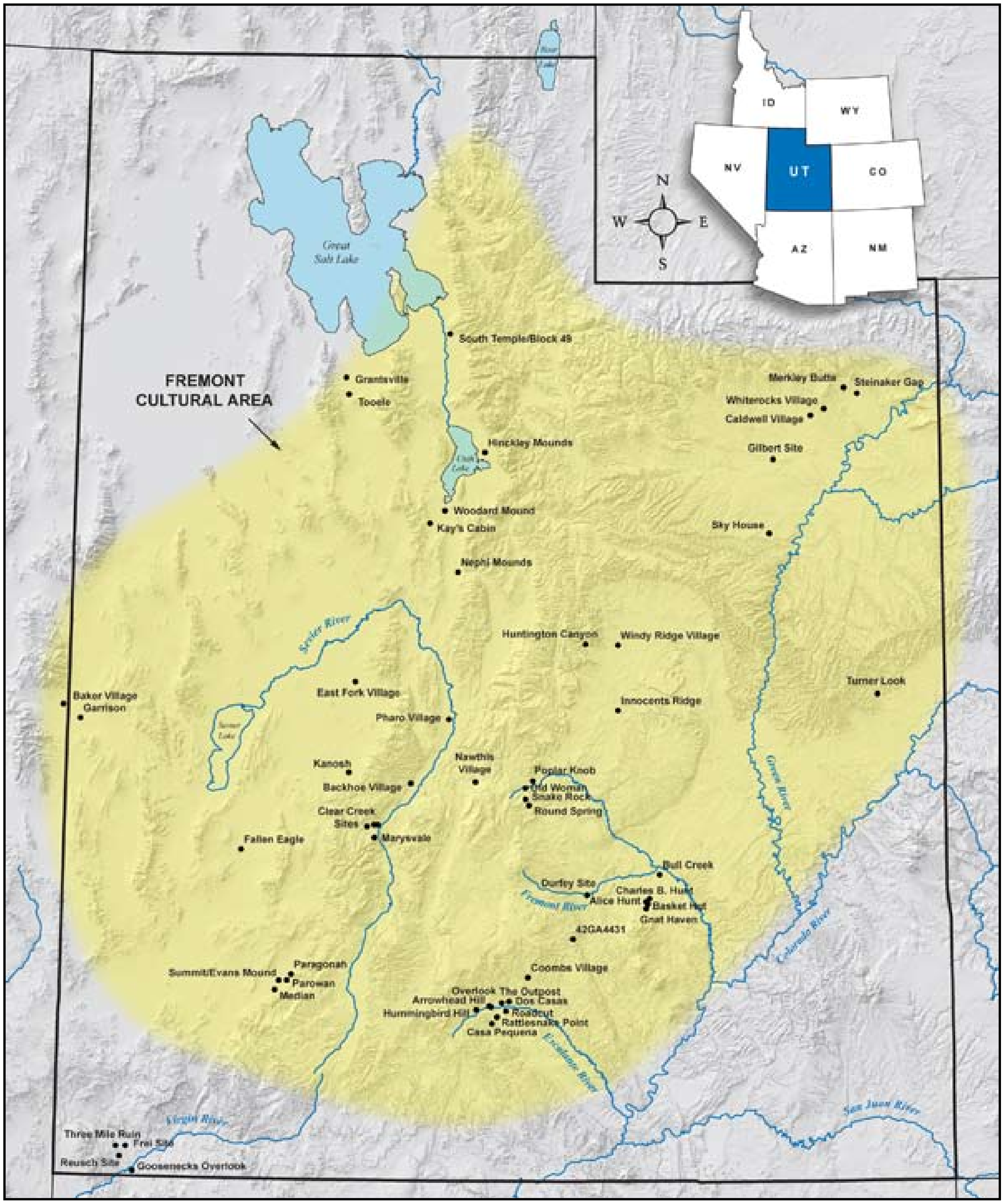

Figure 1.1. Map showing Fremont sites mentioned in text and the Fremont cultural area.

Mounds, and Kay's Cabin, as well as a spatial distribution of *Olivella* and turquoise in the Fremont area. I also explore the possibility that the exchange of *Olivella* and turquoise to the Fremont area was conducted through different networks and that exotic artifacts were differentially distributed among sites in Parowan Valley and within each specific site.

Prompted by the research conducted in the Parowan Valley, and based on limited previous research on exotic artifacts in the Fremont area, I will present in this thesis an analysis of new data and currently reported counts of *Olivella* and turquoise. This chapter will review exchange in small scale societies, as well as the background and history of Fremont research, followed by the research questions this thesis will assess. Chapter 2 will present the methods used for artifact analysis and report recent turquoise mineral characterization results from Kay's Cabin and Parowan Valley. In Chapter 3, new data on *Olivella* and turquoise artifacts from the Parowan Valley and *Olivella* from Nephi Mound will be described. Also, the distribution of exotics in Parowan Valley, within Parowan Valley sites, and throughout the Fremont region will be discussed. Chapter 4 will consider the research questions and how the material presented here addresses them.

EXCHANGE IN SMALL SCALE SOCIETIES

Exchange of raw materials and goods is an important aspect of archaeological investigations, as patterns can be reconstructed from objects frequently found in the archaeological record. Understanding that an item was obtained through exchange is especially critical when archaeologists are dealing with items that are foreign to the area, items that, to simplify discussion, I will call exotic throughout this thesis. Exotic artifacts indicate either long distance exchange and interaction with other people or direct access to the materials at the source area (Hughes and Bennyhoff 1986). Exchange will be considered as the "transfer of goods, services, or information between individuals or groups of individuals. Such transfers may not necessarily involve payments or reciprocation with equivalence" (Darvill 2002:140). Trade is a parallel term that also means the "transfer of goods between communities, recognizing that many different social mechanisms may be responsible for those movements" (Darvill 2002:436).

Direct access, though there is no exchange transaction, is also important to consider when studying artifact distributions. The study of trade is a useful way to investigate interactions between individuals, to separate and distinguish different polities, and to provide information on the social and economic organizations of a society (Renfrew 1975). Because of its importance, a discussion of exchange in small scale societies, highlighting major theorists' perspectives and topics, will be useful.

Exchange in small scale (band and tribal) societies is not only based on economic incentives but also on social obligations, political control, and peace maintenance (see Polanyi 1957; Mauss 1967; Sahlins 1972). Trade has been defined as "the mutual appropriative movement of goods between hands" (Polanyi 1957:266). Karl Polanyi (1957) identified three patterns of trade: reciprocity, redistribution, and market exchange. Reciprocity and redistribution are mechanisms used to distribute goods in living societies and prehistoric small scale societies may leave similar archaeological patterns. Reciprocity represents exchange between associated people and redistribution denotes movement of goods and services toward a center and then out of it again. Market exchange designates movements of goods and services between individuals or groups under a market system (Polanyi 1957:250-251). Polanyi explains that the peacefulness of trade is ensured by its two-sidedness. Claude Lévi-Strauss agrees with this idea, and wrote, "exchanges are peacefully resolved wars, and wars are the result of unsuccessful transactions" (cited in Sahlins 1972:302).

Polanyi explains that trade can be internal and external. Internal trade varies between trading with neighboring groups or nearby villages. Goods that are transported a long distance are seen as external to the group (1975:151). A type of external trade Polanyi defines is called gift trade and is applicable to patterns exemplified by small scale societies. Anthropologist Marcel Mauss (1967) focused on the social obligations that surround gift exchange, and the transaction itself as based on economic self-interest. Mauss suggests that there are three social obligations of gift giving: to give, to receive, and to repay (1967:39). Hence, exchange is economical and assumes diplomatic and social dimensions as well (Janetski 2002).

In addition to the approaches to trade reviewed above, archaeologist Timothy Earle (1982) addresses analytical techniques and scientific procedures to understand exchange. Earle (1982:2) defines exchange as “the spatial distribution of materials from hand to hand and from social group to social group.” He believes that archaeologists have three interrelated jobs: 1) sourcing the objects of exchange, 2) describing the spatial patterning of the objects, and 3) reconstructing the organization of the prehistoric exchange. In this thesis, I use scientific techniques for sourcing and material identification, a distributional analysis was carried out in the Fremont area and in the Parowan Valley, and a suggestion for the way *Olivella* and turquoise traveled in exchange networks is presented for exotics in the Fremont region.

Colin Renfrew (1975) clarifies that trade is synonymous with exchange. Renfrew argues that goods move through exchange and that the “movement need not be over any great distance and may operate within social or spatial units (internal trade) or between them, across cultural boundaries (external trade)” (Renfrew 1975:4). He emphasizes the need to plot exchanges in time and space in order to understand the degree of organization and its evolution within a culture. The intensity of a trade interaction can be measured in terms of frequency or in terms of quantity of goods transferred (Renfrew 1975). As an archaeologist, Renfrew understands that the study of trade is fundamental to the study of society and explains that “all interactions imply information flow, so that continuous spatial distributions of any class of artifact imply repeated interaction and effective information flow” (1975:53). He emphasizes that through an understanding of the distribution of stylistic and symbolic materials indicating information change, traded materials (especially exotic materials) effectively document goods and information exchanged.

Renfrew and Bahn (2000:376) address the study of trade from a distributional perspective and urge archaeologists to identify the sources of traded goods by means of scientific characterizations, as these are "the most important procedures in the investigations of exchange." Renfrew and Bahn also recognize the difficulties encountered when trying to determine the mechanisms of distribution in the absence of written records, as is the case in small scale societies. Two models that seem appropriate to describe exchange in small scale societies include down-the-line exchange and directional exchange (Renfrew and Bahn 2000:371). Down-the-line exchange refers to repeated exchanges of a reciprocal nature, so that goods travel across successive territories and a chain of partners create a fall-off pattern that is generated by exchange in a linear sequence (Renfrew 1977; Renfrew and Bahn 2000). Down-the-line trade is governed by the law of monotonic decrement, which states that in a down-the-line pattern the volume of goods decreases with every transfer away from the source of those goods (Darvill 2002). Directional trade, in contrast, describes a situation where goods are directed to a central place, thereby passing over smaller settlements, and are distributed from the central place (Renfrew and Bahn 2000; see also Janetski 2002). Directional trade results in departures from the fall-off curve observed during down-the-line exchange (Figure 1.2).

In addition to the exchange of goods, the stylistic attributes of material items exchanged between people facilitates communication of information. Variation in material culture, which is called "style" by archaeologists, has a behavioral basis. According to Polly Wiessner (1984:193), "style is one of many channels through which

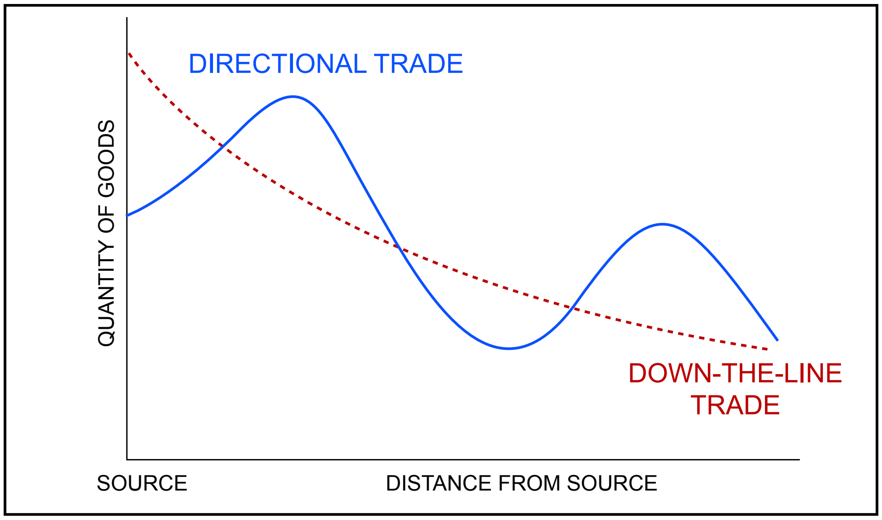

Figure 1.2. Adapted from Renfrew and Bahn's (2000) model depicting down-the-line versus directional trade.

…people, acting individually or within the context of group membership, can comment on other people, social groups, and institutions and their corresponding ideas, values, and practices." In the archaeological record, the lack of stylistic comparability between groups may indicate a lack of knowledge of another group and its material culture, a desire to avoid comparison, or a conscious attempt to disrupt similarity (Wiessner 1984:226, see also Hodder 1982a; 1982b). Ethnographic examples of trade among the Kalahari San suggest that style in material culture is used by the San to define themselves as comparable or incomparable among the different San groups (Wiessner 1984:209).

There are three aspects of trade that require systematic research according to James Brown et al. (1990:251): "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." Trade is an aspect of external relations. Brown et al. (1990) recognize trade as a major vehicle used by small scale societies to conduct external relations.

Brown et al. (1990:253) explain that settled populations regularly use foreign materials and finished items as a means of validating social transactions, and even hunter-gatherers are known to employ exotic materials to express social differences and mark distinction. Archaeological evidence for trade is not always obvious; absence of clear evidence for it leads to false impressions that trade in small scale societies was rare and that cultural isolation was predominant (Brown et al. 1990:252). This impression is due to the relative invisibility of trade goods in the archaeological record as a consequence of random samples and poor preservation of perishable items and food stuffs. Exotic items such as *Olivella* shell and turquoise, however, endure well in the archaeological record and provide valuable insights to long distance trade relations. External relations, often extending over long distances, have been observed by cultural anthropologists as integral to activities within small scale societies. Access to foreign items through trade or direct access is often discovered to be a critical medium for local level transactions of all kinds (Brown et al. 1990). Therefore, understanding the origin of foreign artifacts is crucial to understanding the prehistoric interactions of people.

Janetski's Trade Fair/Festival Model

Ethnographic examples from small scale societies in the Great Basin and Southwest are especially useful while trying to reconstruct exchange mechanisms used in the past by the Fremont. Hughes and Bennyhoff (1986) discuss exchange for the ethnographic Great Basin and conclude that exchange was accomplished either by casual bartering between individuals or during festivals. The existence of casual bartering of turquoise and shell is suggested by the journals of the Spanish explorers, Domínguez and Escalante: "We saw eight Indians atop the little bluffs…and they came down, showing us for barter some strings of native turquoise, each one having a vari-colored conch shell" (Warner 1976:81). In the Southwest, festivals or trade fairs were important mechanisms for intervillage and long distance exchanges (Ford 1983). Trade fairs were held at Taos and Pecos and attended by other nomadic groups (Ford 1983). Janetski's model is based on 1) Great Basin ethnographic patterns; 2) trade fairs held in the Southwest at Taos, Pecos, and in the Phoenix area; and 3) trade centers on the Snake/Columbia River (Janetski 2002). People gathered together to exchange goods at fairs which were often held when agricultural products were available (Janetski 2002). Janetski (2002:348) explains that "fall was…the usual time for festivals in the Great Basin as the pine nut crop was in and rabbits were fat and available through drives…in areas of significant fisheries, festivals were held in the spring during the spawning runs." It must also be mentioned that gambling was an important activity at fairs. Janetski explains that nearly all accounts of fairs, festivals, or social gatherings mention gambling and the recovery of gaming bones or dice in excavations is significant.

The Janetski model is based on these and other ethnographic analogs and archaeological examples of how the Fremont might have implemented exchange between communities and with the Anasazi or other neighbors. Janetski (2002) suggests that trade fairs/festivals were likely instrumental in distributing exotics to the Fremont area. When the sites from his sample are lined up from southwest to the northeast in the Fremont area, a pattern emerges of a gradual, although somewhat noisy, fall-off in raw numbers of turquoise and marine shell. When the raw numbers are adjusted for volume, the fall-off pattern is less clear, with occasional "blips," or sudden increases in exotics, at the larger residential sites, which Janetski (2002:358) interpreted as evidence for Renfrew's directional trade model (see Figure 1.2). Janetski argues that the pattern supports the concept of central places on the Fremont landscape. Renfrew (1977:85) describes central places as locations for exchange activity where more material passes through per person than through smaller communities.

The Fremont are typically described as egalitarian (Sammons-Lohse 1981; however, see Janetski and Talbot 2000 for discussions of Fremont social complexity), and therefore central places in the Fremont area were likely not locations for central place redistribution or market exchange (see discussion on Exchange in Small Scale Societies above). The distribution of goods was not necessarily tightly controlled in Fremont society, and Janetski suggests that locales, such as Baker Village, Parowan Valley, Sevier Valley, and Utah Valley were places where people aggregated and where goods were exchanged through bartering or gambling. Janetski's trade fair model will be supported if these central sites prove to have been locations for trade fairs/festivals by exhibiting higher frequencies of exotics, and if the additional counts of *Olivella* and turquoise presented in my thesis parallels the high distributions of exotics at large sites as Janetski observed.

THE FREMONT

The Fremont culture developed and thrived north of the Colorado and Virgin River drainages on the northern Colorado Plateau and eastern Great Basin between 2000 and 650 years ago (Janetski 2002; Talbot 2000a) (see Figure 1.1). Early explorers and researchers noted the archaeology of the Fremont area and similarities between the Fremont and their Puebloan neighbors to the south. The earliest description of archaeology in Utah was recorded in 1776 by the famous Spanish explorers, Fathers Domínguez and Escalante (Warner 1976). One hundred years later in 1876, Edward Palmer (1878) observed the similarities between the pottery he discovered near modern Payson, Utah, and "Puebloan" pottery. Similar to Palmer, Neil Judd, the first university-trained archaeologist to work in Utah (1915-1920), confirmed that the ruins he investigated along the Wasatch Front belonged to "Puebloan" farmers (Judd 1926). A.V. Kidder agreed with Judd and described the prehistoric farmers of southern Utah as the

"Northern Peripheral District" of the Southwest (Kidder 1926). The Fremont were soon after named and defined by Morss, based in his work along the Fremont River (Morss 1931). Julian Steward (1933) used the label "Northern Periphery" to refer to the Fremont culture in Utah north of the Anasazi, similar to Judd and Kidder's descriptions.

After the initial observations of Fremont similarities to the Puebloan Anasazi, researchers started to recognize regional variation based on material traits among the Fremont (Marwitt 1970, 1986). Although recognition of regional variation was noted early when Morss (1931) called his culture "Fremont" in contrast to the "Puebloan" sites explored by Judd, Steward (1936) was the first to model the material variation of the Fremont. Based on the noticeable variation in the Fremont area, theories began to be presented about Fremont development. University of Utah archaeologist, Jesse D. Jennings, emphasized the Desert Culture concept. The Desert Culture model describes the Fremont as an indigenous local development that derived from the Archaic period in the Great Basin based on the continuity of moccasins, one-rod and bundle basketry, and perhaps certain projectile points (Jennings 1978; Marwitt 1986). Although Jennings et al. (1956) acknowledged some Southwestern influence on the Fremont, he supported the adoption of the terms "Sevier Fremont" for western farmers, and "Fremont" for the eastern manifestation (for further discussion see Janetski 1997; Madsen and Simms 1998; Talbot 2000a). Madsen and Lindsay (1977) also placed an emphasis on a Basin/Colorado Plateau dichotomy as seen through differences of material remains and subsistence strategies, and Marwitt (1970) focused on where to draw regional variant boundaries. This initiated a forty-year "introspection" of Fremont researchers focusing on understanding variability within the Fremont tradition (Talbot 2000a:278).

Subsistence studies and the importance of domesticates in the Fremont diet soon became the focus of Fremont researchers. Based on work done in Parowan Valley, Michael Berry (1972a, 1974), presented a model emphasizing heavy reliance on maize with wild resources used to supplement crop shortages. In contrast, David Madsen (1982) argued that Colorado Plateau Fremont were mainly agriculturists and Great Basin Fremont were more dependant on wild resources. Steven Simms (1986) supported the idea of Fremont variability, expanding on Madsen's arguement, and presented a model of Fremont adaptive diversity as a way to explain Fremont shifts into foraging to supplement agricultural production. Simms (1986) argued that the Fremont followed three subsistence strategies: foraging to supplement agricultural production, periodic shifting from farming to foraging strategies, and farmers and foragers occupying the same territory. Behavioral perspectives, as presented by Madsen and Simms (1998), emphasize decision making at the individual level.

The claim that the Fremont had a mixed economy has never been questioned, although the approaches to Fremont definitions and cultural development have differed (Madsen 1979; Madsen and Simms 1998; Barlow 2000; Coltrain 1996; Talbot 2000a; Janetski 2002; Watkins 2006). Talbot (2000a:280) uses three general periods to discuss Fremont cultural development: early Fremont (A.D. 1-500), middle Fremont (A.D. 500-900), and late Fremont (A.D. 900-1350). Recently excavated sites, including the Elsinore Burial site, support maize cultivation north of the Colorado River during the early Fremont period at approximately A.D. 1 (Wilde and Newman 1989). Stable carbon isotope (13C) analysis of the human remains suggests a lifetime diet of around 50 percent maize (Coltrain 1996). Barlow explains that "clearly, maize farming was an important component of Fremont subsistence in some areas," and she points out that Fremont skeletal remains have comparable isotopic ratios to those from burials in the Anasazi area (Barlow 2002:68). Throughout the Fremont period, agriculture appears to take hold where the environment was suitable for farming, especially along the Wasatch Front.

Sedentism in the Fremont period also seems to increase through time. Early Fremont architecture included circular, basin-shaped pit structures with conical roofs and underground bell-shaped storage pits; they are similar to Basketmaker II and Late Archaic pithouses (see Janetski 1993). During the middle and late Fremont periods the continual use of pithouses is found, with changes in old forms and some additional new forms, such as subrectangular and deep pithouses with long ventilation tunnels (Talbot 2000a). Separate surface adobe or masonry storage structures were located near pithouses, and occasional surface jacal habitation structures appeared (Talbot et al. 1997). Over time, the Fremont used formal pithouses and wikiups, as well as granaries in the cliffs and on-site storage pits or structures (Yoder 2006). Based on excavations of large villages, the late Fremont made a significant commitment to raising corn and probably beans and squash (see Meighan 1956, Janetski 2000). After A.D. 1300, Fremont sites were small and scattered, and much of the Fremont area was abandoned. By A.D. 1350-1400 the Fremont had mostly disappeared (Talbot 2000a).

In addition to population growth and agricultural reliance during the Fremont period, it appears, however, that exotic trade items increased through time (Janetski 2002). The number of sites excavated from each time period biases the sample since many more middle and late Fremont period sites have been excavated and reported. Janetski (2002) demonstrates that the Fremont acquired more *Olivella* and turquoise items over time. In contrast, research in California, where the *Olivella* beads were manufactured, shows that *Olivella* production decreased over time (Hughes 1994). The increase in turquoise found during later Fremont periods may be due to the fall of the Chaco Canyon monopoly of mining and processing turquoise that was strong between A.D. 950 and A.D. 1150 (Weigand and Harbottle 1993). In A.D. 1200, the popularity and procurement of turquoise experienced a "quasi-exponetial rise" in the rest of the Southwest (Weigand

and Harbottle 1993:171-173). Additional data from my thesis clarifies and supports the previously discussed late arrival of *Olivella* and turquoise in the Fremont area.

PREVIOUS RESEARCH ON FREMONT EXOTICS

Marine shell sourcing and trade route research for the greater Southwest and Great Basin have a long history, starting with studies by Donald Brand (1938), Malcolm Rogers (1941), and Donald Tower (1945). James Bennyhoff and Robert Heizer (1958) proposed a scheme for cross-dating marine shell beads from Great Basin sites, and James Bennyhoff and Richard Hughes (1987) published an *Olivella* bead and ornament typology as well as a discussion of California and Great Basin exchange networks (see also Davis 1961 for ethnographic trade between native Californians and their neighbors). All of these bear indirectly on Fremont trade goods and routes. Margaret Lyneis (1984) explored the details of exchanged goods and the systems that moved those goods into the greater Southwest, including the Fremont area. She speculates that the lowland Virgin Anasazi at Lost City in southern Nevada may have operated as a "gateway community" that funneled marine shell and perhaps other commodities into Fremont sites, such as those in Parowan Valley (Lyneis 1984:88). The fact that major excavations in Parowan Valley have gone unreported has limited the testing of her proposals (however, for interim reports see Meighan 1956; Alexander and Ruby 1963). The highly detailed report on ethnographic and prehistoric trade in the Great Basin (including Utah) presented by Hughes and Bennyhoff (1986) laid the foundation for subsequent research on trade. This thesis reports for the first time quantified shell and turquoise data from the UCLA and SUU work as well as Neil Judd's (1919, 1926) excavations in Parowan Valley.

Early references are found in Judd's (1919) report, and Malouf (1939, 1940) discussed marine shell and other possible goods as well as routes. Taylor (1957:108-

109) also provided thoughtful discussions of *Olivella* beads and routes by which Fremont obtained marine shell. He recognized that elaborate appliqué ornaments on Fremont figurines may represent shell beads and pendants in addition to bone ornaments (see also Gunnerson 1969). In her doctoral work, Kae McDonald (1994) focused specifically on Fremont trade and did exhaustive research on toolstones, ceramics, and exotics, and suggested various economic explanations for the exchange of goods. More recently, Janetski (2002) updated what is known of Fremont exotic trade goods and explored possible mechanisms of exchange.

RESEARCH QUESTIONS

This thesis addresses research and new ideas about trade during the Fremont era and the distribution of *Olivella* and turquoise throughout the Fremont region. First, were *Olivella* and turquoise goods traded together in the same exchange networks? The suggestion that imported items, including *Olivella* from the California coast and Gulf of California, and turquoise from western turquoise mines (especially those in Nevada), may have been traveling along the same corridors and finally ending up in Fremont sites, appears logical, albeit simplistic. For example, Hughes (1994:373) demonstrates that marine shell and obsidian in the western Great Basin were moving in different ways and perhaps in different directions between ca. 1800 and 1500 B.C. Given the expectation that *Olivella* and turquoise artifacts may have moved differently, then *Olivella* and turquoise should not have the same fall-off patterns or distributional patterns and I predict greater concentrations of *Olivella* at some sites, and turquoise at others.

Janetski (2002) presented a trade fair/festival model as a mechanism for regional exchange and distribution of long distance, or exotic, goods in the Fremont region after arrival. He also organized data on the occurrence of marine shell and turquoise artifacts in the Fremont area. The data in this thesis updates that reported by Janetski (see Janetski 2002:351-352 for tables). In his research, once the number of items recovered were adjusted for the number of excavated houses, Janetski observed that the pattern for exchange in the Fremont area resembled Renfrew's predicted distributional pattern for directional trade (see Figure 1.2). Janetski suggests that perhaps trade festivals were the mechanism used by the Fremont for the redistribution of exotic artifacts at central places. In light of new data presented in this thesis, I test the trade fair model and readdress the question of whether or not *Olivella* and turquoise were distributed across the Fremont region via directional or down-the-line exchange. If exotics were traded directionally rather than down-the-line showing a fall-off pattern, then concentrations of *Olivella* and turquoise in the Fremont area would be expected at core sites (or central places).

The largest data set analyzed for the research of this thesis are the *Olivella* shell beads from Parowan Valley. Specific questions about the Parowan Valley and its complexity can be addressed because of the updated counts for Parowan Valley exotics. Are turquoise and *Olivella* artifacts differentially distributed within the Parowan Valley? If so, assuming the sites are contemporaneous, this may suggest that a site hierarchy existed in the region and may be reflected archaeologically by a non-random distribution of exotics among the Parowan Valley sites. In addition to intersite studies, explorations into intrasite issues are appropriate. Were exotic artifacts differentially distributed within specific sites in the Parowan Valley? If so, the archaeological record would reflect certain individuals had greater access to those materials, and concentrations would be found in different residential structures. Based on existing findings in the Fremont area (Wilde and Soper 1999; Janetski et al. 2000), it is likely that *Olivella* and turquoise will be found distributed randomly more often in residential structures, rather than storage structures.

2 | Methods

ANALYSIS

Olivella Analysis

Methods used for analysis of *Olivella* ornaments were based upon the definitions and typologies established by Bennyhoff and Hughes (1987) in *Shell Bead and Ornament Exchange Networks Between California and the Great Basin*. This publication was referenced often for information on *Olivella* shell species, associated source areas, and identification of bead types as I described specimens and noted the length, width, and hole diameter of each bead. This monograph was critical to the analysis of my data, and it is important to note the circumstances that led to its publication by the American Museum of Natural History.

Two major *Olivella* shell bead typologies had been in use by students of California prehistory prior to Bennyhoff and Heizer (1958): the "Bulletin 2" typology (Lillard et al. 1939) and the Gifford (1947) typology. Bennyhoff and Hughes were asked to analyze the shell beads and ornaments from Gatecliff Shelter, prompting them to initiate a comprehensive review of cross-dating evidence for all Great Basin shell beads and ornaments, a task previously undertaken by Bennyhoff and Heizer (1958). Bennyhoff and Hughes (1987:83) report that "although several unpublished manuscripts contained smatterings of these typological data, not only were they out of date, but they lacked metric classification criteria for all known *Olivella* bead types in northern and central

California." Thus, it was clear to Bennyhoff and Hughes that a more sensitive shell typology was needed to acquire more measurement data, a better method for dealing with variants, and to add new data on seriated grave lots (1987:84-85).

In addition to using Bennyhoff and Hughes's (1987) work as a reference for *Olivella* shell species identification, I examined modern *Olivella biplicata* and *Olivella dama* specimens at BYU's Monte L. Bean Life Science Museum (Figure 2.1). Unfortunately, there was not an *Olivella baetica* specimen available for examination, although a shell reference book (Rehder 1981) was used to view a photograph of *O. baetica*. Studying the modern specimens was very beneficial as I analyzed the archaeological specimens. I feel confident that I was able to correctly identify the species of the *Olivella* ornaments when they retained traces of original, distinguishing characteristics because I was familiar with the differences between *O. biplicata* and *O. dama*.

Marine shell is common in the Fremont area, and most marine shell found at Fremont sites is *Olivella*. Since other marine shell species are not common in Fremont sites, they are not included in this research. *O. biplicata* and *O. dama* are the most prevalent species of *Olivella* found in Fremont sites, with *O. baetica* found occasionally. The morphological differences between *O. biplicata* and *O. dama* are important, as *O. dama* is found in a different source area, which will be discussed below. Some bead types are only made from specific *Olivella* species. The identification of the *Olivella* species used in bead manufacture helps connect the bead to a general source area. Hughes and Bennyhoff (1986) have outlined the general production areas associated with specific bead types, and along with species classification, the *Olivella* bead can provide a plethora of information about interaction and trade as the analyst correctly identifies the species. For this reason, my observations and study of the modern specimens of *O. biplicata* and *O. dama* enabled the descriptions provided below and helped with my thesis research.

Figure 2.1. Modern *Olivella* shell: *O. dama* (top) and *O. biplicata* (bottom). Shells are actual size (from Monte L. Bean Life Science Museum at Brigham Young University).

Common names for the *Olivella biplicata* shell are purple olive shell and purple olivella. *O. biplicata* is found on the Pacific coast from Vancouver Island to the northern Baja peninsula (Eerkens et al. 2005). *O. Biplicata* shells can reach up to 30 mm in length. These snails are usually found in waters less than five meters in depth and at times are found in very high densities, up to 500 in an area less than one square meter in size (Eerkens et al. 2005:1502). The body of the *O. biplicata* shell is ovate and quickly comes to a point towards the spire. The spire at the top of the shell is approximately 1/4 to 1/5 of the length of the shell. *O. biplicata* shells can be a variety of colors including, white, brown, tan, purple, and grey. There are growth lines, which look like striations, on the body of the shell that extend from the top of the last suture line of the spire to the fasciole, or the basal white band the surrounds the canal at the bottom of the shell (Figure 2.2). Two suture lines are usually outlined in brown, if the shell is colored, or else the two suture lines are obvious if the shell is mostly white. The third suture line often goes into the spire and is not noticeably separated, although it may be outlined on darker colored shells.

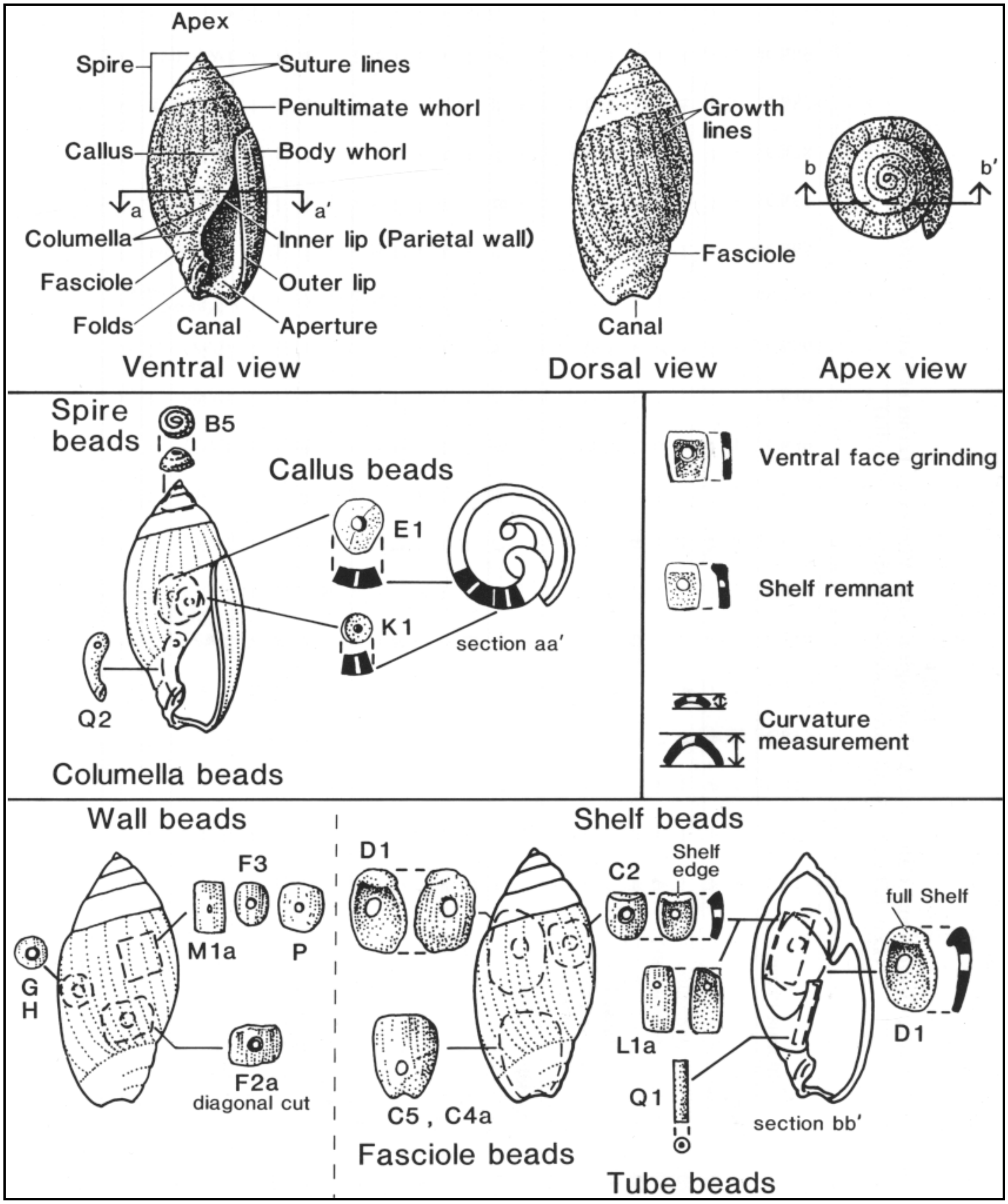

Figure 2.2. *Olivella* shell showing landmarks and loci of manufacture for various classes of beads (From Bennyhoff and Hughes 1987:89, Fig. 1).

Olivella dama is commonly referred to as dwarf olive shells and measures between 10 and 22 mm on average. *O. Dama* shells come from the Gulf of California. The *O. dama* shell has a narrow profile, more slender than the *O. biplicata* body. The slender spire tapers gradually and is approximately 1/3 of the total length of the shell. Three suture lines are usually outlined darkly in brown. The color and patterning of the body of the *O. dama* shell is distinctly different than the *O. biplicata*. Most of the specimens at the Bean Museum are brown, with some shells that were brownish/purple in color. Starting from the last suture line to the fasciole, the coloring is speckled brown. The area between the bottom and middle suture lines is approximately twice the area between the middle and top suture lines. Occasionally the bottom suture line will drag or smear into the speckled body of the shell, causing slight striations, although not all over the body like *O. biplicata*.

As scholars have suggested (see Renfrew 1975; Plog 1977; Brown et al. 1990), the raw materials of traded artifacts need to be accurately sourced. The source area of the *Olivella* shell varies according to species. *O. biplicata* is found along the entire Pacific coast of North America, *O. dama* comes from in the Gulf of California, and *O. baetica* is found on the northern California coast (Tower 1945, Hughes and Bennyhoff 1986). *O. baetica* is mostly subtidal and is generally found in deeper waters, which may explain the lack of *O. baetica* beads in the archaeological record (McDonald 1994:144). These shells were widely used and traded historically by Native Californians (Davis 1961; Hughes and Bennyhoff 1986) and were likely also obtained by Fremont peoples through trade networks. Northern and southern trade routes for moving shell into the eastern Great Basin have been proposed by Hughes and Bennyhoff (1986), although it appears the southern routes were more important during the Fremont period, due to *Olivella* shells from southern waters being more prevalent in the archaeological record (see also Tower 1945; Lyneis 1984; McDonald 1994).

Turquoise Analysis

Turquoise is less common than marine shell in Fremont sites; nonetheless, it is occasionally present (see Janetski 2002). There is no formal model established for turquoise analysis. Hence, methods for analysis on turquoise artifacts from Parowan Valley and Kay's Cabin were descriptive, in addition to collecting length, width, thickness, and hole diameter measurements. Artifacts were defined as either pendants or beads, based on shape. Turquoise pendants are usually tear-drop in shape, with the drilled hole in the smaller end. Turquoise beads are circular with a centrally drilled hole. Because of the rarity of turquoise in Fremont sites, Parowan Valley and Kay's Cabin specimens that were worked in any way were described and measured as well.

Given that there are no surface turquoise sources in Utah, all archaeological turquoise originated in mines from either New Mexico, Arizona, Colorado, Nevada, or California and had to be imported into the Fremont area (Chesterman 1978, Weigand and Harbottle 1993). This conclusion is supported by sourcing results on six turquoise artifacts from Five Finger Ridge, a Fremont site in central Utah (Talbot et al. 2000). There were 53 pieces of turquoise recovered in 27 structures at Five Finger Ridge. Six were submitted to Brookhaven National Laboratory for instrumental neutron activation analysis (INAA), and analysis concluded that the samples were indeed turquoise. The results suggest that 1) the bulk of the turquoise artifacts from the site was coming from the same sources that were supplying both Chacoan and Hohokam peoples; 2) at least some of the turquoise found in both Fremont as well as Southwestern sites may have ultimately been coming from Nevada mines; and 3) Fremont exchange connections appear to have been more to the southeast than to the southwest (Janetski et al. 2000:232). These data are important because it is the first attempt by Fremont researchers to compare Fremont turquoise with the source data collected by Weigand and Harbottle (1993; see also Weigand et al. 1977) from turquoise mines in the Southwest.

Mineral Identification and Analytical Results from Parowan Valley Artifact

The Parowan Valley artifact collection, on loan to BYU from the Fowler Museum, contains ten possible turquoise artifacts from ten years of excavation by UCLA (1954-1964). Initially, I was interested in having these turquoise artifacts chemically analyzed using INAA to see if sourcing information was available and to verify that the artifacts were chemical turquoise, not only "cultural turquoise" (see Weigand and Harbottle 1993 for discussion). As I researched the possibilities of INAA, I realized that the database created by Weigand and Harbottle (see Weigand et al. 1977; Harbottle 1982; Weigand and Harbottle 1993 for partial publication of data) had never been fully published. I found out from Phil Weigand (personal communication 2006) that Dr. Ron Bishop at the Smithsonian Institution has the database in Washington DC. Through further investigation, I realized that regardless of access to the database, INAA would not be ideal for identifying the Parowan Valley materials, since INAA causes the artifacts to be radioactive after the analytical process has been performed (Arelyn Simon, personal communication 2006).

Performing microprobe analysis on the Parowan Valley turquoise was an option available at BYU, but as discussed below, it is slightly destructive as a tiny piece of the material needs to be removed for testing. Since the Parowan Valley artifacts are on loan to BYU from the Fowler Museum, I was interested in exploring non-destructive means of analysis. A fellow colleague and former BYU graduate student, Chris Watkins, recommended I investigate the scientific method of Proton Induced X-ray Emission (PIXE) as a possible process to identify the Parowan Valley materials. PIXE is non-destructive and requires no sample preparation, and is therefore ideal for small and delicate artifacts when one does not want to damage the sample (Kim et al. 2003:1582). While attending the PhD program at Arizona State University (ASU), I arranged for Watkins to use an artifact from the Parowan Valley, identified macroscopically as cultural turquoise from the Parowan Valley collection, to be tested for material identification and characterization for his archaeometry class final project (Archaeometry III Advanced Characterization of Archaeological Materials). Below I summarize the results from his analysis of the Parowan Valley turquoise specimen, and the data is also presented as Appendix A.

In addition to testing the Parowan Valley artifact, Watkins also tested an unaltered turquoise sample from a geological context near Kingman, Arizona. Four different analytical methods (see Appendix A for further discussion) were used in the investigation, including X-ray Diffraction (XRD), Raman Spectroscopy, Scanning Electron Microscopy (SEM) with Energy Dispersive X-ray Spectroscopy (EDX), and Particle Induced X-ray Emission (PIXE). Watkins then applied the material characterization to archaeological questions, identifying the most important questions as the issue of sourcing the Parowan Valley sample. I would add that not only is sourcing data important, but the identification of the Parowan Valley artifact as chemical turquoise is also a significant contribution to turquoise studies in the Fremont area, as the presence of turquoise signifies long distance exchange and interaction.

The PIXE and quantitative EDX show that the elemental composition of the sample is consistent with turquoise, rather than some other blue-green stone mineral (Appendix A:14). Watkins determined through a close inspection of the compositional data generated with both the PIXE and EDX that there were several inconsistencies between the two methods. The qualitative EDX failed to determine the Parowan Valley sample as turquoise (most likely because the sample was not coated in gold, and due to the rarity of Fremont turquoise artifacts, we did not see it fit to coat the artifact in gold for this test). Watkins explains that PIXE is the more accurate of the two methods, as EDX was likely hindered by such factors as the absorption effect (Appendix A:14).

Watkins assembled a comparative database of turquoise samples (n=38) also analyzed by PIXE from two previous research efforts at ASU (Appendix A:2, 14). The majority of the database is composed of several archaeological samples recovered from excavations in the Tonto Basin (Kim et al. 2003). An additional sample in the database was recovered from an archaeological context near Florence, AZ (Bearat et al. 2003). The Parowan Valley archaeological sample and the Kingman geological sample were both inconsistent with the sources exploited by the Salado in the Tonto Basin (Appendix A:20, Kim et al. 2003). It is also apparent from the scientific testing that the Parowan Valley artifact is not from the same geological source as the Kingman specimen (Appendix A:20). Although no source identification was made for the Parowan Valley artifact, valuable information is gained in that the turquoise is not from the Kingman source and not from the same source as the Salado were exploiting.

Kay's Cabin Turquoise Identification

Additional chemical analysis conducted on Fremont turquoise includes the electron microprobe identification of turquoise at a Fremont site, Kay's Cabin (42UT813). Kay's Cabin is in Goshen Valley, south of Utah Lake. The site dates to approximately A.D. 1200, which places it in the late Fremont period (Talbot 2000a). Kay's Cabin is a structural site with a surface structure and a Fremont style pithouse. Two *Olivella* beads were recovered from excavations. One is a B3 Barrel bead, the other is a G2 Normal Saucer bead (see descriptions of bead types in Chapter 3 and measurements located in

Appendix B). Twenty-nine blue-green artifacts were found, all in structural fill with the exception of one pendant which was found on the floor of the pithouse. Sixteen artifacts were raw and unworked and thirteen were worked, including two pendants. Eight were coarse-grained minerals that resembled azurite or malachite; one of these pieces was worked. The remaining 21 blue-green artifacts resembled turquoise or variscite. Variscite is a mineral similar to turquoise found modified and worked into ornaments at Orbit Inn, a post-Fremont site near Brigham City, UT (Simms and Heath 1990). Variscite is available in Clay Canyon, 30 miles north of Kay's Cabin (Chesterman 1978).

Dr. Jeffrey Keith, a mineralogist in the Department of Geology at Brigham Young University, macroscopically examined the blue-green artifacts from Kay's Cabin and confirmed that the coarser pieces of blue-green material were azurite/malachite conglomerates. Through a simple scratch test to determine the hardness index of the minerals, he concluded that the worked artifacts that appeared to be variscite or turquoise were neither, but a similar and softer mineral called chrysocolla. All of the worked pieces, except for one, were classified as chrysocolla. One modified piece was identified as turquoise and the coarse-grained pieces were various types of azurite/malachite conglomerates. Dr. Keith suggested the artifacts be tested by electron microprobe analysis, a type of microanalysis, to verify his macroanalysis.

Since variscite and other blue-green minerals had been locally exploited in the past, it was not surprising to discover a different blue-green mineral being used in ornament production. Keith pointed out that chrysocolla was probably found prehistorically on the surface near the Bingham Mines in Salt Lake City, further supporting the new chrysocolla hypothesis (Jeff Keith, personal communication 2002). Because chrysocolla had not been identified previously in Fremont sites, it was important to do further testing and identify the mineral artifacts from Kay's Cabin.

Mineral Description

Chrysocolla is a copper silicate. Its chemistry formula is $Cu_4H_4Si_4O_{10}(OH)_8$ (Klein and Hurlbut 1999). It has high amounts of copper, and it forms in the oxidized zones of copper deposits associated with malachite, azurite, cuprite, or native copper (Klein and Hurlbut 1999). It is a soft mineral with a hardness index between 2 and 4 and fractures conchoidally (Klein and Hurlbut 1999). Its color is greenish-blue and it is distinguished from turquoise by its inferior hardness (Klein and Hurlbut 1999).

Turquoise, $CuAL_6(PO_4)_4(OH)_8$*$4H_2O$ is a copper aluminum phosphate. Turquoise has a hardness of 6 and its diagnostic features include that it is harder than chrysocolla, the only common mineral which it resembles, and turquoise can sometimes be recognized by its color (Klein and Hurlbut 1999). The color varies from blue, bluish-green, and green (Klein and Hurlbut 1999). Throughout the world turquoise is found in arid regions and in the United States it is located in New Mexico, Arizona, Nevada and California (Klein and Hurlbut 1999). As noted, turquoise was not available in surface mines in Utah. A bluish-green mineral, also similar to turquoise, is variscite, $AL(PO_4)$*$2H_2O$. Variscite resembles turquoise and has been found in the Fremont area at Fairfield, Utah, in a large deposit (Klein and Hurlbut 1999). Variscite has a hardness of 4-4.5 (Chesterman1978). Chrysocolla, turquoise and variscite are all used today as gemstones. The suggestion that the Fremont were exploiting chrysocolla is new; therefore, as Renfrew (1975) advises, it is critical to confirm Keith's identification through chemical analysis.

Electron microprobe analysis is a technique used to chemically analyze a small selected area of solid samples, in which X-rays are excited by a focused electron beam (Reed 1996). This analysis is helpful in recording qualitative and quantitative information. The qualitative approach was most useful for the classification of minerals and it identifies the X-ray spectrum lines, which are characteristic of the elements present, from their wavelengths (or photon energies) (Reed 1996).

Before the electron microprobe analysis began, Dr. Michael Dorais (Department of Geology, Brigham Young University) and I prepared 21 blue-green specimens from Kay's Cabin. The remaining artifacts were not microprobed as Dr. Dorais did not consider the specimens to be a homogenous material, and, therefore difficult to characterize. Microprobe analysis is minutely destructive to the artifact, but only a tiny piece (approximately 1 mm in size) was needed (Reed 1996). The grains were mounted on a glass slide with double sticky tape. We put approximately five to eight grains on a slide.

The qualitative microprobe analysis identifies minerals by the elements present. A recording time of only a few seconds is usually ample to reveal the major elements and determine the approximate relative amounts (Reed 1996). The electron microprobe is connected to a computer and the computer produces a graph called the Energy Dispersive spectrum (Figure 2.3). The Energy Dispersive spectrum graph shows peaks of elements that are present in the sample. The higher the peak, the more the element is present in the mineral. This is a qualitative approach to determine the relative amount of the key elements in the chemical signature of the mineral. In *Electron Microprobe Analysis and Scanning Electron Microscopy in Geology*, it explains that "different minerals containing the same major elements in different proportions are often distinguishable on the basis of the relative height of the peaks" (Reed 1996:119). The ability to differentiate between similar minerals with different chemical signatures made the electron microprobe the ideal tool for differentiating between chrysocolla, turquoise, and variscite.

To verify we were reading the graphs correctly, Dr. Dorais took five samples and polished them for further testing (see Figure 2.3). He wanted to verify the amount of copper in the minerals to establish the artifacts were turquoise. The difference between

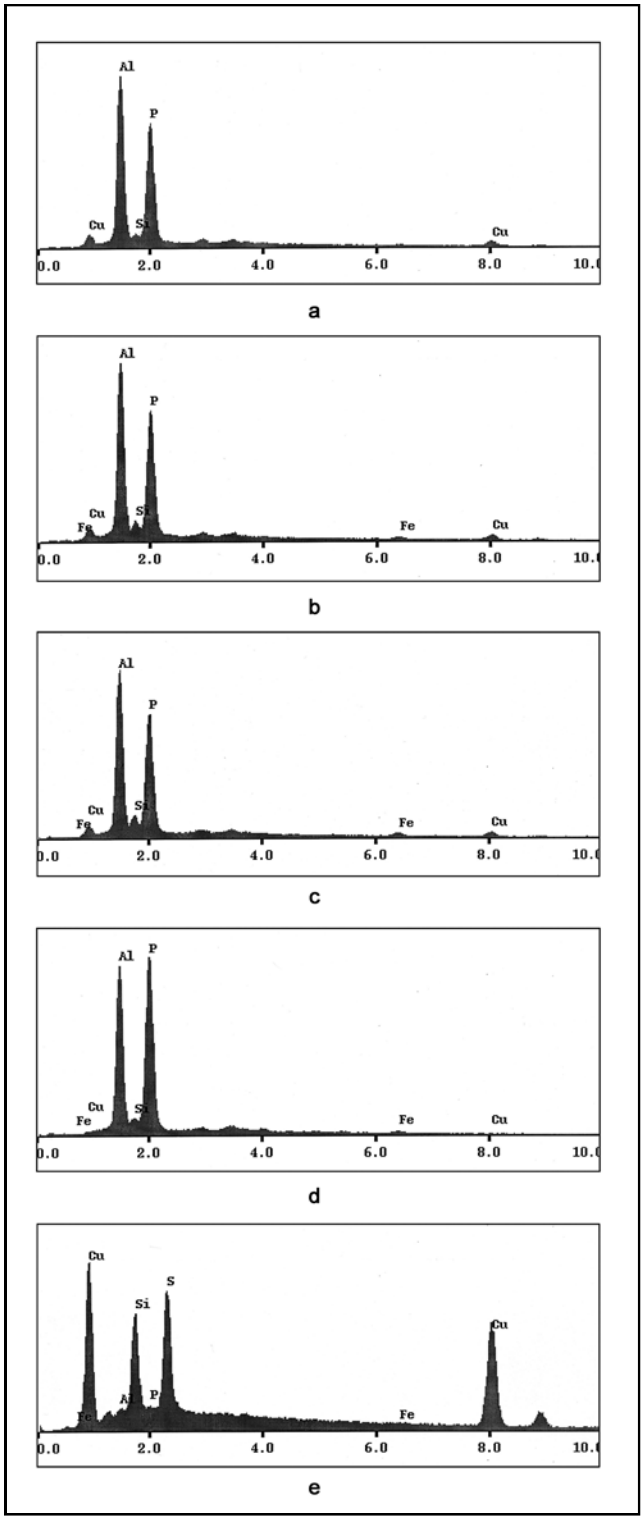

Figure 2.3. Energy dispersive graphs generated by electron microprobe analysis: turquoise (a-c), variscite (d), and copper oxide (e).

polishing the grains and mounting the grains (as we had done previously) is that the grains are placed in a brass ring mounted with epoxy, and then ground down to expose the grains and then polished. The polished grains are then subjected to more detailed testing. Three of the polished samples produced the copper peak expected for turquoise. The sample that we thought was variscite showed the complete absence of copper, enabling us to confirm that the mineral is definitely variscite. The specimen we thought might be chrysocolla showed a high amount of copper, although it contained various other elements including Sulfur, making us unable to verify that it was chrysocolla.

Results and Discussion

The microprobe analysis showed the artifacts initially identified as chrysocolla are turquoise. Between the macroanalysis and microanalysis, I concluded 13 of the specimens from Kay's Cabin are turquoise, one is variscite, and one is either chrysocolla or a copper oxide (Figure 2.4). Seven additional specimens are azurite/ malachite conglomerates. Seven specimens were not identifiable. The turquoise artifacts from Kay's Cabin are significant in several ways. First, these artifacts, along with the turquoise found at Woodard Mound, also in Utah Valley, are the northern-most occurrence of turquoise in Fremont period sites in Utah, which demonstrates this exotic material was widespread in the Fremont area.

Second, the 13 turquoise artifacts are found in structural fill, rather than in pits, burials, or caches. This is comparable to other occurrences of turquoise in the Fremont area. The intrasite distribution of turquoise at Five Finger Ridge is widespread rather than concentrated (Talbot et al. 2000; Janetski 2002). No more than three or four turquoise artifacts were found in any one pithouse (Talbot et al. 2000). Similarly, at Baker Village, a site near the Utah-Nevada border, 15 turquoise artifacts were found. Six

Figure 2.4. Turquoise (a-c, f-o) and *Olivella* artifacts (d, e) from Kay's Cabin (42UT813). Artifacts are actual size.

turquoise artifacts came from granaries and the remainder from pithouses (Wilde and Soper 1999). This is an interesting contrast with Five Finger Ridge, where no turquoise artifacts were associated with the granaries (Talbot et al. 2000). The distribution of Kay's Cabin artifacts is similar to that at Baker Village and Five Finger Ridge in that turquoise is associated with living areas. The Fremont pattern contrasts with the distribution of turquoise at Anasazi sites. For example, at the Main Ridge site at Lost City, an Anasazi site in Nevada, all of the turquoise was found in burials (Lyneis 1992). Additionally, Lyneis (1992) reports that all were finished pieces, suggesting that the production of turquoise ornaments was not an activity at the site. Another example is in southwestern Utah, at the Anasazi sites of Quail Creek where 67 flat turquoise beads of various shapes were found in a single burial (Walling et al 1986).

Third, the thirteen pieces of turquoise from Kay's Cabin are not all worked (Figure 2.4). Five pieces show no modification, which suggests perhaps the Fremont may have been trading for raw materials and possibly shaping and making their own ornaments. This is very different from the artifact assemblages at Five Finger Ridge and Baker

Village. At Five Finger Ridge, there is no evidence of turquoise being worked or modified at the site, suggesting that the Fremont at Five Finger Ridge were consumers of turquoise ornaments rather than producers (Janetski 2002). Likewise, all of the turquoise artifacts from Baker Village were modified. In contrast, Coombs Village, an Anasazi site in southern Utah, contained unworked turquoise fragments, as well as many finished beads, suggesting that some Anasazi were working turquoise into ornaments. Although there is only minimal evidence for Fremont unworked turquoise, this observation has never before been reported in the Fremont area.

Stylistically the shaped pendants from Baker Village are morphologically similar to the blue-green pendants at Kay's Cabin, although the pendant fragments were not identified as turquoise. The stylistic similarity between the pendants at Kay's Cabin and Baker Village suggests interaction or perhaps the same trade connections. The pendants at Five Finger Ridge are much larger and may have been traded from the Anasazi or other trade partners (Figure 2.5). Five Finger Ridge turquoise is not only different stylistically, but also in color. Five Finger Ridge turquoise is much more blue than the blue-green turquoise found at Baker Village and Kay's Cabin, suggesting the different colored artifacts likely came from different turquoise sources. This observation may suggest that these stylistically different turquoise artifacts may have come from different trade connections as well as different prehistoric turquoise mines.

The turquoise artifacts from Kay's Cabin may suggest new ideas about the distribution of long distance trade items, and more importantly that the Fremont may have obtained raw turquoise and made decorative items rather than traded for them. These implications, however, would not be possible if the material had not been accurately identified. As Renfrew (1975) advises, it is important to determine the source of the minerals using modern analytical techniques, such as electron microprobe analysis and

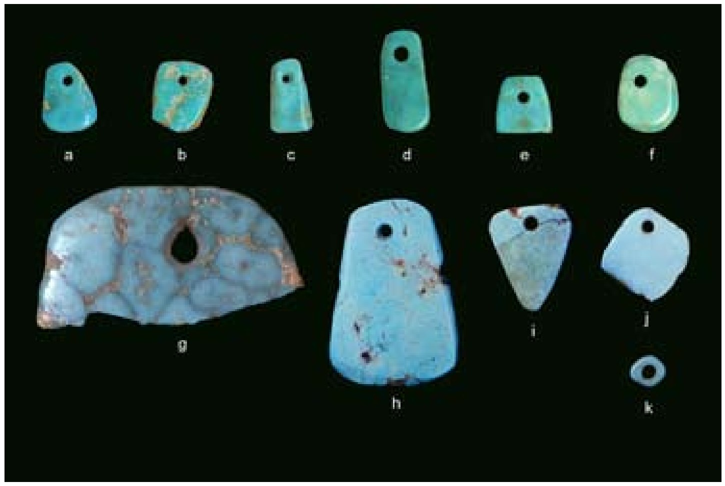

Figure 2.5. Turquoise from Baker Village (top) and Five Finger Ridge (bottom). Artifacts are actual size.

the various techniques used by Watkins (see Appendix A), in order to fully understand what material the artifacts are and what information we can learn from them.

The amount of archaeological turquoise testing and identification in the Fremont area is very limited, although each attempt has proved fruitful in providing additional information about Fremont turquoise. It appears that if a PIXE database can be established in the Southwest, this method would be ideal for testing rare turquoise artifacts found in Fremont contexts. Further research in turquoise identification and characterization is critical for understanding Fremont trade relations and ties to the Southwest.

3 | Data

DATA SETS

Olivella and Turquoise

Data and analysis on *Olivella* and turquoise were gathered via a rigorous literature search and the examination of archaeological collections from Parowan Valley generated by Clement Meighan of the University of California at Los Angeles (UCLA) and now on loan to Brigham Young University from the Fowler Museum; by Neil Judd (1919, 1926) whose collections are now at the Smithsonian Institution (SI) in Washington DC; and by Richard Thompson at Southern Utah State College (SUSC, later changed to SUU) whose collections are stored at Southern Utah University (SUU). The UCLA excavations were conducted at three sites, Paragonah (42IN43), Summit/Evan's Mound (42IN40), and Parowan (42IN100). Paragonah was excavated from 1954-1960, Summit/Evan's Mound 1959-1964, and Parowan 1963-1964. Judd's excavations took place at Paragonah from 1915-1917, and Thompson's excavations took place at Summit/Evan's Mound between 1964 and 1970. *Olivella* shell was found by each principal investigator, but turquoise was present only in the UCLA archaeological collections.

Other collections analyzed for this thesis include turquoise and *Olivella* from Kay's Cabin and *Olivella* from Nephi Mounds. Both collections are curated at the Museum of Peoples and Cultures at Brigham Young University. The *Olivella* beads found at Nephi Mounds are from the Foote Collection, donated by Alfred Reagan (Sharrock and Marwitt

1967; DeBlois 1967). I viewed collections from Hinckley Mounds (Berge 1966), Seamon's Mounds, and Woodard Mounds (Richens 1983) at the Museum of Peoples and Cultures to obtain complete counts of *Olivella* and turquoise artifacts from various excavations. In addition, information on exotics was obtained from staff at the University of Utah Natural History Museum for *Olivella* and turquoise counts at Nawthis Village, although no specifics on bead types were available. I also examined the turquoise and *Olivella* artifacts from Coombs Village at Anasazi State Park (Lister and Lister 1961).

Parowan Valley

The majority of the artifacts included in this thesis were collected in Parowan Valley. For this reason, a brief history on the background of Parowan Valley and the investigations that took place there is appropriate. Parowan Valley is located approximately 20 miles northeast of Cedar City in southwestern Utah, on the eastern edge of the Great Basin physiographic zone. In close proximity are the Hurricane Cliffs, which delineate the boundary between the Great Basin and the Colorado Plateau. Three perennial drainages, Red, Summit, and Parowan Creeks, once flowed into the valley and are currently diverted for modern irrigation. Shadscale and sagebrush dominate the valley vegetation. As elevation rises to the east, pinyon and juniper are increasingly found, eventually transitioning to conifer and aspen communities (Berry 1972b). Climate is typical of the southeastern Great Basin; the average rainfall is 12.77 inches per year, and the average frost-free period is 123 days (Berry 1972b). The major sites of the valley, Paragonah (42IN43), Summit/Evans Mound (42IN40), and Parowan (42IN100), and Median Village (42IN124) occur on the valley bottom along prehistoric channels of the three perennial rivers listed above and are found within 15 km of one another.

The early historical descriptions of Parowan Valley sites are fascinating in their implication of site size and complexity. Brigham Young likely observed Paragonah and described it in a letter dated 1851:

> …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.
> (Janetski 1997:102).

Many early historic accounts of archaeological sites ought to be considered suspect. In the case of Parowan Valley, later visitors and excavations confirmed Young's description of the mounds at Paragonah (Janetski 1997:102). While Young's designation of a structure as a "temple or council hall" is probably unfounded, his description of site size and density are intriguing. Other amateurs and quasi-professional archaeologists visited and worked in Parowan Valley in the succeeding decades. 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 (Chief of the Department of Archaeology and Ethnology for the Utah Territorial World's Fair Commission), and Henry Montgomery (University of Utah Professor of Natural History).

As part of the first generation of professionally trained archaeologists in Utah, Neil Judd's interpretations of the sites in and around Parowan Valley greatly influenced future research. He worked throughout the state between 1915 and 1920, spending a fair portion of that time at Paragonah during 1915 and 1916, and conducted extensive excavations at Paragonah's "Big Mound" in 1917 (Judd 1919, 1926, 1968). 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 ancestral Pueblo people of the Southwest (Judd 1926, see also discussion in Chapter 1). His designation of the Wasatch Front culture as "Puebloid" or Puebloan was accepted well into the 1950s (Meighan et al. 1956; Ruby 1963).

The next major archaeological work that took place in Parowan Valley were 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 (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 not been published for over 40 years.

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 *Olivella* bead artifacts from his excavations at Summit (42IN40) are included here in my analysis of Parowan Valley *Olivella* shell. The extent of Thompson's excavations are unknown, and his notes are now rumored to have been destroyed or lost. Marwitt (1970) mentioned 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: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 Michael S. 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.

In 2001, faculty and staff from the Anthropology Department and Office of Public Archaeology at BYU requested a loan from the Fowler Museum to study and analyze the artifacts collected by UCLA excavations in Parowan Valley. Since 2001, BYU students have worked under mentored supervision by faculty and staff to prepare the artifacts and notes for analysis and publication as part of the Parowan Valley Archaeological Project (PVAP) at BYU.

Dates for the sites in Parowan Valley, according to Talbot's scheme (2000:280), almost always fall in the late Fremont era, A.D. 900-1350 (see discussion on Fremont in Chapter 1). Marwitt (1970:151) reported two radiocarbon dates for Summit/Evans Mound as A.D. 655 ± 90 and A.D. 1095 ± 90, although the first date is not considered correct. The early date came from charcoal, and the late date from charred corn. Three dates from Median Village fall into the early part of the late Fremont era, during the A.D. 900s. Also at Median village, a very late date, A.D. 1450 ± 80, was rejected by Marwitt (1970:151). All of the dates generated by the University of Utah for Median Village were obtained from charred structural wood (Marwitt 1970:8). BYU has dated corn from Parowan and Summit. AMS corn dates from Parowan (n = 4) and Summit (n = 4) fall primarily in the A.D. 900s with one in the A.D. 1000s. Corn dates from Paragonah (n = 12) are mostly in the late Fremont period, although there is one date in the A.D. 800s and four dates where the upper range reaches the A.D. 1200s. Seven dendrochronolgy dates from Paragonah structural wood each fall in the A.D. 1100s.

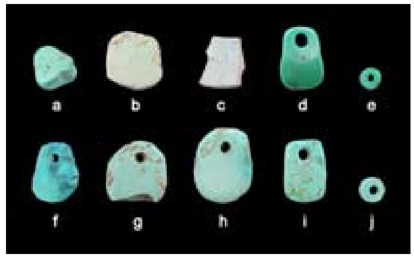

Figure 3.1. Turquoise artifacts from the Parowan Valley: Summit site (a-c) , Parowan site (d-e), Paragonah (f-j). Artifacts are actual size.

Data Presentation

The turquoise and *Olivella* artifacts, including beads, pendants, and fragments were sorted according to various morphological characteristics. All were measured, described, and typed according to the parameters discussed in Chapter 2.

Turquoise Artifacts

Turquoise artifacts from Kay's Cabin were described and discussed in Chapter 2, along with the chemical characterization performed on the Kay's Cabin and Parowan Valley turquoise. Turquoise artifacts from Parowan Valley in the UCLA collection include ten artifacts: five pendants, two beads, and three worked artifacts, one of which shows evidence of a partially drilled hole (Figure 3.1). Four of the five pendants are complete and range in length from 8.2 mm to 10.2 mm, and in width from 5.9 mm to 8.2 mm. One pendant is broken near the bottom, opposite the end with the drilled hole. Three of the pendants have been biconically drilled; the remainder were drilled conically. One pendant is very blue with blackish mottling, another pendant is a very deep green/ turquoise with some brownish mottling, and three pendants are pale turquoise with light brownish/rust colored mottling.

The two turquoise beads are both round; one measures 2.9 mm in diameter and 1.2 mm thick, the other measures 3.4 mm in diameter and 1.7 mm thick. Both beads were conically drilled. One bead is deep green/turquoise in color; the other bead is pale green/turquoise. One artifact has been modified and worked to be triangular in shape and has been partially drilled and broken at the top (5.8 mm by 5.7 mm in size). This artifact was tested at ASU (see Appendix A) and characterized as turquoise. It is light green/turquoise in color with some light rust colored mottling. Two artifacts without perforations include a polished fragment (7.1 mm by 5.6 mm in size) with a thin veneer of very pale green over a thick light brown matrix (2.5 mm in total thickness); and a thin (1.5 mm thick) flat and polished subrectangular disk (7.9 mm by 7.5 mm in size) that might be a pedant or bead blank. The flat disk is a light green with brown/rust colored mottling.

Olivella Beads

Marine shell, specifically *Olivella*, was relatively abundant (for the Fremont area) at Parowan Valley sites. There were 319 *Olivella* shell artifacts found from Parowan Valley sites in the UCLA, SUU, and SI collections. Of the 319 *Olivella* beads, only 35 were unidentifiable as to species because the shells were too fragmented, eroded, or altered to sort beyond the genus level[1]. Sixty-eight were identified as *Olivella biplicata* and two as cf. *O. biplicata*, or in other words, probably *O. biplicata*. The remaining 214 beads were identified *Olivella dama*, with one cf. *O. dama*. In many cases, the identification of the beads were based on observations of color remnants (brown to purple) retained on a surprising number of beads and the ovate shape of the body whorl for *O. biplicata* specimens. The narrow body shape of the *O. dama* shell made identification fairly obvious, especially for spire-lopped beads where the majority of the shell is used in bead production. Additionally, as previously noted, my examination and study of modern *O. biplicata* and *O. dama* specimens helped me to differentiate between the *Olivella* species (see Figure 2.1).

Table 3.1. *Olivella* counts per bead type analyzed from the UCLA Parowan Valley and Nephi Mound Foote collections.

Types	Nephi Mounds (42JB2)	Paragonah (42IN43)	Parowan (42IN100)	Summit (42IN40)
A1	4	2	4	2
A4	–	–	1	1
A6	–	1	1	–
B2	1	–	–	–
B3	9	42	47	109
B6	1	–	1	1
C2	3	1	6	9
C2i	–	1	–	–
C3	5	–	–	6
C4	–	1	1	2
C5	–	–	1	–
C7	1	2	2	2
C8	–	–	–	1
D1	10	5	5	11
D2	–	3	1	1
D3	4	1	6	2
F1	–	–	–	2
F3a	–	1	–	2
F3b	1	–	–	–
G1	–	1	1	2
G2	–	–	–	3
G3	–	1	1	2
G5	–	1	1	4
G6b	1	–	–	–
J	–	–	–	1
Frag	–	8	2	4
Total	40	71	81	167

Of the 40 shell beads collected at the Nephi Mounds site, 15 were identified as *O. biplicata*, 14 as *O. dama* and one cf. *O. dama.* The remaining 10 were complete beads, although many characteristics of the shells were removed during manufacture to make the specific bead types. Although I did not assign a species designation, these beads may be considered *O. biplicata*, based on Bennyhoff and Hughes' classifications (see endnote 1).

Olivella Bead Types

Presented in this analysis, there are 25 different bead types, as defined by Bennyhoff and Hughes (1987) (Table 3.1). In the sample of artifacts from Parowan Valley, 22 bead types were observed and 11 different bead types were identified in the artifacts from Nephi Mounds (Figures 3.2 and 3.3). Table 3.1 shows the *Olivella* bead types and counts

Figure 3.2. Beads from Nephi Mounds made from *Olivella dama* shell (a-j); beads made from c.f. *Olivella biplicata* (k-p); beads made from *Olivella biplicata* (q-x). Artifacts are actual size.

Figure 3.3. Selected *Olivella* shell types from Parowan Valley: a) A1, b) A4, c) A6, d-f) B3, g) B6, h) C2, i) C3, j-k) C4, l) C5, m) C7, n) C8, o) D1, p) D2, q) D3, r) F1, s) F3a, t) G1, u) G2, v) G3, w) G5, x) J. Artifacts are actual size.

at each site. The beads are described below with a brief summary of the class and then reviewed according to type, starting with Class A and continuing in alphabetical order.

Class A: Spire-lopped. This class of beads consists of a nearly complete shell with only the spire removed. The spire may be ground down, broken off, or naturally waterworn. Variable amounts of the outer lip may be removed or broken away to facilitate stringing (see Bennyhoff and Hughes 1987:116-117).

A1 Simple Spire-lopped (n=12). Bennyhoff and Hughes (1987:117) report that Great Basin A1 beads were made from three species: *O. baetica, O. biplicata,* and *O. dama.* Simple Spire-lopped beads are described by Bennyhoff and Hughes (1984:116) as a "nearly complete shell with only the spire removed…the spire may be broken off, ground down, or naturally waterworn." In the Parowan Valley collection, there are eight A1 Simple Spire-lopped beads. All A1 beads have been identified as *O. dama* shell. A1 beads in this data set range in size from 13.8 to 11.4 mm in length and 6.7 to 5.3 mm in diameter. Six of the A1 beads from Parowan Valley fall into the A1a category[2], and two are A1b. At Nephi Mounds, four A1 beads were found; they range in size from 14.8 to 12.8 mm in length and 6.9 to 6.4 mm in diameter. One bead is A1a and three are A1b at Nephi Mounds.

A4 Punched Spire-lopped (n=2). This bead type is spire-lopped with a perforation punched in the body whorl. The shell ornament was probably strung as a pendant (Bennyhoff and Hughes 1987:119). Bennyhoff and Hughes (1987:119) explain that it is difficult to distinguish punched holes from accidental breakage unless the shell is well preserved. There were two specimens from the UCLA Parowan Valley collection, one identified as an A4a bead, the other as a probable A4b bead because of breakage. The complete specimen has a squarish, punched perforation that measures 2.4 mm. The length of the bead is 11.2 mm, and the diameter is 6.4 mm. The broken bead is 11 mm long and 6.6 mm in diameter (these dimensions were still retrievable). The bead is broken at the punched hole to the outer lip; hence, no complete measurement is available for the perforation, although the remaining end of the bead is ground. Both beads were made from *O. dama* shells.

A6 End-perforated Spire-lopped (n=2). Two A6 End-perforated Spire-lopped beads were present in the SI and UCLA collections from Parowan Valley. The A6 bead in the Smithsonian Institution collection is the same bead Judd reported (1926, see plate 46f) and the one Bennyhoff and Hughes used to define this type. Bennyhoff and Hughes report, "the single known specimen came from Paragonah, Utah…confined to the Fremont culture at present" (1987:120-121). Both specimens were made from *O. biplicata* shells, and Bennyhoff and Hughes (1987:20) explain that the shell likely came from the southern California Pacific Coast. The unique specimen probably represents the local redrilling of an A1 bead to serve as a pendant (1987:120). A6 beads are spire-lopped with a perforation drilled conically near the canal end, below the fasciole (see Figure 2.2). The specimen from the Smithsonian Institution measures 19.8 mm in length and 12.4 mm in diameter and is therefore classified as A6c. The drilled hole is 2.9 mm in diameter. The UCLA A6c bead measures 18.6 mm in length and 11.5 mm in diameter. The drilled hole is 2.7 mm in diameter. The UCLA specimen is the second A6 bead found, further supporting this bead type as possibly limited to the Fremont area, and perhaps restricted to Parowan Valley.

Class B: End-ground. Class B beads have both the spire and part of the aperture end (opposite of the spire) removed, usually by grinding (Bennyhoff and Hughes 1987:121).

B2 End-ground (n=1). One B2c end-ground bead was found at Nephi Mounds. The bead is large, measuring 13.8 mm in length and 10.4 mm in diameter. The spire has been removed and ground. The canal end was removed by grinding, with the maximum diameter towards the spire (see Bennyhoff and Hughes 1987:121). The bead is identified as cf. *O. dama*, as it appears to have a narrow body which is characteristic of *O. dama.*

B3 Barrel (n=207). This was the most abundant style of bead recovered from Parowan Valley (see Table 3.1). Barrel beads are characterized by the removal of the spire, then grinding and/or smoothing the spire end and the canal end. Beads were then strung through the natural opening where the spire was removed towards the canal. Bennyhoff and Hughes (1987:121) report that Class B beads are normally made from *O. biplicata* shells. In contrast, every barrel bead in the Fremont area from Parowan Valley and Nephi Mounds is shaped from *O. dama* shells. There were 195 barrel beads found in Parowan Valley sites, and three broken beads were identified as likely B3. According to criteria set by Bennyhoff and Hughes (1987), 168 beads in Parowan Valley are B3a and 29 beads are B3b. One bead was too fragmented to measure the diameter dimensions. The largest B3 bead measures 10.4 mm in length and 8 mm in diameter. The smallest B3 bead measures 3.9 mm in length and 3.5 mm in diameter. At Nephi Mounds, nine barrel beads were collected. Seven beads are classified as B3a and two beads as B3b.

B6 Double-Oblique (n=3). This bead type is similar to the barrel bead, except the spire and end are ground diagonally. There are two B6a beads from Parowan Valley. These measure 6.3 and 6.1 mm in length and 5.6 and 5.3 mm in diameter. One B6a bead was found at Nephi Mounds; it is 8 mm long and 6.3 mm in diameter. Bennyhoff and Hughes (1987:122) did not report any Great Basin occurrences of this bead type, so the discovery of this style is new in the Fremont area.

Class C: Split. Split beads range from half-shell beads usually with a full shelf to quarter-shell beads with shelf edge or no shelf. All the edges of the bead are ground (see Bennyhoff and Hughes 1987:122).

C2 Split Drilled (n=18). Split drilled beads are a type of "shelf bead" made from a section of the shell rather high up on the body whorl, and such beads include the shelf or remnants of the interior of the spire (see Figure 2.2). Split drilled beads are different than D1 beads (see below) in that they retain less of the spire, and the perforations are drilled instead of punched. The C2 split drilled bead is made from a half-shell to quarter-shell that retains the shelf edge (see Figure 2.2), although the amount of shelving retained is variable (see Bennyhoff and Hughes 1987:123). There are fourteen C2 beads in Parowan Valley collection, and an additional two probable C2 beads that are partially broken. The drilled perforation size was rather consistent, measuring between 2 and 3.2 mm. Bead shapes are circular to somewhat oval with ground edges; and they range in size from 12.7 to 9.1 mm in length to from 11 to 7.7 mm in width. All of the C2 beads were identified as *O. biplicata*, and many retained the coloring and striping characteristic of this species. There are two C2 beads in the Nephi Mounds collection. Both are identified as *O. biplicata*, and one bead retained the striping typical of the shell. The dimensions of these two beads are 14.1 and 13.4 mm in length and 11 and 10.9 mm in width.

C2i Split Drilled Incised (n=1). One bead from the Parowan Valley collection at the Smithsonian is a C2i type. This is an incised variant of the split drilled bead and is unique to the Great Basin (Bennyhoff and Hughes 1987:123). This specimen has three incised lines on the lower half of the bead. Two lines connect from the oval-shaped perforation to the opposite edges of the shell at a diagonal. The third incised line runs somewhat parallel to the bottom of the shell from edge to edge, below the diagonal lines. The shell is *O. biplicata*, with some color still remaining on the shell.

C3 Split Oval (n=11). Split oval beads are medium-sized beads made from a quarter-shell (Bennyhoff and Hughes 1987:123). The bead is centrally perforated with no shelf, although occasionally some shelf edge remains. The average dimensions of C3 beads given by Bennyhoff and Hughes (1987:123) are 8.5-12.0 mm in length, 7.5-10.0 mm in width, and 1.8-2.8 mm in drilled perforation diameter. Five beads from Parowan Valley were identified as C3 beads, and one was identified as a probable C3 bead. Three of the Parowan Valley C3 beads are *O. biplicata*, and the remaining three are likely *O. biplicata* (see endnote 1), although they were identified only to the genus level. Five C3 beads were found at Nephi Mounds and all were only identified as *Olivella*.

C4 Split End-Perforated (n=4). There were four split end-perforated ornaments, which were likely worn as pendants, found in the Parowan Valley UCLA collections. C4 beads were made from half-shells, with the drilled perforation near the canal end. Full shelf or shelf edge remains on the opposite end of bead. The average size of these pendants varies between 18.0 to 21.0 mm in length, 11.0 to 13.0 mm in width, and with a perforation diameter of approximately 2.0 mm (see Bennyhoff and Hughes 1987:123). Although two pendants were partially broken, all the dimensions could be measured. Three C4 beads were identified as *O. biplicata* and one C4 bead as *O. dama.* One of the *O. biplicata* C4 beads is drilled near the spire end, not the canal end, and is therefore identified as a C4b bead. The three beads drilled on the canal end are C4a. Each of the *O. biplicata* beads retained purplish color and faint striping found on the body whorl of the shell. Bennyhoff and Hughes (1987:123) note that this type is local to the Great Basin.

C5 Scoop (n=1). The scoop bead is a flaring bead cut from the canal end of the shell, and it has a perforation just below the fasciole (see Figure 2.2). This type of bead is worn as a pendant. Only one C5 was identified from the Parowan Valley collection. It measures 9.7 mm in length, 8.6 mm in width, and 2.7 mm in perforation diameter. The perforation is not round and may have been punched and then smoothed or retouched. The edges of the bead are ground, although the top of the bead was ground unevenly.

C7 Split Amorphous (n=7). C7 beads are quarter-shell beads of highly variable form, as implied by the name. Most beads are oval to rectanguloid in shape, and the chipped edges produce uneven outlines. Partial edge grinding or smoothing of the chipped edges may suggest unfinished beads, but their widespread occurrence in central California sites suggests that they also functioned as finished beads (Bennyhoff and Hughes 1987:125). Most C7 beads retain part of the shelf edge, although full shelf and shelfless variants occur. The average range of C7 beads observed by Bennyhoff and Hughes (1987:125) is 8.0 to16.0 mm in length, 8.0 to 13.0 mm in width, and 2.0 mm in hole perforation diameter. Six C7 beads were found in Parowan Valley; one additional bead is probably a C7, although it has a punched perforation, or perhaps drilled and then retouched. Three of these beads were identified as *O. biplicata*, and three were not identified to the genus level since much of the shell characteristics are missing. One bead found at Nephi Mounds is defined as *Olivella*, although no species designation was able to be assigned.

C8 Split Rough (n=1). The split rough bead is similar to the split amorphous bead in that it is made from a quarter-shell of highly variable form, with only chipped edges. No smooth or ground edges are evident, and C8 beads are possibly unfinished. One bead was found in Parowan Valley. It has evidence of the shelf on the interior and has chipped edges. C8 beads are usually smaller than C7 beads, with average measurements of 7 mm long and 9 mm wide (Bennyhoff and Hughes 1987:125). The bead from Parowan Valley is slightly larger than average, measuring 9.9 mm in length and 9.8 mm in width.

Class D: Split Punched. Class D are half-shell or quarter-shell beads with central, punched perforations. Chipped and unground edges are common (see Bennyhoff and Hughes 1987:125)

D1 Shelved Punched (n=31). A shelved punched bead, as the name implies, retains a full shelf (the remaining portion of the spire from the inside of the shell), has a punched perforation, and is made high up on the body whorl. D1 beads vary in size. The beads with the full shelf and made from the larger half-shell are D1a beads, and D1b (small punched) beads are usually made with a quarter-shell, with only the shelf edge retained (Bennyhoff and Hughes 1987:125). Punched beads are easily recognized as such since the holes are almost always irregular in shape, although perforations are often polished from string wear. Chipped edges are common, although ground and smoothed edges occur as well. The Parowan Valley collection includes 12 complete (and can also be classified as D1a) and nine broken D1 beads. There are 10 complete D1a beads in the Nephi Mounds collection (see Table 3.1). A number of the complete beads are rather large in size. The largest bead from Parowan Valley measures 19.8 mm long and 13.2 mm wide; the largest at Nephi Mounds measures 20.3 mm long and 13.6 mm wide. *O. biplicata* was clearly preferred for D1 bead manufacture, as all D1 beads, except for one cf. *O. biplicata,* were identified as the *O. biplicata* species. Many of beads were well preserved with color and/or striping retained, which facilitated species identification.

D2 Rectangular Punched (n=5). D2 beads are large rectangular beads with ground edges, a central punched perforation, and a full shelf (Bennyhoff and Hughes 1987:125). There are five D2 beads in the Parowan Valley collection, and the largest measures 17.7 mm long and 13.5 mm wide. Four of the D2 beads are *O. biplicata,* and the other bead is a smaller bead identified only to the genus level. Two of the specimens retained some color; one purplish, the other tan/brown, both colors typical of the *O. biplicata* species.

<u>*D3 Oval Punched* (n=14)</u>. As the name describes, D3 beads are oval beads, with a central punched perforation (Bennyhoff and Hughes 1987:127). Oval punched beads do not retain shelving and often have an irregular shape and outline, although edges seem to frequently be ground. Bennyhoff and Hughes (1987:127) report that the average size of D3 beads is 9 mm long by 7 mm wide to 12 mm long to 10 mm long. Nine D3 beads were found in Parowan Valley. Seven beads are *O. biplicata* and two beads are only identifiable as *Olivella* due to the removal of much of the shell during manufacture. Four beads show evidence of shell coloring or striping, supporting the *O. biplicata* identification. Four beads are fragmented, although the D3 designation remains. At Nephi Mounds, four D3 beads are in the collection. Two are identified as *O. biplicata* and the other two are identified only to the genus. One of the Nephi Mounds D3 beads was a fragment. Bennyhoff and Hughes (1987:127) note that this type is local to the Great Basin.

Class F: Saddle. Saddle beads are oval to rectanguloid beads made from the shell wall (see Bennyhoff and Hughes 1987:129).

<u>*F1 Oval Saddle* (n=2)</u>. Oval saddle beads were made from the shell wall. F1 beads are oval in shape, with a large central perforation and are usually drilled biconically. The width is equal to, or greater than, the length, and average measurements are between 6 to 11 mm long and 7 to 14 mm wide with an average perforation diameter of 2.6 mm (Bennyhoff and Hughes 1987:129). Ground edges are also typical. Two F1 beads were found in Parowan Valley, both identified as *O. biplicata*. One of the beads is tentatively identified as F1 because its width is not equal to or greater than the length, although it is oval in shape. Likely the curvature of the shell bead causes the width measurement to be less than the length.

<u>*F3a Square Saddle* (n=3)</u>. Identification of three beads as type F3a is tentative and is based on the fact that square saddle beads have a central perforation. All three beads analyzed have off-center perforations. These squarish beads were also made from the shell wall with bead length equal to, or slightly exceeding, bead width (Bennyhoff and Hughes 1987:131). By definition, the perforation is drilled conically from the interior, with exterior retouch. Three F3a beads are from the Parowan Valley, one from each collection. The bead from the Smithsonian collection may have been punched off-center, although as is typical of F3a beads, the perforation is smoothed on the exterior. The example from the SI was only identified as *Olivella*, although it is likely *O. biplicata* (see Bennyhoff and Hughes 1987:117). The dimensions of this bead are 10.4 mm in length and width, and 2.9 mm in perforation diameter. The F3a beads from the UCLA and SUU collections are *O. biplicata.* Both have an off-center drilled perforation with exterior retouch. The dimensions of the UCLA bead are 9.1 mm in length and 9.0 mm in width, and 2.4 mm in perforation diameter. The SUU bead is 8.3 mm long, 8.0 mm wide, and has a 2.1 mm perforation diameter.

<u>*F3b Small Saddle* (n=1)</u>. Small saddle beads are a smaller version of the square saddle beads and are less than 6.5 mm long. The single bead of this type from Nephi Mounds is 5.3 mm long, 5.5 mm wide, and 1.6 mm drilled perforation. The F3b bead was too small to assign a species designation.

Class G: Saucer. Saucer beads are circular and made from the wall of the main body whorl of the shell. The central hole is usually drilled conically from the interior with exterior retouch. The beads edges are always ground. Class G beads are divided into types based on bead diameter and hole perforation size (see Bennyhoff and Hughes 1987:132).

G1 Tiny Saucer (n=2). These are wall beads shaped by edge grinding and centrally drilled perforations with exterior retouch. G1 beads are very small and nearly flat in cross section (Bennyhoff and Hughes 1987:132). Average dimensions for these tiny beads as defined by Bennyhoff and Hughes range between 2 to 5 mm in diameter, with perforation diameter of 0.8 to 2.0 mm. Two G1 beads were found in Parowan Valley. One measures 3.8 mm in diameter with perforation diameter of 2.0 mm and the other measures 3.2 mm long and 3.4 mm wide with perforation diameter of 1.2 mm. The latter bead is slightly oval in shape. Both beads were too small to assign a species designation.

G2 Normal Saucer (n=2). The normal saucer bead is a circular wall bead with small drilled perforation and ground edges with diameter ranging from 5 mm to 10 mm (Bennyhoff and Hughes 1987:132). Size divisions include: G2a (Small Saucer) 5.0-7.0 mm diameter; G2b (Large Saucer) 7.1-10.0 mm diameter. Two G2 beads are in Parowan Valley SUU collections; both of these beads were identified as type G2a. One bead is beautifully crafted with all edges ground and perfectly symmetrical with dimensions of 5.3 mm in diameter and the drilled perforation diameter measures 2.2 mm. The other bead is not entirely symmetrical and measures 5.9 mm long and 5.8 mm wide, with a 2.5 mm perforation diameter. The drilled hole is also slightly off-center, and the edges of the bead are ground.

G3 Ring (n=2). G3 beads were also made from the shell wall, with all edges ground, and a large central perforation. These circular beads range in diameter from 5.0 to 10.0 mm and have two divisions including G3a (Small Ring) and G3b (Large Ring). The two G3 beads are from Parowan Valley and are very small G3a beads with dimensions of 4.8 mm in diameter and 4.9 mm in diameter. Both are too small to identify the *Olivella* species from which they were made.

G5 Oval Saucer (n=11). G5 beads are circular to slightly oval beads made from the wall of the body whorl. Often the perforation is drilled off-center, and some beads retain the shelf or shelf edge. More of the shell is used in this type than in types G2 and G3 (Bennyhoff and Hughes 1987:133). Oval saucer beads are often poorly finished and have unground edges. All the Parowan Valley specimens, however, show evidence for at least partial edge grinding. Four of the 11 beads found in Parowan Valley have off-center drilled perforations. One G5 bead is identified as *O. biplicata*, one as cf. *O. biplicata*, and the remaining nine were assigned to genus only. Most of the G5 beads fit within the parameters for oval saucer beads established by Bennyhoff and Hughes (1987:133) between 6.5 mm long and 6.5 mm wide to 11.5 mm long and 11.0 mm wide, although four beads are smaller, with the smallest measuring 5.6 mm long and 5.3 mm wide.

G6b Asymmetrical Irregular Saucer (n=1). One G6b bead was found in the Nephi Mounds collection. G6b beads were made from the wall of the shell and are often irregularly shaped. These beads can be round to oval in shape, with marked asymmetry indicative of individual finishing (Bennyhoff and Hughes 1987:134). The G6b bead from Nephi Mounds is an irregularly-shaped oval bead with ground edges. The perforation was conically drilled with exterior retouch and measures 2.8 mm in diameter. The bead is 7.1 mm long and 6.2 mm wide. This bead could not be identified to species.

Class J: Wall Disk. Wall disk beads are round to oval in outline, medium-size disks with ground edges. The central perforation is drilled conically or biconically. Rare specimens retain a shelf edge at the upper interior edge (see Bennyhoff and Hughes 1987:136). There is only the J bead class, no sub-types in this class.

J Wall Disk (n=1). One wall disk bead was found in Parowan Valley and measures 9.4 mm in length and 8.6 mm in width, with a 2.0 mm wide perforation. This bead is

Table 3.2. Exotics in the Parowan Valley from various collections

Site	UCLA (*Olivella*)	UCLA (Turquoise)	SUU (*Olivella*)	SI (*Olivella*)	Total
Paragonah	37	5	–	34	76
Summit	77	3	90	–	170
Parowan	81	2	–	–	83
Total Exotics	195	10	90	34	329

oval in shape with ground edges and no shelf present. This single J bead is identified as *O. biplicata.*

The data presented above represents a large variety of *Olivella* bead types found at Parowan Valley sites and Nephi Mounds. After identifying and measuring these beads, I feel that Bennyhoff and Hughes (1987) provide a useful system for defining *Olivella* beads. The bead types are usually separated by distinctive characteristics, although occasionally differences between bead types, such as certain saucer bead and saddle beads, are not easily detectable.

Distribution of Data in Parowan Valley

In Parowan Valley, ten pieces of turquoise are found in the UCLA collections and 319 *Olivella* artifacts are in the UCLA, SUU, and SI collections (Table 3.2). The UCLA collections contained 195 *Olivella* artifacts from the three sites excavated (see Table 3.2). Within the UCLA collection, there are 81 *Olivella* artifacts and two turquoise pieces from Parowan, 77 *Olivella* artifacts and three turquoise pieces from Summit, and 37 *Olivella* artifacts and five turquoise pieces from Paragonah. The SUU collection contains 90 *Olivella* beads from Summit. The SI collection contains 34 *Olivella* beads excavated from Paragonah.

The distribution of *Olivella* and turquoise is done in two ways: 1) raw numbers or frequency, and 2) by a ratio. In order to standardize the data, a ratio of the number of exotics (*Olivella* plus turquoise) per excavated residential structure will be used for the data compiled from the UCLA excavations (Table 3.3). These adjusted numbers identify Parowan as having a particularly high concentration of exotics compared to the other two Parowan Valley sites. The Parowan site was excavated during the 1963 and 1964 UCLA field seasons, which were also the last two years of the ten year field school. During the excavations at Parowan, UCLA began to use screens to sift the excavated dirt. This is likely the reason for the higher concentration of exotics, although small bead retrieval may have still been difficult due to the use of ¼ inch screens, which may not catch many of the small beads (Margaret Lyneis, personal communication 2007).

The distribution of exotics within Parowan Valley sites from UCLA's excavations is very interesting, albeit frustrating as incomplete provenience data caused problems. Artifacts from SUU and SI were not plotted due to the absense of site maps for those excavations. At the Parowan site excavated by UCLA, 77 of the 83 exotic artifacts were successfully plotted on the composite overview map of the site (Figure 3.4). Three *Olivella* artifacts could not be placed because of the provenience associated with test pits that were far from the excavation areas, and three *Olivella* artifacts are unprovenienced. The remainder of the provenience data was rather useful, as each artifact was associated with a grid square.

The distribution of *Olivella* and turquoise over the Parowan site shows they are associated with living areas. Pit structures and storage structures are often associated with the distribution of *Olivella* and turquoise throughout Parowan Valley sites. Pit structures in the Fremont area, and at Parowan Valley sites, are defined as relatively deep structures and subrectangular or circular in shape (Talbot 2000b). Domestic activities occur in these structures (Talbot and Janetski 2000). Surface structures often have low artifact frequencies, are above ground and rectangular in shape, and are used for storage

Table 3.3 Distribution of *Olivella* and Turquoise in the Fremont area

Site Name	*Olivella*	Turquoise	Total Exotics	No. of Residential Structures	Ratio (exotics/excavated Res. Str.)	Reference
Colorado Plateau						
Steinaker Gap	9	–	9	1	9	Talbot and Richens (1993)
Caldwell Village	164	–	164	16	10.25	Ambler (1966)
Gilbert Site	1	–	1	2	0.5	Shields (1967)
Whiterocks Village	4	–	4	4	1	Shields (1967)
Huntington Canyon	11	–	11	4	2.75	Montgomery and Montgomery (1993)
Snake Rock	1	2	3	13	0.2307	Aikens (1967)
Poplar Knob	4	–	4	3	1.3333	Taylor (1957)
Round Spring	44	1	45	13	3.4615	Metclalf et al. (1993)
Durfey Site	2	1	3	3	1	Baadsgaard and Janetski (2005)
Turner Look	10	–	10	8	1.25	Wormington (1955)
Bull Creek	2	–	2	2	1	Jennings and Sammons-Lohse (1981)
Roadcut	1	–	1	1	1	Jordan and Talbot (2002)
Rattlesnake Point	2	–	2	3	0.6666	Baer and Sauer (2003)
Arrowhead Hill	2	–	2	2	1	Janetski et al. (2007)
Sky House	2	–	2	1	2	Gillin (1938)
Eastern Great Basin						
Bear River No. 1	2	–	2	–	–	Aikens (1966)
42WB144	4	–	4	–	–	Simms et al. (1997)
42WB32	4	–	4	–	–	Fawcett and Simms (1993)
South Temple/Block 49	6	–	6	3	2	Clements (2004)
Woodard Mound	28	1	29	1	29	Richens (1983), MPC Collections
Kay's Cabin	2	13	15	2	7.5	Jardine (2004)
Benson Mound	13	–	13	–	–	Bee and Bee (1934-1966)
Peay Mounnd	3	–	3	–	–	Bee and Bee (1934-1966)
Hinckley Mounds	3	–	3	3	1	Berge (1966), MPC Collections

Table 3.3 Continued

Site Name	*Olivella*	Turquoise	Total Exotics	No. of Residential Structures	Ratio (exotics/excavated Res. Str.)	Reference
Seamon's Mound	3	–	3	–	–	MPC Collections
Grantsville	1	–	1	8	0.125	Steward (1936)
Tooele	2	–	2	1	2	Gillin (1941)
Nephi Mounds	46	–	46	10	4.6	Sharrock and Marwitt (1967) DeBloois (1967), MPC Collections
Nawthis Village	43	4	47	4	11.75	Personal communication with Kathy Kinkanean (2006) and Duncan Metcalfe (2007)
Kanosh	4	1	5	12	0.4166	Steward (1936)
Pharo Village	–	1	1	3	0.3333	Marwitt (1968)
Backhoe Village	3	1	4	10	0.4	Madsen and Lindsay (1977), Sneddon et al. (2001)
Five Finger Ridge	20	53	73	38	1.9210	Talbot et al. (1997)
Radford Roost	7	–	7	1	7	Talbot et al. (1999)
Icicle Bench	3	–	3	3	1	Talbot et al. (1999)
Marysvale	3	–	3	5	0.6	Gillin (1941)
Hunchback Shelter	1	–	1	–	–	Kersey (2005)
Fallen Eagle	1	–	1	1	1	Seddon et al. (2001)
Baker Village	112	15	127	8	15.875	Wilde and Soper (1999)
Garrison	2	–	2	1	2	Taylor (1954)
Paragonah (UCLA)	37	5	42	39	1.0769	UCLA Collections
Summit (UCLA)	77	3	80	17	4.7058	UCLA Collections
Parowan (UCLA)	81	2	83	8	10.375	UCLA Collections
Paragonah (SI)	34	–	34	?	–	SI Collections
Summit/Evans Mound (SUU)	90	–	90	?	–	SUU Collections
Totals	894	103	997			

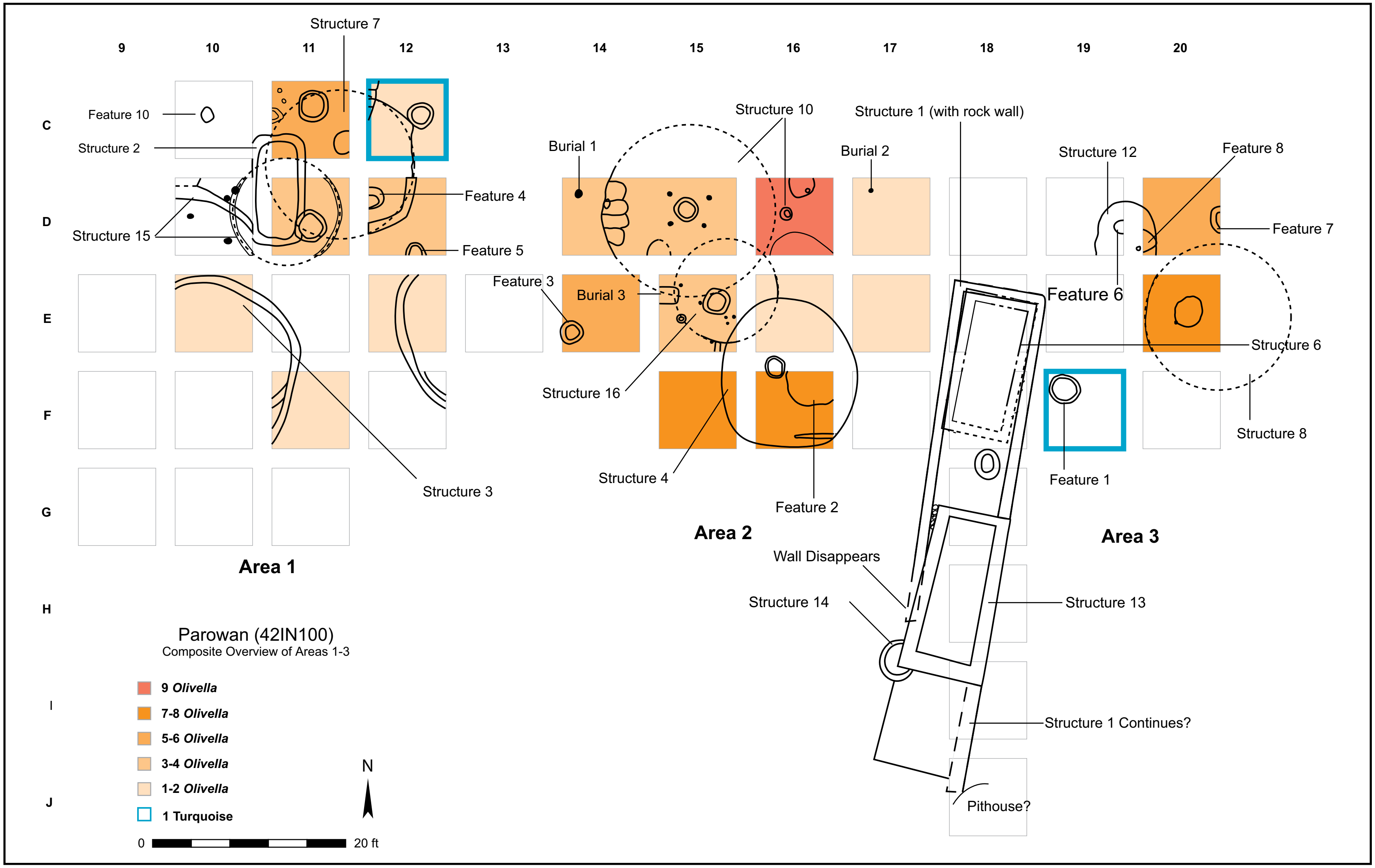

Figure 3.4. Parowan site map from UCLA excavations showing distribution of exotics across the site.

(Yoder 2006; Talbot 2000b). Exotics are almost without exception provenienced to grids containing pithouses at the Parowan site, although it is difficult to positively correlate the exotic artifacts with the floor and subfloor levels of the pit structures with the data at hand. There is no obvious association of exotics with surface storage structures.

At the Parowan site, there are no more than nine *Olivella* beads in one specific provenience grid, and no more than three beads at any specific depth (Figure 3.5). The distribution of the bead types does not show evidence that a single necklace was dropped or deposited in a specific square at the Parowan site, or else a plethora of beads of likely the same type would have been recovered. Evidence from Ticaboo Town Ruin, an Anasazi site in southern Utah, shows that a burial was accompanied by 60 B3 beads that were located around the neck of the individual (Madsen 1982). The beads were threaded on fiber cord. Additional support for necklaces made of the same type of beads is found at a Basketmaker cave in the Prayer Rock District in northeastern Arizona where there is evidence of a shell necklace made out of what appear to be A1 beads strung together (Morris 1980). At the Coombs site, an Anasazi site in southern Utah, there is a necklace displayed in the museum of 120 large D1 beads strung together.

Margaret Lyneis (1992:69) also reports that the matching beads on the three necklaces found in burials at Main Ridge, an Anasazi village, "indicates that necklaces, or at least long strands, were the items traded, not small lots of unstrung beads that were assembled into necklaces." The diversity of bead types at Main Ridge also must be addressed. There are four categories of bead types identified by Lyneis including: Split-drilled, C2; tiny saucers, G1; normal saucers, G2a; and small barrels, B3a. Lyneis notes that all of the B3a beads appear to be *O. dama.* She also mentions that one simple spire-lopped *O. biplicata* A1 bead was in the Main Ridge collection. There are no counts associated with the bead types, although most beads were found in large quantities (hundreds) in burial lots (Lyneis 1992 Table 65).

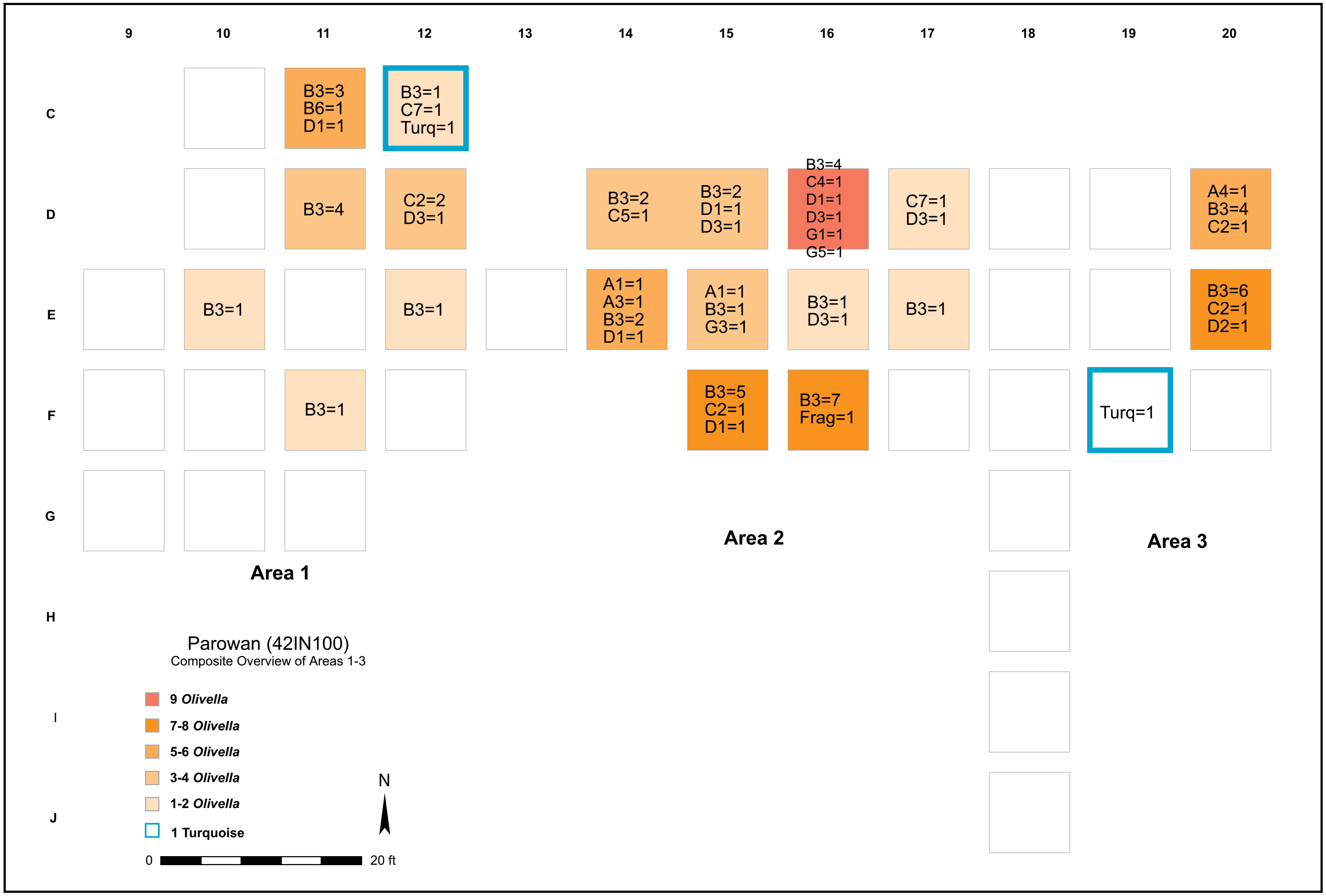

Figure 3.5. Parowan site map from UCLA excavations showing distribution of bead types.

There are many bead types present at the sites in Parowan Valley (see Table 3.1). In contrast, even with over three hundred *Olivella* artifacts that are in Parowan Valley collection, this number does not compare to the larger numbers of *Olivella* found at nearby Anasazi sites. One must note, however, the eclectic collection of 22 different *Olivella* bead types found in Parowan Valley. There is a major contrast between the diversity of bead types at Main Ridge and Parowan Valley, and this may suggest that the Fremont had many more or different trade partners than their neighbors at Main Ridge. Another explanation for the diversity of bead types in Parowan Valley may be that trade fairs indeed occurred in the past and many different groups gathered and traded bringing the different bead types into the valley.

It appears that *Olivella* beads were likely worn as necklaces by Anasazi, and if the Fremont wore necklaces similar to their Anasazi contemporaries, or the earlier Basketmakers, then we should see evidence of such necklaces in the form of multiple beads of similar type in a single provenience. It is possible that Fremont necklaces were constructed with a variety of beads made from various materials, since bone and stone ornaments are often found at Fremont sites in addition to exotic *Olivella* ornaments. Support for this idea is seen in a disk bead necklace made of lignite and bone beads at Nawthis Village (Janetski 2000:92). There is little support for necklaces in the Fremont area made of similar bead types, especially since no *Olivella* necklaces have been found accompanying Fremont burials or caches. At the Parowan site, the largest concentration in an excavation square of a single bead type is seven B3 beads, likely not representing a complete necklace. It should also be noted that B3 beads are the most abundant style found at the site (n=47 out of 81 *Olivella* beads) (see Figure 3.5). There were 15 different bead types found at the Parowan site.

The methods used to record provenience data varied according to excavation year and also depended on the excavation style of the principal investigator. At times provenience data was associated with a grid, at other times it was associated with a structure. If an artifact could not be plotted on the map, it was usually due to the absence of the artifact catalog for the 1961 excavations at Summit. At the Summit Site, 65 of the 80 exotic artifacts were plotted according to provenience information on the site overview map (Figure 3.6). Similar to the distribution of exotics at the Parowan site, many exotic artifacts were associated with the residential structures, although, some exotics were located near the surface granaries as well. It is unclear from available provenience data, however, whether the artifacts are associated with floor and/or subfloor contexts. It is interesting to observe that in the southeast portion of the site, there are three pithouses, one of which is superimposed on an earlier pithouse. In this area of obvious heavy prehistoric habitation, there is a large concentration of 31 exotics. One grid square has nine *Olivella* beads, eight are B3 and one is D1 (Figure 3.7). As at Parowan, B3 beads are dominant (n=45 B3 beads, total n= 77). There are 14 different bead types found at the UCLA excavations at Summit.

The Paragonah site had the smallest number of exotic artifacts that were plotted on the overall site map (Figure 3.8). There were 42 exotic artifacts, and 21 were plotted. Due to the absence of field notes from the UCLA excavations at Paragonah (much of the available data and information comes from the artifact catalog), I lack the notes to determine their provenience. Hence, the provenience information for the artifacts is mostly located in structures. All of the exotics were found associated with pithouse structures; none were associated with surface granaries. The remaining provenience information is located in grids or test trenches that I cannot identify. Similar to the distribution at Parowan, and despite these problems, it appears that the exotic artifacts

Figure 3.6. Summit site map from UCLA excavations showing distribution of exotics across the site.

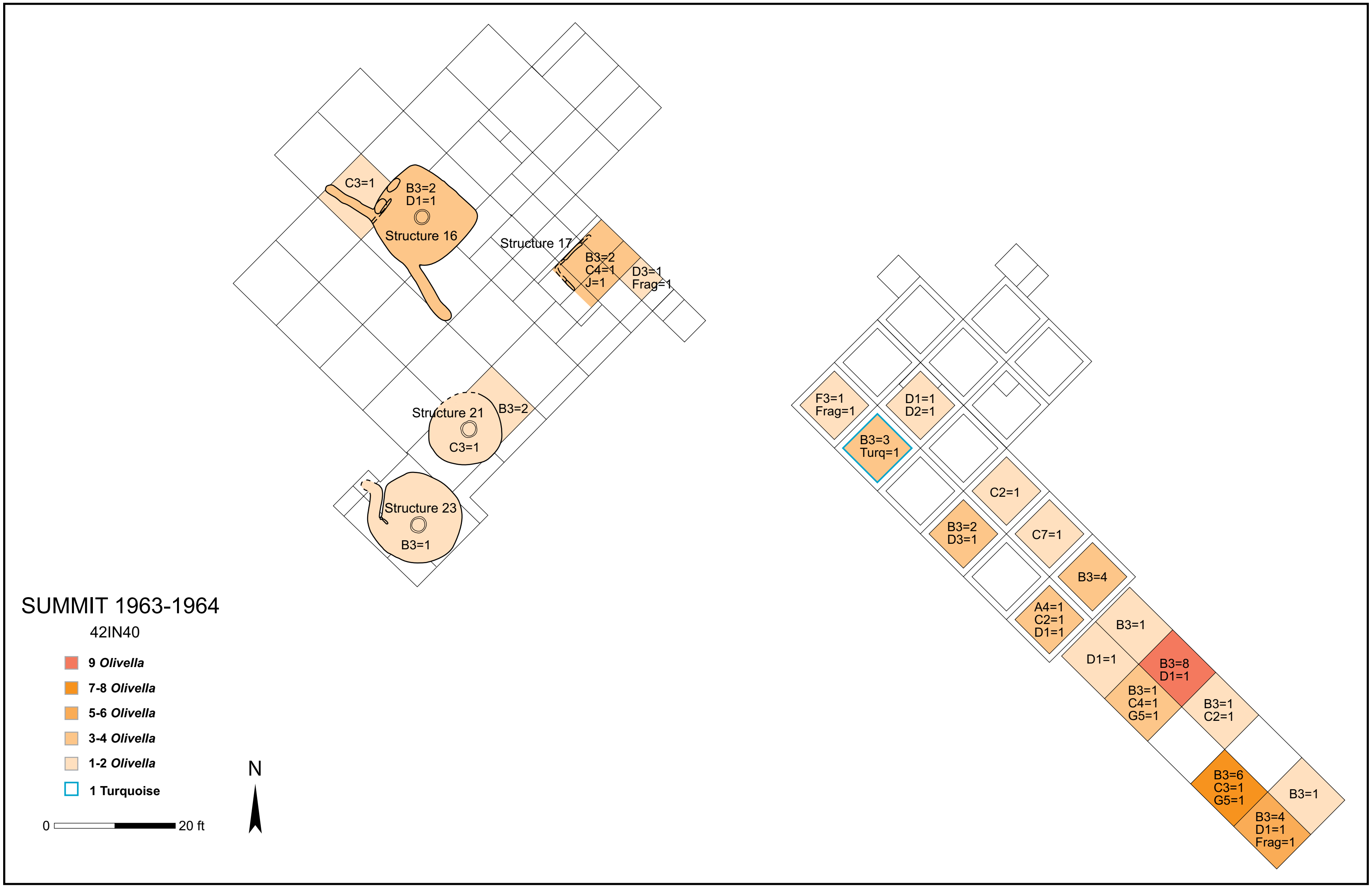

Figure 3.7. Summit site map from UCLA excavations showing distribution of bead types.

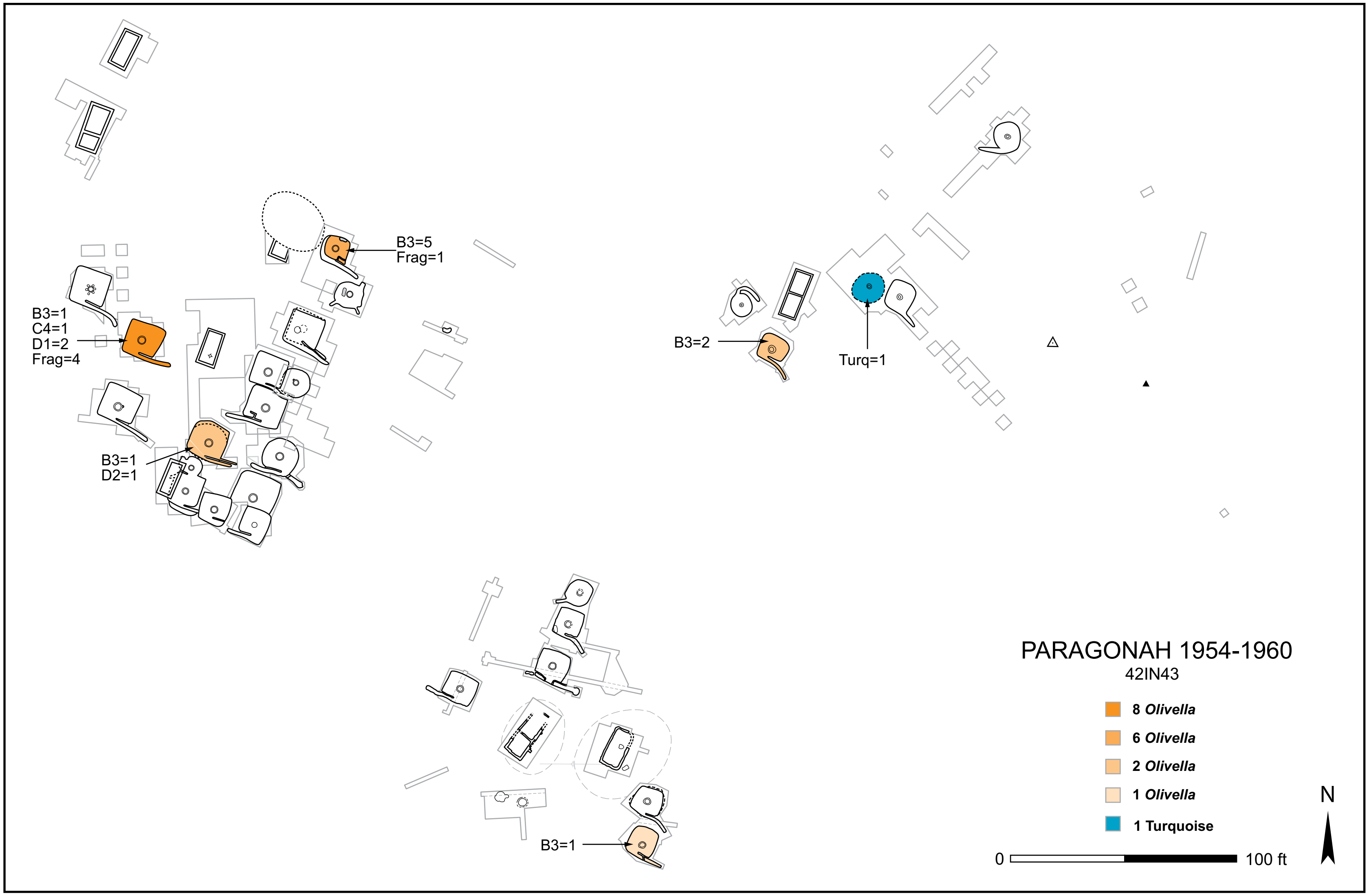

Figure 3.8. Paragonah site map from UCLA excavations showing distribution and types of exotics across the site.

are again associated frequently with habitation areas. Structure 22 at Paragonah has a concentration of five B3 beads and a fragment associated with the pit structure (Figure 3.8). As at the other sites, B3 beads dominate the assemblage at Paragonah (n=20 B3 beads, total n=37), although only seven different bead types were found during UCLA's excavations at Paragonah.

Distribution of *Olivella* and Turquoise at Fremont Sites

Turquoise and *Olivella* are distributed across the Fremont region, although these exotic materials are not recovered from all sites. The distribution of turquoise and *Olivella* at Fremont sites is presented visually in Figure 3.9. To counter sample size effects, the GIS distributional map represents a ratio of the number of exotics (*Olivella* plus turquoise) per excavated residential structure at the site rather than raw frequencies (see Figure 3.9; see Table 3.3). Turquoise has been recovered from 14 sites in the Fremont area (see Table 3.3). All but three sites that report turquoise have five or fewer pieces of turquoise. The three sites reporting higher amounts of turquoise are Five Finger Ridge, Baker Village, and Kay's Cabin. At Five Finger Ridge, a site in Clear Creek Canyon, located in south central Utah, excavators recovered 53 turquoise artifacts (Talbot et al. 2000). The quantity of turquoise recovered there is clearly due, in part, to the massive excavations (81 structures). The turquoise from Five Finger Ridge is the largest concentration in Fremont sites and represents more than 50 percent of the 103 pieces of turquoise known in the Fremont area. At Baker Village, near the Nevada/Utah border, 15 turquoise artifacts were recovered. As discussed previously, Kay's Cabin had 13 artifacts identified as turquoise through microprobe analysis. It is interesting to note that more turquoise was found per excavated residential structure at Kay's Cabin than at Five Finger Ridge, where the highest frequency of turquoise in the Fremont area was found.

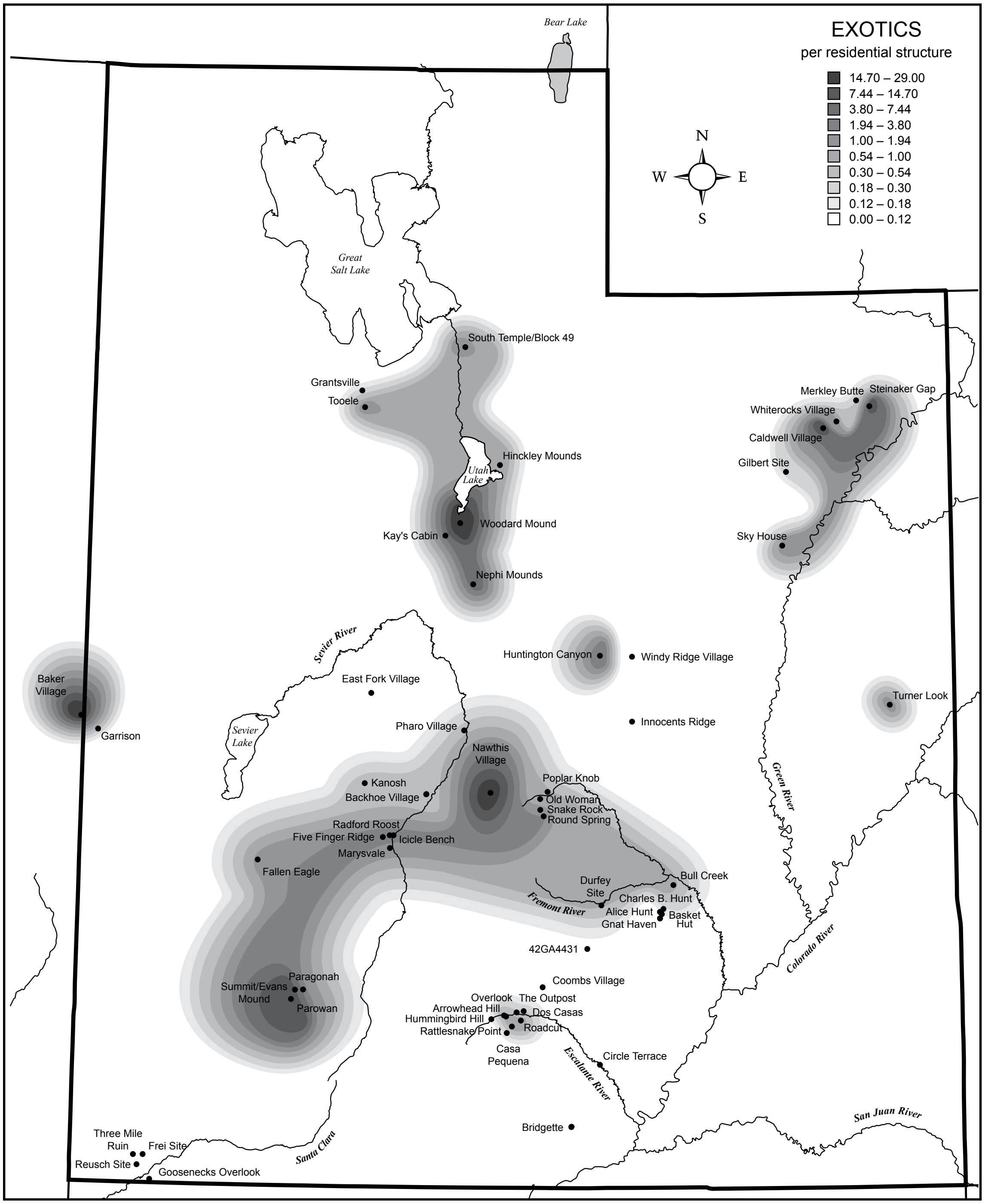

Figure 3.9. Distribution of exotics per excavated residential structure across the Fremont area.

Olivella shell is more abundant than turquoise at Fremont sites and has been recovered from 42 excavations. Table 3.3 identifies Caldwell Village, Nawthis Village, Baker Village, Woodard Mound, and Parowan as containing particularly high concentrations of *Olivella*. Caldwell Village is unusual as 153 of 164 *Olivella* shells found appear to be from a necklace (Ambler 1966). Only six of the beads from the necklace are complete, however, while 147 shells are fragments (Ambler 1966:65), perhaps suggesting the quantity of shell was overstated. Baker Village also stands out as it yielded 112 *Olivella* beads that included nine different types (Wilde and Soper 1999). Woodard Mound, in Utah Valley south of Utah Lake, had 28 *Olivella* artifacts associated with a single pithouse. Nawthis Village had 43 *Olivella* artifacts recovered, with four residential structures excavated. At the Parowan site, 81 *Olivella* artifacts were retrieved from the UCLA excavations. Unfortunately, data are not available for the total number of excavated residential structures at the Paragonah and Summit sites since other institutions excavated there before and after UCLA. Nonetheless, it is obvious that Parowan Valley was a place where *Olivella* artifacts were concentrated in the Fremont area.

Data pertinent to how turquoise and *Olivella* are distributed within each of the Fremont sites listed in Table 3.3 will not be addressed, although the investigations at Baker Village and Five Finger Ridge show interesting patterns that will briefly be reviewed. At Five Finger Ridge, similar to patterns observed at many other Fremont sites, few beads were found on floors and occurred most commonly in fill or midden inside the houses (Janetski and Talbot 2000). A different pattern was noticed at Baker Village. The occurrence of turquoise and shell ornaments in presumed storage structures and exterior pits was observed in addition to residential proveniences (Wilde and Soper 1999:174). Thus the distribution at Baker Village is in contrast with the pattern seen at Five Finger Ridge, and as described, Parowan Valley sites appear to have deposits of exotic ornaments near residential structures.

ENDNOTES

[1] Of these *Olivella* shells, 22 may indeed be *biplicata* species, according to Bennyhoff and Hughes (1987:117) "except for A1, B2, and B3, all types are made only from *O. biplicata.*" There are 22 beads that were typed to styles where much of the shell is removed during manufacture, and therefore may be *O. biplicata* as per Bennyhoff and Hughes (1987).

[2] Bennyhoff and Hughes (1987:117) created three divisions based on maximum diameter used for all species and classes A, B, and O. The diameter of the shell is used instead of the length, due to the variable extent of end-grinding and natural wear. The measurements are: Small (a): 3.0–6.5mm; Medium (b): 6.51–9.5mm; Large (c): 9.51–14.0mm.

[3] A punched hole was identified by the irregular shape of the hole, and a drilled hole was identified by its uniform, circular shape and then it was noted whether it was conically or biconically drilled.

4 | Analysis and Discussion

The data presented in the previous chapter will help facilitate a discussion of my research questions. In previous chapters I have presented data that are directly applicable to addressing the issues of turquoise and *Olivella* exchange in the Fremont area. The distribution of exotics in light of new data from Parowan Valley and Nephi Mounds, as well as updated counts added to a database of exotics across the Fremont area will also be addressed. I will focus on *Olivella* and turquoise exchange in Parowan Valley and the Fremont area. The distribution of exotics in Parowan Valley, within Parowan Valley sites, and in the Fremont area will be reviewed.

OLIVELLA AND TURQUOISE EXCHANGE QUESTIONS

As previously stated, *Olivella* and turquoise beads are exotic (meaning both have non-local and distant origins) to the Fremont area. As both materials were used for ornaments, a logical question is, are they moving together along trade routes into the Fremont area? There are turquoise surface mines in California that show evidence of ancient mining activities (Weigand and Harbottle 1993; Sigleo 1975). Perhaps turquoise was acquired from inland mines as traders traveled to final destinations, as *Olivella* beads were moved from the California coast and inland on trade routes (see Hughes and Bennyhoff 1986; Davis 1961; Tower 1945). Without specific source and characterization data, these assumptions are difficult to test. Hughes (1994:374-375) shows that between

1500 and 1800 B.C. shell and obsidian, both items of long-distance trade and exotic to their final destination, were moving in different ways in the western Great Basin. He explains that both materials were likely transported to the area through a southern exchange route, though not necessarily in the same transaction (Hughes 1994:374). Were *Olivella* and turquoise artifacts recovered in the Fremont area traded together, in the same exchange networks? If these different materials moved through different networks, then one would expect greater concentrations (or higher numbers of items) of *Olivella* at some sites, and turquoise at others.

The trade fair model proposed by Janetski (2002) is beneficial for conceptualizing how the Fremont might have implemented exchange. The location of prehistoric Fremont trade fairs is difficult to determine, although places of choice based on ethnographic patterns and site densities may point to important central locations on the Fremont landscape (Janetski and Talbot 2000). Trade fairs or festivals, with people gathering from surrounding communities for social events (especially gambling), may be evident archaeologically by the presence of gaming pieces and exotic goods (see McDonald 1994; Janetski 2000). Concentrations of exotic goods would support Janetski's argument for trade fairs exhibiting characteristics of directional trade, or departures from the fall-off curve typical of down-the-line exchange. Do the new data presented in this thesis show that exotics were distributed using down-the-line exchange mechanisms or are directional trade patterns observed with concentrations at central places along the Fremont landscape? The discussion below addresses this and other questions.

Analysis and Discussion of Exotics in Parowan Valley

Over 20 years ago, Hughes and Bennyhoff (1986:251) reported 187 shell artifacts from 23 Fremont sites. In 1994, McDonald reported five sites where one piece of turquoise was recovered from each excavation. Janetski (2002) updated the total Fremont *Olivella* and turquoise counts, reporting approximately 515 *Olivella* artifacts from 29 sites and 77 turquoise artifacts from nine Fremont sites. This thesis reports *Olivella* data from 42 Fremont sites, with a total of 894 *Olivella* artifacts documented, and 359 *Olivella* counts presented as new data in this analysis. Turquoise counts have also increased to 103 pieces, with 14 Fremont sites known to have turquoise artifacts. These new and updated data provide useful insight into the distribution of exotics in the Fremont area. Key questions that can be addressed with this recent data include how *Olivella* and turquoise were distributed in Parowan Valley and within Parowan Valley sites[1]. I hypothesized that if exotics were differentially distributed in Parowan Valley, assuming the sites were contemporary, that there may have been a site hierarchy present among them. Based on existing research done at Clear Creek Canyon (Talbot et al. 2000), I predicted that within each site in Parowan Valley exotics would be found associated more often in larger houses because of the possibility that leaders had differential access to *Olivella* and turquoise goods.

As Parowan Valley artifacts were analyzed, provenience data were gathered for later use for plotting the distribution of artifacts on site maps. Due to how the provenience information was recorded, as noted in Chapter 3, missing notes from the UCLA excavations, and incomplete maps from the SUU excavations, the data proved often to be insufficient to answer the questions asked and do not support status differentiation. Regardless, the distribution of turquoise and *Olivella* artifacts between sites in the valley still shows some noteworthy patterns.

The Parowan site had the most exotics recovered from excavation and the fewest residential structures excavated (see Table 3.3) and, therefore, the highest concentration of exotics in Parowan Valley. As discussed, this may be due to the use of ¼ inch screens during at least the last year of excavations at the site (although small beads may have slipped through the screen, thus ornaments may have been recovered at the same rate). In any case, there appears to be a higher concentration of exotics at Parowan. If the three sites were contemporaneous, perhaps the Fremont at the Parowan site had greater control over exotic exchange and, therefore, a site hierarchy may have existed.

The plotting of *Olivella* and turquiose at the Parowan site map was was successful since 77 of the 83 exotic artifacts were plotted. An interesting pattern is immediately noticed as there are major concentrations of exotic ornaments near pithouses in living areas and almost no exotics associated with the surface storage structures, Structures 1 and 13 in grids D18-J18 (see Figure 3.4). Provenience information is associated with grid squares only, except for two beads designated to Structure 10. The majority of the artifacts are not associated with floor or subfloor contexts, and I assume that the exotic beads were found in structural fill when the grid association contained a pithouse. At the Parowan site, because many of the structures are superimposed on each other and the definite outline of structures is not conclusive, there is no specific association (except the two previously mentioned) of beads to structures. Structure 10 appears to have been the largest structure, and there are more beads associated with the grids adjacent to this structure. It appears that ornaments tend to be associated with the grids that sampled residential structures.

The largest pithouse at Summit had three *Olivella* beads, but the highest highest concentrations are not found here. In the southeastern portion of the site the largest concentration of beads (n = 31) is associated with three pithouses (see Figure 3.6). In general, it appears that exotics are concentrated in living areas, although some are associated with surface storage structures at this site. The distribution of exotics at Summit is similar to the distribution of exotics at Baker Village, as artifacts were found near the surface storage structures, Structures 10 and 11, although the beads are not associated with the floor. The majority of the exotics found at Summit are found in structural fill contexts or outside structures. This is typical for the distribution of Fremont exotics (Janetski 2002). The Paragonah site (see Figure 3.8) is the most difficult to examine, as noted in Chapter 3, since approximately half of the ornaments were plotted on the site map and provenience data was only available for pithouses, skewing the distribution. It must be noted though that almost all of the pithouse provenience data (18 out of 20 artifacts that were plotted) were found in the subfloor and floor levels. Exotic ornaments are found in six of the 39 residential structures excavated, and there appears to be no emphasis on large houses.

At each of the sites, the highest concentration of one bead type in the same provenience is three B3 beads (although up to eight B3 beads have been found in one grid, dispersed over five successive six inch levels). It appears that complete *Olivella* necklaces were either not made, lost, left, or dropped. Nor are exotics found with burials, storage structures, or cache pits, as they often are found in Anasazi sites, such as Coombs Village (see Lister and Lister 1961). In Fremont contexts exotic beads are typically recovered throughout the fill and on floors of pithouses. Perhaps the occurrence of these beads in fill is not only due to loss (Janetski 2002), but maybe it is a type of deposition that is unique to the Fremont, such as tossing the beads into middens or old pithouses.

Support for the Fremont possibly participating in deposition ceremonies can be seen in an interesting comparison observed in Prehistoric Europe. Richard Bradley (2005:56) examined the possibility of "The Consecration of the House" by noticing the offerings that were deposited there. Bradley (2005:79) suggests that "the abandonment of houses may be marked by the deposition of cultural material, but in some cases it was commemorated in a much more obvious manner…because one of the inhabitants had died. In such cases the house could be burnt down and replaced on another site." At the Parowan site (see Figure 3.4), in the area where Structures 4, 10, and 16 are located, there are also three burials nearby, Burials 1, 2, and 3. If these three superimposed structures are associated with the burials, and if there is evidence for possible burning of the structures (many structures in Parowan Valley excavations show evidence of burned beams), then perhaps the large number of exotics clustered near these three pithouses can be viewed as deposits associated with the abandonment of one or more of the houses.

Analysis and Discussion of *Olivella* and Turquoise Exchange in Fremont Area

A test of the prediction that exotics accumulated in central places or sites where periodic aggregations occurred requires the examination of the distribution of those artifacts across the Fremont area. As discussed previously, the sources of turquoise and *Olivella* are distant from the Fremont cultural area, making direct access to those exotics improbable. Acquisition of exotics, therefore, likely occurred via trade with neighbors. If so, high frequencies of exotics are more likely in sites located along trade routes, or transportation corridors. Figures 4.1 and 4.2 illustrate where exotics accumulated at sites across the Fremont landscape. Concentrations of exotics are found in these central locales along transportation corridors because these sites are usually easily accessible (see Janetski 2002). Central places are likely to be located in resource-rich areas since fairs require abundant foodstuffs to accommodate visitors. Adequate water is also necessary at locations where trade fairs occurred. Central places, therefore, typically require rich resources, abundant foodstuffs, adequate water, and a strategic location along a transportation corridor.

Parowan Valley meets these criteria for a central place. It lies in the eastern Great

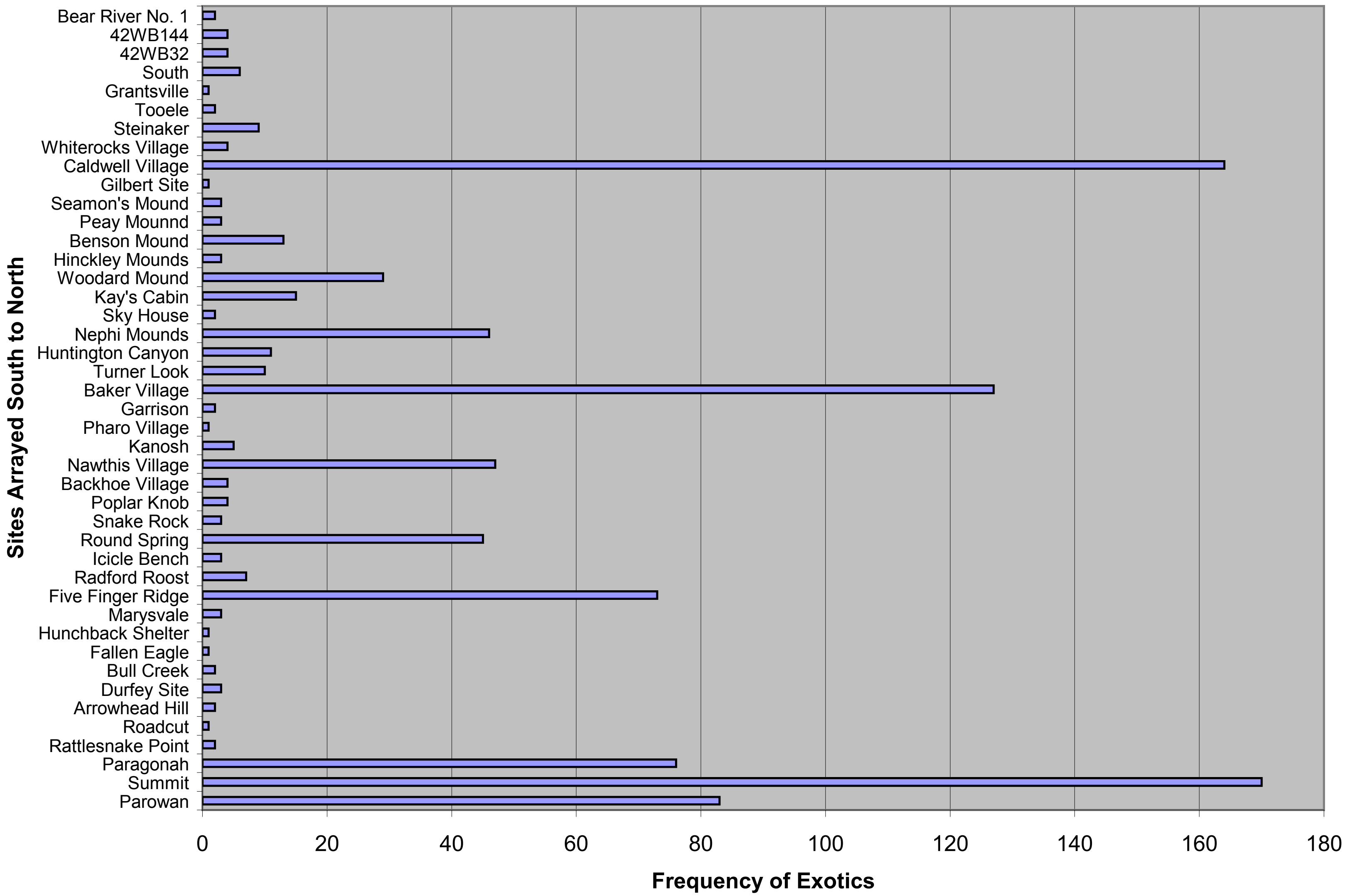

Figure 4.1. Fremont Exotics (Olivella and Turquoise n=997).

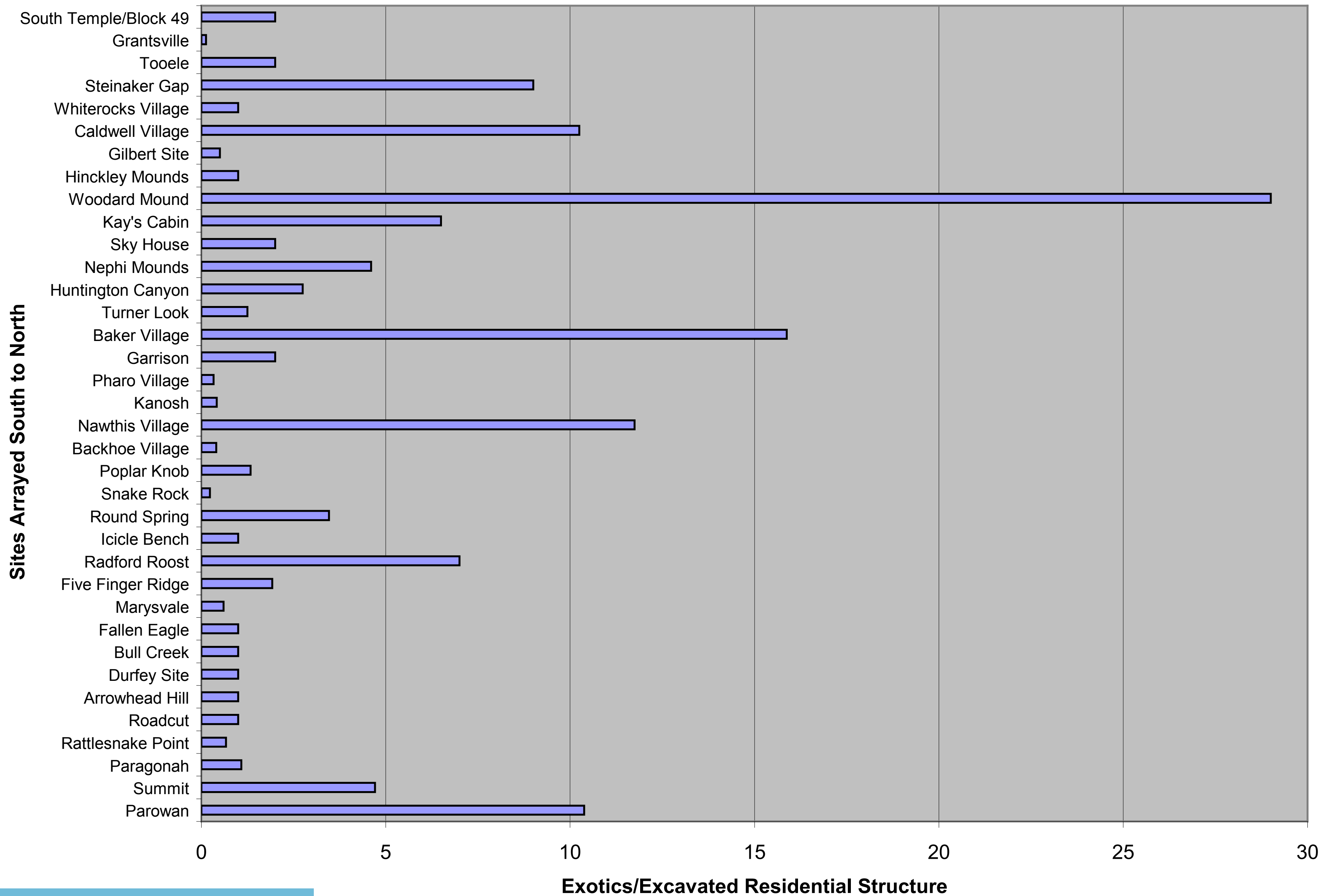

Figure 4.2. Fremont Exotics / Excavated Residential Structure.

Basin in a locale identified by several as a logical corridor for prehistoric travel (Figure 4.3) (Malouf 1940; Hughes and Bennyhoff 1986; Lyneis 1994). The diary of Orville Pratt records on October 1, 1848, that the Parowan Valley had "in the center of it…a fine lake full of fish, with gravelly banks, and into which run four fine mountain streams from the south and about 6 meters apart" (Hafen and Hafen 1954:353). Although Crampton and Madsen (1994:70) report that "Orville Pratt's description is fair enough, but his fish story is quite an exaggeration," perennial drainages, as described previously, did indeed flow into the valley and are now diverted for modern irrigation. In addition, at least four large Fremont villages (Paragonah, Summit, Parowan, and Median Village) are located on the valley bottom along prehistoric channels of the perennial drainages, suggesting that subsistence resources were adequate to support these larger communities. Mormon pioneers settled in the Parowan Valley and founded the towns of Paragonah and Parowan in the early 1850s (Crampton and Madsen 1994:70), further evidence that the Parowan Valley was a suitable location for permanent settlements. Additionally, the Spanish Trail ran between Santa Fe and Los Angeles from 1829 to 1848 and went through the Parowan Valley (Crampton 1979). Historic routes almost always have prehistoric roots (Stein 1994:3), which can also be seen today as the highway Interstate 15 runs through the Parowan Valley.

Excavators recovered a high number (n = 319) of *Olivella* artifacts for the Fremont area from Paragonah, Parowan, and Summit sites (Judd 1919, 1926; Meighan et al. 1956). The number of *Olivella* beads from Parowan Valley sites is over 35 percent of the total *Olivella* shell artifacts reported for the Fremont area. Although the larger numbers of beads could simply be a result of the amount of excavation in the valley, I suggest that their frequency is due to the importance of the sites on the Fremont landscape, as well as its location along a transportation corridor (see also Lyneis 1984).

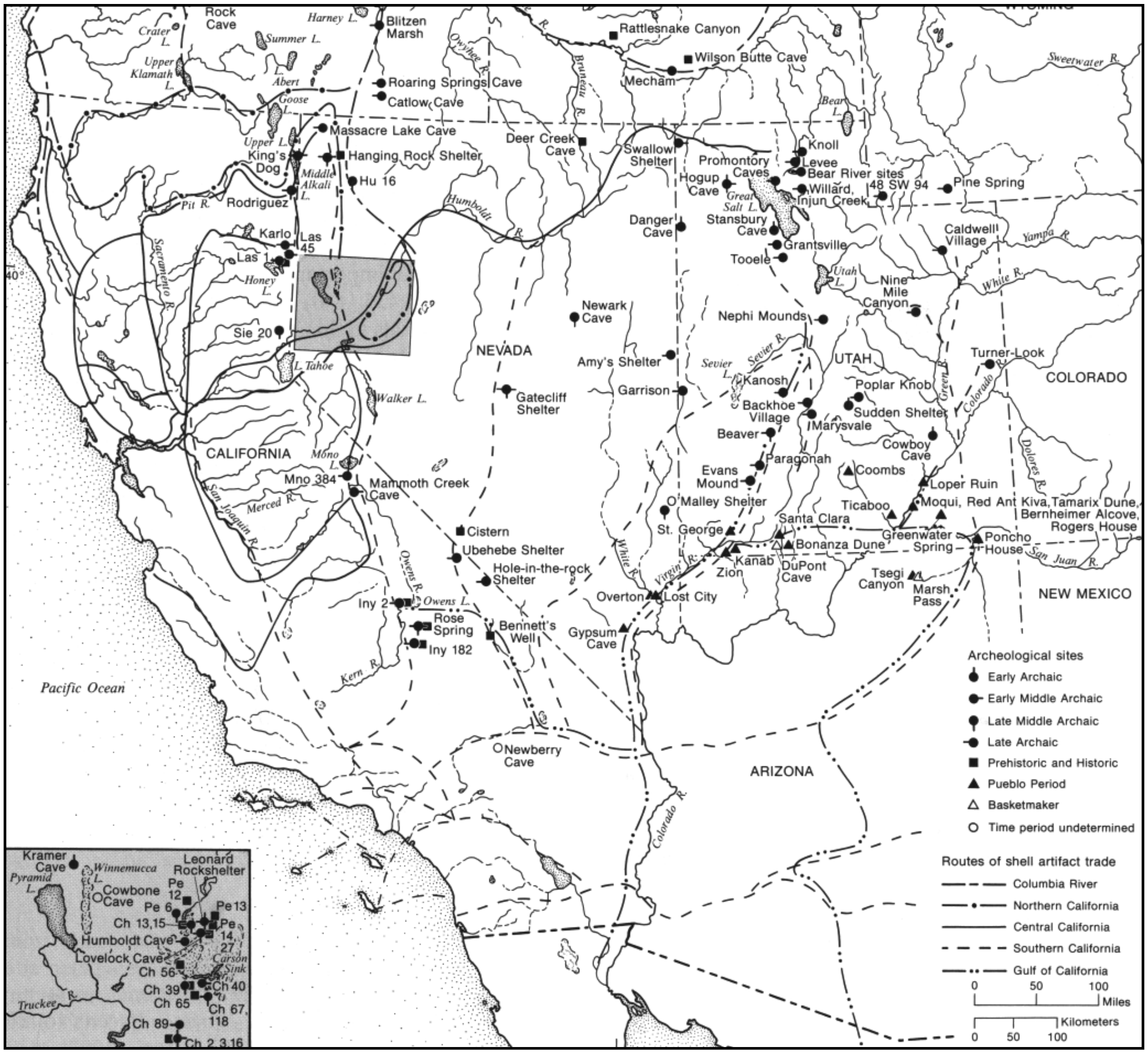

Figure 4.3. Shell artifact distribution: major sites and trade routes after Tower 1945 and Davis 1961 (From Hughes and Bennyhoff 1986:239).

The strategic location of Baker Village on the border of the Fremont area may have made the site an ideal location for exchange, perhaps in a fair or festival setting. The location of Baker Village may have facilitated turquoise and *Olivella* exchange with Nevada hunters and gatherers and may provide some explanation for the exceptional concentration of exotics there. Woodard Mound, in Utah Valley, also yielded a relatively high concentration of exotics (see Table 3.3 and Figure 4.1) (Richens 1983). Also in Utah Valley, the amount of turquoise at Kay's Cabin is notable. Kay's Cabin and Woodard Mound in Utah Valley represent the northernmost occurrences of turquoise in the Great

Basin, and perhaps in North America (Jardine 2004). The frequency of exotics in Utah Valley generally, combined with the number of known Fremont sites and the presence of Utah Lake and abundant wetland resources (Janetski 1990), marks it as another possible central place in the Fremont area. Utah Valley is also located along a likely prehistoric trade corridor and was visited during the journey of Dominguez and Escalante (Warner 1976).

Nawthis Village also shows high concentrations of exotics. This site has not been adequately published, so it is difficult to understand its importance on the Fremont landscape. The ratio of exotics compared to the four excavated residential structures at Nawthis Village (Duncan Metcalfe, personal communication 2007), shows that despite the fact that only a few residential structures were excavated, there is still a high concentration of exotics. Caldwell Village, which also shows a high concentration of exotics (Figures 3.9 and 4.2), may not be a central place like the other sites discussed, because the reported counts of *Olivella* beads may misrepresent the actual number of beads at the site, as previously discussed. Neither of these large sites, however, is located on an obvious transportation corridor.

Thus far, the central places that have been distinguished by exotic concentration do not show a down-the-line pattern, supporting Janetski's (2002) observation of Fremont exotic trade following a directional pattern (see Figure 3.9). It does not appear that *Olivella* and turquoise were traded together in the same exchange networks since there are high concentrations for the Fremont area of *Olivella* at sites where little turquoise was found (i.e., Parowan Valley sites), and high concentrations of turquoise where small numbers of *Olivella* beads were discovered (i.e., Five Finger Ridge). As previously mentioned, Baker Village is the only Fremont site where high numbers of both turquoise and *Olivella* artifacts were found.

The exchange networks used to transport turquoise and *Olivella* ornaments to the Fremont area in the past have been discussed by Tower (1945), Davis (1961), and Hughes and Bennyhoff (1986) (see Figure 4.3). Tower (1945) provides possible trade routes from the California coast, beginning near Los Angeles, that go through Parowan Valley and continue along the Wasatch Front. These trade routes also pass through the Virgin Anasazi lowlands, specifically through the Lost City site. Margaret Lyneis (1984) suggests that perhaps Lost City is a gateway community where, as a result of its situation on the landscape, commodities from southern California were channeled to Parowan Valley to the north and to the Anasazi to their east (Lyneis 1984:88). Davis (1961) suggests routes that go through central Nevada, crossing the territory of hunter-gatherer groups that may have been willing to trade turquoise and *Olivella* with the Fremont for corn and other perishable goods. The patterns observed from the distributional map (Figure 3.9) show that sites with high densities of exotic artifacts recovered from excavations may have had connections to the south as well as the west. *Olivella* bead types and shell species provide important clues regarding what exchange networks were used by the Fremont in Parowan Valley.

The frequency of *Olivella* and turquoise reported at Fremont sites is exhibited in Figure 4.1, while Figure 4.2 shows the ratio of exotics per excavated residential structure. Figures 4.1 and 4.2 update Janetski's (2002:359-360) data and figures. A similar pattern is demonstrated in Figure 4.1 as was observed by Janetski with a gradual, although somewhat noisy, fall-off in raw numbers of *Olivella* and turquoise (with the Caldwell counts questionable as addressed earlier). This distribution could support the notion that goods moved from the south to the north in a down-the-line method. However, Figure 4.2, after raw numbers are adjusted for volume (exotics per excavated residential structure), shows a less clear pattern, with peaks emerging among lower frequencies, resembling Renfrew's directional trade model (see Figure 1.2).

The direction of trade is likely influenced by the trade routes the Fremont used in the past. The most abundant bead type in Parowan Valley is the B3 barrel bead, exclusively (in these collections) made of *Olivella dama* shells (n=198). These shells are found on the Gulf of California and were likely carried to the Fremont area through southern trade routes going up the Colorado River (Hughes and Bennyhoff 1986). At Main Ridge, B3 barrel beads were identified as *O. dama* (Lyneis 1992:69-70). B3 beads were also found at the excavation at Lost City, although Richard Shutler identifies them as made from *O. biplicata*, and from the photos, this designation appears to be erroneous (Shutler 1961:40, see plate 77). Lyneis (1992) explains that it is unlikely that the Hohokam network (through which Lost City likely received other goods) was the source of the barrel beads as this bead type is not common in Hohokam sites. Lyneis suggests that the *O. dama* barrel beads moved up the Colorado River and into the Moapa Valley communities (1992:70). The Fremont in Parowan Valley may have been connected to the southern trade routes that the Virgin Anasazi at Main Ridge were receiving goods from, or perhaps the Fremont were exchanging with the Virgin Anasazi directly for *Olivella* beads. Although it has been assumed by researchers that the Virgin Anasazi and the Fremont of Parowan Valley must have interacted because of their close proximity (Lyneis 1992), there is not much evidence in the material record of such interaction besides the occurrence of *Olivella* and turquoise artifacts in Parowan Valley and the occasional Parowan Valley basal notched projectile point found in the St. George Basin[2] (Jim Allison, personal communication 2005).

Bennyhoff and Hughes (1987) have been able to loosely connect manufacturing locations to the bead styles they defined. They report that occupants of the western Great

Basin participated in four major exchange networks involving Pacific shell beads and ornaments from centers in northern California, central California, southern California, and the Gulf of California (Bennyhoff and Hughes 1987:154) (Table 4.1). Unfortunately, at least 22 bead types were produced at more than one manufacture center, and therefore 50 percent of the shell artifacts cannot be assigned to a single source. Bennyhoff and Hughes (1987:154) report reasons for their inability to be more specific about manufacture centers including 1) deficient ethnographic data on centers of manufacture and 2) large portions of the California coast that have not yet been archaeologically sampled. The use of freshwater shells and the reworking of imported beads and pendants in the Great Basin have been noted by Bennyhoff and Hughes (1987:154) and this also complicates the sourcing problem based on bead styles. The bead chronology is also problematic in that there are three dating schemes for the central California archaeological sequence and it is not clear which dating sequence is used by Bennyhoff and Hughes (1987).

Due the variety of *Olivella* bead types, it is likely that the Fremont received finished products. Exceptions are found in styles that appear to be local to the Great Basin, although it is likely that these beads were only modified, rather than manufactured, in the Great Basin because no evidence for bead manufacture has been found at Fremont sites thus far. The data presented in Table 4.1 are based on the assignments of bead classes to particular manufacturing loci. Bennyhoff and Hughes (1987:154) suggest these assignments be viewed as a first approximation. I would also suggest that the B3 bead type be added to the Gulf of California as a possible manufacturing locale, since all of the B3 beads in the Parowan Valley collection were identified as *O. dama*, and as noted, these beads were likely transported to the north via trade routes along the Colorado River and into the Parowan Valley.

Table 4.1. Possible manufacturing locations for *Olivella* beads (Bennyhoff and Hughes 1987). *In Parowan Valley, B3 beads are made exclusively of *O. dama* beads. The source area of *O. dama* beads is the Gulf of California.

Central California	Southern California	Gulf of California	Local Great Basin emphasis
B2	A4	A1	A6
B6	A6	B3*	C2i
C5	B3		C3
C7	C2		C4
C8	C3		D3
D1	D1		
D2	G1		
F1	G2		
F3a			
F3b			
G1			
G2			
G3			
G5			
G6b			
J			

Based on the data from Parowan Valley and Nephi Mounds, it appears that trade connections were focused on central and southern California exchange networks. The high frequency of *Olivella dama* beads also suggests connections to the source area in the Gulf of California. Five major trails are known to have been used between central California and the Great Basin (Bennyhoff and Hughes 1987:155; Davis 1961). Bennyhoff and Hughes (1987:155) suggest that southern California exchange networks were most important for the southwestern part of the Fremont area. Main distribution routes passed through Owens Valley, the southern San Joaquin Valley, as well as across the Mojave and Sonora Deserts (Bennyhoff and Hughes 1987; Davis 1961). Although more bead types found in Parowan Valley and Nephi Mounds come from central California, due to the high number of B3 beads recovered, connections to southern California exchange systems (possible B3 manufacture area, according to Bennyhoff and Hughes 1987) and the Gulf of California appear to be important. Spatially, beads from central California occur at a high frequency, although beads produced in southern California are much more common in Parowan Valley. It appears there was likely differential access to the different kinds of beads, depending on the proximity to a trade route. The variety of beads from the central California trade systems, and the total amount of beads from the southern California exchange routes, suggest that Parowan Valley was not connected to only one *Olivella* ornament exchange system. Although a greater number of beads may have been exchanged through the southern connections in Parowan Valley, the Fremont had interactions with multiple trade routes or people with access to many exchange systems.

Further support for the argument that Parowan Valley Fremont had connections to southern trade networks due to the amount of *O. dama* shell can be revealed through chi-square statistical testing. Did Parowan Valley, located in the southern part of the Fremont area, have greater differential access to *O. dama* shell beads than Nephi Mounds located to the north, and Baker Village located on the western margins of the Fremont area? A chi-square test comparing Nephi Mounds and Parowan Valley data in Table 4.2 shows that it is unlikely the differences in species is due to sampling error alone (χ^2a = 14.09, p = 0.001, d.f. = 2). The chi-square results are statistically significant and suggest that Parowan Valley had much more *O. dama* shell than Nephi Mounds (Figure 4.4). This supports the notion that Parowan Valley had easier access to *O. dama* shell beads. The Baker Village and Parowan Valley data is organized in Table 4.3. The B3 beads at Baker Village (n=6) were not initially described at the species level, but it is likely that they are *O. dama* (Joel Janetski, personal communication 2007). A chi-square test comparing data between Baker Village and Parowan Valley shows that it is also unlikely that the differences are due to sampling error alone (χ^2a = 131.1, p > 0.001, d.f. = 2). These

Table 4.2. *Olivella* counts in Parowan Valley and Nephi Mounds used to calculate chi-square

	Parowan Valley	Nephi Mounds
O. dama	214	15
O. biplicata	70	15
Olivella sp.	35	10
Total *Olivella*	319	40

Table 4.3. *Olivella* counts in Parowan Valley and Baker Village used to calculate chi-square

	Parowan Valley	Baker Village
O. dama	214	6
O. biplicata	70	83
Olivella sp.	35	23
Total *Olivella*	319	112

results suggest that the differences between the two sites are statistically different and the chi-square test supports the perception that Parowan Valley had differential access to *O. dama* beads. These chi-square tests demonstrate that while Parowan Valley was highly connected to southern trade routes, sites to the west and north lacked access to southern shell sources and were more strongly connected to trade networks that brought *O. biplicata* from the coast of California and across Nevada, finally ending at Fremont sites such as Baker Village and Nephi Mounds.

Additional chi-square tests were run to examine whether there are differences among Parowan Valley sites in the representation of species and bead types. The data was organized comparing the *Olivella* species and then comparing the bead classes. Two classes, Class F and Class G, were not used in the test because the counts were too low. Table 4.4 shows the data organized according to species and Table 4.5 shows the data organized according to bead class. Figure 4.5 shows the percentage of *Olivella* species in each bead class. The chi-square test based on species ($\chi^2 = 4.98$, p = 0.29, d.f. = 4) and bead classes ($\chi^2 = 9.26$, p = 0.32, d.f. = 8) suggests that differences as large as the ones observed between these sites could be due to sampling error. The chi-square tests illustrate that Parowan, Summit, and Paragonah are similar, or similar enough, in their distribution of *Olivella* species and bead classes and that the differences in the Parowan Valley are not statistically significant.

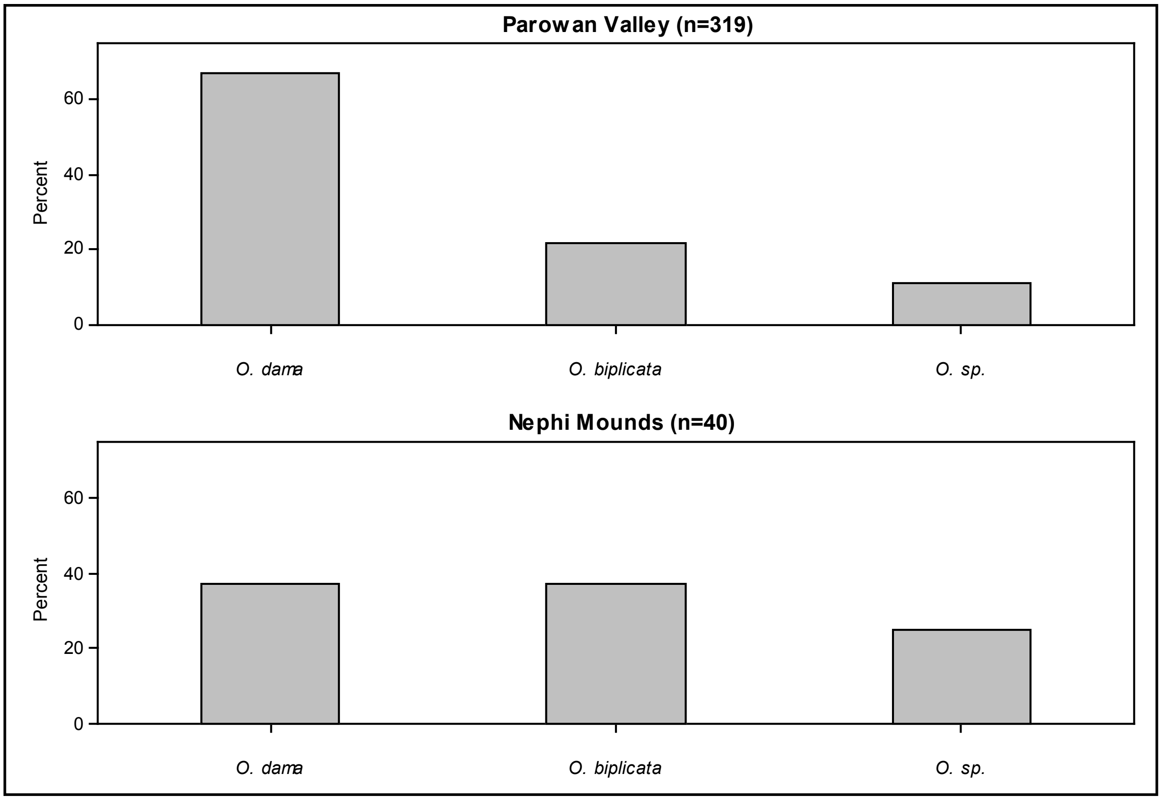

Figure 4.4. Percentages of *Olivella* species in Parowan Valley and Nephi Mounds.

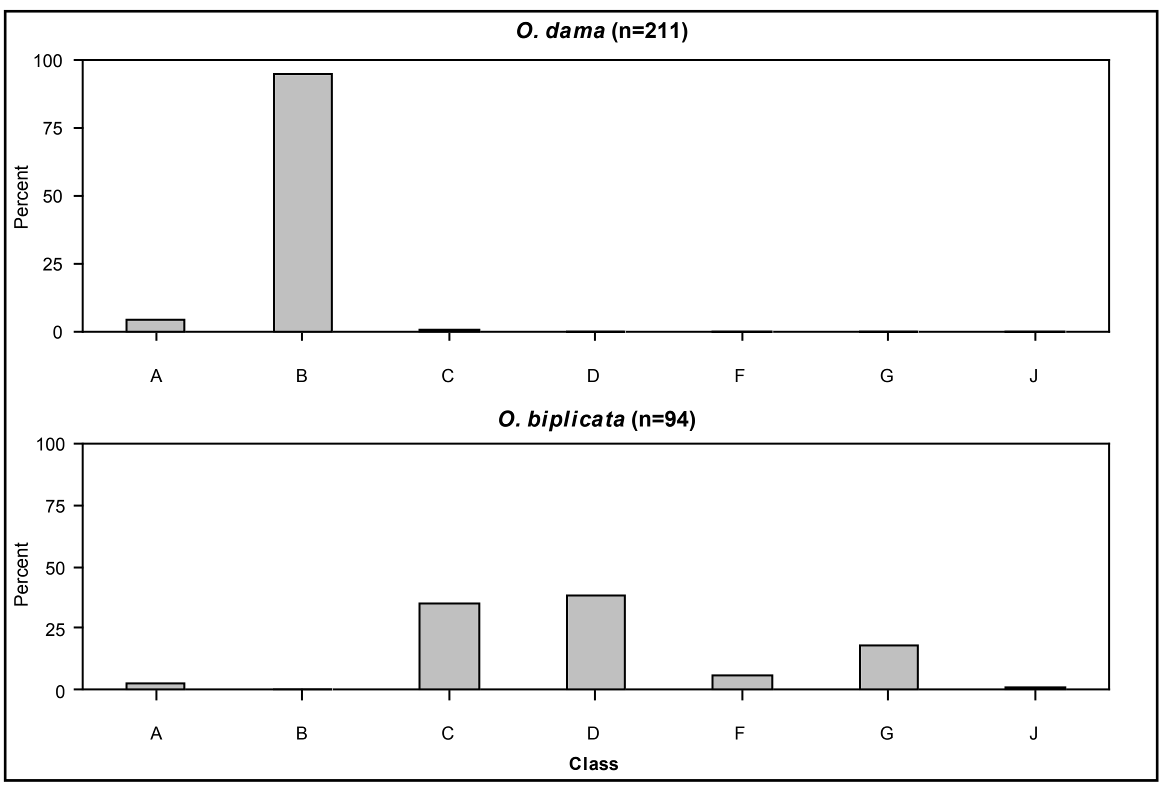

Figure 4.5. Percentages of *Olivella* in each bead class in the Parowan Valley.

Table 4.4. *Olivella* counts in Parowan Valley sites

	Parowan (42IN100)	Paragonah (42IN43)	Summit (42IN40)
O. dama	53	46	115
O. biplicata	22	13	35
Olivella sp.	6	12	17
Total *Olivella*	81	71	167

Table 4.5. *Olivella* bead classes in Parowan Valley sites

Class	Parowan (42IN100)	Paragonah (42IN43)	Summit (42IN40)
A	6	3	3
B	48	42	110
C	10	5	20
D	12	9	14
F*	–	1	4
G	3	3	11
J*	–	–	1
Total**	79	63	163

*Classes dropped and not used in chi-square test due to low frequencies
** Fragments not included in total, as fragments were not identified to a class (n=14)

In this thesis, the analysis of 359 *Olivella* artifacts from Parowan Valley and Nephi Mounds were divided into 25 different bead styles (Tables 4.6 and 4.7). As presented in Chapter 3, there are 22 bead forms identified, as per Bennyhoff and Hughes's (1987) typology, in the Parowan Valley collections, and 11 bead types found in the Nephi Mounds collection, eight of which were also found in Parowan Valley and three that were not found in Parowan Valley (types B2, F3b and G6b). While analyzing the Parowan Valley *Olivella* beads, I noticed that beads made from *O. dama* shell were exclusively made into Class A and B beads, with only one C4 bead type made from *O. dama* (Table 4.8). I also observed that beads shaped from *O. biplicata* shell were found only in Classes C, D, F, G, and J, while two A6 beads were also made from the *O. biplicata* shell. Although Bennyhoff and Hughes (1987:117) report that all types except for A1, B2, and B3 are made from *O. biplicata*, if I was unable to confidently identify a shell bead by

Table 4.6. Total *Olivella* bead counts according to types in Parowan Valley and at Nephi Mounds

TYPES	Parowan Valley	Nephi Mounds
A1	8	4
A4	2	–
A6	2	–
B2	–	1
B3	198	9
B6	2	1
C2	15	3
C2i	1	–
C3	6	5
C4	4	–
C5	1	–
C7	5	1
C8	2	–
D1	21	10
D2	5	–
D3	10	4
F1	2	–
F3a	3	–
F3b	–	1
G1	2	–
G2	2	–
G3	2	–
G5	11	–
G6b	–	1
J	1	–
Total	305	40

Table 4.7. Total *Olivella* bead counts according to class in Parowan Valley and at Nephi Mounds

Class	Parowan Valley	Nephi Mounds
A	12	4
B	200	11
C	34	9
D	36	14
F	5	1
G	17	1
J	1	–
Total	305	40

Table 4.8. *Olivella* beads according to Species and Class at Parowan Valley

Class	O. dama	O. biplicata
A	10	2
B	200	–
C	1	28
D	–	32
F	–	4
G	–	2
J	–	1
Total	211	69

species, I did not assume it was *O. biplicata* (see Tables 4.2 and 4.3). Therefore, some of the split drilled (Class C), split punched (Class D), saddle (class F), and saucer (Class G) beads did not retain enough of the shell characteristics for me to positively identify the *Olivella* species.

Prior to this analysis, Kae McDonald (1994:147–160) reported eight bead forms found associated with the Fremont era, including A1, A3, B3, C2, C4, C5, D2, and O1. The only two bead forms not observed in my thesis analysis that McDonald observed are A3 (Drilled Spire-lopped) and O1 (Drilled whole shell). She also included in her analysis two B2 beads found at Danger Cave with the associated date range of 8,960–3,819 B.P. The conclusions McDonald (1994:160) draws from her analysis are that the majority of marine shell in the Great Basin and Colorado Plateau were recovered from the Fremont period, although some *Olivella* beads were also associated with the Archaic/Fremont transition and the Fremont/Late Prehistoric transition. McDonald (1994:164) recognizes that there are more Fremont sites excavated and that this could increase the sheer count of artifacts, although she suggests also that the increase in the number of shell beads during the Fremont period "may indicate an increase in social transactions, possibly as a way to maintain favorable relationships with other groups."

In total, McDonald (1994) reports 316 *Olivella* artifacts from the eastern Great Basin and the northern Colorado Plateau, which nearly equals the 319 *Olivella* artifacts found in the Parowan Valley sites. The patterning noted by McDonald is similar to that described by Bennyhoff and Hughes (1987), thereby showing that there was an increase in *Olivella* ornament trade over time during what is referred to in California as the Late Prehistoric Period (ca. 1,250 – 450 B.P.), which corresponds with the middle and late Fremont periods (see Talbot 2000a). The increase in *Olivella* ornament exchange over time during the Fremont period was similarly noted by Janetski (2002). The new data from Parowan Valley *Olivella* distribution also supports this conclusion. Table 3.3 shows that most exotics appear in Middle and Late Fremont sites, although many more Middle and Late Fremont sites have been excavated (for exceptions, see discussion in Chapter 1).

Similarly, turquoise found at Fremont sites occurs after A.D. 1100 (Janetski 2000:234). Five Finger Ridge (Janetski et al. 2000), Baker Village (Wilde and Soper 1999), Kay's Cabin (Jardine 2004), and Parowan Valley sites account for 88 percent of the turquoise, and each of these sites dates to or has occupations later than A.D. 1100. It is true that the turquoise sample is so small that its temporal distribution could change with one or two additional finds. Turquoise in the Fremont area also appears to postdate the heaviest use of the mineral in the Southwest, especially since the bulk of turquoise recovered in the Southwest is from Chaco Canyon and dates prior to the Fremont occurrences (Weigand and Harbottle 1993; McDonald 1994).

The turquoise chemical analysis conducted in the Fremont area, although limited as it may be, also provides interesting insights for Fremont exchange. The Parowan Valley piece, as discussed in Chapter 2, did not match the Kingman, Arizona, source, which may continue to support the notion that turquoise and *Olivella* were not linked items of trade. Although it is not known whether the Kingman turquoise mine was exploited anciently, Kingman is approximately 35 miles east of the Colorado River. If it had been used prehistorically, perhaps turquoise would have been traded and moved along the Colorado River, as the *Olivella* ornaments are thought to have moved (Lyneis 1992; Hughes and Bennyhoff 1986). This may not be the case, as the chemical analysis performed by Watkins at ASU (see Appendix A) shows that Kingman was not likely a source for turquoise found at Parowan Valley.

Data available to date suggest turquoise did not pass through Parowan Valley to other Fremont areas. The large number of *Olivella* recovered there shows that *Olivella* exchange was likely brought by fairs to Parowan Valley, but the presence of only 10 pieces of turquoise in the UCLA collection shows that turquoise trade was probably not conducted through Parowan Valley[3]. It is more likely that turquoise came from sources to the west of the Fremont area, instead of from the southwest connections near the Parowan Valley. This evidence further supports the notion that turquoise and *Olivella* were probably not traded in the same exchange networks. The INAA performed on the Five Finger Ridge specimens also concluded that the Nevada mines may be the source of turquoise in Fremont and Southwestern sites (Janetski 2000). It is possible, however, that turquoise trade was connected to the south and southeast as Five Finger Ridge samples were also matched to Chaco Canyon and Arizona sources. Based on the Parowan Valley turquoise and *Olivella* data, it is possible that turquoise was traded from the west and the *Olivella dama* ornaments were traded from the south.

The turquoise artifacts from Five Finger Ridge differ stylistically from Baker Village and Kay's Cabin pendants (see Figure 2.5). Turquoise ornaments from Five Finger Ridge are more diverse morphologically and tend to be larger in general than those from other sites. There is also a distinct color difference, with Five Finger Ridge specimens being more blue and those from elsewhere more green. Reasons for this are unclear but may suggest that the turquoise from Five Finger Ridge is from a different source and therefore the Fremont in the Clear Creek area may have had different exchange partners. Along with the color and stylistic differences, the high number of turquoise pieces found at Five Finger Ridge may also suggest that their trade connections had access to different turquoise sources than the Fremont at Baker Village or Parowan Valley. I recently examined turquoise pendants from the Coombs Village site and noted they are more similar in size and shape to turquoise pendants found at Baker Village and Kay's Cabin. The turquoise artifacts recovered at Baker Village (Wilde and Soper 1999), Kay's Cabin (see Figure 2.4), and Coombs Village are smaller and more often tear-drop shaped. Although no source information is available for these objects, the proximity of Baker Village to the central Nevada turquoise sources (Grass Valley) could suggest that Baker turquoise ornaments were from that area (see Weigand and Harbottle 1993:162-163 for Nevada turquoise sources).

Both of my initial hypotheses about Fremont exotic exchange proved to be supported by the data. Observations from my analysis support the notion that although turquoise and *Olivella* may both be present at a site, high concentrations of one or the other exotic material, not both, were observed at a site (with the exception of Baker Village). Both materials have sources to the west and to the south of the Fremont area, so it is likely that ornaments of both material types came from both directions. It does not appear, however, that the turquoise and *Olivella* ornaments traveled together. The presence and concentration of exotic artifacts at central places in the Fremont area also supports the idea that exotic trade was conducted directionally, as there is not a fall-off pattern visible in the distributional map (see Figure 3.9). Specific areas, including Parowan Valley, Utah Valley, and Baker Village have major concentrations of exotics and appear to have been important central places on the Fremont landscape especially late in the Fremont period.

Fremont Finery: Relative Value of Turquoise and *Olivella*

With few exceptions, turquoise in Fremont sites was highly curated and intended for ornaments (McDonald 1994). At Kay's Cabin in Utah Valley, five turquoise fragments show no modification, suggesting the Fremont may have been trading for raw materials and possibly making their own ornaments. For the most part, however, it seems that Fremont were consumers of turquoise ornaments rather than producers (see Janetski 2002).

The value of turquoise and marine shell is suggested by the presence of imitations of exotic artifacts. For example, three sites—Paragonah, Meadow[4], and Five Finger Ridge—yielded carved calcite imitations of *Olivella* shell (Talbot et al. 2000; Judd Collections at SI). Also, the microprobe research on the Kay's Cabin worked blue-green materials identified three mineral types resembling turquoise—variscite, possibly one piece of chrysocolla, and an azurite/malachite conglomerate—that were worked or modified in some way. These examples imply that turquoise and marine shell were valuable, so much so that Fremont sought out and worked minerals that looked like the exotic materials.

Directions for Further Research

If Fremont trade patterns are to be fully understood, then more chemical analysis on exotic trade items, such as turquoise and *Olivella,* must be performed. An example is a recent provenience study performed in California on *Olivella biplicata* shell beads that examined the potential of stable carbon and oxygen isotopes to fingerprint *Olivella* beads (Eerkens et al. 2005:1501). The use of stable carbon and oxygen isotopes testing is new in its application to *Olivella* and will prove innovative and helpful with much more precise sourcing results. Hopefully, the ASU PIXE turquoise database (see Appendix A) will receive funding and provide easily attainable source information for the turquoise mines in the Southwest. Also, as new excavations are performed it is important to update the distributional data presented in this thesis to see how the patterns currently noted really represent what occurred in prehistory.

CONCLUSIONS

In this research, I have examined questions related to Fremont exchange and distribution of turquoise and *Olivella* ornaments in Parowan Valley and throughout the Fremont area and have reached several conclusions. Fremont exotic exchange moved directionally, with *Olivella* and turquoise artifacts concentrated at central sites on the Fremont landscape (see Figure 3.9). It appears, based on different concentrations of turquoise and *Olivella* artifacts at sites, that these ornaments were not traded together. It cannot yet be proved, however, whether or not the same trade routes from the west and the south were used to transport both *Olivella* and turquoise goods. Turquoise also appears to be a late phenomenon in the Fremont area, with the majority of the turquoise found in Fremont sites that date to or have occupations after A.D. 1100.

The distribution of turquoise and *Olivella* artifacts in Parowan Valley shows the largest concentration of exotics present at the Parowan site. Because excavation recovery methods may have had an impact on the amount of exotics found at the Parowan site, it is difficult to know whether a site hierarchy existed in Parowan Valley. Perhaps future work will allow a re-examination of Fremont social structure in Parowan Valley. Although the provenience data was less than ideal, interesting patterns emerged. Paragonah exotics were mostly associated with the pithouse subfloor and floor levels. At Summit, a distribution similar to Baker Village was observed, with *Olivella* and turquoise ornaments located not only in or near pithouses, but also surface structures. At Parowan the distribution was similar to Five Finger Ridge with exotics found concentrated in or near pithouses.

The number of different *Olivella* beads types from Parowan Valley and Nephi Mounds is striking and suggests the Fremont had connections to a variety of exchange systems. Continued excavations in the Fremont area will shed further light on Fremont distributional patterns of these exotics. The thirteen pieces of turquoise identified at Kay's Cabin and the turquoise artifact tested from Parowan Valley provide evidence that the Fremont, through trade connections, had access to distant turquoise mines. Perhaps the five unworked pieces of turquoise at Kay's Cabin suggest the first noted Fremont modification of this exotic material. I encourage future researchers to focus on performing turquoise and *Olivella* chemical analysis and sourcing techniques to enable additional insights into Fremont exchange and, by extension, socio-economic patterns.

ENDNOTES

[1] The Nephi Mounds *Olivella* beads are not addressed in the distribution analysis because there is no provenience data associated with the artifacts.

[2] Many Parowan Basal-Notched points are found at sites in the St. George Basin and elsewhere in the Virgin area. The point style was shared across the Fremont/Anasazi boundary, but pottery and obsidian, both items that are frequently traded, do not move across the boundary for some reason (Watkins 2006:82-84; Jim Allison, personal communication 2007).

[3] Exchange of exotics in the Fremont area emphasized *Olivella.* McDonald (1994) reported 316 *Olivella* ornaments and only five turquoise artifacts. The Parowan Valley and the Fremont area follow this pattern of *Olivella* occurring more often than turquoise in the archaeological record. The totals presented in this thesis include 894 *Olivella* artifacts and 103 turquoise artifacts. On a much larger scale, Ronna Bradley (1993:128) also reports that marine shell was "found in far-higher quantities than other exotic artifacts" at Casas Grades, a complex and large site in northwestern Mexico.

[4] Meadow Utah is located in the Pavant Valley of central Utah. Neil Judd excavated at Meadow in 1916 (Judd 1926:64). The Meadow and Paragonah specimens are in the Judd collections at the Smithsonian Institution.

Appendix A

**Material Characterization and Archaeological Analysis of Two Turquoise Samples:
A Bead Recovered from Parowan, UT and a Geological Sample from Kingman, AZ**

Final Paper
ASB 591
Archaeometry III Advanced Characterization of Archaeological Materials
Hamdallah Béarat – Professor

5-9-06

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Introduction

This report details a semester-long investigation of two turquoise samples. The first sample is an unaltered nodule from a geological context near Kingman, AZ. The sample was procured from a mineral shop by Dr. Hamdallah Bearat. The second sample is a bead fragment recovered during archaeological excavations conducted by the University of California Los Angeles (UCLA) between 1955 and 1964 (Meighan et al. 1956; Watkins 2006) at the large Fremont sites in southwestern Utah's Parowan Valley (Marwit 1970; Berry 1972a, 1972b, 1974; Dodd 1982).

This research first seeks to characterize these two samples from a traditional material science perspective (i.e., a textural, structural [phase], and compositional [element] description). Four analytical methods were employed in the investigation, X-ray Diffraction (XRD), Raman Microscopy, Scanning Electron Microscopy (SEM) with Energy Dispersive X-ray Spectroscopy (EDX), and Particle Induced X-ray Emission (PIXE). Each method is discussed in detail below, followed by the sample preparation techniques. The textural, structural, and compositional facets of the materials are then characterized. The different methods are then compared and synthesized.

The material characterization is then applied to specific archaeological questions. The most pressing archaeological issue is the sourcing of the archaeological sample. I have assembled a comparative database of samples also analyzed by PIXE from two previous research efforts. One sample from the database was recovered from an archaeological context near Florence, AZ (Béarat et al. 2003) (note: this sample was also subjected to XRD and SEM/EDX). The remainder of the database is made up of several archaeological samples recovered from excavations in the Tonto Basin, AZ (Kim et al. 2003). This database is compared to both the archaeological and geological samples with a variety of methods, explained in detail below. Additional inquiries are directed at the possibility that technological variability in beads manufactured by different cultural groups may be observable with microscopy and the appropriateness of different methods for identifying the minerals from which blue-green stone artifacts have been manufactured. The analysis is concluded with suggestions for further research.

Experimental Methods

XRD

XRD is a technique in which the pattern produced by the diffraction of X-rays through the closely spaced lattice of atoms in a crystal is recorded and analyzed to reveal the nature of the lattice. The nature of the lattice can then be used to understand the phases present in, and the molecular structure of the substance in question. XRD is a good method for any initial analysis in that it is effective on with a wide variety of materials.

The XRD analysis was undertaken with a Rigaku D/MAX-IIB X-ray diffractometer with Cu$K\alpha$ radiation. The following settings were used in the analysis:

Scan speed – 5°/minute
2θ range – 5°-65°
Timestep – 1 count every 0.05°
Voltage – 25Kv
Kα average wavelength – 1.541871

These settings, particularly the scan speed, are probably not adequate for a robust analysis. They were justified, however, in that several students were attempting to learn a method and only a limited amount of machine time was available. Ideally, the sample should have been run at a slower scan speed. Only the geological sample was subjected to XRD.

Raman Microscopy

Raman Spectroscopy is a technique in which a pattern produced by molecular interaction with light (i.e., the Raman Effect) is used to determine the phase or phases present in a sample. In a successful Raman analysis, the investigated object is bombarded with monochromatic light, in this case, generated by a laser. Photons or other excitations in the system are absorbed or emitted by the sample, resulting in the energy of the laser photons being shifted up or down. The shift in energy is passed through a monochomator to filter out wavelengths close to the laser line, and are then amplified and recorded to produce a Raman scatter. Different materials have distinct Raman scatters, making identification of a phase possible by comparing the Raman scatter of the unknown sample to those of known standards.

Setting up for the actual Raman procedure is quite simple. The sample is first mounted on the stage. The point on the object to be sampled is then determined with a microscope. After focusing the microscope, the sample is then exposed to the beam for x number of seconds at n accumulations. Both the geological and archaeological samples were subjected to Raman. A successful Raman scatter was obtained for only the geological sample. This sample was exposed for 5 seconds at 12 accumulations, for a total of 1 minute. This is a relatively weak signal, but was entirely adequate to obtain a Raman spectrum. The sample is not impacted in any way by this procedure.

SEM/EDX

SEM produces high resolution, three-dimensional images useful for judging the surface structure, or texture of a sample. EDX is a complimentary method used to investigate elemental concentrations by measuring the energy spectrum of X-ray radiation for an object. In both methods, electrons are projected at the sample in question. Some of these electrons can dislodge another electron from the inner level of an atom in the sample. An electron from an upper level fills this void, emitting an energy characteristic of the specific atom. The secondary electrons are measured and used to generate spectral textural surface images. During EDX, the backscattered electrons are collected and used to image the atomic density of the surface to determine elemental concentrations. EDX is a useful and appropriate analytical technique to use on turquoise, which is relatively homogeneous. In other words, one or only a few measurements will probably reflects the composition of the material fairly well. The geological sample was imaged at 25 Kv, and the archaeological sample at 3 Kv.

PIXE

PIXE is a technique used in determining the elemental composition of a sample. This technique, like many others, is based the fact that materials bombarded with subatomic particles (in this case an ion beam) will emit wavelengths in the x-ray spectrum that are specific to each element in the sample. Advantages of PIXE include a low cost, a relatively high degree of accuracy, and the potential for non-destructive analysis. Elemental assays conducted with PIXE return values for Mg, Al, Si, P, S, Cl, Ar, K, Ca, Sc, Ti, V, Cr, Mn, Fe, Co, Ni, Cu, and Zn. Sodium (Na) is on the verge of PIXE's detection limit, and the values returned for this element should be, in most cases (including this one), disregarded. The PIXE analysis was undertaken with the following analytical standards: beam current=1.72 nA, counts=20,000, filter=yes, vacuum=yes, energy=low, sample tilt=45 degrees, acquisition time=~12 minutes.

Sample Preparation

XRD

A portion of the geological turquoise sample was reduced to powder by hand in an agate mortar and pestle. The mortar and pestle were first cleaned with alcohol to prevent sample contamination. The sample was ground with brisk repeated strokes until the desired consistency was reached. The precise grain size of the particles is unknown, but the powder could probably be described as "fine." Portions of this same powder were used in other analyses detailed below.

A glass slide was then cleaned with alcohol and a laboratory wipe. A plastic "mask" was then placed over the slide. The mask covered most of the slide, but had a square hole near one end leaving a portion of the slide exposed. The slide (with mask) was held vertically and sprayed with a solution of petroleum jelly and hexane. The hexane is mixed with the petroleum jelly to get it into solution. The hexane then evaporates, leaving a square-shaped area of "stickiness" on the glass slide. The mask was then removed and the slide was placed on a piece of weighing paper with the sticky side facing up. The sticky portion of the slide was then lightly dusted with the powdered turquoise. The slide was gently shaken to spread the powder evenly over the sticky area. The loose turquoise was then shaken onto the weighing paper and the process was repeated. The loose powder was then disposed of; leaving a glass slide with a square of turquoise powder adhered to one end.

Raman Microscopy

Aside from being mounted on a stage prior to analysis, the samples were not prepared or otherwise altered in anyway.

SEM/EDX

A fragment of the geological sample was broken off and secured to a 50mm aluminum mount with a piece of carbon tape before being coated in gold. The uncut portion of the sample was placed facing up. The mounted sample was then placed in a Denton vacuum. When the pressure in the vacuum reached 100-150 mtorrs, Argon gas was introduced. The pressure was then brought again to the level, 100-150 mtorr level, whereupon a 20 ma current was introduced. This caused the gold in the top of the vacuum to literally being to "rain" down upon the sample, coating it in a fine dusting of gold. The newly coated sample was placed in a plastic container and stored for future analysis.Three images and 3 EDX spectra were taken. The archaeological sample was sonicated in acetone for 10 minutes, rinsed again with acetone and kept soaked in acetone over the weekend. Prior to imaging, the sample was mounted on a carbon tape stage. Five images and 2 EDX spectra were taken.

PIXE

The geological sample was analyzed as a powdered, pressed pellet. A portion of the previously prepared powder (see above) was placed in an apparatus made of three interlocking cylinders. The center of the larger cylinder was hollowed out so that the other solid cylinders fit securely inside, meeting one another near the one end of the largest cylinder. After cleaning the entire apparatus with alcohol, a small portion of powdered turquoise was placed inside the larger cylinder, in the space between the two smaller pieces of the apparatus. With the aid of a small plastic ring, the sample was compacted in a laboratory press at ca. 500 psi for 30 seconds. The apparatus was then rearranged and the pellet was levered out and stored in a labeled plastic container. The archaeological sample underwent no sample preparation other then the sonication in acetone described above.

Material Characterization

Textural

SEM

Figures 1 and 2 show the geological sample at 500x and 2500x magnification respectively. The geological sample appears to be pure and homogeneous; no distinctions can be made at either magnification. At the higher magnification (Figure 2), some small pits are visible on the surface of the material, indicating some porosity. Turquoise is a secondary mineral that is formed by the action of percolating acidic aqueous solutions during the weathering and oxidation of pre-existing minerals. The observed porosity is consistent with this formation process.

Figures 3 and 4 show the archaeological sample at 500x and 2500x magnification respectively. The pitting evident in these images reflects the method by which the object was constructed. The bead was relatively well-polished, but was not polished enough to eliminate evidence of pitting at 500x magnification. At the higher magnification, the abrasions left by smoothing are apparent alongside larger pits. This is generally consistent with grinding and polishing/smoothing with stone tools. Without additional comparative samples, it is difficult to say more about the sample other than the material appears fairly homogeneous/pure. The texture of the archaeological sample is discussed further in the Technological Differences section below.

Structural

XRD

Figure 5 shows the peaks in the experimental geological sample and those in the known standard. The sample is primarily a pure phase, turquoise ($CuAl6(PO_4)4(OH)8 \cdot 4H_2O$). The peaks in the turquoise sample deviated very little from the standard. However, the peaks at d=4.254, 3.3537, and a Two-theta value of ca. 18 do not belong to the turquoise phase. These three deviations from the standard are indicative of a phase impurity. However, I was unable to identify this phase impurity due to the limited number of peaks. The slight “hump” in Figure 5 between Two-theta values of 10 and 40 may reflect an additional amorphous phase present in the sample, but again, the exact nature of this impurity is not clear from this analysis.

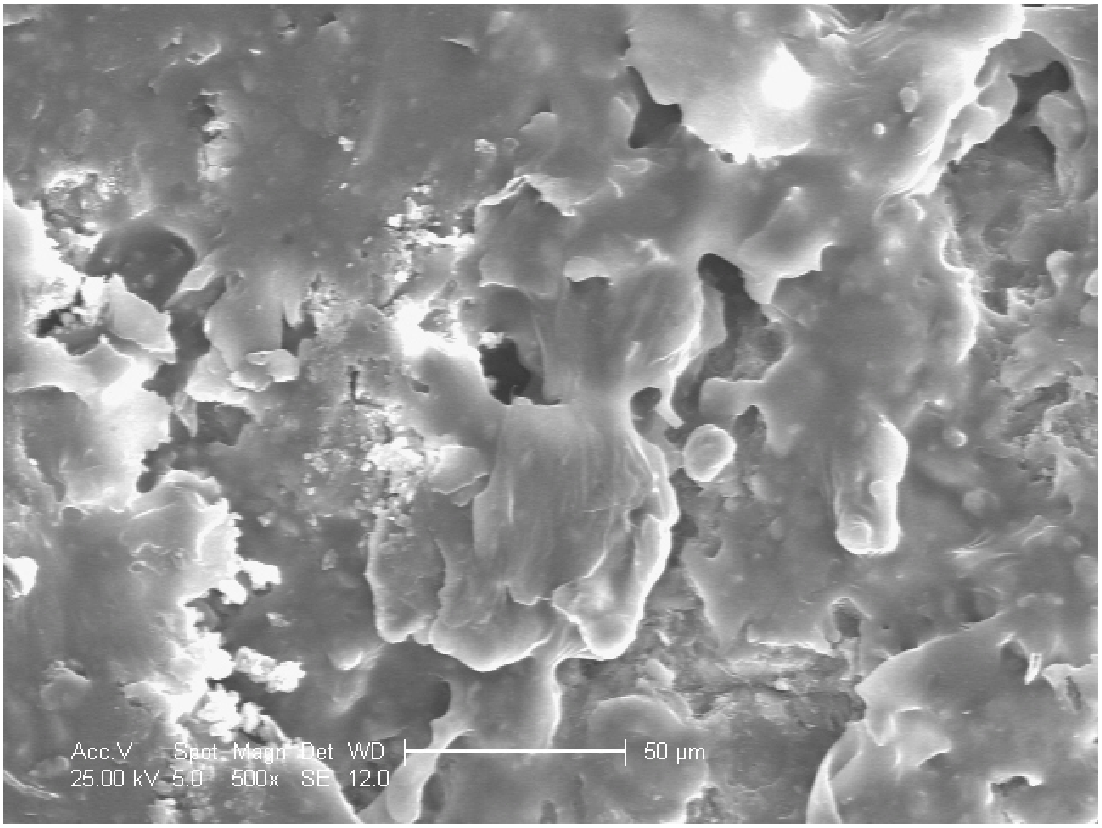

Figure 1. Geological Turquoise Sample at 500x Magnification.

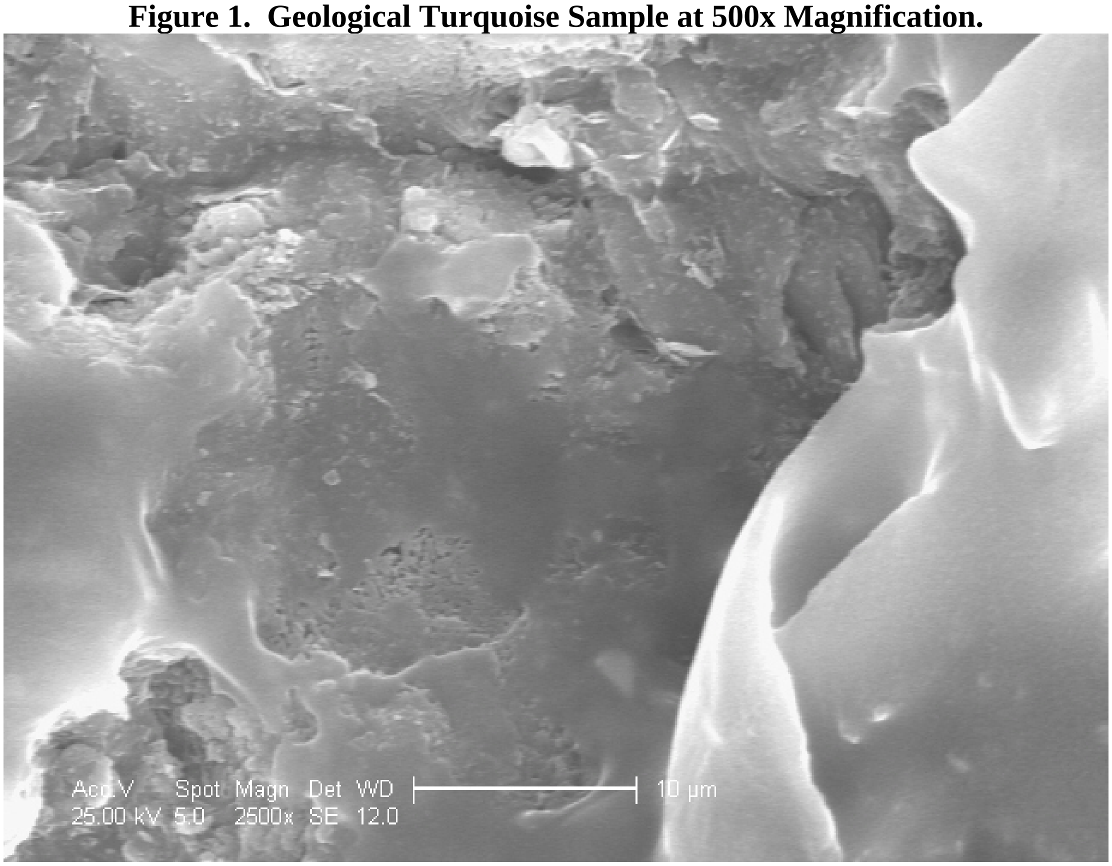

Figure 2. Geological Turquoise Sample at 2500x Magnification.

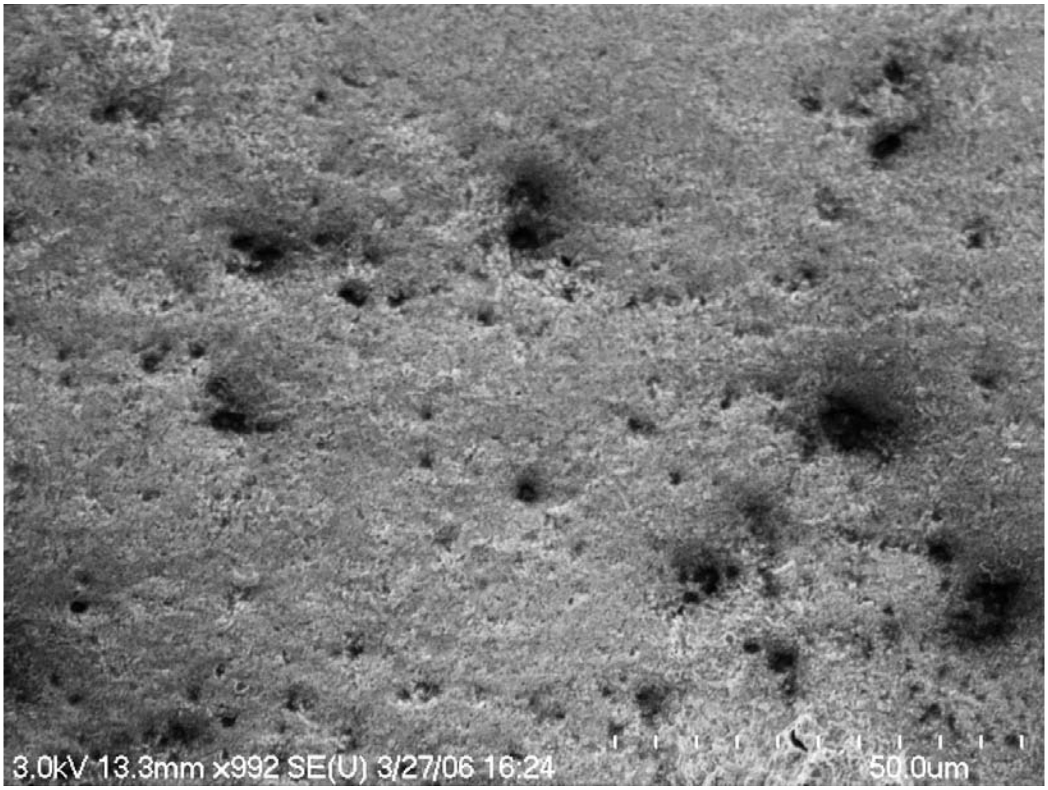

Figure 3. Archaeological Turquoise Sample at 500x Magnification.

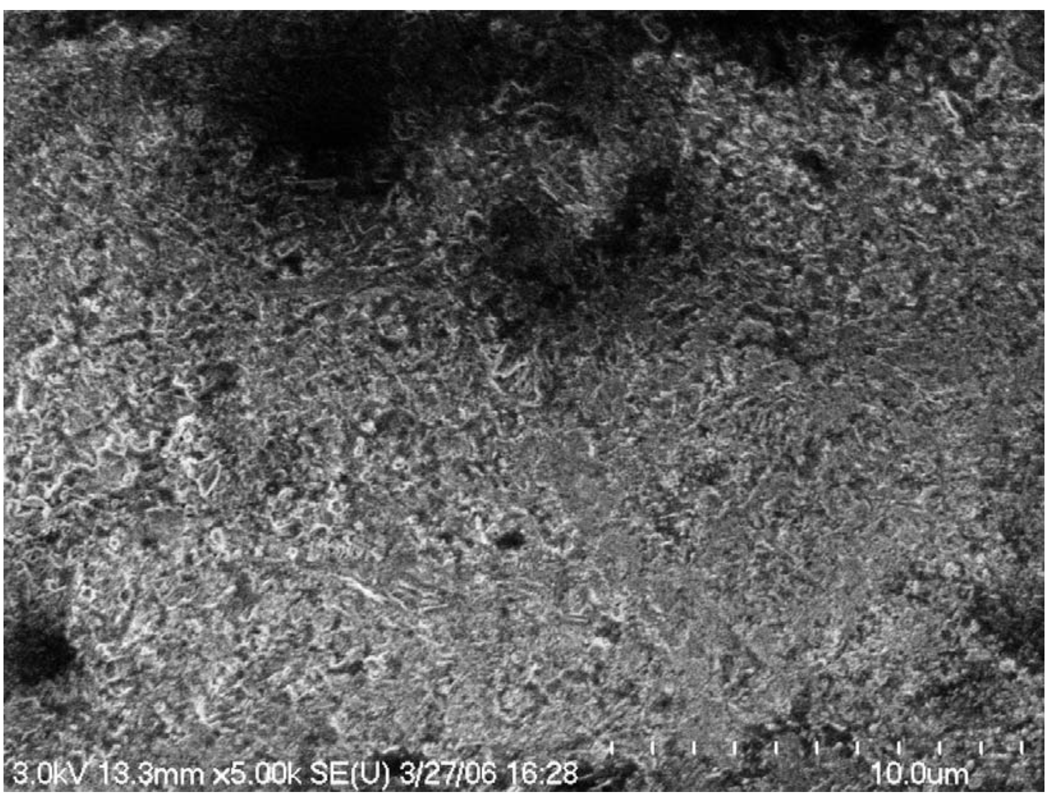

Figure 4. Archaeological Turquoise Sample at 2500x Magnification.

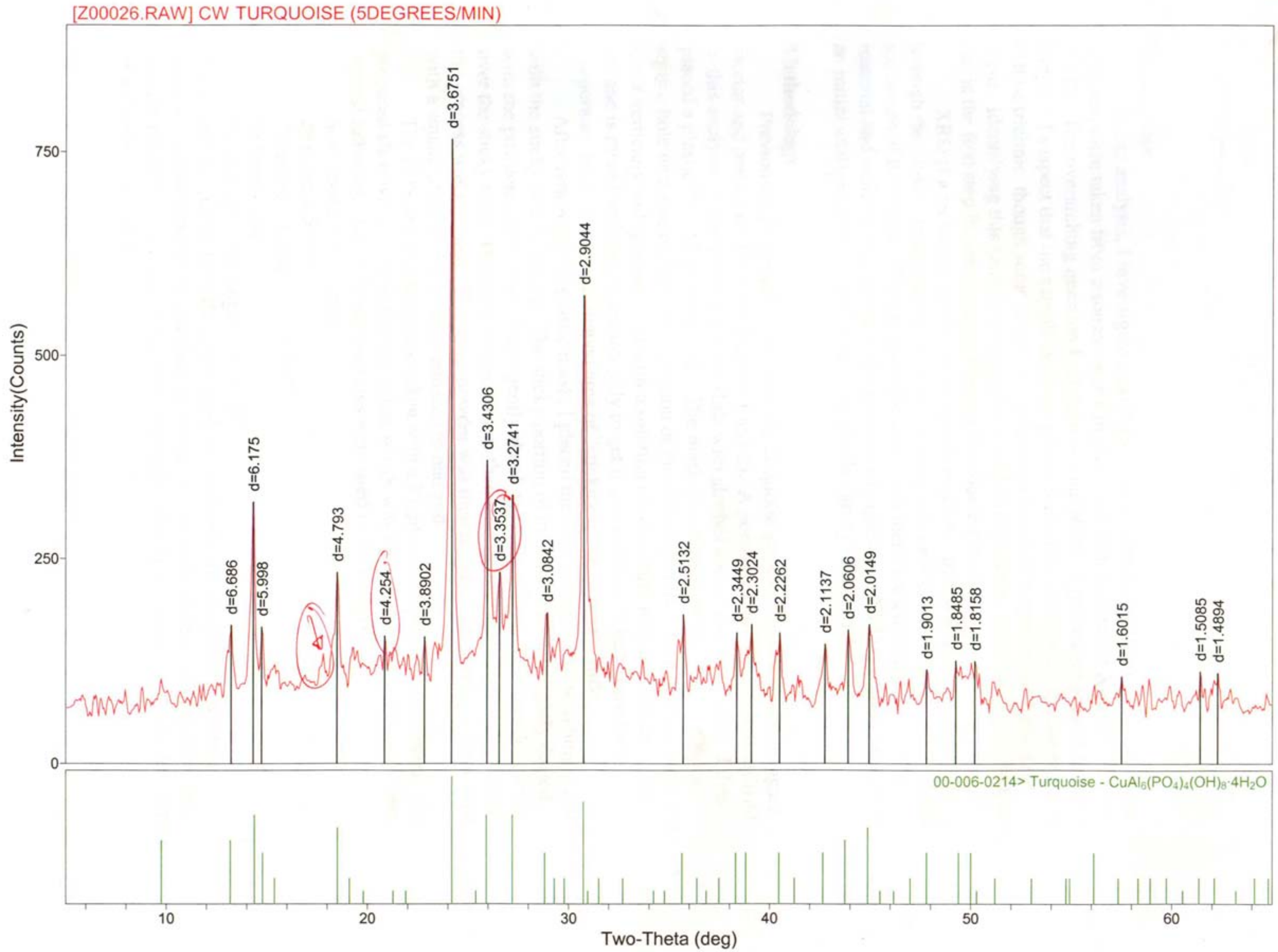

Figure 5. XRD Analysis of the Geological Sample.

As expected for turquoise, the cell type is triclinic, P-1(2). This is evidenced by (a,b,c) values of (7.47, 9.89, 7.62) and [α,β,γ] values of [11.32, 115.44, 69.43]. The deviation of the sample from the standard for (a,b,c) and [α,β,γ] are, respectively, (0.025, 0.030, 0.008) and [0.715, 0.245, 0.323].

Raman

The Raman spectra of the experimental geological and standard turquoise sample are given in Figures 6 and 7 respectively. The standard Raman spectrum was obtained from the University of Arizona Rruff project (http://rruff.geo.arizona.edu/rruff/new_rruff/index.php/r=sample_search/sample_search_id=fBVTUeyXdcyxLrdXyGsIcDnhK). The scatters are remarkably similar in form, with every peak matched. This again confirms that the geological sample is indeed turquoise. Unfortunately, Raman failed to adequately characterize an archaeological sample. When exposed to the laser, the sample "fluoresced", or in other words, failed to emit energy in an observable way. There are three possible reasons for this. First, the sample may not have been turquoise, but an amorphous look-alike mineral that could not be characterized by Raman Microscopy. Second, the object may have been simply the wrong color, being much greener than the blue tending geological sample. The more likely explanation is that the archaeological sample had become impregnated with organic compounds, either during manufacture, use, or following deposition. Following fluorescence, the sample was sonicated in acetone (see SEM/EDX Sample Preparation above) to remove any lingering organic compounds. Unfortunately, by then it was too late to re-attempt Raman analysis of this object.

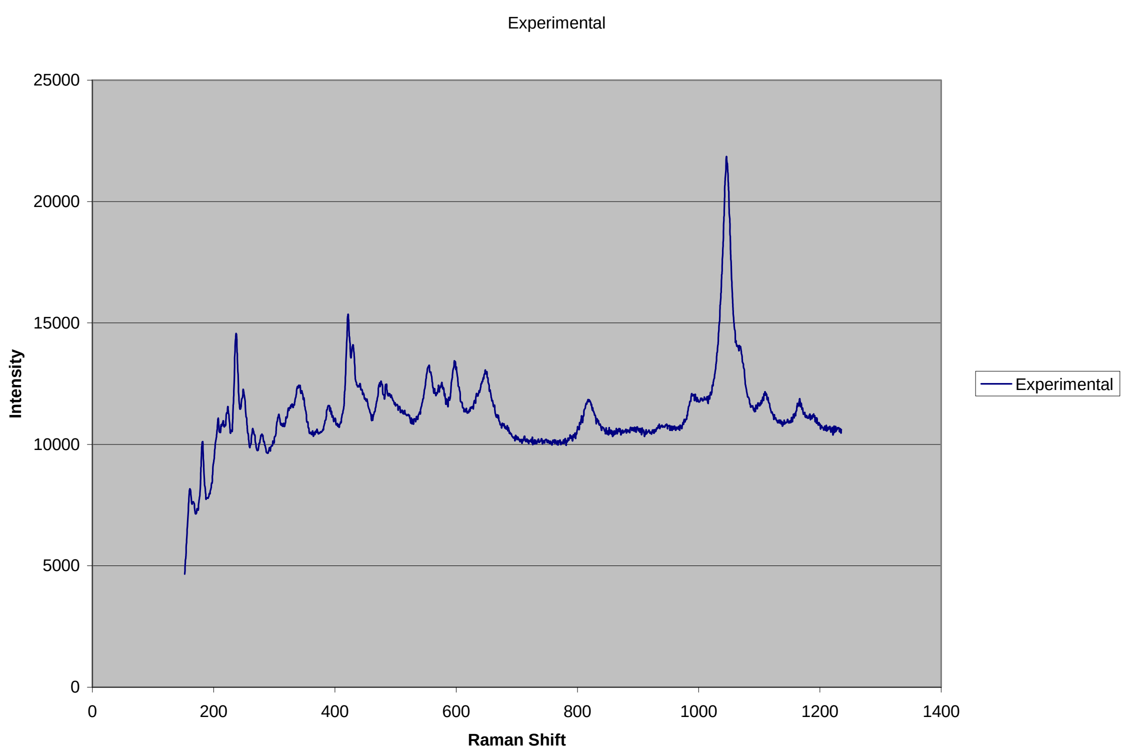

Figure 6. Raman Spectrum of the Experimental Sample.

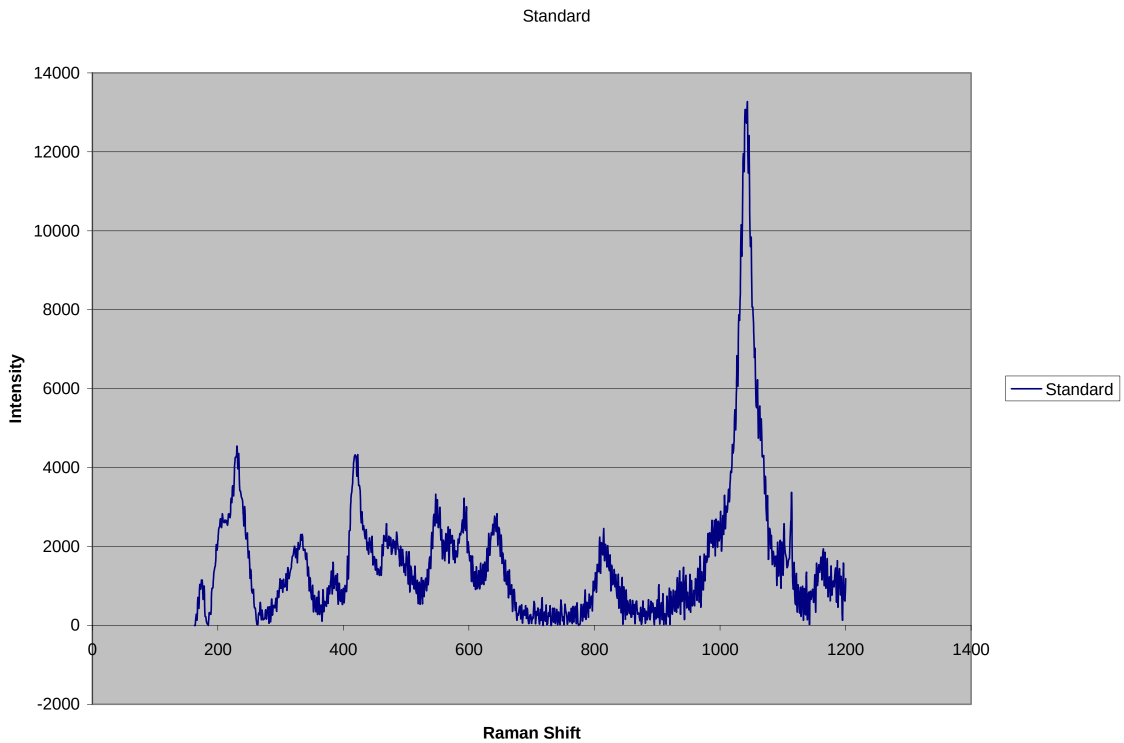

Figure 7. Raman Spectrum of the Standard Turquoise Sample.

Compositional

PIXE

The results of the analysis are reported in Table 1 and Table 1. In Table 1, the columns "Geological" and "Archaeological "are the raw elemental counts in ppm. The next two columns are these data expressed as percentages. The final two columns are these percentages normalized (i.e., divided by the total percentage and multiplied by 100%. Table 2 reports the same data in normalized oxide form. There are clearly some important differences in the samples. These data are discussed further in the Method Comparison and Sourcing of Turquoise Sections below.

EDX

Qualitative EDX

The qualitative analysis for the geological sample is summarized in Figure 8. The analysis detected C, O, Al, P, and Cu. This elemental composition is consistent with turquoise. The qualitative examination of the archaeological sample (Figure 9) failed to discover any Copper or Phosphorus, only detecting C, O, and Al. This is because the image was not coated with gold, and subsequently had to be imaged at a low Kv (3). From the PIXE analysis, copper and phosphorus are known to be present (Tables 1 and 2), but were not detected in this analysis.

Table 1. Results of PIXE analysis in ppm, Percent, and Normalized Percent

Element	Geological	Archaeological	G_%	A_%	G_Norm%	A_Norm%
Al	184444.4	183374.8	18.44444	18.33748	48.38114	46.6308
Si	4126.8	14178.4	0.41268	1.41784	1.08249	3.605458
P	116921.2	111874	11.69212	11.1874	30.6693	28.4487
S	0	1428.4	0	0.14284	0	0.363231
Cl	0	794.2	0	0.07942	0	0.201959
K	1109.8	2310.7	0.11098	0.23107	0.291109	0.587593
Ca	319.8	3763.3	0.03198	0.37633	0.083886	0.956978
Ti	309.6	261.4	0.03096	0.02614	0.08121	0.066472
Fe	2373.5	11231.1	0.23735	1.12311	0.622587	2.855983
Cu	69592.1	64031.9	6.95921	6.40319	18.25453	16.28282
Zn	2034.8	0	0.20348	0	0.533743	0
Total			38.1232	39.32482	100	100

Table 2. Results of PIXE Analysis as Normalized Oxides.

Spec No	Geological	Archaeological
Al2O3	48.38637769	46.72846935
SiO2	1.225642009	4.090361629
P2O5	37.19860172	34.57377351
SO3	0	0.50125791
ClO2	0	0.203788472
K2O	0.185604551	0.375380519
CaO	0.06212387	0.710122297
TiO2	0.071716809	0.058817946
MnO	0	0
FeO	0.423928469	1.948542603
CuO	12.09439984	10.80948577
ZnO	0.351605035	0
Total	100	100

Quantitative EDX

Table 3 reports the results of the semi-quantitative analysis of the geological sample. The atomic weights are not accurate, and this is probably due to the sample not being perfectly flat, or to absorption of electrons by the surrounding matrix. The analysis only identified C, O, Al, Si, P, and Cu. The chemical formula for turquoise is ($CuAl6(PO_4)4(OH)8 \cdot 4H_2O$). The results of Table 3 are a good reflection of the chemical formula for turquoise.

The elements discovered in the quantitative analysis of the archaeological sample are C, O, Cu, Zn, Al, and P (Table 4). As stated above, turquoise can contain Zinc as part of its normal range of variation. The zinc then should probably not be considered a true impurity. The absence of silicon precludes this sample from being Chrysocolla, and the elemental concentrations are consistent with mineralogical turquoise.

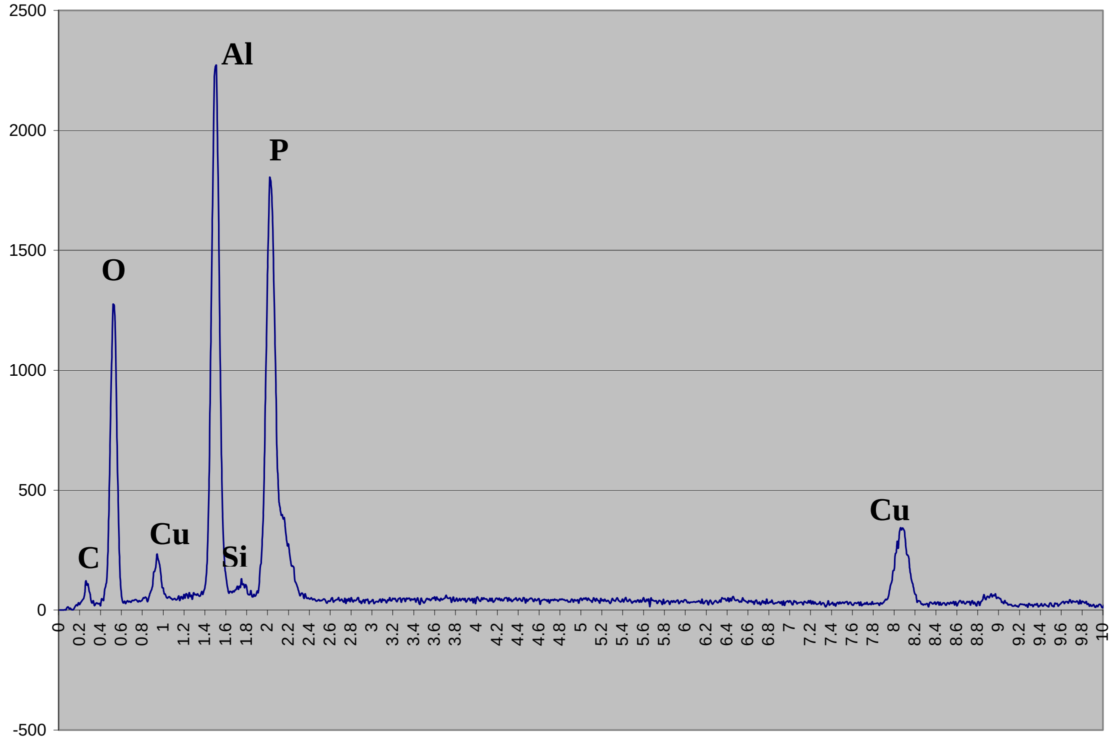

Figure 8. Qualitative EDX Analysis of the Geologic Sample.

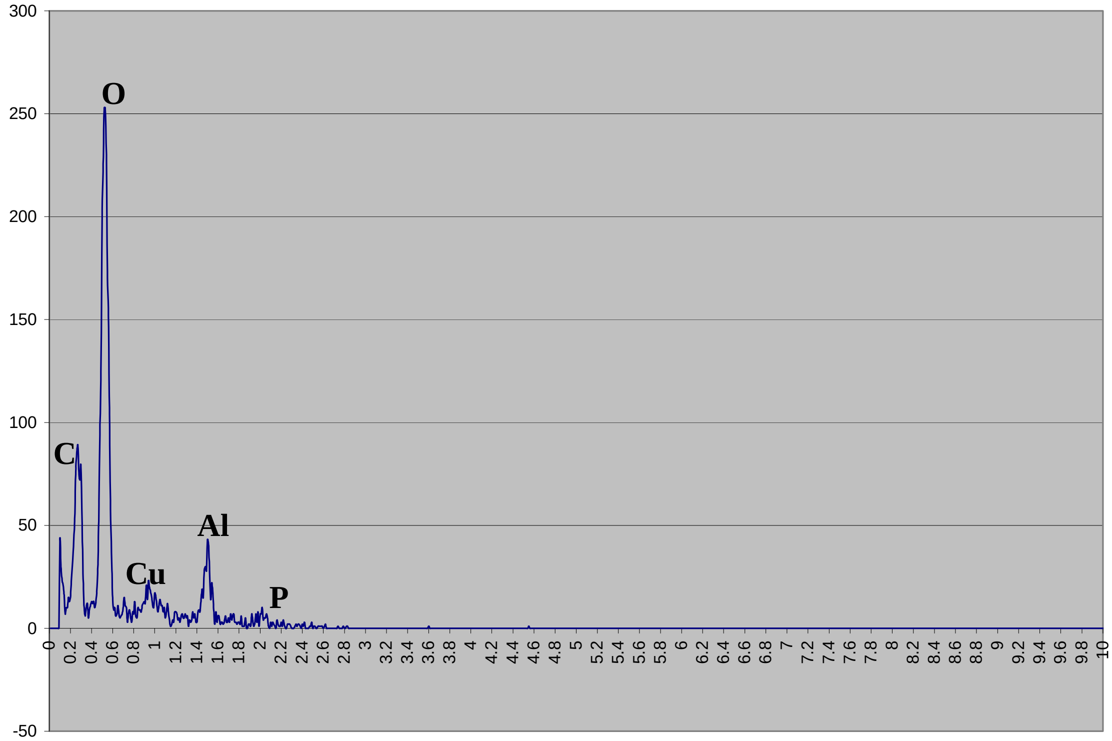

Figure 9. Qualitative EDX Analysis of the Archaeological Sample.

C:\EDS\USR\Bearat\ASB591\CW2.spc

Current Time:01:10:46 Date: 8-Mar-2006

kV:25.00 Tilt: 0.00 Take-off:35.00 AmpT:35.0
Detector Type :SUTW-Sapphire Resolution :133.50 Lsec :30

EDAX ZAF Quantification Standardless
Element Normalized

SEC Table : Default

Element	Wt %	At %	K-Ratio	Z	A	F
C K	12.41	21.35	0.0163	1.0593	0.1237	1.0004
O K	35.66	46.05	0.0903	1.0431	0.2426	1.0007
AlK	22.04	16.87	0.1103	0.9746	0.5115	1.0043
SiK	0.66	0.49	0.003	1.0036	0.447	1.0067
P K	16.79	11.2	0.0922	0.9709	0.5654	1
CuK	12.45	4.05	0.109	0.8666	1.0107	1
Total	100	100				

Table 3. Semi-quantitative EDX Analysis of Geological Turquoise.

G:\New Folder\turquoise 1.spc

Acquisition Time: 16:37:13 Date: 27-Mar-2006

kV:3.00 Tilt: 0.00 Take-off: 31.07 Tc:35.0
Detector Type :SUTW-Sapphire Resolution :139.24 Lsec :100

EDAX ZAF Quantification Standardless
Element Normalized
SEC Table : Default

Element	Wt %	At %	K-Ratio	Z	A	F
C K	16.92	27.53	0.1418	1.1457	0.7314	1.0001
O K	35.89	43.83	0.3497	1.0804	0.9016	1.0001
F K	0.4	0.41	0.0035	1.0003	0.8735	1.0003
CuL	5.73	1.76	0.0395	0.709	0.9711	1.0007
ZnL	3.99	1.19	0.0274	0.7049	0.9723	1.0008
AlK	20.33	14.72	0.1867	0.9322	0.9845	1.001
P K	16.73	10.55	0.1493	0.8995	0.9922	1
Total	100	100				

Table 4. Semi-quantitative EDX Analysis of Archaeological Turquoise.

Synthesis: Conclusions of Analytical Study

The textural, compositional, and structural investigation of the two samples has revealed that they are both mineralogical turquoise. Although the structural investigation of the archaeological sample was unsuccessful, the elemental composition of the sample (as derived by both PIXE and EDX) is consistent with turquoise, rather than another blue-green stone mineral. A close inspection of the compositional data generated with both PIXE and EDX reveal several inconsistencies between the two methods. PIXE is the more accurate of the two methods, as EDX was likely hindered by such factors as the absorption effect.

Archaeological Investigations

Sourcing of Turquoise

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 10). Raw turquoise deposits are essentially lithic outcrops – leaving Approach 1 as the ideal method for pursuing provenience studies. Unfortunately, raw material samples from known sources have yet to be analyzed by PIXE. A limited database of unknown archaeological samples (n=38) has been compiled by ASU researchers (Béarat et al. 2003; Kim et al. 2003). This database has enabled partial investigation via Approach 2 (only a single known raw material source is in the sample). While not the ideal, this approach is certainly better than no analysis whatsoever.

1. Sources localized and easy to identify (e.g. obsidian flows and other lithic outcrops)	2. Source materials widespread and boundaries indistinct (esp. ceramics)
Sample and analyze raw material samples from known sources	Sample and analyze unknowns
Form reference groups of knowns and characterize them statistically	Use pattern recognition to partition the unknown data and characterize the resulting groups statistically
Sample and analyze artifacts of unknown provenance and compare them to the known reference groups	Sample and analyze raw materials sources as widely as possible and compare with unknown groups to infer likely sources or source zones for the groups

Figure 10. Two Approaches to Provenance Determination (from Neff and Glowacki 2002:6).

Statistical Methodology

There is some disagreement in the literature as to how to report and analyze provenience data. The Archaeometry Lab at Missouri University Research Reactor (MURR) have developed a standard procedure of reporting major elements as percentages, minor elements in parts per million (ppm). These data are then log ($\log_{10}$) transformulated and subjected to a Principal Components Analysis (PCA) prior to group characterization. This characterization occurs in two steps. Bivariate plots and various cluster analyses are first used to search for initial group hypotheses. These groups are then tested and refined by applying the Mahalanobis Distance metric (references are various, but see Neff and Glowacki 2002; Neff 1994, 2000).

Material Science investigations, however, have long reported these sort of data as normalized oxides. This is calculated by first converting the initial elemental concentrations from ppm to percentages. The percentages of each element are then divided by the atomic weight of the element in question, giving the number of mols of each atom detected in the analysis. The number of mols of each oxide is then determined by taking this value and dividing it by the number of non-oxygen elements in the oxide formula. For example, the number of mols of aluminum is divided by two, since there are two aluminum atoms in Al_2O_5, while the number of mols of titanium is divided by one, since there is only one atom of titanium in TiO_2. These values are then multiplied by the total atomic weight of the oxide to obtain the Weight Percent Oxide. This value is finally divided by the sum of all the Weight Percent Oxide values for that sample, giving the Normalized Weight Percent Oxide. This final step is performed to make the values add up to 100%, even though the values do not actually represent 100% of the elements in the sample.

Each of these values was calculated for the entire database. However, I only report the values for the two samples that I actually analyzed here. Dr. Arleyn Simon, a member of the Arizona State University faculty and one of the authors of Kim et al. 2003, was kind enough to share the raw PIXE data with me for this analysis. The data, however, has not yet been published. Parties interested in this dataset are referred to Kim, Simon, or one of the other authors of the Roosevelt PIXE study (Kim et al. 2003).

In this analysis, I have tended towards a material science methodology. The data, expressed as normalized oxides, were subjected to various cluster analyses. Following Duff (2002), I subjected the un-transformed data to hierarchical cluster analyses with the Ward's and Average Link algorithms, as well as a non-hierarchical k-means cluster analysis. The hierarchical analyses were conducted with SYSTAT 10.0, and the k-means analysis with Keith Kintigh's (2005) Tools for Quantitative Archaeology software package. Kintigh's k-means algorithm includes a Monte Carlo estimation, which enables the user to determine which cluster solutions are significant by comparing the observed numbers to those generated by random runs.

In addition to the above, I attempted to follow variations of the MURR procedure by performing a Principal Components Analysis and log standardization on the data expressed as both ppm and normalized oxides. The PCA failed to produce interpretable results in the case of the log transformed and un-transformed data as ppm or as normalized oxides. Wih each analysis, the first Principal Component summarized more than 85% of the variation, and subsequent attempts to discern compositional groups proved ineffective. As a result of the failed PCA, attempts to asses the strength of the clusters by measuring the Malhalanobis Distance metric were also ineffectual. The calculation requires at least two more samples than measured variables. By eliminating Mn, an element that varied the least among all the samples, I was able to assess the probabilities of group membership for the two cluster solution only, but, as indicated below, I am wary of the high probabilities returned. For reasons discussed below, I opted not to use the first principal component as the sole variable in calculating the Malhalanobis Distance metric, and have instead, chosen to interpret this dataset primarily from the cluster analyses.

Statistical Analysis

Figures 11 and 12 respectively report the results of the Ward's and Average Link cluster analysis. Two cases were identified as outliers in a cursory view of the data and were subsequently omitted from this analysis, leaving a database of 38 cases. Cases of note include Case 36 (the geological sample), Case 37 (the archaeological sample), and Case 38 (the sample recovered from the Florence Junction Project). The remaining cases

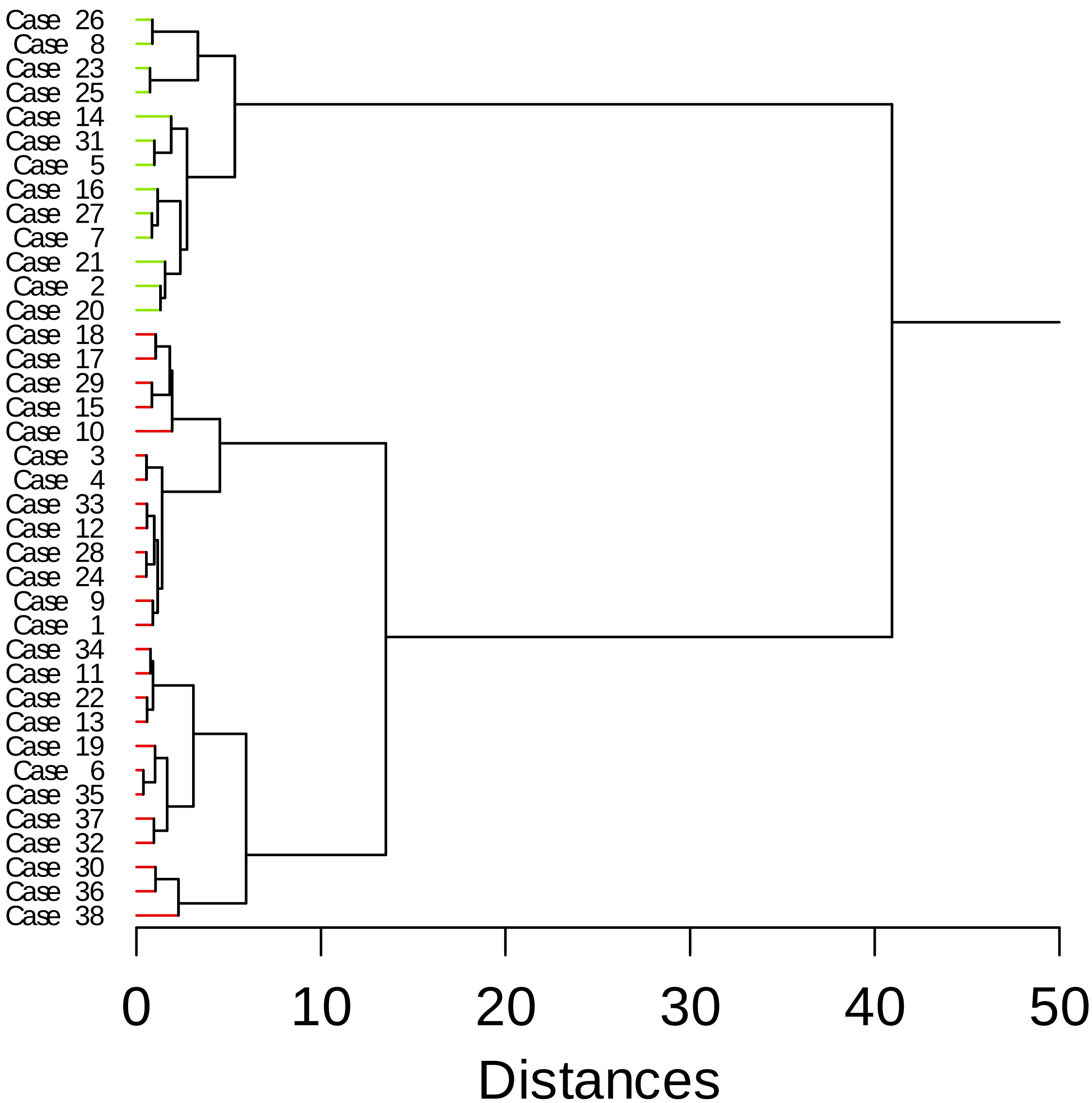

Figure 11. Results of the Ward's Cluster Analysis on the PIXE Database as Normalized Oxides.

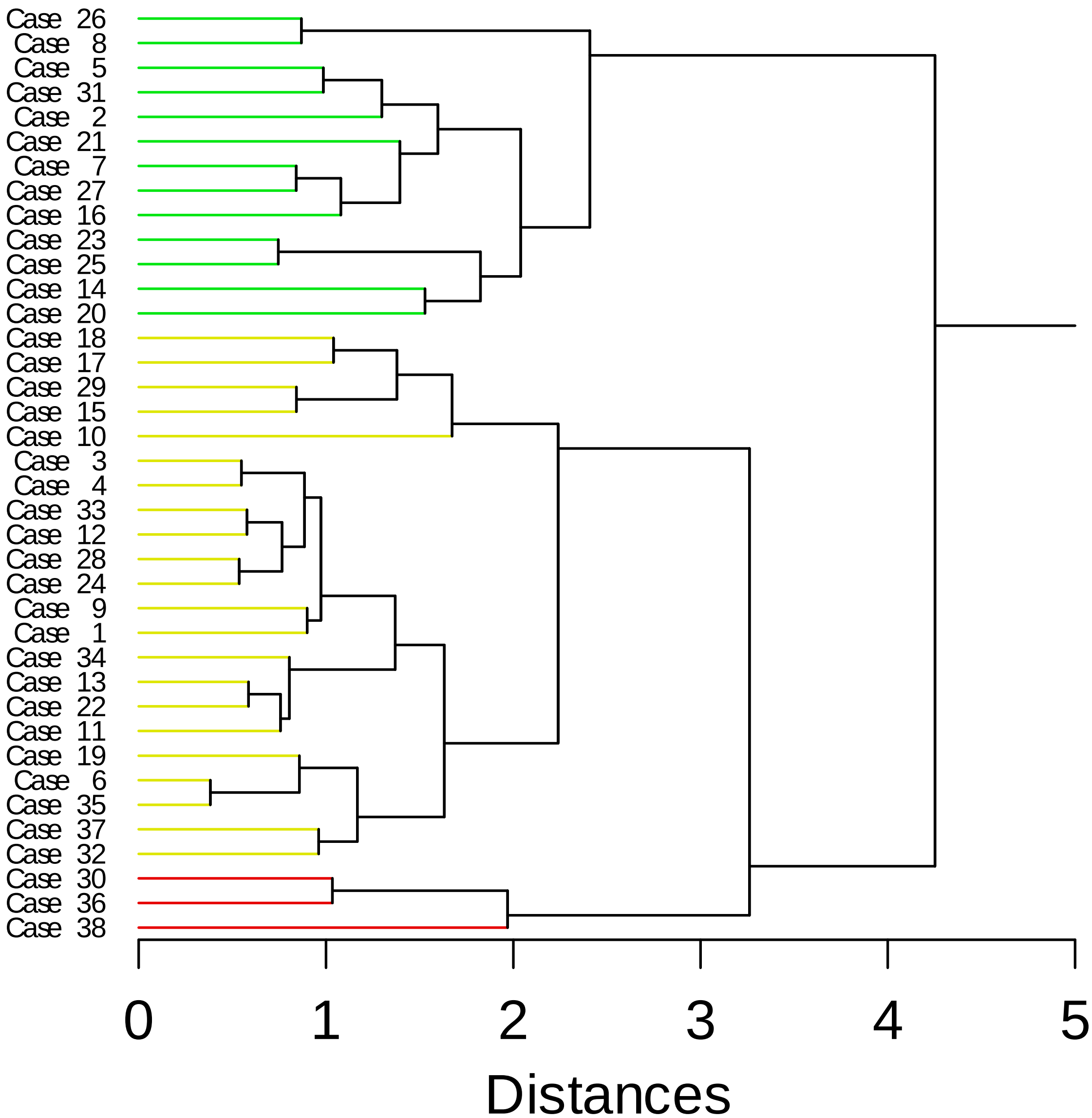

Figure 12. Results of the Average Link Cluster Analysis on the PIXE Database as Normalized Oxides.

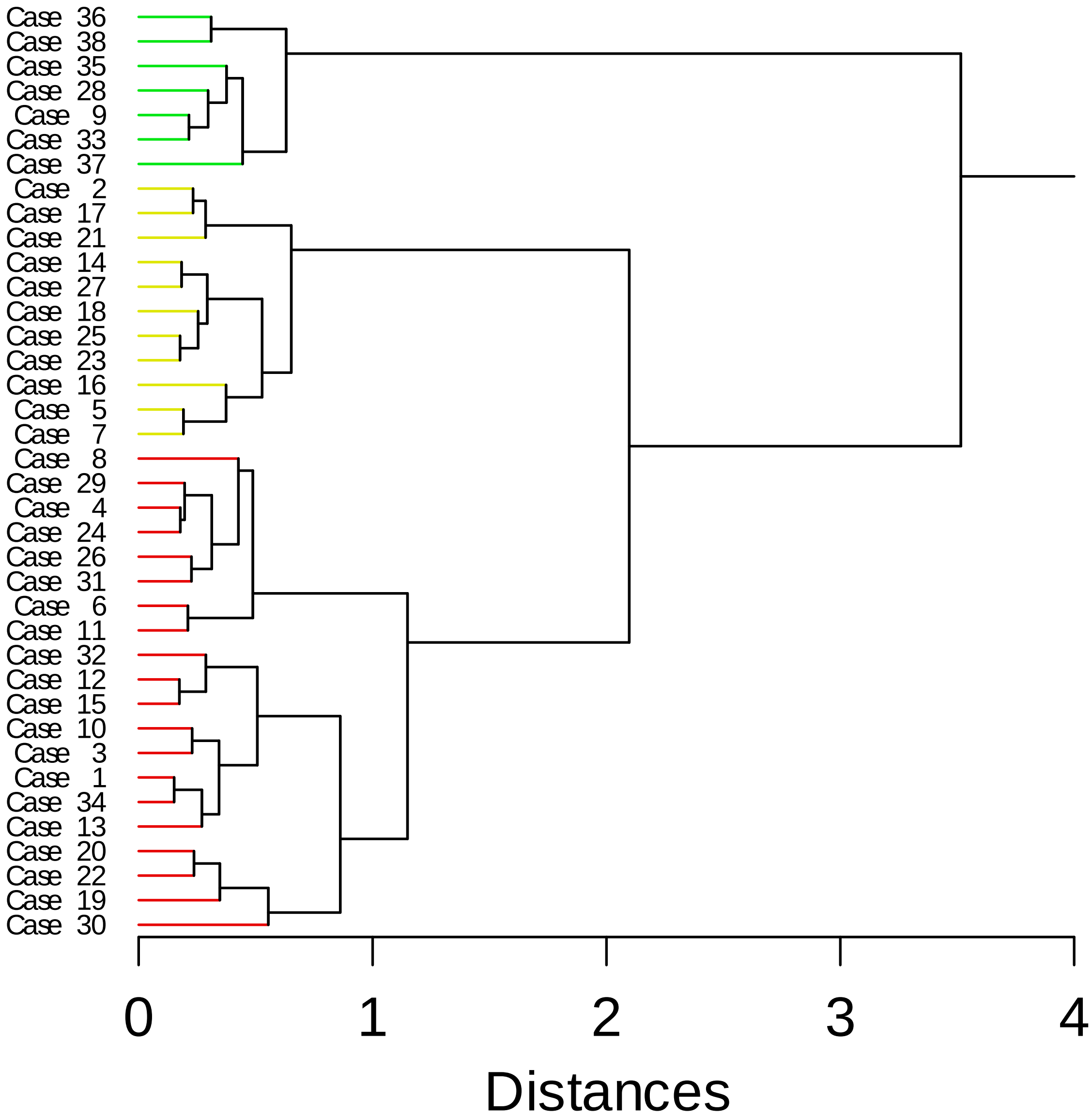

Figure 13. Results of the Ward's Cluster Analysis on the PIXE Database as Log Transformed Normalized Oxides.

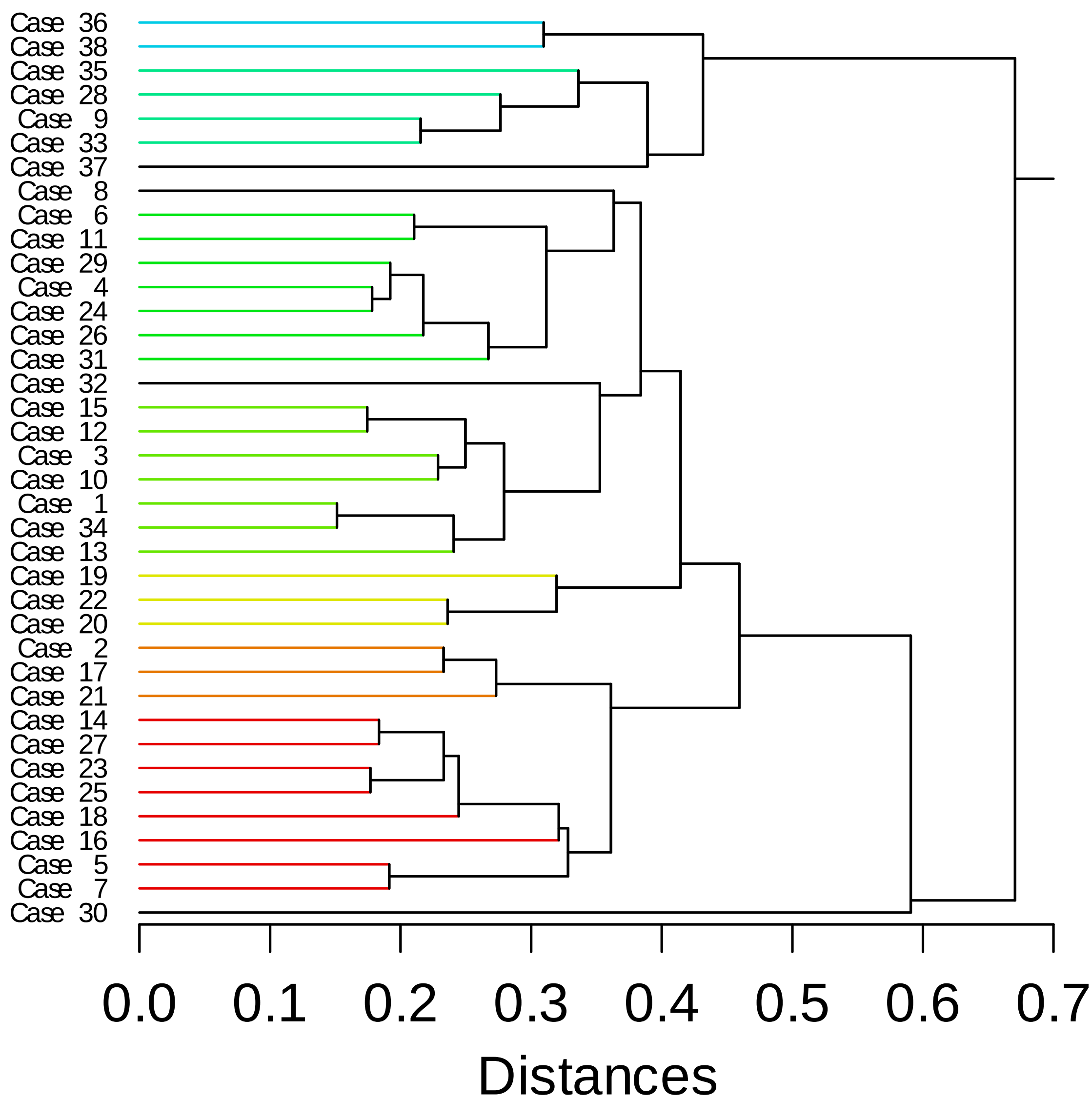

Figure 14. Results of the Average Link Cluster Analysis on the PIXE Database as Log Transformed Normalized Oxides.

represent turquoise objects recovered from the two sites in the Tonto Basin (Kim et al. 2003). Figures 13 and 14 show the results of the same cluster analyses on the data log transformed and expressed as normalized oxides. The log transformed data are significant, in that doing so gives more "weight" to the trace elements, which significant in distinguishing between sources. Table 5 shows the probability of group membership for the two cluster solution identified in the normalized oxide k-means cluster analysis. The k-means cluster analysis too lengthy to be reported here, but in the case of the normalized oxide and log transformed normalized oxide, 2, 3, and 5 cluster solutions were identified as significant. The Geological sample (case 36) may be the source of case 30, as it clusters together in several of the clustering analyses. The archaeological sample (case 37), though it appears to belong to some of the larger clusters, is revealed as an outlier in Figure 14. In short, it appears that a robust possible reference group is present in the Tonto Basin samples, but that neither the Geological or Archaeological sample can be assigned to that group.

Table 5. Mahalanobis Distance Statistics for the Two Cluster Solution of the Normalized Oxide K-means Cluster Analysis (Mn Omitted).

MAHALANOBIS DISTANCE CALCULATION AND POSTERIOR CLASSIFICATION FOR TWO OR MORE GROUPS.

Date: 5/09/06
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Variables used:

Al2O3	SiO2	P2O5	SO3	ClO2	K2O	CaO
TiO2	FeO	CuO	ZnO			

Group 1

Sample	P of Membership in Group 1	P of Membership in Group 2
SH885	93.438	14.623
SH848	91.574	34.988
SH055	96.264	68.156
SH289	96.995	7.469
SH602	96.038	0.442
SH107	91.685	77.611
SH607	95.144	0.549
SH060	98.188	96.818
SH167	95.612	24.435
CT933	97.428	1.831
CT298	95.919	81.102
CT203.1	97.509	0.018
CT203.3	99.009	0.022
CT203.4	93.246	26.970
CT352	94.150	52.370

CT712	96.122	15.448

Group 2

Sample	P of Membership in Group 1	P of Membership in Group 2
SH632	1.970	74.077
SH709	94.527	99.681
SH621	17.711	91.933
SH034	32.595	76.224
SH672	88.969	75.166
SH113	37.064	86.043
SH154	3.415	83.696
SH219	95.652	97.229
SH718	78.324	96.209
SH118	4.784	85.289
CT583	52.281	84.183
CT203.2	79.198	98.156
CT510	78.771	85.533
CT511	23.825	96.679
CT619	25.799	92.289
CT425	67.816	98.598
CT672	0.006	59.678
CT291	83.504	87.561
CT377	19.831	81.344
GEO001	13.802	82.929
ARC001	35.508	99.102
FLO001	0.393	64.707

Interpretation

Custer 1, as seen in the preceding table, seems to represent a robust group, with all probabilities above 0.9. I do not believe that Group 2 represents a legitimate group, but rather simply represents the remaining samples. Kim et al. (2003) included barium and strontium in their PIXE analysis, and demonstrated that these trace elements were the distinct ones providing the variation in the sample. I was forced to omit these elements from the analysis, as they were not recoded in the archaeological and geological samples. Without these trace elements, I believe that significant differences in this second group are being obscured by the major elements.

Technological Differences

Blue-green stone manufacturing detritus has not yet been discovered in Fremont contexts. This, combined with the lack of turquoise sources in the Fremont area (Klein and Hurlburt 1999; Talbot et al. 2000), has led Janetski (2002; Janetski et al. 2000) to conclude that the Fremont imported completed artifacts and were not manufacturing their own from imported or directly procured raw materials. The question then remains, from where were the Fremont obtaining these objects? It has long been thought that the Fremont acquiring their exotic artifacts (i.e., non-native minerals such as turquoise and

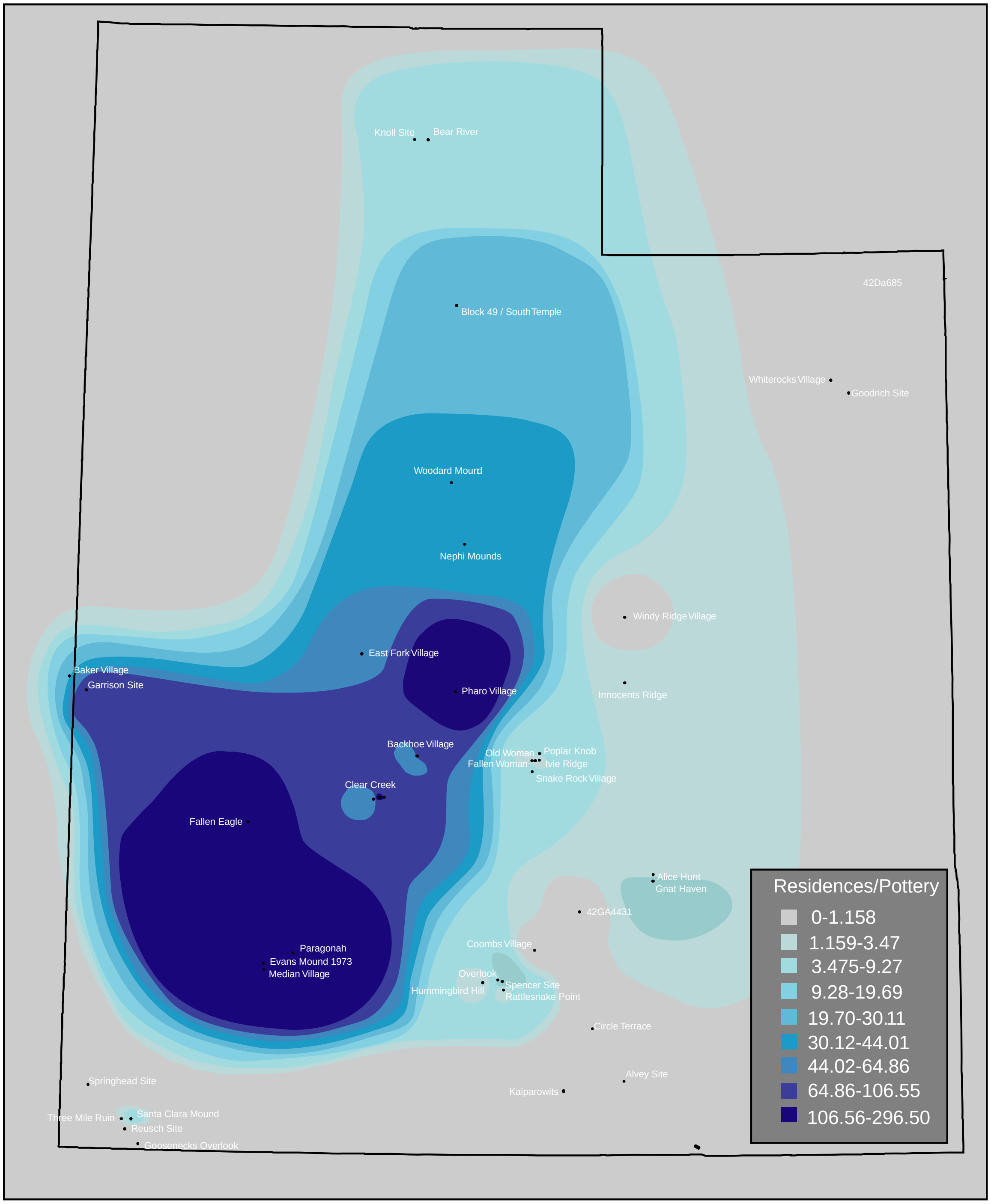

Figure 15. Distribution of Snake Valley Black-on-gray Pottery Expressed as a Ratio of Residences Divided by Pottery.

marine shell) from the same network that supplied Chaco and other Ancestral Puebloan peoples. The tie-in point was assumed to be a connection between Lost City, a substantial Virgin Anasazi pueblo, and the Parowan Valley, a sprawling Fremont pithouse aggregation (Janetski 2002; Lyneis 1992). My own work (Watkins 2006) has cast doubt on this hypothesized link. With ceramic data, I identified a distinct boundary between the Parowan Valley and Virgin Anasazi settlements in the St. George Basin and around Lost City (Figure 15). Almost no pottery was exchanged between Virgin Anasazi and Fremont groups in this region. This boundary represents at least a strong social differentiation, and at most, could be interpreted as evidence for minimal trade and interaction.

A combination of spectral and EDX applied to a collection of blue-green artifacts from Fremont and Anasazi sites could shed light on this problem. The spectral analysis would reveal valuable data regarding the context of manufacture of the objects. Information about how the objects were manufactured would be valuable even if it stood alone. But furthermore, if the beads recovered from Fremont and Anasazi contexts were manufactured differently, than the Fremont were not obtaining their beads from the Anasazi, or from a common third party supplier. EDX would also provide sufficient compositional information to determine what material the objects were constructed from. If many of the Fremont objects are not turquoise, and many of the Anasazi objects are, this would further indicate that the beads were not obtained from a common source, and would also shed light on how the Fremont perceived blue-green stone objects. This analysis only considers a single object from a relevant context, a bead recovered from a Fremont site; however, I consider this a first attempt at what will be a more intensive investigation.

Discussion of Methods for Determining Mineral Composition

Recent research has indicated that some of the blue-green stone ornaments recovered from Fremont contexts are Chrysocholla or copper oxides (Jardine 2004; for a Salado Example see Kim et al. 2003). This phenomenon is common elsewhere in Mesoamerica and the greater Southwest, and all worked blue-green stone artifacts from Pre-Columbian contexts are sometimes labeled by archaeologists as “cultural turquoise” (Weigand and Harbottle 1993). This designation is indicative of the apparent failure of aboriginal peoples to distinguish between the several blue-green minerals available to them, or the distinctions may have been noted but consciously ignored. Regardless, cultural turquoise should not be confused with “mineralogical turquoise”, which refers to a specific mineral species.

In Jardine’s (2004) research, a number of blue-green stone artifacts were taken to a highly qualified mineralogist for identification. After analysis with an electron microprobe, most of his initial designations were shown to be incorrect. This section of the report is an evaluation of the appropriateness of the various analytical methods that might be employed to conclusively determine whether an object is actually mineralogical, or merely an example of cultural turquoise.

The critical factor in analyzing blue-greenstone objects recovered from archaeological contexts is the relative value placed on them by archaeologists and museum professionals. Unlike sherds or lithic debitage, most archaeologically recovered turquoise are in the form of beads, and although they are often found in various stages of completeness, they are usually relatively rare and are considered exhibitable. As such, they are not considered good candidates for destructive analysis. There are, fortunately, a number of non-destructive techniques that are particularly suited to the analysis of flat objects such as a bead. Each of the techniques in this study, for example, could have been carried out on the archaeological sample without lasting impact.

Suggestion for Further Study

As a lithic outcrop that meets the provenience postulate, turquoise is a prime candidate for provenance investigations with "Approach 1", the sampling of raw material sources and comparison with unknown samples. Projects are apparently underway in this direction, including a PhD dissertation from the University of New Mexico and a recently funded NSF proposal. The effective sourcing of turquoise has hamstrung Southwestern for the last 20 years, and critical insights will surely be gained in the near future.

As explained in detail above, I also advocate the microscopic analysis of bead manufacture. In addition to the possibility that differences in manufacture might be correlated to different cultural groups, crucial information would be gleaned regarding the manufacture of turquoise jewelry, including the possibility of finding imbedded grains of whatever may have been used to polish the ornaments.

As has been argued by Kim et al. (2003) and Jardine (2004), better sampling, identification, and characterization is required of blue-green stone artifacts recovered from archaeological contexts. Establishing how much of this material is actually turquoise or other blue-green minerals would go far in revealing prehistoric exchange networks and procurement behavior. Characterizing the objects is best done with an integrative and multifaceted analysis in which texture, structure, and composition are all adequately addressed. As indicated above, there are a variety on non-destructive, appropriate methodologies available at many research laboratories and research institutions.

The archaeological turquoise sample had to be sonicated in acetone to remove organics that were interfering with the analysis. It occurs to me that this organic material might be the remains of prehistoric treatment against turquoise degradation. If this is the case, can we discover what was being used in the treatment? This further insight into the organization of turquoise production would shed light on a significant, yet poorly understood resource.

More intensive work on how to present and analyze provenience data is imperative to future investigations. Questions as to the effectiveness of log-transformulation of the data and various pattern recognition techniques would be best answered by subjecting groups of known, distinct samples to an elemental assay and then experimenting with a variety of techniques to see which is the most effective in revealing the known relationships. Although research along these lines has been undertaken (most notably by MURR personnel and Duff [2002]), a satisfactory methodology has yet to emerge. Of particular interest is the presentation of data in oxide form, and how this might influence log or other transformations and analyses.

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Appendix B - Data Analysis

Table B.1. *Olivella* artifacts from UCLA Paragonah (42IN43) collection

Acc. No.	Provenience	Depth	Genus	Species	Length	Width	Hole Diameter	Drilled/Punched Hole	Type	Complete/Fragment
125-5669	J-5, House 8	30-36	*Olivella*	*dama*	5.5	5.7	4.4	N/A	B3a	C
125-2269	House 22	Floor I	*Olivella*	*dama*	6.3	5.4	4.3	N/A	B3a	C
125-2269	House 22	SW Post Hole	*Olivella*	*dama*	7.6	6.3	3.7	N/A	B3a	C
125-2269	House 22	SW Post Hole	*Olivella*	*dama*	6.2	5.8	4.3	N/A	B3a	C
125-2269	House 22	SW Post Hole	*Olivella*	*dama*	5.8	6.1	4.6	N/A	B3a	C
125-2269	House 28	Floor	*Olivella*	*dama*	6	5.5	4.5	N/A	B3a	C
125-3543	House 37, SE Quadrant	41”	*Olivella*	*dama*	6.3	6	3.9	N/A	B3a	C
125-7698	Mound B, Pit E-4	12-18	*Olivella*	*dama*	4	3.9	3.2	N/A	B3a	C
125-7747	Mound B, Pit G-4	0-6	*Olivella*	*dama*	6.5	6.2	4.6	N/A	B3a	C
125-7792	Mound B, Pit H-3	6-12	*Olivella*	*dama*	6.3	5.4	3.8	N/A	B3a	C
125-7792	K-6	24-30	*Olivella*	*dama*	7.3	5.9	3.9	N/A	B3a	C
125-9161	K-7	12-18	*Olivella*	*dama*	7.2	4.2	4.4	N/A	B3a	C
125-9038	L-6	30-36	*Olivella*	*dama*	6.7	5.5	4.7	N/A	B3a	C
125-269	No Provenience	Surface	*Olivella*	*dama*	6.2	6	4.4	N/A	B3a	C
125-2269	House 22	Floor II	*Olivella*	*dama*	7.6	6.7	4	N/A	B3b	C
125-2269	1JB, House 28	Hole K	*Olivella*	*dama*	7.1	7.1	4.8	N/A	B3b	C
125-7768	Mound B Pithouse, Pit G-16	6-12	*Olivella*	*dama*	8.3	7.6	4.9	N/A	B3b	C
125-7792	K-5	30-34	*Olivella*	*dama*	7.9	7.4	4.4	N/A	B3b	C
125-11228	B-17	6-12	*Olivella*	*dama*	7.6	6.5	4.9	N/A	B3b	C
125-1906	M-7	30-36	*Olivella*	*dama*	7.2	N/A	N/A	N/A	B3?	F
125-156	House 8	Post Hole	*Olivella*	*biplicata*	18.7	10.9	2.3	N/A	C4	F
125-70	J-5, House 8	30-36	*Olivella*	*biplicata?*	7	8.3	2.6	P	D1 Frag?	F
125-3475	J-5, House 8	30-36	*Olivella*	*biplicata*	10.7	13.2	2.7?	P	D1?	F
125-5548	H-22	6-12	*Olivella*	*biplicata*	7.5	10.9	N/A	P?	D1?	F
125-5549	Mound B Pithouse	Subfloor	*Olivella*	*biplicata*	13.3	11.4	3.2	P	D2	C
125-5232	N-1	12-18	*Olivella*		8	7	3	P	D2	C
125-5232	N-13	18-24	*Olivella*	*biplicata*	10.6	10.1	2.8	P	D3	C
125-5152	J-5, House 8	30-36	*Olivella*		4.6	3.7	N/A	N/A	Frag	F
125-5693	J-5, House 8	30-36	*Olivella*		6.8	4.5	N/A	N/A	Frag	F

Table B.1. Continued

Acc. No.	Provenience	Depth	Genus	Species	Length	Width	Hole Diameter	Drilled/Punched Hole	Type	Complete/Fragment
125-5482	J-5, House 8	30-36	*Olivella*		3.9	5.4	N/A	N/A	Frag	F
125-5506	J-5, House 8	30-36	*Olivella*		2.2	3.3	N/A	N/A	Frag	F
125-5313	House 22	Fill	*Olivella*		8.7	6.7	N/A	N/A	Frag	F
125-3748	K-5	30-34	*Olivella*		4	4.2	N/A	N/A	Frag	F
125-6197	No Provenience		*Olivella*		4.8	4.8	2.2	D	G3a	C
125-6093	No Provenience		*Olivella*		6.7	6.1	2	D	G5	C
125-7118	J-7	30-36	*Olivella*	*dama*	N/A	N/A	N/A	N/A	?	F
2313-25	J-7	30-36	*Olivella*	*dama*	N/A	N/A	N/A	N/A	?	F

Table B.2. *Olivella* artifacts from UCLA Summit (42IN40) collection

Acc. No.	Provenience	Depth	Genus	Species	Length	Width	Hole Diameter	Drilled/Punched Hole	Type	Complete/Fragment
333-4253	Pit G0, Stratum 2	30-36	*Olivella*	*dama*	11	6.6	5.6	P	A4?	F
395-1592	17A23	6-12	*Olivella*	*dama*	7.8	5.9	4.5	N/A	B3a	C
395-1199	18A22	6-12	*Olivella*	*dama*	7	5.5	4	N/A	B3a	C
395-1585	18A23	6-12	*Olivella*	*dama*	8.5	5.9	4.1	N/A	B3a	C
395-1585	18A23	6-12	*Olivella*	*dama*	5.5	5.2	3.7	N/A	B3a	C
395-1743	18A23	12-18	*Olivella*	*dama*	6.6	5.3	4.1	N/A	B3a	C
395-2250	18A23	12-18	*Olivella*	*dama*	6.2	6.1	4.7	N/A	B3a	C
395-2736	18A23	18-24	*Olivella*	*dama*	7.3	6.1	3.8	N/A	B3a	C
395-2736	18A23	18-24	*Olivella*	*dama*	7.4	6.4	4.4	N/A	B3a	C
395-3137	18A23	24-30	*Olivella*	*dama*	6.7	6	4.3	N/A	B3a	C
395-5379	18A23	48-54	*Olivella*	*dama*	7.2	5.6	4.5	N/A	B3a	C
395-455	19A23	0-6	*Olivella*	*dama*	5.9	4.8	3.7	N/A	B3a	C
395-1958	20A22	12-18	*Olivella*	*dama*	6.6	6.2	4.5	N/A	B3a	C
395-1958	20A22	12-18	*Olivella*	*dama*	4.9	4.2	2.9	N/A	B3a	C
395-2549	20A22	18-24	*Olivella*	*dama*	5.9	5.5	4.1	N/A	B3a	C
395-3060	20A22	30-36	*Olivella*	*dama*	6.1	5.5	3.9	N/A	B3a	C
395-516	20A22	0-6	*Olivella*	*dama*	7	6	3.6	N/A	B3a	C
395-282	21A22	0-6	*Olivella*	*dama*	5.4	4.7	3.6	N/A	B3a	C
395-86	21A22	0-6	*Olivella*	*dama*	6.2	5.6	4.1	N/A	B3a	C
395-907	21A23	12-18	*Olivella*	*dama*	6.9	5.3	4.1	N/A	B3a	C
509-2673	Area 12, 7A18	0-12	*Olivella*	*dama*	7.5	6.3	4.8	N/A	B3a	C
509-2673	Area 12, 7A18	0-12	*Olivella*	*dama*	6.7	5.5	3.6	N/A	B3a	C

Table B.2. Continued

Acc. No.	Provenience	Depth	Genus	Species	Length	Width	Hole Diameter	Drilled/Punched Hole	Type	Complete/Fragment
509-3409	Area 12, Struct. 16, A Wall Trench	28-34	*Olivella*	*dama*	7	5.5	4	N/A	B3a	C
509-2067	Area 12, Struct. 16, South Quadrant	24-30	*Olivella*	*dama*	5	4.6	4	N/A	B3a	C
509-3401 (3410?)	Area 12, Structure 23, East Quadrant	30-36	*Olivella*	*dama*	7.1	5.6	4	N/A	B3a	C
356-681	E4 ST II	12-19	*Olivella*	*dama*	7.1	6.4	4.2	N/A	B3a	C
333-7626	Inside Structure 2	42-48	*Olivella*	*dama*	8	6.2	4.6	N/A	B3a	C
333-1477	Pit G4, Stratum 2	12-18	*Olivella*	*dama*	7.2	5.7	4.2	N/A	B3a	C
333-2983	Pit G4, Stratum 2	18-24	*Olivella*	*dama*	7	5.9	4	N/A	B3a	C
333-663	Pit G4, Stratum 2	12-18	*Olivella*	*dama*	5.4	4.6	3.7	N/A	B3a	C
333-2326	Pit H9E, Stratum 1	6-12	*Olivella*	*dama*	6.3	5	3.5	N/A	B3a	C
333-9228	No Provenience	Surface?	*Olivella*	*dama*	6.2	5.3	3.9	N/A	B3a	C
356-1062	No Catalog		*Olivella*	*dama*	5.2	5.3	3	N/A	B3a	C
356-5068	No Catalog		*Olivella*	*dama*	6.1	5.6	4.2	N/A	B3a	C
356-776	No Catalog		*Olivella*	*dama*	7.6	5.3	3.2	N/A	B3a	C
395-6611	No Provenience		*Olivella*	*dama*	7	5.7	4.1	N/A	B3a	C
395-516	20A22	0-6	*Olivella*	*dama*	9.4	7.1	5.1	N/A	B3b	C
395-282	21A22	0-6	*Olivella*	*dama*	7.8	6.8	4.6	N/A	B3b	C
509-2449	Area 10, Struct. 17	30-36	*Olivella*	*dama*	7	6.7	4.2	N/A	B3b	C
333-7128	Balk between Pits G2 and G3, Stratum 2	30-36	*Olivella*	*dama*	6.5	6.6	4.7	N/A	B3b	C
333-3500	Pit F0, Stratum 2	12-18	*Olivella*	*dama*	9.1	6.9	4.4	N/A	B3b	C
333-5614	Pit F0, Stratum 2	30-36	*Olivella*	*dama*	7.6	7	4.8	N/A	B3b	C
333-7040	Pit F0, Stratum 2	30-36	*Olivella*	*dama*	7.7	6.7	4.8	N/A	B3b	C
333-7041	Pit F0, Stratum 2	30-36	*Olivella*	*dama*	9.8	7.9	4.6	N/A	B3b	C
333-2536	Pit G2, Stratum 2	18-24	*Olivella*	*dama*	8	6.7	4.6	N/A	B3b	C
395-282	21A22	0-6	*Olivella*	*dama?*	8.8	6.1	N/A	N/A	B3?	F
395-5315	19A23	54-60	*Olivella*	*biplicata*	10.6	8.2	2.2	D	C2	C
333-8163	Pit F2, Stratum 2	66-72	*Olivella*	*biplicata*	9.1	9	2.6	D	C2	C
333-4562	Pit G0, Stratum 2	36-42	*Olivella*	*biplicata*	10.9	9.3	2.6	D	C2	C
395-6611	No Provenience		*Olivella*	*biplicata*	11	9.8	2.2	D	C2	C
395-317	20A22	0-6	*Olivella*	*biplicata*	9.3	8.4	2.3	D	C3	C
509-2103	3A19	6-12	*Olivella*		7.8	6.5	2.7	D	C3	C
509-3346	Area 12, Struct. 21, South Quadrant	36-42	*Olivella*		8.1	7.4	2.4	D	C3	C
356-4659	No Catalog		*Olivella*	*biplicata*	8.1	9.2	2.5	D	C3	C
395-327	18A22	0-6	*Olivella*	*dama*	14.8	7.4	1.9	D	C4	C
333-5799	Pit H9S, Stratum 2	12-18	*Olivella*	*biplicata*	17.6	11.9	2.2	D	C4	C
333-3082	Pit F1, Stratum 2	12-18	*Olivella*		9.2	7.1	2.6	D	C7	C
395-844	17A22	0-6	*Olivella*	*biplicata*	14.5	12.5	4.2	P	D1	C
395-3742	18A23	30-36	*Olivella*	*biplicata*	15.9	11.3	3.7	P	D1	C
333-713	Pit G0, Stratum 2	0-6	*Olivella*	*biplicata*	12.7	12.7	2.8?	P	D1	F
356-1118	No Catalog		*Olivella*	*biplicata*	13.6	11	4.2	P	D1	C

Table B.2. Continued

Acc. No.	Provenience	Depth	Genus	Species	Length	Width	Hole Diameter	Drilled/Punched Hole	Type	Complete/Fragment
356-2475	No Catalog		*Olivella*	*biplicata*	17.3	14.2	6.8	P	D1	C
395-3726	21A22	30-36	*Olivella*	*biplicata*	14.3	11.4	3.1	P	D1	C
509-2530	Area 12, Struct. 16, South Quadrant	30-36	*Olivella*	*biplicata*	12.4	broken	3.4	P	D1?	F
333-139	Pit F4	12-18	*Olivella*	*biplicata*	12.1	13.2	Broken	P	D1?	F
333-4289	Pit F4, Stratum 2	36-42	*Olivella*	*biplicata*	11	9	4	P	D2	C
395-333	7A21E, East Quad?	0-6	*Olivella*		7	6.6	2	P	D3	F
333-2035	Pit G2	12-18	*Olivella*	*biplicata*	12.3	10.6	3.4	P	D3	C
333-4903	Pit G5, Stratum 2	48-54	*Olivella*	*biplicata*	9.1	9	2.4	D	F3a	C
333-1034	Pit G5, Stratum 1	24-30	*Olivella*	*dama*	8.7	5.9	N/A	N/A	Frag	F
509-2257	Struct. # illegible	2-25	*Olivella*		3.2	3.4	1.2	D	G1	C
356-1808	No Catalog		*Olivella*		8.6	8.3	2.7	D	G2	C
395-1199	18A22	6-12	*Olivella*		8	6.9	2.6	D	G5	C
395-5396	20A22	48-54	*Olivella*		6.3	5.6	2.3	D	G5	C
509-2228	Area 10, Struct. 17	6-12	*Olivella*	*biplicata*	9.4	8.6	2	D	J	C
395-282	21A22	0-6	*Olivella*		5.1	4.3	N/A	N/A	?	F
395-333	7A21E, East Quad?	0-6	*Olivella*		4	4.8	N/A	N/A	?	F

Table B.3. *Olivella* artifacts from UCLA Parowan (42IN100) collection

Acc. No.	Provenience	Depth	Genus	Species	Length	Width	Hole Diameter	Drilled/Punched Hole	Type	Complete/Fragment
433-9530	Area 2, E-14	42-48	*Olivella*	*dama*	11.7	6.3	3.6	N/A	A1	C
433-6613	Area 2, E-15	36-42	*Olivella*	*dama*	13.8	6.7	4.2	N/A	A1	C
433-5346	No Provenience		*Olivella*	*dama*	13.4	6.2	2.5	N/A	A1	C
434-173	Pit A	18-24	*Olivella*	*dama*	11.6	6.4	3.5	N/A	A1	C
433-2054	Area 3, D-20	0-6	*Olivella*	*dama*	11.2	6.4	3.2/2.4	P	A4	C
433-8484	Area 2, E-14	36-42	*Olivella*	*biplicata*	18.6	11.5	6.6/2.7	D	A6	C
433-4881	Area 1, C-11	0-6	*Olivella*	*dama*	7	5.9	5	N/A	B3a	C
433-4960	Area 1, C-11	0-6	*Olivella*	*dama*	7.3	5.8	4.6	N/A	B3a	C
433-9810	Area 1, C-11	36-42	*Olivella*	*dama*	5.4	5.3	4.7	N/A	B3a	C
433-5320	Area 1, C-12	0-6	*Olivella*	*dama*	7.4	6.4	4.5	N/A	B3a	C
433-2006	Area 1, D-11	0-6	*Olivella*	*dama*	7.7	6.1	4.1	N/A	B3a	C
433-4230	Area 1, D-11	6-12	*Olivella*	*dama*	6.6	6.4	3.6	N/A	B3a	C
433-4230	Area 1, D-11	6-12	*Olivella*	*dama*	6.6	5.6	4.1	N/A	B3a	C

Table B.3. Continued

Acc. No.	Provenience	Depth	Genus	Species	Length	Width	Hole Diameter	Drilled/Punched Hole	Type	Complete/Fragment
433-6643	Area 1, E-12	6-12	*Olivella*	*dama*	6.9	5.7	3.9	N/A	B3a	C
433-4102	Area 1, F-11	6-12	*Olivella*	*dama*	7.3	6.2	3.9	N/A	B3a	C
433-3090	Area 2, D-14	30-36	*Olivella*	*dama*	6.6	6.3	5	N/A	B3a	C
433-5833	Area 2, D-14	30-36	*Olivella*	*dama*	7.5	6.3	3.9	N/A	B3a	C
433-3420	Area 2, D-15	12-18	*Olivella*	*dama*	6.7	5.9	3.9	N/A	B3a	C
433-8154	Area 2, D15/16 Structure 10	48-54	*Olivella*	*dama*	6.3	5	3.5	N/A	B3a	C
433-2215	Area 2, D-16	0-6	*Olivella*	*dama*	6.3	5.8	4.5	N/A	B3a	C
433-2215	Area 2, D-16	0-6	*Olivella*	*dama*	6.7	6.2	4.5	N/A	B3a	C
433-2215	Area 2, D-16	0-6	*Olivella*	*dama*	7.2	5.8	4.4	N/A	B3a	C
433-2215	Area 2, D-16	0-6	*Olivella*	*dama*	7.4	6	N/A	N/A	B3a	F
433-5584	Area 2, D-20	12-18	*Olivella*	*dama*	6.5	6	4.5	N/A	B3a	C
433-5585	Area 2, D-20	12-18	*Olivella*	*dama*	6.3	5.4	3.7	N/A	B3a	C
433-6591	Area 2, E-14	18-24	*Olivella*	*dama*	5.6	5.7	3.7	N/A	B3a	C
433-9114	Area 2, E-14	30-36	*Olivella*	*dama*	4.9	4.4	3	N/A	B3a	C
433-3798	Area 2, E-16	24-30	*Olivella*	*dama*	3.9	3.5	2.9	N/A	B3a	C
433-6689	Area 2, E-17	none	*Olivella*	*dama*	7.4	5.5	3.8	N/A	B3a	C
433-2244	Area 2, F-15	0-6	*Olivella*	*dama*	7.5	6.4	4	N/A	B3a	C
433-2393	Area 2, F-15	12-18	*Olivella*	*dama*	6.6	6	4.3	N/A	B3a	C
433-2394	Area 2, F-15	12-18	*Olivella*	*dama*	7.4	6.1	4.8	N/A	B3a	C
433-3396	Area 2, F-16	0-6	*Olivella*	*dama*	5.7	5.5	4.3	N/A	B3a	C
433-4979	Area 2, F-16	24-30	*Olivella*	*dama*	6.5	6.3	4.7	N/A	B3a	C
433-7163	Area 2, F-16	24-30	*Olivella*	*dama*	7.5	5.5	3.3	N/A	B3a	C
433-7430	Area 2, F-16	12-18	*Olivella*	*dama*	7.5	5.9	3.8	N/A	B3a	C
433-7431	Area 2, F-16	12-18	*Olivella*	*dama*	6.3	5.3	4.1	N/A	B3a	C
433-2054	Area 3, D-20	0-6	*Olivella*	*dama*	6.2	6	4.8	N/A	B3a	C
433-2054	Area 3, D-20	0-6	*Olivella*	*dama*	6.9	5.9	4.2	N/A	B3a	C
433-10,032	Area 3, E-20	60-66	*Olivella*	*dama*	5.1	5	3.3	N/A	B3a	C
433-3057	Area 3, E-20	0-6	*Olivella*	*dama*	7.8	6.1	4.5	N/A	B3a	C
433-3473	Area 3, E-20	12-18	*Olivella*	*dama*	7.5	6	4.5	N/A	B3a	C
433-6934	Area 3, E-20	18-24	*Olivella*	*dama*	7.1	5.8	4	N/A	B3a	C
433-7013	Area 3, E-20	18-24	*Olivella*	*dama*	7.5	5.8	4.4	N/A	B3a	C
433-7014	Area 3, E-20	18-24	*Olivella*	*dama*	6.9	6	4.4	N/A	B3a	C
433-2006	Area 1, D-11	0-6	*Olivella*	*dama*	8	6.8	5.2	N/A	B3b	C
433-4605	Area 1, E-10	6-12	*Olivella*	*dama*	7.1	6.7	4.7	N/A	B3b	C
433-6892	Area 2, E-15	48-54	*Olivella*	*dama*	7	6.7	4.2	N/A	B3b	C
433-2243	Area 2, F-15	0-6	*Olivella*	*dama*	7.2	7	5	N/A	B3b	C

Table B.3. Continued

Acc. No.	Provenience	Depth	Genus	Species	Length	Width	Hole Diameter	Drilled/Punched Hole	Type	Complete/Fragment
433-2245	Area 2, F-15	0-6	*Olivella*	*dama*	6.9	6.7	4.5	N/A	B3b	C
433-3954	Area 2, F-16	6-12	*Olivella*	*dama*	7.7	6.6	4.1	N/A	B3b	C
433-7429	Area 2, F-16	12-18	*Olivella*	*dama*	8.7	7.9	4.6	N/A	B3b	C
433-Y-438	No Provenience		*Olivella*	*dama*	7.2	6.6	4.4	N/A	B3b	C
433-5037	Area 1, C-11	6-12	*Olivella*	*dama*	6.1	5.3	4	N/A	B6a	C
433-3300	Area 1, D-12	0-6	*Olivella*	*biplicata*	14.6	10	3.6	P	C2	C
433-5908	Area 1, D-12	24-30	*Olivella*	*biplicata*	13.3	10.9	3	D	C2	C
433-4006	Area 2, F-15	24-30	*Olivella*	*biplicata*	12.7	11	2.6	D	C2	C
433-4047	Area 3, D-20	18-24	*Olivella*	*biplicata*	9.1	7.7	2.1	D	C2	C
433-7501	Area 3, E-20	36-42	*Olivella*	*biplicata*	12.3	9.4	2	D	C2	C
434-589	Pit B	42-48	*Olivella*	*biplicata*	10.4	8.7	2.1	D	C2	C
433-4821	Area 2, D-16	24-30	*Olivella*	*biplicata*	14.4	9.6	2.1	D	C4	F
433-5834	Area 2, D-14	30-36	*Olivella*	*biplicata*	9.7	8.6	2.7	P	C5	C
433-6425	Area 2, D-17	0-6	*Olivella*		7.3	7.3	2	D	C7	C
433-5499	Area 1, C-12	12-18	*Olivella*	*biplicata*	9.5	9.6	2	D	C7	C
433-4846	Area 2, D-15	36-42	*Olivella*	*biplicata*	15.2	9.2	3	P	D1	F
433-2350	Area 2, D-16	6-12	*Olivella*	*biplicata*	16.7	12.7	4.4	P	D1	C
433-8522	Area 2, E-14	36-42	*Olivella*	*biplicata*	10.4	8.6	2.9	P	D1	F
433-2899	Area 2, F-15	24-30	*Olivella*	*biplicata*	11.3	9.5	3.3	P	D1	C
433-4882	Area 1, C-11	0-6	*Olivella*	*biplicata*	12.9	10.2	3.1?	P	D1?	F
433-7502	Area 3, E-20	36-42	*Olivella*	*biplicata*	12	8.2	2.7	P	D2	C
433-3300	Area 1, D-12	0-6	*Olivella*	*biplicata*	11.2	8.3	3.1	P	D3	C
433-8154	Area 2, D15/16 Structure 10	48-54	*Olivella*		6.3	8.9	2.6	P	D3	F
433-6165	Area 2, D-16	30-36	*Olivella*	*biplicata*	11.8	10.8	3.1	P	D3	C
433-5301	Area 2, D-17	30-36	*Olivella*	*biplicata*	11.3	10.3	3.6	P	D3	C
433-2344	Area 2, E-16	6-12	*Olivella*	*biplicata*	14.5	8.3	4.1	P	D3	F
433-5566	No Provenience		*Olivella*	*biplicata*	12.8	13.6	5	P	D3	C
433-4980	Area 2, F-16	24-30	*Olivella*		10.7	8.1	N/A	N/A	Frag	F
433-6405	Area 2, D-16	36-42	*Olivella*		3.8	3.8	2	D	G1	C
433-2189	Area 2, E-15	0-6	*Olivella*		5.7	5.3	2.8	D	G3	C
433-6406	Area 2, D-16	36-42	*Olivella*	*biplicata?*	7.2	7.9	2	D	G5	F
434-370	Pit B	24-30	*Olivella*		10	7.6	1.8, 2	D	?	F

Table B.4. *Olivella* artifacts housed at the Smithsonian Institution from Judd's excavations at Paragonah (42IN43)

Acc. No.	Provenience*	Depth**	Genus	Species	Length	Width	Hole Diameter	Drilled/Punched Hole	Type
A303121			*Olivella*	*dama*	7.2	6.5	4.2	N/A	B3a
A303121			*Olivella*	*dama*	7.5	6.4	4.6	N/A	B3a
A303121			*Olivella*	*dama*	6.4	6.5	4.1	N/A	B3a
A303121			*Olivella*	*dama*	6.9	5.9	4.2	N/A	B3a
A303121			*Olivella*	*dama*	8.3	6.1	4.6	N/A	B3a
A303121			*Olivella*	*dama*	8.2	7.2	4.4	N/A	B3b
A303121			*Olivella*	*dama*	7.1	6.6	4.5	N/A	B3b
A291932			*Olivella*	*biplicata*	11	10.3	3.4	P	C2i
A303119			*Olivella*	*biplicata*	12	10.4	3	P	C7?
A303119			*Olivella*		7.6	6.9	2.4	D	C7
A303119			*Olivella*	*biplicata*	11.5	10.4	3.2	D	C2
A303120			*Olivella*	*dama*	13.5	6.7	2.6	N/A	A1b
A291947			*Olivella*		10.4	10.4	2.9	P	F3a
A303118			*Olivella*	*biplicata*	17.7	13.5	4.4	P	D2
A303118			*Olivella*	*biplicata*	19.8	13.2	3.4	P	D1
A303118			*Olivella*	*biplicata*	17.4	11.8	4.5	P	D1
A303117			*Olivella*	*biplicata*	19.8	12.4	7, 2.9	D	A6c
A291946			*Olivella*		5.9	4.8	2	D	G5
A288572			*Olivella*	*dama*	11.4	5.3	2.2	N/A	A1a
A288571†			*Olivella*	*dama*				N/A	B3a
A288571†			*Olivella*	*dama*				N/A	B3a
A288571†			*Olivella*	*dama*				N/A	B3a
A288571†			*Olivella*	*dama*				N/A	B3a
A288571†			*Olivella*	*dama*				N/A	B3a
A288571†			*Olivella*	*dama*				N/A	B3a
A288571†			*Olivella*	*dama*				N/A	B3a
A288571†			*Olivella*	*dama*				N/A	B3a
A288571†			*Olivella*	*dama*				N/A	B3a
A288571†			*Olivella*	*dama*				N/A	B3a
A288571†			*Olivella*	*dama*				N/A	B3a
A288571†			*Olivella*	*dama*				N/A	B3a
A288571†			*Olivella*	*dama*				N/A	B3a
A288571†			*Olivella*	*dama*				N/A	B3a
A288571†			*Olivella*	*dama*				N/A	B3a

* No provenience information available
** No depth information available
† A288571 accession number contained 15 B3 beads, none were measured

Table B.5. *Olivella* artifacts from SUU Summit (42IN40) collection

Acc. No.	Provenience	Depth	Genus	Species	Length	Width	Hole Diameter	Drilled/Punched Hole	Type	Complete/Fragment
37-13,763	28A24East	6-12	*Olivella*	*dama*	12.5	6.5	3.7	N/A	A1a	C
37-13,421	Pithouse 67-3	None	*Olivella*	*dama*	12.7	6.2	2.4	N/A	A1a	C
37-558	13A18	6-12	*Olivella*	*dama*	4.7	4.6	3.7	N/A	B3a	C
37-3,798	14A19	48-54	*Olivella*	*dama*	6.5	5.4	4	N/A	B3a	C
37-4,890	14A19	18-24	*Olivella*	*dama*	6.9	5.6	3.1	N/A	B3a	C
37-9,077	14A19	54-60	*Olivella*	*dama*	6.8	5.7	3.8	N/A	B3a	C
37-1,198	14A20	12-18	*Olivella*	*dama*	7.7	6.3	4.2	N/A	B3a	C
37-2,346	14A20	24-30	*Olivella*	*dama*	7.6	6	4.2	N/A	B3a	C
37-872	14A21	12-18	*Olivella*	*dama*	5.9	5.3	2.7	N/A	B3a	C
37-3,529	15A18	12-18	*Olivella*	*dama*	7.2	6.3	4	N/A	B3a	C
37-5,815	15A18	30-36	*Olivella*	*dama*	6.1	5.5	3.6	N/A	B3a	C
37-7,083	15A19	36-42	*Olivella*	*dama*	5.5	4.5	3	N/A	B3a	C
37-8,319	15A19	36-42	*Olivella*	*dama*	5.7	4.8	2.7	N/A	B3a	C
37-9,957	15A19	60-66	*Olivella*	*dama*	4.7	3.6	2.6	N/A	B3a	C
37-5,915	19A21 North	18-24	*Olivella*	*dama*	6.2	6.5	3.9	N/A	B3a	C
37-6,197	19A21 West	6-12	*Olivella*	*dama*	6.3	5.4	3.4	N/A	B3a	C
37-5,573	20A21 North	18-24	*Olivella*	*dama*	7.5	6.2	4.2	N/A	B3a	C
37-5,951	21A21 East	6-12	*Olivella*	*dama*	7.4	6.4	4.2	N/A	B3a	C
37-5,312	21A21 North	0-6	*Olivella*	*dama*	5.5	5.1	3.7	N/A	B3a	C
37-5,313	21A21 North	0-6	*Olivella*	*dama*	5.5	4.7	3.2	N/A	B3a	C
37-5,967	21A21 North Outside Structure	12-18	*Olivella*	*dama*	4	4.6	3	N/A	B3a	C
37-8,595	22A21 South	12-18	*Olivella*	*dama*	5	4.6	3.1	N/A	B3a	C
37-5,976	23A21 North	12-18	*Olivella*	*dama*	4.8	4.9	3	N/A	B3a	C
37-12,359	28A21 South	12-18	*Olivella*	*dama*	6.1	5.4	4	N/A	B3a	C
37-12,898	28A23	6-12	*Olivella*	*dama*	3.8	3.7	3.1	N/A	B3a	C
37-13,081	28A23 South	6-12	*Olivella*	*dama*	5.8	5.4	3.3	N/A	B3a	C
37-12,976	28A24 South	6-12	*Olivella*	*dama*	6.8	5.1	3.3	N/A	B3a	C
37-13,922	29A24 North	6-12	*Olivella*	*dama*	7.2	6.2	4	N/A	B3a	C
31-2,795	HO/HI Balk	48-54	*Olivella*	*dama*	6	5.4	4	N/A	B3a	C
37-7,244	Inter. Sruct. #1	18-24	*Olivella*	*dama*	7.3	6.1	3.8	N/A	B3a	C
37-7,242	Inter. Struct. #1	18-24	*Olivella*	*dama*	6.8	5.7	4	N/A	B3a	C
37-7,243	Inter. Struct. #1	18-24	*Olivella*	*dama*	8	6.4	4.2	N/A	B3a	C
37-7,245	Inter. Struct. #1	18-24	*Olivella*	*dama*	7.8	6.3	3.9	N/A	B3a	C
37-7,246	Inter. Struct. #1	18-24	*Olivella*	*dama*	7.6	6.3	4	N/A	B3a	C
37-8,012	Inter. Struct. #2	18-24	*Olivella*	*dama*	6.1	5.4	3.1	N/A	B3a	C
37-8,014	Inter. Struct. #2	18-24	*Olivella*	*dama*	6	5.5	3.5	N/A	B3a	C
37-8,049	Inter. Struct. #2	24-Floor	*Olivella*	*dama*	6	5.4	3	N/A	B3a	C
37-11,109	No provenience		*Olivella*	*dama*	6.9	5.9	3.1	N/A	B3a	C
37-11,109	No provenience		*Olivella*	*dama*	6.8	5.4	3.9	N/A	B3a	C

Table B.5. Continued

Acc. No.	Provenience	Depth	Genus	Species	Length	Width	Hole Diameter	Drilled/Punched Hole	Type	Complete/Fragment
37-11,109	No provenience		*Olivella*	*dama*	5.8	5.3	3.5	N/A	B3a	C
37-11,109	No provenience		*Olivella*	*dama*	5.5	5.1	3.2	N/A	B3a	C
37-11,109	No provenience		*Olivella*	*dama*	6.5	5.8	4	N/A	B3a	C
37-11,109	No provenience		*Olivella*	*dama*	6	4.6	3.5	N/A	B3a	C
37-11,110	No provenience		*Olivella*	*dama*	4.4	3.5	2.6	N/A	B3a	C
37-13,460	No Provenience		*Olivella*	*dama*	6.1	5	3.4	N/A	B3a	C
37-13,460	No Provenience		*Olivella*	*dama*	6.5	5.4	3.9	N/A	B3a	C
37-14,063	No Provenience		*Olivella*	*dama*	4.4	4.1	3	N/A	B3a	C
37-391	No Provenience		*Olivella*	*dama*	6.9	5.4	3.4	N/A	B3a	C
37-5,175	No Provenience		*Olivella*	*dama*	7.3	6.3	4	N/A	B3a	C
37-12,576	Pithouse 101 Fill	12-18	*Olivella*	*dama*	6.4	5.1	3	N/A	B3a	C
37-12,613	Pithouse 101 Fill	12-18	*Olivella*	*dama*	7.1	5.8	3.7	N/A	B3a	C
37-12,700	Pithouse 101 Fill	30-36	*Olivella*	*dama*	6.6	4.9	3.2	N/A	B3a	C
37-12,739	Pithouse 101 Fill	36-Floor	*Olivella*	*dama*	7.9	5.9	3.6	N/A	B3a	C
37-12,739	Pithouse 101 Fill	36-Floor	*Olivella*	*dama*	6.3	5.8	3.3	N/A	B3a	C
37-13,330	Pithouse 67-3 Fill	30-36	*Olivella*	*dama*	7.6	5.4	3.9	N/A	B3a	C
37-13,330	Pithouse 67-3 Fill	30-36	*Olivella*	*dama*	6.8	5.5	3.3	N/A	B3a	C
37-13,330	Pithouse 67-3 Fill	30-36	*Olivella*	*dama*	6.4	5.4	3.5	N/A	B3a	C
37-13,217	Pithouse 67-3 fill	18-24	*Olivella*	*dama*	7.8	6.5	4.4	N/A	B3a	C
37-13,217	Pithouse 67-3 fill	18-24	*Olivella*	*dama*	7	5.8	3.7	N/A	B3a	C
37-13,174	Pithouse 67-3 fill	12-18	*Olivella*	*dama*	7	6.4	4.1	N/A	B3a	C
37-13,174	Pithouse 67-3 fill	12-18	*Olivella*	*dama*	5.7	4.8	3.4	N/A	B3a	C
37-418	13A19	12-18	*Olivella*	*dama*	7.8	7.4	4.9	N/A	B3b	C
37-10,074	14A19	60-66	*Olivella*	*dama*	10.4	8	4.6	N/A	B3b	C
37-12,869	28A23	0-6	*Olivella*	*dama*	7.9	6.8	4.2	N/A	B3b	C
37-6,479	Inter. Struct. #1	18-24	*Olivella*	*dama*	8.2	7.1	4.6	N/A	B3b	C
37-13,374	Pithouse 67-3 fill	36-floor	*Olivella*	*dama*	6.6	6.9	4.2	N/A	B3b	C
37-5,722	27A21 East	0-6	*Olivella*	*dama*	6.3	5.6	3.4	N/A	B6a	C
37-12,160	16A18	84-90	*Olivella*	*biblicata*	10	7.9	2.1	D	C2	F
37-10,966	16A19	42-48	*Olivella*	*biblicata*	9.8	9.1	2.1	D	C2	C
31-1,715	I-O	36-42	*Olivella*	*biblicata*	10.9	10.1	2	D	C2	C
37-10,535	16A19	36-42	*Olivella*	*biblicata*	10.7	5.2	2.2	D	C2?	F
37-11,793	16A19	72-78	*Olivella*	*biblicata*	6.5	7.5	2.7?	D	C2?	F
37-9,278	16A18	18-24	*Olivella*		7.9	7.1	1.8	D	C3	C
37-11,023	15A18	66-72	*Olivella*	*biblicata*	9.4	6	2.2	D	C3?	F
37-12,000	13A18 large intrusive pit	72-78	*Olivella*	*biblicata*	10.3	9.5	2.1	D	C7	C
37-11,112	No provenience		*Olivella*	*biblicata*	9.9	9.8	2.2	D	C8	C
37-10,165	14A19 Pithouse interior	66-floor	*Olivella*	*biblicata*	16.5	13.3	4	P	D1	C
37-10,166	14A19 Pithouse interior	66-floor	*Olivella*	*biblicata*	18.2	13.8	4.6	P	D1	C
31-2,608	G-1/H-1 Balk	30-36	*Olivella*	*biblicata*	18.9	13.9	4.1	P	D1	C
37-11,437	16A19	54-60	*Olivella*	*biblicata*	8	8.3	2	D	F1	C

Table B.5. Continued

Acc. No.	Provenience	Depth	Genus	Species	Length	Width	Hole Diameter	Drilled/Punched Hole	Type	Complete/Fragment
37-5,182	No Provenience		*Olivella*	*biblicata*	10.5	10	2.2	D	F1	C
37-11,566	16A18	36-42	*Olivella*	*biblicata*	8.3	8	2.1	D	F3a	C
37-8,321	15A19	36-42	*Olivella*		5.9	5.8	2.5	D	G2	C
37-12,433	28A22	6-12	*Olivella*		5.3	5.3	2.2	D	G2	C
37-11,111	No provenience		*Olivella*		4.9	4.9	2.3	D	G3a	C
37-1,692	13A20	18-24	*Olivella*		5.6	5.3	2.5	D	G5	C
37-11,265	14A18 Pithouse interior	66-72	*Olivella*	*biblicata*	7.5	6.6	1.7	D	G5	C
37-8,520	21A20 North	12-18	*Olivella*		7.5	7.1	1.5	D	G5	C
37-8,262	Balk 18A21	6-12	*Olivella*		8.5	7	3.1	D	G5	C
37-13,218	Pithouse 67-3 fill	18-24	*Olivella*	*biblicata*	19	10.3		N/A	?	F

Table B.6. *Olivella* artifacts from Nephi Mounds (42JB2) Foote collection

Acc. No.	Bag No.	Provenience*	Depth**	Genus	Species	Length	Width	Hole Diameter	Drilled/Punched Hole	Type	Complete/Fragment
1967.042.00002.000	1			*Olivella*	*biplicata*	18.5	13.8	4.4	P	D1	C
1967.042.00002.000	2			*Olivella*	*biplicata*	20.3	13.6	5.3	P	D1	C
1967.042.00002.000	3			*Olivella*	*biplicata*	18.9	13.3	5.4	P	D1	C
1967.042.00002.000	4			*Olivella*	*biplicata*	19.2	13.2	5	P	D1	C
1967.042.00002.000	5			*Olivella*	*biplicata*	16.8	12.8	5.6	P	D1	C
1967.042.00002.000	6			*Olivella*	*biplicata*	18.6	13.1	4.7	P	D1	C
1967.042.00002.000	7			*Olivella*	*biplicata*	19.2	13.4	4.2	P	D1	C
1967.042.00002.000	8			*Olivella*	*biplicata*	17.7	12.6	4.5	P	D1	C
1967.042.00002.000	9			*Olivella*	*biplicata*	16.7	12.1	3.9	P	D1	C
1967.042.00002.000	10			*Olivella*	*biplicata*	16	11.9	3.8	P	D1	C
1967.042.00002.000	11			*Olivella*	*biplicata*	11.7	N/A	4.2	P	D3?	F
1967.042.00002.000	12			*Olivella*	*dama*	7.8	5.8	4.5	N/A	B3a	C
1967.042.00002.000	13			*Olivella*	*dama*	8	6.3	4	N/A	B6a	C
1967.042.00002.000	14			*Olivella*	*dama*	7.5	5.5	4.3	N/A	B3a	C
1967.042.00002.000	15			*Olivella*	*dama*	7.5	6.8	5.1	N/A	B3b	C
1967.042.00002.000	16			*Olivella*	*dama*	6.2	5.5	3.8	N/A	B3a	C
1967.042.00002.000	17			*Olivella*	*dama*	8.1	7.2	4.7	N/A	B3b	C
1967.042.00002.000	18			*Olivella*	*dama*	6.6	5.2	3.7	N/A	B3a	C
1967.042.00002.000	19			*Olivella*	*dama*	4.9	4.8	3.5	N/A	B3a	C
1967.042.00002.000	20			*Olivella*	*dama*	6.8	5	3.3	N/A	B3a	C
1967.042.00002.000	21			*Olivella*	*dama*	7.1	5.6	4.5	N/A	B3a	C

Table B.6. Continued

Acc. No.	Bag No.	Provenience*	Depth**	Genus	Species	Length	Width	Hole Diameter	Drilled/Punched Hole	Type	Complete/Fragment
1967.042.00002.000	22			*Olivella*	*dama*	13.6	6.4	2.3	N/A	A1	C
1967.042.00002.000	23			*Olivella*	*dama*	14.8	6.8	2.8	N/A	A1	C
1967.042.00002.000	24			*Olivella*	*dama*	14.8	6.9	2.2	N/A	A1	C
1967.042.00002.000	25			*Olivella*	*dama*	12.8	6.9	3.3	N/A	A1	C
1967.042.00002.000	26			*Olivella*	*dama?*	13.8	10.4	3.7	N/A	B2c	C
1967.042.00002.000	27			*Olivella*	*biplicata*	14.1	11	2.4	D	C2	C
1967.042.00002.000	28			*Olivella*	*biplicata*	13.4	10.9	2.9	D	C2	C
1967.042.00002.000	29			*Olivella*	*biplicata*	11.4	10.3	2.3	D	C2	C
1967.042.00002.000	30			*Olivella*		8.1	7.8	2.5	D	C3	C
1967.042.00002.000	31			*Olivella*		9.7	8.5	2.3	D	C3	C
1967.042.00002.000	32			*Olivella*		9.8	7.8	2.8	D	C3	C
1967.042.00002.000	33			*Olivella*		8	8.1	2.8	D	C7	C
1967.042.00002.000	34			*Olivella*		9.3	8.9	2.4	D	C3	C
1967.042.00002.000	35			*Olivella*		7.9	7.9	2.5	D	C3	C
1967.042.00002.000	36			*Olivella*		5.3	5.5	1.6	D	F3b	C
1967.042.00002.000	37			*Olivella*		7.1	6.2	2.8	D	G6b	C
1967.042.00002.000	38			*Olivella*	*biplicata*	12.3	9.7	4	P	D3	C
1967.042.00002.000	39			*Olivella*		10.7	8.3	3.4	P	D3	C
1967.042.00002.000	40			*Olivella*		10.3	8.2	2.5	P	D3	C

* No provenience information available
** No depth information available

Table B.7. Turquoise artifacts from UCLA Parowan Valley collection

Acc. No.	Site	Provenience	Depth	Material	Length	Width	Thickness	Artifact Type	Hole Diameter	Drilled/Punched Hole	Complete/Fragment	Worked
125-2276	42IN43	J5, Str. 8	30-36	Turquoise	8.2	6.2	1.2	Pendant	1.1	D	C	x
433-7264	42IN100	Area 1, C-12 (Structure 7)	36-42	Turquoise	8.6	6.2	1.5	Pendant	2.1	D	C	x
125-3147	42IN43	N-11	12-18	Turquoise	8.6	5.9	1.7	Pendant	1.6	D	C	x
125-3147	42IN43	N-11	12-18	Turquoise	10.2	7.9	2.1	Pendant	1.9	D	C	x
125-9103	42IN43	1, Str. 26	0-6	Turquoise	N/A	8.2	1.6	Pendant	1.3	D	C	x
356-2840	42IN40	E4 ST II	29-36	Turquoise?	7.9	7.5	1.5		N/A	N/A	F	x
356-1727	42IN40	No Provenience		Turquoise?	7.1	5.6	2.5		N/A	N/A	F	x
433-2281	42IN100	Area 3, F-19	0-6	Turquoise	2.9	2.9	1.2	Bead	1.1	D	C	x
125-6663	42IN43	Surface		Turquoise	3.4	3.4	1.7	Bead	1.6	D	C	x
333-8508*	42IN40	Pit G4, Stratum 2	54-60	Turquoise	5.8	5.7	3.4		1.8	D	F	x

* 333-8509 was sent to ASU for PIXE identification (see Chapter 2 and Appendix A).

Table B.8. Blue-green artifacts and *Olivella* from Kay's Cabin (42UT813)

FS No.	Provenience	Depth	Material	Length	Width	Thickness	Hole Diameter	Drilled/Punched Hole	Complete/Fragment	Worked
2029	104 N 110 E	(F99) -0.61 to -0.76	Azureite/Malachite	8.3	7.7	7.1	N/A	N/A	F	
3130	106 W 105 E	(F39) -1.04 to -1.35 mbd	Azureite/Malachite	13.1	10.7	5.6	N/A	N/A	F	
3032	105 N 106 E	(F99) .34 to -.66 mbsd	Azurite	18.5	15.7	12.5	N/A	N/A	F	
3178*	106 N 106 E	(F39) -1.16 to -1.34	Azurite/Malachite	16.1	10.5	4.8	N/A	N/A	F	x
1826	None	None	Azurite/Malachite	42.5	31.3	27.5	N/A	N/A	F	
2086	107 N 108 E	(F99) -0.72 to -0.98	Azurite/Malachite	16.2	8	6.6	N/A	N/A	F	
2086	107 N 108 E	(F99) -0.72 to -0.98	Azurite/Malachite	5.5	3.4	3.2	N/A	N/A	F	
1349**	108 N 106 E	(F39) 1.1-1.186 mb	Copper Oxide (Chrysocolla?)	16.2	12.6	8.5	N/A	N/A	F	
908	110 N 107 E	(F39) 1.036-1.156 mb	Malachite	7.5	6.9	5.9	N/A	N/A	F	
1597*	108 N 106 E	(F39) 1.261-1.46 mb	Malachite	10.3	9.3	6.3	N/A	N/A	F	
1882*	107 N 105 E	(F39) 0.85-1.1 m	Turquoise	13.4	4.6	3.2	N/A	N/A	F	x
1897**	107 N 106 E	(F39) 0.879-1.101 mdb	Turquoise	12.7	7.1	3.6	N/A	N/A	F	x
1897*	107 N 106 E	(F39) 0.879-1.101 mdb	Turquoise	11.3	5.9	2.8	N/A	N/A	F	x
845*	114 N 105 E	(F39) .89-1.121	Turquoise	6.9	7.8	2.4	N/A	N/A	F	x
1187*	110 N 104 E	(F39) 1.17-1.34	Turquoise	5.9	5.5	3	N/A	N/A	F	x
434*	109 N 109 E	10-20 cm	Turquoise	7.4	5	1.5	N/A	N/A	F	
1915*	107 N 107 E	(F39) -1.112 to -1.2 mbd	Turquoise	18	12.9	3.1	N/A	N/A	F	x
193*	115 N 101 E	0-10 cm	Turquoise	6	4	2	N/A	N/A	F	
3023*	105 N 105 E	(F99) -.27 to -.56	Turquoise	12.9	6.6	4.1	N/A	N/A	F	x
1015*	111 N 117 E	(F39) 1.157-1.220 mb	Turquoise	10.4	7.8	2.3	N/A	N/A	F	x
197**	115 N 104 E	20-30 cm	Turquoise	7.2	6.4	3.2	N/A	N/A	F	
1028**	109 N 195 E	(F39) 1-03-1.17 mb	Turquoise	6.8	5.1	3.4	N/A	N/A	F	
1843*	110 N 103 E	(F39) 0860-.90 mb	Turquoise	14.1	9.5	4.8	N/A	N/A	F	x
458*	109 N 109 E	30-40 bsd	Unidentifiable	4.6	4.2	2.9	N/A	N/A	F	
1938*	107 N 107 E	(F39) -.922 to -1.112 mbd	Unidentifiable	15.5	7.8	3.3	N/A	N/A	F	x
1325*	110 N 102 E	.825-.938	Unidentifiable	7.6	4.1	1.6	N/A	N/A	F	
184	113 N 104 E	0-10 cm	Unidentifiable	7.9	5.1	4.6	N/A	N/A	F	
3104*	107 N 106 E	(F99) -.06 to -.91	Unidentifiable	9.4	7.6	1.9	1.2	D	F	x
3266**	107 N 106 E	(F39) 1.41-1.45	Variscite	12	8.8	2	1.2	D	F	x
3069	107 N 105 E	(F39) 1.07-1.41	*Olivella*	6.4	6	G2	2.5	D	C	
1129	110 N 104 E	(F39) 1.17 mbd2	*Olivella dama*	5.9	6	B3	4	N/A	C	

* Artifact subjected to microprobe analysis
** Artifact subjected to microprobe analysis and then polished

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