A Multi-factor Analysis of the Emergence of a Specialist-based Economy among the Phoenix Basin Hohokam

by

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A Dissertation Presented in Partial Fulfillment
of the Requirements for the Degree
Doctor of Philosophy

Approved April 2013 by the
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ARIZONA STATE UNIVERSITY

May 2013

ABSTRACT

This project examines the social and economic factors that contributed to the development of a specialist-based economy among the Phoenix Basin Hohokam. In the Hohokam case, widespread dependence on the products of a few concentrated pottery producers developed in the absence of political centralization or hierarchical social arrangements. The factors that promoted intensified pottery production, therefore, are the keys to addressing how economic systems can expand in small-scale and middle-range societies. This dissertation constructs a multi-factor model that explores changes to the organization of decorated pottery production during a substantial portion of the pre-Classic period (AD 700 – AD 1020). The analysis is designed to examine simultaneously several variables that may have encouraged demand for ceramic vessels made by specialists.

This study evaluates the role of four factors in the development of supply and demand for specialist produced red-on-buff pottery in Hohokam settlements. The factors include 1) agricultural intensification in the form of irrigation agriculture, 2) increases in population density, 3) ritual or social obligations that require the production of particular craft items, and 4) reduced transport costs. Supply and demand for specialist-produced pottery is estimated through a sourcing analysis of non-local pottery at 13 Phoenix Basin settlements. Through a series of statistical analyses, the study measures changes in the influence of each factor on demand for specialist-produced pottery through four temporal phases of the Hohokam pre-Classic period.

The analysis results indicate that specialized red-on-buff production was initially spurred by demand for light-colored, shiny, decorated pottery, but then by comparative advantages to specialized production in particular areas of the Phoenix Basin. Specialists concentrated on the Snaketown canal system were able to generate light-colored, mica-dense wares that Phoenix Basin consumers desired while lowering transport costs in the distribution of red-on-buff pottery. The circulation of decorated wares was accompanied by the production of plainware pottery in other areas of the Phoenix Basin. Economic growth in the region was based on complementary and coordinated economic activities between the Salt and the Gila River valleys.

ACKNOWLEDGEMENTS

I am grateful to my dissertation chair, Dave Abbott, who has guided me with great expertise and patience. Dave's research on Hohokam prehistory is the most consistent, logical, and enthusiastic approach that I have witnessed. I have learned a great deal from him. I am also greatly appreciative of my three committee members, Kate Spielmann, Andy Darling, and Gordon Moore. Each has provided complementary expertise on various aspects of this analysis. Kate Spielmann provided a wealth of insight on specialized craft production in the American Southwest and economic archaeology. I am indebted to her for her keen advice on various aspects of this project. Andy Darling's insightful comments drew from his expertise spanning the American Southwest to Mexico, the prehistoric to the historic. Gordon offered guidance on the mineralogical analyses that form the basis for this research. He also provided a valuable perspective from outside of the anthropological discipline. Of course, all short-comings in this study are my responsibility, and not that of my committee.

In archaeology, particularly in the American Southwest, no woman stands alone. Many people helped me throughout the course of this project. Andy Lack has been a tremendous help to me through the years. I could not have done this without his wit and wisdom. I am also grateful to my friends and colleagues Josh Watts and Chris Watkins for their expertise and support. Doug Craig kindly lent his expertise on Hohokam population estimates. Bill Doelle shared his Southwestern population database that was a cornerstone of this project. Kyle Woodson was an invaluable consult on population and canal length estimates for the middle Gila River valley, which were essential to the research design. Jerry Howard gave me helpful advice and information regarding canal systems in the Salt River valley. Billy Graves and Jim Heidke provided invaluable assistance with comparative information on craft specialization in the American Southwest. Erik Steinbach assisted with GIS renditions of some of the maps in this dissertation. Beth Miksa, whose methodology has changed the course of Hohokam research, offered essential guidance on implementing the sand petrofacies model. Mary Ownby provided comments on the methods used in this analysis. Hector Neff and Richard George were invaluable help with the TOF-LA-ICP-MS analyses. Bob Hunt and Sunday Eiselt offered their perspective and expertise on several issues that I tackle in this project. Kostalena Michelaki granted access to her lab space and microscopes. She also and provided critical insights on how to present this material to the public. Arleyn Simon, Dolma Roder and Nathan Wilson offered invaluable assistance with the ASU Anthropology collections. Arthur Vokes was extremely helpful with collections at the Arizona State Museum. Holly Young and Lindsey Vogel helped me with collections from the Pueblo Grande Museum. Ok Soon Kim, Ian Wilder, and Alyssa Snyder assisted with morphological attribute collection on the ceramic samples.

This analysis utilized ceramic collections and data gathered by the Gila River Indian Community's (GRIC) Cultural Resource Management Program (CRMP) in conjunction with the Pima-Maricopa Irrigation Project (P-MIP). These entities receive funding from the U.S. Department of the Interior, Bureau of Reclamation, under the Tribal Self-Governance Act of 1994 (P.L. 103-413), for the design and development of a water delivery system that uses Central Arizona Project water. I am a research collaborator with GRIC-CRMP and have agreed to follow all protocols associated with this status (see Appendix A). I appreciate the assistance of Andy Darling (formerly the CRMP Director) in facilitating the research collaborator agreement.

I am grateful to the GRIC-CRMP in Sacaton, Arizona for logistical support with portions of this analysis including help with accessing P-MIP ceramic collections and for providing analysis space for research on these collections. In particular, I am greatly indebted to Linda Morgan for her assistance throughout this project. I am also very grateful to Lorie Sinclair. Ceramic collections that I analyzed in the CRMP laboratory are housed on-site at CRMP or have been transferred to the Huhugam Heritage Center.

Financial support for this dissertation was provided by a National Science Foundation doctoral dissertation improvement grant (BCS 1115362) and research grants from the School of Human Evolution and Social Change at Arizona State University and from the Arizona Archaeological and Historical Society. Funding for research at the IIRMES laboratory was provided by a National Science Foundation grant awarded to Hector Neff (BCS 0917702) for the support of visiting researchers at California State University Long Beach. The Dean's Dissertation Writing Fellowship provided funding while I was compiling this research.

I am indebted to my parents, Ann and Henry Kelly, for emphasizing the importance of education throughout my life. I would not have been able to complete this dissertation without your unflagging encouragement. I'm sure that you imagined that I would have graduated long before now, and with a much more practical degree than archaeology. But, you have had the courtesy to never point this out to me. Your support is a gift that cannot be forgotten, or repaid.

My sister Alice Kelly has been the best friend and cheerleader a person could wish for. It is fitting that we have gone through the last throes of graduate school in the same strides. Finally, my husband, Scott Thompson, has been in the trenches with me (literally and figuratively) from the very beginning. Thank you for all that you have done and continue to do.

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CHAPTER 1: INTRODUCTION TO CRAFT SPECIALIZATION IN THE HOHOKAM ECONOMY

The development of specialized craft production represents a significant shift in the economic relationships among households. This type of change can be a precursor to the emergence of complex and interdependent economies. Prehistoric economic systems in the American Southwest were characterized by the specialized craft production and distribution of a variety of goods. Almost all documented cases of craft specialization, however, were part-time, independent production at a community or household industry level (Mills and Crown 1995:13). Output from individual specialists was relatively low (Harry 2005; Heidke et al. 2002:169) and the vast majority of households relied minimally on specialist producers, if at all. One notable exception to this trend was the Hohokam culture region of central and southern Arizona. For over 600 years, Hohokam households relied almost entirely on specialists to supply them with their domestic ceramic assemblage. Households across this wide geographic expanse were particularly dependent on part-time specialists concentrated along the Gila River to provide them with decorated vessels (Abbott 2009).

The prehistoric Hohokam economy provides an opportunity to evaluate the effects of multiple factors on the development of specialized economies, because it was characterized by long-term and intensive craft production. Intensive craft production in this region presents a compelling exception to many models for the development of specialized economies in middle-range societies that highlight unequal access to subsistence resources and increasing political centralization as driving factors. High supply and demand for specialist-produced crafts in this region persisted in the absence of resource scarcity or hierarchical political arrangements. Social contexts of production and consumption of specialist goods likely played a pivotal role in the emergence of specialized craft economies as well as economic factors that underwrote enduring relationships between specialist producers and consumers.

The remarkable contrast between the Hohokam economic system during the mid-tenth century and many other regions of the prehistoric Southwest introduces two compelling issues: What factors contributed to the development of a specialist-based economy in the Phoenix Basin? And, what conditions allowed households to become entirely dependent on craft specialists to supply them with daily necessities? The answers to these questions reveal the factors that limit or encourage specialized economies in small-scale and middle-range societies. This project uses one specialist-produced item—red-on-buff pottery—to explore the development of a specialist-based economy in the Phoenix Basin. This study investigates the conditions that encouraged the expansion of specialized red-on-buff pottery production from its early stages in the eighth century until the height of Hohokam economic expansion during the eleventh century AD.

Craft Production among the Phoenix Basin Hohokam

The Hohokam economy developed on a social and environmental landscape characterized by large, stable population centers and subsistence intensification in a desert ecosystem. The cultural developments in the Hohokam region are rooted in the tradition of deep sedentism in central and southern Arizona throughout prehistory (Clark and Gilman 2012; Fish 2006 [1989]; Fish and Fish 2012; Hill et al. 2004:689; White and Lekson 2001:99). Although individual household architecture may have had relatively short use-lives and shifted in location through time (Ciolek-Torrello 2012), particular areas were intensively occupied over long temporal spans. Permanent villages were established in the Tucson Basin as early as 2100 BC (Mabry 1999; 2008). By AD 500-650, the material markers that archaeologists use to identify Hohokam culture, such as pottery, particular stylistic motifs, pithouse dwellings, and large-scale irrigation agriculture, appear at settlements throughout central and southern Arizona (Abbott 2000:27; Haury 1976; Wallace et al. 1995). Hohokam communities continued to develop over the next 1,000 years, often in the same areas, until the disintegration of the regional system after AD 1400 (Abbott 2003a; Ackerly 1988; Dean 2007).

Although the Hohokam archaeological culture stretched across a vast territory in central and southern Arizona during prehistory, most settlements were located along major river systems where intensive agriculture provided most subsistence staples. Long-term human occupation of central and southern Arizona is generally attributed to the wide and level river valleys that enabled the development of the largest prehistoric irrigation systems in North America (Howard 1993b; 2006; Hunt et al. 2005; Woodson 2010). Canal networks were constructed as early as 1250 BC in the Tucson Basin (Mabry 1999; 2008), and remained critical to Hohokam subsistence until the 15th century. Although the Sonoran desert offered a diversity of wild resources (Fish and Nabhan 1991; Rice 1992:15-17), low annual rainfall prohibited intensive agriculture away from waterways and contributed to population concentration along rivers and canals. Researchers speculate that the importance of canal irrigation to Hohokam subsistence was reflected in many other aspects of Hohokam social and political life. The construction, maintenance, and operation of the canal systems made the irrigation community the fundamental organizational unit of Hohokam society and was the basis of social, political, and ritual life (Abbott 2000; Abbott et al. 2006; Doyel 2007; Hunt et al. 2005; Woodson 2007; 2010).

Uninterrupted, permanent occupation of the Phoenix Basin coupled with subsistence investments in the form of irrigation agriculture contributed to large and densely-occupied villages (Craig et al. 2010; Doelle 1995; Fish 2006 [1989]). The Salt and Gila River valleys were possibly the largest population centers in the prehistoric American Southwest, and rivaled settlement densities of other populated areas, such as the American Bottom during the Mississippian cultural sequence. Although regional population estimates vary, most archaeologists believe that at least ten thousand if not tens of thousands of people resided in central Arizona during prehistory. Individual villages may have included more than a thousand people.

Economy

The preClassic Hohokam economy was likely rooted in a shared cultural ethic that fostered the widespread sharing of ideas and information among Hohokam communities. Close similarities in lifeways, technological styles, motifs, and iconography indicate the transfer and implementation of knowledge across a broad geographic expanse. The construction of a network of ballcourts around AD 800 is one of the strongest indicators of social and economic integration in Hohokam society. The ubiquity of these ballcourts at settlements has been interpreted as a sign of a pan-Hohokam identity and widespread participation in an inclusive social and religious system (Wilcox and Sternberg 1983). Ballcourts are also one of several material markers for the influence of ideas from northern and central Mexico (Doolittle 1990; Gladwin 1948; Plog 1980a; Schroeder 1966; Wilcox 1979; 1991a).

The long-term growth of Hohokam settlements and subsistence infrastructure in the Sonoran desert provided a stable platform for economic development in the region. In particular, the later preClassic period (AD 650 – 1100) marked the rapid expansion of the economic system in the Phoenix Basin to its greatest extent during prehistory. Households began to focus their productive activities on particular tasks through specialization, and consequently to rely on the products manufactured by other households. The diversity of goods produced and traded indicates an increased dependence on supply and demand relationships within the regional economy (cf Doyel 1991). Raw materials and finished craft items such as shell (Marmaduke 1993; Nelson 1991), groundstone (Bostwick and Burton 1993), textiles (Hunt 2011), minerals (Nelson 1981), obsidian (Peterson et al. 1997), and stone palettes (Krueger 1993; White 2004) were moved in quantities across the region (Bayman 2004; Doyel 1991).

Of the many items that were produced and traded in the Hohokam economy, ceramic containers are perhaps the best documented (Abbott et al. 2007a). New advances in ceramic sourcing have enabled archaeologists to determine where these pots were produced and consumed (Miksa and Heidke 2001; Miksa 2001a; Miksa et al. 2004). In addition, stylistic seriation of red-on-buff pottery designs allows researchers to date Hohokam decorated wares with precision (Wallace 2004). Recent archaeological analyses have combined detailed provenance with chronological data on pottery to reconstruct the organization of Hohokam ceramic manufacture and distribution in prehistory. This research indicates that both supply and demand for specialist-produced pottery in the Hohokam economy developed early on in the culture history (ca. AD 450), and eventually increased to a massive scale by the 11th century AD (Abbott et al. 2007a; Abbott 2009). At this time, the volume of pottery generated by Hohokam potters was substantial enough to satisfy consumers at the regional level. Specialized pottery producers generated almost *all* of the plain and decorated pottery for the approximately 20,000 people living in the Phoenix Basin (Figures 1.1 and 1.2). These wares were distributed to settlements across 2,000 km^2 surrounding the confluence of the Salt and Gila rivers (Abbott et al. 2001; Abbott et al. 2007b; Abbott 2009). Decorated red-on-buff pottery made by specialists in the vicinity of the large settlement of Snaketown was distributed more broadly than any other type of pottery in the region. During the middle Sedentary period, approximately seventy percent of Hohokam decorated red-on-buff vessels consumed by households across the lower Salt River valley was manufactured by potters living in this area (Abbott et al. 2007b).

Figure 1.1: PreClassic Hohokam red-on-buff pottery from the Phoenix Basin. Photographs are courtesy of the Alfred E. Dittert, Jr. Whole Vessel Collection in the Arizona State University Anthropology Collections.

Figure 1.2: PreClassic Hohokam plainware pottery from the Phoenix Basin. Photographs are courtesy of the Alfred E. Dittert, Jr. Whole Vessel Collection in the Arizona State University Anthropology Collections.

Specialized pottery manufacturers across the Phoenix Basin coordinated their output so that there was little overlap in the production and distribution of varieties and forms of different wares. By the mid-11th century, producers residing in the middle Gila River generated almost all decorated wares used across the Salt River valley (Abbott 2009; 2010) and the Gila River valley. Meanwhile, plainware producers on the Gila River made a range of bowls and jars for distribution to the Gila and northern Salt Rivers. Ceramic producers at Las Colinas manufactured similar forms as Gila River producers, but distributed them to settlements to the north of the Salt River (Abbott 1988; Abbott et al. 2007a). Finally, potters working near South Mountain manufactured large water jars for distribution across the Salt River valley (Abbott 2000:202-208).

The intensive production and widespread circulation of Hohokam pottery appears to have reached an apex during the middle Sacaton phase (ca. AD 1000). Abbott and his colleagues (2007a) have argued that periodic marketplaces at ballcourts may have been a mechanism by which pottery was exchanged between distant producers and consumers. Although ballcourts were first constructed in the Gila Butte phase, they may have increasingly served as the locus for economic exchanges, including the transfer of pottery between producers and consumers (see also Wallace 1994; Wilcox and Sternberg 1983; Wilcox 1991b). The high volume of production, high demand for the products of distant producers, and widespread circulation of pottery throughout the Hohokam region suggest that other craft items such as shell or agricultural products like cotton may have been produced and circulated in the same quantities. Although the organization of shell and cotton craft production likely differs substantially from pottery production, detailed chronological and sourcing data on pottery can provide the basis for constructing hypotheses about various aspects of the Hohokam economy. The methods used to evaluate the production and consumption of pottery are highly sensitive in comparison to any other item circulated in the Phoenix Basin. Therefore, red-on-buff pottery can function as a foundation to evaluate the scale of production and consumption of other goods in the Phoenix Basin.

Why Here and Why Now? Political and Economic Theories for Developing Reliance on the Regional Economy

The supply and demand for specialist-produced pottery in the Phoenix Basin was marked by long-term and extensive economic reliance between producers and consumers. Heavy reliance on exchange for basic necessities can only occur in economies that maintain continuous and relatively equal levels of supply and demand (Yang 2003). Therefore, factors that increase and sustain supply and demand for exchanged goods are the keys to addressing economic growth in middle-range and small-scale societies.

The anthropological literature highlights two ways in which stable supply and demand relationships develop. First, societies that exert political or social control over the economy create conditions that underwrite intensified production and a market for the goods of specialist producers. Second, social or environmental stress can force the production of goods for trade and can push people to obtain items from exchange that they cannot obtain themselves. These models are described in greater detail in the sections that follow.

Political Models

In those models that emphasize socio-political factors, the exercise of elite control can create both a need for and a supply of specialist-produced goods. Craft specialization is viewed as a pathway for emerging elites to increase their control over labor and resources (Frankenstein and Rowlands 1978; Friedman and Rowlands 1977). Here, specialization improves the efficiency of production so that a moderate increase in output by a few people can result in significant surpluses of particular items. These surpluses enable potential aggrandizers to leverage goods in exchange for labor. The ability to organize labor is then used to consolidate political control (D'Altroy and Earle 1985; Dietler and Herbich 2001; Earle 1982; 1997). Additionally, craft specialists create symbolic and/or prestigious items, whose controlled production and exchange help to reify existing power structures (Appadurai 1986:21-33; DeMarrais et al. 1996; Gosden 1989; Vaughn 2006; Voutsaki 1995:9-11). In these cases, particular goods are only produced by craftsmen who are part of an elite social group (embedded) or are directly governed by elite control (attached). The increased output of these select specialists represents an intensification of craft production.

Although these political models explain the development of specialized production in some middle-range societies, preClassic Hohokam society lacked elites that would motivate the supply and demand for specialized craft production. Extensive archaeological research in the Phoenix and Tucson Basins has revealed almost no material evidence for ranked status differences among individuals or communities. As a result, archaeologists generally agree that Hohokam social organization lacked centralized authority and hierarchical political structures (Elson and Abbott 2000; Fish and Yoffee 1996; Fish and Fish 2000; Harry and Bayman 2000). This characterization of Hohokam society aligns with archaeological and ethnographic research throughout the broader American Southwest that emphasizes the virtual absence of material evidence for overtly hierarchical relationships (Graves and Spielmann 2000; Lightfoot and Feinman 1982; Mills 2000a). Additionally, ethnographic research on contemporary tribes indicates that political organization is marked by an overt ethos of equality that is maintained through leveling mechanisms that impose social sanctions on potential aggrandizers (Mills 2004). The prehistoric and historic societies of the American Southwest appear to use material goods to construct social identities only loosely tied to vertical relationships (c.f. Bourdieu 1984:208-225; Spielmann 2002:196). Most craft objects were likely associated with establishing and maintaining *horizontal* social connections (Clark 2007; Mills 2004; Weiner 1992).

Economic Models

High economic reliance between consumers and specialized producers that defines a specialist-based economy can also develop in cases where environmental stress forces people to depend on one another. Various anthropological models posit different types of responses to social and environmental stress that result in an increase in both the supply and demand for the products of craft specialists. The first, and perhaps best known of these theories is the Agricultural Marginality Model. It contends that unequal access to resources for subsistence production, such as land, forces some people to engage in specialized craft manufacture as a livelihood (e.g. Arnold 1985; 1993; Durrenberger and Tannenbaum 1992; Stark 1991). In these situations, craft production becomes the vocation of the dispossessed and is considered a less preferable strategy to agricultural production.

Another proposition for sustained economic ties among populations is the Mutualism Model. This theory holds that the supply and demand for specialized craft production emerges as a way to balance economic relationships among communities in different environmental or resource zones. Unlike the Agricultural Marginality Model, mutualistic relationships involve relatively even benefit to participants. In the American Southwest, various communities, such as settlements in Mesa Verde and southern Colorado and the Rio Grande, participated in long-standing mutualistic relationships with populations who lived in diverse geographic regions (Cordell et al. 2007; Rautman 1996; Spielmann 1986). The circulation of craft items and agricultural products among these communities solidified extensive economic networks.

Finally, the Buffering Model posits that populations living in different ecological zones produce craft items for exchange as a safeguard against risk (e.g. Ford 1972; Mohr Chavez 1992; Spielmann 1986).[1] In this theory, communities create temporary economic arrangements to alleviate periods of resource scarcity, because seasonal variation and environmental unpredictability "push" them to do so. Unlike mutualistic relationships, economic networks based on buffering are characterized by punctuated, short-term

[1] Ford's work extends beyond risk minimization and buffering. Here, I refer to his theories for why communities might create temporary economic relationships.

relationships (Spielmann 1986). These intermittent economic networks can contribute to temporary increases in production to generate goods for trade.

While anthropological theories that posit a relationship between social and environmental stress and the supply and demand for specialized craft production may fit particular situations in the American Southwest, these models only loosely apply to the Phoenix Basin Hohokam. First, economic models constructed from ethnographic data, such as the Agricultural Marginality Model, apply to cases where extensive land tenure prevents some people from participating in subsistence production and forces them to produce crafts for exchange (Harry 2005). In contrast, specialized pottery production in the Phoenix Basin emerged and grew during a time when land along the Salt and Gila rivers would have been relatively plentiful. Population increases and resource stress during the late Sedentary and Classic periods may have encouraged notions of land ownership (Watkins 2011), but only well after the peak of red-on-buff specialized production in the Phoenix Basin. In addition, the model assumes that specialist producers lack access to large social networks that they could rely on during times of stress. Hohokam social arrangements, in contrast, likely consisted of nested, kin-based groups that cooperated in social, ritual, and economic activities (Abbott 2000). Finally, the Agricultural Marginality Model posits that specialists obtain a substantial portion of their food from the exchange of their craft items. Heavy reliance on others for food is a risky strategy that Hohokam households presumably would have avoided.

Although mutualism models have been applied to some cases in the American Southwest, these models only weakly explain the development of large-scale craft specialization in the Phoenix Basin (see also Hirth 2009:15). First, the Hohokam resided in the Sonoran desert, which differs environmentally from Puebloan culture regions above the Mogollon rim (Fish 2006 [1989]; Gasser 1976). The arid desert conditions may have generated inter-community relationships that differed from those posited elsewhere. Second, specialized pottery production in Hohokam communities began during a time when population densities were adequately supplied by the agricultural production on individual canal systems. The productive capacity of different Phoenix Basin canal systems during the earlier pre-Classic period was probably not different enough to encourage widespread demand for specialized pottery production. While mutualistic relationships may have become more important through the pre-Classic period, a changing combination of different variables over time likely encouraged the emergence and growth of a specialist-based Hohokam economy.

Finally, buffering relationships that mitigate localized shortages on a household scale probably would not account for the emergence of large-scale specialized production in the Phoenix Basin. Reliance on craft production in exchange for food is risky over the long term (Arnold 1985:193; Netting 1990; Sahlins 1972). During times of resource shortfall, many prehistoric populations may have opted to move to other areas, instead of producing crafts for exchange (after Spielmann 1986). The scale and duration of specialized pottery production in the Phoenix Basin would require more frequent economic interactions than those characterized by buffering relationships alone.

Situating the Hohokam Economy in the American Southwest

Extant models for economic development in small-scale and middle-range societies do not explain the development of the Hohokam preClassic economy. In the Hohokam case, geographically concentrated craft specialists supplied almost all of the material items that households used on a daily basis including pottery. On a landscape dotted by culture areas that engaged in specialized pottery production, the Phoenix Basin economy is unique within the American Southwest for the reliance and duration of economic relationships between widespread producers and consumers. Some condition, or series of conditions, must have contributed to economic development in this region that did not similarly affect surrounding areas. In order to address why the Hohokam economy developed, I characterize how the Hohokam economy is similar to, and differs from, the organization of ceramic production in surrounding regions in the American Southwest. This characterization is then used as the basis to identify conditions that may have contributed to economic development in the Phoenix Basin.

Specialized Pottery Production in the American Southwest

The scale of specialized prehistoric pottery manufacture in the American Southwest best fits the definition of individual or community specialization (Costin 1991:8-9), or a household industry (Peacock 1982; van der Leeuw 1984). Pottery was manufactured by autonomous household production units that distributed their goods through unrestricted exchange networks. Potters fashioned and distributed their wares without technological advancements such as the pottery wheel or pack animals. The intensity, or time, that specialists devoted to ceramic and other craft production was likely part-time work that varied seasonally. In other words, potters distributed their productive efforts across a range of tasks and shifted how much time they devoted to these tasks relative to the yearly agricultural cycle. Even during the height of specialist pottery production in the Phoenix Basin, the estimated volume of pots consumed by Hohokam households could have been satisfied by part-time work by Phoenix Basin potters (Heidke 2003; Kelly 2010a). Ceramic manufacture would have likely been coordinated around the agricultural cycle as well as the activities that the potter participated in within the domestic context. Pottery production took place within or near to the home and would have been coordinated with other activities that the potter and her family engaged in at the same space. Archaeological excavations of pottery manufacturing areas in the Hohokam region indicate that they are situated within communal domestic areas that would have been used for a variety of other household activities. For example, at Snaketown, pottery firing pits and clay mixing basins with buffware clay were located directly behind several Sacaton phase pithouses (Abbott 2007; Haury 1976:196-197).

The concentration of specialized decorated pottery production in the American Southwest was typified by community based specialization“in which individual specialists, aggregated in a limited number of communities, produce pottery for regional distribution" (Hegmon et al. 1995:33). The Hohokam region also displays this pattern of community specialization, wherein particular settlements generate goods for exchange. Potters in villages along the Gila River produced large quantities of decorated and plainware pottery for exchange. By the mid-1100s, and perhaps well before this time, specialists around the site of Snaketown in the Gila River valley manufactured a large proportion of the red-on-buff pottery used by households across the Phoenix Basin (Abbott et al. 2007b).

Distinctive Aspects of the Hohokam Economy

Although the basic organization of pottery and other craft production in the Hohokam economy is similar to other areas of the American Southwest, the duration of specialized production, the number of consumers supplied, and the amount of pottery produced by specialists in the Phoenix Basin exceeded that of specialized production areas throughout the American Southwest. A large number of consumers in this region relied almost entirely on concentrated specialists for domestic necessities such as pottery that they used on a daily basis for cooking and storage. Likewise, a concentrated group of producers relied on continuous demand for their wares to justify their high output and distribution of these items across the region.

Tables 1.1 and 1.2 display summary statistics on specialized production in each major specialized ceramic production locale in the American Southwest. These major production locales include the Arizona Strip, the Northern and Central Rio Grande, the Hopi Mesas, the Flagstaff area, the Chuska Mountains, the Tucson Basin, and the Tonto Basin. Of these areas, the Phoenix Basin and possibly the Flagstaff areas were the only regions where specialized pottery manufacture continued for more than 500 years. Specialized pottery production also accounted for up to 100 percent of all domestic pottery (decorated and plainwares) used by certain settlements in the Phoenix Basin. In the American Southwest, reliance on specialists for the supply of pottery was only matched by producers in the Chuska Mountains whose production accounted for up to 70 percent of wares used by communities to the west. The number of consumers supplied by specialists in the Phoenix Basin was unparalleled, with the exception of the Rio Grande region of New Mexico. Finally, specialists in different areas of the Phoenix Basin coordinated their outputs so that they did not overlap. This type of regional coordination in specialist output has only been documented in the Arizona Strip and the Tonto Basin.

Table 1.1: Regions of the American Southwest with specialized pottery production.

	Time Period	Production Location	Consumption Location	Transport Distance (km)	Ware Types	Total in Consumer Assemblages	Producer/ Consumer Population	Geographic Area (km2)	References
Arizona Strip	AD 1050-1150	Uinkaret Plateau	Moapa Valley; Saint George Basin	75-110	Moapa Gray (decorated and undecorated)	~20%	300-400	48000	(Allison 1996; 2000)
	AD 1050-1150	Shivwits Plateau	Moapa Valley; Saint George Basin	75-110	Shivwits Plain	~10%	300-400	48000	(Allison 1996; 2000)
Phoenix Basin	AD <600 - 1070	western middle Gila River	eastern middle Gila River; Salt River	10-45	red-on-buff, plainware	Dec: 28-38%[1], plain: 35-70%	13850	7000	(Abbott 2007; Abbott et al. 2007b; Abbott et al. 2007a; Abbott 2009)
	AD 950 - 1070	Las Colinas	Northern Salt River	10-20	plainware	7-35%	13850	350	(Crown et al. 1988; Nials and Fish 1988; Van Keuren et al. 1997)
	AD <600 - 1070	South Mountain	Salt River	5-30	plainware	7-35%	13850	700	(Abbott et al. 2007b; Abbott et al. 2007a; Abbott 2009)
Tucson Basin	AD 900-1100	Beehive Petrofacies	Eastern Tucson Basin	18-35	red-on-brown, redware, polychrome	44%[2]	3500	3600	(Heidke et al. 2002: Table 12.4; Heidke 2009)
Tonto Basin	A.D. 1200-1325	Griffin Wash (Armer/Cline Petrofacies)	Eastern Tonto Basin	80-100	Corrugated ware	0.49	3150	1300	(Heidke 2004a; Stark and Heidke 1998; Wallace 1995)
	A.D. 1200-1325	Ash Petrofacies	North and western Tonto Basin	40-100	Plainware, redware	0.27	3150	1300	(Heidke and Miksa 2000; Heidke 2004a; Stark and Heidke 1998)
Northern and Central Rio Grande	AD 1350 – 1450	Albuquerque Region	Northern and Central Rio Grande	150	Early Glaze Ware	20%[3]	10,000, up to 30,000-50,000	35769	(Shepard 1942; 1965; Warren 1969; 1970; 1979)
	AD 1300-1670s	Rio Abajo/Salinas	Rio Abajo/Salinas	50	Early, Intermediate, and Late Glaze Ware	28%[4]	3,000 to 5,000	35769	(Graves and Spielmann 2000; Graves 2002; Graves 2004)
	AD 1320-1450	Zia-Santo Domingo Region	Northern and Central Rio Grande	150	Early and Intermediate Glaze Ware	52%[5]	10,000, up to 30,000-50,000	35769	(Nelson and Habicht-Mauche 2006: Table 11.3; Shepard 1942; 1965; Warren 1969; 1970; 1979)
	AD 1450-1515	Galisteo Basin (Tonque, San Marcos)	Northern and Central Rio Grande	150	Early and Intermediate Glaze Ware	20%[6]	10,000, up to 30,000-50,000	35769	(Lang 1993; Nelson and Habicht-Mauche 2006: Table 11.3; Shepard 1942; 1965; Warren 1969; 1970; 1979)
Hopi Mesas	AD 1300 - 1500(1630)	Hopi Mesas	Northeastern Arizona	90-200	Jeddito Yellowware	~2.3-18%[7]	~3,000-5,000	27225	(Adams et al. 1993: Table 3; Bishop et al. 1988)
Sunset Crater	A.D. 700-1200	Sugarloaf Petrofacies	North-central Arizona	140	San Francisco Mountain Grayware	4-65%	~1,000	19600	(Heidke et al. 2007)
Chuska Mtns	AD 1040-1200	Crumbled House, Newcomb, and Skunk Springs	Northeastern Chuska communities, Chaco Canyon, Salmon Ruin, Aztec Ruin	30-100	Trachyte Plainware (mostly) and decorated	~30-70%[8]	~1,000	10904	(King 2003:70-78; Reinhard 1996:181; Toll et al. 1980; Toll 1981; Toll 1991; Toll 2001)

Table 1.1 notes:

[1] Based on an average of 40% red-on-buff wares in site assemblages; With assemblages composed of between 70-95% non-local ceramics.
[2] Based on 25% of plainware ceramics, 50% red-on-brown and redware ceramics, and 90% polychrome ceramics; With assemblages on average composed of 30% plainware ceramics, 66% red-on-brown and redware ceramics, and 4% polychrome ceramics (Heckman and Whittlesey 1999: Table 17; Heidke 1996a; Heidke 1996b; Heidke 2000: Table 4.13; Heidke 2004b; Heidke 2009:Table 4).
[3] Based on an average site assemblage with 40% decorated ceramics, 50% imported wares (Graves 2002: Table 7.3)
[4] Based on an average site assemblage with 40% decorated ceramics, 70% imported wares
[5] Based on an average site assemblage with 40% decorated ceramics, 13% imported wares
[6] Based on an average site assemblage with 40% decorated ceramics, 50% imported wares
[7] Based on average site assemblage with 30% decorated ceramics, percent could be higher if Awatovi Yellow Ware is calculated in
[8] Based on average site assemblage with 70% plainware ceramics, unsure about organization of production

Table 1.2: Summary data on specialized production in the American Southwest.

Location	Duration of Specialized Production (years)	Maximum Regular Transport Distance (km)	Total Percent of Pottery from Specialists	Consumer Population Density	Geographic Area (km^2)	Coordination of Community Specialization[1]
Arizona Strip	100	110	30	Low	48,000	Yes
Phoenix Basin	500+	45	50 - 100	High	7,000	Yes
Tucson Basin	200	35	44	Medium	3,600	No
Tonto Basin	125	100	76	Medium	1,300	Yes
Northern & Central Rio Grande	200	150	28	High	35,769	No
Hopi Mesas	200	200	2.3 - 18	Medium	27,225	No
Flagstaff Area	500?	140	4 - 65	Low	19,600	No
Chuska Mountains	160	100	30 - 70	Low	10,904	No
SUMMARY	**Phoenix Basin**	Rio Grande	**Phoenix Basin**	**Phoenix Basin,** Rio Grande	Arizona Strip, Rio Grande, Hopi Mesas	**Phoenix Basin**, Arizona Strip, Tonto Basin

[1] Different types of specialists coordinate their outputs with one another.

Charting the Development of the Phoenix Basin Economy

Among middle-range societies, the Hohokam economy is a superlative case in which to examine economic development, because it involved intensive production and widespread distribution of specialist-produced goods. For hundreds of years, large populations of people received all of their domestic pottery from geographically concentrated specialists. Most importantly, in the absence of elite intervention or resource pressures, Hohokam producers and consumers participated in an economic system characterized by enduring reliance on one another. Although the basic organization of specialized production across the American Southwest was roughly similar— community specialization and part-time household production by independent craft specialists— particular conditions in the Hohokam case actively encouraged the supply and demand for specialist-produced goods.

Those conditions that allowed economic development in the Phoenix Basin are the keys to addressing economic change in societies characterized by an egalitarian social and political structure. On a landscape characterized by intermittent reliance on specialized production, what factors contributed to high supply and demand for specialist-produced pottery in the Hohokam economy? To address this issue, I identify specific social or economic conditions that encouraged the supply and demand for specialist-produced pottery in the Phoenix Basin. The analysis principally focuses on the organization of red-on-buff pottery production, which was manufactured at only a few locations, yet widely distributed to settlements across the region. It tracks the supply and demand for specialist-produced decorated pottery from the early beginnings of widespread reliance on specialists in the Snaketown phase of the preClassic pioneer period (AD 650-750) until the early Sacaton phase (AD 950-1020), which directly precedes the apex of the Hohokam economy in the middle Sacaton phase.

The analysis begins by characterizing the relationship between the organization of production (supply) and the market (demand) for red-on-buff pottery manufactured by specialists. In Chapter 2, I discuss how the development of the Hohokam economy was spurred by increases in either the supply or the demand for goods. From this characterization I identify factors that may have affected the supply or demand for specialist production. I outline how archaeological data in the Hohokam region can directly address each of these conditions. Chapter 3 then summarizes the methods used to source decorated Hohokam pottery (dependent variables) and data collection methods for each of the factors that may have influenced specialized production in central Arizona.

The results of the red-on-buff analyses in Chapter 4 indicate that supply of specialist-produced decorated pottery, particularly vessels with characteristics of social valuables, spurred economic development in the Phoenix Basin. In particular, specialized production of decorated wares on the Snaketown canal system was associated with economic growth in the Phoenix Basin during the latter portion of the preClassic period. Chapter 5 explores why decorated pottery manufacture was concentrated on the Snaketown canal system; it also considers the comparative advantages to intensive ceramic manufacture in this area. The discussion highlights how Snaketown potters may have reduced transport costs by situating production in a geographically central area and by distributing pottery through social events at large ballcourts. Close proximity to the materials necessary to manufacture light-colored, shiny pottery demanded by Phoenix Basin consumers and the social or political caché of the Snaketown community may have also heightened both the supply and demand for decorated vessels.

The development of intensive red-on-buff manufacture in the Phoenix Basin is then compared to that of specialist-produced plainware pottery. Chapter 6 explores how the conditions that encouraged the supply and demand for specialist-produced decorated pottery may be similar to or different from those conditions that affected plainware production. Specifically, plainware pottery production was not as geographically concentrated as red-on-buff production because of greater transport costs incurred in moving these bulky wares and the relative abundance of the materials necessary to make plainwares. However, both decorated and plainware producers may have relied on low transport costs through centralized production areas and on distribution through a network of large ballcourts. Chapter 7 provides an analysis at the river system level that pieces together available evidence on the development of the Phoenix Basin economy from ceramic sourcing data. The study concludes that complementary economic relationships between the Salt and the Gila Rivers based on comparative advantages to particular economic activities on each river system spurred economic development in the Phoenix Basin. These conditions might be the basis for addressing economic growth in small-scale and middle-range societies.

CHAPTER 2: ADDRESSING THE FACTORS THAT INCREASE THE SUPPLY AND DEMAND FOR SPECIALIST-PRODUCED POTTERY

The Hohokam archaeological culture exhibited population levels in the tens of thousands, widespread exchange systems, and infrastructure characteristic of an early state-level society, but never developed the social or political institutions that mark these organizations. The supply and demand for specialist-produced pottery —and most likely other crafts—was higher than any other documented area in the American Southwest. As a result, the rise of a specialist-based economy in central Arizona directly addresses the conditions that encourage or limit economic development in small-scale and middle range economies.

Specialized production of utilitarian goods and the widespread dependence on the products of specialists for domestic necessities used by every Hohokam household suggests that large portions of the Hohokam economy were characterized by regular and reliable interactions between specialist producers and consumers. Economic systems that involve heavy reliance between producers and consumers are typically structured by "rational" supply and demand relationships rather than by interactions controlled through social, ritual, or political institutions. For example, the supply and demand for everyday household items would not likely be controlled by strong social proscriptions. In addition, manufacturing of Hohokam pottery took place in ordinary domestic contexts where many other activities likely took place. Finally, red-on-buff pottery was likely used for standard household functions such as food storage and serving. Therefore, the production, transfer, and use of decorated pottery were likely closely governed by economic conditions.

The economic root for the supply and demand for specialist-produced red-on-buff pottery in the Phoenix Basin indicates that it can be analyzed in economic terms. Specialization, which is often defined as "production above the needs of the household for purposes of exchange" (Spielmann 1998a:1), is an economic phenomenon. The process of intensification occurs when a division of labor reduces the number of craftsmen, while the number of craft objects manufactured remains the same or increases (after Hunt 2000; Morrison 1994:115; Turner and Doolittle 1978). In other words, people devote more attention to producing particular items for exchange and in turn rely on complementary trade with other specialists for goods they do not produce.

An analysis that seeks to identify the factors that contributed to a high level of craft specialization in the Hohokam economy must simultaneously address the supply and the demand for goods made by specialists. Supply and demand are two sides to the division of labor and to the extent of the market. A change to the supply for particular goods will require a change in demand to reach equilibrium again and vice versa (Smith 1759; Yang 2001:13-15; Young 1928:534, 539). In other words, it is impossible to analyze consumer and producer decisions separately (Young 1928). Therefore, the relationship between these economic components must be part of an analysis that identifies the conditions that encouraged high reliance between producers and consumers.

Defining Supply: Division of Labor and Level of Specialization

Factors that affect the supply-side of an economic system are those that influence an individual's choice to invest more time and resources into a particular productive activity (specialization). Economists rely on the concept of comparative advantage to explain the conditions that encourage or discourage specialization (e.g., Deardorff 2005; Dornbusch et al. 1977; Jones 1961). Comparative advantage is defined as the ability for a person to produce an item at a lower overall (marginal) or opportunity cost than another person (Ricardo 1817). Opportunity cost is the cost incurred by participating in one activity relative to the costs associated with other possible activities to which a person could devote their time. Conditions that contribute to a comparative advantage to specialization are conditions that allow someone to incur a lower opportunity cost by devoting more of their time to a specialized activity than to a range of different activities. By specializing in pottery production, for instance, a person may be able to produce more pots per unit time than they would be able to produce a range of other items.

Archaeologists have long noted that specialized craft production confers significant advantages, which include greater efficiency within an economic system and the potential for higher quality goods. In particular, scholars have argued that specialists can produce more items with less labor than household production by capitalizing on efficiencies in the production process (Blanton et al. 1982; Brumfiel 1980; Lees and Bates 1974). Specialists can also produce better quality products because they concentrate their efforts on particular skills (Blau 1977:188). Recently, archaeologists have used the concept of comparative advantage to address the emergence and development of specialized craft production within ancient economies (Earle 2000:49; Rowlands 1998:219; Shennan 1999; Shennan 2011:207). Tibbet (2004) applied the concept to his analysis of aboriginal subsistence strategies in Australia. Comparative advantages in production of various agricultural and craft items were critical factors in the development of a state-level economy in Mesopotamia (Algaze 2005; Algaze 2008:23, 29-30, 35, 63, 148) and Rome (Scheidel 2010:7).

Comparative Advantages: External and Internal

Recently, the concept of comparative advantage has been incorporated into various economic models for prehistoric economies. Smith (2007) generated a model for economic specialization in the Late Pleistocene based on the comparative advantages of particular production activities in negotiating climate change. Watts (2011) used the concept of comparative advantage to propose a model for the relationship between intensive irrigation agriculture in the Hohokam region and specialized pottery production in the Phoenix Basin. Rouse and Weeks (2011) proposed an agent-based model for economic relationships in Bronze Age Arabia that focuses on the role of comparative advantage in specialized production and exchange networks.

Comparative advantages can be divided into exogenous and endogenous, or external and internally derived, comparative advantages. Most modern economists argue that endogenous comparative advantages are the main cause of changes to the division of labor within societies (Yang 2001:38; Young 1928). Endogenous comparative advantages are a result of economies of specialization where an increase in the level of specialization results in increasing returns (productivity) (Yang 2001:8-9). In other words, when an individual focuses more of their time and attention to a particular production task and less or no time to other production tasks, they will be able to generate more goods in a shorter period of time. The increased productivity and efficiency of specialists versus non-specialists is the largest motivator (advantage) toward devoting time to a specific productive task (Babbage 1832; Rae 1834; Yang and Ng 1993; Yang 2001).

An increase in production with an increase in specialization (economies of specialization) is a result of an individual's ability to increase returns through learning while doing (Borland and Yang 1994; Yang and Ng 1993; Yang and Ng 1998). Individuals who specialize in a particular productive activity will become more proficient and skillful than individuals who engage in this activity less frequently. Specialists conserve time and effort because they do not switch between different tasks (Maxwell 1721:33; Rashid 1986; Tucker 1755; 1774). Specialization also increases productivity by reducing fixed learning costs associated with redundant training and learning (Babbage 1832:170-174; Yang 2001:10) and by increasing the usability of fixed training and learning investments (Arrow 1979:154; Barzel and Yu 1984; Becker 1981). The division of labor encourages the development and use of different materials, machinery, and tools that can significantly boost production efficiency (Rae 1834:164-5, 352-7). Finally, the division of labor can allow a society to accumulate knowledge more quickly and can contribute to a faster rate of innovation, as individuals perfect particular skills associated with their production activities (Ehn 2011:20; Yang and Ng 1993).

In addition to inherent advantages to specialization, external (exogenous) factors can increase the comparative advantage to specialization in some people. Exogenous comparative advantages are differences in the productivity of two individuals that are caused by external factors unrelated to their choice of productive activities or to their level of specialization in those activities (Yang 2003:59). These external factors (termed *ex ante* factors) may include age, gender, or access to particular materials. Archaeologists have highlighted the role of the uneven distribution of critical resources as one possible reason why specialized production of particular items occurs in certain locations (Burton 1984; Costin 1991; Elson 1986; Gasser and Miksicek 1985; Gasser and Kwiatkowski 1991; Malinowski 1922; Murra 1980; Sanders 1956; Shennan 1999; Stark 1991). For example, a person who lives near to an excellent source of pottery clay may be able to increase her overall productivity in ceramic manufacture by concentrating more of her time on manufacturing pottery for exchange. The ease of access to the clay may be a critical factor in her ability to complete pottery production tasks efficiently. Therefore, she has an external comparative advantage to specializing in pottery production over a person who has to travel further to obtain clay suitable for ceramic manufacture. This woman incurs a low opportunity cost when she chooses to specialize in pottery production. In contrast, a person who lives further from high quality clay sources may not be able to increase her overall productivity by investing more of her time in pottery manufacture, because the higher transportation costs associated with the clay limit her ability to increase her output. In other words, she incurs a high opportunity cost when choosing to devote more time to specialized ceramic manufacture.

Defining Demand: The Extent of the Market

Demand for particular goods is defined as the extent of the market for an item. At the most basic level, the market for an item is controlled and limited by the number of potential consumers, or by the population of a society (Roumasset 2007:8; Yang 2003). The market for specialist-produced goods in a city can reach much higher levels than in a small village by virtue of a larger population size. For instance, overall demand for pottery manufactured by specialists on the Arizona Strip never rose to the level of demand for these goods in the Phoenix Basin because overall population levels were much lower.

In addition to basic population levels, the number of goods produced and traded represents another, interrelated dimension of demand (Yang and Ng 1993:22). A society that produces and uses a wide range of items has a larger and more varied market than a society with less material complexity. People living in the modern city of Phoenix, Arizona use a high number and diversity of material objects in their daily lives, while, comparatively speaking, communities in the prehistoric Southwest used a lower variety of items. Phoenix Basin households, however, created an increasing market for various craft goods through the preClassic. A wide range of goods, including red-on-buff and plainware pottery in various forms, were circulated through the economy. Demand for increasingly varied goods (including ceramics) was linked to an expansion of the market and the growth of the economy.

Finally, transaction and transportation costs (Becker and Murphy 1992; Petty 1683:471-472; Smith 1776:31-32) determine the extent of the market. Large population sizes and the number of goods used in a society can only extend the market so far without mechanisms that lower costs incurred in the exchange and movement of goods across the landscape. Transaction costs consist of the time and energy required to locate trading partners and to complete an exchange (Coase 1937; 1961:15; Wang 2003:2). Social institutions are often cited as one of the primary mechanisms that influence transaction costs (Oberschall and Leifer 1986; Yang and Zhou 2009). For instance, regularized places and times to conduct exchanges reduce the effort involved in arranging transfers. Markets and fairs that are scheduled in tandem with other social events, such as religious festivals or other holidays, are one example of social institutions that lower transaction costs. In contrast, some social institutions increase transaction costs by controlling and limiting exchanges. Geertz's (1979) famous example of the Moroccan *suq* demonstrates that the identities of producers and consumers within the market contribute to nonlinear economic transactions that increase the transaction costs of business.

Transportation costs are defined as the expense, time, and energy required to move goods across a particular distance (Glaeser and Kohlhase 2003; Krugman 1991; Limão and Venables 2001). Depending on the economic system, producers or consumers might bear the direct burden of transporting goods. Alternatively, these costs may be shared by moving the locus for exchange to a geographically central point such as a marketplace.

Economic Growth: Putting Supply and Demand Together

To this point, I have described the general factors that influence increases or decreases to supply and demand, respectively. Identifying how and why supply and demand for specialist-produced goods increase requires an understanding of how supply and demand relate to each other. Even though specialization may be more efficient than extensive production, people will not choose to specialize if sufficient demand is not present. Alternatively, although the products of specialists might be better made than those manufactured by individual households, people will continue to produce and use their own goods until there are sufficient incentives to rely on exchange relationships for these goods. Here, I describe how changes to supply and demand contribute to economic development.

Economic growth and development occur as the supply and variety of goods rises through specialization, and as the market for these goods (demand) expands with the number of consumers. This process ultimately increases the reliance that both producers and consumers have on each other and leads to a more interdependent economy. Since both supply and demand are intertwined, change to one side will result in a change to the other. Economic growth occurs through a "ratcheting" effect whereby supply increases, demand increases, and the economy reaches equilibrium at a higher level of specialization (Figure 2.1).

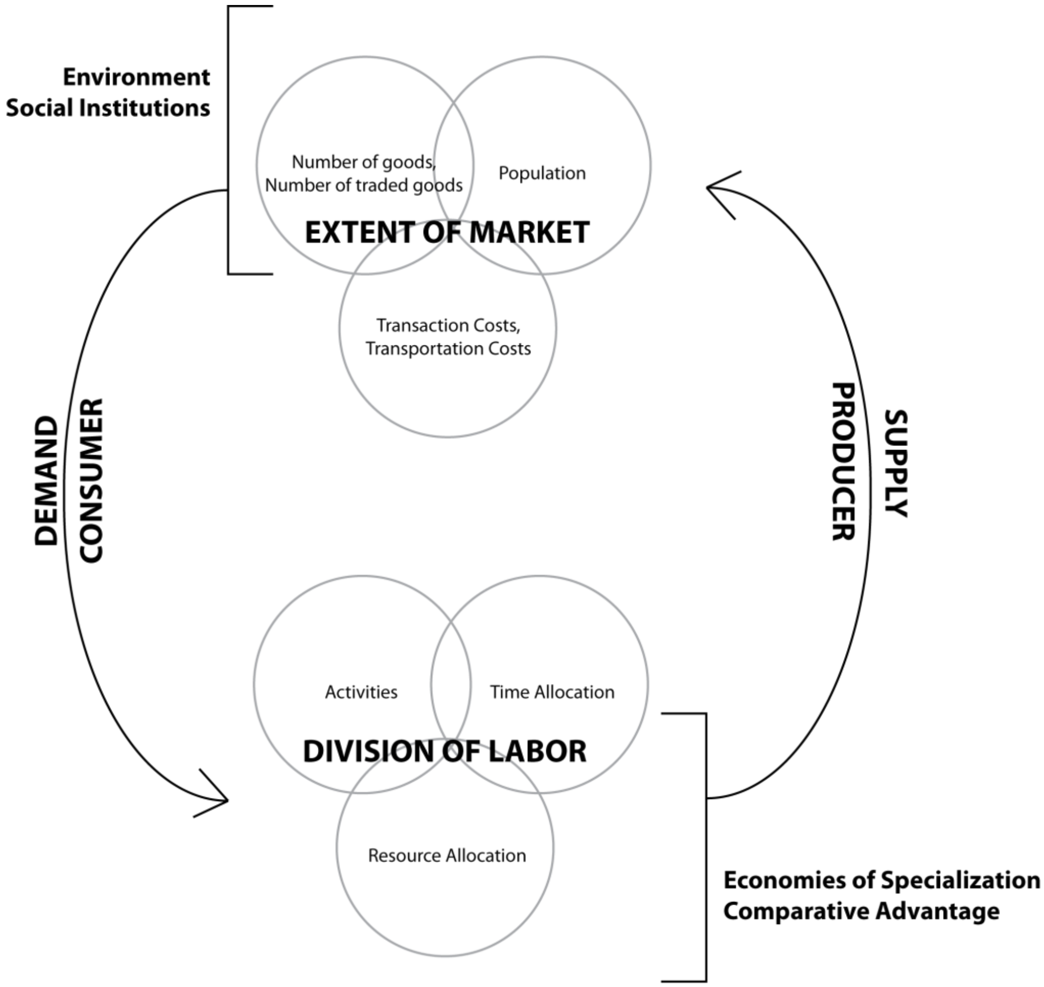


Figure 2.3: New Classical diagram of the relationship between the Division of Labor and Extent of the Market.

Economic growth starts from a point of limited supply and demand for specialist-produced goods. The supply-demand relationships present in small-scale economies are depicted in the first panel of Yang's (2001:13-15) figurative example (reproduced here as Figure 2.2). The figure depicts a four-producer, four-good economy in a state of autarky where each person produces and uses the four items that they need. On the supply side, people within these societies each participate in many productive activities over which they divide their time and resources. There is often little to no comparative advantage to devoting more time to specialized production because the low numbers of potential consumers and the high transaction costs make self-production of all necessary items more efficient than the production of items for exchange (and receipt other items in return). Specialization is also a risky endeavor in which to invest significant time, because it makes the individual reliant on an often unpredictable and small market. Economies of specialization, which often rely on regular and intensive access to certain resources, may also be inhibited in this situation.

Demand for specialist-produced goods in many small-scale and middle-range prehistoric societies is extremely limited or does not exist at all. Most households produced almost all the items that they required. The market in these cases was characterized by low population densities and by low numbers and variety of overall goods produced. Without technological or subsistence intensification, environmental conditions also may dramatically affect the ability of people to live in dense settlements and to transport items across long distances. In addition, large-scale transport of goods was costly and inefficient without social institutions that lowered transaction costs and technologies that lowered transportation costs. The movement of items such as pottery across the landscape likely occurred during periodic social or economic interactions.

The second diagram in the figure (Figure 2.2) represents the economies of most middle-range societies, in which a small market and a partial division of labor develop. In this example, the agents only produce three goods instead of the four goods that they need. Because the agents only produce three of the four goods that they require, they create complementary exchange relationships with other agents. The person who produces good #1 but does not produce good #2 exchanges with another person who produces good #2 but not good #1. Therefore, the exchange of goods #1 and #2 creates a market for each type of good. In this situation, the market for two goods develops; the scenario indicates that demand for these goods is rooted in a larger consumer base for these items and lower transaction costs. On the production side, specialized production of goods #1 and #2 implies that there are comparative advantages and economies of specialization in the manufacture of these goods. Social institutions might simultaneously increase and decrease transaction costs; thus, the institutions produce an uneven market and subsequent specialized production of certain items.

The final example represents a complete division of labor that is typically associated with state-level societies. In this case, each person specializes in producing one good, which they trade to receive the other three goods that they need. The high level of exchange that provides the market for the products of specialist producers is based on extremely low transportation and transaction costs, high population densities, or a high number of overall goods produced. Social institutions in these venues, such as regular fairs for the exchange of goods, might actively lower transaction costs. The comparative advantages to specialized production are high. In general, these advantages encourage people to capitalize on economies of specialization.

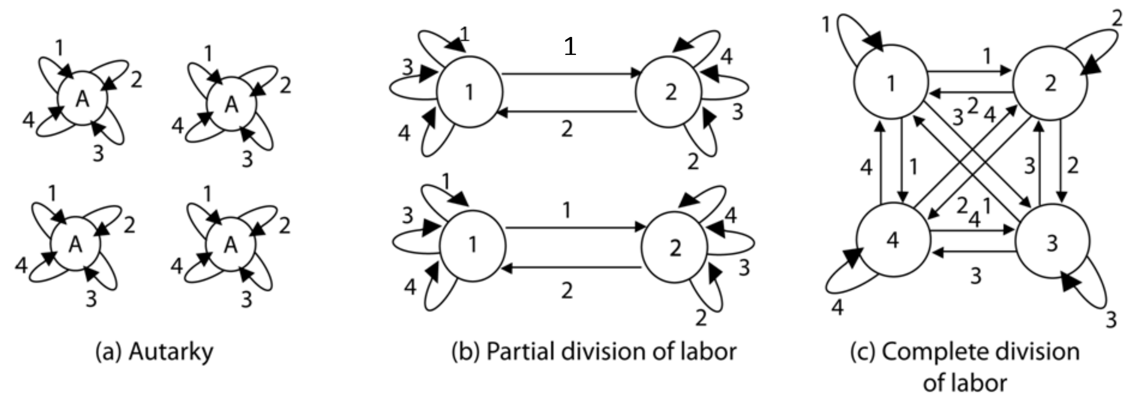


Figure 2.4. Increases to specialized production in a four-good, four-person economy. After Figure 0.2 in Yang 2001.

Identifying Factors that Change the Supply and Demand for Goods

I suggest that, throughout most of prehistory in the American Southwest, low comparative advantages to specialized craft production and inadequate incentives to rely on specialists for goods were the primary limiting factors to the development of specialized economies. The Hohokam economy in the Phoenix Basin, however, was characterized by concentrated specialized pottery production by a few communities and high demand for the products made by specialists. In order to evaluate the conditions that may have promoted the supply and demand for specialized pottery production in the Phoenix Basin, this study first identifies factors that have been implicated in the intensification of craft production. In particular, I focus on four conditions that have been linked with increases to the benefits of specialization (supply) and to the market for specialist-produced goods (demand) in the economic literature and that have been associated with documented cases of craft specialization in other parts of the American Southwest. These include 1) high, stable population densities, 2) intensification of subsistence production, 3) ritual or social obligations that require particular craft items, and 4) lower transport costs in the distribution of pottery across the region.

Factor 1: Population Density

Increases in population density in the Phoenix Basin may have provided the consumer base necessary for large-scale specialized production in the Phoenix Basin and encouraged producers to intensify production. Population density has been closely associated with the emergence of craft specialization in the archaeological literature (Blinman and Wilson 1993:69; Clark and Parry 1990; Curet 1993:438; Durkheim 1893; Ehn 2011:18; Naroll 1956; Pauketat 1994:174, 177-178; 1997; Rice 1981). In particular, rising population densities in several regions of the American Southwest are correlated with an increase in specialized craft production. On the Hopi Mesas, population aggregation into a series of large pueblos immediately preceded the specialized production and widespread distribution of Jeddito Yellow Ware (Adams et al. 1993). Population aggregation has also been linked with a period of intensified pottery production in the Rio Grande during the fourteenth century (Snow 1981:369).

While population size represents the scale of the potential market, or demand, for the products of specialists (Yang 2003), clustering of people on the landscape produces several other effects that can contribute to the supply of goods in an economic system. As population densities increase, specialization can develop as a means to share resources efficiently across a wide and densely occupied area, and to create economic niches for people in a larger economy. Technological innovations and the perfection of craft production techniques, which are both a catalyst and an effect of increasing specialization, are also correlated with increases in population density (Ehn 2011:20-21; Kremer 1993).

Increasing demographic scale may be a particularly important variable in the development of a specialist-based economy in the Phoenix Basin, because the resident population was larger and more stable than most other regions of the prehistoric Southwest (Doelle 1995). The expansive Salt and Gila River valleys provided a stable, resource-rich area for sustained population growth that may have enabled widespread reliance on specialized producers for domestic items. Population density in the Phoenix Basin may be related to demand for specialist-produced goods in several ways. First, increasing regional population densities in central Arizona could place a higher demand on particular resources. One way that large population centers could efficiently receive these resources is through specialist production and distribution of finished craft items (Harry 2005). In addition, stable population centers in the Phoenix Basin may have allowed reliable social and economic networks to develop between producers and consumers. It is these networks that encouraged demand for the products of craft specialists (2007b; Abbott et al. 2007a; Boserup 1965).

If population density is correlated with increases in the supply of pottery by concentrated craft specialists, those production areas that manufacture the greater portion of exchanged pottery in the Phoenix Basin are expected to be located in areas with the highest population densities. If population density is correlated with increases to the demand for red-on-buff pottery made by specialists, consumer locales in areas that are densely populated are expected to import substantial amounts of pottery from specialists.

Factor 2: Irrigation Agriculture

Second, subsistence intensification in the form of irrigation agriculture may have increased supply and the market for specialist-produced red-on-buff pottery. Extensive anthropological and economic research suggests a strong correlation between the processes of agricultural intensification and specialized craft production (Barlett 1976; 1980; Boserup 1965; Childe 1946; Dalton 1960; Dow 1985; Smith 1976). Archaeologists have also noted that prehistoric subsistence intensification in the American Southwest may have encouraged demand for specialized craft production in particular regions. Examples include the co-occurrence of agricultural intensification and specialized craft production of various pottery wares in the Dolores area during the Pueblo I period (Blinman 1986; Wilshusen 1989:827). In the Chuska Mountains, areas with extremely productive environmental conditions for agriculture were also locales for specialized pottery production (Toll et al. 1980; Toll 1981; 1991; 2001). Researchers identified corn from this region in Chaco Canyon. The movement of this staple crop indicates that local residents may have engaged in surplus corn production either for exchange or for their own use in ceremonies in the canyon (Benson et al. 2003).

Subsistence intensification in the Phoenix Basin may have also encouraged specialized pottery production. The extremely large size of prehistoric irrigation systems in this region indicates that irrigation agriculture played a pivotal role in economic development (Bayman et al. 2004; Doyel 1991; Howard 1993b). Approximately 27,250 ha of arable land were irrigated by canals that extended from the Salt and Gila rivers (Fish et al. 1992). The high labor requirements of irrigation agriculture could have introduced scheduling conflicts with craft production; these conflicts would have made specialist-produced goods more cost effective than household production (Abbott 2009). Under these conditions, the time investment and scheduling burden involved in irrigation agriculture may have increased the opportunity costs for craft production and contributed to the supply and demand for specialized red-on-buff production (Costin 1991:17; Mills and Crown 1995; Schortman and Urban 2004:197). Hohokam irrigation systems were also capable of producing surplus food and cotton that could have been exchanged for craft items. These surpluses may have supported a division of labor in craft production (Abbott 2009).

If agricultural workloads are correlated with the supply of specialist-produced pottery, the pottery manufactured by producers on canals with the least number of people relative to the size of the canal system is expected to account for the highest portion of exports throughout the Phoenix Basin. If agricultural workloads are correlated with the market for red-on-buff pottery from specialists, settlements on canal systems with the highest number of people per canal system size are expected to import the most pottery.

Factor 3: Socially Valued Goods

Third, demand for specialized red-on-buff pottery production may have been the result of ritual requirements for social valuables. Ritual requirements increase the number of goods used by a society and increase demand for a larger range of goods (see Figure 1.1). Spielmann (2002) suggests that communal ritual and ceremonial participation motivate specialized craft production and other forms of economic intensification in small-scale societies. In this model, the intensity and scale of craft production are affected by sustained demand for material items that satisfy social and ritual obligations (Rappaport 1984). Although some craft items are exclusively associated with ritual practice, many social valuables are also linked to less formal contexts. For instance, Rio Grande glaze ware bowls were closely associated with ritual feasting, but were also used for food preparation and serving in domestic settings (Spielmann 1998b).

Craft production associated with ritual activities may have promoted the development of specialized production centers in particular areas of the Southwest. For example, the emergence of new regional ritual systems in the Rio Grande during the fourteenth and fifteenth centuries is linked to concentrated production and widespread distribution of Rio Grande glaze wares (Graves and Spielmann 2000; Spielmann 1998b). The rise of Chaco Canyon as a ritual center is associated with the development of specialized white ware production by settlements to the east of the Chuska Mountains. For instance, three settlements on the eastern side of the Chuska Mountains supplied up to thirty percent of the pottery recovered from sites in Chaco Canyon (Toll 1981, 1991, 2001; Toll et al. 1980). The Phoenix Basin Hohokam also participated in a pan-regional ritual system. This system consisted of an extensive network of ballcourts that may have hosted large community gatherings. Social and ritual events associated with the ballcourts may have promoted specialized production of social valuables (Doyel 1991; Haury 1937a; Marshall 2001; Wilcox and Sternberg 1983).

Hohokam red-on-buff vessels may have been produced as social valuables that were used in various contexts, ranging from domestic food preparation and consumption to large-scale social gatherings. Although red-on-buff vessels were a functional component of Hohokam household pottery assemblages, the designs on these vessels may have simultaneously signaled participation in Hohokam social and ritual spheres of life. Red-on-buff bowls and small jars were ubiquitous in Hohokam households from the early Pioneer period until the end of the Sedentary period. The form and size of red-on-buff vessels suggest that they were primarily used for food preparation and consumption. In particular, large red-on-buff bowls could have been used as serving bowls for communal feasts (c.f. Mills 2007). The production of exotic red-on-buff vessel forms such as tripods, censers, and human and animal effigies indicates that some red-on-buff items were used in ceremonial contexts (Whittlesey 2007:69). Several authors draw a connection between red-on-buff pottery and the display of particular decorative motifs with a regional Hohokam ideological system (Doyel 2007), as well as with pan-regional interaction spheres (Nelson and Crider 2005).

The organization of production for socially-valued goods is often affected by the aesthetic and material qualities of these items. Spielmann (2002:197) notes that the production of socially-valued goods “has an aesthetic quality to it beyond production for ordinary, everyday consumption, which may require a certain level of skill and affects the organization of craft production.” Technological complexity has been closely linked to particular scales of production, such as workshop production (Francis 1991; White and Pigott 1996). Sometimes the technologies and skills necessary to produce particular craft items are so complex that only specialists can devote the time and resources to perfect them (Ambler 1983; Rosen 1997). For instance, Crown (1995:160) argues that large Salado Polychrome bowls and jars were produced by specialists because the skills necessary to make them were particularly difficult to master.

The technological investments and skill necessary to produce Hohokam red-on-buff pottery suggest significant investment in the aesthetic qualities of the pots. Recent research has highlighted the complexity of the buff ware clay recipe, which contributes to its light color when fired. Archaeologists believe that ancient potters worked to lighten the pottery paste so that it provided a contrastive background to red painted designs. To this end, calcium-rich, and possibly salt-rich, calcareous clays were carefully selected for buffware production. Caliche nodules were added to the clay to lighten the paste even further. Most importantly, the firing temperature of the finished pot was carefully controlled between 800°C and 900°C to induce a chemical reaction between the calcareous clay and caliche and to prevent spalling. This complex process was not developed quickly, and ample evidence of experimentation during the late Pioneer period suggests that potters were actively adjusting their methods to obtain light colored pottery (Abbott 2007).

If specialized red-on-buff pottery production began as a response to ritual requirements for the production of socially-valued goods, then the physical appearance of red-on-buff pottery should reflect this special role early on in the history of its production. Specifically, specialist producers who manufactured the most red-on-buff wares for export would also manufacture wares with light surface exteriors and high mica densities. If this physical appearance of red-on-buff wares was important to demand for these pots, the majority of households who imported buffware would have selected light-colored vessels with a shiny mica exterior.

Factor 4: Transport Costs

Finally, widespread and uniform circulation of red-on-buff vessel forms suggests that demand for specialist pottery production may have been related to lower transport costs within an efficient distribution system (Abbott et al. 2001; Abbott 2010). Transportation costs can significantly impact the organization of craft production by increasing or decreasing the ease with which goods are moved from producer to consumer. Archaeologists working in the American Southwest note that transportation costs were likely hindered the development of specialized craft production. In particular, bulky, fragile items, such as pottery, would have been difficult to transport in significant quantities to potential consumers due to the absence of transportation technologies such as pack animals (Harry 2005:312).

Despite the fact that transportation in the prehistoric American Southwest was limited to foot travel, notable cases of specialist production involve the regular transport of items across long distances. For instance, Moapa Gray Wares and Shivwits Plain Wares produced by specialists in the Arizona Strip were distributed to Virgin Anasazi settlements as far away as 110 km (Allison 2000; Lyneis 1992). Jeddito Yellow Wares were distributed from specialist production centers on the Hopi Mesas to settlements over 200 km away (Adams et al. 1993). These instances demonstrate that, although improvements to transportation methods themselves may not have reduced transport costs, changes to exchange systems may have lowered the transport costs incurred by individuals. In particular, the establishment of central exchange areas between producers and consumers could have reduced the cost of transporting goods by dividing the effort among the relevant parties (Alden 1982; Belshaw 1965). Both producers and consumers would travel to exchange goods, but they would not have to travel as far as would be necessary if only one individual assumed the entire burden of transport.

Changes to exchange systems that lower transportation costs may have been particularly influential in increasing supply and demand for specialist-produced goods in the Phoenix Basin. Abbott and his colleagues (2007a) suggest that, by the middle Sedentary period, marketplaces at ballcourts were important mechanisms to circulate pottery and other items through the region. Markets, particularly centralized marketing systems, increase the ease and regularity with which producers and consumers can exchange goods. As a result, marketplaces lower the cost of their goods and increase demand for them across a wider geographic area. If supply is correlated with low transportation costs as a result of ballcourts, the producers who manufacture the most wares for export are expected to be located on canal systems with the highest number of ballcourts per capita. If demand is correlated with ballcourts, settlements on canal systems with the highest number of ballcourts per capita are expected to import the most pottery.

If an efficient distribution system reduced transportation costs, then the volume of supply and the volume of consumed pottery (demand) should not decrease as the distance between production and consumption locale increases. In other words, the volume of non-local pottery should not display patterns consistent with a distance-decay curve. The absence of efficient distribution mechanisms would be signaled by distinct fall-off distributions from the location of production to places of consumption. If the supply of specialist produced pottery is related to transportation costs, those producers who generate the most wares for export should also transport those wares the farthest. If demand for pottery is correlated with low transportation costs, villages that import the most pottery would also import pottery from the furthest distance away.

Finally, producers and consumers could have lowered transport costs by modifying the form and size of exchanged vessels. For instance, bowls can be carried more easily than jars because they can be nested inside of one another. Exporting and importing more bowls than jars may indicate that producers and consumers were reducing transport costs by modifying the wares that were moved. Similarly, small vessels are easier to transport than large ones. Producers and consumers could have lowered transport costs by exchanging those vessels that are smaller than the ones they produced and used locally. If the supply of specialist-produced pottery is related to changes in the form and size of vessels, those producers that generate the most wares for export will also export more bowls than jars (high bowl jar ratio) and small bowls. If demand for specialist-produced pottery is related to lowered transport costs through modifying the form and size of vessels, those households that import the most non-local wares will also import more bowls than jars and will import small bowls.

Summary

Although current archaeological work has provided substantial information about specialized pottery production in central Arizona, it has yet to offer a thorough explanation for why specialization developed. Population density, subsistence intensification, ritual obligations, and lower transport costs are all factors that may have influenced intensive ceramic manufacture and the market for decorated pottery made by specialized producers in the Phoenix Basin. The effect of the timing, extent, and coincidence of these conditions on the development of the Hohokam economy, however, is not yet known. The producers and consumers were likely influenced by several of these factors, and the impact of these factors likely changed through time as the Hohokam economy expanded. The precision possible in sourcing and dating decorated red-on-buff pottery in the Phoenix Basin allows for a close evaluation of each factor at various stages in the development of regional specialized production.

In the following chapter, I describe the data used to address each of the four factors that may have contributed to increases in either supply or demand for specialist-produced pottery. The analysis uses a series of multiple regression analyses to examine demand for specialist-produced red-on-buff pottery. These regression analyses incorporate each of the four factors as independent variables. The supply and demand for buffware pottery represents the dependent variables in these equations. I describe in detail how I calculate the independent and dependent variables that are used in each of the multiple regression analyses.

CHAPTER 3: METHODS

To evaluate changes in the supply and demand for specialist-produced Hohokam pottery, I construct and test several interrelated hypotheses that may explain why large-scale specialized craft production developed in the Phoenix Basin. In particular, I investigate the role of four different factors that encouraged the complex supply and demand relationships in the Hohokam economy. Those factors include

1. increases in population density
2. agricultural intensification in the form of irrigation agriculture
3. ritual or social obligations that required the production of particular craft items
4. reduced transport costs.

One or several of these conditions may have encouraged specialized production in the Phoenix Basin. Various authors have argued that multiple, often interrelated factors contribute to the development of specialized economies (Clark 2007; Costin 2001; 2005; 2007; Flad and Hruby 2007; Hendon 2007; Li 2007; Menon 2008; Morrison 2007). Therefore, I evaluate the role of each of these factors simultaneously through a series of multiple regression analyses. The multiple regression approach provides a methodology to evaluate the role of multiple factors in the economic decisions that Hohokam households made. The four factors are independent variables that are used to predict the dependent variable: the supply or the demand for decorated vessels. Each analysis creates a "best fit model" that includes the relative contributions of the four independent factors on either producer supply or household demand for buffware vessels manufactured by specialists (Pedhazur and Schmelkin 1991:417). Finally, the overall strength of each regression model is measured by how well it explains the variance in the dependent variable (R^2) (Shennan 1997:186-192).

The supply, volume, and concentration of non-local decorated wares from Phoenix Basin settlements are determined through a sourcing analysis that identifies the production locale of red-on-buff vessels. The supply of specialist producers in different areas is measured as the proportion of total exports that one production area manufactures. Production area is identified on the basis of sand temper composition in pottery sherds (discussed below).

Demand for specialist-produced Hohokam red-on-buff pottery is identified through patterns in household ceramic assemblages across the Phoenix Basin. Because demand is difficult to measure archaeologically, I assume that household demand is equivalent to household consumption of red-on-buff pottery (Costin 2005:1047). Therefore, I assess demand by measuring the volume and concentration of non-local red-on-buff pottery consumed by Phoenix Basin households. The volume of non-local red-on-buff pottery in an assemblage is measured by the proportion of pottery that is produced outside of the sand composition zone for the sample site (discussed below). The concentration of red-on-buff pottery from particular sources is measured by the richness (number) of represented source areas for red-on-buff pottery in an assemblage as well as the evenness (distribution) of those sources.

The analysis addresses temporal change in supply and demand for specialist-produced red-on-buff pottery produced by creating a set of regression models for each of three temporal intervals: the Snaketown to Gila Butte phases (AD 650-850), the Gila Butte to Santa Cruz phases (AD 750-950), and Santa Cruz to early Sacaton phases (AD 850-1020). These regression models provide a diachronic perspective on the relative influence of the four independent factors over time. For example, population densities and irrigation infrastructure, both of which were low during the Snaketown and Gila Butte phases, may have had a relatively insignificant influence on household demand for red-on-buff pottery manufactured by specialists, but may have become much more important later in the temporal sequence. The results of the analysis provide a refined perspective on the changing conditions related to demand for decorated vessels produced by specialists, and thus the growth of a Hohokam specialist-based economy. Most importantly, a multi-factor model that tests several different, independent factors at the same time may provide data that is broadly applicable to studies of economic intensification in other middle range societies.

Sampling Regime

The sourcing analysis begins with systematic sampling of Hohokam decorated pottery[2] from 13 village sites (Table 3.1, Figure 3.1). These 13 settlements were occupied over the Snaketown (AD 700-750), Gila Butte (AD 750-850/900), Santa Cruz (AD 850/900-950), or the early Sedentary (AD 950-1020) phases of the preClassic. Although the study analyzes pottery from 13 sites, not all of these sites were occupied during all

[2] Decorated pottery includes Hohokam red-on-gray, red-on-buff, and brown-paste variants.

temporal phases included in the study. Therefore, I sampled ceramic assemblages from a minimum of six sites for each of the four temporal phases. These samples include an average of approximately 150 sherds and at least 20 sherds per site per temporal phase. Sites were selected for an even geographic distribution across the lower Salt and middle Gila River valleys in the Phoenix Basin during each of the four major preClassic phases. Settlement selection also maximized the number of canal systems associated with sites in the analysis.

With the exception of the site of Snaketown, all ceramic collections used in the study are derived from federally-mandated CRM excavations in compliance with Section 106 of the Historic Preservation Act. Snaketown was the subject of a series of academic excavations in the early 1930s (Gladwin et al. 1937; Gladwin et al. 1938; Gladwin 1942; Gladwin 1948) and the mid-1960s (Haury 1976). Collections for sites located along the lower Salt River valley, Snaketown, and Grewe are housed in public collections repositories at the Arizona State Museum (ASM), the Pueblo Grande Museum (PGM), and at Arizona State University (ASU). Ceramic collections for the remaining settlements located along the middle Gila River valley are housed in tribal collections facilities at the Huhugam Heritage Center or the Cultural Resource Management Program for the Gila River Indian Community (GRIC-CRMP).

Table 3.1: Collections used in sourcing analysis.

Site Name	Site Number	GR Number	Temporal Phases of Ceramic Collections Used in Study	River Valley	Canal System	Curation Facility	Petrofacies Zone
Chee Nee	AZ U:14:217, AZ U:14:218, AZ U:14:219	GR-140	Snaketown	Middle Gila	Chee Nee	GRIC-CRMP	A
El Caserio	T:12:49 (ASM)		Gila Butte, Santa Cruz, Early Sacaton	Lower Salt	Canal System 2	ASM	I
Grewe	AA:2:2 (ASM)		Snaketown, Gila Butte, Santa Cruz, Early Sacaton	Middle Gila	Grewe-Casa Grande	ASM	F5/G
La Ciudad	T:12:11,12 (ASU)		Snaketown, Gila Butte, Santa Cruz, Early Sacaton	Lower Salt	Canal System 2	ASU	I
La Lomita	U:9:67 (ASM)		Early Sacaton	Lower Salt	Canal System 2	ASM, PGM	I
La Villa	T:12:148 (ASM)		Snaketown, Gila Butte, Santa Cruz	Lower Salt	Canal System 2	PGM	None[a]
Las Colinas	T:12:10 (ASM)		Gila Butte	Lower Salt	Canal System 2	ASM	None[a]
Las Ruinitas	AZ U:9:65 (ASM)		Early Sacaton	Lower Salt	pre-Lehi	ASM	U
Los Hornos	U:9:41 (ASU)		Snaketown, Gila Butte, Santa Cruz, Early Sacaton	Lower Salt	Canal System 1	ASU	Q
Lower Santan	U:13:6	GR-522	Early Sacaton	Middle Gila	Granite Knob/Santan Canal System	GRIC-CRMP	A
Sacaton Park	AZ U:14:23 (ASU)	GR-915	Early Sacaton	Middle Gila	Sweetwater	GRIC-CRMP	H
Snaketown	U:13:1 (ASM)	GR-898	Snaketown, Gila Butte, Santa Cruz	Middle Gila	Snaketown	ASM	N
Upper Santan	U:14:8 (ASM)	GR-441	Snaketown, Gila Butte, Santa Cruz, Early Sacaton	Middle Gila	Granite Knob/Santan	GRIC-CRMP	B

Note: [a] These sites are located to the west of Petrofacies V. However, it is likely that the composition of local sands in this area closely match Petrofacies V.

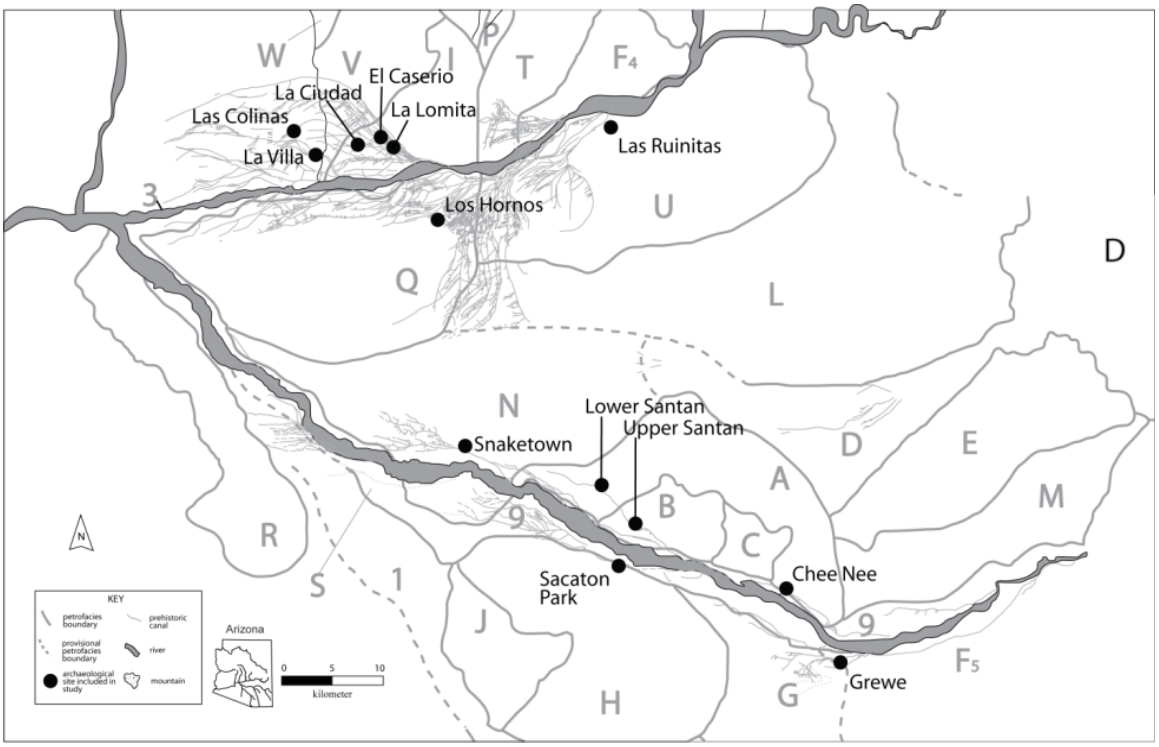


Figure 3.1: Map of the Phoenix Basin with study sites marked.

Establishing Temporal Control for Ceramic Samples

To establish the production period for the ceramic assemblages at each site, I selected sherds for analysis that are either a) associated with features that have been dated using refined ceramic seriation techniques, or b) have painted designs large enough to assign to a temporal phase in the standard Hohokam buffware typology or Wallace's (2001; 2004) refined red-on-buff typology. The following sections describe the techniques used to maintain temporal control over the selected sample.

Dated Features

Most ceramic collections used in this analysis were selected from features that were dated through a refined ceramic seriation technique to particular sub phases in the

Hohokam temporal sequence. This novel methodology, which was developed by Henry Wallace in the early 2000s, marks a considerable breakthrough in the resolution and accuracy of dating techniques in the Hohokam culture region. Below, I briefly review Hohokam chronology building and then discuss how Wallace's stylistic seriation addressed known issues in Hohokam ceramic dating and analysis.

Until relatively recently, the Hohokam chronological sequence was a matter of continued debate (Bullard 1962; Cordell 1984; Dean 1991; Deaver and Ciolek-Torrello 1995; Deaver 1997; Di Peso 1956; Eighmy and McGuire 1988; Gladwin 1942; 1948; Henderson 1987; Plog 1980a; Schiffer 1982; 1986; Wallace et al. 1995; Wilcox 1979). In the 1920s and 1930s, Harold Gladwin and his colleagues established the first Hohokam chronology using stratigraphic sequences from their excavations at Snaketown and the vicinity of Casa Grande. Although subsequent analyses have confirmed the basic accuracy of the original periods and phases (Haury 1976; Schiffer 1982), the calendric dates linked to each temporal phase have been hotly disputed. Unlike other regions of the Southwest, the Hohokam heartland lacked coniferous trees that could provide precise absolute dates from dendrochronological samples.

The Hohokam chronology is largely based on Hohokam ceramic typologies that were cross-dated with intrusive Puebloan sherds and matched to radiocarbon and archaeomagnetic dates (Dean 1991). Despite the emphasis on ceramic typologies to anchor the Hohokam chronological sequence, little attention was devoted to refining Hohokam ceramic classification. Until just a few years ago, analysts relied on Emil Haury's original definitions for Hohokam ceramic types in his landmark studies at

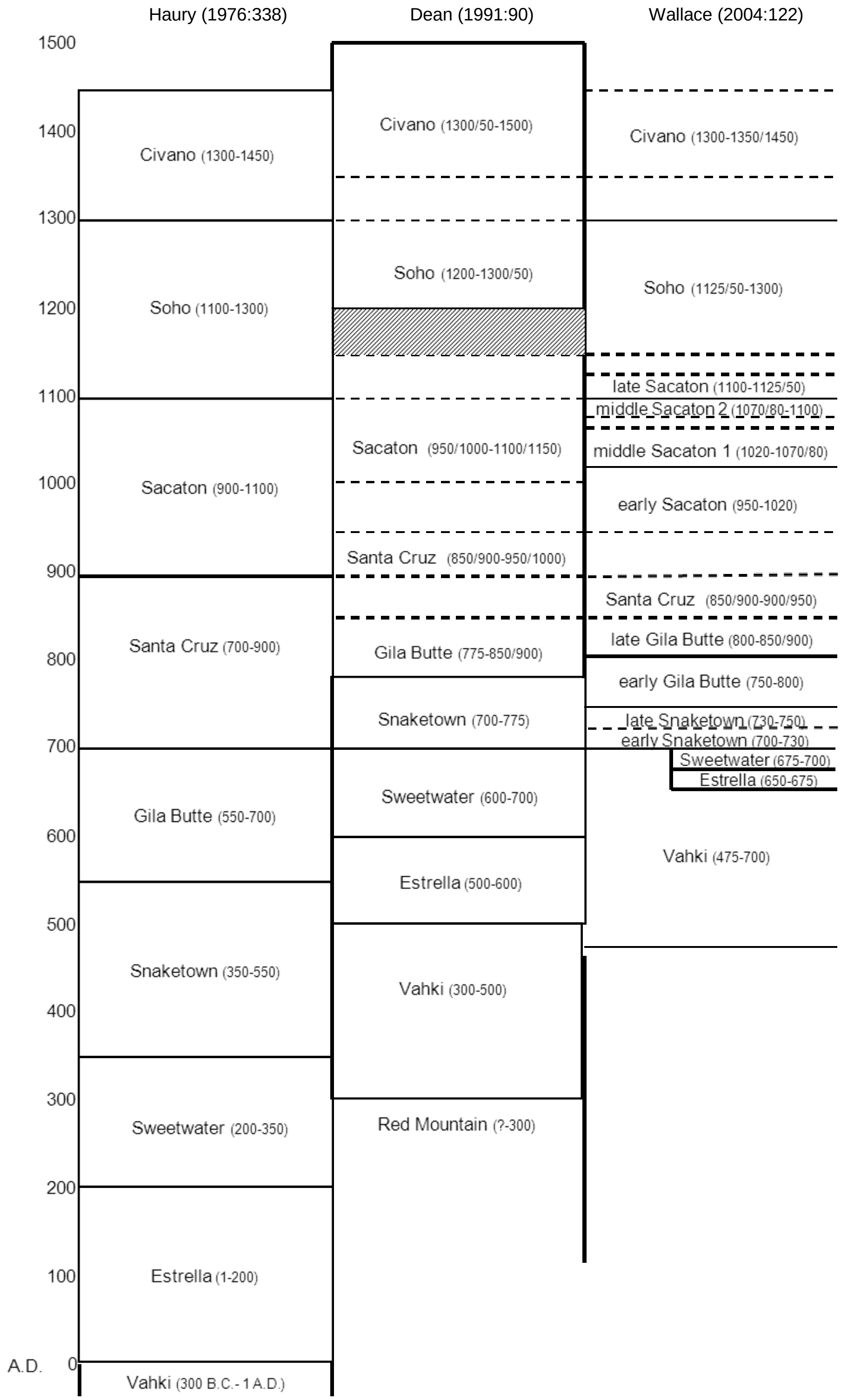
Snaketown (Haury 1937b; 1976). Although the relative sequence of Hohokam red-on-buff pottery has been refined and corroborated over time (Abbott 1988; Dean 1991; Wallace and Craig 1988), analysts noted that lack of systematization in how these types are defined led to ambiguities in how each type was identified (Dean 1991; Doyel and Elson 1985; Henderson 1987; Marmaduke 1993; Neitzel 1984; Wallace 1992:33-35; Wallace et al. 1995:58-59). In addition, the long time periods in the Hohokam chronology made it difficult to address research questions that require greater temporal resolution.

Wallace's Refined Seriation of Red-on-buff Pottery

In his ground-breaking studies of Hohokam decorated ceramics, Henry Wallace (2001; 2004) created a refined seriation of red-on-buff pottery that addressed documented problems in the Hohokam chronology—specifically the ambiguity of defining ceramic types and the long time periods associated with each type. Wallace's seriation has quickly become a baseline for Hohokam ceramic research and the foundation on which detailed studies on Hohokam pottery production and distribution rely (Table 3.2). To create his seriation, Wallace carefully selected sherds from excavated features that represented rapid and unmixed deposition. Wallace then recorded stylistic attributes for sherds in these contexts. By recording shifts in the presence and proportions of design attributes through time, Wallace identified specific stylistic characteristics that were linked with pottery manufactured during each temporal phase. Most importantly, he identified stylistic trends within phases; he then used those trends to define temporal sub-phases. For instance, Wallace was able to divide the Gila Butte phase into Early Gila Butte and

Late Gila Butte sub-phases. He was also able to divide the Sacaton phase into four sub-phases: the Early Sacaton, Middle Sacaton I, Middle Sacaton II, and Late Sacaton. These sub-phases, some of which represent temporal spans as short as 50 years, mark a dramatic increase in the resolution of the Hohokam chronology.

Table 3.2: Comparison of Wallace's Hohokam chronology to Haury and Dean's temporal sequences (from Lack 2013: Figure 5.2)



Ensuring Temporal Sensitivity in the Artifact Collection

In this analysis, I use sherds collected from excavated features that either Wallace (2001; 2004) or Abbott (2009) dated with Wallace's refined red-on-buff typology (see also Lack 2012). These features, listed in Table 3.3, were contexts such as pits that were quickly filled by sherds dating to a single or adjacent temporal phases.

Table 3.3: Features used in analysis that were dated using Wallace's criteria.

Site Name	Date	Features	Source for Rough Sort	Source for Dating
El Caserio	2. Gila Butte	31, 36	Mitchell , ed. 1989	Abbott 2009
El Caserio	3. Santa Cruz	45, 59, 62, 74	Mitchell , ed. 1989	Abbott 2009
El Caserio	4. Early Sacaton	21, 28, 46, 50, 60, 65, 67, 88	Mitchell, ed. 1989	Abbott 2009
Grewe	1. Snaketown	339	Abbott 2001	Wallace 2001
Grewe	2. Gila Butte	350	Abbott 2001	Wallace 2001
Grewe	4. Early Sacaton	97, 165, 440	Abbott 2001	Wallace 2001
La Ciudad	1. Snaketown	78, 538, 1633	Henderson 1987	Abbott 2009
La Ciudad	2. Gila Butte	43, 44, 373, 374, 492, 766, 874, 1015, 1196, 1381, 1634, 1650	Henderson 1987	Abbott 2009
La Ciudad	3. Santa Cruz	293, 598, 674, 841	Henderson 1987	Abbott 2009
La Lomita	4. Early Sacaton	9, 36, 37, 38	Mitchell & Motsinger 1997	Abbott 2009
La Lomita	4. Early Sacaton	26, 37, 66	Mitchell, ed. 1990	Abbott 2009
La Villa	1. Snaketown	58, 155, 254, 323, 344	On-going	Abbott 2009
La Villa	1. Snaketown	106, 115	Schroeder ed. 1994	Abbott 2009
La Villa	2. Gila Butte	95, 310, 235, 236, 261	On-going	Abbott 2009
La Villa	2. Gila Butte	13, 14, 75, 76, 109, 116, 117, 128	Schroeder ed. 1994	Abbott 2009
La Villa	3. Santa Cruz	80, 81, 84	Schroeder, ed. 1994	Abbott 2009
Las Colinas	2. Gila Butte	1004	Abbott 1988	Abbott 2009
Las Ruinitas	4. Early Sacaton	12	King 2007	Abbott 2009
Los Hornos	1. Snaketown	1, 15, 83	Chenault et al. 1993	Abbott 2009
Los Hornos	2. Gila Butte	11, 16, 17, 25, 39, 63, 64, 75, 82, 84, 85, 93, 103, 106, 112, 125, 126	Chenault et al. 1993	Abbott 2009
Los Hornos	2. Gila Butte	21	Effland ed. 1990	Abbott 2009
Los Hornos	2. Gila Butte	11, 75, 99, 737, 589	Wilcox et al. 1990	Abbott 2009
Los Hornos	4. Early Sacaton	38, 76	Effland ed. 1990	Abbott 2009
Lower Santan	4. Early Sacaton[c]	166, 784, 152, 161	Kelly n.d.	Lack 2012
Snaketow n	1. Snaketown	15E, House 1; 8D, Strat Test 1 (Levels 5 & 6); 11F Pit 34; 5F House 8[a]; 11F House 5 subfloor Pit 9C [b]	Haury 1976	Wallace 2001, 2004
Snaketow n	2. Gila Butte	8D, Strat Test 1 (Levels 3 & 4); 9E Pit 7	Haury 1976	Wallace 2001
Snaketow n	3. Santa Cruz	10E Pit 4, Broadside 1; 10G House 15	Haury 1976	Wallace 2004

Notes: [a] Wallace (2004) dated feature to Snaketown/Gila Butte. I selected Snaketown phase sherds.
[b] Wallace (2004) dated feature to Sweetwater/Snaketown. I selected Snaketown phase sherds.
[c] Lack (2012) dated feature to Early Sacaton - Middle Sacaton 2. I selected Early Sacaton phase sherds.

To increase sample size for the analysis, I also included some sherds that were not associated with dated features, but that had temporally diagnostic designs. I used Wallace's stylistic criteria to date the designs on the surface of these sherds. Table 3.4 lists the contexts from which sherds were individually selected. Some features furnished sherds that dated to several different temporal phases, while other features furnished sherds that dated to only one of the four preClassic temporal phases addressed in this study. The phases of dated sherds from each set of features are noted in Table 3.4.

Table 3.4: Contexts from which individually-typed sherds were selected.

Site	Phases from which Sherds Were Selected	Feature#	Source for Rough Sort	Source for Individual Sherd Temporal Assignment
Chee Nee	Snaketown	120, 171, 203, 208, FE-1, TR-28, TR-33, TR-41, TR-42, TR-43	GRIC-CRMP ceramic database	Kelly analysis
Grewe	Santa Cruz	13, 98, 99, 105, 109, 110, 114, 119, 171, 216, 218, 221, 359, 368, 369, 375, 379, 416, 419, 427, 437, 572, 576, 578	Abbott 2001	Kelly analysis
Grewe	Snaketown	78, 172, 248, 414, 519, 553, 560, 666, 668	Abbott 2001	Kelly analysis
Grewe	Snaketown, Santa Cruz	77, 103, 219, 238, 554, 664, 673, 680, 690,	Abbott 2001	Kelly analysis
La Lomita	Early Sacaton	9, 36, 38	Mitchell ed. 1990	Kelly analysis
Sacaton Park	Early Sacaton	151, 160, 174, 214, 217, 278, 333, 339	GRIC-CRMP ceramic database	Kelly, Rheaume, and Sinclair analysis
Snaketown	Gila Butte	5F House 7**	Haury 1976	Wallace 2004
Upper Santan	Early Sacaton	SU-49	GRIC-CRMP ceramic database	Kelly analysis
Upper Santan	Gila Butte	SU-63	GRIC-CRMP ceramic database	Kelly analysis
Upper Santan	Gila Butte, Santa Cruz	872, 876	GRIC-CRMP ceramic database	Kelly analysis
Upper Santan	Santa Cruz	480, 761, 791, 801, 829, 860, SU-66	GRIC-CRMP ceramic database	Kelly analysis
Upper Santan	Snaketown	812, 839, SU-64, TR-510, TR-514	GRIC-CRMP ceramic database	Kelly analysis
Upper Santan	Snaketown, Gila Butte	TR-643, TR-644	GRIC-CRMP ceramic database	Kelly analysis
Upper Santan	Snaketown, Gila Butte, Santa Cruz	833, 862	GRIC-CRMP ceramic database	Kelly analysis
Upper Santan	Snaketown, Gila Butte, Santa Cruz, Early Sacaton	1168, TR-642	GRIC-CRMP ceramic database	Kelly analysis
Upper Santan	Snaketown, Santa Cruz	827, 873, TR-501	GRIC-CRMP ceramic database	Kelly analysis

** Wallace (2004) dated feature to MSAC1, but notes presence of earlier sherds. I selected Gila Butte sherds from this feature.

In sum, an average of approximately 150 sherds and at least 20 sherds per site per temporal phase were selected from temporally sensitive contexts or were individually typed to a particular Hohokam temporal phase (Table 3.5). In total, 4,310 sherds were included in the analysis. The sub-phases for dated sherds are grouped by the main phase in the Hohokam chronology (e.g., Late Snaketown with Snaketown). However, Early

Sacaton sherds, which represent the temporal limit of the analysis, are not grouped with later Sacaton phase sherds. The selected sherds were all subjected to a sourcing analysis detailed in the next section.

Table 3.5: Red-on-buff sherd counts by site.

Sites	Snaketown	Gila Butte	Santa Cruz	Early Sacaton	Grand Total
Chee Nee	53				53
El Caserio			109	226	335
Grewe	127	121	131	174	553
La Ciudad	99	788	162		1049
La Lomita				262	262
La Villa	58	339	131		528
Las Colinas		28			28
Las Ruinitas				104	104
Los Hornos	91	179		112	382
Lower Santan				105	105
Sacaton Park				20	20
Snaketown	302	145	86		533
Upper Santan	171	123	64		358
Grand Total	**901**	**1723**	**683**	**1003**	**4310**

The Ceramic Sourcing Analysis

I determined the production locale of each sherd in the analysis through a sourcing analysis focused on sand temper. I first characterized the sand temper composition in sample sherds using a low-powered binocular microscope, and then used these qualitative data to match sand temper in sherds to raw sands collected from defined sand composition zones (petrofacies) in the Phoenix Basin (Miksa and Castro-Reino 2001; Miksa 2001a; Miksa et al. 2004). To provide a check on the accuracy of petrofacies designations with the low-powered binocular microscope, I analyzed approximately 4 percent of the sample (total = 182) as petrographic thin sections. The following sections detail the petrographic and binocular microscope analyses that I use to source pottery to specific production areas.

Sand Petrofacies Model

Researchers have long recognized that the geological diversity of the Phoenix Basin offers the potential for comprehensive ceramic sourcing analyses (e.g., Abbott 1994b; Fournier 1989; Gladwin 1937; Hepburn 1984; Lombard 1987; Miksa 1995; Schaller 1994; Walsh-Anduze and Abbott 1994). In the early 2000s, Elizabeth Miksa and her colleagues developed a technique for sourcing sand temper in central Arizona that has among the highest resolution and accuracy in the world. Through the characterization of unique and geographically isolated sand composition zones called petrofacies, Miksa's methodology enables archaeologists to identify the movement of pottery over distances as little as 5 km (see petrofacies marked on Figure 1).

Miksa's sand temper sourcing techniques in the Phoenix Basin are based on a similar methodology that she developed and tested in the Tonto Basin (Heidke and Miksa 2000; Miksa and Heidke 1995; Miksa and Heidke 2001). She began to define sand petrofacies boundaries in the Phoenix Basin by collecting and point-counting 80 sand samples from the Salt River valley and 180 sand samples from the Gila River valley (Miksa and Castro-Reino 2001; Miksa 2001a; Miksa 2001b; Miksa et al. 2004).[3] The point count data from the raw sand samples were then examined using a series of correspondence analyses. These exploratory analyses demonstrated that distinct sand

[3] Miksa collected 87 samples from the Salt River valley and 236 sand samples from the Gila River valley for a total of 323 samples from the Phoenix Basin. However, she only point counted 260 of these sand samples (Miksa et al. 2004: Table 2.2).

composition groups could be identified on the basis of lithic and mineral content of the sands. Most importantly, these sand composition groups were geographically discrete, which indicates that sand composition can be used for provenance identification.

The correspondence analyses on Phoenix Basin sands delineated three major groups in the sand data-- mineral-rich, lithic-volcanic, and lithic-metamorphic sands. Miksa plotted where these sands appeared on a map of the Phoenix Basin, and, based on geologic maps of the region, proposed boundaries for different sand composition zones (petrofacies). Then, she used a series of nested discriminant models to determine if these sand petrofacies were statistically distinguishable from one another and to define the precise criteria by which the groups were separated. The first discriminant model that used all of the sand samples divided the sand composition zones into two categories: petrofacies that are primarily mineralic and petrofacies that are primarily lithic. A second discriminant analysis of the lithic samples then divided the petrofacies into two additional groups: those that have high proportions of volcanic grains and those that are rich in metamorphic lithic grains. Finally, separate discriminant models evaluated membership in the mineralic, volcanic, and metamorphic-rich sand petrofacies. Using the discriminant analysis parameters, Miksa defined the mineralic and lithic composition of each sand composition zone. Finally, she developed detailed descriptions for each of the sand petrofacies that she identified. Using these descriptions and a detailed flowchart, analysts can now use a low-powered binocular microscope to identify sands from different areas.

Binocular Microscope Examination

I examined the temper in each of the 4,310 red-on-buff sherds to determine if there were sufficient sand inclusions to match the temper to a specific sand petrofacies in Miksa's classification scheme. To observe the temper with a binocular microscope, I inspected a fresh cross-section of each sherd with a magnification of 30x or less. Approximately 82 percent of the sample was tempered with enough sand to source to specific petrofacies. The remaining 18 percent of the sample was predominantly tempered with coarse-grained mica schist that cannot be sourced to a specific production locale. Although on-going research has identified techniques that may allow schist deposits to be sourced, these techniques have not yet identified consistent chemical differences among many of the schist outcrops in the Phoenix Basin (Kelly 2012; Neff and Dudgeon 2006; Walsh-Anduze 1993).[4] Therefore, the "schist-only" samples were not included in the main statistical analyses presented in Chapters 4 and 5. I explore the possible origin of schist-tempered red-on-buff and plainware pottery in Chapter 6.

For sand-tempered sherds, raw sand samples collected from wash beds in each petrofacies were repeatedly studied and referenced during the analysis to maintain consistency and accuracy. In addition, I consulted reference "grain boxes" that contained individually identified particles of rock and mineral types along with other comparative samples for each petrofacies.[5] I then used the estimated proportions of each rock and

[4] It is likely that most schist-only samples were manufactured in the vicinity of extensive schist deposits at Gila Butte or Pima Butte in Petrofacies A, H, and N. An LA-ICP-MS analysis of schist temper in preClassic red-on-buff wares linked the chemical signatures of the temper grains to schist outcrops at Gila Butte, Pima Butte and other schist outcrops in the middle Gila River valley (Kelly 2012).

[5] All sands, grain boxes, and initial training were generously provided by Elizabeth Miksa. The sand samples and grain boxes are housed in the research collections for the Laboratory for Sonoran Ceramic Research at ASU.

mineral type in the sand temper as a guide to navigate through a detailed and comprehensive flow chart for the sand petrofacies (Miksa et al. 2004:Figure 2.12). My petrofacies determinations are based on a process of elimination that relied on proportions of mineral and lithic sand grains in the samples. I also used qualitative descriptions of the petrofacies to make petrofacies determinations.

Petrographic Analysis

I analyzed 182 thin sections of red-on-buff pottery in order to provide a check on petrofacies assignments made through the binocular microscope. Similar to the low-powered binocular microscope analysis, the petrographic analysis relies on methods developed by Miksa and her colleagues for the identification of sand temper in Hohokam sherds (Miksa and Castro-Reino 2001; Miksa et al. 2004).

Thin-section Selection and Preparation

The 182 sherds selected for thin sectioning in this analysis were pulled from collections from various sites and temporal phases. Selected sherds were at least 9 cm^2 and contained enough sand temper to match to a specific petrofacies on a petrographic slide.[6] Sherds were thin-sectioned perpendicular to the vessel wall. Thin sections of several different areas of a sherd were then mounted on a single slide to increase the surface area available for identification. The sections were cut to a standard 30 microns

[6] Due to internal variability in sherds, 15 samples that were deemed to have enough sand temper to identify petrographically did not produce thin sections with enough sand temper for analysis.

thick and were partially stained with potassium cobaltinitrite and potassium rhodizonate to aid in the identification of feldspars.[7]

Modification of Petrofacies Discriminant Model Technique

In this analysis, I use a qualitative assessment of the sand temper in the red-on-buff sherds to match them to a specific sand petrofacies. This technique departs from Miksa's method for determining petrofacies assignments. In particular, Miksa used point count data on pottery thin sections from the Phoenix Basin in a discriminant model to predict petrofacies assignments. The merit of this approach is that it is strictly quantitative and avoids biases associated with qualitative assessments. However, the technique does not always capture the visible variation among the sand petrofacies. The inability to capture these variations makes the technique inaccurate in some cases. For instance, in Miksa's (Miksa et al. 2004: Table 2.9) analysis of 23 thin sections, only 13 of the samples were given a final petrofacies assignment that corresponded to the petrofacies predicted by the discriminant model. Similarly, in Miksa's (Miksa 2001b:Table 7) analysis of 11 buffware sherds from Palo Verde ruin, one was placed in another petrofacies category and two were indicated as "possibly" from the discriminant category. In practice, therefore, the discriminant model was 63% accurate at predicting the final petrofacies assignment. However, when a conflict between the petrographer's

[7] The ceramic thin sections used by Miksa in her petrographic analyses were cut horizontally to the vessel wall. The orientation of platy minerals and rock fragments such as mica and schist may differ in comparison between the thin sections used in this analysis and Miksa's thin sections.

petrofacies assessment and the discriminant model arose, the analysts always decided in favor of the petrographer's assessment in the final petrofacies assignment.

Due to the large sample size included in the present analysis (n = 182) and the variable effectiveness of the quantitative discriminant technique, I rely on a qualitative assessment of sand composition to determine petrofacies assignments. I developed this technique in a previous analysis and have refined the approach here (Kelly 2010b).

Petrofacies determinations were made using a series of nested elimination procedures. These elimination steps focus on the most diagnostic and easily recognizable differences among the different sand petrofacies. In particular, the presence of volcanic grains, which are easily recognizable both in thin section and under the binocular microscope, were used as defining criteria for separating several of the petrofacies.

In general, the revised flowchart (Figure 3.2) avoided using naturally occurring schist in the sands as a criterion for identifying sand petrofacies. Hohokam potters often added coarse-grained mica schist to the sand temper in red-on-buff pottery. Although natural and added schist can be distinguished in thin section, separating natural from added schist in thin section is less reliable than focusing on other distinctive mineralic and lithic grains. The exception to this rule is the identification of Petrofacies E, which could not be distinguished from Petrofacies F4 without accounting for natural schist in the sand. In this case, I used schist mineral composition, texture, weathering, and size to distinguish between crushed mica schist and schist present within the sand temper.

The flowchart was also simplified by eliminating petrofacies that are not likely to appear as temper in Hohokam red-on-buff sherds (Figure 3.2). All petrofacies comprised of river sands were eliminated (1, 3, 5 and 9) because these small, rounded sands were not preferred as temper by prehistoric potters (Beth Miksa personal communication, 2009). In addition, petrofacies J, K, P, R, S, W and Y were eliminated from consideration because no permanent preClassic Hohokam sites were occupied in or near these regions.[8] Therefore, use of sand for pottery production in these areas is extremely unlikely.

[8] One sherd selected for thin sectioning was tentatively assigned to Petrofacies J. The sherd was thin sectioned specifically to determine if the sand matched this petrofacies. However, the sand matched that of Petrofacies V instead.

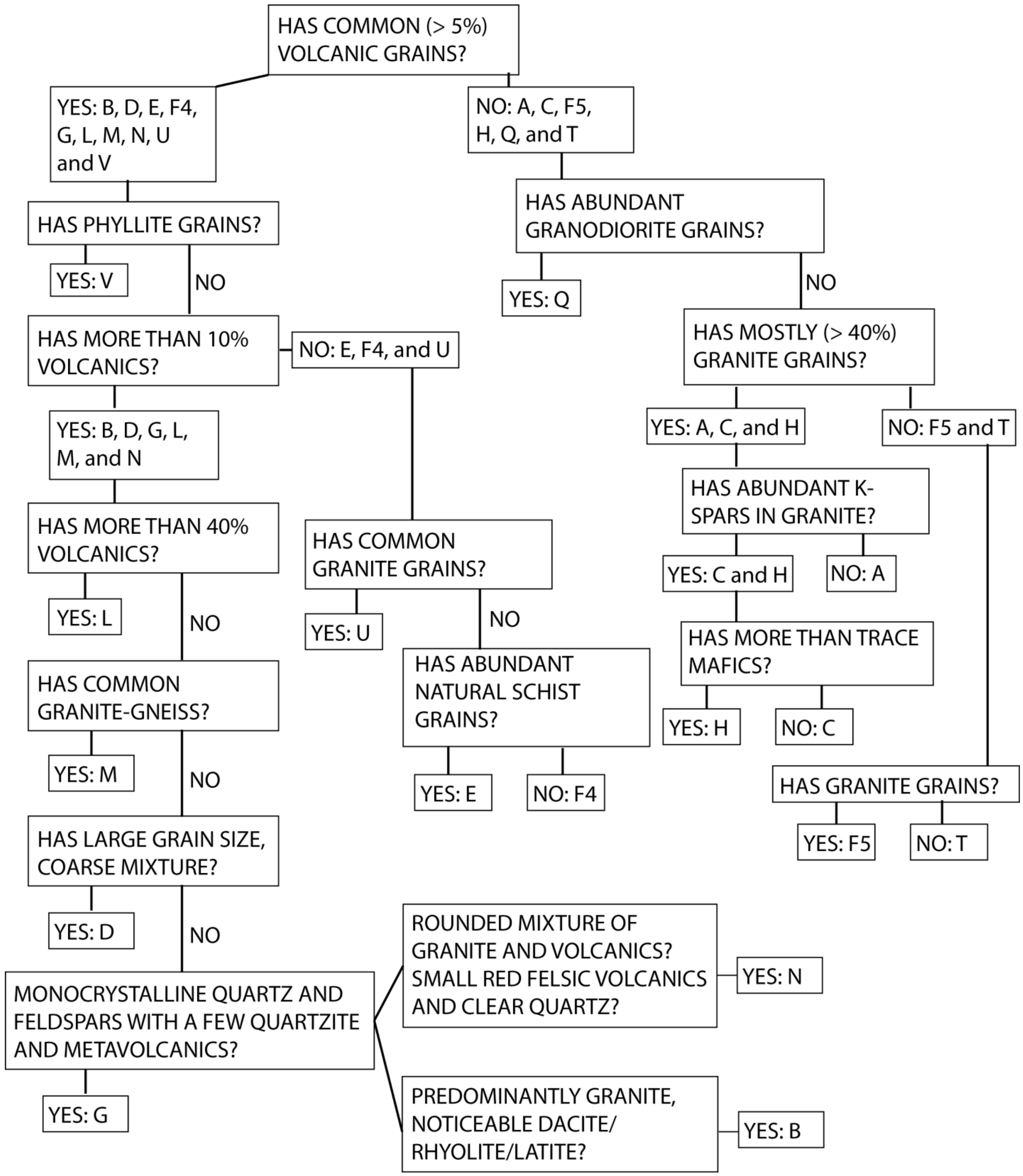


Figure 3.2: Flowchart for sand identification in sherd thin sections.

Results from Petrographic Analysis

The results of the petrographic analysis (see Appendix B, Table 3a) indicate that all 182 samples were produced in the Phoenix Basin. No non-local temper varieties were detected. Fifteen of the samples were tempered with abundant coarse-grained mica schist and too little sand temper to match to a specific petrofacies. These were labeled as "schist-only." Fifty-three samples were matched to the Snaketown Petrofacies (N). Other common petrofacies in the analysis were Santan (A) with 39 samples, Sacaton (H) with 31, and Queen Creek (D) with 18 sherds.

No sherds were assigned to Petrofacies E, F4, L, M, or T in the thin section or binocular microscope stages of this analysis. The sites analyzed in this study are not located near these sand composition zones. Therefore, it is not likely that pottery produced in these regions would appear in the assemblages. In addition, there is little evidence to suggest that red-on-buff pottery production occurred in these areas during the preClassic period. If potters produced ceramics in Petrofacies E, F4, L, M, or T, then sourcing data should indicate that large numbers of sherds were manufactured with sand from these composition zones. In addition, archaeological excavation should encounter direct evidence for ceramic manufacture. Available data on ceramic production in these petrofacies do not meet either of these conditions.

Accuracy of Low-Powered Microscope Analysis

Petrofacies assignments using the low-powered microscope were predominantly accurate when compared to petrofacies assignments based on the thin section analysis. Overall, 71% of sherds that were matched with a specific petrofacies in the binocular microscope analysis (n = 166) were confirmed in the petrographic analysis. Accuracy, however, varied among the different sand composition groups. The most accurately identified sands were Petrofacies, A, D, H, I, N, and sherds manufactured using Squaw

Peak Schist (Table 3.6). Squaw Peak Schist appears in the center of the Phoenix Mountains and has been associated with ceramic manufacture on the western side of Canal System 2, which lies on the north side of the Salt River (Crown 1981; Schaller 1994). The sands eroding from Squaw Peak Schist and other deposits from the Phoenix Mountains constitute Petrofacies V sands (Miksa and Castro-Reino 2001; Miksa et al. 2004).

In the few instances when sherds manufactured with sand from Petrofacies, A, D, H, I, N, and Squaw Peak Schist were misclassified, they were confused with nearby sand composition zones. For instance, when sherds manufactured with Santan Mountain sand (A) were misclassified, they were most often confused with those manufactured using Sacaton Mountain sand (H). Similarly, when Queen Creek (D) sand was misclassified, it was most often confused with Snaketown sand (N). Lower Salt River petrofacies were only confused with each other with the exception of one sherd that was classified as Petrofacies C but that was produced in Petrofacies Q. Limited misclassification among adjacent sand composition units is heartening because it indicates that those sherds that are mislabeled are likely misclassified to a nearby locale.

Petrofacies that were not accurately identified were B, C, F4, G, and U. With the exception of B and C, most of these petrofacies were not frequently assigned to samples in the binocular microscope analysis. Therefore, even though these petrofacies were not accurately identified, their misclassification does not significantly alter the analysis. It is likely that pottery production did not occur in these regions regularly during prehistory. No large prehistoric sites are located in this area. The site of Granite Knob is located on the middle Gila River floodplain just over the boundary of Petrofacies C. Although

Granite Knob was continuously occupied from the early preClassic through the Classic period, the small populations at this site during the preClassic suggest that local pottery production was not large scale.

Table 3.6: Accuracy of specific petrofacies assignments based on examination with a binocular microscope.[1]

Petrofacies Assignments	Number	% Accuracy	% A	% B	% D	% F5	% G	% H	% I	% N	% Q	% U	% V	% X
A. Santan Mountains	42	83	83	2	0	0	0	7	0	7	0	0	0	0
B. Olberg	10	50	10	50	0	0	10	20	0	10	0	0	0	0
C. Twin Buttes	10	0	20	0	10	0	0	30	0	30	10	0	0	0
D. Queen Creek	21	81	0	0	81	0	0	0	0	19	0	0	0	0
F4. Fountain Hills	1	0	0	0	0	0	0	0	100	0	0	0	0	0
F5. Florence	4	50	25	0	0	50	25	0	0	0	0	0	0	0
G. Picacho	3	0	0	0	0	0	0	0	0	100	0	0	0	0
H. Sacaton Mountains	19	95	0	5	0	0	0	95	0	0	0	0	0	0
I. Camelback Mountain	3	100	0	0	0	0	0	0	100	0	0	0	0	0
N. Snaketown	47	83	0	0	0	0	2	11	0	83	0	4	0	0
U. Usery	4	0	0	0	0	0	0	0	50	0	0	0	0	50
V. Phoenix Mountains	1	100	0	0	0	0	0	0	0	0	0	0	100	0

[1] One sherd typed as Petrofacies E and one sherd typed at Petrofacies J in the binocular microscope analysis were included in the thin section analysis. However, it was determined that both of these sherds were from Petrofacies V in the Phoenix Basin. Closer inspection of the four sherds assigned to these two petrofacies indicated that they also came from Petrofacies V. Therefore, these sherds were reassigned to Petrofacies V. No sherds in the bulk analysis were considered to be from either Petrofacies E or Petrofacies J.

Creating Generic Sand Composition Categories

Due to the inaccuracy of assigning sherds to some of the petrofacies categories, adjacent petrofacies that have compositions that were frequently confused were combined to form six "generic" groups: 1) petrofacies in the northwest of the lower Salt River (V & I), 2) petrofacies south of the lower Salt River (Q and U), 3) Petrofacies N, 4) Petrofacies D, 5) petrofacies in the center of the middle Gila River valley (A, B, C, and H), and 6) petrofacies in the southeastern portion of the middle Gila River valley (G & F5) (Figure 3.3).

In general, the accuracy of these generic groups is improved over the accuracy of assigning sherds to one, specific petrofacies. Eighty-two percent of samples were assigned to the correct generic petrofacies group. Table 3.7 presents the percent of sherds in each generic group (based on binocular microscope identification) that were correctly classified to a petrofacies that was part of this generic group. While sand varieties on the lower Salt River can be accurately distinguished based on a series of obvious qualitative differences, middle Gila River valley sand composition groups are defined by more subtle distinctions. Therefore, the high accuracy of middle Gila River valley petrofacies in these generic categories suggests that combining different sand composition groups may provide a more reasonable measure of where pots were produced.

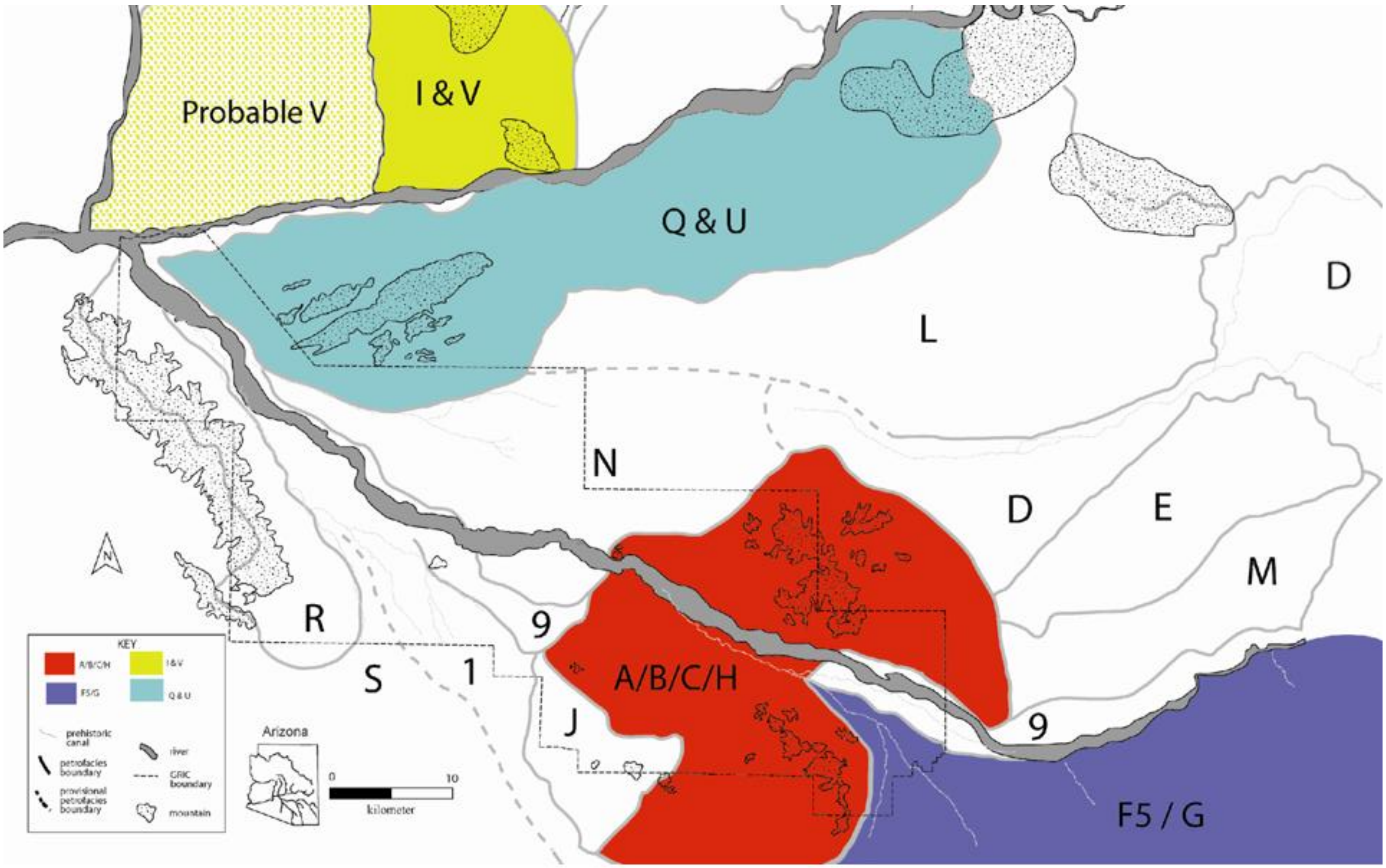


Figure 3.3: Generic petrofacies boundaries used in this analysis. Note: Sands from the area of "Probable V" have not been systematically sampled. However, local pottery production in this region appears to use temper on or near to the base of the Phoenix Mountains (phyllite), and thus is similar in composition to Petrofacies V.

Table 3.7: Generic petrofacies accuracy of middle Gila River valley and Salt River valley petrofacies from thin sectioned samples.[a]

Generic Petrofacies	# Assigned to One of the Petrofacies in Generic Petrofacies	Total Sherds from Generic Petrofacies	% Correct
A, B, C, & H	71	81	88
D	17	21	81
N	39	47	83
F5 & G	3	7	43
South Salt	0	4	0[b]
North Salt	5	5	100
TOTAL	135	165	82

[a] Table does not include the 15 sherds that did not have enough sand temper to match to a sand composition group.
[b] No Sherds from Petrofacies Q were thin sectioned due to the high accuracy with which analysts are able to type these sherds. Therefore, the low accuracy rating of sherds from the south of the Salt River does not represent the overall accuracy rate of identifying sherds produced in this area, which is quite high.

Applying the Petrographic Data to the Binocular Microscope Analysis

The temper sourcing analysis utilized in this study focused on the consistent compositional patterning of sand temper across the Phoenix Basin. I examined a sample of petrographic thin sections to verify petrofacies identifications made with a low-powered binocular microscope. This procedure demonstrated that assignments to Petrofacies A, D, H, and N— the most common sand composition groups in Hohokam pottery assemblages— were accurate. The identification of a few other sand composition groups was not as exact. By combining sherds into six well-identified generic groups, however, the compositional data are very accurate. The generic categories represent relatively limited geographic regions, which will allow us to determine how pottery moved across the Phoenix Basin with high precision.

After judging the accuracy of each petrofacies identified using the binocular microscope, each of the 4,310 sherds included in this analysis were placed into one of the six generic categories based on the sand petrofacies that they were grouped with in the initial analysis. Sherd counts by generic petrographic groups are presented by site and temporal phase in Table 3.8. These counts represent the final numbers that are used to calculate the volume and concentration of red-on-buff sources.

Table 3.8: Sherd counts in generic petrofacies groups.

	Sites	A, B, C, H	D	F5-G	N	North Salt	South Salt	Unsourced[1]	Total
Snaketown	Chee Nee	26		1	21			5	53
	Grewe	35		28	36			28	127
	La Ciudad	47	2	4	14	3	1	28	99
	La Villa	20	1	3	1	3	10	20	58
	Los Hornos	27			48	1	6	9	91
	Snaketown	39			214		3	46	302
	Upper Santan	71			77			23	171
Gila Butte	Grewe	71		4	5			41	121
	La Ciudad	267	24	11	66	27	141	252	788
	La Villa	123	4	7	26	64	71	44	339
	Las Colinas	7	1		3	6	2	9	28
	Los Hornos	108	6	1	21	4	6	33	179
	Snaketown	23	1		110			11	145
	Upper Santan	62	1		51			9	123
Santa Cruz	El Caserio	19	2	1	72		5	10	109
	Grewe	15	6	5	93			12	131
	La Ciudad	76	2		29	7	9	39	162
	La Villa	42	9	5	54	7	7	7	131
	Snaketown	27	1	3	28			27	86
	Upper Santan	18	2		42			2	64
Early Sacaton	El Caserio	45	3	1	145	4	13	15	226
	Grewe	31	1	23	77			42	174
	La Lomita	61	4		190		1	6	262
	Las Ruinitas	11			93			0	104
	Los Hornos	41	12		37	1	5	16	112
	Lower Santan	10	18	7	59			11	105
	Sacaton Park	9			10			1	20
	Total								4310

Notes:
[1] Sherds that did not have an appreciable sand component that could be matched to a specific petrofacies zone. Sherds in this category are primarily tempered with coarse-grained mica schist (schist-only).

Calculating the Dependent Variables: Supply and Demand

This analysis constructs a model for demand for specialist-produced red-on-buff pottery by identifying four factors that may have affected the organization of Hohokam pottery production. It then tests this model through a series of multiple regression analyses that calculate the correlation between these factors and the supply and demand for imported (non-local) buffware vessels. Each of the four factors-- increases to population density, agricultural intensification, ritual requirements for social valuables, and efficient regional distribution systems-- represents an independent variable or set of independent variables in a series of multiple regression equations. The supply and demand for pottery produced by specialists represents the dependent variable in these equations. Below, I describe in detail the dependent and independent variables that are used in each of the multiple regression analyses.

Supply

The dependent variable in the multiple regression analyses for production supply is the average proportion of pottery from each petrofacies that was exported outside of that petrofacies (Table 3.9). Production areas are defined at the scale of petrofacies or generic petrofacies (sets of petrofacies) used in previous analyses in this study. First, I calculate the proportion of non-local pottery from each production locale (petrofacies) in site assemblages within each petrofacies. For instance, during the Snaketown phase 0.65 out of 1 (65 percent) of the non-local buffwares at sites within the “North Salt” generic petrofacies were manufactured in Petrofacies A/B/C/H. Next, I average the proportion of non-local pottery from each production locale within each area for each time period.

Table 3.9: Proportion of pottery exported from each petrofacies to sites in other petrofacies.[a]

		Consumption/Recovery Location							
	Production Are	A, B, C, H	F5-G	N	North Salt	South Salt	Average Proportion	Gila Avg. Proportion	Salt Avg. Proportion
Snaketown	A, B, C, H		0.49	0.93	0.65	0.36	0.61	0.71	0.5
	D	0	0	0	0.03	0	0.01	0	0.01
	F5-G	0.01		0	0.07	0	0.02	0.01	0.03
	N	0.99	0.51		0.15	0.63	0.57	0.75	0.39
	North Salt	0	0	0		0.01	0	0	0.01
	South Salt	0	0	0.07	0.11		0.04	0.02	0.11
Gila Butte	A, B, C, H		0.93	0.96	0.53	0.77	0.8	0.95	0.65
	D	0.02	0	0.04	0.04	0.04	0.03	0.02	0.04
	F5-G	0		0	0.02	0.01	0.01	0	0.02
	N	0.98	0.07		0.13	0.15	0.33	0.52	0.14
	North Salt	0	0	0		0.03	0.01	0	0.03
	South Salt	0	0	0	0.28		0.07	0	0.28
Santa Cruz	A, B, C, H		0.13	0.87	0.41	0.52	0.48	0.5	0.47
	D	0.05	0.05	0.03	0.04	0.05	0.04	0.04	0.05
	F5-G	0		0.1	0.02	0	0.03	0.05	0.01
	N	0.95	0.82		0.47	0.41	0.66	0.89	0.44
	North Salt	0	0	0		0.02	0	0	0.02
	South Salt	0	0	0	0.06		0.02	0	0.06
Early Sacaton	A, B, C, H		0.28	0.87	0.23	0.27	0.41	0.58	0.25
	D	0.19	0.01	0.03	0.02	0.06	0.06	0.08	0.04
	F5-G	0.07		0.1	0	0	0.04	0.09	0
	N	0.73	0.71		0.72	0.67	0.71	0.72	0.7
	North Salt	0	0	0		0.01	0	0	0.01
	South Salt	0	0	0	0.03		0.01	0	0.03

Missing Values: Inserted average between Gila Butte and Santa Cruz values

Missing Values: Inserted Santa Cruz value

Note: [a]Data on ceramic assemblages consumed in Petrofacies D are unavailable because none of the sites included in this analysis were located within this sand composition zone. These data do not include "schist-only" sherds.

Demand

The volume, or proportion, of non-local pottery that Phoenix Basin households consumed is an indicator of household demand for pottery manufactured by specialists. The concentration of pottery from different sources in Phoenix Basin assemblages is also a measure of demand for specialist-produced pottery, because it indicates whether or not households obtained pottery from a wide range of places or from only a few specialized producers. If demand for specialist-produced pottery is rooted in some advantage to obtaining pottery from specialists instead of making it locally, household pottery assemblages would be marked by high consumption of wares from a few pottery production locales.

Demand: Volume of Non-Local Wares

The volume of non-local red-on-buff pottery is measured by 1) the proportion of non-local buffware out of an entire ceramic assemblage that includes both plain and buffwares, and 2) the proportion of non-local buffware from the site's decorated pottery assemblage alone (see Appendix B, Tables 3b and 3c). Regarding the first measure, Hohokam settlements vary in the proportion of buffware pottery relative to plainware pottery. In particular, sites on the Salt River tend to have less decorated pottery than sites on the Gila River. The role of decorated pottery in an entire ceramic assemblage provides a measure of overall supply and demand for that pottery type.

The second measure of volume is the proportion of non-local red-on-buff pottery in the decorated ceramic assemblage (Table 3.10; Appendix B, Table 3c). This variable does not consider the proportion of plainware pottery in site assemblages. It provides a useful complement to the proportion of pottery from the entire ceramic assemblage, because it focuses on the composition of the decorated wares irrespective of other ceramic wares in the assemblage.

Table 3.10: Proportion of non-local red-on-buff pottery out of entire ceramic assemblage and out of decorated ceramic assemblage.

		Sherd Counts From Dateable Features at Each Site[5]			Sherd Counts from Sherds Used in Sourcing Analysis Only			Volume Metrics	
	Sites	**Total Sherds**	**Total Buff**	**Proportion of Buffwares in Assemblage**	**No. Local Sherds**	**No. Non-local Sherds**	**Proportion of Buffwares in Assemblage**	**Proportion of Buffware Assemblage**	**Proportion of Entire Assemblage**
Snaketown	Chee Nee	1003	218	0.22	26	22	0.22	0.46	0.10
	Grewe	229	42	0.18	28	71	0.18	0.72	0.13
	La Ciudad	1790	246	0.14	3	68	0.14	0.96	0.13
	La Villa	5148	553	0.11	3	35	0.11	0.92	0.10
	Los Hornos	969	112	0.12	6	76	0.12	0.93	0.11
	Snaketown[1]			0.17	214	42	0.17	0.16	0.03
	Upper Santan			0.24[2]	71	77	0.24[2]	0.52	0.12
Gila Butte	Grewe	1572	216	0.14	4	76	0.14	0.95	0.13
	La Ciudad	14384	2527	0.18	27	509	0.18	0.95	0.17
	La Villa	4016	1173	0.29	64	231	0.29	0.78	0.23
	Las Colinas	329	90	0.27	6	13	0.27	0.68	0.19
	Los Hornos	5644	1464	0.26	6	140	0.26	0.96	0.25
	Snaketown[1]			0.32	110	24	0.32	0.18	0.06
	Upper Santan	34541	8212	0.24	62	52	0.24	0.46	0.11
Santa Cruz	El Caserio	858	217	0.25	0	35	0.25	1.00	0.25
	Grewe			0.20[3]	6	22	0.20[3]	0.96	0.19
	La Ciudad	3318	808	0.24	33	129	0.24	0.94	0.23
	La Villa	600	276	0.46	11	71	0.46	0.94	0.43
	Snaketown[1]			0.28	0	99	0.28	0.53	0.15
	Upper Santan			0.43[4]	5	114	0.43[4]	0.71	0.31
Early Sacaton	El Caserio	5777	1554	0.27	7	116	0.27	0.98	0.26
	Grewe	5402	1443	0.27	7	117	0.27	0.83	0.22
	La Lomita	1361	383	0.28	28	31	0.28	1.00	0.28
	Las Ruinitas	344	92	0.27	18	44	0.27	1.00	0.27
	Los Hornos	564	124	0.22	4	207	0.22	0.95	0.21
	Lower Santan	6919	4340	0.63	23	109	0.63	0.89	0.56
	Sacaton Park	6298	2495	0.40	0	256	0.40	0.53	0.21

Notes:
[1] Feature data for Snaketown are not available. Proportions of buffwares are from Haury (1965:221)
[2] Missing value, same value as Gila Butte
[3] Missing value, averaged Sacaton and Gila Butte figures
[4] Missing value, averaged Gila Butte and Sacaton figure for Lower Santan
[5] Sherds from these features were not all used in the sourcing analysis. Sherds in the sourcing analysis were selected from a sub-set of sherds from dateable features at each site.

Demand: Concentration of Pottery from Different Sources

In addition to addressing the conditions that might affect the volume of non-local red-on-buff pottery, I also determine what factors influence the concentration of wares from different production locales. The concentration of red-on-buff pottery in site assemblages is measured by 1) the richness (number) of represented source areas for red-on-buff pottery as well as 2) the evenness (distribution) of those sources.

Calculating Richness. The richness (*S*) of red-on-buff production sources in Phoenix Basin site assemblages is the number of sources represented in a particular ceramic collection. Richness does not include temper categories that are not linked with a particular geographic locale because these pots could be produced in a variety of different locations that overlap other provenance-linked temper groups. Temper varieties that are not included in richness are schist and unidentified sand, schist- only, unidentified sand, and no temper. Table 3.11 presents the richness scores for each site's assemblage for each temporal phase.

Calculating Evenness. The evenness of sand temper sources represented in red-on-buff assemblages is calculated using a common index for evenness called Simpson's E. Simpson's E is a reliable estimate of the concentration of samples when a population is divided into types. This measure, therefore, is amenable to calculating the evenness of sand temper varieties that have been classified into groups. In order to calculate Simpson's E, we must first calculate the diversity index Simpson's D such that

$E = D/D_{max}$

In other words, Simpson's E is the ratio between the diversity measure of the population (Simpson's D) and the maximum number of sand source groups (D_{max}). Simpson's D is the probability that any two sherds chosen at random from an assemblage will have the same sand type.

Simpson's D is calculated as

$D = 1 / \Sigma p_i^2$

Where p_i are proportions of red-on-buff sherds manufactured with sand from a particular source locale. The sum of the squares of these proportions produces Σp_i^2. By taking the reciprocal of this equation ($1 / \Sigma p_i^2$), the high values for this index denote assemblages with even distribution over a number of different sand composition types.

Simpson's E is the ratio between D and the maximum value of D_{max}. In this case, D_{max} is 6 because there are six total sand source groups. The Simpson's E index ranges from the reciprocal of D_{max} ($1/D_{max}$), which in this case is 0.17, and 1. Therefore, a value close to 0.17 indicates that there is very low evenness and a value close to 1 indicates high evenness in the sources represented in the red-on-buff assemblages. Table 3.11 provides the final Simpson's E scores for each assemblage. Calculations for Simpson's D and E are presented in Appendix B, Table 3d.

Table 3.11: Richness and evenness indices for assemblages.

	Snaketown		Gila Butte		Santa Cruz		Early Sacaton	
Sites	**Richness**	**Evenness**	**Richness**	**Evenness**	**Richness**	**Evenness**	**Richness**	**Evenness**
Chee Nee	3	0.34						
El Caserio					5	0.29	6	0.32
Grewe	3	0.49	3	0.21	4	0.26	4	0.39
La Ciudad	6	0.35	6	0.49	5	0.37		
La Lomita							4	0.27
La Villa	6	0.46	6	0.58	6	0.52		
Las Colinas			5	0.61				
Las Ruinitas							2	0.21
Los Hornos	4	0.37	6	0.29			5	0.48
Lower Santan							4	0.37
Sacaton Park							2	0.33
Snaketown	3	0.23	3	0.24	4	0.38		
Upper Santan	2	0.33	3	0.34	3	0.31		

Calculating the Independent Variables

Each of the dependent variables (supply, volume and concentration) is included in a separate multiple regression equation with independent variables (or set of variables) related to the four factors that may have influenced the supply or demand for specialist-produced pottery: population densities, canal system workloads, the production of decorated vessels as social valuables, and reduced transport costs. The following section describes the independent variables that are used in each of the multiple regression models. I first present how the independent variables are calculated for the demand analyses because the calculations are more involved. I then present how the independent variables were calculated for each production group (supply analysis).

Factor 1: Population Density

Accurate population densities for major temporal phases in the Hohokam preClassic are necessary to evaluate the relationship between demand for specialist-produced decorated pottery and population density. In this analysis, population density is defined as the number of people living within a 2.5 km radius of a settlement. Population estimates are based on Doelle's (1995) study. While there is some debate over precise population estimates, the relative population figures provide an accurate evaluation of areas of high, medium, and low population densities. Table 3.12 lists the site populations within 2.5 km distance from each of the study sites.

Table 3.12: Population within a 2.5 km radius of study sites. See Appendix B, Table 3e for list of sites used in population calculations.

Sites	Snaketown	Gila Butte	Santa Cruz	Sacaton
Chee Nee	100	200	200	200
El Caserio	150	350	300	350
Grewe	100	200	600	500
La Ciudad	300	400	300	350
La Lomita	150	200	200	250
La Villa	50	0	0	0
Las Colinas	0	0	0	250
Las Ruinitas	0	450	450	450
Los Hornos	100	150	200	250
Lower Santan	0	50	100	300
Sacaton Park	0	100	250	400
Snaketown	150	300	350	450
Upper Santan	50	300	350	200

Justification for Doelle's Population Database

Several criteria influenced the selection of Doelle's population database as a baseline for population estimates for the Phoenix Basin. First, the population estimates must be calculated independently of canal system workloads. Due to the importance of canal systems to the agricultural economy, recent estimates of Hohokam populations refer directly to the number of people required to construct, maintain, and farm canal systems (Woodson 2010). This study assesses the role of canal system workload in demand for red-on-buff pottery produced by specialists. Workload in this case is calculated as the ratio of the number of people living along a canal system and the length of the main canal in that canal system. Therefore, population estimates must be based on different measures than the size, field, or command area of canal systems. Doelle's data is not based on variables linked with canal system size.

Second, the population data must provide separate population estimates for each major temporal phase in the Hohokam preClassic. Doelle provided separate estimates for the following time spans: AD 700 – 800, AD 800 – 900, AD 900 – 1000, and AD 1000 – 1050. The date ranges roughly correspond to the Snaketown, Gila Butte, Santa Cruz, and Early Sacaton phases in the Hohokam culture sequence.

Third, the selected population data must cover all sites within the Phoenix Basin. Doelle's (1995) regional population estimates, which are still among the most complete inventory of prehistoric community sizes in the southern Southwest, cover the entire Phoenix Basin. The database is grounded in site information collected from over 200 years of archaeological survey and excavation projects in central Arizona. Large reconnaissance surveys during the late 1800s and early 1900s were the first projects to identify and record an extensive number of archaeological sites systematically in the Phoenix Basin (Bandelier 1892; Cushing 1890; Fewkes 1909; Gabel 1931; Gladwin 1928; 1929a; 1929b; 1930a; 1930b; 1935; Haury 1934; Haury 1945; Huntington 1912; 1913; 1914; Kelly 1936; Midvale 1965; Mindeleff 1896; Sauer and Brand 1930; Schroeder 1940; Turney 1929). These early surveys provided particularly complete information on large sites that were more visible on the landscape. Doelle then used more recent survey data collected by the Gila River Indian Community (Gregory and Huckleberry 1994; Wood 1971a; Wood 1971b; Wood 1972) and the Central Arizona Water Control Study (Rice and Bostwick 1986) to update his database. He also reviewed reports generated by excavation projects and compared these findings to the survey data. Finally, Doelle used previous population studies focused on the Phoenix Basin as a starting point for his own calculations (Bostwick and Downum 1994; Downum and Bostwick 1993; Gregory and McGuire 1982; Gregory and Nials 1985; Howard and Huckleberry 1991; Wilcox et al. 1981; Wilcox and Sternberg 1983; Wilcox 1987; Wilcox et al. 1990; Wilcox 1993).

Fourth, the population estimates used in this analysis must be consistent relative to one another so that they can be equally compared across the study area. One of the most important features of Doelle's population database is that the population figures are internally consistent; they are all based on the same criteria and were calculated at the same time. As a result, the relative differences among settlement population data will be accurate even if the particular population numbers themselves are too high or too low. In order to control for change in settlement size over occupation span, Doelle created a measure for occupation intensity at each site for each temporal phase. Intensity is measured by the location of the site in the context of regional population distribution, occupation length, size and number of middens, site structure, site area, and size and number of public architecture.

Finally, the population estimates must include correction factors that mitigate the issues posed by missing data, the underrepresentation of small sites, and temporal confusion in sites characterized by long occupation spans. Doelle noted that his database was affected by these three main sources of error. First, it is likely that not all sites are recorded in the database. In particular, early components (i.e., Snaketown phase) are disproportionately represented (Doelle 1995:517). Second, the low resolution on small sites in general is troublesome. In particular, it is difficult to determine the difference between sites that are seasonally occupied from those that are more permanent. In these cases, Doelle suggested that we rely on general population trends through time as a baseline for our estimates for small and ephemeral sites. Third, the long temporal phases recorded in the database may mask shifts in population levels. To compensate for these sources of error, Doelle modeled the effect of occupation length, abandonment rate, and settlement growth rate on population estimates and developed correction factors for the population data in each temporal span.

Although Doelle's population data are almost 20 years old, these data remain the most complete array of population estimates through each of the major temporal phases in the preClassic period (for updated population estimates on specific time periods see Craig et al. 2010). These population data enable me to compare population estimates among different temporal phases for archaeological sites across the Phoenix Basin. In addition, the consistency of Doelle's data enables me to measure relative population differences among sites.

Factor 2: Workload in Irrigation Agriculture

Time investment in irrigation agriculture is calculated as a ratio between the number of people living on a canal system and the length of the main canal of each irrigation system (Table 3.13). Population estimates for particular canal systems are based on estimates compiled by Doelle (1995), discussed above. The length of the main canal is used as a proxy for time investment in irrigation management. Canal length is a suitable estimate for the amount of time invested in canal irrigation for several reasons: 1) cleaning the main canals is a time-intensive task, 2) the main canal must be cleaned periodically as part of routine maintenance of the system, 3) the workload of cleaning the main canal was presumably shared among all members in the irrigation community, and 4) the length of the main canal is a rough proxy for the number of lateral canals and fields that extend from it (e.g., Castetter and Bell 1942; Howard 1993b; Lewis 1991; Sheridan 1996).

Table 3.13: Population per length of main canals for each study site.

		Length of Main Canals (km)			Canal Population				Number of People per 1 km of Main Canal				
Site	Canal System	Pioneer	Colonial	Sedentary	Snaketown	Gila Butte	Santa Cruz	Sedentary	Snaketown	Gila Butte	Santa Cruz	Sedentary	Source for Canal Length
Los Hornos	Canal System 1[1, 2]	14	161.5	129	300	1600	1700	2200	21	9.9	10.5	17	Howard 2006:140-142
Las Ruinitas	Canal System 1 (pre-Lehi)[2]	14	161.5	129	300	1600	1700	2200	21	9.9	10.5	17	Howard 2006:185-188
El Caserio	Canal System 2	14	161.5	129	450	700	650	1000	32	4.3	4	7.8	Howard 1993: Table 5
La Ciudad	Canal System 2	14	161.5	129	450	700	650	1000	32	4.3	4	7.8	Howard 1993: Table 5
La Lomita	Canal System 2	14	161.5	129	450	700	650	1000	32	4.3	4	7.8	Howard 1993: Table 5
La Villa	Canal System 2	14	161.5	129	450	700	650	1000	32	4.3	4	7.8	Howard 1993: Table 5
Las Colinas	Canal System 2	14	161.5	129	450	700	650	1000	32	4.3	4	7.8	Howard 1993: Table 5
Chee Nee	Chee Nee Canal System	8.4*	16	16	200	300	300	300	24	19	18.8	19	Woodson 2010: Table 3.1
Grewe	Grewe-Casa Grande Canal System	17.7*	33.6	34	100	400	1000	1100	5.7	12	29.8	33	Woodson 2010: Table 3.1
Lower Santan	Santan Canal System	9.3	26.6	27	150	600	650	700	16	23	24.4	26	Woodson 2010: Table 3.1
Upper Santan	Santan Canal System	9.3	26.6	27	150	600	650	700	16	23	24.4	26	Woodson 2010: Table 3.1
Snaketown	Snaketown Canal System	14.1	25.5	27	300	500	550	650	21	20	21.6	24	Woodson 2010: Table 3.1
Sacaton Park	Sweetwater Canal System	5.4*	10.3	10	100	300	500	650	18	29	48.5	63	Woodson 2010: Table 3.1

Notes:
[1] Canal length estimates are based on Howard's (1993) estimates for Canal System 2.
[2] The Lehi Canal System was not constructed prior to the middle Sedentary sub-phase. Therefore, populations along Canal System 1 and the pre-Lehi system were combined.
*Snaketown canal length was modified based on average increase between Snaketown and Colonial-Sedentary period canals on the Gila River (Woodson 2010: Table 4.2).

Canal Length Figures

The lengths of canals along the lower Salt River and the middle Gila River valleys are based on the extensive work of Jerry Howard and Kyle Woodson, respectively. Jerry Howard reconstructed the construction sequence for Canal System 2 for the Pioneer, Colonial, Sedentary, and Classic periods (Howard 1993b). Similarly, Kyle Woodson (2010) documented changes to the canal length of the Granite Knob, Santan, Gila Butte, and Snaketown canal systems along the middle Gila River valley for specific temporal phases from the Pioneer period to the Classic period.

Howard and Woodson's canal length estimates are used in this analysis as a proxy for canal system workloads. However, high resolution data on the construction sequence of Canal System 1, the Chee Nee Canal system, the Grewe-Casa Grande Canal System, and the Sweetwater Canal System do not yet exist. In the following sections, I detail the methods used to compensate for these gaps in data.

Canal System 1 Length Proxy

Unlike the detailed construction sequence of Canal System 2 (Howard 1993b), very little research has been devoted to reconstructing the development of Canal System 1. Howard speculates that Canal System 1 was constructed as a mirror image to Canal System 2 on the north side of the lower Salt River valley (Howard 2006:140-142). He suggests that these two canal systems were likely organized and administered similarly because they share the same structural elements (Howard 2006:142). The comparability of the two largest canal systems on the lower Salt River suggests that Howard's canal length estimates for Canal System 2 during the preClassic may be used as a proxy for the growth of Canal System 1. Therefore, in my estimates, I use the length of Canal System 2 as the length of Canal System 1 during each temporal phase.

A Canal System for Las Ruinitas

A second issue associated with canal length calculations is linking Las Ruinitas to a canal system during the preClassic period. Las Ruinitas, which is located in the Lehi canal system, had a preClassic occupation span that predated the construction of the Lehi System in the middle Sacaton phase. Howard (2006:185-188) argues that, prior to the construction of the Lehi Canal System, settlements in this area likely relied on irrigation channels linked with Canal System 1 on the lower Salt River terrace. Therefore, the canal lengths for Canal System 1 are used for Las Ruinitas even though this site was eventually incorporated within the Lehi Canal System when the system was constructed in the middle Sedentary phase. One potential source of error in combining the populations of Canal System 1 and the pre-Lehi System is that the population per canal length in the Sedentary period may be overestimated. The Lehi Canal System was constructed during the Sedentary period. Therefore, the additional population gain in the Sedentary period would be offset by the construction of more canals.

Gila River Canal Length Proxy

Finally, although Woodson (2010) provides a detailed reconstruction of changes to canal system length for several middle Gila River canal systems, his estimates do not include phase by phase changes to the Chee Nee, Grewe-Casa Grande, or Sweetwater canal systems. Woodson does provide total length estimates that likely approximate the greatest extent of each canal. In order to compensate for a lack of phase-by-phase documentation for these canals, I calculate the average increase in canal length for each period for each Gila River canal system that Woodson analyzed (Table 3.14). Woodson's data suggest that canals increased in length at a remarkably even rate from the Pioneer to the Colonial period (1.9 times, about double), and then did not increase much more from the Colonial to the Sedentary period. Therefore, using Woodson's estimates for the ultimate length of the Chee Nee, Grewe-Casa Grande, and Sweetwater Canal Systems, I calculated the size of these canals during the Pioneer period by dividing them by 1.9.

Table 3.14: Canal lengths for canals in the Middle Gila River Valley and proportion increase between the Pioneer, Colonial, and Sedentary Periods (from Woodson 2010:Table 4.2).

Canal System	Pioneer	Colonial	Sedentary	Proportion Increase Pioneer-Colonial	Proportion Increase Colonial-Sedentary
Granite Knob	4.2	5.5	5.5	1.3	1.0
Santan	9.3	26.6	26.6	2.9	1.0
Gila Butte	6.4	10.4	11.6	1.6	0.9
Snaketown	14.1	25.5	26.7	1.8	1.0
			Average	1.9	1.0

Factor 3: Socially Valued Goods

The analysis evaluates if the aesthetic characteristics of non-local pottery imported to Phoenix Basin settlements fit expectations for social valuables. As discussed in Chapter 2, researchers contend that socially valued items have aesthetic qualities that distinguish them from ordinary goods. Hohokam red-on-buff pottery was distinguished by the combination of light vessel color and the glitter of mica schist on the surface of the pottery. Therefore, I used the exterior color of red-on-buff vessels and the density of mica on the surface of these vessels as variables to identify the production of these pots as social valuables.

The exterior vessel color for each sherd was measured using a standard Munsell color book. In this case, the color value measurement—the indicator of how light a color is on each page of the Munsell book—was recorded. Color value ranges on an ordinal scale from 2 or 2.5 to 8 depending on the specific color chart (Table 3.15). In each case, higher numbers (e.g., 8) designated the lightest color values while lower numbers (e.g., 2) designated the darkest color values. Color readings on bowls were taken on the inside surface, because the interior surfaces bear the decorative designs. Similarly, color readings on jars were taken on the exterior surface of the vessel where the painted designs appear. In cases where color variation existed, I measured the lightest portion of the sherd.

The density of mica particles on the surface of sherds was measured using a standardized mica density gauge developed by David Abbott (Abbott 2001a). This gauge consists of a piece of cardboard with nine 1 x 1 millimeter holes cut in a line at 5 millimeter intervals. To measure mica density, I counted the number of mica particles that appear within the holes when the gauge was placed against the surface of the pot. Mica densities range from zero (no mica) to nine (mica filling every hole in the gauge) (Table 3.15).

Table 3.15: Average values for mica density and exterior color for non-local pottery imported to study sites.

DATE	SITE	Nonlocal Mica Density	Nonlocal Color
Snaketown	Chee Nee	6.18	6.14
	Grewe	7.38	5.94
	La Ciudad	6.10	7.22
	La Villa	4.37	6.86
	Los Hornos	7.13	6.30
	Snaketown	6.10	6.14
	Upper Santan	6.40	6.05
Gila Butte	Grewe	5.93	6.99
	La Ciudad	4.19	7.09
	La Villa	3.98	6.88
	Las Colinas	4.54	7.08
	Los Hornos	5.59	7.19
	Snaketown	5.58	6.75
	Upper Santan	5.06	7.10
Santa Cruz	El Caserio	5.95	7.35
	Grewe	5.29	7.51
	La Ciudad	5.75	7.37
	La Villa	5.05	7.20
	Snaketown	4.58	7.52
	Upper Santan	5.89	7.39
Early Sacaton	El Caserio	5.58	7.28
	Grewe	4.65	7.55
	La Lomita	5.73	7.48
	Las Ruinitas	5.05	7.50
	Los Hornos	6.18	7.16
	Lower Santan	6.00[a]	7.87
	Sacaton Park	6.00	7.75

Notes:
[a] Low sample size (n<5), substituted average of other settlements on the same river system for same time period.

Factor 4: Transport Cost

Ballcourts may have served as centralized meeting areas where producers and consumers interacted and exchanged goods. Therefore, I use the number of ballcourts per person per canal system as a variable to measure how important ballcourts may have been to lowering transportation costs. I used data from site maps, excavation reports, and regional surveys to calculate the number of ballcourts in each canal system (Doelle 1995; Marshall 2001; Wilcox and Sternberg 1983) (Table 3.16).

Phoenix Basin ballcourts have a bimodal size distribution. While most ballcourts are around 30 m in length, a few ballcourts are double that size at 60 m in length (Marshall 2001; Wilcox and Sternberg 1983). In order to compensate for the larger size and the special role that large ballcourts may have played in the distribution of pottery across the Phoenix Basin, I count each large ballcourt as two courts.

Table 3.16: Number of ballcourts per person per canal system.

Site	Canal System	Ball Courts per Canal System	SN Ballcourt-Pop Ratio[1]	GB Ballcourt-Pop Ratio	GB-SC Ballcourt-Pop Ratio	SC Ballcourt-Pop Ratio	ESAC Ballcourt-Pop Ratio
Chee Nee	Chee Nee Canal System	2	---	100.0	150.0	150.0	150.0
El Caserio	Canal System 2	7	---	64.3	100.0	92.9	142.9
Grewe	Grewe-Casa Grande Canal System	8	---	12.5	50.0	125.0	137.5
La Ciudad	Canal System 2	7	---	64.3	100.0	92.9	142.9
La Lomita	Canal System 2	7	---	64.3	100.0	92.9	142.9
La Villa	Canal System 2	7	---	64.3	100.0	92.9	142.9
Las Colinas	Canal System 2	7	---	64.3	100.0	92.9	142.9
Las Ruinitas	Canal System 1 (pre-Lehi)	12	---	25.0	133.3	141.7	183.3
Los Hornos	Canal System 1	12	---	25.0	133.3	141.7	183.3
Lower Santan	Santan Canal System	2	---	75.0	300.0	325.0	350.0
Sacaton Park	Sweetwater Canal System	2	---	50.0	150.0	250.0	325.0
Snaketown	Snaketown Canal System[2]	3	---	100.0	166.7	183.3	216.7
Upper Santan	Santan Canal System	2	---	75.0	300.0	325.0	350.0

Notes:
[1]Wallace argues that the first ballcourts were constructed in the early Gila Butte phase. Therefore, measurements for the number of people per canal system are not available for the Snaketown phase.
[2] Has one small ballcourt and one large ballcourt. Adjusted ballcourt count is three.

To estimate the transport cost associated with moving non-local red-on-buff pottery, I measured the linear distance between a sherd's production location and its recovery location. I examined scaled maps of the Phoenix Basin to determine these linear distances (Table 3.17, Figure 3.4). I used a center point (marked on Figure 3) in each petrofacies as a proxy for the production locale in that sand composition zone. Then, I measured the distance between this center point (i.e., approximate production location) and known consumption locales. Finally, to determine the mean travel distance for a given pottery assemblage, I averaged the distance that each sherd traveled from production area to consumption area. [9]

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Table 3.17: Average distance that non-local pottery travels from production locale to consumption locale. Note: Shaded cells represent site data that is not used in the analysis.

Sites	Chee Nee	El Caserio	Grewe	La Ciudad	Las Colinas	La Lomita	Las Ruinitas	La Villa	Los Hornos	Lower Santan	Sacaton Park	Snaketown	Upper Santan
Snaketown	37.5		33.5	47.1				53.6	28.3			22.6	27
Gila Butte			21.7	46.9	48.7			49.3	36.7			22.7	26.8
Santa Cruz		34.9	42.2	44.7				41.8				24.9	26.6
Early Sacaton		35.1	38.9			33.8	36.7		31.5	20.5	22.9		

[9] The south Salt centroid is placed in the geographic center of the petrofacies. Although the centroid looks oddly placed, it is likely situated just west of the demographic center for the petrofacies. Several large preClassic villages in the southwestern portion of the Salt River include Villa Buena, Las Cremaciones, Pueblo Viejo, and Los Hornos. These populations likely outweigh those in the southeastern Salt River where large villages did not develop until the latter Sedentary and Classic periods.

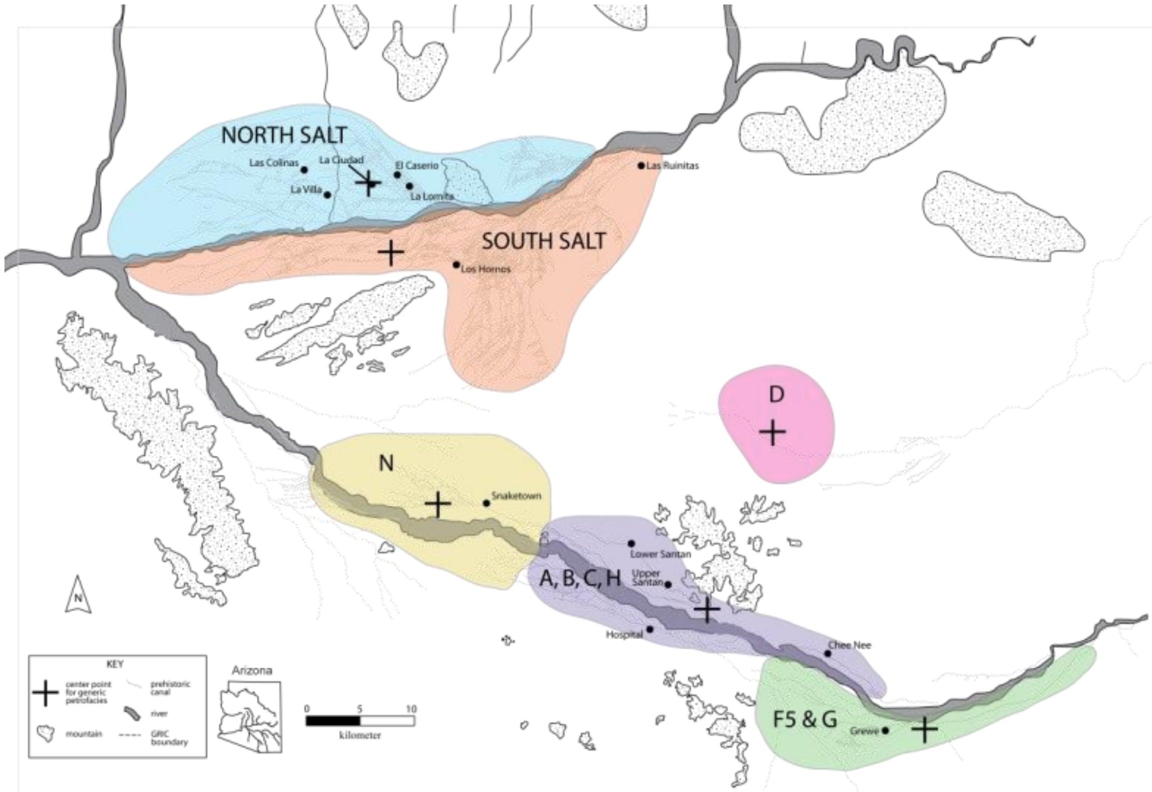

Figure 3.4: Map used to calculate linear distances between study sites and generic petrofacies. The cross-hairs denote centroid location on each generic petrofacies that distances were measured from.

Vessel Form

Finally, the form and size of vessels likely influenced the transport costs incurred in moving these items. Specifically, bowls can be moved more efficiently than jars because they can be nested. Smaller vessels are also easier to transport in quantity than larger vessels. Therefore, I evaluate if average bowl aperture and bowl to jar ratio are correlated with supply or demand for specialist-produced vessels. If so, vessel forms may have been a factor that contributed to lower transport costs in the Phoenix Basin economy (Table 3.18).

Table 3.18: Average values for bowl aperture and bowl-jar ratio for non-local pottery imported to study sites.

			Bowl-Jar Ratio[c]		
DATE	SITE	Nonlocal Bowl Aperture	bowl	jar	Bowl-Jar Ratio
Snaketown	Chee Nee	26.50	17	4	4.25
	Grewe	28.72	44	14	3.14
	La Ciudad	30.67	23	38	0.61
	La Villa	37.60	20	14	1.43
	Los Hornos	34.13[a]	41	35	1.17
	Snaketown	35.45	12	6	2.00
	Upper Santan	30.96	43	20	2.15
Gila Butte	Grewe	33.69	55	20	2.75
	La Ciudad	41.57	348	142	2.45
	La Villa	37.11	129	95	1.36
	Las Colinas	36.02[a]	7	5	1.40
	Los Hornos	29.39	44	17	2.59
	Snaketown	38.83	1	6	1.36[d]
	Upper Santan	30.40	26	23	1.13
Santa Cruz	El Caserio	32.94	62	37	1.68
	Grewe	38.27	61	21	2.90
	La Ciudad	31.56	72	32	2.25
	La Villa	31.56	58	56	1.04
	Snaketown	47.00	13	18	0.72
	Upper Santan	43.40	25	15	1.67
Early Sacaton	El Caserio	35.44	69	69	1.00
	Grewe	29.60	71	18	3.94
	La Lomita	34.77	116	84	1.38
	Las Ruinitas	32.11	53	50	1.06
	Los Hornos	35.37	41	42	0.98
	Lower Santan	29.68	n/a	n/a	1.19[b]
	Sacaton Park	45.80	n/a	n/a	1.19[b]

Notes:
[a] Low sample size (n<5), substituted average of other settlements on the same river system for same time period.
[b] Low sample size, substituted average of other settlements on the same river system for the Santa Cruz phase.
[c] Counts used for bowl-jar ratio were derived from contexts (specimen numbers) that had rim as well as body sherds.
[d] Low sample size, substituted average of same settlement for Snaketown and Santa Cruz phases.

Calculating the Independent Variables for Supply

The independent variables assessed in the multiple regression analyses are calculated at the scale of each production area (petrofacies) (Table 3.19). Population density for each production locale is measured by the most densely populated area (2.5 km radius) within each petrofacies (Appendix B, Table 3f). Irrigation workload is a ratio of the number of people who lived along a canal system and the length of the main canal in that system. (Appendix B, Table 3g). Petrofacies D is represented by the Queen Creek canal system. The northern Salt River is represented by Canal System 2, the southern Salt River is represented by Canal System 1, Petrofacies F5-G is represented by the Grewe-Casa Grande canal system, and Petrofacies N is represented by the Snaketown canal system. Petrofacies A/B/C/H spans seven different canal systems: the Casa Blanca, Chee Nee, Gila Butte, Granite Knob/Santan, Santan, and Sweetwater canal systems. Population and canal length ratios were averaged among these canal systems to provide a single metric for Petrofacies A/B/C/H. The same canal systems were used to calculate the people per ballcourt per canal system (Figure 3.5; Appendix B, Table 3h). Vessel metrics, such as exterior color value, mica density, bowl aperture, and bowl jar ratios, are averages. Each metric represents a statistical mean of all vessels from an individual production group for a particular time period. Transport distance for each production locale is the average distance that locally produced pottery was transported to consumers.

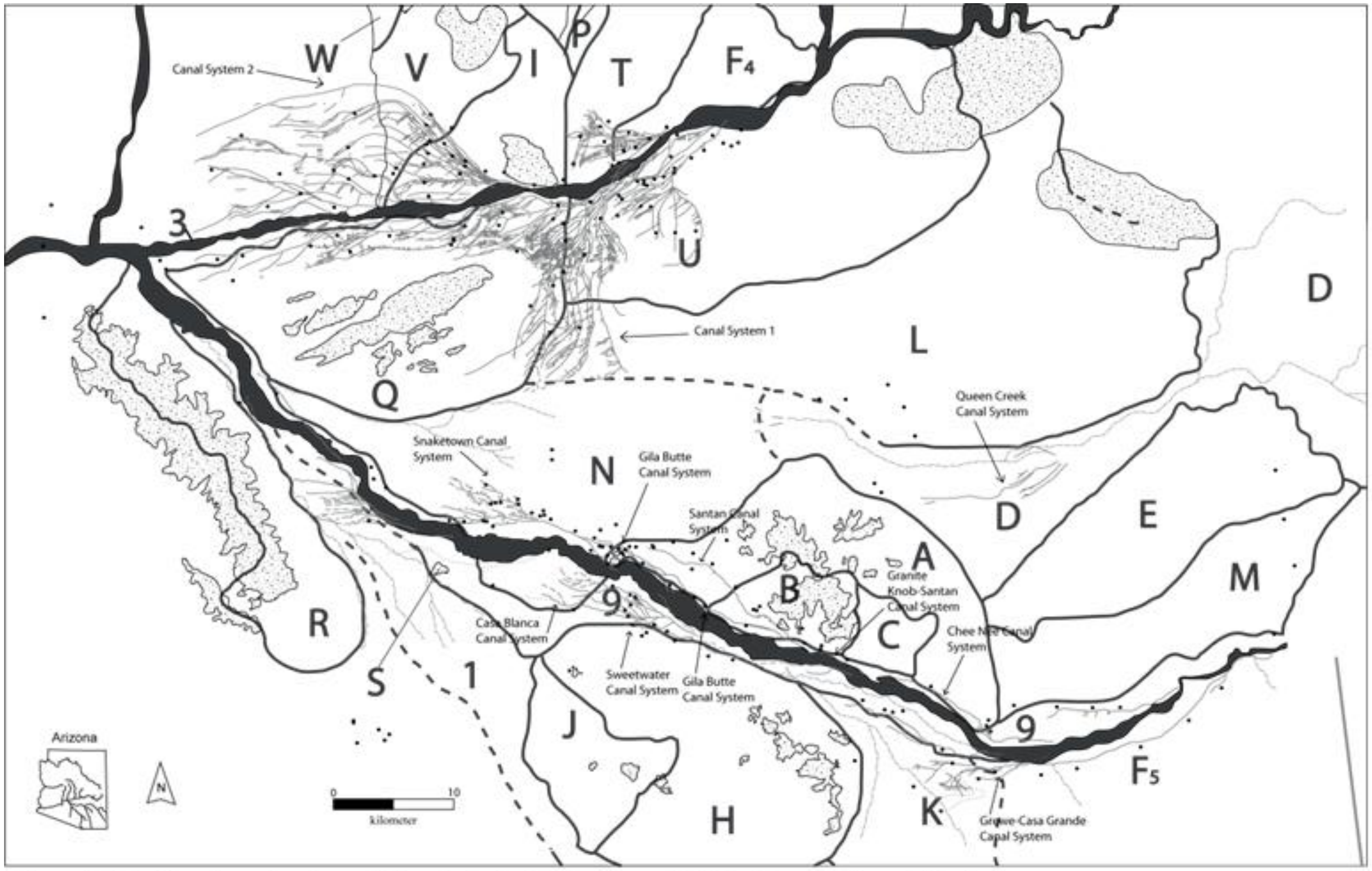

Figure 3.5: Position of canal systems within petrofacies. Black dots mark the location of major prehistoric sites.

Table 3.19: Independent variables for each production area (petrofacies). Note: Variables represent averages for each production locale for each time period.

Time	Temper	% of Nonlocal	Population Density (w/n 2.5 km)	Canal Pop-Length Ratio	People per Ballcourt	Mica Density	Exterior Color	Bowl Aperture	Bowl-Jar Ratio[b]	Transport Distance
SNAKETOWN	A, B, C, H	0.61	750	44.03[a]	---	6.59	6.27	29.88	2.03	22.86
	D	0.01	0	0	---	3.89	7.44	43.6	1.20	44.65
	F5-G	0.02	100	5.65	---	6.94	6.11	35.11	6.00	14.56
	N	0.57	750	14.18	---	6.08	6.25	34.8	1.75	14.84
	North Salt	0.00	300	32.14	---	3.00	6.43	41.5	1.45	1.69
	South Salt	0.04	200	21.43	---	0.6	6.35	41.5	0.80	8.00
GILA BUTTE	A, B, C, H	0.80	800	33.66[a]	166.53	5.7	7.08	36.09	2.30	39.99
	D	0.03	0	0	0	3.89	7.44	43.6	1.20	41.29
	F5-G	0.01	200	11.9	80	5.39	7.14	35.11	1.88	59.56
	N	0.33	800	15.69	200	5.19	7.08	38.63	1.69	17.52
	North Salt	0.01	400	4.64	107.14	1.25	6.77	34.67	1.45	0.54
	South Salt	0.07	700	8.98	96.67	1.06	6.57	38.52	1.38	6.93
SANTA CRUZ	A, B, C, H	0.48	900	38.55[a]	188.61	5.72	7.37	38.93	1.64	39.85
	D	0.04	300	22.70	90	4.59	7.45	28.91	1.33	37.72
	F5-G	0.03	600	25.3	170	4.93	7.36	29.92	2.50	41.52
	N	0.66	900	17.65	225	5.64	7.4	36.41	1.48	31.90
	North Salt	0.00	300	4.33	100	1.29	6.86	31.67	2.33	0.10
	South Salt	0.02	700	9.60	103.33	1	6.63	31.67	1.13	7.15
EARLY SACATON	A, B, C, H	0.41	900	46.26[a]	210.14	5.99	7.43	33.05	0.99	37.60
	D	0.06	150	18.6	60	4.55	7.64	28.91	1.00	26.65
	F5-G	0.04	500	28.27	190	3.22	7.81	29.92	5.00	9.60
	N	0.71	900	20.60	275	5.45	7.46	33.89	1.48	31.32
	North Salt	0.00	450	8.17	150	4.8	6.8	39.5	2.33	2.33
	South Salt	0.01	750	19.46	166.67	2.26	6.58	39.5	0.78	5.17

KEY

- Missing data, data from South Salt
- Missing data, combined North and Salt Rivers
- Missing value, from SN period
- Missing value, from SC period
- Missing value, from ESAC period
- Missing value, from GB period

Notes:

[a] Canal estimates for petrofacies A/B/C/H are a combination of data on the following canal systems: Casa Blanca, Chee Nee, Gila Butte, Granite Knob-Santan, Santan, and Sweetwater.

[B] Bowl-jar ratio is based on contexts (specimen numbers) that have both rim and body sherds.

The Multiple Regression Analysis

This study examines the relationships among the demand for non-local red-on-buff pottery and the independent variables for two major temporal phases of the Hohokam preClassic period—the early preClassic represented by the Snaketown and Gila Butte phases, and the later preClassic represented by the Santa Cruz and early Sacaton phase. The eight independent variables include population density, canal length-population ratio, average bowl aperture, average bowl-jar ratio, average exterior color, average mica density, ballcourts per person per canal, and the average distance between production and consumption locale. For each temporal phase, I construct a multiple regression equation for each dependent variable: 1) proportion of non-local buffware pottery in the entire ceramic assemblage, 2) proportion of non-local buffware pottery in the decorated assemblage, 3) richness of red on buff production sources represented in the assemblage, 4) evenness of production sources represented in the assemblage, and 5) proportion of non-local pottery supplied by each production locale. Thus, in total, the study examines 10 multiple regression equations.

Multiple Regression Method

Multiple regression allows the analyst to determine the relationship among several independent variables and a single dependent variable. In particular, it predicts the amount of change expected in the dependent variable per unit change in the independent variable. Multiple regression analysis is ideally suited to studies that require prediction or modeling of the relationships among the independent and dependent variables. It has been used to assess the influence of several variables simultaneously on a single dependent variable in various types of archaeological analyses, including mortuary and dental studies (Gordon and Buikstra 1981; Kvaal and Solheim 1994; Walker et al. 1991), faunal analyses (Marshalla and Pilgram 1991), dating methods (Plog and Hantman 1986), site hierarchies and classifications (Kohler and Parker 1986), lithic analysis (Dibble and Whittaker 1981), agricultural productivity and crop yields (Burns 1983) and ceramic analyses (Longacre 1964).

Multiple linear regression analyses were performed with JMP Statistical Software. Prior to importing the dependent and independent variables into the multiple regression model, each variable was converted into a z-score. The z-scores were calculated using the mean and standard deviation for each combined time period (Snaketown-Gila Butte and Santa Cruz-Early Sacaton). As a result, the estimates (β) provided by the multiple regression analyses for each dependent variable for each temporal phase can be compared. The resulting estimates, therefore, are standardized regression coefficients or beta weights for each variable. These estimates will be referred to as <u>scaled estimates</u>.

To identify variables that should enter the multiple regression models, I first performed a stepwise regression analysis on each of the dependent variables and the full set of independent variables. This stepwise regression involved the forward selection process whereby variables are added to the model one by one if they are considered statistically significant. The selection process was set to pick the solution that would minimize the Bayesian Information Criterion (BIC).

After the forward stepwise regression selected independent variables, I performed an ordinary least squares (OLS) regression analysis on the dependent variables and the selected independent variables. Ordinary Least Squares minimizes the sum of the squared errors (difference between the observed and predicted responses) in the dataset. From this analysis, I generated the R^2 and the individual estimate coefficients that are used in the interpretation of each regression model. The results of the least squares regression analysis were accepted if the F-value or F-ratio was statistically significant at the 0.1 level. Statistical significance indicates that the model explains more than random variation in the sample. In addition, the model was accepted if each estimate coefficient was statistically significant at the 0.1 level. If these conditions were not met, I removed independent variables that were not significant and re-ran the least squares regression analysis. In some cases, I could not identify a model with an F-value probability less than 0.1 or with independent variables statistically significant at the 0.1 level.

Output of Multiple Regression Analyses

The results of the multiple regression analyses are measures of correlation among the four factors (8 independent variables) described above and the demand for specialist-produced red on buff pottery. Each of the 12 regressions performed in this study returned a coefficient of determination (R^2) that measures the correlation among one of the dependent variables (volume, richness, evenness of buffware pottery) and the eight independent variables. The significance of each independent variable's contribution to the regression model was examined by testing if its associated regression coefficient was statistically different from zero (Pedhazur and Schmelkin 1991:417).

The overarching hypothesis that population density, time investment in irrigation agriculture, ritual demands for socially valued goods, and transport costs are related to increased demand for specialist-produced red-on-buff pottery would be supported by a coefficient of determination value (R^2) that is statistically greater than zero. An R^2 value above zero would indicate that some proportion of the variance is explained by the independent variables in the equation (Pedhazur and Schmelkin 1991:417). If an R^2 value for a particular multiple regression equation is close to 1, the factors included in this analysis explain the majority of variance in demand for specialist-produced red-on-buff pottery. This result would indicate that the present model is strongly predictive. If an R^2 value for the multiple regression equation is statistically above zero but significantly below 1, other factors may be influencing demand for red-on-buff pottery than those included in the present analysis. This result would indicate that the model should be revised to include additional variables. If an R^2 value for the multiple regression equations is statistically close to zero, none of the variables in the analysis are strongly associated with demand for red-on-buff pottery. This result would provide a foundation for subsequent analyses by eliminating factors that are not explanatory.

The regression analysis also produced estimate coefficients for each of the independent variables (Shennan 1997:186-192). The estimate coefficients correspond to the amount of variation in demand (the dependent variables) that is explained by individual independent variables when variation in the other factors is held constant. A comparison of the estimates indicated the relative influence of each independent variable on the dependent variable. The resultant correlations led to inferences about the conditions that contributed to demand for specialized red-on-buff pottery production in the Phoenix Basin through time.

Checks on Multicolinearity

One issue in multiple regression analyses is the potential for covariance or multicolinearity among some of the independent variables. Multiple regression analyses with highly correlated independent variables will generate unstable estimates for independent variables and high standard errors. In this analysis, correlation matrices indicate that covariance may be an issue in a few of the multiple regression solutions. For instance, the maximum population density, the number of people per ballcourt, and canal workload covary during certain time periods. This type of correlation, unfortunately, is unavoidable because each of the independent variables addresses human behavior either with respect to settlement position or ballcourt/canal construction. Although there is not a direct link between the number of ballcourts, population, and canal workload, these variables are closely connected by patterns in human activities.

In order to verify if multicolinearity was an issue in the variables selected by the stepwise regression analyses, I analyzed the Variance Inflation Factors (VIF) for each of the multiple regression solutions. The VIF is considered to be a reliable estimate of multicolinearity (Adnan et al. 2006; e.g., Mansfield and Helms 1982). Multicolinearity is likely an issue with a VIF greater than 10. For the multiple regression analyses in this project, no independent variable had a VIF score greater than 4.7 and the average VIF score was 1.7. The low VIF scores indicate that multicolinearity was not a large issue in the solutions proposed by the multiple regression analyses. In addition, I did not accept regression solutions with standard errors for the independent variables greater than 0.19.

Although multicolinearity did not affect the multiple regression solutions presented in this project, it is possible that multicolinearity between some independent variables in certain time periods may have influenced the variable selection during the initial stepwise procedure. To address this issue, I cross-checked the results of the multiple regression data with extant archaeological data. I present these data in the results discussion. By using the multiple regression data as an exploratory method to flesh out patterns, and by matching these data with other lines of evidence, I reduce issues associated with possible multicolinearity in the stepwise variable selection.

Limitations of the Regression Analyses

The relatively small sample sizes of sites dated to each time period increase the overall R^2 in the multiple regression analyses and the possibility of over-fitting the independent variables. Therefore, the statistics on each of the multiple regression models may indicate that the models explain more of the variation in the dependent variables than they actually do. The results presented in this dissertation are thus preliminary and should be reexamined with additional data.

CHAPTER 4: MULTIPLE REGRESSION ANALYSES FOR THE SUPPLY AND DEMAND OF SPECIALIST-PRODUCED RED-ON-BUFF POTTERY

The development of the Phoenix Basin ceramic economy was first encouraged by demand for specialist-produced pottery in the 8^{th} and 9^{th} centuries and then by conditions that promoted the supply of these wares during the 10^{th} and 11^{th} centuries. Consumption of pottery made by specialists was initially spurred by desire for vessels with particular aesthetic characteristics. While demand for these types of wares continued into the latter preClassic, growth of the specialized ceramic economy was principally related to Gila River specialists increasing production output and distribution of ceramic wares.

The independent variables addressed in this analysis– population density, irrigation workload, mica density, exterior color value, bowl aperture, bowl-jar ratio, people per ballcourt, and transport distance for non-local pottery—significantly influenced the supply and demand (volume, and concentration) of specialist-produced pottery in the preClassic period. Statistically significant ($p(F) < 0.1$) coefficients of determination (R^2) were achieved for 8 of the 12 multiple regression models (Appendix C). These coefficients ranged between 0.37 and 0.95. The results indicate that various combinations of the eight independent variables explained a large percentage of variation in the volume and concentration of Hohokam decorated pottery in Phoenix Basin assemblages. Estimates provided for each variable included in the multiple regression models indicate the influence that a particular variable has on the dependent variable. The estimates provide the basis to evaluate changes to the factors that most significantly influenced supply and demand for decorated pottery through time.

Supply of Specialist-Produced Decorated Pottery

Hohokam economic development in the Phoenix Basin was mainly encouraged by conditions that increased the supply of pottery from specialists. Detailed sourcing analyses of preClassic red-on-buff pottery indicate that Hohokam households received decorated ceramics manufactured by specialists residing in just a few areas of the Phoenix Basin (Figure 4.1). The vast majority of decorated pottery used by Phoenix Basin households throughout the preClassic period was manufactured in the Snaketown Petrofacies (N) on the middle Gila River. Communities in the Santan-Sacaton Mountain Petrofacies (generic petrofacies A/B/C/H) also produced a considerable amount of decorated pottery during the earlier preClassic period. Depending on time period, pottery from Petrofacies N and Petrofacies A/B/C/H accounted for an average of 63 – 82 percent of red-on-buff assemblages.[10]

[10] These sourcing analyses focused on pottery with sand temper that could be matched to particular sand composition groups (petrofacies) across the Phoenix Basin. Sherds that were tempered only with coarse-grained mica schist (~20 percent of buffware assemblages) were not included in this portion of the study because they could not be sourced to particular production locales.

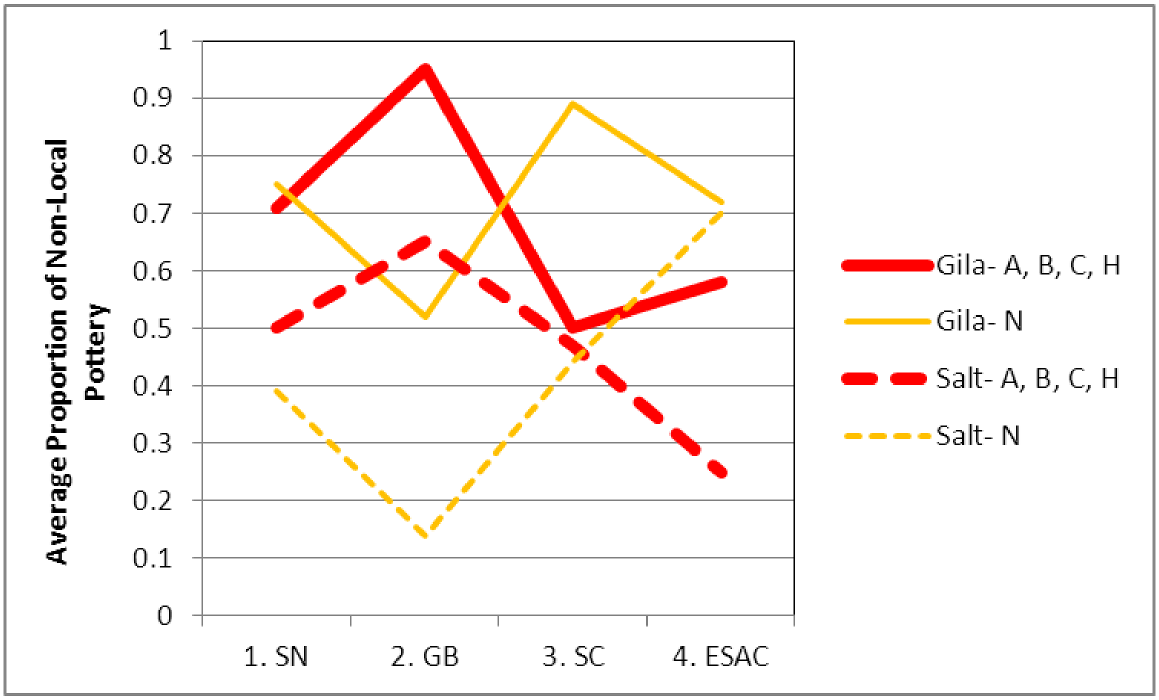

Figure 4.1. Supply of pottery from Petrofacies A/B/C/H and N to settlements on the Gila River and the Salt River. Note: Proportions represent the average amount of pottery from Petrofacies A/B/C/H and N exported to other petrofacies in either the Salt or the Gila River systems. These data help to compensate for uneven distribution of study sites across different petrofacies.

The multiple regression analyses suggest that various factors encouraged specialized red-on-buff production in particular locations during the later preClassic period. Although supply during the Snaketown and early Gila Butte phases was not significantly influenced by any of the factors addressed in this analysis, this pattern reverses during the Colonial period when several factors significantly influence the supply of pottery from particular areas (Table 4.1). The Santa Cruz phase, which witnessed a distinct increase in the production output of decorated wares from the Snaketown Petrofacies (N), appears to have been the time period when circumstances changed to encourage specialized production of red-on-buff pottery. The supply of specialist-produced pottery was principally rooted in the ability of specialists to produce pottery with the aesthetic characteristics desired by Phoenix Basin consumers and to lower the costs of transporting wares to distant consumers.

Table 4.1: Estimates returned for multiple regression analyses for the supply of red-on-buff wares from production locales across the Phoenix Basin.

Term	Snaketown – Gila Butte	Gila Butte – Santa Cruz	Santa Cruz – Early Sacaton
Ballcourts per Capita		-0.59	-1.09
Bowl-Jar Ratio			
Canal Workload			1.01
Exterior Color			0.82
Mica Density		0.47	
Population Density			
Transport Distance			0.55

Social Valuables

During the later preClassic, an economy of specialization that focused on social valuables likely encouraged the supply of specialist-produced decorated pottery. In economies of specialization, an increase in the level of specialization results in increasing productivity because specialists can perfect production techniques. In other words, specialists who manufactured the most wares for export were able to produce pottery with physical characteristics that best suited their consumer base. In the Hohokam case, light surface color and mica shine were desirable attributes in decorated bowls and jars. Exterior color lightness and mica density were positively correlated in multiple regression analyses for the 8th to 11th centuries (see Table 4.1). A chart of the average exterior color value of pottery manufactured in different locales indicates that potters in areas that generated the most pottery for export—Petrofacies N and Petrofacies

A/B/C/H—manufactured wares with a combination of light paste and high mica shine (Figure 4.2 and 4.3).

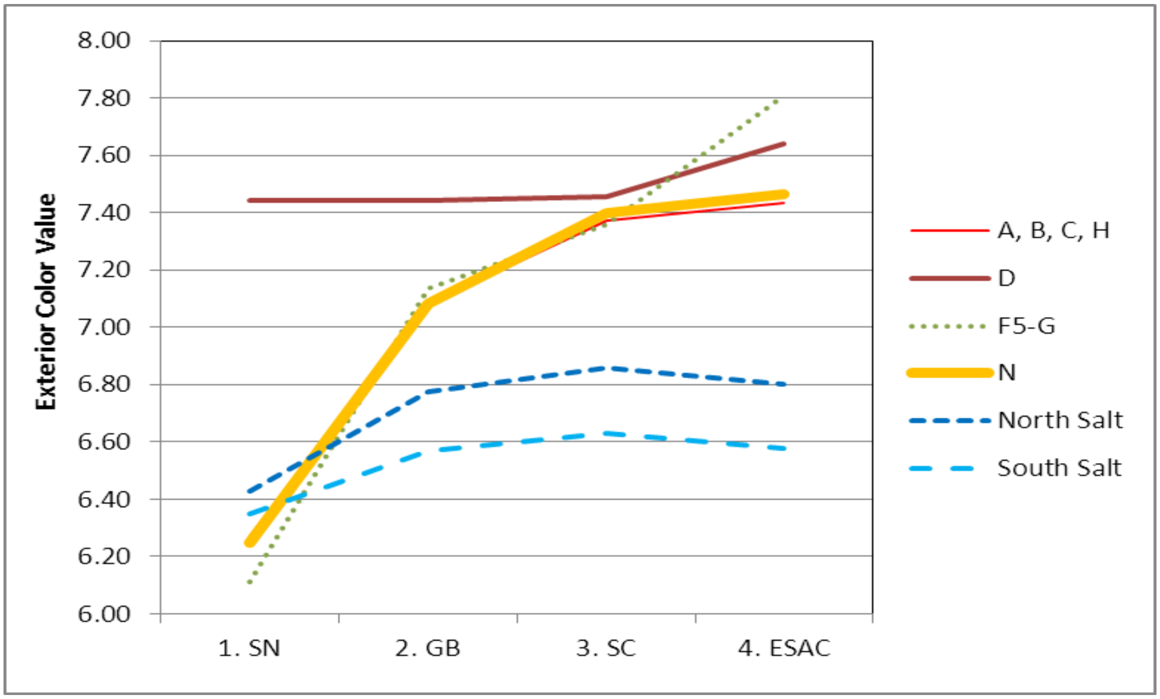

Figure 4.2: Average exterior color value for pottery manufactured in Phoenix Basin production locales.

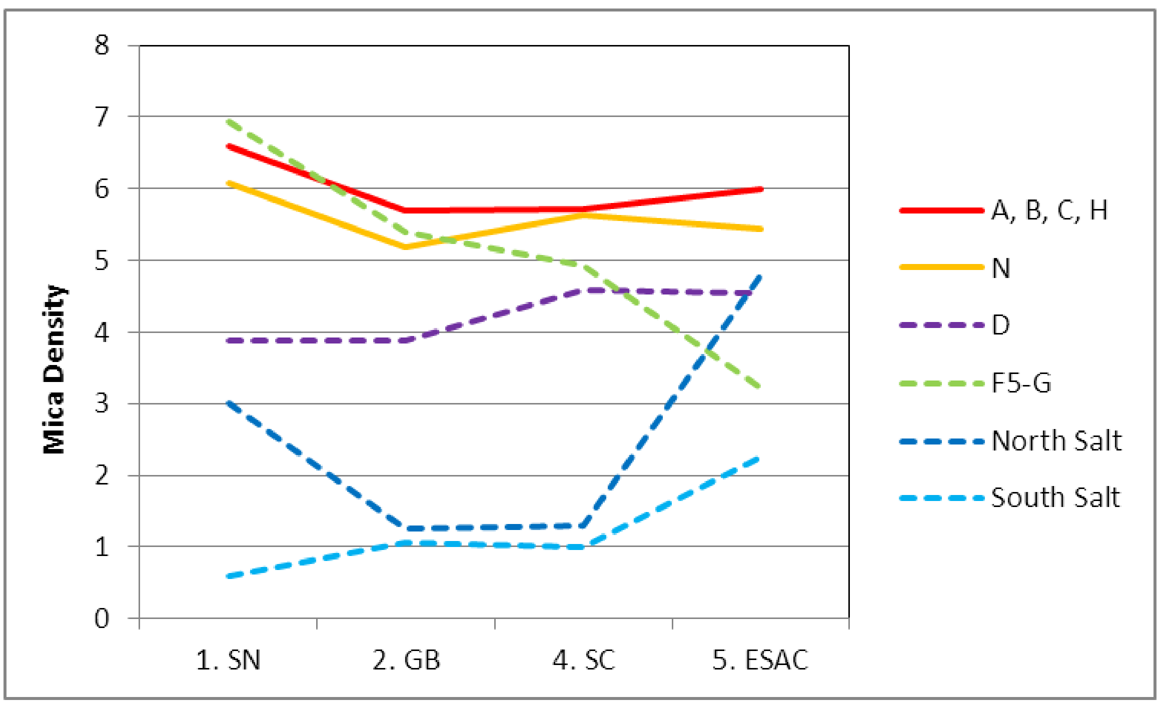

Figure 4.3: Average mica density for pottery manufactured in Phoenix Basin production locales.

Transport Costs

Lowered transport costs also encouraged the supply of specialist-produced red-on-buff pottery in the later preClassic period. The multiple regression analyses indicated a positive correlation between transport distance and the output from production locales. Those suppliers that exported the most wares also exported their wares the farthest. Therefore, circumstances during the Santa Cruz phase must have reduced the cost of moving decorated pottery across the Phoenix Basin without improvement to transportation technologies.

The use of large ballcourts to distribute pottery may have reduced transport costs and encouraged the supply of specialist-produced red-on-buff pottery in the Phoenix Basin. Those areas that generated the most decorated pottery for export—Petrofacies N and Petrofacies A/B/C/H—had fewer ballcourts per capita in comparison to other areas. However, these two regions had three of the five large, preClassic ballcourts in the Phoenix Basin (Marshall 2001). The supply of pottery from specialist producers was negatively correlated with the number of ballcourts per capita on canal systems in the multiple regression analyses (Figure 4.4; see Table 4.1). Consumers of red-on-buff pottery, in contrast, tended to have a relatively high number of small ballcourts per capita. The presence of large ballcourts at the location of specialized pottery production and the presence of high numbers of small ballcourts at consumer locales indicates that ballcourts of different sizes may have served different functions in the distribution of pottery across the region. In the Santa Cruz phase, this system of large and small ballcourts may have lowered transport costs, and thus increased the supply of specialist-produced pottery (this issue is addressed in more detail in Chapter 5).

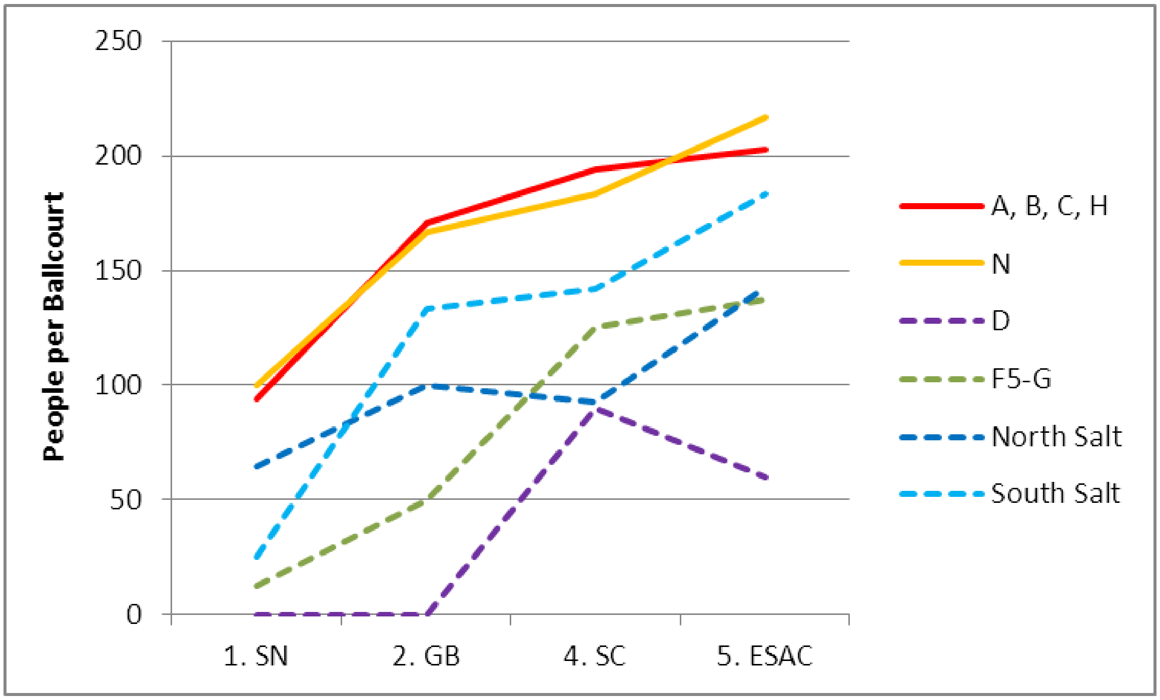

Figure 4.4: Number of people per ballcourt per canal system in major production locales.

In addition to ballcourts, specialists may have reduced transport costs by modifying the size and form of their wares. For instance, settlements on both the Salt and the Gila Rivers uniformly imported bowls that were smaller than bowls that they manufactured locally. In particular, Salt River settlements imported small bowls throughout the preClassic period ($t = -2.221$, $p = 0.068$, d.f. = 6) (Figure 4.5). This result suggests that bowl size may have been influenced by the transport of these vessels from the Gila River specialists to consumer settlements to the north. Similarly, both Salt and Gila River settlements imported pottery assemblages with a higher bowl to jar ratio than the assemblages that they produced and used themselves (Figure 4.6). Bowls can be more easily transported than jars because they can be nested within one another. Therefore, the forms that settlements imported may have been directly related to the transportation costs incurred in their movement.

Differential change in bowl sizes and vessel forms through time on the Salt and Gila Rivers may indicate that transport costs affected the supply of vessels. While the form and size of the bowls used at Salt River settlements remained relatively the same through time, larger bowls and a more even number of bowls and jars were consumed at Gila River villages. Before and after this point, Gila River settlements had small bowls and a high bowl to jar ratio. In the Gila Butte phase, large bowl size and an even bowl to jar ratio may be linked with the rise of large-scale social events associated with ballcourt (Mills 2007). Substantial transport distances to Salt River communities, however, may have prevented the same assemblages from being imported to communities to the north.

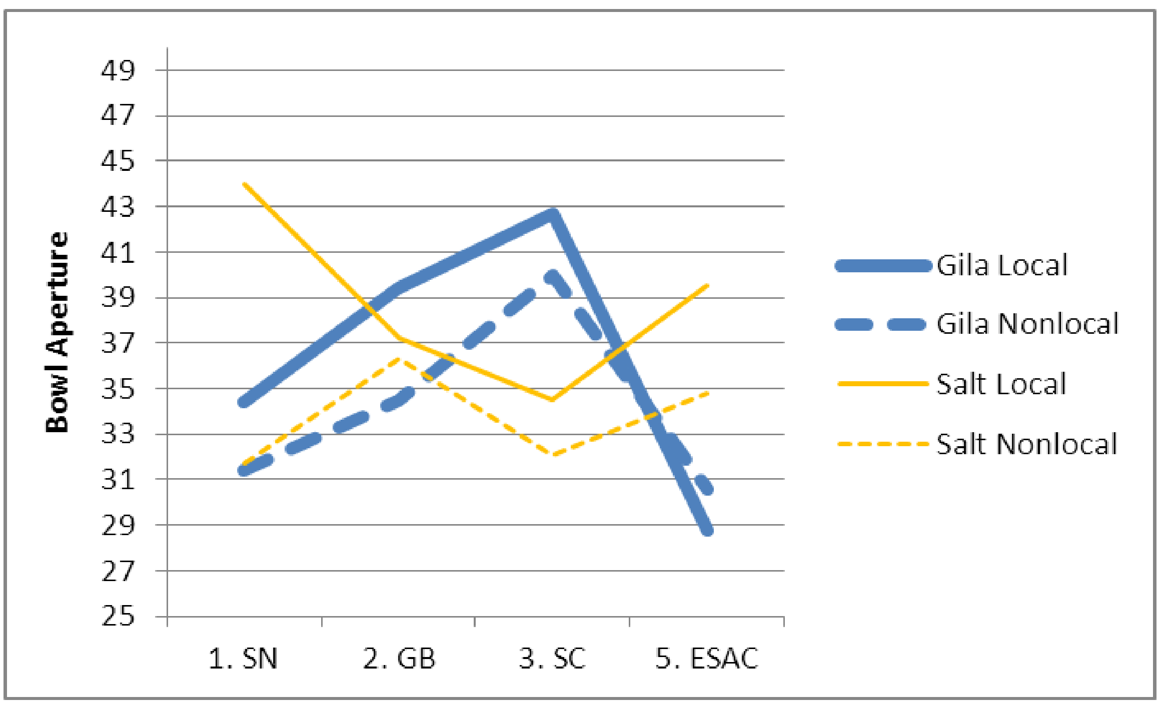

Figure 4.5: Average bowl aperture of local and non-local pottery consumed by Gila River and Salt River households.

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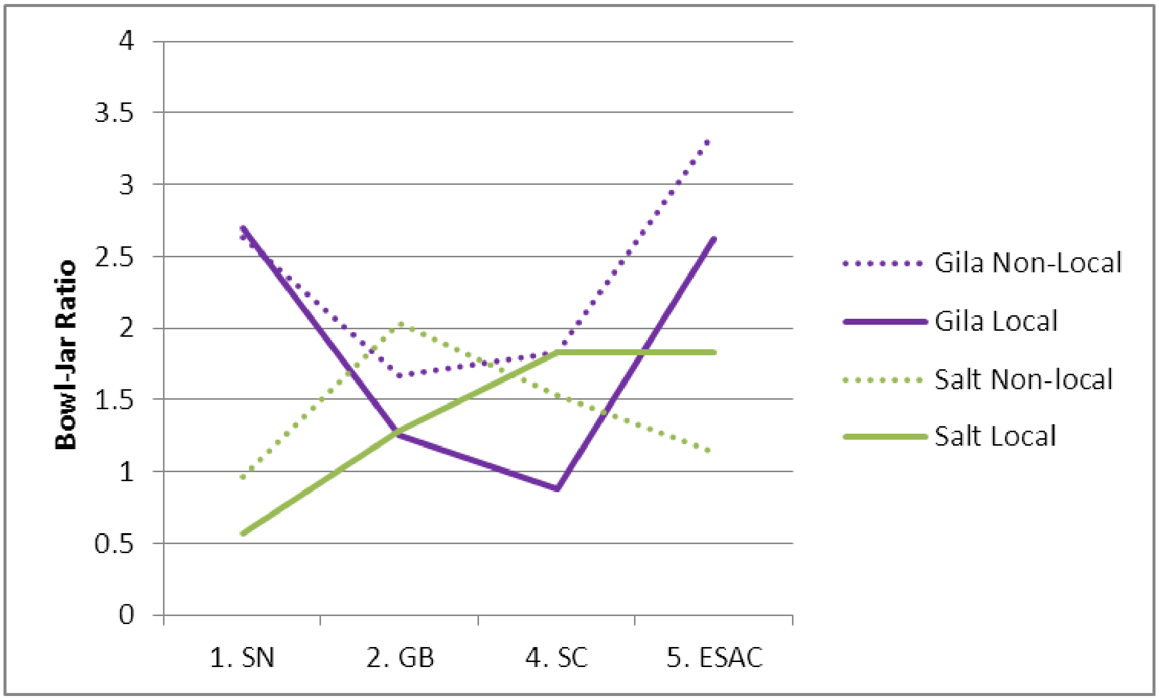

Figure 4.6: Average bowl-jar ratio of local and non-local pottery consumed by Gila River and Salt River households.

Demand for Specialist-Produced Decorated Pottery

In contrast to the supply of specialist-produced decorated wares, demand for these pots was uniform and continuous throughout the preClassic period. Demand for red-on-buff pottery manufactured by specialists grew steadily and in concert for general demand for decorated pottery (Figure 4.7). Consumers actively desired decorated pottery manufactured by specialists as early, or earlier, than the Snaketown phase of the preClassic period. Multiple regression analyses for the volume and concentration of non-local pottery at Hohokam settlements return significant results for the Snaketown-Gila Butte and the Gila Butte-Santa Cruz phases (Table 4.2).

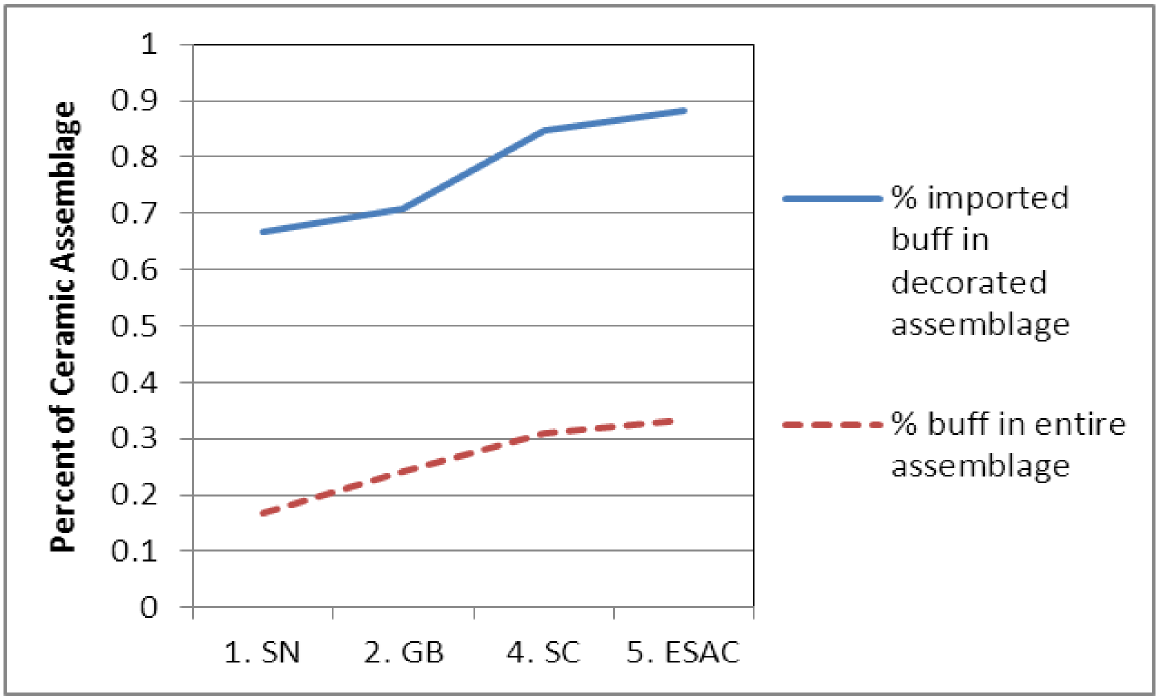

Figure 4.7: Average proportion of imported buffwares in decorated assemblages and proportion of buffwares in the entire site assemblage. Proportions are calculated by site.

Table 4.2: Estimates returned for multiple regression analyses for the volume (proportion) of imported pottery in decorated assemblages and the concentration of decorated pottery sources.

	% Buffware in Buffware Assemblage			Concentration		
Term	Snaketown – Gila Butte	Gila Butte – Santa Cruz	Santa Cruz – Early Sacaton	Snaketown – Gila Butte	Gila Butte – Santa Cruz	Santa Cruz – Early Sacaton
Ballcourts per Capita	0.75					
Bowl-Jar Ratio		0.57		0.33	0.28	
Canal Workload		0.62		-0.51	-0.42[a]	
Exterior Color	0.75	0.52		0.41[b]		
Mica Density					0.36	
Population Density					0.25	
Transport Distance				-0.77[c]	-0.54[a]	

Notes:
[a] Estimates for richness. All other estimates are for evenness.
[b] Estimates were returned for both richness and evenness. The directionality of these estimates differed. The displayed estimate is for evenness because it was larger.
[c] Estimates were returned for both richness and evenness. The estimates were averaged because the directionality was the same.

Transport Costs

Although Hohokam consumers shared a uniform demand for decorated pottery, transport costs largely dictated the amount of red-on-buff vessels that households actually used. Variation in the proportion of decorated pottery in Phoenix Basin assemblages was almost entirely a function of the effort required to move red-on-buff pottery from specialized producers to consumers (Figure 4.8). Those sites located the farthest distance from production sources tended to have the lowest proportion of decorated pottery relative to plainware pottery in their domestic assemblages. In addition, these villages consumed a range of different wares and used local production to supplement imports from specialists. In the multiple regression analyses, the concentration of decorated pottery sources was negatively correlated with transport distance during the Snaketown-Gila Butte and the Gila Butte-Santa Cruz phases (see Table 4.2). Settlements within the major production zones, however, had the highest proportions of buffwares in their site assemblages. For instance, decorated wares figure prominently in site assemblages in Petrofacies N along the middle portion of the middle Gila River valley (i.e., Gila Crossing, Hidden Ruin, and GR-1157C).

A fall-off distribution in buffwares indicates that transport costs were not lowered enough during the preClassic to negate the effects of transport distance on pottery distribution. This result contradicts the expectations discussed in Chapter 2 for transport costs. It is possible that without the introduction of new transportation technologies such as wheeled carts, barges, or pack animals, the efficiency of pottery transport stops at a certain threshold.

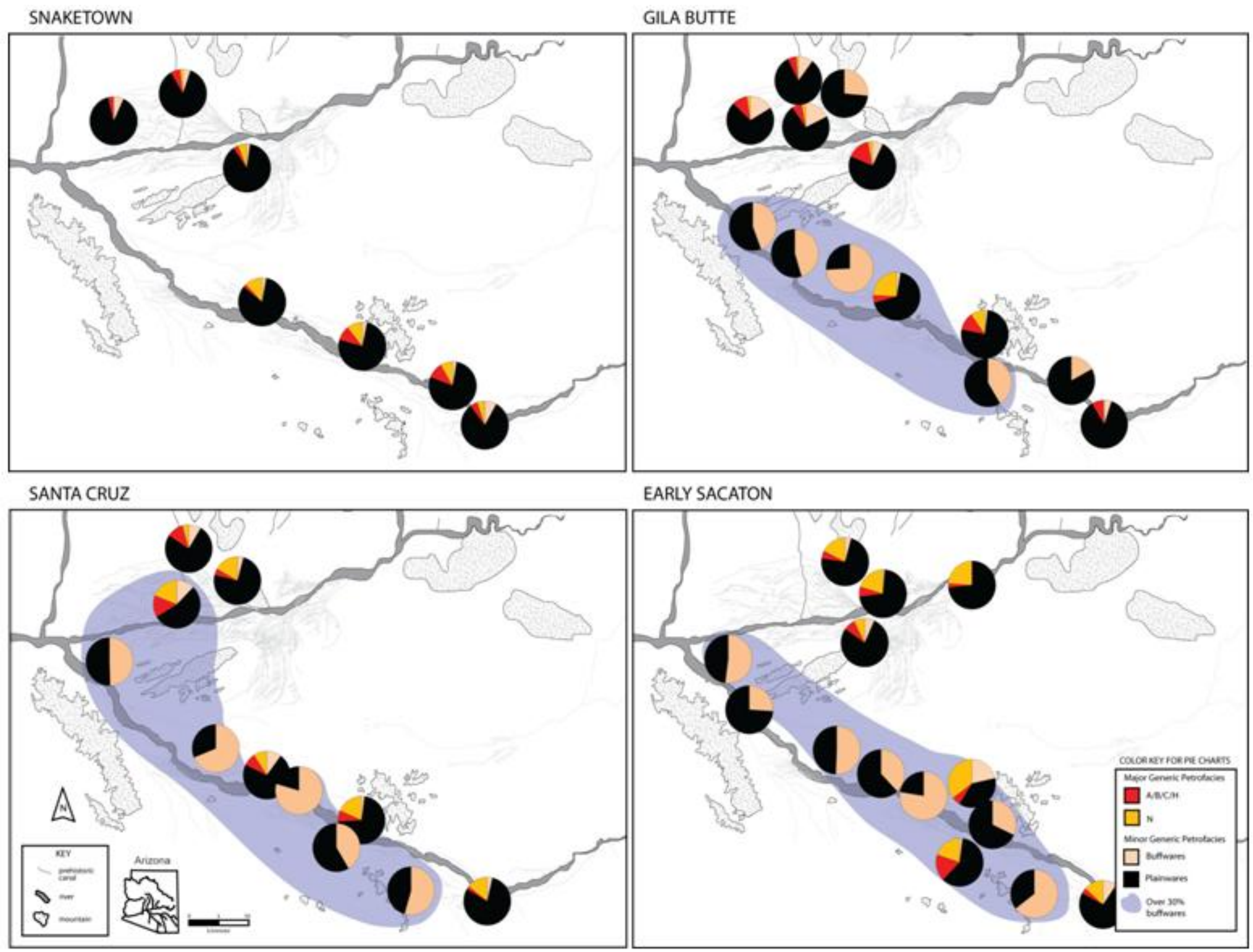

Figure 4.8: Proportion of buffware and plainware pottery in Phoenix Basin ceramic assemblages through the preClassic.

Social Valuables

Consumer demand for red-on-buff pottery was rooted in the desire for social valuables in the form of light-colored, mica-rich decorated bowls and jars. These desires were particularly important to encouraging demand for specialist-produced red-on-buff wares in the earlier preClassic. Consumers preferentially imported wares that were light colored and had a high mica shine. Estimates produced by the multiple regression analyses for the lightness of pottery exteriors indicate that they were positively correlated with the amount of decorated pottery consumed by households in the Snaketown-Gila Butte phases and in the Gila Butte-Santa Cruz phases (see Table 4.2). Households that imported decorated wares from just a few specialist producers also imported decorated wares with a high mica shine. The evenness of red-on-buff sources was positively correlated with mica density in the Gila Butte – Santa Cruz phases (see Table 4.2).

Salt and Gila River settlements also shared a uniform level of demand for light colored, mica dense pottery. Salt River settlements consistently imported decorated wares from the Gila River that were lighter in color and had more mica sheen than wares that could be produced with local materials (Figures 4.9 and 4.10). The difference between the mica density and exterior color of local Salt River buffwares and imported buffwares was statistically significant (Mica Density: $t = 9.165$, $p < 0.001$, d.f. = 6; Color Value: $t = 3.692$, $p = 0.010$, d.f. = 6).

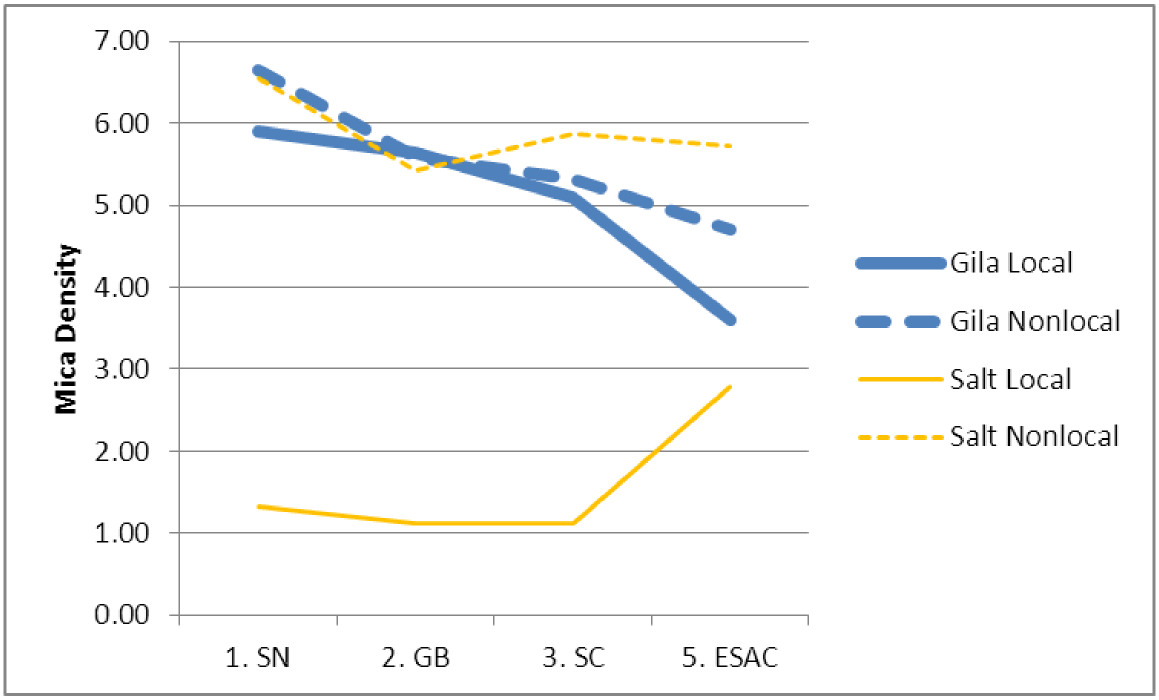

Figure 4.9: Average mica density of local and non-local pottery consumed by Gila River and Salt River households.

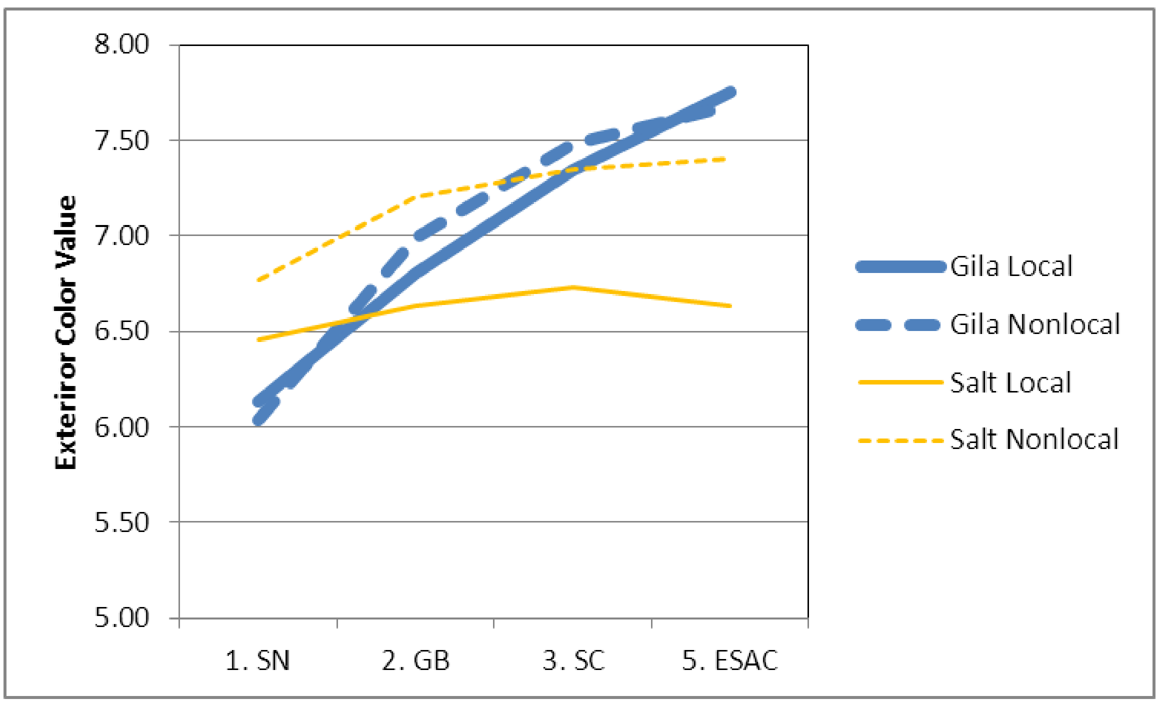

Figure 4.10: Average exterior color value of local and non-local pottery consumed by Gila River and Salt River households.

Rising Supply Meets Enduring Demand

Data generated by the multiple regression analyses suggest that demand existed for specialized red-on-buff production from a very early point in the preClassic period. Thus, economic development in the Phoenix Basin can be attributed to conditions in the 9th century that allowed or encouraged specialized suppliers to meet regional demands for their products. Most importantly, specialist producers were able to reduce the transport costs of moving pottery across long distances. Here, I have proposed that large ballcourts may have played an influential role in facilitating the transfer of pottery across the region in the Santa Cruz phase onwards (after Abbott et al. 2007a; Lack 2013). Specialists also adapted the forms and shapes of their wares to reduce the cost of moving pottery over long distances.

Demand and the Social Functions of Red-on-buff Pottery

Widespread and continuous demand for red-on-buff pottery made by specialists is ultimately rooted in the functional and social uses of red-on-buff pottery. Household ceramic assemblages in almost every prehistoric archaeological culture in the American Southwest were generally divided between undecorated (or sparsely decorated) utility wares and decorated vessels. These two pottery types fall into different functional classes. Utility wares tend to be coarser and were fashioned into shapes such as cooking pots and storage jars that reflect basic practical purposes. In general, demand for utilitarian pottery is based almost entirely on the suitability of the wares to specific tasks (Balfet 1981:259; Birmingham 1975; Nicholson and Patterson 1992:42). Researchers working in the Hohokam culture area (e.g., Van Keuren et al. 1997) and elsewhere in the American

Southwest (e.g., Blinman 1993:15-16) also contend that demand for plainware vessels was likely rooted in their real or perceived functionality. Strength tests of Hohokam decorated and plainware pottery indicate that the plainware fabric was more resilient to breakage than decorated red-on-buff pottery (Beck 2002)

In contrast to plainware pottery, decorated pottery was associated with serving, eating, and other activities in which ceramic vessels were readily visible. Decorations on publicly visible vessels suggest that pottery aesthetics were important in social contexts. The social function of pottery is only loosely associated with the functions that a pot performs. For instance, while unpainted pottery is sometimes used for cooking, ethnographic data suggests that painted pottery was almost never used over a direct flame (Plog 1980b:85). Direct or close contact with heat can blister and obscure paint, damage that would negate the purpose of the design. Therefore, the social function(s) of pottery define how ceramic vessels are used irrespective of whether or not the pot can perform a particular task.

The anthropological literature is replete with analyses directed at why people decorate pottery. As Braun notes (1991:362), "There are no cross-culturally consistent reasons why people vary in the extent to which they decorate utilitarian household objects." The predominant explanation for decoration is that it conveys social or even ideological information to people. In terms of different classes of material culture, decoration on pottery is an efficient way to convey social information because it is high impact and bears a relatively low cost. Since pottery manufacture is a multi-step process, decoration can be added at various stages of the production sequence. Additionally, most decorative treatments do not represent a large additional time investment in comparison to the time required to fashion and fire ceramic vessels (Arnold 1985; Braun 1991; Feinman et al. 1981; Rice 1987; Rye 1981). Finally, domestic pottery are suitable for signaling various messages because these vessels are highly visible and ubiquitously present in household contexts (Braun 1991:367). Decoration on pottery, therefore, is an effective way to convey information.

Decoration on domestic vessels can signal the tone, importance, etiquette, and rules of social settings in which these vessels are used. In cases where people may be unclear as to the social expectations of a particular gathering, decoration on vessels and the use of these vessels may signal the appropriate response (DeBoer and Moore 1982; Douglas 1970; Gluckman 1962; Hodder 1982; Roe 1980; Wobst 1977). Decoration can also reflect ideological, religious or spiritual themes (Boas 1966:32, 159-161; Braun 1991:366). For instance, David and his colleagues (1988) argue for a metaphorical association between ceramic decoration and body adornment in Mafa and Bulahay ceramic traditions in northern Cameroon. Finally, decoration can serve as a means to mark and maintain social boundaries (Carr and Neitzel 1995; Hegmon 1992; Hegmon 1998; Rice 1996:148-153; Stark et al. 1998; 2000).

Ethnographic and archaeological information from the American Southwest indicate that decorated pottery served a variety of social functions that differed from the use of plainware pottery. For instance, decorated pottery may have been associated with both household and supra-household social gatherings (Crown 1994; Mills 1999; Potter and Ortman 2004; Van Keuren 2004). The more frequent movement of decorated or burnished bowls across the landscape in comparison to plainwares suggests that these wares may be linked with exchanges and ritual preparations associated with large ritual events and public ceremonies (Abbott 1996; 2000; Graves and Spielmann 2000; Huntley 2008; Mills 1999:104; 2000b:308; Spielmann 1998b; 2004). In particular, large bowls for both the display and the serving of food are prominent features in communal feasts (Mills 2007).

Demand for decorated red-on-buff pottery in the Hohokam region was likely rooted in the social functions that these pots performed. As domestic items in every Hohokam household across the Phoenix Basin, red-on-buff pottery was not restricted in its use to particular areas or groups of people. Decorated vessels were likely used in everyday contexts as food dishes, serving wares, and storage jars. However, the use of red-on-buff pottery also signaled participation in pan-Hohokam social and ideological realms of life. Lack (2013) argues for the arrival of a new ideological system during the Gila Butte phase that involved the widespread arrival of ballcourts and other ideas from Mesoamerica to the south (see also Wallace 1994; Wilcox 1991b). In a stylistic analysis of Hohokam red-on-buff pottery, Lack contends that red-on-buff pottery styles heralded the arrival of this new way of thinking and promoted the spread of the ideology across the Hohokam culture region. The data presented here also indicates that light exterior color and mica shine were also aesthetic attributes that may have been important to the social function of these wares (Figures 4.9 and 4.10). The consumption of red-on-buff pottery may have served as a powerful symbol of community participation and consensus during a time of social change.

The intricate connection between the social function of red-on-buff pottery and Hohokam ideologies during the preClassic is further evidenced by the precipitous drop in the production and use of decorated pottery after the collapse of the ballcourt network

(Abbott et al. 2007a). When Hohokam ballcourts were suddenly abandoned ca. AD 1070, concentrated ceramic manufacture and widespread distribution of pottery in the Phoenix Basin appears to have ceased as well (Abbott et al. 2007a). Lack (2013) argues that the abandonment of the ballcourts and the drop in decorated buffware vessels signaled widespread ideological shifts in Hohokam society. As the social and ritual importance of red-on-buff pottery waned, red-on-buff pottery became a much less prominent part of Hohokam lifeways, and production was much less concentrated on the landscape (Lack et al. 2012).

While the social functions of red-on-buff pottery created enduring demand for these wares in Hohokam households, economic factors dictated the extent to which Hohokam consumers manufactured their own pottery or relied on specialists for these wares. The underlying economic conditions that ultimately contributed to long-standing demand and increasing supply of specialist-produced red-on-buff pottery are likely rooted in endogenous (interally derived) comparative advantages to specialization of red-on-buff pottery manufacture. Specialists could manufacture red-on-buff wares more efficiently and more skillfully than individual household production. The complex paste recipes required to generate a light-colored paste, for instance, intensified the importance of learning while doing and emphasized the accumulation of skill and knowledge that separates the specialist from an occasional potter. Demand for social valuables that required technical expertise, therefore, created the fundamental conditions for increases to the supply and the level of specialization in ceramic production.

Encouragements to Supply

Although demand for the products of specialized red-on-buff producers was widespread, the location of manufacturing locales was not. The location of the Snaketown canal system in Petrofacies N must have offered some type of incentive to specialized pottery production. Concentrated red-on-buff manufacture on the Gila River is not surprising given that materials necessary to manufacture decorated wares were geographically concentrated in the Gila River valley (Abbott 2007). In particular, hematite used for paint (Fernald 1973; Fontana et al. 1962; Rea 1996; Russell 1975; Spier 1970; Stoeppelmann 1995), mica schist used for temper (Cogswell et al. 2005; Kelly 2012; Miksa 2001b; Ownby et al. 2004; Rafferty 1982; Walsh-Anduze 1993), and calcareous clays that produced light-colored buffwares (Abbott 1994a; Abbott 2001b; Beck 2006) were available along the Gila River. Even though Gila River settlements were located near the materials necessary to manufacture light colored, mica dense buffwares, these settlements also relied on decorated pottery manufactured by specialists in the vicinity of Snaketown. For instance, households at Grewe, a large preClassic village in the eastern portion of the middle Gila River, imported over 70 percent of their buffwares from the Snaketown area by the early Sacaton phase.

In the following chapter, I explore why the Snaketown area became the preeminent location for specialized red-on-buff production in the preClassic period. I investigate the combination of endogenous and exogenous comparative advantages to specialized production in this area. The results of the analysis indicate that potters in the Snaketown area capitalized on lowered transport costs through a central geographic location, the distribution of pottery and other items through large ballcourts, and the social or political importance of the Snaketown community.

CHAPTER 5: THE SUPPLY OF DECORATED POTTERY FROM THE SNAKETOWN COMMUNITY

Following initial consumer demand for light-colored shiny pots, specialized suppliers of decorated wares provided the major push to economic growth in the Phoenix Basin economy during the later portion of the preClassic period. Specifically, specialists working on the Snaketown canal system in Petrofacies N manufactured large numbers of decorated wares for export to settlements across the region. Production likely occurred at the community scale and was intertwined with the seasonal cycle of canal maintenance and subsistence activities.

The impetus for specialized decorated pottery production on the Snaketown canal system was based on comparative advantages to intensive ceramic manufacture in this area. I suggest that these comparative advantages are rooted in geographic centrality of the Snaketown canal system in the Phoenix Basin, the local availability of materials necessary to make light-colored shiny pottery, and the importance of the Snaketown canal system as a social, ritual, or political center in the Phoenix Basin. All of these factors are likely closely intertwined. For instance, the position of the Snaketown canal system in the center of the Phoenix Basin would allow it to operate as a communication or exchange hub between the Salt and Gila River valleys. The geographic centrality of the Snaketown canal system provides the ideal location for a settlement of social importance because it could allow people from across the region to convene in this area. Finally, the location and importance of Snaketown area would have highlighted the production and distribution of social valuables such as decorated pottery. Although settlements on the Salt River could (and occasionally did) make decorated wares, they vastly preferred to import light-colored, mica-dense decorated pottery that could only be made from materials located on the Gila River. Conversely, although Gila River settlements could have made their own decorated wares, as the materials were locally available to them, they opted to import pottery from the Snaketown region. The red-on-buff pottery manufactured in this area may have been linked to the importance of the activities that took place in the Snaketown area and the ease of exchange from this central place.

Archaeological excavation, survey, and material science data indicate that the Snaketown canal system was the primary locus of decorated pottery manufacture. All direct evidence for red-on-buff production in the Phoenix Basin is located directly on or adjacent to the Snaketown canal system. Clay mixing basins and possible pit kilns were uncovered at a Sedentary period courtyard group at Snaketown (Haury 1976:194-197). Chemical testing of a ball of clay left in the mixing basin determined that it was buff-firing clay that was presumably intended for red-on-buff ware manufacture (Abbott and Love 2001:142-144). Archaeologists have also noted the existence of a prehistoric trail that links the center point of the site of Snaketown to extensive schist outcrops at Gila Butte. Based on the trail alignment, potters could have traveled regularly back and forth from their settlements to mine raw schist from Gila Butte for pottery production (Motsinger 1998). The Gila Butte site, which is located adjacent to Gila Butte near the headgates of the Snaketown canal system, also revealed evidence for red-on-buff production in the form of pottery production tools, high proportions of decorated pottery, and proximity to schist sources at Gila Butte (Rafferty 1982; Walsh-Anduze 1993). Finally, clay mixing basins, possible pit kiln, and tools associated with red-on-buff production provide strong evidence for decorated pottery production during the Sedentary period at the Maricopa Road site on the western side of the Snaketown canal system (Lascaux and Ravesloot 1993:43-45; Woodson 2011:132).

In this chapter, I characterize the history of specialized pottery manufacture in the Snaketown canal system. Specifically, the supply of pottery from the Snaketown canal system (Petrofacies N) appears to have lowered supply from other specialist production areas including Petrofacies A/B/C/H. Potters in the Snaketown canal system also tailored their output to consumer demands much more noticeably than any other production locale. I then present evidence that the Snaketown canal system was positioned in an ideal location for the production and distribution of social valuables such as red-on-buff pottery. This positioning contributed to early comparative advantages to specialized decorated pottery manufacture in this area, and widespread demand for the products of specialists living along the Snaketown canal system.

Snaketown Production and Distribution

Specialized production of red-on-buff pottery from the Snaketown canal system underwent a critical shift between the Gila Butte and Santa Cruz phases from widespread distribution to the Gila River alone to distribution across the entire Phoenix Basin. Maps of the proportion of pottery from different source locales indicate that pottery from

Petrofacies N consistently dominated site assemblages on the Gila River with the exception of the Gila Butte phase (Figure 5.1). In contrast, Petrofacies A/B/C/H pottery was a major component of ceramic assemblages on the Salt River during the earlier preClassic period. During the Gila Butte phase, the distribution of N retracted considerably and pottery from Petrofacies A/B/C/H was dominant at all study sites, with the exception of Snaketown in Petrofacies N. By the Santa Cruz and early Sacaton phases, however, decorated pottery from Petrofacies N was dominant at almost all sites with the exception of a few in the Salt River valley.

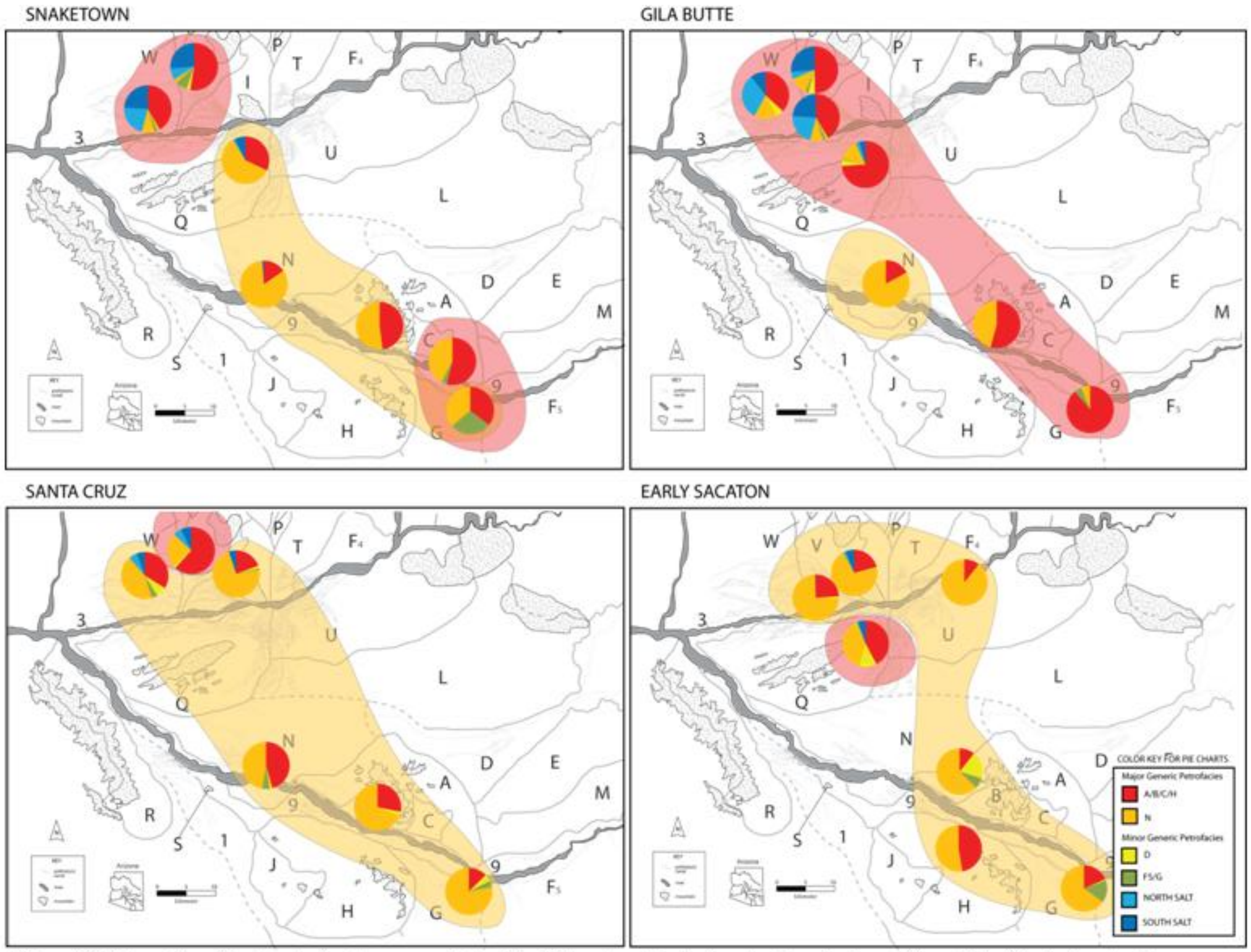

Figure 5.1: Proportion of red-on-buff pottery manufactured in different production locales through the preClassic. Shading designates the dominant source locale for pottery in a particular assemblage.

Through time, decorated pottery manufactured in Petrofacies N appears to replace wares made at other production locales. A statistically significant negative correlation exists between the proportion of Petrofacies N pottery in Phoenix Basin assemblages through the preClassic and the evenness of sources represented in those assemblages (Figure 5.2). In other words, assemblages that have more pottery from Petrofacies N tend to receive decorated wares from fewer sources. This result could indicate that the production and distribution of pottery from Petrofacies N reduced production in other locales. In contrast, the proportion of pottery from production areas such as Petrofacies A/B/C/H in site assemblages was not significantly correlated with the evenness of pottery in those assemblages.

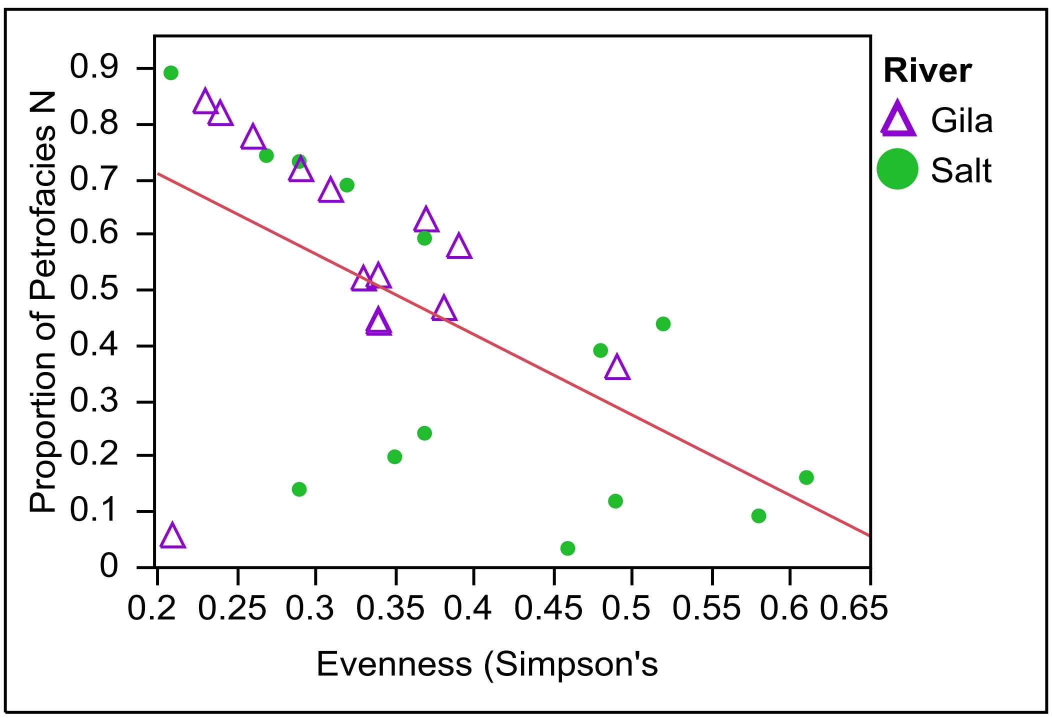

Figure 5.2: Relationship between the proportion of pottery from Petrofacies N in site assemblages and the evenness of sources represented. Fit Line: R^2 = 0.420, Prob > F = <0.0001, Estimate = -1.474.

The supply and demand for pottery produced in Petrofacies N particularly impacted the supply and demand for pottery from Petrofacies A/B/C/H. With respect to demand, a statistically significant negative relationship between the proportion of pottery manufactured in Petrofacies N and Petrofacies A/B/C/H in Phoenix Basin assemblages was present through time (Figure 5.3). This result suggests that, as demand for Petrofacies N pottery increased through time, demand for pottery from Petrofacies A/B/C/H decreased.

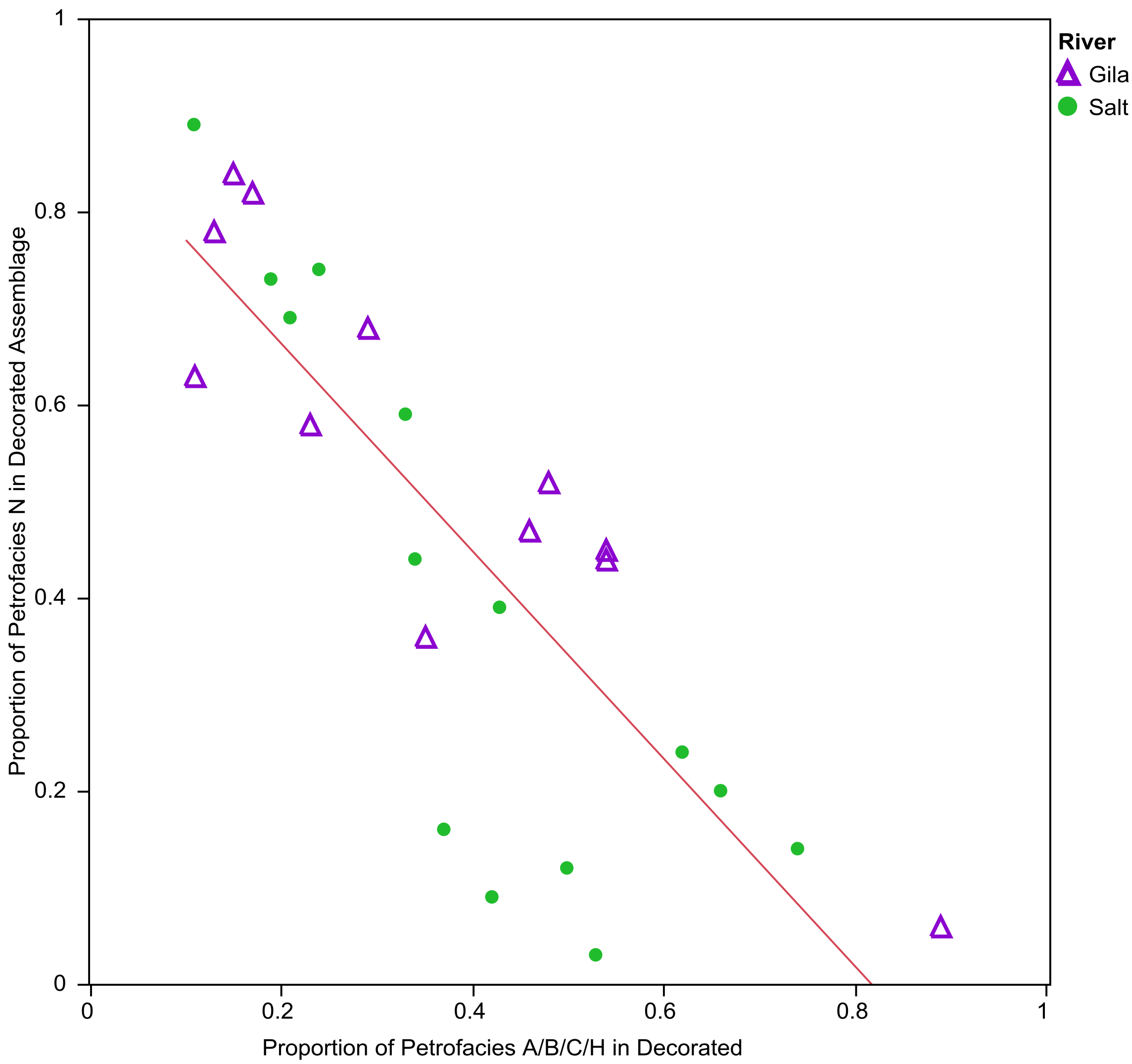

Figure 5.3: Proportion of pottery from Petrofacies A/B/C/H and N in Phoenix Basin assemblages. Fit Line: R^2 = 0.681, Prob > F = <0.0001, Estimate = -1.076.

The supply of decorated pottery from Petrofacies N was also associated with a decrease in the supply of decorated pottery from Petrofacies A/B/C/H. The average supply of ceramics manufactured in Petrofacies N is negatively correlated with the supply of ceramics from Petrofacies A/B/C/H (Figure 5.4). Through time, as the supply (proportion of non-local pottery) from Petrofacies N increased, the proportion of non-local pottery from Petrofacies A/B/C/H decreased.

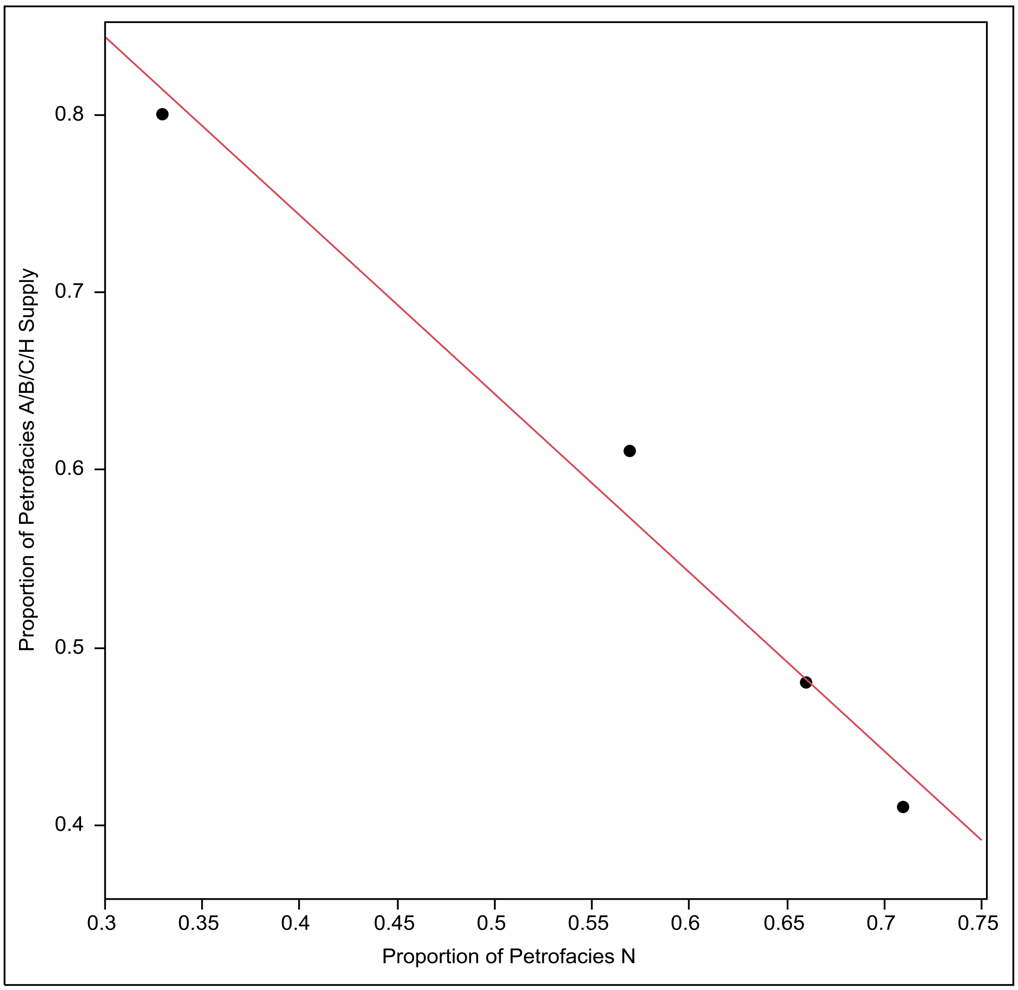

Figure 5.4: Proportion of non-local pottery from Petrofacies N and from Petrofacies A/B/C/H. Fit Line: R^2 = 0.976, Prob > F = 0.012, Estimate = -1.004.

The supply of pottery from Petrofacies N was particularly important to Phoenix Basin consumers. When the supply of pottery from Petrofacies N periodically dropped during the Gila Butte phase, Salt River settlements imported more pottery from Petrofacies A/B/C/H, but they also began local production. In particular, potters working in the vicinity of South Mountain on the Salt River began to manufacture and distribute decorated pottery to Salt River settlements (Figure 5.5). Either the additional transport distance from Petrofacies A/B/C/H impacted the number of decorated wares that Salt River settlements imported, or Salt River settlements preferred to manufacture their own pottery if wares from Petrofacies N were not available.

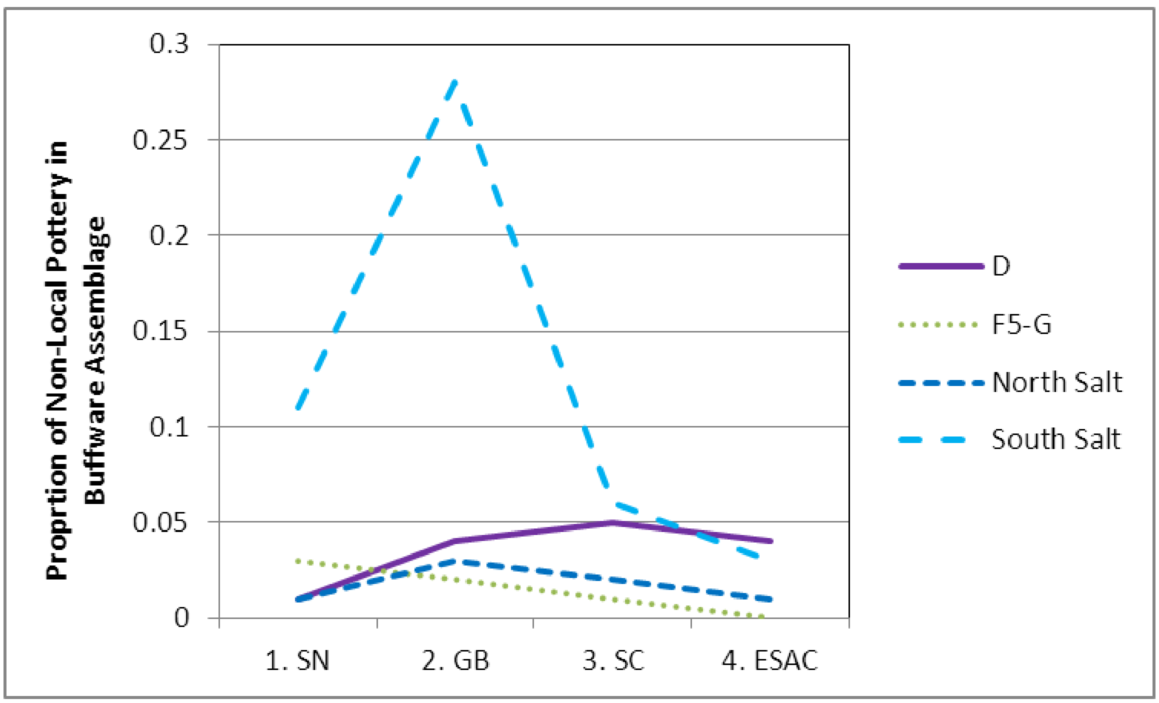

Figure 5.5: Supply of pottery from small-scale production locales to settlements on the Salt River. Proportions represent the average amount of pottery from the selected petrofacies exported to petrofacies on the Salt River. These data help to compensate for uneven distribution of study sites across different petrofacies.

Supply of Petrofacies N Responds to Consumer Demand

Unlike other production locales, specialized pottery producers working within Petrofacies N may have manufactured wares that would specifically fit the demands of consumer bases. In the case of vessel form, potters in Petrofacies N appeared to have exported different proportions of bowls and jars to different areas of the Phoenix Basin. With the exception of the Gila Butte phase, pottery specialists in Petrofacies N exported a more even number of bowls and jars to the Salt River than to the Gila River ($t = 2.45$, $p = 0.09$, d.f. = 6) (Figure 5.6). This trend continues relatively consistently throughout the entire preClassic period. A low bowl-jar ratio for exports to the Salt River from Gila River producers is counterintuitive to what would be expected if transportation costs were an issue. Bowls can be nested for easy transport. Therefore, the difference in the vessels exported from Petrofacies N to settlements along the Salt and Gila Rivers suggests that specialists were catering to the desires (demand) of different populations.

It is possible that, since Gila River settlements were in close proximity to the materials necessary to manufacture red-on-buff pottery, people at some distance from production locales opted to manufacture their own jars. Therefore, the vessels they received from specialists were composed of many more bowls than jars. Salt River settlements, in contrast, did not have easy access to materials necessary to make light-colored, mica dense decorated wares. As a result, these settlements appear to have imported the full complement of decorated wares including both bowls and jars.

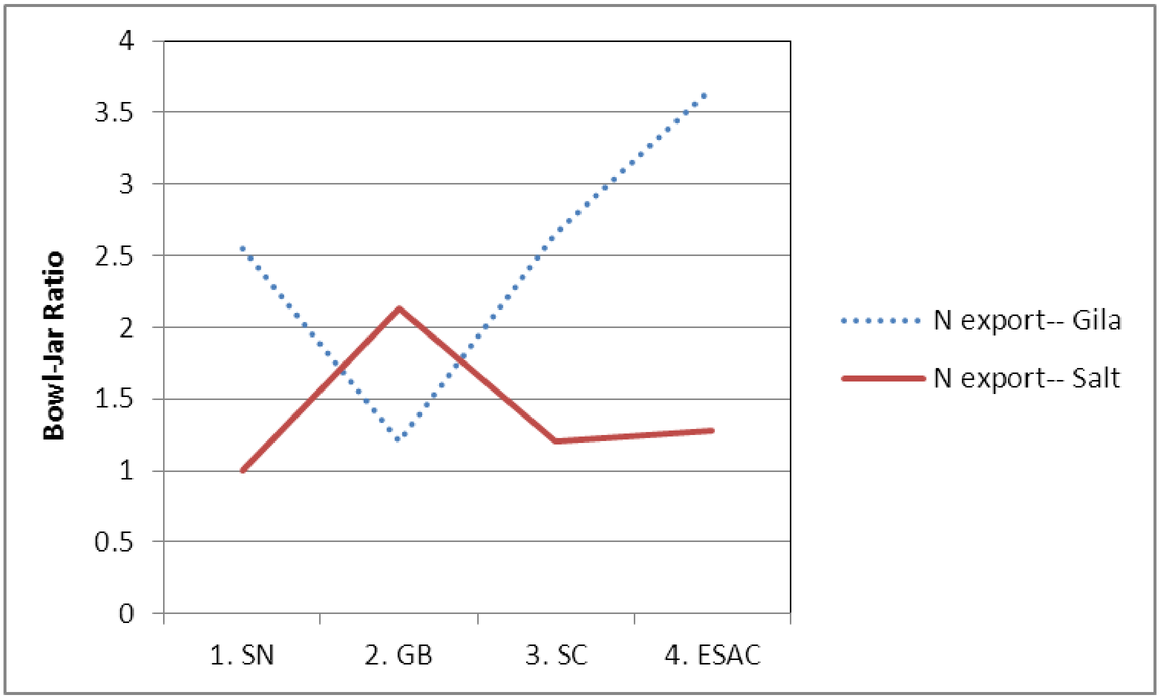

Figure 5.6: Bowl-jar ratio of vessels exported from Petrofacies N to Gila River settlements and to Salt River settlements. Note: Does not include sampled assemblages where only rims were selected.

Petrofacies N was also the only major production locale to export pottery whose appearance and form differed from pottery that did not move out of the petrofacies zone. Although the mica densities in wares exported from Petrofacies A/B/C/H and N do not differ significantly, the wares that these two production locales produced and used locally do vary (Figure 5.7). In particular, vessels made and used in Petrofacies A/B/C/H have significantly more mica flakes on their surface than vessels made and used in Petrofacies N ($t = 1.995$, $p = 0.103$, d.f. = 5). This result indicates that producers in Petrofacies N may have intentionally exported wares that had higher mica sheen than the wares they choose to keep and use locally.

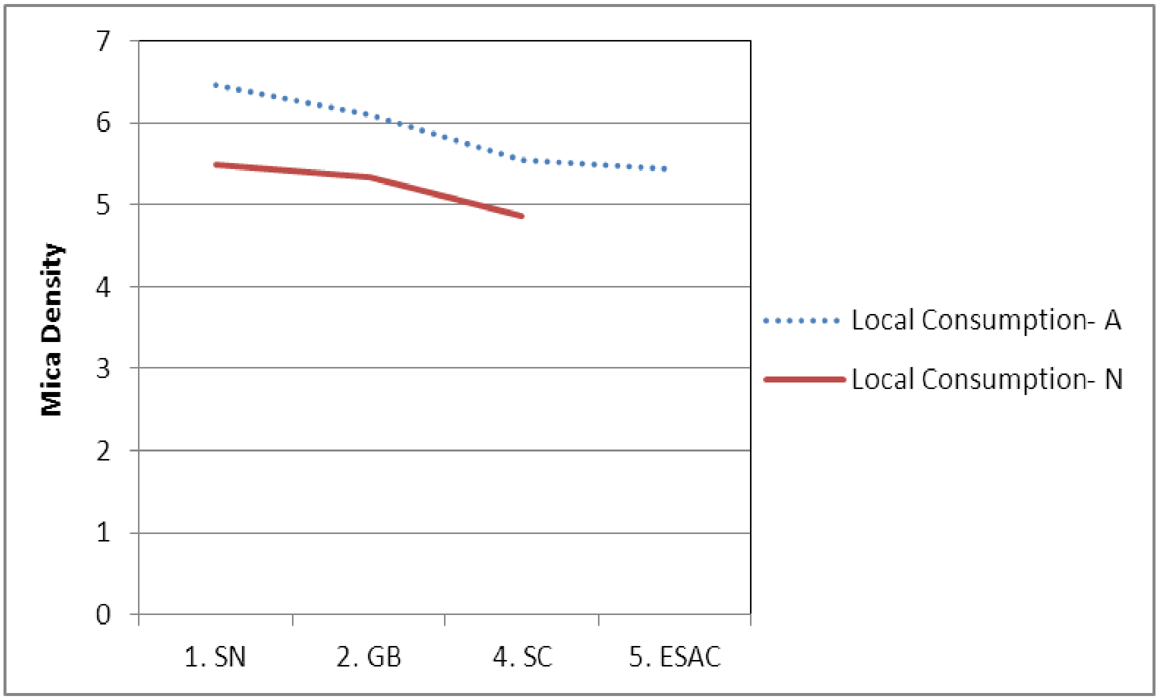

Figure 5.7: Average mica density for vessels made and consumed locally in Petrofacies A/B/C/H and Petrofacies N. Note: No data is available for local Petrofacies N consumption during the early Sacaton phase.

Finally, the size of bowls exported from Petrofacies N differed significantly from the size of bowls produced and used within the petrofacies (Figure 5.8). In particular, exported bowls tended to be smaller than bowls that remained within Petrofacies N ($t = -2.923$, $p = 0.033$, d.f. = 5). This result may indicate that potters in Petrofacies N were either catering to the demands of non-local consumers for smaller bowls, or that transportation costs associated with moving a large volume of pottery from Petrofacies N to various locales contributed to smaller average bowl sizes for exported vessels. The latter suggestion, however, contradicts the lower bowl-jar ratio of vessels exported from Petrofacies N to more distant Salt River settlements.

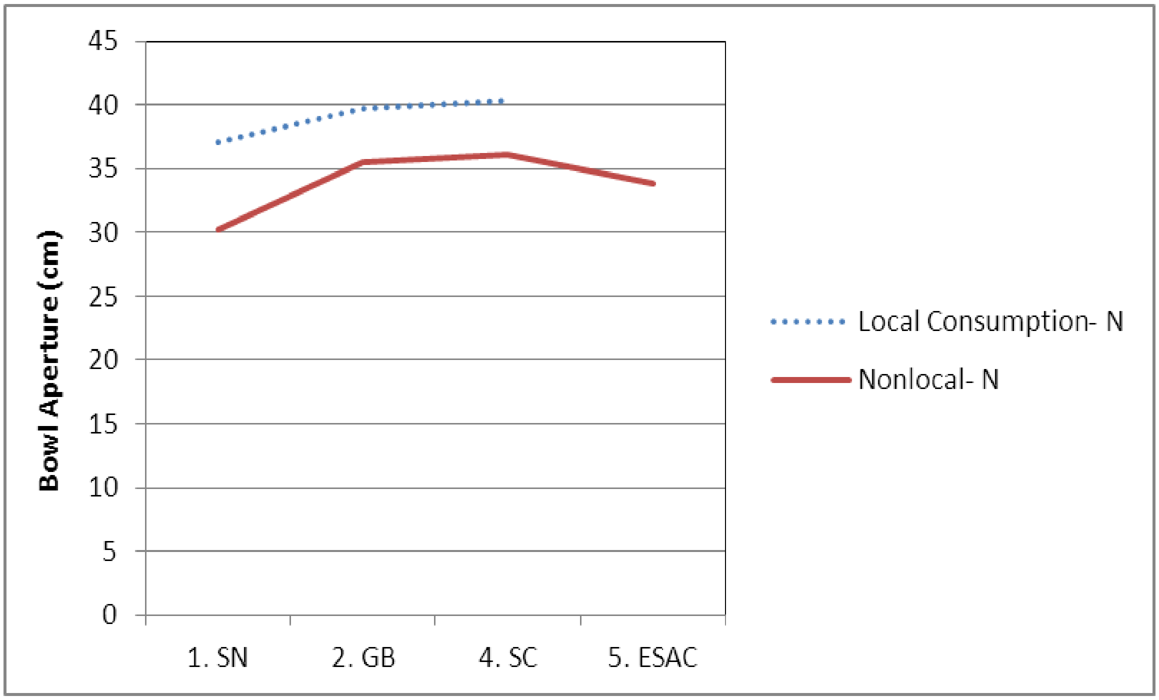

Figure 5.8: Average bowl aperture for vessels made in Petrofacies N that were consumed both within and outside the petrofacies. Note: No data is available for local Petrofacies N consumption during the early Sacaton phase.

Summary: What's Special About Snaketown

The history of specialized decorated pottery manufacture in Petrofacies N followed a different trajectory than any other production locale. Since the Snaketown phase, and perhaps well before this time, potters working in this area supplied most of the decorated wares to sites in the central middle Gila River valley and the Salt River valley. The supply of pottery from Petrofacies N reduced the presence of wares from other source locales. In addition, potters working in this area may have directed their output to different consumer bases. The Gila Butte phase was the only time period wherein pottery from Petrofacies A/B/C/H dominated most site assemblages on both the Salt and Gila Rivers.

Production of Social Valuables

I contend that specialized decorated pottery production was concentrated on the Snaketown canal system because production in this location was best suited to the manufacture of social valuables. First, the social and political caché of the Snaketown community could have heightened the social signaling of decorated pottery manufactured in this area. The previous chapter argued for a close connection between demand for Hohokam red-on-buff pottery and the social functions of these vessels in the adoption of a pan-Hohokam ideological system (after Lack 2013). Archaeological data indicates that the Snaketown community was at the core of Hohokam social and ideological life. Early and persistently high population densities, concentrations of ritual items, shell ornament production, and the construction of among the first ballcourts and platform mounds in the Phoenix Basin provide convincing evidence that Snaketown was no ordinary Hohokam settlement (Haury 1976). If demand for red-on-buff pottery was linked to the use of these vessels as social valuables, specialists at Snaketown would have been well placed to signal the latest conceptualization of Hohokam ideology.

Second, the role of red-on-buff vessels as social valuables is reinforced by the attention to the aesthetics of these wares. While economies of specialization are present in ceramic manufacture, they are particularly key to encouraging specialization in items like decorated pottery for which aesthetics are important to demand for these items. Economies of specialization mean that specialists can produce pottery much more skillfully, efficiently, and at a lower opportunity cost than non-specialists (Borland and Yang 1994; Yang and Ng 1993; Yang and Ng 1998). When present, economies of specialization in supply encourage reliance (demand) on specialists as long as there are sufficient mechanisms to distribute wares to potential consumers.

Economies of specialization in the production of Hohokam red-on-buff wares are rooted in the skills and knowledge necessary to complete relatively complicated production tasks. In particular, recent research suggests that careful control over buffware clay chemistries contribute to the light color of the ceramic paste. This process involves the careful selection and mixing of raw materials as well as the accurate firing of the wares to a narrow temperature range. Over the course of approximately 100 years, potters experimented with buffware recipes to obtain light colored wares (Abbott 2007). The skill necessary to manufacture decorated pottery, therefore, would have contributed to economies of specialization in ceramic manufacture. Specialists could learn while doing and could produce greater numbers of vessels and higher quality wares than non-specialists. The clustering of specialists on the landscape also indicates that learning and specialist recruitment may have taken place along kinship lines (Costin 1991; 1998; Habicht-Mauche 1995; Hagstrum 1995; Lindeman 2006; Stark 1991). In these contexts, knowledge on ceramic manufacturing techniques could be easily transmitted and any fixed investments in ceramic manufacture would remain within pottery producing families or communities.

The artistry of decorated wares manufactured at Snaketown increased concurrently with the dramatic increase in supply from Snaketown potters in the Santa Cruz phase. Haury (1976:117) notes that “artistic achievements in stone sculpture and other arts reached their peak of excellence” during the Santa Cruz phase at Snaketown. In particular, he hails “the Santa Cruz Phase potter as the best in the line. Grace in form, and imagination and skill in composing the painted line, were never exceeded (Haury 1976:210).” Elaboration in painted designs on decorated wares at Snaketown in concert with increased output of these wares indicates that the use of these pots as social valuables was closely linked to increases in their supply and demand.

Finally, widespread demand for red-painted, shiny, and light-colored decorated pottery, which requires materials from localized sources, likely generated exogenous advantages to specialist production along the Snaketown canal system. Although settlements on both the Salt and the Gila River could and did manufacture their own decorated pottery, the buff-firing calcareous clays and mica schist required to produce light-colored shiny pots were all in close proximity to the Snaketown canal system (Abbott 2007; Beck 2006; Miksa 2001b; Ownby et al. 2004; Walsh-Anduze 1993). Hematite sources used to produce the red pigments for Hohokam red-on-buff pottery are clustered near Tertiary volcanic formations on both sides of the Gila River valley (Fernald 1973; Fontana et al. 1962; Rea 1996; Russell 1975; Spier 1970; Stoeppelmann 1995). Coarse-grained mica schist was mined from Gila Butte and other bedrock sources and incorporated within both plain and decorated wares manufactured along the Gila River (Cogswell et al. 2005; Kelly 2012; Miksa 2001b; Ownby et al. 2004; Rafferty 1982; Walsh-Anduze 1993). Finally, although alluvial clay sources used to manufacture plainware containers were widely distributed, calcareous clays used to manufacture light-colored Hohokam pottery were predominantly located along the Gila River (Abbott 1994a; Abbott 2001b; Beck 2006). Recent analyses by Margaret Beck (2012) and her colleagues suggests that sources of buff firing clay were located in only a few areas, including areas near the Snaketown canal system, and were not ubiquitously distributed across the Gila River valley.

The spatial concentration of specialized pottery manufacture on the Snaketown canal system in close proximity to various raw material sources used in red-on-buff manufacture supports the general argument that potters were often situated in locations that reduced the transport distance of bulky materials such as clay (Kelly et al. 2011). Ethnographic and archaeological data suggest that the uneven distribution of resources used in craft production was an important factor in the location of craft specialists in pre-modern economies (Arnold 1975; 1985; 1993; Hagstrum 2001; Harry 2005; Muller 1997; Toll 1991; 2001). Harry's (2005) analysis of specialized pottery production in the American Southwest suggests that the location of intensified craft production is strongly correlated with the distribution of raw materials necessary for pottery manufacture. The economic advantage of transporting finished craft items instead of raw materials is a common explanation for the relationship between the distribution of critical raw materials and specialized production. In the Phoenix Basin, widespread demand for decorated pottery with a particular appearance coupled with the uneven distribution of raw materials required for making these pots encouraged a specialist-based economy.

Transport: Central Location

An additional and interrelated exogenous comparative advantage to specialized pottery production at Snaketown was its central physical, and perhaps, social location in

Phoenix Basin Hohokam society. Snaketown is located in center of the middle of the Gila River. It is also situated on the most direct route between the Gila River and the Salt River. Although settlements to the west of the Gila River are closer to the Salt, South Mountain would have blocked direct movement. People could have walked directly through Canal System 1, through the modern-day city of Ahwatukee, to reach the site of Snaketown on the Snaketown canal system.

Perhaps due to its central location, Snaketown was among the largest settlements in the Phoenix Basin both in aerial extent and population size (Craig et al. 2010; Doelle 1995). Population aggregation in this area was noticeable by the Snaketown phase and the area continued to be occupied throughout the Hohokam preClassic period. Early and continuous occupation of this location indicates that opportunistic locale might have been a principal reason for the growth of the Snaketown community. Darling (2009) documented numerous historic and prehistoric trails that connected the Snaketown area to other places both within and outside of the Phoenix Basin. People residing in the large communities surrounding Gila Butte could travel easily to both the Salt and Gila river valleys.

Lower transportation costs are critical to economic growth because they increase the incentives for specialized production and demand for the products of specialists (Arnold 1995; Glaeser and Kohlhase 2003). Reduced exchange costs allow people to rely on others to provide them with goods. Although technological improvements to transportation technologies were not evident in the Hohokam case, centralized positioning of production centers would have dramatically reduced transport costs. The

Snaketown canal system may have cut distribution costs to consumers on both the Salt and Gila Rivers to the point where there was little to no comparative advantage to specialized decorated pottery manufacture elsewhere.

Transport: Ballcourts

The costs incurred by distributing decorated pottery from Snaketown to villages throughout the Phoenix Basin may have also been lowered through regularized meetings at events associated with the ballcourt network. Abbott and his colleagues (Abbott et al. 2007a; Abbott 2010) have argued that periodic marketplaces associated with communal gatherings at ballcourts could have served as a regular and efficient means to transport specialist-produced goods across the region. Interestingly, though, the supply of pottery from specialist producers was negatively correlated with the number of ballcourts per capita on canal systems (Chapter 4). In particular, the Snaketown canal system has relatively few ballcourts relative to the number of people on this canal system. This result may indicate that the absence of many small ballcourts may be less important to regional trade as the *presence* of particularly large ballcourts designed for large, inter-community gatherings. The site of Snaketown has one of five large, preClassic ballcourts in the Phoenix Basin (Marshall 2001).[11] This ballcourt could have accommodated more than a thousand spectators around its edges (Wilcox et al. 1981; Wilcox and Sternberg 1983). If the size of the ballcourt is a proxy for the scale of exchanges that took place at the

[11] Large ballcourts in the Phoenix Basin include: Las Cremaciones, Snaketown, Casa Blanca, and Sweetwater. Although a large ballcourt was also constructed at Casa Grande, this ballcourt appears to date to the late Sedentary/early Classic period.

settlement, the Snaketown ballcourt could signal the large-scale transfer of goods at this location.

The importance of ballcourts to the supply and distribution of pottery from the Snaketown canal system is supported by a large increase in the output of specialists after the construction of ballcourts in the Gila Butte phase. While the Snaketown canal system continuously supplied decorated pottery to Gila River settlements through the preClassic, the supply and demand for Snaketown decorated pottery on the Salt River rose dramatically in the Santa Cruz and early Sacaton phases (Figure 5.9). These data suggest that ballcourts may have significantly reduced the transport costs incurred in moving decorated pottery to the Salt River valley.

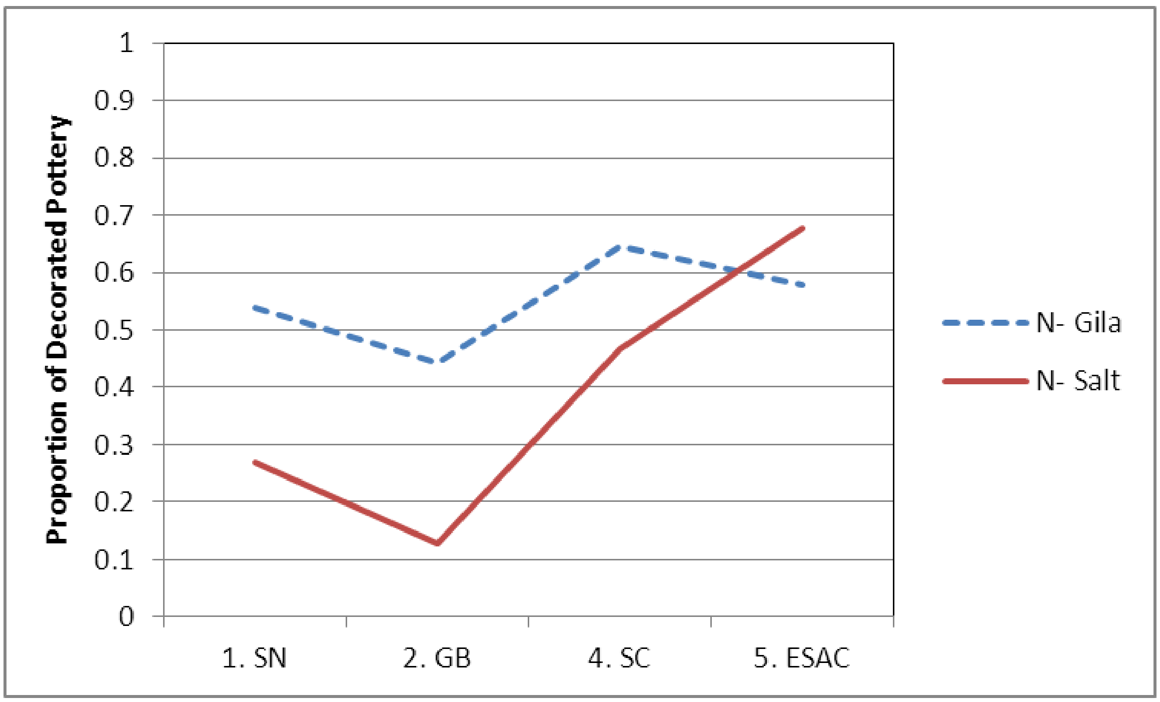

Figure 5.9: Proportion of Petrofacies N red-on-buff pottery in Gila River and Salt River site assemblages. Excludes "schist only" decorated pottery.

Summary

Exogenous comparative advantages to specialized production of decorated wares on the Snaketown canal system are likely linked with geographic proximity to materials necessary to manufacture social valuables, the social and political importance of the area, and a centralized position in the region that lowered transport costs in exchanges. Early and continued settlement in this region indicates that people chose to live in this location instead of being compelled to do so because of shortage of cultivable land. In addition, while workloads for the Snaketown canal system were relatively low in comparison to the large Salt River canal systems 1 and 2, canal workloads were high in comparison to many other Gila River canal systems. Therefore, irrigation requirements, at least on the Snaketown canal system, do not seem to have encouraged people to specialize in decorated pottery production. Dramatically lower transport costs in the Santa Cruz phase, perhaps due to the advent of large ballcourts in regional distribution, appear to have provided the impetus for the expansion of the Phoenix Basin economy.

CHAPTER 6: SPECIALIZED PRODUCTION OF DECORATED AND PLAINWARE VESSELS

Specialized decorated pottery production in the Snaketown canal system accounted for the highest output and widest distribution of any specialist production location in the Phoenix Basin. By the early Sacaton phase, almost all settlements in the Phoenix Basin relied on specialists in the Snaketown canal system to supply them with decorated pottery. Distribution of decorated pottery spanned both the Salt and Gila River systems. The previous chapters have argued that the production of social valuables and lowered transport costs allowed Snaketown area potters to capitalize on economies of specialization in the production of decorated pottery. In other words, specialists in this area could produce red-on-buff pottery with the aesthetic attributes that consumers wanted more efficiently than non-specialists. Greater incentives to specialized production in this region met with existing demand for the products of specialist producers to encourage the development of the Phoenix Basin economy.

Decorated ceramics, however, are complemented by a large proportion of plainware pottery in Hohokam household assemblages (See Figures 1.1 and 1.2). Delineating the conditions that encouraged specialized pottery production in the Phoenix Basin requires an understanding of both decorated and plainware pottery production. In this chapter, I argue that some of the factors that influenced the organization of decorated pottery manufacture in the Phoenix Basin differ slightly from those that influenced the organization of plainware production. While decorated pottery producers were spatially concentrated and distributed their wares widely, specialized plainware production took place in several locations in the Phoenix Basin and distribution from these locales was more limited. For instance, specialist-produced plainwares were less often circulated between the Salt and Gila River systems. PreClassic plainware producers also manufactured small amounts of decorated wares when specialized production on the Snaketown canal system waned during the Gila Butte period (see Figure 5.5).

Specialized Plainware Production in Salt River Valley: Abbott's Research

The products of Salt River plainware producers were only distributed to communities in the Salt River valley. To date, there is no indication that plainwares manufactured on the Salt River were distributed to communities on the middle Gila River valley. David Abbott (2009) has demonstrated that plainwares used by households on the Salt River were generally manufactured by specialists on the eastern half of South Mountain through most of the preClassic period. These specialists began large-scale output for exchange in the Vahki phase (AD 450-500) and continued supplying plainwares to settlements on both the north and south sides of the Salt River until the end of the early Sacaton phase (AD 1020). Potters on the eastern side of South Mountain also produced small amounts of decorated pottery during the preClassic period. In particular, production of this pottery increased in the Gila Butte phase when supply of decorated pots from the Snaketown canal system dropped. Decorated pottery manufacture at South Mountain never accounted for more than 30 percent of Salt River decorated assemblages.

In addition to suppliers at South Mountain, potters using phyllite temper from the Phoenix Mountains to the north of the Salt River supplied small amounts of plainwares to nearby settlements that were also on the north side of the river. These producers manufactured wares for local use at a low level until the middle Sacaton phase when they increased production to generate most of the plainware jars and bowls used by settlements to the north of the Salt River (Abbott 2009).

Direct evidence for plainware production on the Salt River valley corresponds to sourcing data on plainware pottery. On the south side of the Salt River, a kiln feature was excavated at the site of Las Canopas near the eastern side of South Mountain (Rice et al. 2009). The feature was not datable but appeared to be used during the preClassic when low to moderate levels of pottery sourced to South Mountain were distributed across Salt River settlements. In contrast, there is no direct evidence for ceramic production on the north side of the Salt River before AD 1020.[12] The absence of direct evidence for plainware production on the north side of the river corresponds to low levels of sherds sourced to this area prior to the middle Sacaton phase. Several clay settling basins possibly used for plainware pottery manufacture in the middle Sedentary period were exposed in the vicinity of Las Colinas; the basins dated to a period of time when ceramic manufacture to the north of the river was higher (Crown et al. 1988; Nials and Fish 1988; Van Keuren et al. 1997).

[12] In the middle Sacaton phase, plainware production on the north side of the Salt River increased. During this time, several settling basins at Las Colinas may have been used to levigate plainware clay for ceramic production (Nials and Fish 1988).

Specialized Plainware Production in the Gila River Valley

In contrast to the Salt River, plainware pottery specialists on the middle Gila River supplied plainwares to settlements across the Gila River valley as well as to settlements on the south side of the Salt River. Through the preClassic period, however, Salt River settlements received fewer and fewer plainwares from the Gila River. The number of plainwares imported from the Gila River to the south side of the Salt River declines from over 40 percent in the middle Pioneer (AD 600-650) to roughly 10 percent of plainware assemblages during the early Sacaton phase (AD 1000) (Abbott 2009).

Plainware production locales on the middle Gila River valley are not as well-known as Salt River plainware production locales. As a result, the scale of plainware production on the middle Gila River is more difficult to estimate. Most plainwares manufactured on the Gila River were tempered with mica schist exclusively, which cannot be easily sourced to specific areas like sand temper. The chemical variation in schist composition has not yet been mapped across the Phoenix Basin. Schist deposits in southern Arizona (known as the Pinal Schist) also have complicated chemistries that can often only be separated by trace elements, which are not detectable with standard characterization techniques (Cogswell et al. 2005; Miksa 2001b; Neff and Dudgeon 2006; Walsh-Anduze 1993).

Despite set-backs in sourcing plainware pottery on the middle Gila River, current evidence indicates that specialized plainware production on the middle Gila River valley was likely concentrated on the Santan, Gila Butte, Sweetwater, and Casa Blanca canal systems in Petrofacies A and H. Direct evidence for plainware production in this region was recovered in excavations of the Lower Santan site in Petrofacies A on the Santan canal system. Pottery production tools and a possible pit kiln with plainware waster sherds indicate that plainware manufacture occurred at the site (Kelly 2011). Just across the river from the Lower Santan site, evidence for plainware pottery manufacture at the Sweetwater site during the Classic period indicates that the area continued to manufacture plainware pottery for exchange (Woodson 2002)

Indirect evidence for specialized plainware production in Petrofacies A and H consists of large schist deposits with indications of prehistoric schist mining. Specialized plainware production on the Gila River was characterized by the prevalent use of mica schist temper that was mined from outcrops along the river valley. Plainwares, even in comparison with decorated wares, had much more schist than sand temper, and most plainwares were only manufactured using schist temper. Therefore, specialized plainware production that relied on large quantities of schist temper was likely located in close proximity to natural mica schist sources. The most extensive prehistoric schist mines have been identified on the sides of Gila Butte in Petrofacies A. The identification of more than 40 schist quarry pits on the butte indicates that thousands of tons of rock were removed for ceramic production (Rafferty 1982; Walsh-Anduze 1993). Evidence for prehistoric schist mining is also present at Rattlesnake Hill adjacent to Petrofacies H on the south side of the Gila River. Eight pits at the base of the hill may represent prehistoric schist quarries (Burton and Simon 2002; Eiselt and Woodson 2002; Walsh-Anduze 1993). Finally, settlements in Petrofacies A and H have higher proportions of plainware pottery than prehistoric villages elsewhere on the middle Gila River (see Figure 4.2).

Specifically, through many portions of the preClassic period, these settlements had more plainwares relative to decorated wares than settlements in the Snaketown canal system in Petrofacies N.

Production of "Schist Only" Decorated and Plain Wares on the Gila River

Despite direct and indirect evidence linking plainware production on the middle Gila River to Petrofacies A and H, no conclusive argument has yet connected plainware production to this area. In the following sections, I present additional data that indicates that almost all "schist-only" Hohokam decorated, and by extension plainware pottery, was manufactured in Petrofacies A or H. These data allow me to compare the organization of decorated and plainware production in the Phoenix Basin.

I focus on four lines of evidence that support the argument for concentrated specialist plainware production in Petrofacies A and H in the middle Gila River valley. First, I discuss the results of a schist sourcing analysis using Time of Flight-Laser Ablation-Inductively Coupled Plasma-Mass Spectroscopy (TOF-LA-ICP-MS) that linked the chemical signature of schist temper in pottery from Petrofacies A/B/C/H with the chemistry of raw schist samples collected from Gila Butte. Gila Butte is located on the edge of Petrofacies A and across the Gila River from Petrofacies H. Therefore, potters working in those sand composition zones would have had the most direct access to the Gila Butte schist source. Second, I provide evidence that decorated pots manufactured in Petrofacies A/B/C/H included more schist and less sand than pots produced in other production locales. As a result, it is likely that "schist-only" wares were manufactured at a production locale where potters used a large proportion of schist temper. Third, I discuss similarities in the proportion of pottery manufactured in Petrofacies A/B/C/H and the proportion of "schist-only" sherds in Phoenix Basin assemblages through the preClassic period. I argue that similar changes to the proportions of pottery manufactured in Petrofacies A/B/C/H and "schist-only" pots may indicate that they were manufactured in the same place. Finally, I discuss the close similarities between the technological characteristics of decorated pottery manufactured in Petrofacies A/B/C/H and "schist-only" wares, and the dissimilarities between "schist-only" wares and pottery from other petrofacies.

I. TOF-LA-ICP-MS Analyses of Schist

The first piece of evidence that most "schist-only" decorated pottery and, by extension, most schist-tempered plainware pottery were manufactured in the vicinity of Gila Butte in Petrofacies A and H is a close chemical match between schist temper in this area and raw schist from those outcrops. New advances in chemical characterization techniques have detected consistent variability among different schist outcrops, variation that can be used to source "schist-only" pottery. Due to extensive mixing over multiple tectonic episodes, the composition of Pinal Schist outcrops varies substantially across the region (Miksa 2001a). Thus, the composition of schist outcrops may be unique to defined geographic areas throughout southern Arizona.

Recent chemical analyses of raw schist samples and schist temper in Hohokam pottery sherds suggest that chemical sourcing with Inductively Coupled Plasma-Mass Spectroscopy (ICP-MS) may be able to detect the variation in schist composition. Unlike other elemental characterization methods, such as the electron microprobe, ICP-MS can measure a large range of elements in concentrations as low as parts per trillion. Walsh-Anduze's (1993) analysis of 49 raw schist samples and Miksa's (2001a; 2001b) analysis of 59 raw samples using ICP-MS identified consistent differences in the chemical composition of schist outcrops at Gila Butte, Pima Butte, and Sacaton Butte along the middle Gila River valley. However, the bulk ICP-MS analyses in these cases produced data that represented a combination of minerals within the raw schist. In addition, ICP-MS cannot analyze raw schist temper in a ceramic because it cannot target the schist temper and the ceramic paste separately. As a result, chemical data on raw schist samples and schist temper cannot be compared at present.

Laser ablation represents a substantial improvement on ICP-MS analysis; it allows analysts to target a specific spot on a material (LA-ICP-MS). For instance, an analyst can target a mica grain on a piece of schist, either in a raw sample or a piece of temper. Time of flight spectroscopy represents the latest advancement in ICP-MS analysis. It simultaneously measures and standardizes the entire elemental mass spectrum of a targeted spot on a sample. TOF-ICP-MS can measure the chemical differences between different schist samples with great sensitivity.

In 2005 and 2006, researchers at the IIRMES laboratory in partnership with archaeologists from the Cultural Resource Management Program for the Gila River Indian Community analyzed 56 raw schist samples using TOF-LA-ICP-MS. Chemical readings were taken on single pieces of muscovite mica within the schist. This analysis was able to detect consistent chemical differences among muscovite in schist outcrops at Pima Butte, Gila Butte, Rattlesnake Hill, and Enid (Cogswell et al. 2005; Darling et al. 2007; Neff and Dudgeon 2006) (Figure 6.1). Cesium and rubidium most effectively discriminated the source groups in a two dimensional bi-plot (Figure 6.2). These data were subsequently compared to a TOF-LA-ICP-MS analysis of schist temper in 71 Hohokam sherds. The project was able to match the composition of schist temper in these sherds to particular outcrops.

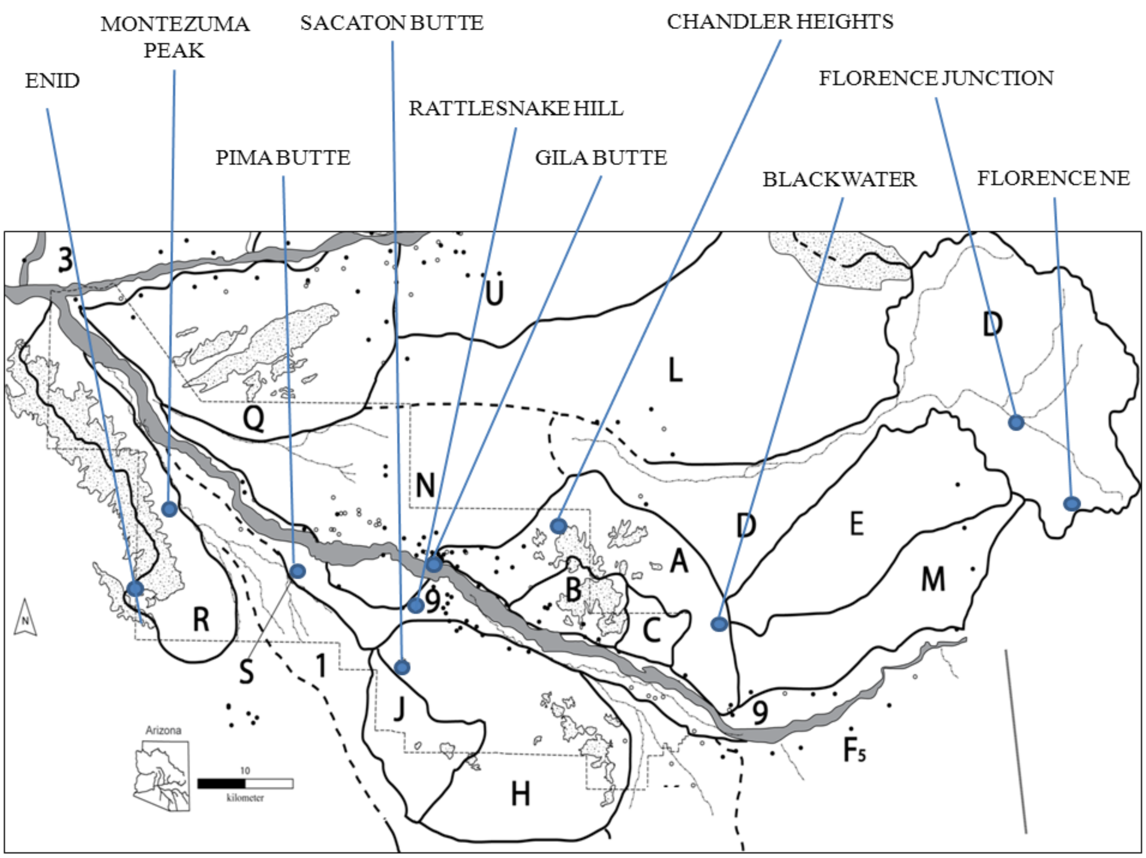

Figure 6.1: Locations of raw schist samples collected and analyzed by the Cultural Resource Management Program of the Gila River Indian Community.

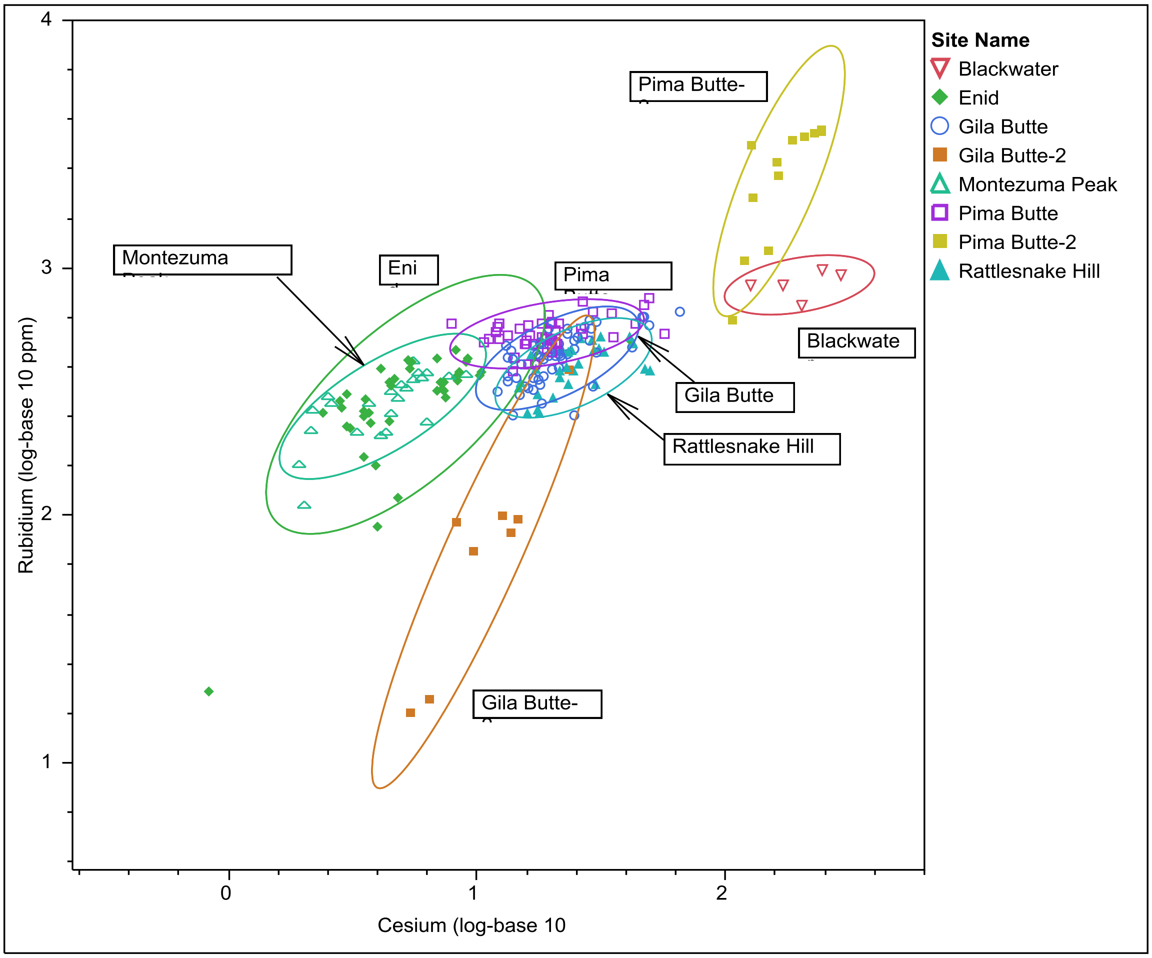

Figure 6.2: Bivariate plot of cesium and rubidium log concentrations in schist rock samples (Neff and Dudgeon 2006: Figure 6). Ninety percent confidence intervals are marked for each reference group. Note: samples from Chandler Heights, Florence Junction, Florence. Gila Butte-2 and Pima Butte-2 represent chemical sub-groups of Gila Butte and Pima Butte and were treated as separate from these groups in the statistical analyses.

In a recent study, I used TOF-LA-ICP-MS to collect chemical data on schist temper in a sample of Hohokam red-on-buff sherds of known provenance (Kelly 2012) (Appendix D, Tables 6a and 6b). The analysis focused on muscovite mica flakes in the schist temper. Five readings were taken on different pieces of schist temper in each sherd sample. Using a discriminant analysis with the same four source groups in Neff and Dudgeon's analysis, I generated probabilities for source group membership for each of the sherds. The discriminant analysis of schist temper indicates that most readings fell within the range of one of the four sampled raw schist sources. Sherds were selected with at least two schist temper readings with a greater than a five percent probability match with a particular source group and less than a one percent probability match with any other source group. Of sherds that fit these criteria, only samples with 65 percent or more of their readings assigned to a particular source group were considered to have a high probability of belonging to the that schist source group. Twenty-seven sherds were matched to a specific schist source.

The limited results from the schist chemical analysis indicate that potters working in Petrofacies A/B/C/H used schist temper from Gila Butte to manufacture their wares. Of the 27 sherds that were matched with a specific schist source, a slight majority of samples with sand matching Petrofacies A/B/C/H contained schist temper with a chemical composition matching Gila Butte (5 of 8 sherds). Although this sample size is small, it provides an important contrast to the schist chemical data retrieved from schist temper in sherds from Petrofacies N. Specifically, most sherds from Petrofacies N contained schist temper with a chemical composition matching Pima Butte (9 of 11 sherds). Therefore, the locus of decorated pottery manufacture in Petrofacies A/B/C/H was likely in the vicinity of Gila Butte or nearby schist sources in the eastern middle Gila River valley. In contrast, decorated pottery production in Petrofacies N may have been concentrated in the western portion of the middle Gila River valley at the end of the Snaketown canal system.

II. Amount of Schist Temper Used in Decorated Pottery Production

In addition to close proximity to large, quarried schist deposits that match the chemistry of schist temper used in decorated ceramics, potters in Petrofacies A/B/C/H used a large quantity of schist temper relative to sand temper in decorated ceramic production throughout the preClassic period (Figure 6.3). These data suggest that those potters in Petrofacies A/B/C/H were likely to have produced decorated and plainwares that are tempered only with schist (schist-only). In comparison, potters in Petrofacies N used increasingly less schist in decorated ceramic manufacture through time. This drop-off may indicate that the locus for ceramic manufacture within the Snaketown canal system shifted further west and away from the large schist sources on Gila Butte. This proposition is supported by the match between schist from Pima Butte in the western middle Gila River and schist temper from Petrofacies N pottery.

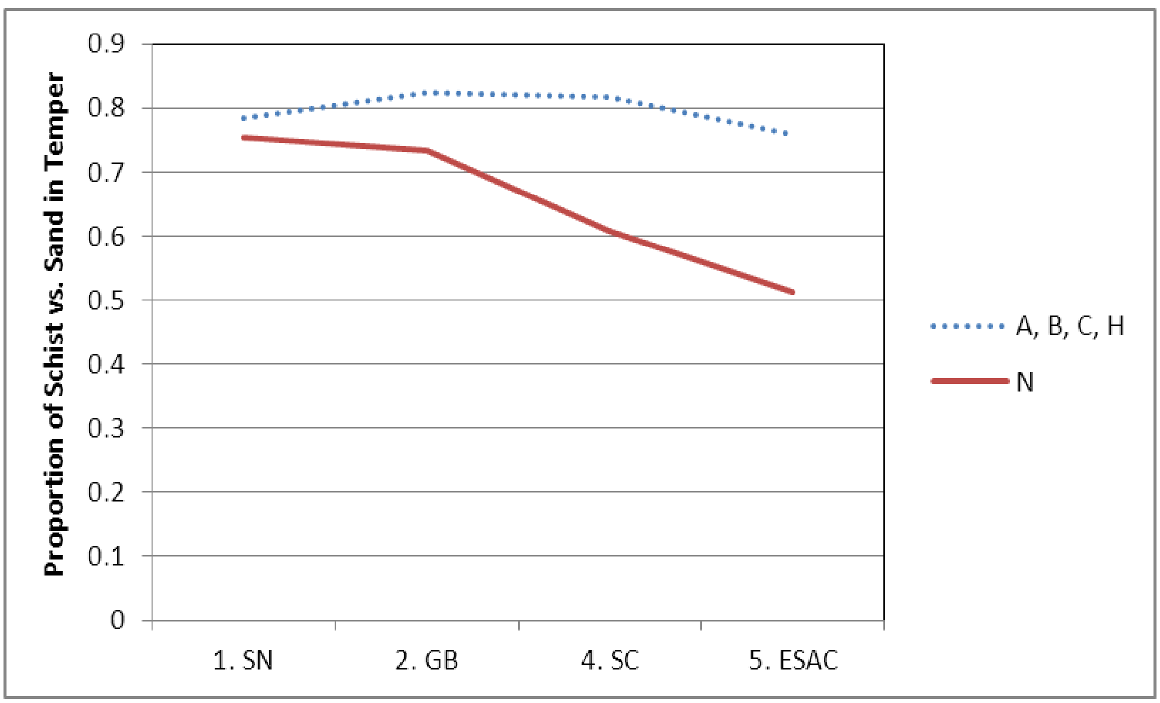

Figure 6.3: Proportion of schist versus sand temper in pottery manufactured in Petrofacies A/B/C/H and N.

III. Production Output

The third piece of evidence linking the production locale of “schist-only” decorated sherds (and likely plainware pottery) to Petrofacies A/B/C/H are close similarities in the production output of these temper groups through time. In particular, the proportion of pottery manufactured in Petrofacies A/B/C/H and the proportion of pottery manufactured using only schist temper in red-on-buff pottery assemblages changed concurrently throughout the preClassic period (Figure 6.4). The proportion of both ware categories is highest in the Gila Butte phase, but then declines for the Santa Cruz and early Sacaton phases. In contrast, the proportion of pottery from Petrofacies N follows the opposite trajectory. It falls to its lowest proportion during the Gila Butte phase and then increases markedly through the preClassic period. The similarity in the proportions of pottery manufactured in Petrofacies A/B/C/H and “schist-only” pottery exported to the Salt River indicates that the production and distribution of these wares were affected by similar conditions and may have been manufactured in the same locale.

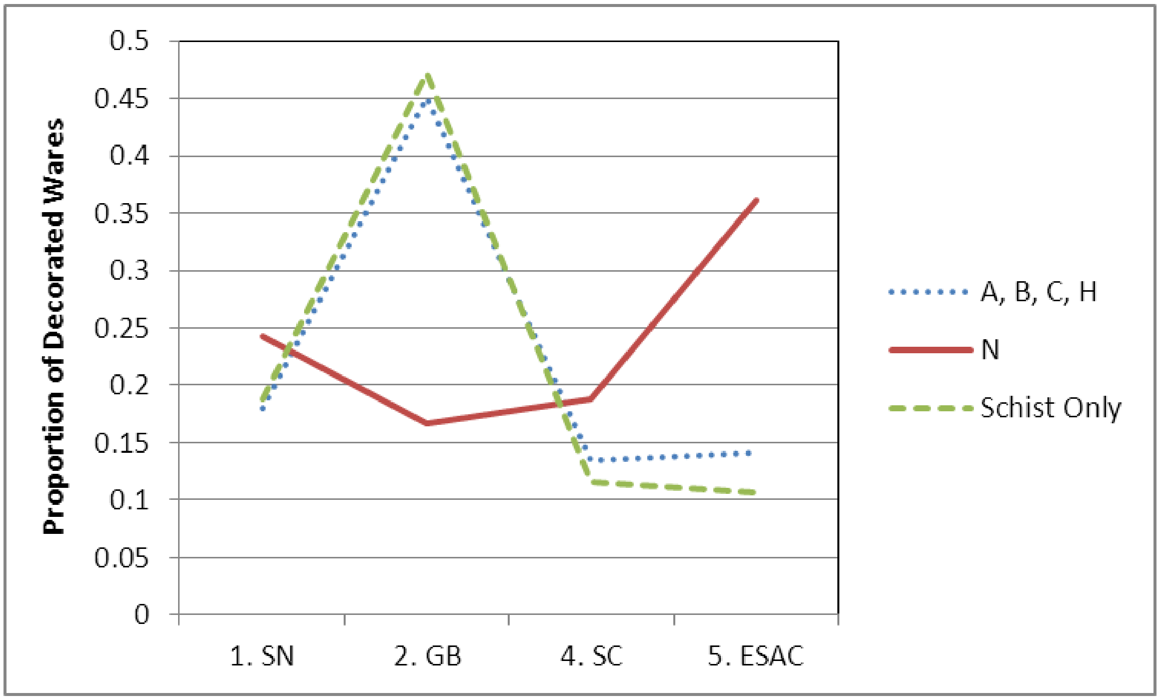

Figure 6.4: Proportion of "schist-only," Petrofacies A/B/C/H, and Petrofacies N decorated sherds. Values represent proportions calculated from all analyzed sherds.

"Schist-only" plainware production on the middle Gila River also corresponds closely to trends in sand-tempered pottery from Petrofacies A/B/C/H (Figure 6.5). Settlements on the Salt River received declining amounts of Gila River plainware as well as decorated wares from Petrofacies A/B/C/H. These data suggest that potters in Petrofacies A/B/C/H may have exported fewer pots —both sand and schist-tempered decorated wares as well as plainwares—to the Salt River through the preClassic period.

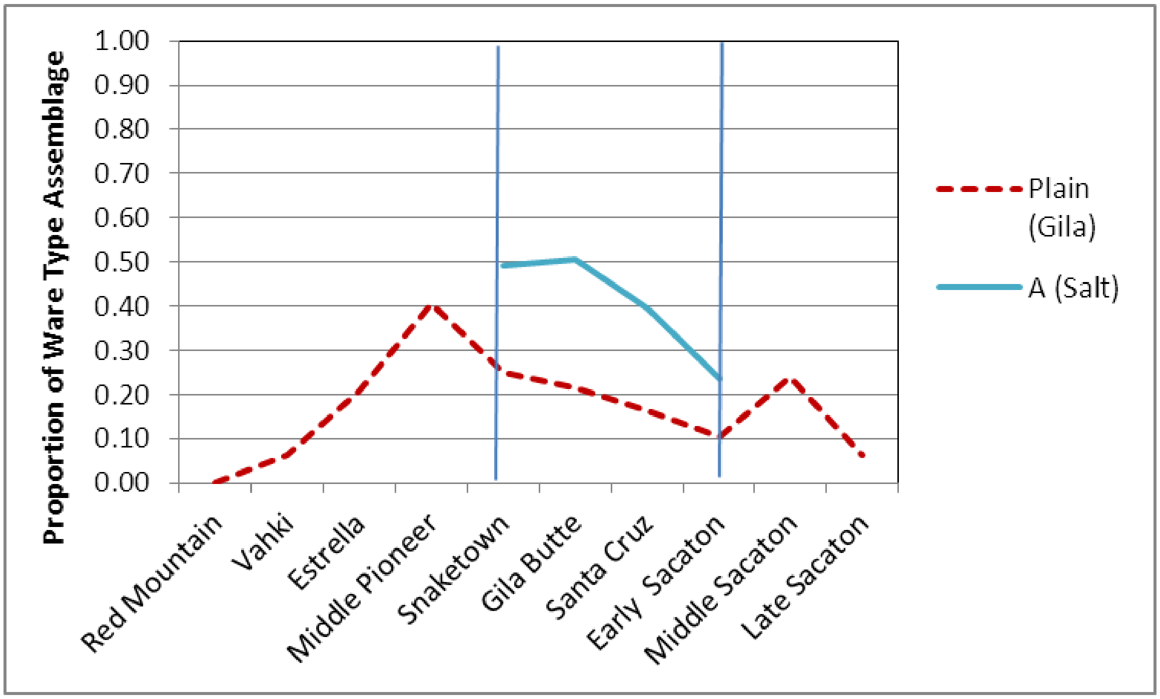

Figure 6.5: Proportion of "schist-only" plainwares and decorated wares from Petrofacies A as a proportion of plain and decorated Salt River assemblages, respectively. Plainware data is from Abbott 2009.

V. Technological Similarities

The appearance and size of decorated pottery from Petrofacies A/B/C/H and "schist-only" decorated pottery provide convincing evidence that these wares were manufactured using similar methods, and therefore may have been manufactured in the same location. The mica density and exterior color of "schist-only" vessels are remarkably similar to vessels manufactured in Petrofacies A/B/C/H throughout the preClassic period (Figures 6.6, 6.7). The close correspondence in the façade of these wares indicates that the potters who manufactured "schist-only" pottery resided in Petrofacies A/B/C/H.

Mica density was included as a technological variable for comparison between "schist-only" wares and vessels from other petrofacies because mica visibility on the surface of a vessel is not directly related to the proportion of schist temper that is used in vessel manufacture. The surface visibility of mica is a factor of the way that the potter polishes the pot. Rubbing aligns platy mica grains so that they are more clearly visible on the surface. In addition, surface treatments such as washes can highlight or obscure mica visibility. Finally, the paste recipe and firing process that the potter uses influences mica visibility on the surface by either preventing or encouraging the development of mineral build-up on the pot's surface. Therefore, mica density is a technological variable that can indicate similarities in production techniques, regardless of the temper (e.g., "schist-only" or a mixture of sand and schist) used to make the vessel.

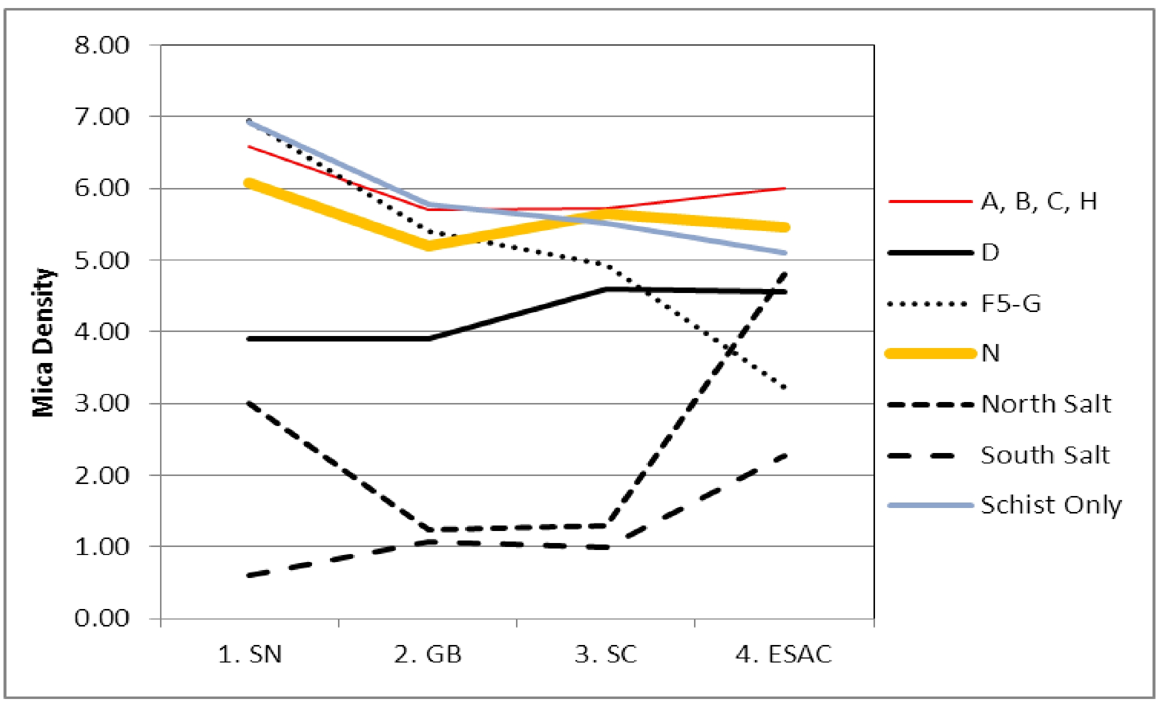

Figure 6.6: Average mica density of wares from each petrofacies that highlights the similarity among pottery from Petrofacies A/B/C/H, N, and "schist-only" sherds.

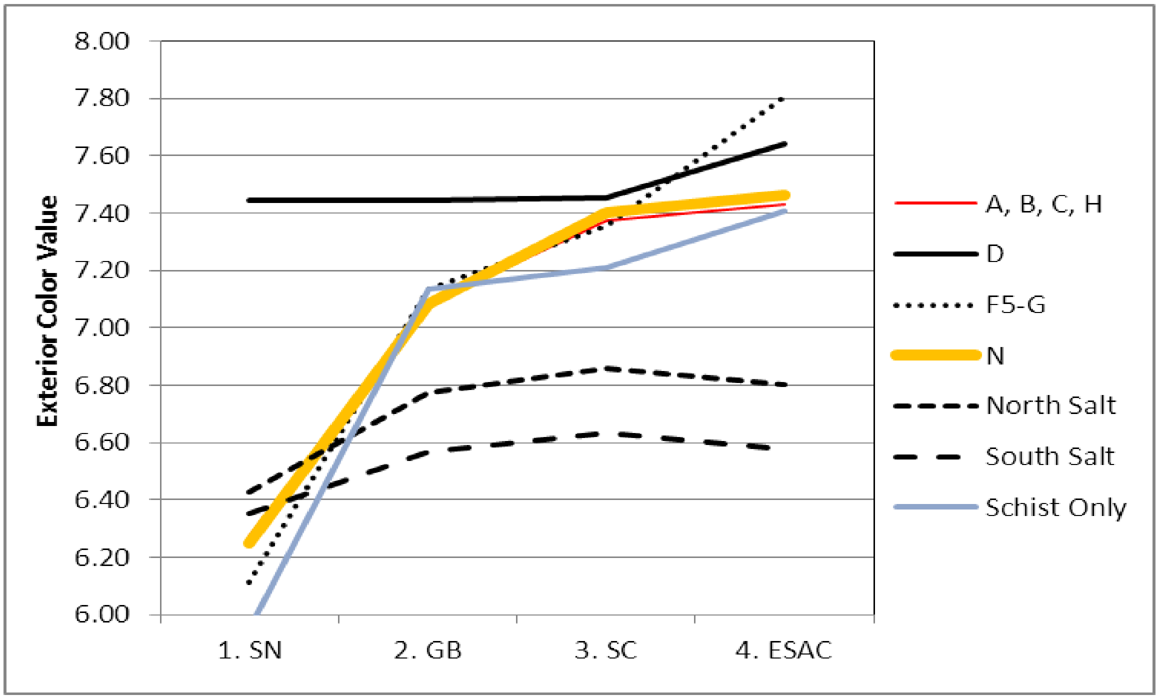

Figure 6.7: Average exterior color value of wares from each petrofacies that highlights the similarity among pottery from Petrofacies A/B/C/H, N, and "schist-only" sherds.

The vessel forms of decorated pottery manufactured in Petrofacies A/B/C/H and schist only wares also show remarkably similar trends through the preClassic period. Decorated pottery production locales on the Gila River that manufactured wares in small quantities, such as Petrofacies A, F-G, and those that produced “schist-only” wares generally made more bowls than jars (Figure 6.8). In particular, the bowl-jar ratio of Petrofacies A and “schist-only” wares are remarkably similar through the preClassic, with the exception of the early Sacaton. Similarly, the bowl apertures of vessels from Petrofacies A/B/C/H and of “schist-only” wares are comparable to each other throughout the preClassic period (Figure 6.9). These data again suggest that most “schist-only” decorated wares were manufactured in either Petrofacies A or H in the vicinity of Gila Butte.

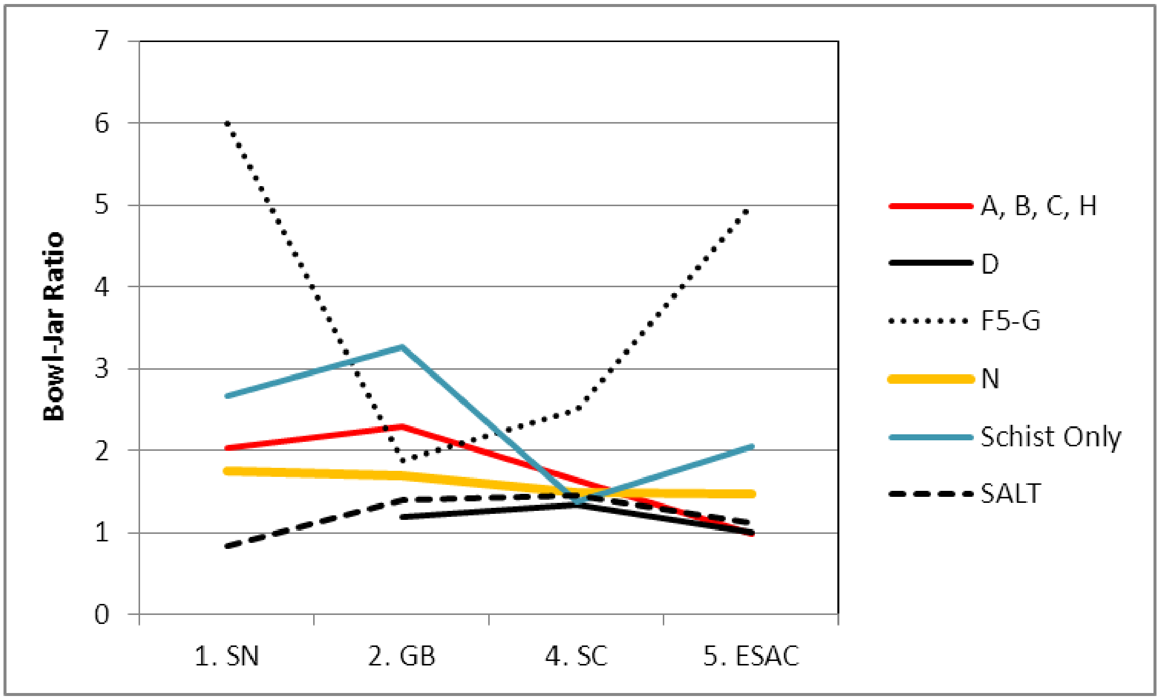

Figure 6.8: Average bowl-jar ratio of wares from each petrofacies that highlights the dissimilarity in production output from Petrofacies A/B/C/H, N, and "schist-only" sherds.

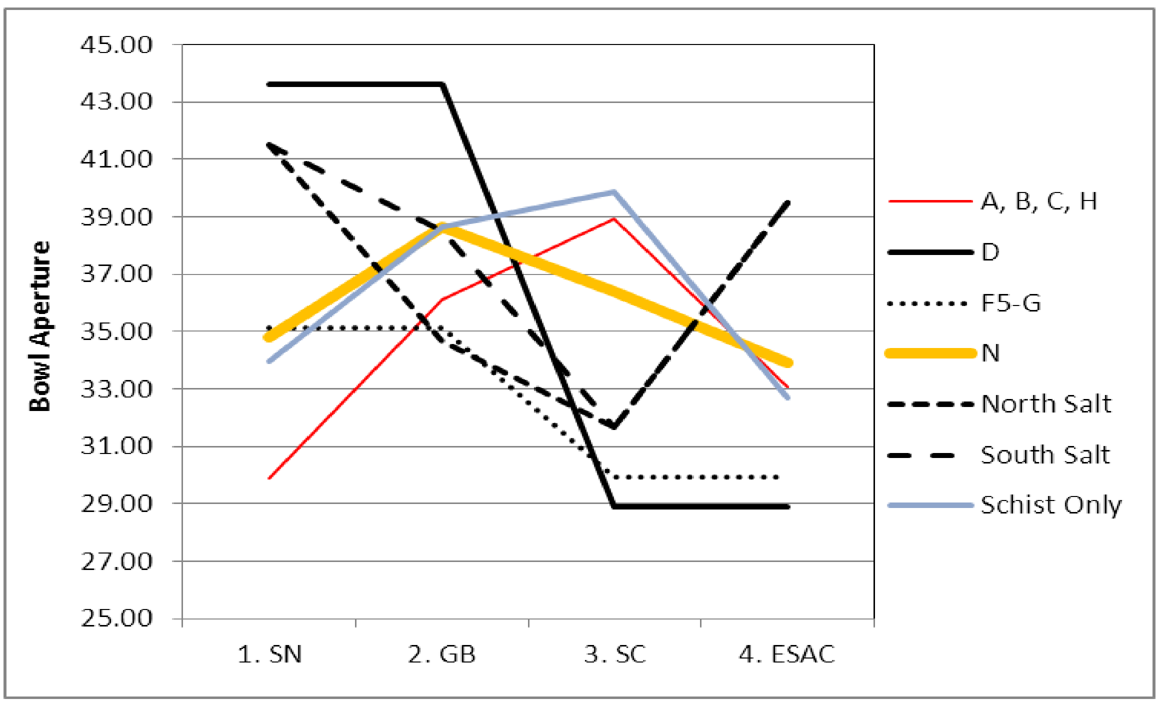

Figure 6.9: Average aperture of bowls from each petrofacies that highlights the similarity among pottery from Petrofacies A/B/C/H, N, and "schist-only" sherds.

Plainware Moves East, Decorated Wares Move West

Changes in the proportion of Petrofacies A/B/C/H and "schist-only" decorated pottery through time may signal shifts in the locus and organization of decorated pottery production. In particular, specialized decorated pottery production was increasingly concentrated in the central and western portions of the Snaketown canal system in Petrofacies N. Production locales that exported the most pottery to Salt River settlements during the latter portion of the preClassic period may have been located further away from mica schist sources. For instance, increasing numbers of decorated pots manufactured in Petrofacies N were exported to the Salt River, yet the amount of schist in Petrofacies N pottery dropped (see Figure 6.4). If production for export to the Salt River within Petrofacies N shifted to the western side of the Snaketown canal system, these potters would not have been located as close to schist sources at Gila Butte and may have used less schist temper. In addition, the proportion of "schist-only" decorated pottery in Salt River site assemblages dropped through the preClassic, while the proportion of "schist-only" decorated wares in Gila River assemblages remained the same (Figure 6.10).

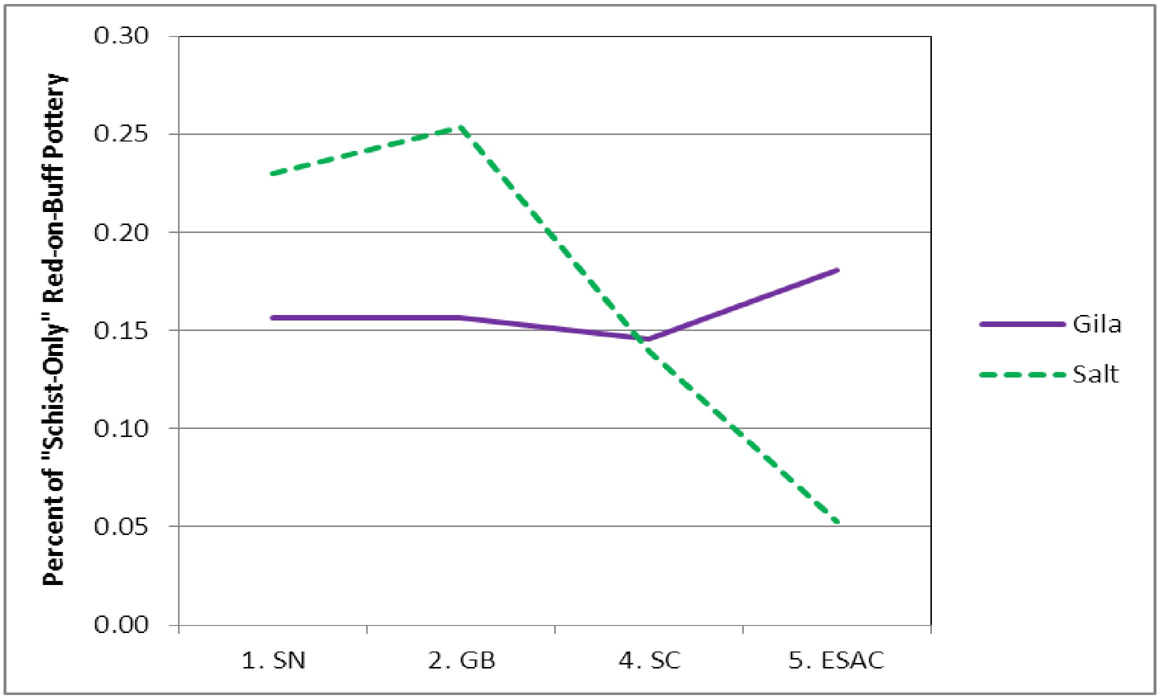

Figure 6.10: Proportion of "schist only" pottery in Gila River and Salt River decorated pottery assemblages.

Although Snaketown potters reduced the amount of schist that they used to manufacture their wares, they still catered production to consumers who wanted mica shine on the surface of their vessels. The mica density on the surface of vessels imported to the Salt River from the Gila River does not change measurably through the preClassic (see Figure 6.8). Snaketown potters may have accomplished high shine with less schist by not crushing the schist as much in order to produce larger mica flakes and a higher mica glimmer on the surface (Abbott 2001a:88).

Using less schist temper in decorated pottery production may have been a result of longer travel distances to Gila Butte or Pima Butte from the western Snaketown canal system or some type of restrictions in access to schist sources. Rafferty (1982) suggests that the Gila Butte site may have regulated access to schist quarries on Gila Butte. More recently, Eiselt and Darling (2010) have proposed that resources such as mica schist may have been controlled and distributed by particular communities on the Gila River.

Schist-Tempered Decorated Wares and Plainwares

"Schist-only" decorated wares and schist-tempered plainwares were likely manufactured in Petrofacies A or H in the middle Gila River valley. Multiple lines of evidence converge to support the inference that "schist-only" wares were made in this area. Foremost, there is direct archaeological evidence for the production of plainware vessels in these petrofacies, as well as for prehistoric mining at large, raw schist outcrops. Technological studies of pottery from Petrofacies A and H have identified distinctive similarities between decorated pottery and "schist-only" decorated pottery. Finally, ceramic sourcing data suggest similar trends in the production outputs of Petrofacies A/H decorated pottery, "schist-only" decorated pottery, and schist-tempered decorated and plainwares.

The results of the multiple regression analyses presented in Chapter 4 would not differ dramatically if "schist-only" decorated wares were manufactured in Petrofacies A/B/C/H. Data related to Petrofacies N and Petrofacies A/B/C/H principally affected the multiple regression models of the supply and demand of decorated pottery. The relationships between Petrofacies N and Petrofacies A/B/C/H do not change, however, if schist only wares are added to sherd counts for Petrofacies A/B/C/H. For instance, Petrofacies N accounts for the greatest supply of non-local pottery during the Snaketown, Santa Cruz, and early Sacaton phases. The combined Petrofacies A/B/C/H and schist only wares are only dominant during the Gila Butte phase, which is the same as when schist only wares were not included in these counts. Therefore, if the "schist-only" decorated sherds were included with Petrofacies A/B/C/H in the statistical analyses, we would likely see an intensification of the trends reported in Chapters 4.

What Encouraged Specialist Plainware Production?

Reconstructing the probable production locales for plainware pottery on the middle Gila River allows us to consider the factors that encouraged the supply and demand for specialized plainware manufacture. Prior to the middle Sedentary period, most plainwares used by Salt River households were produced on the eastern side of South Mountain in the vicinity of Canal System 7 (Abbott 2009). The vast majority of plainwares used by households on the Gila River were likely manufactured in the vicinity of Gila Butte on the Santan, Gila Butte, Sweetwater, and Casa Blanca canal systems in Petrofacies A and H. The conditions that encouraged the supply and demand for specialist-produced plainware production appear to differ from those that encouraged decorated pottery production. Specifically, the amount of time investment that people devoted to subsistence agriculture appears to distinguish the producers and consumers of plainware pottery.

Demand for plainware pottery may have been rooted in economic conditions that increased the comparative advantages of subsistence intensification in lieu of craft production. Settlements that imported the most plainware pottery were located on canal systems with high irrigation workloads. These canal systems had a long main canal, and presumably more lateral canals and fields within the irrigation network than canal systems with a short main canal. For instance, households on Canal System 2 in the Salt River valley imported almost all their plainware pottery prior to the middle Sedentary period. Few people lived on Canal System 2 relative to the massive size of the irrigation network. Therefore, settlements likely devoted considerable time and energy to cleaning and maintaining the irrigation networks and to preparing, planting, and harvesting fields.

In contrast to the consumers of specialist-produced plainware pottery, Phoenix Basin plainware production locales were situated in areas where additional investments in subsistence agriculture could not generate proportionally higher agricultural yields. These areas were characterized by topography that limited the expansion of irrigation networks, yet were occupied by sizeable populations. People living on these canal systems probably devoted less time to canal maintenance, field preparation, and sowing and harvesting than people who lived on expansive irrigation networks. Time freed from agricultural responsibilities would have increased the comparative advantages to intensive craft production such as ceramic manufacture. For instance, plainware production on the eastern end of South Mountain was likely concentrated on Canal System 7. Hundreds of people resided in the large settlements of Las Canopas, Las Cremaciones, and Pueblo Viejo on Canal System 7 throughout the preClassic period (Czarzasty and Rice 2009; Hackbarth 1997), yet the canal system itself was one of the smallest in the Salt River valley. South Mountain prevented expansion of the main and lateral canals to the south unlike Canal System 1 to the east. Similarly, the canal systems in Petrofacies A and H on the Gila River were characterized by a series of large settlements on relatively small irrigation networks. Canal workloads on the Gila Butte, Granite Knob-Santan, and Sweetwater canal systems were lower than anywhere else in the Phoenix Basin. The Santan and Sacaton Mountains and steeper topography on the river sides prevented expansion of these canal systems far from the Gila River (Woodson 2010:304).

Interestingly, Hohokam settlements were founded relatively early in prehistory in areas where the geographic extent of canal systems was limited; these villages continued to grow through the preClassic period. It appears that people in these areas consciously decided to pursue a more diverse economic strategy that involved both specialized craft production and irrigation agriculture. The early foundation and subsequent growth of these areas indicates that this strategy was not linked with resource pressures or land scarcity.

Limitations: Plainwares versus Decorated Wares

While the comparative economic advantages to time investment in ceramic production encouraged the supply and demand for specialist-produced plainware pottery, several factors may have limited the growth of the plainware economy in comparison to the production of red-on-buff pottery. First, specialized plainware production was not encouraged by demand for vessels with particular aesthetic qualities or raw materials. The resources necessary for plainware production such as alluvial clay were ubiquitously available across the Phoenix Basin. Plainware jars and bowls were used for utilitarian domestic functions, in which performance characteristics outweighed physical appearance. For instance, settlements on the Salt River were not located near sources for mica schist temper and could not manufacture plainware vessels with high mica sheen locally. If Salt River consumers desired sparkly plainwares, they would have imported them from producers along the Gila River. Yet, households on both the north and the south side of the Salt River principally relied on plainware vessels with South Mountain granodiorite temper and little to no mica sheen on the surface. Gila River plainwares were imported to sites to the south of the Salt River, but their numbers declined from the Snaketown to the early Sacaton phase (Abbott 2009). The advantages conferred by a sparkly surface did not outweigh the additional costs incurred by transporting large quantities of plainwares between river systems.

Transportation costs incurred in moving plainware pottery may have presented a significant limit on the supply and demand for specialist-produced plainwares. While decorated wares were produced in one area and then circulated across the Phoenix Basin, plainware production areas were present on both the Salt and the Gila Rivers. The size difference between plainwares and decorated wares was likely the principal reason why plainwares could not be distributed as easily as red-on-buff pottery. Plainware jars and bowls were on average larger than decorated jars and bowls (Abbott 2009:545). These sizeable and bulky items would have been more difficult than red-on-buff pottery to move in quantity. The weight of plainware vessels relative to decorated vessels would have also been a hindrance to their transport. On average, the vessel walls of plainware vessels were thicker and more substantial than decorated vessels. The thickness of these wares corresponds to their larger size, as well as to their function as utilitarian vessels that require durability. Finally, plainwares were predominantly jars, which unlike bowls, could not be nested for efficient transport. The utilitarian use of plainwares did not permit specialists to reduce their size and forms for easier distribution as decorated pottery specialists appeared to have done (see results in Chapter 4).

Regional Distribution of Plainwares and Decorated Wares

Although plainware pottery production was less concentrated than specialized red-on-buff production, both plainware and decorated pottery specialists in the Phoenix Basin were spatially concentrated, generated a high output, and distributed their wares widely. Continuous demand existed for the products of specialized decorated and plainware producers from an early time in Hohokam culture history. Increasing incentives to specialized production, however, contributed to grow in the Hohokam economy. By the early Sacaton phase, two plainware manufacturing areas and one decorated pottery production area generated almost all the pottery used by households across the Phoenix Basin.

Low transport costs, which facilitated movement of pottery across the region, encouraged specialized production of both plain and decorated ceramic wares. Specialized producers could limit transport costs by situating production areas in geographically central areas. Plainware producers on the east side of South Mountain were directly across from Canal System 2 and directly adjacent to Canal System 1. Producers and consumers could easily exchange goods from this central location. Petrofacies A and H, while not as centrally located as Petrofacies N, were approximately in the center of the Gila River system. Plainware producers, therefore, could transport their wares widely from this position.

In addition to operating in centralized locations, specialized plainware and red-on-buff ware producers may have also lowered transport costs by distributing their wares through periodic gatherings at large ballcourt sites. Each of the five large preClassic ballcourts was situated in an area of intensive plainware or red-on-buff production. On the Salt River, large ballcourts were located at the sites of Las Cremaciones and Villa Buena at the base of South Mountain. On the Gila River, large ballcourts were situated at the site of Snaketown in Petrofacies N and Casa Blanca and Sweetwater in Petrofacies H. The position of these ballcourts at specialist pottery production locales indicates that these extramural features were likely instrumental in the distribution of pottery across the Phoenix Basin. The function of the five large ballcourts may have differed from that of the abundant small ballcourts in the Phoenix Basin. The latter may have served for localized social and economic gatherings within particular canal system communities.

Dramatic decreases to transportation costs may have been the underlying cause of rapid economic expansion during the middle Sedentary period. During this time, Abbott (2009) documents an increase in the number of plainwares that are transported to the Salt River and a continued increase in the number of decorated wares from Petrofacies N. Transport costs were reduced to the point where South Mountain consumers began to rely on Gila River specialists for plainware pottery in lieu of using pottery manufactured nearby at South Mountain. South Mountain potters reduced their plainware production to large ollas that could not be transported efficiently under any circumstance.

Summary

The supply of specialized plainware production at eastern South Mountain in the Salt River valley and Petrofacies A and H on the Gila River valley was encouraged by economic conditions that increased the comparative advantages to intensive subsistence or craft manufacture. While the specific locale for decorated pottery manufacture was associated with a socially or politically important area (Snaketown), the locus for plainware production appears to be directly related to economic conditions that supported diversification in productive activities. People in areas where additional subsistence investments would not lead to significant increases in agricultural productivity decided to engage in surplus craft production for exchange. This strategy appears to have developed early on in the Phoenix Basin and intensified in the 9th and 10th century when incentives to specialized production increased. Specifically, transportation costs appear to have dropped dramatically. The drop in cost facilitated the movement of plainware and decorated pottery across the region.

CHAPTER 7: REGIONAL COORDINATION OF A SPECIALIST-BASED HOHOKAM ECONOMY

At a regional scale, the Salt and Gila River systems are characterized by different demographic histories and subsistence infrastructure that contributed to distinctive and complementary local economies. The comparative advantages to specialization in different productive activities in each river valley encouraged economic development in the Phoenix Basin (Yang and Ng 1993; 1998; Yang 2001; 2003). For instance, the comparative advantages to ceramic specialization on the Gila River appeared to outweigh the benefits of ceramic production on the Salt River. Plainware and decorated pottery sourcing data indicate that there was a large-scale, one-way movement of pottery from the Gila River to the Salt River valley. Of the 1,622 decorated sherds recovered from Gila River sites sourced in this analysis, only 3 sherds (0.2 percent) were sourced to the Salt River. In contrast, Salt River decorated and plainware assemblages were almost entirely composed of pottery manufactured on the Gila River. The large and uni-directional transport of pottery from the Gila River to the Salt River suggests that pottery was a traded commodity that was exchanged for items from the Salt River. Here, I explore how macro-scale economic differences in the Phoenix Basin may have provided the foundation for a specialist-based economy in this region.

Irrigation and Demographics: Critical Differences between the Salt and Gila River Valleys?

The topography of the Gila and Salt River valleys contributed to differences in the extent of irrigation networks in the two areas and to the density of populated sites. The wide and level Salt River valley enabled canal systems to extend freely from the river (Graybill 1989; Graybill and Nials 1989; Nials and Gregory 1989; Nials et al. 1989). This fortuitous landscape contributed to the earliest and most extensive irrigation infrastructure in the Phoenix Basin and a number of villages were established along these irrigation networks. Archaeological data and Pima oral histories indicate that Red Mountain phase irrigation settlements on the Salt River were among the first in the region (Bahr et al. 1994; Woodson 2010:239-240). In contrast, the Gila River is more entrenched and canals are forced to run parallel to the river instead of away from it (Graybill et al. 2006). As a result, almost all Gila River settlements are concentrated within 1 or 2 kilometers from the river.

In concert with differences in canal infrastructure and settlement distribution, the Salt and Gila River valleys may have been characterized by different levels of time commitment to subsistence agriculture. A chart of the average number of people per kilometer of main canal for Salt River and Gila River canal systems indicates that Salt River canal systems have significantly higher irrigation workloads than Salt River canal systems throughout the preClassic period ($t = 3.564$, $p = 0.012$, d.f. = 6) (Figure 7.1). Most Salt River communities would have had to invest significant time in subsistence activities through large portions of the year. In contrast, large settlements in the Gila

River valley are located on relatively small canal systems that do not extend far from the river. These communities would probably not have devoted as much time and labor in irrigation agriculture.

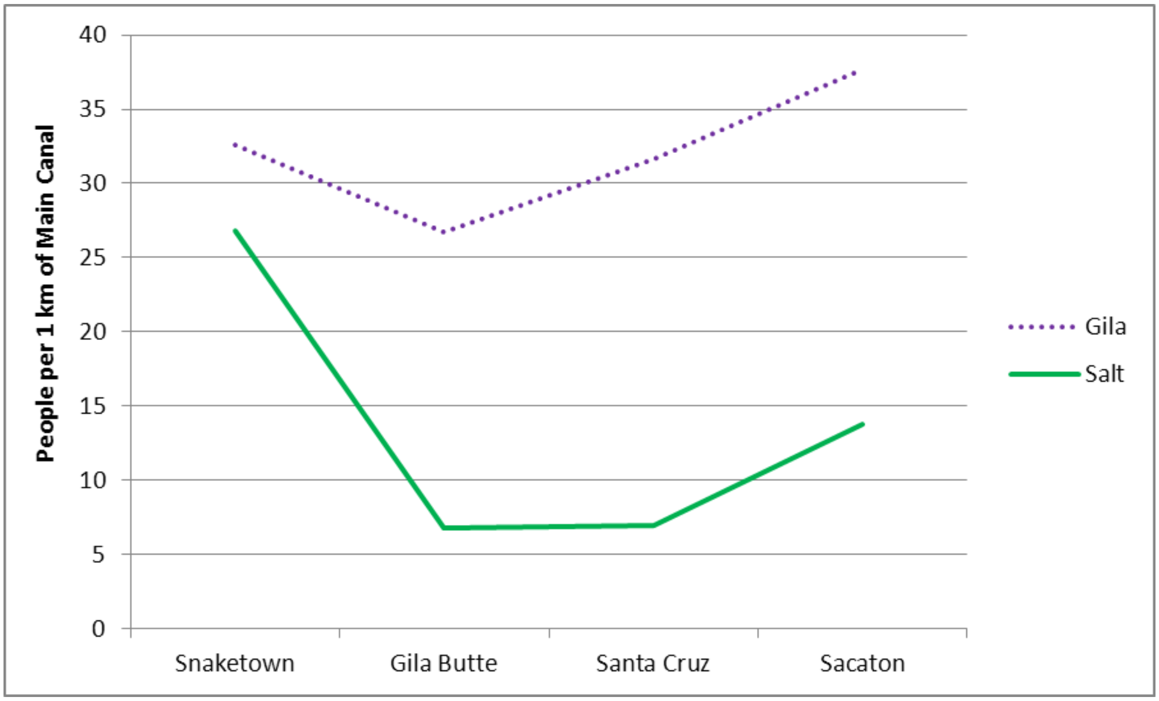

Figure 7.1: Average number of people per kilometer of main canal for the Gila and Salt River systems (see Appendix B, Table 3g).

In concert with the larger size of Salt River irrigation systems, recent simulations indicate that Salt River canal systems may have been more productive than Gila River canal systems during prehistory (Ingram and Hunt 2007). Salt River communities on extensive canal systems would have had comparative advantages in the production of non-food agricultural products such as cotton. Cotton may have been a particularly important item traded in the Hohokam economy if, for instance, smaller canal systems on the Gila River settlements could not produce both food and non-food crops (Bob Hunt personal communication, 2009).[13].

In contrast to the Salt River, conditions that limited the extent of subsistence intensification on the Gila River may have broadly encouraged economic diversification in the form of specialized craft production. Large numbers of people on relatively small canal systems meant that people did not have to invest as much time in canal and field maintenance. In addition, those canal systems that specialized in ceramic production are further downstream on the Gila River and would have been most affected by water shortages. Therefore, it is possible that benefits of specialized ceramic production in the vicinity of Snaketown and Gila Butte and cotton cultivation on the Salt River created complementary economic relationships that encouraged specialization on both the Salt and the Gila Rivers.

Refining Models on Specialized Production

Complementary economic relationships between the Salt and Gila Rivers may have provided the basis for enduring supply and demand relationships in a regional economy. Analysis of the Hohokam case provides several interesting insights that may be used to refine models for the development of specialist-based economies in middle range societies. First, those conditions that encouraged supply and demand relationships were identifiable early on in Hohokam prehistory. Abbott's (2009) recent analyses of Salt River site assemblages suggest that widespread distribution of plainwares from specialized producers in the vicinity of South Mountain began as early as the Vahki phase

[13] Bob Hunt's work on Salt and Gila River agriculture is on-going.

(AD 450-500). By the Estrella phase (AD 500-600), Salt River consumers also received large quantities of “schist-only” plainwares from the Gila River. These data are consistent with the results of this study, which indicate that by the Snaketown phase (AD 650), specialists in the Gila River valley manufactured a large portion of the decorated wares used by settlements across the region While some of the vessels may have been exchanged for the contents they held, the number of vessels produced for export and the widespread reliance of Hohokam households for these wares indicates that the ceramics themselves were the primary commodity.

Second, the Hohokam case suggests that when supply is relatively regular, households are more than willing to forgo their own ceramic production. Acquiring pottery from specialists likely conferred significant advantages because pottery manufacture requires some skill, is relatively time consuming, and messy. Although Gila River residents were located in proximity to all the necessary resources to manufacture decorated wares, settlements on the Gila River also relied on specialists to supply them with most of their decorated, and likely plainware pottery. Low transport costs through the preClassic, perhaps through exchanges at large ballcourts, may have allowed consumers to rely on specialists to a high degree (Abbott et al. 2007a).

Finally, the Gila River economy defies the premise that subsistence intensification is always a preferable strategy to intensive craft production. Some of the earliest, largest and most densely occupied areas of the region were areas where topography limited the size of potential canal systems. Although agricultural settlements on the Salt River began before the Gila River, settlers soon began to move southwards to the Gila River to occupy irrigable farmland in this river system (Woodson 2010:239). Population growth in these areas occurred long before resource pressures or notions of land tenure may have induced or forced people to aggregate in particular locations. It is possible that economic diversification in the form of specialized craft production was an attractive strategy to some people and that these benefits outweighed potential limitations to irrigation systems in this area. The early and continuous specialized production of pottery in areas where residents could not expand canal systems indicates that the comparative advantages to pottery production in these areas were always strong.

Network Effects

The development of large-scale specialist production of red-on-buff wares along the middle Gila River was likely related to myriad changes throughout the Hohokam economy. Economists have long noted that economic systems consist of networks of relationships. A change to one part of an economic system, therefore, can send rippling effects throughout other areas of the same system. These indirect influences are termed network effects (Cheng and Yang 2004). Classical economists Adam Smith and Allyn Young formalized the relationship between the division of labor and network effects by stating that the level of specialization within an economy depends on the extent of the market and vice versa (Smith 1776; Young 1928). This circular relationship mean that a change to demand for a particular item will necessitate a change in the supply of that item in order to restore the system to equilibrium (and vice versa). Network effects hold that as supply and demand for specialist-produced goods increase, the following also increase: a) economic integration, b) diversity of types of specialists, c) degree of interpersonal dependence and interaction between individuals, and d) commodification. In the following sections, I consider each of these factors in the Hohokam case.

A. Economic Integration

Economic integration tends to increase with societal complexity. For instance, various authors have argued for close connection between economic integration and state development in Mesoamerica (Feinman 1997; Smith 2002). Economic integration is not a new concept to Hohokam archaeology and various researchers have remarked on the complementarity in economic production among different communities within the society. Bayman contends that Tucson Basin Hohokam communities were economically integrated with respect to several craft production activity, such as shell ornament manufacture (Bayman 1994:96-108; 1996:404). Abbott and his colleagues have argued that the Hohokam economy was economically integrated through a series of ballcourt marketplaces during the middle Sedentary period (Abbott et al. 2007a).

High and continuous supply and demand of specialist-produced decorated pottery throughout the preClassic period indicates that the Hohokam economy was highly integrated. Hohokam households relied on a limited number of specialists to supply them with almost all of their decorated pottery. Research also suggests that preClassic households also received almost all of their plainware pottery from concentrated ceramic producers (Abbott 2009). These producers specialized in particular vessel sizes and forms; this relationship indicates that their production coordinated with the output of other manufacturing locales. The movement of high volumes of pottery to Phoenix Basin consumers suggests that significant quantities of other types of goods were exchanged in return. Widespread household reliance on these wares as part of their domestic ceramic assemblages and the large volume of wares transported indicates that the pots were the focus of exchange rather than the contents of the vessels.

B. Diversity of Specialists

As the level of specialization increases in a society, the number of different specialties also increases (Ehn 2011:23-24; Söderlund 1943). This observation is borne out in the Hohokam economy. The output of Phoenix Basin specialists became increasingly more limited through time and the distribution of pottery was coordinated such that specialists with overlapping production outputs did not distribute to the same area. On the Gila River, specialists working on the Snaketown canal system (Petrofacies N) increasingly took over decorated pottery production, while potters in the vicinity of Gila Butte (Petrofacies A and H) appear to have reduced decorated pottery production to focus on plainware manufacture. On the Salt River, potters working on the eastern end of South Mountain reduced their production of decorated wares to a negligible amount and focused on plainware manufacture. By the middle Sedentary period, these potters further limited the scope of their production by focusing exclusively on large ollas as plainwares from the Gila River became dominant in assemblages to the south of the Salt River. Potters to the north of the Salt River began plainware production that mirrored the Gila River plainware forms distributed to the south of the Salt River (Abbott 2009).

In concert with evidence for early and continued reliance on specialized pottery producers, Hohokam archaeologists have long noted the diversity of goods that were generated by specialists in the Hohokam economy (Doyel 1991). Shell (Howard 1993a; Marmaduke 1993; Nelson 1991), groundstone (Bostwick and Burton 1993), textiles (Hunt 2011), minerals (Nelson 1981), obsidian (Peterson et al. 1997), and stone palettes (Krueger 1993; White 2004) were among the goods that circulated within the Hohokam economy and may have been procured or manufactured by specialists at various points during the preClassic period.

Some of the settlements that participated in specialized pottery manufacture may have also been the locus for the intensive production of other craft items. For instance, archaeological data suggests that marine shell artifacts were manufactured at the site of Snaketown during the preClassic period (Seymour and Schiffer 1987; Seymour 1988). The conditions that promoted intensive pottery manufacture in particular areas—such as geographically central locations and low agricultural workloads—likely increased the comparative advantages to specialized production of a range of different craft items.

C. Degree of Interpersonal Interaction & Trade Dependence

Archaeologists have noted the increasing role of trade dependence in the development of ancient economies (Ames 1981; Peregrine et al. 2007; Wattenmaker 1990). Hohokam archaeologists have emphasized the intense reliance on exchange relationships to obtain a variety of necessities during the middle Sedentary period in the Phoenix Basin (Abbott 2003b:205; Abbott et al. 2007a). This means that people may have interacted with individuals outside of their household, and their extended family on a relatively regular basis. These interactions likely involved some type of formality that would increase the security and ease of economic transactions with strangers and lower the transaction costs involved.

One of the most important prerequisites of trade dependence is reliable exchange relationships (Bestor 2001; Geertz 1978). Reliable exchange relationships are fostered during times of peace when feuding does not prevent the free transfer of goods throughout an economic system. Reliable exchange relationships are encouraged by stable and sedentary populations. Finally, reliable exchange relationships are fostered by a society that lacks strict social proscriptions to the production, movement, and use of goods.

PreClassic Hohokam society appears to have met these prerequisites by providing a safe and dependable platform for the movement of goods from specialists to consumers. Notably, the Hohokam economy included "pure consumers," or people who did not make the items that they use regularly. For instance, settlements north of the Salt River settlements were, for the most part, "pure consumers" of red-on-buff pottery. People in these areas relied entirely on exchange relationships to obtain this pottery.

One implication for increases to household interaction spheres and trade dependence are shifts to the gendered division of labor. Ethnographic data in the American Southwest closely associate women with ceramic production (Bunzel 1972; Colton 1953; Cushing 1886; Hardin 1993; Mills 1995; Stevenson 1904:373). Specialized ceramic manufacture by women living in certain communities indicates that women's tasks varied across the Phoenix Basin. While some women produced surplus pottery for exchange, other women did not produce pottery at all. Those women who did not produce pottery likely devoted their time to agricultural activities or to the specialized production of other types of craft items such as textile production. Depending on the gendered division of labor in the Hohokam economy, women's roles may have varied more or less than men's roles across the Phoenix Basin. It is possible that women in less productive canal systems devoted most of their time to various craft production activities while the men focused their labors on agricultural production. Women in more productive canal systems may have assisted men with agricultural tasks. In this scenario, women's work would vary substantially between different areas of the Phoenix Basin while men's work would be relatively consistent across the region. Alternatively, both men and women in craft production communities could have devoted equal amounts of time to craft and agricultural tasks.

I have argued that large scale production and distribution of red-on-buff pottery manufactured by specialists in the Hohokam region may be a signal for the increased importance of women's contributions to the regional economy (Kelly 2010a). If prehistoric Hohokam women were the primary potters, their products would have seen an early and dramatic rise in importance to the Hohokam economy through the preClassic. For this reason, female potters were probably quite empowered in preClassic Hohokam society. Wealth, prestige, and status are closely linked with work associated with the entire community (Costin 1996; Joyce 1992; 1996). Male dependence on the products of women would have potentially enabled women to have economic and potentially social influence in Hohokam society (i.e., Brumfiel 1991; Nash 1978; Sillitoe 1985:517; Strathern 1984:25; Weiner 1986:108; Wylie 1992). Although pottery production is connected to the domestic sphere, it was produced and distributed in public areas where women could easily interact with others. In addition, exchange of the pottery that women produced in regional markets would have provided women the opportunity to network and establish social ties with a variety of different people (Costin 1996). In general, women have greater social prominence in societies where they sell their products in a marketplace (Hadfield 1999). Female potters in non-stratified societies, such as the Hohokam, also tend to have relatively high status (Arnold 1985:198).

Although the social position of women in Hohokam society is difficult to specify, archaeological data suggest that Hohokam women had the greatest freedoms and access to resources during the preClassic period when they participated in specialized pottery manufacture. Based on an analysis of domestic architecture, access to ritual spaces, production activities, and burial treatments, Crown and Fish (1996) contend that preClassic women had lower workloads and greater rights and privileges in domestic and public life in comparison to Classic period women. Although sexual stratification may have existed during the preClassic period as evidenced by the possible presence of menstrual huts at some Hohokam sites (Crown 1985; Haury 1976:62, 68) and higher incidences of ritual and rare items in male graves than female graves (McGuire 1992; Teague 1984), preClassic women were not restricted from participation in public ritual or social events at ballcourts, and women's' activities were not inhibited by domestic architecture. PreClassic Hohokam society may have thrived on comparatively equal access to productive activities and social opportunities for both men and women.

D. Commodification

In market economies, increases in the extent of the market and in the level of specialization are also marked by increases in the commodification of items circulated in these economies (Carrier 1994; Gregory 1982; Hart 1982; Kopytoff 1986; Marx 1911). Commodification is the transformation of a good whose production and exchange are dictated by the identity of the producer, the identity of the consumer, and the social context that the items are used in to an item that has an economic value. Commodification increases with the level, output, and dependence on specialization within an economy because people use goods that they do not produce, that are manufactured by people they may not know, and that they obtain through an economic exchange of some sort.

The craft items circulated at a large scale within the Hohokam may have been more commoditized than craft items exchanged in other areas of the American Southwest. The emergence of specialist-based economy in the Phoenix Basin indicates a shift from an economy based on generalized exchanges or delayed reciprocity to an economic system founded on frequent, regularized, and balanced reciprocity between non-kin (after Sahlins 1972). While both types of exchanges probably co-existed in economies throughout the American Southwest, the scale of the Hohokam economy implies that most goods were likely moved across the region through economic transactions. Hohokam red-on-buff wares may have assumed some aspects of commodities in exchange contexts that emphasized the equal and probably direct exchange of one good for another between geographically distant and unrelated people.

The disassociation of the individual and the household from material items that they use every day, and which are visible to members of the household and wider community, also implies a shift in the messages these items might have conveyed and their social meanings. Stylistic consistency in decorated wares used by people across the Phoenix Basin likely resulted directly or indirectly from concentrated specialized production of these wares in a few locations along the middle Gila River. The similarities in the designs of Hohokam pottery across a vast region likely reflected participation in a pan-Hohokam identity instead of membership within a lineage or other social group (Lack 2013).

On the Brink of Statehood?

The large, stable Hohokam populations that resided along the Salt and Gila river valleys share many of the same characteristics as those societies that directly preceded state formation in Egypt and Mesopotamia. This dissertation has focused one of these characteristics: a complex economy that involves the large-scale production and distribution of a variety of goods (Childe 1942; Wailes 1996). Like Egypt and Mesopotamia, the Hohokam culture region was characterized by a relatively marginal ecosystem that necessitated investments in subsistence intensification, such as irrigation agriculture, in order to sustain year-round sedentary populations. Desert conditions did not permit rainfall agriculture and the availability of wild resources fluctuated dramatically with the seasons. With initial subsistence investments, however, these desert environments were incredibly productive and could support high population densities. Most importantly, the high temperatures permitted multiple crops to be grown each season (Ingram and Hunt 2007). This situation encouraged the early and rapid expansion of canal irrigation and the long sedentism associated with investments in stable subsistence production.

If the Hohokam heartland in the Phoenix Basin exhibited so many of the qualities associated with state-level formation, why did Hohokam society remain politically decentralized? I suggest two potential answers to this question. First, almost all traditional societies in the American Southwest were overtly egalitarian and enforced powerful leveling mechanisms that would reduce an individual's ability to consolidate power (Mills 2004). Although some Hohokam communities contain evidence for political centralization, particularly in the Classic period, archaeologists generally agree that Hohokam social organization lacked the unified authority and hierarchical political structures that characterized complex chiefdoms and state-level societies (Elson and Abbott 2000; Fish and Yoffee 1996; Fish and Fish 2000; Harry and Bayman 2000).

Second, the Sonoran Desert encouraged, but did not force, people to live exclusively along the river valleys. Although the Phoenix Basin receives less than 15 inches of rain per year, it is a relatively resource-rich environment (Fish and Nabhan 1991:51-52). Small permanent settlements could exist away from the major river systems (Bayman et al. 2004; Ferg et al. 1984; Gladwin and Gladwin 1929b; Hill Jr. et al. 2008).

In addition, higher elevation ecozones in northern Arizona and New Mexico were only a few days journey from the Hohokam heartland. While residing along the expansive canal systems on the Salt and Gila Rivers offered many benefits, Hohokam households could have moved or journeyed to receive the foodstuffs and other items that they needed. In other words, the environment did not force people to negotiate the use of limited resources along the river valleys. Alternatives may have prevented the development of institutions to formalize and organize the use of these resources.

It is notable that the first markers of political and social differentiation arose when the regional Hohokam economy contracted in the Classic period. The Classic period was marked by increased immigration to the Salt and Gila River valleys, rising population densities, and fundamental changes in land tenure (Abbott 2000; Ciolek-Torrello 2012; Elson and Abbott 2000). As a result, social stratification linked to competition over water, land, and other resources likely rose during this time. Societal differentiation may have contributed to fragmentation of the economic networks that permitted the large-scale production and exchange in the Hohokam economy. The coincidence of political centralization and the disintegration of a regional economy may indicate that early states or pre-state societies experience an initial period of economic balkanization as new social roles are negotiated.

A Tale of Two Rivers: A Final Note

PreClassic Hohokam culture in the Phoenix Basin was characterized by one of the most complex ancient economies of the American Southwest. The wide and fertile river valleys of the Salt and Gila rivers provided the environmental setting for early and continuous sedentary population growth. Specialized production, encouraged by reliable subsistence production through irrigation agriculture and stable communities, began almost in concert with the first recognizable material signs for Hohokam culture. As populations grew, reliance on specialized production intensified and specialized production of agricultural and craft goods capitalized on both endogenous and exogenous comparative advantages. The most striking of these advantages were differences in the economies of the Salt and Gila Rivers, which were based on agricultural potential of their canal systems and the distribution of raw materials used for craft production. Advantages to red-on-buff manufacture on the Gila River encouraged large-scale ceramic production on the Snaketown canal system; in contrast, agricultural production on the Salt River fueled the growth of a burgeoning complementary economy.

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APPENDIX A

RESEARCH COLLABORATOR AGREEMENT WITH THE CULTURAL RESOURCE MANAGEMENT PROGRAM OF THE GILA RIVER INDIAN COMMUNITY

GILA RIVER INDIAN COMMUNITY
POST OFFICE BOX 2140, SACATON, AZ 85247

CULTURAL RESOURCE MANAGEMENT PROGRAM

(520) 562-7150
(520) 562-7165
Fax: (520) 562-3268

November 18, 2008

Sophie Kelly
Ph.D. Student
School of Human Evolution and Social Change (SHESC)
Arizona State University
Tempe, AZ

RE: Research Collaborator, P-MIP - CRMP 94.14: Ceramic Research

Dear Ms. Kelly:

We are in receipt of your Memorandum of October 20, 2008 in which you outline a course of study regarding the organization of prehistoric Hohokam buffware ceramic production. You also indicate that this work will form an integral part of your doctoral studies including your dissertation. Your dissertation research is of great interest to us in connection with on-going ceramic research for the Pima-Maricopa Irrigation Project (P-MIP). We would like to invite you to collaborate in this effort.

Because this work will be conducted within the lands of a sovereign Indian nation in collaboration with the Cultural Resource Management Program (CRMP) on behalf of P-MIP, a federally funded Tribal Self-Governance project, the following limitations and conditions apply:

- that all work and sampling be performed as part of P-MIP cultural resource management efforts under the supervision of CRMP with the knowledge and approval of the Program Coordinator (J. Andrew Darling);
- that all research is consistent with your proposed plan of work and specified research goals (see attached memorandum of October 20, 2008);
- when collecting samples in the Gila River Indian Community (GRIC), you always be accompanied in the field by a CRMP employee or Community member;
- that GRIC CRMP staff may assist or observe sampling in order to provide training and exposure to research methodology;
- that a report describing the results of your research on GRIC be provided in a timely manner for use by CRMP as a deliverable for P-MIP;
- any publications using the data collected acknowledge the contribution of the GRIC and P-MIP;[1]

[1] We recommend the following statement, or similar: "This research was undertaken in conjunction with the Gila River Indian Community, Cultural Resource Management Program and the Pima-Maricopa Irrigation Project under funding from the Department of the Interior, U.S. Bureau of Reclamation, under the Tribal Self-Governance Act of

- a copy of your dissertation (as final report) and other publications using these data be provided to the GRIC CRMP.

Your cooperation is greatly appreciated and we look forward to working with you. As acknowledgement of this letter and support of these conditions, we ask that you sign a copy and return it to the GRIC CRMP prior to start of work. Your concurrence indicates only that we have discussed these issues and our expectations as a Tribal program.

If you have any questions, please contact me at (520) 562-6824 or (480) 784-7221.

Sincerely,

J. Andrew Darling
Coordinator

I concur with the conditions described above for conducting ceramic research on the GRIC in connection with the P-MIP.

Sophie Kelly — Date: November 24, 2008

I do not concur with the conditions described above for conducting ceramic research on the GRIC in connection with the P-MIP.

Sophie Kelly — Date

1994 (P.L. 103-413), for the design and development of a water delivery system utilizing Central Arizona Project water."

APPENDIX B

SUPPLEMENTARY TABLES FOR METHODS CHAPTER

Table 3a: Petrofacies Assignments from Thin Section Analysis. Data on all samples is filed with the Digital Archaeological Record (tDAR). Individual thin sections are available at ASU, ASM, PGM, and GRIC-CRMP collection facilities. The specimen number and sherd number for each sample can be located by searching the database for the special analysis number.

Special Analysis #	Site Name	Feature Date	Generic Petrofacies	Specific Petrofacies	Alternative Petrofacies	Final Petrofacies
1	Upper Santan	GB	A or N	A. Santan Mountains		A
2	La Villa	EGB	A, B, or C	A. Santan Mountains		A*
3	La Villa	SC	D or G	D. Queen Creek		D
4	La Villa	EGB	Salt River sand	I. Camelback Mountain	I	I
5	La Villa	EGB	A or H	A. Santan Mountains		A*
6	Chee Nee	SN	A or B	A. Santan Mountains	A	A
7	La Villa	EGB	A, H, or C	C. Twin Buttes	A/N	N
8	La Villa	SC	D or N	N. Snaketown		N
9	La Villa	SC	A or H	H. Sacaton Mountains	A or H	H*
10	La Villa	GB	Salt River sand	U. Usery	N or U	X
11	Upper Santan	GB	A or B	A. Santan Mountains	A or N	B
12	Upper Santan	SN	A or N	N. Snaketown		schist only
13	La Villa	SC	D or N	D. Queen Creek		D
14	La Villa	EGB	D or N	N. Snaketown		N
15	La Villa	SC	A, H, or C	H. Sacaton Mountains	A or H	H
16	Upper Santan	SC	J, H, G, F5	H. Sacaton Mountains	A or H	H
17	La Villa	SC	D or N	N. Snaketown		N
18	La Villa	EGB	A or H	H. Sacaton Mountains		schist only
19	Upper Santan	SC	N or B	N. Snaketown		N
20	La Villa	SC	D or N	N. Snaketown		N
21	Grewe	ESAC	A or C	C. Twin Buttes	A or H	H
22	Grewe	EGB	A or B	B. Olberg	B or G	G
23	Grewe	ESAC	N or B	B. Olberg	B or N	B
24	Los Hornos (Effland, ASM)	ESAC	N, A, B, or C	A. Santan Mountains		A*
25	Los Hornos (Effland, ASM)	ESAC	N or B	B. Olberg		B

Special Analysis #	Site Name	Feature Date	Generic Petrofacies	Specific Petrofacies	Alternative Petrofacies	Final Petrofacies
26	Los Hornos (Effland, ASM)	ESAC	D or N	N. Snaketown		N
27	Los Hornos (Effland, ASM)	ESAC	A or C	C. Twin Buttes		schist only
28	Los Hornos (Effland, ASM)	ESAC	A or C	A. Santan Mountains	A or H	H*
29	Los Hornos (Effland, ASM)	ESAC	D or N	N. Snaketown	N or U	U
30	Los Hornos (Effland, ASM)	GB - SC	A or H	A. Santan Mountains	N	N
31	Los Hornos (Effland, ASM)	ESAC	D or G	D. Queen Creek		D
32	Los Hornos (Effland, ASM)	ESAC	D or N	N. Snaketown		N
33	Los Hornos (Effland, ASM)	ESAC	N, A, B, or C	A. Santan Mountains		schist only
34	Los Hornos (Effland, ASM)	ESAC	D or N	N. Snaketown		N
35	Los Hornos (Effland, ASM)	ESAC	A or N	A. Santan Mountains		H
36	Los Hornos (Effland, ASM)	ESAC	D or N	N. Snaketown		N
37	Los Hornos (Effland, ASM)	ESAC	D or N	N. Snaketown		N
38	Los Hornos (Effland, ASM)	ESAC	N or G	N. Snaketown	A/N	N
39	Los Hornos (Effland, ASM)	ESAC	A or H	A. Santan Mountains		A
40	Los Hornos (Effland, ASM)	ESAC	D or N	N. Snaketown	N or U	U
41	La Ciudad	GB	A or C	A. Santan Mountains		schist only
42	La Ciudad	GB	A, B, or C	A. Santan Mountains	A or H	A
43	La Ciudad	GB	A or C	A. Santan Mountains		A
44	La Ciudad	GB	A or C	C. Twin Buttes		Q
45	La Ciudad	GB	D or N	D. Queen Creek		D
46	La Ciudad	GB	A, H, C, or F5	A. Santan Mountains		A*
47	La Ciudad	GB	A, C, or F5	A. Santan Mountains	A or H	A
48	La Ciudad	GB	N	N. Snaketown		N
49	La Ciudad	GB	D or N	N. Snaketown	A or H	H*
50	Grewe	SN	A, H, C, or F5	F5. Florence		F5
51	La Ciudad	GB	B or D	B. Olberg		B
52	La Ciudad	SC	D or N	D. Queen Creek	H?	N
53	La Ciudad	SC	D or N	N. Snaketown	A or H	H
54	Las Colinas	GB - SC	A or H	A. Santan Mountains		A

Special Analysis #	Site Name	Feature Date	Generic Petrofacies	Specific Petrofacies	Alternative Petrofacies	Final Petrofacies
55	Chee Nee	SN	A or B	B. Olberg	A or H	A*
56	Upper Santan	SN	A or N	A. Santan Mountains		A
57	Chee Nee	SN	A or N	N. Snaketown	B or G	G
58	Upper Santan	SN	A or N	A. Santan Mountains	A or N	N
59	Chee Nee	SN	A, H, or C	H. Sacaton Mountains	H or G	H*
60	Upper Santan	GB	A or B	A. Santan Mountains	A or H	A
61	Upper Santan	GB	A or H	A. Santan Mountains	A or H	A
62	La Villa	EGB	A, H, or C	H. Sacaton Mountains		H
63	La Villa	GB - SC	D, E, or M	E. Mineral Mountain	R	V
64	La Villa	SC	D or N	N. Snaketown		N
65	La Villa	GB	B or C	B. Olberg	N.	N
66	La Villa	GB	D or G	D. Queen Creek		D
67	Upper Santan	GB	D or N	D. Queen Creek		schist only
68	La Villa	SC	Q or U	U. Usery	I	I
69	La Villa	EGB	B or G	G. Picacho	B	N
70	Upper Santan	SC	N or B	B. Olberg	B. Olberg	B
71	Upper Santan	SN	A or H	H. Sacaton Mountains		H
72	Upper Santan	GB	N, D, H, F5	N. Snaketown	A	H
73	La Villa	SC	A or H	H. Sacaton Mountains		H
74	Upper Santan	SN	A or H	A. Santan Mountains	A or H	A
75	La Villa	SC	A or H	H. Sacaton Mountains	A or H	H
76	La Villa	EGB	Salt River sand	I. Camelback Mountain	I or Q	I
77	Upper Santan	GB	N, A, B, or C	N. Snaketown	A or N	N
78	La Villa	SN	A, B, or C	A. Santan Mountains		A*
79	La Villa	EGB	A, B, or C	A. Santan Mountains		A*
80	Upper Santan	GB	N, A, B, or C	N. Snaketown	A or N	N
81	La Villa	EGB	Q or U	U. Usery	Q	I
82	Upper Santan	SC	D or N	D. Queen Creek		D
83	Upper Santan	SC	D or N	N. Snaketown		N

Special Analysis #	Site Name	Feature Date	Generic Petrofacies	Specific Petrofacies	Alternative Petrofacies	Final Petrofacies
84	Upper Santan	SN	J, H, G, F5	H. Sacaton Mountains	A or H	H*
85	Upper Santan	SN	A or N	N. Snaketown	H	H
86	Chee Nee	SN	D or N	N. Snaketown		schist only
87	La Ciudad	SC	A, B, or C	A. Santan Mountains		A*
88	La Ciudad	EGB	N	N. Snaketown	N or B	N
89	La Ciudad	GB - SC	A or C	A. Santan Mountains		A
90	La Ciudad	EGB	A or C	C. Twin Buttes	A or H	H*
91	La Ciudad	SN	B or G	B. Olberg		schist only
92	Upper Santan	SN	A or N	A. Santan Mountains		H*
93	Upper Santan	GB	A or H	A. Santan Mountains	A or N	A*
94	Upper Santan	ESAC	A or H	A. Santan Mountains	A	A
95	Upper Santan	SC	D or N	D. Queen Creek		D
96	Upper Santan	SN	A or H	H. Sacaton Mountains	A or H	H
97	La Villa	SC	D or N	D. Queen Creek	N	N
98	La Villa	SC	D or N	N. Snaketown		N
99	Upper Santan	GB	A or H	H. Sacaton Mountains	A or H	H
100	Chee Nee	SN	A or H	A. Santan Mountains	H or G	A*
101	Upper Santan	SC	D or N	N. Snaketown		N
102	Grewe	EGB	A or H	A. Santan Mountains		A*
103	Grewe	ESAC	N, A, B, or C	A. Santan Mountains	A or H	A
104	Grewe	ESAC	D or N	D. Queen Creek		D
105	Grewe	ESAC	N, B, or G	N. Snaketown		N
106	Grewe	LSN	A or H	A. Santan Mountains		A
107	Grewe	ESAC	D or N	N. Snaketown		N
108	Grewe	EGB	A or B	B. Olberg	A	H
109	Grewe	LSN	A, H, or F5	F5. Florence		F5
110	Grewe	LSN	D or N	N. Snaketown	A (KSPAR)	N
111	Grewe	ESAC	D or N	N. Snaketown		N

Special Analysis #	Site Name	Feature Date	Generic Petrofacies	Specific Petrofacies	Alternative Petrofacies	Final Petrofacies
112	Grewe	ESAC	N or G	N. Snaketown		N
113	Grewe	ESAC	A or H	A. Santan Mountains	N.	N
114	Grewe	ESAC	G or F5	G. Picacho		N
115	La Ciudad	GB	B or D	B. Olberg		schist only
116	La Ciudad	GB	B or D	B. Olberg		B
117	La Ciudad	GB	A, B, or C	A. Santan Mountains	A or H	A*
118	La Ciudad	GB - SC	A, B, or C	A. Santan Mountains		A
119	La Ciudad	GB - SC	N, A, B, or C	C. Twin Buttes	A or H	A
120	La Ciudad	GB	N	N. Snaketown	A or N	N
121	Grewe	ESAC	D or N	N. Snaketown		N
122	La Ciudad	SN	H, C, or F5	H. Sacaton Mountains	H	H
123	Los Hornos (ASU, Wilcox excavation)	GB - SC	D or G	D. Queen Creek	D or B	D
124	La Ciudad	SN	H, C, or F5	H. Sacaton Mountains		H
125	La Ciudad	SN	G or F5	F5. Florence	F5	A
126	La Ciudad	SN	N or B	B. Olberg	A	H
127	La Ciudad	GB	A or C	C. Twin Buttes		H
128	La Ciudad	GB	A or C	C. Twin Buttes	A/N	N
129	La Ciudad	GB	D or N	D. Queen Creek	A/N	N
130	La Ciudad	GB	A, H, C, or F5	A. Santan Mountains		schist only
131	La Ciudad	GB	A, B, or C	C. Twin Buttes	A/N	N
132	La Ciudad	GB	D or N	D. Queen Creek		D
133	La Ciudad	SN	A or H	A. Santan Mountains		A*
134	La Ciudad	GB	A, H, C, or F5	A. Santan Mountains	A or H	A*
135	La Ciudad	EGB	A or H	A. Santan Mountains		schist only
136	La Ciudad	SN	D or N	N. Snaketown		N
137	La Ciudad	SN	A or H	H. Sacaton Mountains		schist only
138	La Ciudad	SN	A or H	H. Sacaton Mountains	N or H	H*
139	La Ciudad	GB	N, A, B, or C	N. Snaketown		N
140	La Ciudad	SC	A or H	H. Sacaton Mountains	A or H	H*

Special Analysis #	Site Name	Feature Date	Generic Petrofacies	Specific Petrofacies	Alternative Petrofacies	Final Petrofacies
141	La Ciudad	GB	A or H	A. Santan Mountains		A
142	La Villa	GB	N, A, B, or C	N. Snaketown		N
143	La Villa	GB	A, B, or C	A. Santan Mountains	A or H	A
144	La Villa	GB	Q or U	U. Usery	N or U	X
145	La Villa	SC	D or N	N. Snaketown		N
146	La Villa	GB	D or N	D. Queen Creek	D or N	N
147	Upper Santan	SC	N or B	N. Snaketown		N
148	Upper Santan	SN	A or B	B. Olberg		schist only
149	La Villa	EGB	Salt River sand	I. Camelback Mountain	I or Q	I
150	Upper Santan	SN	A or H	H. Sacaton Mountains		H
151	La Villa	EGB	B or G	G. Picacho	A or H	N
152	Upper Santan	GB	A or N	A. Santan Mountains		A*
153	La Villa	SN	A, B, or C	A. Santan Mountains		schist only
154	La Villa	EGB	Salt River sand	F4. Fountain Hills	Q or I	I
155	La Villa	SC	D or N	D. Queen Creek		D
156	La Villa	SC	N or B	N. Snaketown	N.	N
157	La Villa	SC	D or N	N. Snaketown		N
158	Upper Santan	SC	D or N	N. Snaketown		N
159	La Villa	EGB	D or N	N. Snaketown		N
160	Upper Santan	SN	N, A, B, or C	N. Snaketown	A or H	H
161	Las Colinas	GB - SC	D or N	D. Queen Creek		D
162	Las Colinas	GB - SC	D or L	D. Queen Creek	D or N	D
163	Las Colinas	GB - SC	D or N	N. Snaketown		N
164	Las Colinas	GB - SC	J, H, G, F5	J. Sacaton West	R	V
165	Los Hornos (ASU, Wilcox excavation)	EGB	D or N	D. Queen Creek	D or N	D
166	Los Hornos (ASU, Wilcox excavation)	no date	A or H	H. Sacaton Mountains	A or H	H
167	Los Hornos (ASU, Wilcox excavation)	EGB	Salt River sand	V. Phoenix Mountains		V
168	Los Hornos (ASU, Wilcox excavation)	no date	A or H	H. Sacaton Mountains	A or H	H
169	Los Hornos (ASU, Wilcox excavation)	no date	A, B, or C	C. Twin Buttes	D or N	D

Special Analysis #	Site Name	Feature Date	Generic Petrofacies	Specific Petrofacies	Alternative Petrofacies	Final Petrofacies
170	Los Hornos (ASU, Wilcox excavation)	EGB	A, H, or C	H. Sacaton Mountains	B or N	B
171	La Ciudad	GB	A or H	A. Santan Mountains	A or H	A
172	Grewe	ESAC	D or N	N. Snaketown		N
173	Los Hornos (Effland, ASM)	ESAC	D, E, or M	D. Queen Creek		D
174	Los Hornos (Effland, ASM)	ESAC	A or C	A. Santan Mountains		A
175	Los Hornos (Effland, ASM)	ESAC	N, A, B, or C	N. Snaketown	N	N
176	Grewe	ESAC	G or F5	F5. Florence	N	G
177	Las Colinas	GB - SC	D or N	D. Queen Creek		D
178	Las Colinas	GB - SC	N, A, B, or C	N. Snaketown		N
179	Las Colinas	GB - SC	D or L	D. Queen Creek	N or D	D
180	Las Colinas	GB - SC	A, C, or F5	C. Twin Buttes	A or H	A*
181	La Villa	GB - SC	A, B, or C	A. Santan Mountains	A or H	A*
182	La Ciudad	GB	A or C	C. Twin Buttes		schist only

Table 3b: Feature assemblages from study sites with proportion of buffware.

Site Name	Feature #	Wallace Date	Date	General Date	Source	Total Sherds	Buffware Count	Proportion Buffware	Comments
Chee Nee	120	no	Gila Butte	Gila Butte	GRIC-CRMP ceramic database	20	16	0.80	
Chee Nee	130	no	Gila Butte	Gila Butte	GRIC-CRMP ceramic database	1423	260	0.18	
Chee Nee	131	no	Gila Butte	Gila Butte	GRIC-CRMP ceramic database	157	15	0.10	
Chee Nee	132	no	Gila Butte	Gila Butte	GRIC-CRMP ceramic database	3339	599	0.18	
Chee Nee	134	no	Gila Butte	Gila Butte	GRIC-CRMP ceramic database	256	18	0.07	
Chee Nee	144	no	Gila Butte	Gila Butte	GRIC-CRMP ceramic database	136	26	0.19	
Chee Nee	145	no	Gila Butte	Gila Butte	GRIC-CRMP ceramic database	23	15	0.65	
Chee Nee	151	no	Gila Butte	Gila Butte	GRIC-CRMP ceramic database	1814	245	0.14	
Chee Nee	157	no	Snaketown	Snaketown	GRIC-CRMP ceramic database	593	167	0.28	
Chee Nee	171	no	Gila Butte	Gila Butte	GRIC-CRMP ceramic database	2195	399	0.18	
Chee Nee	208	no	Snaketown	Snaketown	GRIC-CRMP ceramic database	410	51	0.12	
El Caserio	21	yes	ESAC	Sacaton	Mitchell (ed.) 1989:Table D.1.	1163	282	0.24	
El Caserio	28	yes	ESAC	Sacaton	Mitchell (ed.) 1989:Table D.1.	1525	427	0.28	includes subfeatures
El Caserio	31	yes	GB	Gila Butte	Mitchell (ed.) 1989:Table D.1.	566	157	0.28	
El Caserio	36	yes	GB	Gila Butte	Mitchell (ed.) 1989:Table D.1.	73	12	0.16	
El Caserio	45	yes	SC	Santa Cruz	Mitchell (ed.) 1989:Table D.1.	101	36	0.36	
El Caserio	46	yes	ESAC	Sacaton	Mitchell (ed.) 1989:Table D.1.	326	92	0.28	includes subfeatures
El Caserio	50	yes	ESAC	Sacaton	Mitchell (ed.) 1989:Table D.1.	290	77	0.27	
El Caserio	59	yes	SC	Santa Cruz	Mitchell (ed.) 1989:Table D.1.	259	63	0.24	
El Caserio	60	yes	ESAC	Sacaton	Mitchell (ed.) 1989:Table D.1.	1113	248	0.22	
El Caserio	62	yes	SC	Santa Cruz	Mitchell (ed.) 1989:Table D.1.	374	78	0.21	includes subfeatures
El Caserio	65	yes	ESAC	Sacaton	Mitchell (ed.) 1989:Table D.1.	355	86	0.24	
El Caserio	67	yes	ESAC	Sacaton	Mitchell (ed.) 1989:Table D.1.	798	226	0.28	
El Caserio	74	yes	SC	Santa Cruz	Mitchell (ed.) 1989:Table D.1.	124	40	0.32	
El Caserio	88	yes	ESAC	Sacaton	Mitchell (ed.) 1989:Table D.1.	207	116	0.56	includes subfeatures

Site Name	Feature #	Wallace Date	Date	General Date	Source	Total Sherds	Buffware Count	Proportion Buffware	Comments
Grewe	97	yes	ESAC	Sacaton	Abbott and Henderson 2001:Appendix A, pages 273-338	3028	927	0.31	does not include disturbed area
Grewe	339	yes	SN	Snaketown	Abbott and Henderson 2001:Appendix A, pages 273-338	229	42	0.18	
Grewe	350	yes	LGB	Gila Butte	Abbott and Henderson 2001:Appendix A, pages 273-338	1572	216	0.14	
Grewe	440	yes	ESAC	Sacaton	Abbott and Henderson 2001:Appendix A, pages 273-338	2374	516	0.22	
La Ciudad	43	yes	GB	Gila Butte	La Ciudad database, ARI; Henderson 1987: Table C.1, pages 209-212	1536	294	0.19	
La Ciudad	44	yes	EGB	Gila Butte	Henderson 1987: Table C.1, pages 209-212	403	32	0.08	
La Ciudad	78	yes	SN	Snaketown	Henderson 1987: Table C.1, pages 209-212	381	48	0.13	
La Ciudad	293	yes	SC	Santa Cruz	Henderson 1987: Table C.1, pages 209-212	595	171	0.29	
La Ciudad	373	yes	GB	Gila Butte	Henderson 1987: Table C.1, pages 209-212	565	127	0.22	
La Ciudad	374	yes	GB	Gila Butte	Henderson 1987: Table C.1, pages 209-212	5312	955	0.18	
La Ciudad	492	yes	GB	Gila Butte	Henderson 1987: Table C.1, pages 209-212	252	40	0.16	
La Ciudad	538	yes	SN	Snaketown	Henderson 1987: Table C.1, pages 209-212	1207	162	0.13	
La Ciudad	598	yes	SC	Santa Cruz	Henderson 1987: Table C.1, pages 209-212	1229	237	0.19	
La Ciudad	674	yes	SC	Santa Cruz	Henderson 1987: Table C.1, pages 209-212	1207	336	0.28	
La Ciudad	766	yes	GB	Gila Butte	Henderson 1987: Table C.1, pages 209-212	2576	469	0.18	
La Ciudad	841	yes	SC	Santa Cruz	Henderson 1987: Table C.1, pages 209-212	287	64	0.22	
La Ciudad	1015	yes	EGB	Gila Butte	Henderson 1987: Table C.1, pages 209-212	294	43	0.15	
La Ciudad	1196	yes	EGB	Gila Butte	Henderson 1987: Table C.1, pages 209-212	629	122	0.19	
La Ciudad	1381	yes	GB	Gila Butte	Henderson 1987: Table C.1, pages 209-212	2216	330	0.15	
La Ciudad	1633	yes	SN	Snaketown	Henderson 1987: Table C.1, pages 209-212	202	36	0.18	
La Ciudad	1634	yes	GB	Gila Butte	Henderson 1987: Table C.1, pages 209-212	266	52	0.20	
La Ciudad	1650	yes	GB	Gila Butte	Henderson 1987: Table C.1, pages 209-212	335	63	0.19	
La Lomita	9	yes	ESAC	Sacaton	Abbott in Mitchell & Motsinger 1997:Table 4.1, page 48	146	56	0.38	

Site Name	Feature #	Wallace Date	Date	General Date	Source	Total Sherds	Buffware Count	Proportion Buffware	Comments
La Lomita	26	yes	ESAC	Sacaton	Mitchell ed. 1990:Table D.1.	455	128	0.28	
La Lomita	36	yes	ESAC	Sacaton	Abbott in Mitchell & Motsinger 1997:Table 4.1, page 48	234	67	0.29	
La Lomita	37	yes	ESAC	Sacaton	Abbott in Mitchell & Motsinger 1997:Table 4.1, page 48	88	24	0.27	
La Lomita	37	yes	ESAC	Sacaton	Mitchell ed. 1990:Table D.1.	266	69	0.26	includes subfeatures
La Lomita	38	yes	ESAC	Sacaton	Abbott in Mitchell & Motsinger 1997:Table 4.1, page 48	136	27	0.20	
La Lomita	66	yes	ESAC	Sacaton	Mitchell ed. 1990:Table D.1.	36	12	0.33	
La Villa	13	yes	GB	Gila Butte	Schroeder ed. 1994:Appendix B, pages 337-347	175	83	0.47	
La Villa	14	yes	GB	Gila Butte	Schroeder ed. 1994:Appendix B, pages 337-347	84	42	0.50	
La Villa	58	yes	SN	Snaketown		1251	120	0.10	
La Villa	75	yes	GB	Gila Butte	Schroeder ed. 1994:Appendix B, pages 337-347	357	190	0.53	
La Villa	76	yes	EGB	Gila Butte	Schroeder ed. 1994:Appendix B, pages 337-347	45	18	0.40	
La Villa	80	yes	SC	Santa Cruz	Schroeder ed. 1994:Appendix B, pages 337-347	421	173	0.41	
La Villa	81	yes	SC	Santa Cruz	Schroeder ed. 1994:Appendix B, pages 337-347	28	10	0.36	
La Villa	84	yes	SC	Santa Cruz	Schroeder ed. 1994:Appendix B, pages 337-347	151	93	0.62	
La Villa	95	yes	EGB	Gila Butte		698	74	0.11	
La Villa	106	yes	SN	Snaketown	Schroeder ed. 1994:Appendix B, pages 337-347	90	28	0.31	
La Villa	109	yes	EGB	Gila Butte	Schroeder ed. 1994:Appendix B, pages 337-347	391	54	0.14	
La Villa	115	yes	SN	Snaketown	Schroeder ed. 1994:Appendix B, pages 337-347	422	89	0.21	
La Villa	116	yes	EGB	Gila Butte	Schroeder ed. 1994:Appendix B, pages 337-347	728	340	0.47	
La Villa	117	yes	EGB	Gila Butte	Schroeder ed. 1994:Appendix B, pages 337-347	344	136	0.40	
La Villa	128	yes	EGB	Gila Butte	Schroeder ed. 1994:Appendix B, pages 337-347	140	17	0.12	
La Villa	155	yes	SN	Snaketown		2463	195	0.08	
La Villa	235	yes	GB	Gila Butte		266	65	0.24	
La Villa	236	yes	GB	Gila Butte		129	38	0.29	
La Villa	254	yes	SN	Snaketown		379	42	0.11	

Site Name	Feature #	Wallace Date	Date	General Date	Source	Total Sherds	Buffware Count	Proportion Buffware	Comments
La Villa	261	yes	GB	Gila Butte		401	89	0.22	
La Villa	310	yes	EGB	Gila Butte		258	27	0.10	
La Villa	323	yes	SN	Snaketown		194	47	0.24	
La Villa	344	yes	SN	Snaketown		349	32	0.09	
Las Colinas Area 1	1004	yes	GB	Gila Butte	Las Colinas, Vol 7: 112	329	90	0.27	
Las Ruinitas	12	yes	ESAC	Sacaton	King 2007:Appendix A, p. 7 (draft version, 1985)	344	92	0.27	
Los Hornos	1	yes	SN	Snaketown	Chenault et al. 1993: Table A.1, pages 597-674	681	38	0.06	
Los Hornos	11	yes	GB	Gila Butte	Chenault et al. 1993: Table A.1, pages 597-674	10	10	1.00	
Los Hornos	15	yes	SN	Snaketown	Chenault et al. 1993: Table A.1, pages 597-674	200	29	0.15	
Los Hornos	16	yes	EGB	Gila Butte	Chenault et al. 1993: Table A.1, pages 597-674	718	192	0.27	
Los Hornos	17	yes	EGB	Gila Butte	Chenault et al. 1993: Table A.1, pages 597-674	1125	242	0.22	
Los Hornos	21	yes	EGB	Gila Butte	Howard and Effland 1990:Table 10, page 100-101	788	162	0.21	
Los Hornos	25	yes	EGB	Gila Butte	Chenault et al. 1993: Table A.1, pages 597-674	19	12	0.63	
Los Hornos	39	yes	EGB	Gila Butte	Chenault et al. 1993: Table A.1, pages 597-674	1060	69	0.07	
Los Hornos	63	yes	EGB	Gila Butte	Chenault et al. 1993: Table A.1, pages 597-674	188	13	0.07	
Los Hornos	64	yes	EGB	Gila Butte	Chenault et al. 1993: Table A.1, pages 597-674	163	14	0.09	
Los Hornos	76	yes	ESAC	Sacaton	Howard and Effland 1990:Table 12, page 109	564	124	0.22	
Los Hornos	82	yes	GB	Gila Butte	Chenault et al. 1993: Table A.1, pages 597-674	120	13	0.11	
Los Hornos	83	yes	SN	Snaketown	Chenault et al. 1993: Table A.1, pages 597-674	88	45	0.51	
Los Hornos	84	yes	GB	Gila Butte	Chenault et al. 1993: Table A.1, pages 597-674	93	35	0.38	
Los Hornos	85	yes	EGB	Gila Butte	Chenault et al. 1993: Table A.1, pages 597-674	840	528	0.63	
Los Hornos	93	yes	GB	Gila Butte	Chenault et al. 1993: Table A.1, pages 597-674	55	22	0.40	
Los Hornos	103	yes	EGB	Gila Butte	Chenault et al. 1993: Table A.1, pages 597-674	65	27	0.42	
Los Hornos	106	yes	EGB	Gila Butte	Chenault et al. 1993: Table A.1, pages 597-674	68	29	0.43	

Site Name	Feature #	Wallace Date	Date	General Date	Source	Total Sherds	Buffware Count	Proportion Buffware	Comments
Los Hornos	112	yes	GB	Gila Butte	Chenault et al. 1993: Table A.1, pages 597-674	151	2	0.01	
Los Hornos	125	yes	EGB	Gila Butte	Chenault et al. 1993: Table A.1, pages 597-674	41	31	0.76	
Los Hornos	126	yes	EGB	Gila Butte	Chenault et al. 1993: Table A.1, pages 597-674	29	22	0.76	
Los Hornos	75 (Chenault)	yes	GB	Gila Butte		111	41	0.37	
Lower Santan	166	yes	ESAC/MSAC1	Sacaton	GRIC-CRMP ceramic database	6919	4340	0.63	includes subfeatures
Sacaton Park	21	no	Sacaton	Sacaton	GRIC-CRMP ceramic database	396	129	0.33	Counts from adjacent Hospital Site
Sacaton Park	29	no	Sacaton	Sacaton	GRIC-CRMP ceramic database	3094	1301	0.42	Counts from adjacent Hospital Site
Sacaton Park	42	no	Sacaton	Sacaton	GRIC-CRMP ceramic database	383	127	0.33	Counts from adjacent Hospital Site
Sacaton Park	44	no	Sacaton	Sacaton	GRIC-CRMP ceramic database	732	288	0.39	Counts from adjacent Hospital Site
Sacaton Park	46	no	Sacaton	Sacaton	GRIC-CRMP ceramic database	885	358	0.40	Counts from adjacent Hospital Site
Sacaton Park	52.04	no	Santa Cruz	Santa Cruz	GRIC-CRMP ceramic database	130	68	0.52	Counts from adjacent Hospital Site
Sacaton Park	52.13	no	Gila Butte	Gila Butte	GRIC-CRMP ceramic database	135	56	0.41	Counts from adjacent Hospital Site
Sacaton Park	55	no	Sacaton	Sacaton	GRIC-CRMP ceramic database	808	292	0.36	Counts from adjacent Hospital Site
Snaketown		no	Gila Butte	Gila Butte	Haury 1965: Page 221			0.32	Snaketown doesn't list individual features
Snaketown		no	Sacaton	Sacaton	Haury 1965: Page 221			0.38	
Snaketown		no	Santa Cruz	Santa Cruz	Haury 1965: Page 221			0.28	
Snaketown		no	Snaketown	Snaketown	Haury 1965: Page 221			0.17	
Upper Santan	48	no	Sacaton	Sacaton	GRIC-CRMP ceramic database	232	101	0.44	
Upper Santan	54	no	Gila Butte	Gila Butte	GRIC-CRMP ceramic database	6780	1922	0.28	
Upper Santan	56	no	Gila Butte	Gila Butte	GRIC-CRMP ceramic database	45	25	0.56	
Upper Santan	67	no	Gila Butte	Gila Butte	GRIC-CRMP ceramic database	337	81	0.24	
Upper Santan	69	no	Sacaton	Sacaton	GRIC-CRMP ceramic database	372	131	0.35	
Upper Santan	102	no	Gila Butte	Gila Butte	GRIC-CRMP ceramic database	165	27	0.16	
Upper Santan	107	no	Sacaton	Sacaton	GRIC-CRMP ceramic database	943	265	0.28	
Upper Santan	117	no	Gila Butte	Gila Butte	GRIC-CRMP ceramic database	406	90	0.22	

Site Name	Feature #	Wallace Date	Date	General Date	Source	Total Sherds	Buffware Count	Proportion Buffware	Comments
Upper Santan	163	no	Gila Butte	Gila Butte	GRIC-CRMP ceramic database	9260	3020	0.33	
Upper Santan	168	no	Gila Butte	Gila Butte	GRIC-CRMP ceramic database	903	257	0.28	
Upper Santan	173	no	Gila Butte	Gila Butte	GRIC-CRMP ceramic database	128	42	0.33	
Upper Santan	174	no	Gila Butte	Gila Butte	GRIC-CRMP ceramic database	447	136	0.30	
Upper Santan	224	no	Gila Butte	Gila Butte	GRIC-CRMP ceramic database	284	103	0.36	
Upper Santan	251	no	Gila Butte	Gila Butte	GRIC-CRMP ceramic database	971	74	0.08	
Upper Santan	253	no	Gila Butte	Gila Butte	GRIC-CRMP ceramic database	362	35	0.10	
Upper Santan	286	no	Gila Butte	Gila Butte	GRIC-CRMP ceramic database	243	25	0.10	
Upper Santan	297	no	Gila Butte	Gila Butte	GRIC-CRMP ceramic database	1819	408	0.22	
Upper Santan	791	no	Gila Butte	Gila Butte	GRIC-CRMP ceramic database	502	154	0.31	
Upper Santan	827	no	Gila Butte	Gila Butte	GRIC-CRMP ceramic database	1422	202	0.14	
Upper Santan	829	no	Gila Butte	Gila Butte	GRIC-CRMP ceramic database	453	70	0.15	
Upper Santan	833	no	Gila Butte	Gila Butte	GRIC-CRMP ceramic database	1753	298	0.17	
Upper Santan	833.01	no	Gila Butte	Gila Butte	GRIC-CRMP ceramic database	149	20	0.13	
Upper Santan	858	no	Gila Butte	Gila Butte	GRIC-CRMP ceramic database	362	44	0.12	
Upper Santan	859	no	Gila Butte	Gila Butte	GRIC-CRMP ceramic database	158	27	0.17	
Upper Santan	862	no	Gila Butte	Gila Butte	GRIC-CRMP ceramic database	926	154	0.17	
Upper Santan	872	no	Gila Butte	Gila Butte	GRIC-CRMP ceramic database	1356	163	0.12	
Upper Santan	880	no	Gila Butte	Gila Butte	GRIC-CRMP ceramic database	340	37	0.11	
Upper Santan	890	no	Gila Butte	Gila Butte	GRIC-CRMP ceramic database	571	105	0.18	
Upper Santan	894	no	Gila Butte	Gila Butte	GRIC-CRMP ceramic database	876	109	0.12	
Upper Santan	909	no	Gila Butte	Gila Butte	GRIC-CRMP ceramic database	147	39	0.27	
Upper Santan	948	no	Gila Butte	Gila Butte	GRIC-CRMP ceramic database	349	28	0.08	
Upper Santan	957	no	Gila Butte	Gila Butte	GRIC-CRMP ceramic database	1877	282	0.15	
Upper Santan	958	no	Gila Butte	Gila Butte	GRIC-CRMP ceramic database	534	87	0.16	
Upper Santan	976	no	Gila Butte	Gila Butte	GRIC-CRMP ceramic database	221	42	0.19	
Upper Santan	1001	no	Gila Butte	Gila Butte	GRIC-CRMP ceramic database	395	106	0.27	

Table 3c. Calculations for Proportion of Entire Assemblage and Proportion of Buffwares.

					Proportion N of Buffware Assemblage		Proportion of Entire Assemblage	
	Sites	**Total Sherds**	**Total Buffwares**	Proportion of Buffwares in Assemblage	Petrofacies A/B/C/H	Petrofacies N	Petrofacies A/B/C/H	Petrofacies N
Snaketown	Chee Nee	1003	218	0.22	0.54	0.44	11.77	9.51
	Grewe	229	42	0.18	0.35	0.36	6.48	6.67
	La Ciudad	1790	246	0.14	0.66	0.20	9.10	2.71
	La Villa	5148	553	0.11	0.53	0.03	5.65	0.28
	Los Hornos	969	112	0.12	0.33	0.59	3.81	6.77
	Snaketown[1]			0.17	0.15	0.84	2.59	14.21
	Upper Santan			0.24[2]	0.48	0.52	11.51	12.49
Gila Butte	Grewe	1572	216	0.14	0.89	0.06	12.19	0.86
	La Ciudad	14384	2527	0.18	0.50	0.12	8.75	2.16
	La Villa	4016	1173	0.29	0.42	0.09	12.18	2.57
	Las Colinas	329	90	0.27	0.37	0.16	10.08	4.32
	Los Hornos	5644	1464	0.26	0.74	0.14	19.19	3.73
	Snaketown[1]			0.32	0.17	0.82	5.49	26.27
	Upper Santan	34541	8212	0.24	0.54	0.45	12.93	10.64
Santa Cruz	El Caserio	858	217	0.25	0.19	0.73	4.85	18.39
	Grewe			0.20[3]	0.13	0.78	2.52	15.63
	La Ciudad	3318	808	0.24	0.62	0.24	15.05	5.74
	La Villa	600	276	0.46	0.34	0.44	15.58	20.03
	Snaketown[1]			0.28	0.46	0.47	12.81	13.29
	Upper Santan			0.43[4]	0.29	0.68	12.48	29.13
Early Sacaton	El Caserio	5777	1554	0.27	0.21	0.69	5.74	18.49
	Grewe	5402	1443	0.27	0.23	0.58	6.27	15.58
	La Lomita	1361	383	0.28	0.24	0.74	6.71	20.89
	Las Ruinitas	344	92	0.27	0.11	0.89	2.83	23.92
	Los Hornos	564	124	0.22	0.43	0.39	9.39	8.47
	Lower Santan	6919	4340	0.63	0.11	0.63	6.67	39.37
	Sacaton Park	6298	2495	0.40	0.47	0.53	18.77	20.85

Notes:
[1] Feature data for Snaketown is not available. Proportion of buffwares are from Haury (1965:221)
[2] Missing value, same value as Gila Butte
[3] Missing value, averaged Sacaton and Gila Butte figures
[4] Missing value, averaged Gila Butte and Sacaton figure for Lower Santan

Table 3d: Calculations for Simpson's D and E.

		Squares of Proportions (pi^2)						Σpi^2	1/ Σpi^2	D/Dmax
	Sites	sq A, B, C, H	sq D	sq F5-G	sq N	sq North Salt	sq South Salt	Sum Sqs	Simpson's D	Simpson's E
Snaketown	Chee Nee	0.29	0.00	0.00	0.19	0.00	0.00	0.49	2.06	0.34
	Grewe	0.12	0.00	0.08	0.13	0.00	0.00	0.34	2.97	0.49
	La Ciudad	0.44	0.00	0.00	0.04	0.00	0.00	0.48	2.07	0.35
	La Villa	0.28	0.00	0.01	0.00	0.01	0.07	0.36	2.78	0.46
	Los Hornos	0.11	0.00	0.00	0.34	0.00	0.01	0.46	2.19	0.37
	Snaketown	0.02	0.00	0.00	0.70	0.00	0.00	0.72	1.38	0.23
	Upper Santan	0.23	0.00	0.00	0.27	0.00	0.00	0.50	2.00	0.33
Gila Butte	Grewe	0.79	0.00	0.00	0.00	0.00	0.00	0.79	1.26	0.21
	La Ciudad	0.25	0.00	0.00	0.02	0.00	0.07	0.34	2.96	0.49
	La Villa	0.17	0.00	0.00	0.01	0.05	0.06	0.29	3.48	0.58
	Las Colinas	0.14	0.00	0.00	0.02	0.10	0.01	0.27	3.65	0.61
	Los Hornos	0.55	0.00	0.00	0.02	0.00	0.00	0.57	1.75	0.29
	Snaketown	0.03	0.00	0.00	0.67	0.00	0.00	0.70	1.42	0.24
	Upper Santan	0.30	0.00	0.00	0.20	0.00	0.00	0.50	2.02	0.34
Santa Cruz	El Caserio	0.04	0.00	0.00	0.53	0.00	0.00	0.57	1.76	0.29
	Grewe	0.02	0.00	0.00	0.61	0.00	0.00	0.63	1.58	0.26
	La Ciudad	0.38	0.00	0.00	0.06	0.00	0.01	0.45	2.24	0.37
	La Villa	0.11	0.01	0.00	0.19	0.00	0.00	0.32	3.15	0.52
	Snaketown	0.21	0.00	0.00	0.23	0.00	0.00	0.44	2.29	0.38
	Upper Santan	0.08	0.00	0.00	0.46	0.00	0.00	0.54	1.84	0.31
Early Sacaton	El Caserio	0.05	0.00	0.00	0.47	0.00	0.00	0.52	1.92	0.32
	Grewe	0.06	0.00	0.03	0.34	0.00	0.00	0.43	2.35	0.39
	La Lomita	0.06	0.00	0.00	0.55	0.00	0.00	0.61	1.65	0.27
	Las Ruinitas	0.01	0.00	0.00	0.80	0.00	0.00	0.81	1.23	0.21
	Los Hornos	0.18	0.02	0.00	0.15	0.00	0.00	0.35	2.86	0.48
	Lower Santan	0.01	0.04	0.01	0.39	0.00	0.00	0.45	2.23	0.37
	Sacaton Park	0.22	0.00	0.00	0.28	0.00	0.00	0.50	1.99	0.33

Table 3e: Sites used to calculate populations 2.5 km from each study site.

Site Name	Chee Nee	El Caserio	Grewe	La Ciudad	La Lomita	La Villa	Las Colinas	Las Ruinitas	Los Hornos	Lower Santan	Hospital, Sacaton Park	Snaketown	Upper Santan
Casa Buena		X		X									
Casa Buena Locus 2		X		X									
Casa Chica					X	X	X						
Casa de Omni								X					
Casa del Oriente								X					
Casa Grande			X										
Caserio		X			X								
Chee Nee	X												
CRISMON								X					
Dos Casas		X			X								
Double Butte									X				
Dutch Canal Ruin				X									
GR-421											X		
GR-497												X	
GR-520													
GR-534										X			
Grewe			X										
Hospital, Sacaton Park											X		
Kinney Site		X											
La Ciudad		X		X									
La Lomita		X			X								
La Lomita Pequena					X								
La Villa						X							
Las Colinas							X						
Las Moradas							X						

Site Name	Chee Nee	El Caserio	Grewe	La Ciudad	La Lomita	La Villa	Las Colinas	Las Ruinitas	Los Hornos	Lower Santan	Hospital, Sacaton Park	Snaketown	Upper Santan
Las Piedras								X					
Las Ruinitas								X					
Leo's Site		X											
Lomita Pequena		X											
Los Hornos									X				
Los Solares		X		X									
Lower Santan										X			
Olberg Butte													X
Pueblo Grande					X								
Pueblo Patricio					X	X							
Snaketown												X	
T:12:6(ASU)				X	X	X							
U:13:21												X	
U:13:22												X	
U:13:221												X	
U:13:23												X	
U:13:24												X	
U:13:49										X			
U:13:6										X			
U:14:10													X
U:14:44													X
Upper Santan													X

Table 3f: Population data used to calculate the maximum population density in a 2.5 km radius within each production zone (petrofacies). Population data are based on Doelle 1995.

Petrofacies	Center Site	Time Period	Population
D	None	1. SN	0
D	None	2. GB	0
D	SW Germann	3. SC	300
D	Sonoqui Pueblo	4. ESAC	150
F5-G	Grewe	1. SN	100
F5-G	Grewe	2. GB	200
F5-G	Grewe	3. SC	600
F5-G	Grewe	4. ESAC	500
N-A	GR-1167	1. SN	750
N-A	GR-1167	2. GB	800
N-A	GR-1167	3. SC	900
N-A	GR-1167	4. ESAC	900
North Salt	La Ciudad	1. SN	300
North Salt	La Ciudad	2. GB	400
North Salt	La Ciudad	3. SC	300
North Salt	Stone Hoe	4. ESAC	450
South Salt	Primero	1. SN	200
South Salt	Casa de Omni	2. GB	700
South Salt	Casa de Omni	3. SC	700
South Salt	Casa de Omni	4. ESAC	750

Table 3g: Canal length and population data used to calculate that average irrigation workload for each production locale (petrofacies). Population data are derived from Doelle 1995. Canal length data are individually referenced by canal system within the table.

Canal System	River	Pioneer Canal Length	Colonial Canal Length	Sedentary Canal Length	Snaketown Canal Population	Gila Butte Canal Population	Santa Cruz Canal Population	Sedentary Canal Population	Snaketown People per Canal Length	Gila Butte People per Canal Length	Santa Cruz People per Canal Length	Sedentary People per Canal Length	Source for Canal Length
Canal System 1	Salt	14	161.5	128.5	300	1600	1700	2200	21.4	9.9	10.5	17.1	Howard 2006: 140-142
Canal System 2	Salt	14	161.5	128.5	450	700	650	1000	32.1	4.3	4.0	7.8	Howard 1993: Table 5
Casa Blanca	Gila	11.5	24.2	24.2	200	550	600	350	17.5	22.7	24.8	14.5	Woodson 2010: Table 3.1
Chee Nee Canal System	Gila	8.4	16	16	200	300	300	300	23.8	18.8	18.8	18.8	Woodson 2010: Table 3.1
Gila Butte	Gila	6.0	12.7	12.7	750	850	950	950	124.7	66.9	74.8	74.8	Woodson 2010: Table 3.1
Granite Knob/Santan	Gila	2.6	5.5	5.5	200	300	300	500	76.8	54.5	54.5	90.9	Woodson 2010: Table 3.1
Grewe-Casa Grande Canal System	Gila	17.7	33.6	33.6	100	400	1000	1100	5.7	11.9	29.8	32.7	Woodson 2010: Table 3.1
Queen Creek	QC	11.5	24.2	24.2	0	0	450	300	0.0	0.0	18.6	12.4	Sires 1984: Figure 111.7.19; Dart 1983: Table IV.3.2
Riverbend	Gila	11.2	23.6	23.6	100	250	250	300	8.9	10.6	10.6	12.7	Woodson 2010: Table 3.1
Santan Canal System	Gila	9.3	26.6	26.6	150	600	650	700	16.1	22.6	24.4	26.3	Woodson 2010: Table 3.1
Snaketown Canal System	Gila	14.1	25.5	26.7	300	500	550	650	21.3	19.6	21.6	24.3	Woodson 2010: Table 3.1
Sweetwater Canal System	Gila	5.4	10.3	10.3	100	300	500	650	18.4	29.1	48.5	63.1	Woodson 2010: Table 3.1

Shading denotes missing data for Pioneer (Snaketown phase) canal length. In these cases, Pioneer canal length was calculated based on the average increase between Snaketown and Colonial-Sedentary period canals on the Gila River (Woodson 2010: Table 4.2)

Table 3h. Population and ballcourt data for canal systems used to calculate the average number of people per ballcourt on each canal system within the production zones (petrofacies). Population data is derived from Doelle 1995.

Petro	Canal System	River	Ballcourts	Snaketown Canal Population	Gila Butte Canal Population	Santa Cruz Canal Population	Sedentary Canal Population	Snaketown Ballcourt Pop Ratio	Gila Butte Ballcourt Pop Ratio	Santa Cruz Ballcourt Pop Ratio	Sedentary Ballcourt Pop Ratio
A/B/C/H	Casa Blanca	Gila	6*	200	550	600	350	33.33	91.67	100	58.33
A/B/C/H	Chee Nee Canal System	Gila	2	200	300	300	300	100	150	150	150
A/B/C/H	Gila Butte	Gila	1	750	850	950	950	750	850	950	950
A/B/C/H	Granite Knob/Santan	Gila	4	200	300	300	500	50	75	75	125
A/B/C/H	Santan Canal System	Gila	2	150	600	650	700	75	300	325	350
A/B/C/H	Sweetwater Canal System	Gila	2	100	300	500	650	50	150	250	325
A/B/C/H Average			17	1600	2900	3300	3450	94.12	170.59	194.12	202.94
D	Queen Creek	n/a	5	0	0	450	300	0	0	90	60
F5	Grewe-Casa Grande Canal System	Gila	8	100	400	1000	1100	12.50	50	125	137.50
N	Snaketown Canal System	Gila	3*	300	500	550	650	100	166.67	183.33	216.67
North Salt	Canal System 2	Salt	7	450	700	650	1000	64.29	100	92.86	142.86
South Salt	Canal System 1	Salt	12	300	1600	1700	2200	25	133.33	141.67	183.33

* Has large ballcourts

APPENDIX C

RESULTS FROM MULTIPLE REGRESSION ANALYSES

Proportion of Non-local Buffware in Buffware Assemblage: Snaketown - Gila Butte

Summary of Fit		**Analysis of Variance**						**Parameter Estimates**				
		Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F	Term	Estimate	Std Error	t Ratio	Prob>|t|
RSquare	0.67702	Model	2	9.47828	4.73914	11.5289	0.002	Intercept	-1.59E-15	0.171353	0	1
RSquare Adj	0.618296	Error	11	4.52172	0.41107			Ballcourt Ratio 2	-0.74991	0.186976	-4.01	0.002
Root Mean Square Error	0.641144	C. Total	13	14				Color 2	0.75253	0.186976	4.02	0.002
Mean of Response	-6.98E-16											
Observations (or Sum Wgts)	14											

Richness: Snaketown - Gila Butte

Summary of Fit		**Analysis of Variance**						**Parameter Estimates**				
		Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F	Term	Estimate	Std Error	t Ratio	Prob>|t|
RSquare	0.827413	Model	2	11.58379	5.79189	26.368	<.0001	Intercept	-3.97E-16	0.125259	0	1
RSquare Adj	0.796034	Error	11	2.416214	0.21966			Transport 2	0.673445	0.138054	4.88	0.0005
Root Mean Square Error	0.468675	C. Total	13	14				Color 2	0.390687	0.138054	2.83	0.0164
Mean of Response	-6.34E-17											
Observations (or Sum Wgts)	14											

Evenness: Snaketown - Gila Butte

Summary of Fit		Analysis of Variance						Parameter Estimates				
		Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F	Term	Estimate	Std Error	t Ratio	Prob>|t|
RSquare	0.894857	Model	4	12.528	3.132	19.1495	0.0002	Intercept	-1.45E-16	0.108086	0	1
RSquare Adj	0.848127	Error	9	1.471999	0.16356			Canal Ratio 2	-0.5105	0.115722	-4.41	0.0017
Root Mean Square Error	0.40442	C. Total	13	14				Transport 2	0.859054	0.119277	7.2	<.0001
Mean of Response	-6.11E-16							Color 2	-0.40523	0.134673	-3.01	0.0147
Observations (or Sum Wgts)	14							Bowl-Jar Ratio 2	-0.33413	0.130204	-2.57	0.0304

Proportion of Non-local Buffware in Buffware Assemblage: Gila Butte - Santa Cruz

Summary of Fit		Analysis of Variance						Parameter Estimates				
		Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F	Term	Estimate	Std Error	t Ratio	Prob>|t|
RSquare	0.836197	Model	3	10.87057	3.62352	15.3147	0.0007	Intercept	7.90E-16	0.134908	0	1
RSquare Adj	0.781597	Error	9	2.129433	0.2366			Canal Ratio 2	-0.61834	0.14161	-4.37	0.0018
Root Mean Square Error	0.486419	C. Total	12	13				Color 2	0.523109	0.142328	3.68	0.0051
Mean of Response	1.58E-16							Bowl-Jar Ratio 2	0.56679	0.135639	4.18	0.0024
Observations (or Sum Wgts)	13											

Richness: Gila Butte - Santa Cruz

Summary of Fit		Analysis of Variance						Parameter Estimates				
		Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F	Term	Estimate	Std Error	t Ratio	Prob>|t|
RSquare	0.778483	Model	2	10.12028	5.06014	17.5716	0.0005	Intercept	-8.54E-17	0.148835	0	1
RSquare Adj	0.734179	Error	10	2.879722	0.28797			Canal Ratio 2	-0.42116	0.184474	-2.28	0.0456
Root Mean Square Error	0.53663	C. Total	12	13				Transport 2	0.565433	0.184474	3.07	0.0119
Mean of Response	6.83E-17											
Observations (or Sum Wgts)	13											

Evenness: Gila Butte - Santa Cruz

Summary of Fit		Analysis of Variance						Parameter Estimates				
		Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F	Term	Estimate	Std Error	t Ratio	Prob>|t|
RSquare	0.943377	Model	4	12.2639	3.06597	33.3212	<.0001	Intercept	1.11E-15	0.08413	0	1
RSquare Adj	0.915065	Error	8	0.736101	0.09201			5k Pop 2	-0.25234	0.100269	-2.52	0.036
Root Mean Square Error	0.303336	C. Total	12	13				Transport 2	0.519938	0.1208	4.3	0.0026
Mean of Response	7.34E-16							Mica 2	-0.35661	0.118503	-3.01	0.0168
Observations (or Sum Wgts)	13							Bowl-Jar Ratio 2	-0.283	0.113274	-2.5	0.037

Supply: Santa Cruz-Early Sacaton

Summary of Fit

RSquare	0.945431
RSquare Adj	0.914248
Root Mean Square Error	0.305855
Mean of Response	-1.11E-16
Observations (or Sum Wgts)	12

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Model	4	11.34517	2.83629	30.3193	0.0002
Error	7	0.654832	0.09355		
C. Total	11	12			

Parameter Estimates

Term	Estimate	Std Error	t Ratio	Prob>|t|
Intercept	-2.47E-15	0.088293	0	1
Canal Ratio 2	-1.00541	0.191033	-5.26	0.0012
Ballcourts 2	1.086212	0.120078	9.05	<.0001
Exterior Color 2	0.82302	0.158077	5.21	0.0012
Transport Distance 2	0.545993	0.135389	4.03	0.005

Supply: Gila Butte - Santa Cruz

Summary of Fit

RSquare	0.704214
RSquare Adj	0.638484
Root Mean Square Error	0.627998
Mean of Response	9.25E-17
Observations (or Sum Wgts)	12

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Ratio	Prob > F
Model	2	8.45057	4.22529	10.7137	0.0042
Error	9	3.54943	0.39438		
C. Total	11	12			

Parameter Estimates

Term	Estimate	Std Error	t Ratio	Prob>|t|
Intercept	2.13E-16	0.181287	0	1
Ballcourts 2	0.59168	0.186539	3.17	0.0113
Mica Density (Avg) 2	0.471794	0.186539	2.53	0.0323

APPENDIX D

CHEMICAL DATA FROM TOF-LA-ICP-MS ANALYSES OF SCHIST TEMPER PARTICLES IN RED-ON-BUFF POTTERY

Table 6a: Chemical concentrations (ppm) of major elements in schist temper particles in Hohokam red-on-buff sherds generated by TOF-LA-ICP-MS.

Analysis No.	Run	Si	Al	K	Fe	Ca	Na	Mg	Ti	Ba	P
1	A	198086.96	143221.17	51045.71	65540.75	26871.80	17509.67	44073.57	1171.04	899.31	2265.76
1	B	225538.23	154577.94	73914.31	22517.67	37443.99	21023.85	7288.42	2406.15	1665.87	1304.11
1	E	215022.49	120484.38	40904.59	61552.86	27617.27	13749.50	58335.22	3424.36	696.80	2153.34
1	G	209322.40	172720.17	74029.32	33427.80	26411.09	23349.02	6018.33	2931.59	1343.55	860.53
1	H	223676.20	167333.11	62322.42	20674.89	46127.93	12152.29	5042.58	679.59	175.09	3093.73
1	X	266261.23	117352.10	31522.52	33520.98	42686.47	25204.19	12651.20	879.85	794.87	1331.55
1	Y	217313.60	174479.17	68781.09	28017.95	29766.49	17198.30	5398.83	1724.00	1281.59	1015.02
1	Z	195975.18	165933.90	70480.84	30135.11	55132.49	28480.86	6815.66	2926.22	1373.73	1430.62
2	C	227449.97	170438.28	73728.47	26801.88	17836.86	10208.21	6443.99	2817.19	1837.52	2302.32
2	E	267614.82	141286.00	60451.61	19369.46	13118.31	17464.80	3499.21	1650.66	1075.94	2944.78
2	F	234595.84	194232.35	40187.76	14579.82	15085.53	12596.37	7079.16	3141.19	1852.74	1047.98
2	G	210907.06	196367.92	78039.01	22977.74	8030.06	15244.46	4860.85	3386.37	1928.00	493.86
2	H	224644.04	163683.26	81445.80	22237.66	23655.91	18805.69	5701.55	3596.65	1840.54	811.15
3	A	242547.62	176876.71	82232.32	16935.36	3074.07	0.00	4593.28	1530.57	1499.47	2531.15
3	B	327217.73	74066.28	33843.79	59892.80	3631.41	0.00	2425.08	9484.23	622.56	2477.61
3	E	226042.73	86397.21	22007.16	62552.32	106860.30	16938.23	29378.05	3174.18	1538.09	2689.57
3	F	275004.31	161743.38	31622.04	30043.21	0.00	0.00	6829.33	2653.78	1889.35	0.00
3	X	243617.96	159192.38	43969.90	34414.68	16620.85	16013.92	13863.37	1194.86	1192.32	706.58
3	Y	231463.77	170755.47	68229.32	27582.47	10056.18	21402.97	6190.96	1756.87	1270.16	452.67
3	Z	238306.59	174251.10	67281.71	22414.35	4649.59	21476.15	3228.91	1876.73	1368.31	374.90
4	A	352119.45	91145.77	4289.65	408.75	3976.19	38901.04	959.02	51.72	59.16	3326.26
4	B	132358.91	73878.87	14025.44	58590.31	259173.71	37116.86	30029.69	3644.34	2435.95	382.93
4	C	205771.81	164080.52	51456.04	36729.11	58680.92	8516.22	15411.33	3200.19	1989.03	2564.65
4	D	300404.96	115967.33	24181.50	7383.10	17930.01	44585.57	1510.81	152.03	1113.20	3363.08
4	E	191412.75	129708.19	13180.90	60110.87	123121.81	4795.12	29979.86	3613.69	1850.75	1867.06

Analysis No.	Run	Si	Al	K	Fe	Ca	Na	Mg	Ti	Ba	P
4	F	292761.69	87086.17	8107.03	88526.79	0.00	0.00	22394.32	8132.77	1557.00	0.00
4	G	297947.97	116608.26	10347.25	3148.93	23333.92	66222.95	546.45	66.15	164.86	366.26
4	X	267953.60	93423.88	76477.14	52565.49	13934.96	18708.22	16976.39	2595.68	2485.91	105.39
4	Y	295695.03	77391.93	39626.09	58301.60	24275.71	19730.42	12329.56	2681.89	382.92	850.69
5	A	227089.47	184853.55	77528.45	18992.62	10015.43	5172.57	6206.87	1952.47	1809.82	2451.46
5	E	194208.60	133962.92	27577.99	49506.86	87411.42	19088.98	23502.68	17632.82	2679.01	2251.15
5	F	283757.65	158064.29	36026.55	21398.57	0.00	0.00	4983.99	2437.48	1469.45	0.00
5	G	275971.70	123386.09	2872.13	9224.06	60118.52	47615.04	3656.81	300.78	391.22	1346.68
5	X	294540.82	119619.91	43880.83	13057.47	29400.82	9032.42	4058.20	550.68	1252.16	3119.56
5	Y	222952.98	178180.44	72288.27	35666.51	9418.10	7286.35	5321.51	2835.38	2263.24	713.04
5	Z	216679.35	190157.85	75290.31	31835.57	5235.74	10465.96	4466.29	3970.97	2286.51	433.11
6	A	235601.58	177401.63	81284.53	18075.70	6584.58	5619.00	4500.60	1659.64	1827.86	2561.12
6	B	296147.08	115209.60	4915.08	7539.31	30806.22	58791.22	359.82	23.92	126.74	3272.98
6	D	304487.38	123282.01	910.73	1787.93	21071.85	55345.70	470.54	0.00	43.43	2558.23
6	E	203422.04	204341.43	73938.24	33466.86	4606.68	9435.56	4733.91	3381.85	1724.47	2306.27
7	A	258466.18	104618.77	32486.65	26669.17	78606.74	8677.60	22888.78	1583.20	1201.70	2174.11
7	B	234244.58	161851.37	77666.27	28661.76	14563.88	12275.64	4641.29	3244.79	1636.19	2077.85
7	D	313803.17	108756.21	47570.24	14125.50	12250.56	6187.75	3483.80	1202.06	1289.01	4010.14
7	E	290436.61	131824.44	28081.19	3609.05	15611.26	44512.59	542.20	31.67	364.10	2738.03
7	G	210013.27	202922.17	77489.93	20090.43	6452.27	13809.59	4311.09	3404.10	1563.74	536.94
7	H	274022.81	131053.54	82101.58	13602.86	7691.35	16267.63	4284.14	2222.27	1260.23	564.31
8	A	250789.54	124847.81	54024.02	47244.84	32400.22	4581.96	17001.26	2734.85	1388.55	2406.49
8	B	229703.52	133717.31	48440.24	53171.33	51446.80	14198.13	6348.76	2058.76	5415.41	2721.86
8	C	317604.90	98108.91	2874.96	537.87	19910.25	60846.91	3883.02	266.03	148.40	3768.10
8	D	318869.79	106679.10	38375.40	11312.46	6526.28	18920.30	3419.27	306.94	153.63	4598.65
8	F	243344.10	209241.29	36688.72	8593.46	1158.18	7023.39	4963.18	2477.85	1606.43	274.21

Analysis No.	Run	Si	Al	K	Fe	Ca	Na	Mg	Ti	Ba	P
8	G	219968.38	118123.88	35065.86	65334.41	7402.48	10991.66	57331.93	22385.65	323.79	478.72
8	H	210212.11	102479.99	18029.86	84512.69	7672.38	10154.46	96497.93	6167.94	342.51	389.89
9	A	193472.14	184300.11	75163.34	37821.60	28527.08	23016.25	6551.62	4158.27	1574.71	15.23
9	B	207992.49	162587.23	58564.93	27650.48	55652.00	26980.69	7566.36	3906.18	1197.16	30.44
9	D	197651.61	154456.29	73715.74	36585.78	65699.04	20045.14	8889.35	2925.06	1584.33	122.86
9	E	275134.60	132012.26	10028.62	7723.63	29770.99	67782.86	2032.19	267.61	169.44	79.27
10	A	240432.68	111078.43	21667.95	52828.43	60554.17	41281.55	7531.03	10027.77	1627.07	8.06
10	H	212340.74	83816.58	33117.04	96873.00	43338.70	25039.48	29732.71	33563.59	950.31	774.00
11	A	221485.78	171538.80	59267.81	37401.85	34066.41	816.43	11672.33	3011.16	813.63	8.04
11	B	182839.35	165749.64	37568.26	45548.21	77513.24	4582.25	24093.67	15589.71	549.17	27.65
11	C	224568.22	169858.62	64551.22	23225.36	44931.78	0.00	8817.29	3493.38	1372.52	36.25
11	D	218350.41	173886.12	70465.01	26250.16	26105.41	16233.41	8619.41	2865.61	1614.08	159.63
11	E	271786.93	93415.39	30120.95	44939.45	73158.62	3738.03	13292.28	4579.00	547.37	152.81
12	A	214077.71	197117.51	86454.68	24254.50	3757.37	6522.81	4489.38	3255.71	1384.98	8.27
12	B	211610.11	131493.88	73041.25	50323.08	58647.00	16790.62	13134.67	4650.27	838.40	78.78
12	C	214208.32	151497.38	86467.46	31664.48	38862.04	22034.71	7167.76	3465.20	1337.01	54.47
12	D	312800.43	102465.66	3978.06	3507.57	18471.26	72714.86	951.53	174.87	49.03	107.09
13	A	238681.33	166615.17	46976.51	42623.51	15910.63	0.00	13981.12	4887.77	924.43	8.76
13	B	228209.43	180422.73	65793.22	26609.17	6799.48	18431.66	5118.43	4257.85	1234.45	11.90
13	C	229585.85	187752.60	70376.21	22672.33	10081.45	2286.77	5237.58	4240.07	1564.50	19.11
13	D	258618.88	150883.51	45064.03	19856.63	14654.90	32036.50	5361.68	1821.80	819.40	71.30
13	E	200240.26	198547.53	64851.25	30094.99	25374.14	13729.98	6438.85	3701.27	1804.37	45.69
14	A	49277.53	153958.24	481645.74	0.00	0.00	7824.89	4140.37	2156.56	333.08	8.40
14	B	221007.09	167228.63	65032.60	32255.92	20150.61	24674.52	8242.05	4575.10	1295.51	16.80
14	C	220312.12	181416.85	70374.22	19808.10	30279.24	8613.24	5176.30	3759.42	1584.02	24.06
14	D	233744.32	177370.91	68867.92	21541.09	12960.01	10967.56	5880.12	2789.92	1450.84	45.78

Analysis No.	Run	Si	Al	K	Fe	Ca	Na	Mg	Ti	Ba	P
14	E	244866.94	96512.60	34268.03	57464.91	48613.06	34014.10	23716.23	7430.15	734.95	151.81
15	A	306987.51	90230.89	42532.54	34312.73	19568.80	8056.87	14648.32	3452.28	727.35	98.66
15	B	209335.37	182399.33	67202.55	26722.66	24891.06	21563.07	6882.08	3732.66	3300.85	36.09
15	C	289051.98	120676.82	67326.14	14994.40	21152.34	0.00	7276.62	2144.07	2484.30	95.92
15	E	243947.75	163113.63	51550.89	25311.90	10509.85	20460.98	7651.17	2024.54	8092.05	156.85
15	F	233994.35	193207.36	62440.46	19826.13	0.00	6378.81	8543.65	428.49	1846.36	1088.20
15	G	195729.94	171262.80	93119.87	15357.05	26467.92	23015.50	14968.25	380.70	8050.89	6767.52
15	H	219275.91	181642.38	77278.50	25437.42	8194.71	8069.26	12286.15	1191.39	1582.73	4041.19
15	i	253946.00	107589.94	18775.52	28183.51	31150.84	67035.90	16822.48	542.08	308.60	10426.19
16	B	251454.26	95764.46	42407.18	53563.69	37513.54	43101.65	18806.53	4168.66	608.74	34.76
16	D	243401.98	80977.44	40834.37	69806.49	59140.93	27290.15	25822.76	5354.97	849.48	259.08
16	E	274708.48	99643.97	113711.29	25956.86	16907.77	7636.72	5452.24	584.40	2378.57	318.07
16	J	180758.29	225790.53	55580.91	32178.21	13237.24	25295.64	5649.92	3473.72	1407.29	962.79
17	B	202807.68	175568.75	62218.10	40331.00	29378.05	21523.16	10419.14	5436.86	1643.93	82.42
17	C	231264.78	181879.05	76534.72	16247.98	5328.46	14132.24	4951.78	4614.65	1569.23	28.26
17	D	228153.26	170452.67	72078.37	24579.04	25025.03	6484.31	9614.90	2232.90	1176.57	290.37
17	E	216599.02	209159.55	63490.64	23189.13	8064.34	0.00	7234.19	2916.79	1202.28	143.85
18	A	207624.63	210659.12	75466.24	28679.13	3619.71	0.00	4161.82	5339.50	1744.74	0.87
18	B	217290.75	203698.60	67242.33	24581.27	8029.56	4168.17	4142.66	4062.59	1542.10	12.12
18	C	303817.05	86115.07	37563.84	18539.50	63596.79	2050.17	9657.92	2054.58	1452.28	85.66
18	E	186627.12	82523.43	23247.38	46319.99	208627.44	9213.30	20729.98	2937.36	1856.54	519.93
18	F	234537.19	195458.05	43921.85	10231.88	15941.73	6464.49	6696.00	3766.71	2380.61	3391.42
18	G	196972.34	165949.33	74561.44	30762.50	49838.99	13730.20	9546.37	4002.76	1806.77	6573.25
18	H	222936.46	158570.33	74025.35	18949.39	42012.59	9625.15	7032.04	3264.32	1740.90	5925.88
19	A	283509.04	117531.37	54132.36	30759.39	21699.20	0.00	10016.24	3499.11	1278.72	35.02
19	B	249631.03	145640.23	68949.55	19511.06	40442.97	0.00	6953.44	3492.41	593.21	79.81

Analysis No.	Run	Si	Al	K	Fe	Ca	Na	Mg	Ti	Ba	P
19	C	230804.64	168522.38	77444.65	25475.47	23682.16	808.36	8229.56	3536.24	1586.91	67.73
19	D	224010.54	159186.11	59143.80	28736.17	50760.11	8632.00	8437.08	3514.05	1644.83	297.87
19	E	192640.46	117675.89	54996.01	70723.65	86523.48	18327.74	23701.14	3402.52	1387.75	751.12
19	F	255872.49	195245.35	12838.51	28733.20	143.03	0.00	11561.71	704.96	1419.75	0.00
19	G	173915.64	147603.82	66389.57	33314.43	59557.88	63970.51	18722.63	494.11	1046.97	6179.02
19	H	213160.04	78668.24	33399.49	70771.10	68198.37	59792.02	34430.96	1251.08	338.25	5040.30
20	A	287491.93	102571.68	76291.06	20726.96	23325.88	13041.91	6136.87	2556.47	1256.63	69.56
20	B	243702.91	145910.95	43886.47	34429.68	25636.05	17731.70	18223.38	4113.19	909.81	25.96
20	D	241370.57	105527.97	32879.38	49433.48	70351.36	15606.46	21861.80	6050.62	956.54	671.61
20	E	273673.67	136777.57	60927.19	26334.09	8268.82	13675.33	5150.84	2046.15	730.23	156.47
20	G	330814.47	93859.98	36287.43	11122.16	21567.49	11875.45	3024.78	249.64	178.37	797.22
21	E	243934.92	73074.44	22199.01	53745.60	141947.14	0.00	16630.80	3123.35	1217.21	208.22
21	F	243432.01	151063.49	50090.86	39313.28	23178.34	8940.92	11735.88	2787.86	2244.48	1046.11
21	H	195756.86	154050.21	79579.14	57040.82	36135.05	13705.81	16037.88	2845.17	1824.20	2542.86
21	i	209505.06	210796.49	71571.41	21699.94	6139.22	8161.31	4287.21	2810.76	1503.83	480.08
22	A	202621.20	205562.17	49520.60	34486.52	18665.89	12140.02	9471.58	3874.06	1534.44	13.39
22	C	294757.86	94061.10	26193.42	36077.12	52018.62	0.00	14290.93	4279.95	821.39	93.15
22	D	218930.88	166079.50	82198.28	31242.67	24175.58	11944.99	6670.70	4804.69	2127.37	95.41
22	E	210155.96	89686.64	24820.55	55480.21	151903.31	9671.07	20452.82	3590.26	1251.80	275.58
22	F	244790.80	172995.34	49912.13	14504.60	25371.13	4628.71	8816.79	2476.30	1608.20	1453.76
22	G	210857.24	176250.12	72894.35	30952.74	26876.64	14853.65	8026.18	3506.29	1545.19	1039.86
22	H	220691.05	156129.76	77916.47	26487.26	25863.89	29001.57	8901.89	2500.17	1623.96	928.64
23	B	210238.05	214420.56	55441.91	19750.46	22444.84	1856.67	4593.22	2794.23	1399.23	13.52
23	C	280015.89	112048.59	28551.99	37431.35	40821.33	0.00	14661.90	9078.01	949.48	48.76
23	E	194162.34	208587.09	48662.80	53528.35	19579.98	7531.87	4620.53	3931.41	1544.25	45.91
23	F	238250.24	195636.94	46670.98	11669.85	14233.94	5731.95	5974.89	2713.30	1772.93	571.16

Analysis No.	Run	Si	Al	K	Fe	Ca	Na	Mg	Ti	Ba	P
23	H	204873.36	138068.49	77393.14	41276.16	51888.06	27305.81	14548.98	2506.40	1738.87	2327.81
24	A	202863.43	187291.04	60621.33	50678.08	21314.67	0.00	11031.99	4838.06	4215.23	46.89
24	C	234997.26	173739.09	71444.38	24400.29	16517.00	1669.66	6286.46	4593.21	1922.47	26.69
24	D	226081.86	192935.91	67212.77	28858.55	7810.54	0.00	5111.03	3244.78	1926.49	114.06
25	A	221715.68	194447.23	64542.54	25157.05	5377.30	13929.69	6583.40	1900.49	1596.46	34.65
25	B	209082.32	197015.99	70517.15	25515.40	8169.19	22419.21	5183.06	1523.08	3484.91	71.55
25	C	221123.02	177770.94	78605.18	31215.42	4510.38	22038.99	5234.67	1606.07	1812.16	27.42
25	E	222097.40	187050.74	73955.49	24363.20	9239.71	9027.36	5729.08	4582.84	1892.68	85.96
26	A	320262.06	93632.71	55813.09	0.00	6757.44	43193.59	479.33	310.98	83.92	44.52
26	C	249325.08	156368.35	70497.80	26741.69	17031.55	6378.05	5509.98	1219.66	1873.28	101.47
26	D	239998.42	174462.83	71901.28	23065.65	10848.54	3405.26	5029.39	2852.00	1870.71	62.96
26	E	210896.36	171935.57	67766.74	20101.01	65125.50	0.00	7034.36	2800.63	2471.26	88.63
27	A	214104.65	181768.69	68863.58	33872.48	15885.62	16160.47	8481.01	2125.51	1515.62	234.08
27	B	221789.37	185669.08	69364.61	27794.81	17500.73	5488.13	6158.87	1333.38	2099.12	452.09
27	C	217682.59	150089.31	57957.15	90348.96	15121.04	6703.97	5738.87	4051.34	1316.62	137.05
27	D	222125.59	174242.95	78058.42	26391.54	17620.21	12942.55	6660.62	3756.03	1478.95	118.38
27	E	224755.02	190668.10	77601.51	23012.03	9338.88	0.00	4904.19	4325.76	1482.46	73.56
28	A	215292.97	206171.64	65575.75	16647.07	7478.57	16498.75	4207.70	2314.10	1326.39	109.15
28	B	301783.02	111933.18	7419.09	0.00	3878.85	94517.93	47.50	0.00	38.95	23.19
28	C	189706.56	108498.64	25924.31	197823.74	23053.91	5309.06	14428.22	2627.15	1358.03	70.70
28	D	237938.79	173049.86	74317.80	24185.01	9417.44	6010.72	4730.84	3704.29	1725.12	80.88
28	E	220471.54	201762.42	65096.48	17590.04	5076.57	16533.86	3324.57	3295.52	1375.99	50.94
28	F	242350.43	188112.45	43675.65	20869.53	19110.87	0.00	7155.03	501.91	1331.27	0.00
28	G	196830.05	178279.80	60682.78	18826.69	68685.39	17265.33	8102.62	412.87	1552.53	1737.51
28	H	168045.22	140853.92	56072.14	34218.78	146521.72	8736.71	13929.47	1302.67	1682.51	4123.73
29	A	99033.26	126515.44	329281.26	0.00	10987.50	97968.84	0.00	1727.02	460.07	0.00

Analysis No.	Run	Si	Al	K	Fe	Ca	Na	Mg	Ti	Ba	P
29	B	294613.20	71962.97	26820.52	47820.37	39878.38	20780.07	23555.65	1919.89	1106.42	112.15
29	C	205605.85	71776.40	47142.50	123021.92	20385.64	15024.10	74975.38	6144.53	2018.47	73.87
29	F	260602.33	136842.16	5403.00	20599.64	64478.05	29716.88	6821.54	938.74	370.62	332.11
29	G	345439.08	88942.16	0.00	5216.28	32120.23	26856.44	821.55	90.07	129.66	384.84
29	H	317146.46	93125.39	23766.69	10909.20	32839.39	34626.50	2641.97	200.07	197.12	651.01
29	i	204319.40	96345.98	65103.29	87301.78	11225.82	28022.31	60960.04	8881.17	2045.28	594.44
29	J	261070.55	135894.85	108789.66	6623.76	5948.09	21157.05	989.50	330.95	1318.83	873.93
30	D	295326.52	78729.84	26010.63	58020.06	22329.34	0.00	22740.63	6393.93	1128.11	227.88
30	E	219022.83	175653.12	62022.17	27537.59	31104.41	11022.87	7444.66	4506.04	1818.22	167.22
30	G	235897.86	172756.94	58786.64	34228.55	11458.80	8257.45	5731.27	3953.59	1879.58	740.21
30	X	266697.26	108069.73	21047.67	32467.00	52624.27	38622.79	11282.14	768.75	1353.10	1428.99
30	Y	221787.47	158822.15	80337.97	31055.35	31396.82	14509.13	6376.07	971.48	3174.42	1044.88
30	Z	216258.27	102120.71	69060.83	63024.63	55202.62	30528.38	18608.59	3057.04	1469.29	4898.82
31	A	185260.25	109953.66	22763.59	114578.87	20442.03	10611.18	90130.83	838.08	612.60	234.48
31	B	218561.90	195929.85	58983.99	35732.65	6338.32	8472.29	4034.69	5672.83	1295.25	31.07
31	C	206894.33	144206.44	49167.32	98149.57	12002.71	18033.75	9188.34	13888.13	1035.61	67.12
31	D	243642.12	187038.71	53241.85	28907.78	2612.87	0.00	4159.92	3194.28	1399.22	55.45
31	E	219570.83	161467.59	38040.39	57853.13	4452.08	7781.89	41985.18	1863.29	1163.64	27.46
31	F	243101.27	197456.26	48955.29	9594.79	3846.23	8343.90	5343.91	2102.98	1600.40	552.35
31	H	163617.44	101746.79	62085.37	195846.31	9323.44	30771.22	6381.30	19873.37	706.67	458.72
32	A	219277.87	201598.50	58910.25	14778.04	7648.12	22940.59	4881.79	2214.01	1819.18	32.42
32	B	245136.39	182431.87	44897.30	21533.48	10083.34	10608.75	6706.80	1735.14	1213.81	34.21
32	C	200767.84	91795.20	2821.06	149076.35	7670.61	14050.76	82642.50	3048.21	390.95	31.13
32	E	236652.03	181833.89	75641.80	24326.31	3215.63	0.00	4912.35	4689.03	1437.80	21.95
33	B	231780.75	189547.30	57903.12	20241.39	15112.88	8118.26	5268.34	1413.96	1802.74	62.25
33	C	216790.93	162285.99	69502.00	41060.14	28169.64	14628.66	11438.79	1711.37	1869.00	139.85

Analysis No.	Run	Si	Al	K	Fe	Ca	Na	Mg	Ti	Ba	P
33	D	269664.41	67952.22	23052.18	53034.19	77357.73	18615.18	24613.63	5876.90	1319.17	213.28
33	E	236300.67	175733.48	72000.62	22006.88	14835.78	0.00	8654.52	2935.27	1625.80	74.25
34	A	263875.22	130671.70	9001.22	15436.71	66229.76	39442.24	3687.55	258.51	586.80	125.67
34	C	246861.48	76935.01	43154.23	60115.81	77144.46	17816.24	27166.06	1837.65	2602.32	229.43
34	D	281364.15	92840.40	0.00	56684.89	59780.72	0.00	24889.77	3992.55	3131.47	177.48
34	E	213572.63	160780.73	59888.61	33111.82	58930.50	2581.87	11177.60	5421.07	2368.88	140.23
34	F	223489.14	150494.51	53046.61	24937.96	54511.95	5520.23	16079.73	4177.22	2477.13	5979.03
34	G	200178.33	169744.94	78378.00	38561.19	40165.60	7993.53	10781.13	4479.82	1802.08	1673.10
34	H	242810.94	81357.98	76052.07	46458.10	49318.40	31544.19	21296.65	4649.38	1547.68	3453.47
35	A	216253.93	196612.11	67001.46	25426.24	12670.36	10994.02	5193.24	2388.28	1310.91	88.64
35	B	221467.31	185980.72	63100.49	21940.91	12564.09	26400.73	4833.97	1373.58	1411.17	54.33
35	C	285561.21	77028.18	52432.42	45678.78	42878.83	19837.55	12293.91	1349.70	975.27	289.99
35	D	257288.98	137452.24	45505.84	26770.80	32409.33	22047.55	8198.60	2238.97	1125.11	119.25
35	E	240415.67	177408.18	58330.01	17083.89	23817.05	4826.80	4592.27	2979.37	1152.07	48.59
36	A	240884.09	133379.26	39041.71	50246.02	14830.46	30500.10	23426.17	4950.28	622.50	99.80
36	B	210596.62	199759.76	65175.44	47045.40	4946.78	3172.99	6226.09	1029.09	1020.68	44.05
36	C	229808.93	171558.84	69895.43	32900.61	15065.84	8248.82	7834.19	2017.03	1595.17	57.22
36	D	225657.27	162429.00	62385.14	42498.63	11460.07	3155.46	18811.96	10457.95	1456.85	77.09
36	E	148250.45	103591.45	6788.61	190045.53	4664.72	9667.56	105951.16	116.89	63.80	25.41
37	A	210079.61	181240.29	71434.22	31867.05	15158.72	22884.58	8880.29	2065.11	1765.71	421.19
37	C	219405.75	171052.86	69955.53	42658.15	19777.74	2609.88	10886.69	1646.49	1303.52	222.48
37	E	229086.24	193116.58	57912.04	25787.65	9985.67	922.42	6882.07	4259.53	1674.90	71.84
38	A	227604.40	185527.45	67625.98	23542.97	10279.10	12815.66	4975.53	1655.77	1367.23	249.81
38	B	269596.22	164179.07	24549.83	11607.55	20766.76	20197.00	3946.93	689.77	740.87	75.92
38	C	166505.30	103758.31	32326.29	114267.07	49179.33	24849.62	77484.72	1104.91	649.98	451.30
38	D	236199.73	195212.09	62034.79	21337.14	2906.04	0.00	3945.41	3337.41	1915.05	47.37

Analysis No.	Run	Si	Al	K	Fe	Ca	Na	Mg	Ti	Ba	P
38	E	299259.23	141449.18	154.64	0.00	32353.55	32940.41	515.86	7.17	80.95	66.83
39	A	183988.19	86933.79	43733.99	156232.95	29108.64	14602.29	52453.13	3538.51	842.16	938.70
39	B	234469.10	112453.50	48283.88	44179.02	63724.20	28053.01	16180.28	1586.93	2475.52	328.57
39	C	264466.74	103503.79	19432.01	34477.14	52174.73	49710.15	11129.23	575.02	1782.28	249.74
39	F	266293.25	129973.54	43571.22	37094.03	15157.24	18132.70	12277.66	4255.75	1790.20	440.93
39	G	198033.86	175186.17	74386.68	40380.09	28128.09	20831.56	7737.74	1976.43	1321.04	4193.84
39	H	210202.61	181745.40	84494.81	31470.18	20104.58	4214.50	6430.48	3419.92	2631.07	1747.26
39	i	248822.45	119806.97	75339.31	41088.54	36548.06	4077.73	12347.15	1714.10	1668.86	2753.33
39	J	180635.82	239762.41	66246.87	26990.48	3297.98	14967.47	3646.81	3810.24	1694.03	501.53
40	A	180160.65	100614.80	16760.47	118588.97	108109.90	2371.82	39231.38	2619.93	510.94	922.03
40	C	208062.06	96517.23	30023.98	85653.11	29664.25	17767.85	71975.43	13171.60	1045.97	181.52
40	E	205520.93	90401.62	38901.96	89392.49	26138.85	10677.91	77604.08	15228.31	2392.28	444.48
40	F	304094.37	134856.15	0.00	0.00	28508.42	36256.98	811.99	475.30	1019.79	0.00
40	G	262861.96	144424.51	19101.75	17347.30	39501.67	28481.22	9366.18	1961.02	462.19	500.07
40	H	280320.32	110282.18	33211.49	27633.70	15788.24	36999.16	18800.98	2171.37	1101.23	722.01
40	i	179854.56	96360.44	35394.39	88865.95	36269.00	19817.38	82472.30	13588.05	1662.11	7885.85
40	J	160115.34	138792.72	16113.12	119396.65	115576.34	6466.64	7791.03	7815.14	243.02	1105.78
41	B	181921.55	177524.77	76555.99	28194.90	31650.72	59632.56	4826.86	2878.01	1799.81	191.84
41	D	183761.99	143934.65	56850.48	38577.23	129193.86	0.00	10248.40	2522.16	1303.91	1998.87
41	E	221551.77	192205.31	78979.17	29293.30	0.00	0.00	5864.41	6338.66	1319.28	0.00
42	A	227995.74	184852.47	76913.73	26391.28	5121.13	4481.21	5886.86	2428.68	2018.36	495.62
42	C	207420.28	184554.22	62319.54	20288.74	17005.59	44173.32	5391.06	3250.38	2078.98	584.67
42	D	208561.15	175436.86	64231.77	27277.75	25347.58	22314.71	7913.26	2321.62	1899.14	2896.05
42	E	220258.83	202424.21	82996.40	12500.60	0.00	0.00	10170.40	2845.95	1727.94	0.00
43	A	220065.41	198680.52	71544.67	16959.54	3506.79	16096.14	4698.67	1947.36	1682.18	849.65
43	B	220477.28	101741.57	20840.80	74018.70	23896.87	31343.24	62819.53	2552.61	552.29	2870.02

Analysis No.	Run	Si	Al	K	Fe	Ca	Na	Mg	Ti	Ba	P
43	C	207354.01	184215.83	58645.39	32597.94	24596.31	17818.57	9846.51	3216.67	1963.02	2724.31
43	D	143870.84	139490.31	79886.54	31700.04	10373.19	189562.45	5243.23	2989.21	332.12	0.00
43	E	141143.89	120723.49	9707.95	144082.77	3783.91	0.00	129896.05	741.13	304.68	3629.48
45	A	219013.41	189501.35	71469.30	23091.21	20124.34	0.00	9226.15	2032.74	1876.71	611.42
45	B	208558.88	161782.13	58833.89	45372.20	33093.92	18890.42	16296.85	2102.93	1549.37	1752.61
45	C	284343.45	111242.26	20402.93	7924.82	35996.66	53682.98	10215.79	671.19	264.89	1114.47
45	D	308847.84	113415.99	15813.20	6888.46	11023.78	54146.08	2780.15	350.57	162.35	389.29
45	E	204415.33	198014.93	83721.28	19774.79	16150.38	0.00	14592.65	2540.41	1956.04	0.00
45	F	222641.76	127740.73	17241.17	71345.30	51625.67	8492.06	33284.63	289.25	647.08	0.00
45	G	222671.07	187569.26	68582.50	21473.64	14878.54	12130.02	7732.04	390.59	1580.88	618.95
45	H	188834.77	158435.54	69219.21	50233.57	52916.25	26205.21	11539.70	1464.49	1594.95	2362.79
46	A	222655.84	188544.48	76070.63	18193.49	15077.16	0.00	8092.71	2299.51	1901.05	2190.81
46	C	144791.35	133872.35	44885.36	159793.04	9489.15	16718.96	9266.38	58427.84	998.67	906.72
46	D	275569.78	87405.74	24395.66	47740.34	40144.56	41178.92	13253.22	1120.29	344.45	3418.24
46	E	137114.34	114562.42	60819.14	242211.68	0.00	4846.87	9447.70	25032.58	942.77	501.97
46	F	254479.70	127305.88	20180.41	69034.81	0.00	8425.00	38731.92	2078.85	967.28	0.00
46	H	191954.83	136742.45	97485.75	59380.80	27910.34	38797.54	13199.41	4242.45	1026.92	1627.84
46	X	229335.92	193568.86	65530.11	21946.13	3320.23	10188.98	4667.02	1036.87	1319.05	833.80
46	Y	281432.27	106248.98	46884.20	2730.30	27607.96	70018.24	379.35	39.33	67.54	616.13
46	Z	188159.55	138000.56	112868.50	58021.29	14259.55	45726.97	11465.91	3594.99	1365.82	2431.86
47	B	148989.41	98282.46	24389.65	111704.07	26648.17	82559.15	81331.64	2687.81	2734.23	1058.85
47	C	146522.73	128225.22	12182.48	132383.44	18638.42	13252.46	105782.38	1387.89	1025.78	1060.03
47	D	219510.55	96605.74	10149.18	140496.71	29871.03	45226.81	6000.65	10126.26	206.82	541.05
47	F	229196.09	151169.93	62392.88	41580.67	31991.17	7801.35	12137.42	3071.55	2246.19	1227.67
47	G	184187.52	172607.91	63199.67	81291.89	15616.17	16309.37	5246.26	12179.41	1571.22	4456.58
47	H	204359.32	193123.81	71141.35	27664.96	11003.50	22108.32	5448.74	2345.07	1851.78	4452.21

Analysis No.	Run	Si	Al	K	Fe	Ca	Na	Mg	Ti	Ba	P
47	i	199243.81	193486.27	62978.99	22228.53	26685.83	23545.35	6094.95	2125.50	1892.96	5808.62
47	J	218125.43	162318.29	43118.69	39229.73	32802.08	33466.31	7607.72	2277.76	759.86	3148.98
48	A	216052.09	197899.86	32796.82	0.00	0.00	0.00	52462.76	0.00	1373.07	0.00
48	B	194441.61	168180.62	39805.59	58262.90	11972.98	14312.83	48300.35	2141.01	477.18	2531.60
48	C	136249.51	108577.48	8818.84	122527.50	40941.76	69356.50	89042.90	2188.12	427.98	1420.77
48	D	203306.85	119966.46	19610.57	88956.82	6870.17	32247.02	69655.50	2314.02	359.89	1142.18
48	E	113401.48	125918.95	16572.21	97154.25	0.00	82293.47	73263.03	34136.55	1328.51	19984.95
48	F	299728.15	122743.50	30618.18	34644.62	0.00	0.00	12578.34	3474.28	1392.61	0.00
48	G	220241.89	137566.94	47294.54	51652.18	52667.68	15533.03	14106.09	3761.05	1164.53	3696.59
48	X	221676.05	177373.92	69176.82	27449.17	26160.62	4053.65	7317.70	851.77	1371.55	2850.92
48	Y	227012.22	157890.32	64270.75	34818.18	24974.99	16450.81	9939.20	2483.79	1099.89	2066.00
48	Z	213213.54	163149.78	72328.68	41603.49	20993.50	17473.06	11575.02	3189.08	1383.43	2973.48
49	A	231417.74	189085.63	64446.15	15901.17	15053.33	0.00	7908.74	2728.06	1609.04	1320.74
49	B	204278.24	188651.73	64129.37	29379.33	16291.55	29418.51	7603.39	2943.36	1730.44	1163.62
49	C	202395.79	212920.71	52948.04	26966.09	18841.35	9134.50	6837.11	4408.19	1704.26	184.57
49	D	210996.55	141565.06	58964.88	41435.38	45948.95	33763.83	15011.37	2342.26	1221.37	2848.56
50	A	308596.11	120789.23	46309.52	5763.24	6068.45	8788.61	9790.72	2584.18	1734.69	252.00
50	B	282571.23	134551.32	26211.26	4890.67	27837.09	39718.40	3226.88	1429.18	300.37	9.20
50	D	220408.02	184317.47	75409.12	24591.68	6134.10	19844.38	4997.84	2298.15	2562.38	506.09
50	E	178676.43	87711.98	69837.91	151256.23	0.00	0.00	68418.34	15367.95	688.06	0.00
51	A	174566.85	103402.10	23688.27	119206.17	15659.31	14428.92	96181.37	551.26	2483.85	3725.01
51	C	285409.53	151226.75	1919.43	5999.23	32099.67	31933.06	579.51	55.35	162.36	469.80
51	D	208810.46	200084.09	78751.32	17708.99	7108.01	19899.87	4279.29	2389.41	1574.44	1359.99
51	E	309797.19	149148.14	7920.51	0.00	0.00	17298.85	6389.12	2587.75	222.21	0.00
52	A	216443.91	210186.91	68399.39	19698.07	0.00	3732.77	5753.65	5365.65	1565.81	66.90
52	B	257148.47	91394.12	15577.57	27670.81	70334.92	49245.58	23188.85	4299.41	1422.60	1416.26

Analysis No.	Run	Si	Al	K	Fe	Ca	Na	Mg	Ti	Ba	P
52	C	194487.87	215146.06	59666.76	33157.44	6708.74	18335.08	7630.96	3105.79	1449.47	574.45
52	D	239573.33	165696.90	63195.68	18371.01	26004.87	9190.51	5500.24	2190.24	1338.84	2586.20
52	E	199019.58	113423.77	44480.43	93315.50	0.00	0.00	83253.61	11012.30	600.36	0.00
53	A	228070.74	215151.28	69420.37	0.00	440.42	0.00	6106.23	1931.93	1787.85	644.88
53	B	201120.29	214948.42	58448.90	40472.27	4535.06	7618.39	5105.46	3246.07	1982.18	334.65
53	C	178795.35	203213.06	58104.60	73755.27	4168.18	18767.19	4106.29	8363.07	1508.64	171.28
53	E	211300.83	224868.96	85423.90	0.00	0.00	0.00	5930.94	1917.75	1980.32	0.00
54	A	293677.91	82341.59	30652.05	13418.35	67501.45	5437.71	23684.54	3002.55	1053.47	2725.93
54	C	202893.78	82505.29	32006.18	86721.02	97448.37	18589.85	36786.06	4525.99	3266.75	2904.51
54	F	310474.88	115124.49	15380.35	5361.36	2118.55	58383.16	2934.96	1141.92	457.50	0.00
54	G	192144.08	174471.72	78224.69	45381.51	22743.67	21141.42	10670.71	2590.80	1618.31	4864.11
54	H	267426.35	72610.16	19222.89	80765.75	24940.50	10493.61	50833.93	3188.92	480.33	1166.80
54	i	326588.40	97390.33	38230.55	16274.18	18624.40	7123.08	3685.83	1192.42	648.25	664.30
54	J	182637.04	189393.45	53164.02	53515.62	40667.89	14489.11	8667.81	8430.37	442.88	916.91
55	A	261337.99	91315.41	61292.63	0.00	37743.00	70687.51	10226.91	0.00	841.46	3668.29
55	B	190839.70	173808.46	56735.55	48825.91	9261.99	28461.58	5432.25	36437.04	1137.32	197.26
55	C	172080.43	131369.68	40850.07	48795.62	116162.94	46958.70	14190.49	3350.82	1252.62	972.98
55	D	221707.79	179370.96	70934.01	31097.38	16094.33	3923.49	9065.65	4021.65	1647.83	805.87
55	E	244686.65	101790.85	43555.91	46296.23	72798.54	0.00	29985.35	3242.04	2054.84	0.00
56	A	365849.26	71765.64	34141.37	0.00	13549.65	0.00	6247.30	632.90	659.64	1180.59
56	C	229702.77	106772.18	39997.89	53320.87	30834.02	75870.95	13357.54	4115.69	943.18	532.02
56	D	315549.80	121107.42	18820.76	9374.26	31696.58	4985.23	1914.44	156.04	130.23	1118.19
56	E	291569.07	163325.64	30950.84	0.00	0.00	0.00	9846.12	2204.40	600.16	0.00
56	F	234163.17	194055.04	52902.73	11825.22	13834.53	8213.26	5728.65	3484.92	1979.73	802.12
56	G	203954.01	191909.69	79118.15	26133.37	17702.72	17527.07	5007.91	3788.98	2181.52	402.74
57	A	190600.81	122977.66	50602.90	99258.37	0.00	0.00	72925.92	2425.59	250.21	0.00

Analysis No.	Run	Si	Al	K	Fe	Ca	Na	Mg	Ti	Ba	P
57	B	270337.59	100207.28	76319.81	44055.17	38308.90	0.00	11548.39	602.39	434.41	0.00
57	C	221505.43	189240.35	72983.94	32447.54	9786.28	0.00	6158.33	2059.51	1865.33	454.67
57	D	214857.70	193615.34	73875.69	24830.13	5653.77	18933.08	5191.65	1400.02	1634.31	831.39
57	F	249113.82	188599.30	41628.88	12157.08	10264.27	0.00	8729.95	4333.14	1646.80	1101.66
57	G	210619.49	205308.05	76905.99	20787.98	3072.53	12975.74	4604.73	3226.78	1508.64	279.51
57	H	240568.22	170402.06	69783.66	16754.37	4555.17	24537.63	4088.73	2717.21	1549.36	400.17
58	A	207710.42	210759.18	75752.55	27271.79	0.00	0.00	5448.83	5148.88	1300.72	0.00
58	C	147740.57	71304.65	2528.54	262456.07	25126.79	0.00	56418.20	15684.16	68.93	1810.22
58	E	230189.81	138503.25	80399.69	34447.53	42880.17	9173.75	9104.47	1430.26	1581.11	1663.20
58	F	278627.88	81715.55	29173.92	29001.34	77686.28	9624.96	20174.14	3511.05	975.69	3074.10
58	H	224143.46	153233.71	79783.22	31157.66	28016.47	13019.42	12010.03	2770.38	1746.78	1776.33
59	B	218272.52	205425.81	65885.00	21716.22	12547.48	0.00	5588.14	1773.96	2375.22	162.74
59	C	164895.25	94161.33	0.00	147580.50	22080.61	0.00	113219.61	7604.52	131.71	1692.51
59	D	292798.90	110536.87	41589.08	38121.12	22513.45	0.00	11730.37	1776.34	1452.53	755.26
59	E	187762.57	99037.71	11258.74	115549.32	18192.10	7785.08	103291.41	2389.12	132.21	1258.52
59	F	247982.88	175091.46	46035.83	35694.81	0.00	1030.00	4867.07	8886.07	1764.78	0.00
59	G	218945.28	158001.72	51295.22	38224.41	43763.83	19081.93	8839.53	2012.88	1850.88	2782.65
59	H	209023.65	203117.39	49300.81	35048.71	6458.85	16063.57	10648.09	2533.44	1226.76	832.13
59	X	271901.68	110408.21	37785.48	50070.76	10545.50	10103.73	32243.97	452.02	525.73	1348.51
59	Y	222206.20	185894.76	75727.60	25052.48	9808.71	11576.58	4590.90	2124.86	1745.01	790.58
59	Z	219871.35	187941.19	69430.38	22639.81	6866.14	24891.00	3602.64	2326.04	1360.88	676.21
60	A	224735.63	117292.48	16332.89	73459.56	0.00	13468.62	76222.48	2412.72	543.62	0.00
60	B	142095.35	120071.60	10559.41	152441.01	26189.04	0.00	105511.51	505.06	464.88	1941.89
60	C	218987.53	202167.81	65678.53	20614.46	14083.06	0.00	6902.24	2047.61	1877.77	782.83
60	D	273535.97	89898.77	28192.33	46170.27	65675.93	0.00	22557.01	3309.70	826.54	2537.45
60	E	257954.87	139668.21	36036.39	34884.60	26817.89	27124.66	4535.69	2168.89	706.37	756.38

Analysis No.	Run	Si	Al	K	Fe	Ca	Na	Mg	Ti	Ba	P
60	F	310094.15	128187.06	0.00	0.00	35028.40	0.00	9117.60	2118.23	1087.09	9751.43
60	G	202050.47	200241.46	76703.88	21683.78	19604.84	7295.17	5438.13	3725.00	1455.91	4107.34
60	H	284266.45	119610.60	68849.88	14166.60	10987.07	23514.09	4130.15	1771.02	1472.19	928.44
61	A	268849.40	105611.34	26359.28	48427.81	33332.56	0.00	29058.57	5834.15	1038.93	91.84
61	B	205319.50	96924.70	0.00	0.00	131371.39	0.00	98284.72	0.00	381.56	1188.39
61	C	285327.49	117871.72	6820.56	6377.11	70883.66	0.00	11501.54	1188.14	1549.69	9387.08
61	E	148117.65	98528.84	8979.30	163621.90	23206.89	25476.49	97159.00	146.32	393.58	1982.93
61	G	202803.32	183881.46	76488.74	34340.17	26662.94	12329.58	6570.03	3091.74	1531.52	1324.40
61	H	215873.26	180802.72	76339.09	27615.57	17531.46	13487.12	6769.39	2017.39	1604.52	1412.37
62	A	274164.63	170333.74	0.00	29606.98	0.00	0.00	8530.08	1324.99	489.17	0.00
62	B	225853.18	214441.61	60811.17	4832.56	2749.68	459.80	12166.08	1306.10	1276.11	670.18
62	C	230986.10	200596.78	48116.35	14190.94	13804.29	0.00	9406.06	4141.98	956.47	793.01
62	D	147277.56	114021.87	0.00	204114.24	3871.43	1904.42	91926.70	290.63	180.22	44.39
62	E	226514.96	190054.15	66081.23	17705.21	3222.16	22511.95	5131.48	1070.84	3770.82	0.00
63	A	201655.60	122686.28	14591.56	50486.38	154618.76	0.00	11541.46	1349.81	671.63	146.85
63	B	175745.87	124195.23	0.00	179488.67	4735.52	0.00	69072.43	261.44	223.75	95.94
63	C	178897.51	131864.57	1432.43	100348.98	153532.53	0.00	1026.79	397.43	90.91	399.49
63	D	296012.13	142406.43	0.00	3530.43	51165.49	10131.45	1568.71	260.55	1342.63	0.00
63	E	243628.69	70480.21	0.00	20202.48	69739.86	143074.09	11444.55	700.62	577.85	0.00
63	F	236634.97	207073.25	48303.33	10778.35	958.73	5166.27	6410.22	3244.50	2276.06	309.97
63	G	279926.19	145510.60	58540.78	13757.60	2512.23	14351.28	3407.62	2490.72	1413.53	273.83
63	H	222137.35	175236.11	79872.71	21340.31	19469.81	18728.93	5511.37	697.91	319.68	808.12
64	A	153045.81	152095.03	1967.26	83705.35	0.00	0.00	139654.92	925.76	168.81	0.00
64	B	213591.51	201060.31	63310.65	17642.19	27157.01	0.00	9177.24	2262.25	1460.61	438.84
64	C	242678.46	176368.52	47381.42	47732.16	6965.91	0.00	3919.46	362.30	1020.81	319.15
64	D	212255.71	206060.75	51157.51	25944.91	22846.31	5086.57	5950.78	1163.88	2038.67	1019.85

Analysis No.	Run	Si	Al	K	Fe	Ca	Na	Mg	Ti	Ba	P
64	E	217999.27	204012.89	66822.00	20653.46	6301.51	11013.01	4827.20	938.52	1940.16	195.81
65	A	210201.87	207271.79	74170.93	16348.33	0.00	8444.03	9402.17	4433.19	2234.21	0.00
65	B	112012.94	105387.94	27826.64	300402.87	14886.80	0.00	3202.00	40159.90	986.66	416.98
65	C	204292.67	202071.55	72461.52	34948.71	15590.15	0.00	7851.63	1997.39	1203.69	724.32
65	D	225416.02	196884.48	63344.40	19956.02	1863.30	14194.32	6796.52	2231.88	1356.46	0.00
65	E	227122.40	184615.81	82009.29	22207.58	2033.10	9949.68	7106.11	1330.91	1218.52	247.37
66	A	185520.90	171199.40	46093.41	43617.73	10324.34	0.00	74457.56	910.44	744.54	1100.24
66	B	219386.41	208026.70	77342.74	8231.38	9698.51	0.00	6262.83	2248.60	1841.14	399.03
66	E	258413.04	130437.69	23281.88	25400.30	67338.24	11527.10	6004.55	1526.55	503.26	4459.36
66	G	215064.83	141447.78	52314.27	53134.67	35245.96	18014.32	19608.27	5483.29	1024.66	4579.87
66	H	220561.09	174701.40	94589.74	24028.47	14652.24	4150.76	7773.23	2773.60	1496.16	793.25
67	A	168742.91	251624.39	100710.66	1351.43	0.00	0.00	7682.76	3491.93	2379.62	0.00
67	B	218006.01	226912.64	66316.01	3622.05	0.00	0.00	4731.71	2115.28	1999.87	679.12
67	C	201197.32	204149.23	41266.72	42280.91	23216.16	0.00	18464.20	2301.02	1275.33	997.86
67	D	214589.22	203989.89	74894.05	19041.01	11665.24	0.00	7050.05	2077.79	1764.74	571.72
67	E	192109.00	82955.44	26439.54	59816.29	94347.27	73885.33	36111.87	7949.58	686.61	1777.54
67	F	184699.85	103828.98	7609.17	117061.61	59859.15	1765.72	76626.83	918.66	268.60	0.00
67	G	159633.95	109677.64	18634.06	117489.91	60775.87	4169.13	88086.61	470.19	280.77	1444.94
67	H	226504.87	131688.29	48918.84	47116.37	64139.09	10523.23	13526.12	1584.58	1771.24	2580.38
68	C	237533.32	90810.64	2358.90	61919.46	108326.75	0.00	37400.13	3853.19	1248.15	1861.21
68	D	248427.05	125791.95	31066.02	65493.84	28210.29	8584.92	18184.55	6548.28	1245.68	1220.65
68	H	280869.62	108336.27	115602.35	5684.42	8669.34	8170.45	1529.61	0.00	16110.35	697.07
68	i	291330.57	104257.72	13195.08	27007.76	24611.39	50411.81	8911.25	996.14	1083.96	1238.01
68	J	251714.19	137945.80	59521.01	20333.62	16265.24	42924.78	2162.01	35.70	11440.41	618.38
69	A	172674.23	269586.53	60426.10	0.00	0.00	0.00	9290.73	4526.45	2334.05	0.00
69	D	206227.12	197796.48	70052.43	21673.36	24583.35	10119.99	6330.37	1502.49	3903.14	740.03

Analysis No.	Run	Si	Al	K	Fe	Ca	Na	Mg	Ti	Ba	P
69	E	168480.04	98028.56	27503.59	117657.42	36820.27	13263.63	100470.45	3096.19	198.25	699.61
69	F	214670.62	172675.47	53766.31	13046.04	54610.96	9192.28	10083.91	3541.50	6765.28	3503.74
69	G	249192.23	149132.58	49731.09	14219.31	44032.60	18865.57	3964.90	3615.44	1193.84	789.22
70	A	176149.24	135416.76	0.00	69725.25	0.00	0.00	140124.56	6967.45	165.60	0.00
70	B	230408.32	198039.52	80586.54	6886.17	4491.39	0.00	6266.11	2461.09	1190.10	772.63
70	C	214419.45	210065.09	65315.32	26063.34	6283.78	0.00	6049.20	2108.93	2572.70	530.64
70	D	170780.56	113126.59	17387.05	67919.07	78500.11	44500.93	66547.24	180.15	551.21	1305.73
70	G	225304.89	200258.04	58605.89	18569.04	4260.38	14245.37	4679.79	3324.90	1094.05	385.69
70	H	304574.25	112018.94	29310.24	4795.96	3334.39	62242.34	1946.19	319.79	136.37	317.77
71	A	205713.43	233729.74	70559.26	0.00	0.00	0.00	7091.37	5799.66	2037.09	0.00
71	B	222100.32	194609.61	67070.89	16250.89	14389.24	5859.17	7022.07	2562.93	2153.99	2036.81
71	C	212057.19	185439.12	81713.81	37159.85	11856.36	0.00	8011.86	2096.76	1684.72	2796.83
71	D	194378.30	173613.31	64709.23	87564.02	9715.11	0.00	6182.84	12070.89	1271.36	1880.37
72	A	184023.35	154891.75	0.00	62058.89	67026.44	49162.15	11799.09	3203.80	1755.11	14337.25
72	D	174388.45	80500.55	53682.65	109845.21	64430.01	13069.14	69570.27	3550.90	1003.05	5072.96
72	E	214205.84	157040.78	65613.23	30129.55	33367.77	42041.25	5399.65	802.50	1300.21	1421.25
72	F	195811.31	130851.69	37026.49	143388.48	0.00	186.01	3969.00	41372.89	975.69	0.00
72	G	210665.08	180512.74	66268.57	39333.57	31649.16	4475.50	7898.11	1581.29	640.43	1094.15
72	H	199452.95	180559.17	59259.14	43063.53	37166.86	12003.71	11517.66	1708.40	1118.25	1430.78
72	Z	203075.73	75760.58	38902.98	73396.65	128042.86	17985.00	30804.60	3857.42	613.53	2358.30
73	B	213280.34	148877.61	66632.29	45360.86	37684.84	19919.96	10385.51	4294.23	1704.96	3329.66
73	D	222416.35	174119.55	80437.16	29436.37	17233.36	5365.51	6146.18	2571.27	1354.80	2500.53
73	E	222095.89	169348.64	74708.31	28722.00	28939.74	7895.87	5811.79	1392.02	1355.52	2791.21
73	F	250958.99	170156.49	62269.28	27510.92	778.58	6373.12	6761.81	851.78	1736.21	0.00
73	G	213086.86	179655.86	67364.18	28506.76	33924.23	5172.44	8618.28	567.34	2791.17	2861.12
73	H	214645.96	187429.10	72409.36	31777.34	11732.16	12222.58	5316.09	1810.59	1642.67	2048.27

Analysis No.	Run	Si	Al	K	Fe	Ca	Na	Mg	Ti	Ba	P
74	A	201748.40	208382.67	32035.11	36251.08	25682.75	14601.81	9488.77	2785.71	1226.98	1978.08
74	B	216771.88	156383.77	61431.46	40865.21	40441.88	6144.33	18840.12	2127.99	1170.82	1739.27
74	C	237232.44	191457.83	59773.08	25599.81	4351.62	0.00	3980.87	2762.35	1540.19	578.97
74	D	233328.65	178326.61	80068.31	25419.99	5010.87	1282.99	9084.65	1076.78	1305.01	363.72
74	E	231935.00	176657.66	79257.69	26455.97	6014.12	9865.94	5142.24	951.58	1368.54	625.24
75	A	218969.43	202370.80	58943.50	33308.91	0.00	7371.54	5179.25	3518.95	1233.89	238.63
75	B	230101.40	169661.48	81922.56	30759.14	11000.96	5536.63	5977.58	3159.81	1466.92	786.41
75	C	223361.05	169746.12	72732.36	29783.36	20715.06	13031.12	6967.11	3370.58	1461.90	1076.42
75	D	230922.64	128770.93	61176.85	35210.57	69785.69	3682.92	13933.50	1832.09	1908.64	2032.00
75	E	214973.96	163808.76	75002.77	33281.16	31798.57	16355.58	8878.03	1144.54	1651.70	2049.64
75	F	247536.91	148268.61	45040.83	36571.54	25444.58	11867.54	14500.71	611.33	1241.67	0.00
75	G	286356.64	144318.90	59300.79	10149.29	7074.42	4621.49	4333.43	329.53	1115.81	726.24
75	H	244330.44	86487.51	34746.48	70743.07	74504.45	5575.49	29280.81	1372.98	758.22	1453.98
75	i	287331.21	120443.53	60441.89	20660.95	14961.47	11055.25	6593.81	1305.18	1008.78	1240.52
75	J	212654.45	153638.04	63312.92	27396.14	72531.28	4397.70	10588.02	2808.04	1585.13	2131.28
76	A	139365.79	90206.11	3574.22	294168.74	12257.81	5702.64	39556.75	4054.91	332.24	1493.38
76	C	241613.88	103709.02	51516.03	48106.74	77004.80	0.00	21028.36	3800.81	791.04	1403.60
76	D	287994.65	77282.34	30615.80	51531.26	58400.42	7062.07	16010.28	1580.54	503.93	1557.53
76	E	201112.51	85072.39	50724.51	158878.81	9427.28	8244.35	49152.97	3801.69	1884.56	848.61
76	F	273827.50	98705.13	0.00	46085.15	60842.53	0.00	29739.62	5738.90	825.51	0.00
76	G	278499.53	106079.78	108698.61	6508.27	12848.37	17018.16	2418.17	93.63	13892.85	514.90
76	H	194042.01	91123.46	63266.53	108377.32	57759.56	10188.53	36046.45	10426.58	2946.85	926.20
77	A	211874.92	148419.35	11668.69	84589.19	70390.19	0.00	12111.77	2747.77	526.03	1908.61
77	C	224910.95	151120.73	51828.72	42505.13	47014.42	7225.00	12633.94	2515.11	1719.05	2205.69
77	D	194590.22	140939.84	61989.32	46374.42	84115.95	11840.02	19067.95	1333.68	1386.44	1483.93
77	E	211543.32	177561.36	82924.77	14520.46	39916.62	16350.47	4931.95	251.19	267.29	927.58

Analysis No.	Run	Si	Al	K	Fe	Ca	Na	Mg	Ti	Ba	P
78	A	233934.72	217596.05	29943.28	19259.41	725.82	0.00	4250.69	2454.45	1346.48	3328.27
78	B	229056.47	175476.52	70545.30	25154.34	15393.74	7148.77	6050.88	2086.76	1538.76	3402.20
78	E	209187.81	156400.60	84992.21	24493.82	25017.54	43118.59	5458.05	819.12	1293.41	5217.91
78	F	219431.01	193647.75	68224.85	18147.20	17400.46	0.00	4654.07	471.61	1687.32	7837.98
78	G	271486.15	154065.42	51807.60	10227.62	16802.54	5677.11	3347.28	252.50	1193.73	4592.06
78	H	211293.42	197088.09	88355.01	20333.38	4959.65	12899.15	4757.15	1080.77	1611.19	886.95
78	i	311357.00	91964.52	41471.80	15336.31	8630.08	47681.68	3694.49	702.66	714.42	796.97
78	J	212813.50	185683.91	69985.95	21272.15	26546.30	9410.67	5731.82	2177.10	1741.28	4983.35
79	A	192297.17	120527.33	32125.77	124505.42	13086.64	0.00	60076.64	6382.64	1837.70	1370.55
79	B	199718.21	104427.72	44559.67	106389.80	15944.76	13068.94	62190.90	6032.16	897.48	2655.45
79	C	213794.59	157571.44	78607.82	41188.02	33458.47	5325.91	11955.22	3465.33	1766.16	2637.24
79	D	215147.48	160111.37	61196.80	32059.43	57783.71	10331.87	8603.40	1224.66	1125.54	1087.15
79	E	181481.85	119015.32	60288.57	82340.17	64109.93	9734.28	41951.09	3019.92	526.04	4906.14
79	F	225702.80	173628.37	32077.39	26319.94	27527.69	860.99	35321.78	2839.25	1011.40	669.98
79	G	200391.01	199409.31	66857.03	26296.99	28046.14	10049.30	6076.09	4805.35	1395.89	747.67
79	H	272315.24	128319.51	28413.58	6566.31	42043.46	47627.57	1986.95	614.36	317.54	866.98
80	A	251498.14	171787.95	18210.51	38925.46	22418.98	9468.52	4847.26	1105.73	575.49	675.86
80	B	157719.69	117373.79	12188.28	131344.25	23614.82	3550.77	111634.49	724.54	115.47	937.81
80	C	223524.29	184530.91	77095.05	25084.96	12789.70	3111.56	5519.33	3648.63	1980.36	1180.29
80	D	270128.96	152501.17	33818.95	13065.96	25510.04	21422.10	3389.09	264.83	380.49	609.77
80	E	279533.36	98843.62	52792.75	36691.48	31099.59	14995.38	10860.55	829.99	938.20	5260.22
81	B	276135.94	107897.91	20060.76	30553.29	49498.60	27557.18	12410.75	2946.98	427.15	1160.12
81	E	256563.11	101206.54	26454.56	45866.35	57351.78	33449.98	16673.41	652.26	585.45	2178.42
81	G	290343.94	129961.10	11986.17	2906.66	24042.86	56807.22	958.13	24.84	334.13	379.76
81	H	295853.61	132918.55	17410.07	8722.04	16331.54	40175.38	1330.29	30.74	133.99	753.05
81	J	215449.93	109158.33	14956.98	76648.69	94744.96	715.11	27971.32	3114.86	11465.95	1545.66

Analysis No.	Run	Si	Al	K	Fe	Ca	Na	Mg	Ti	Ba	P
82	A	232334.75	227544.56	35461.88	7235.18	0.00	0.00	4514.75	2530.98	2184.50	658.77
82	E	228319.14	167902.56	84249.09	28575.75	10822.55	12374.91	7223.17	924.95	1515.19	1199.96
82	F	321845.95	114971.49	14742.22	35007.77	0.00	0.00	5201.00	6013.48	903.17	0.00
83	B	270512.21	118957.60	15781.62	28967.32	57450.45	23651.23	7405.46	627.13	650.38	2707.39
83	C	273093.26	77616.52	86849.91	18819.28	58327.11	20308.56	9963.93	954.45	861.57	2754.65
83	F	276387.87	158884.05	31043.23	24472.79	0.00	4966.53	9337.90	4189.27	892.42	0.00
83	G	296456.68	92126.77	43648.46	17084.01	36530.36	25518.30	10606.96	3331.63	444.14	1277.04
83	H	206167.96	214044.88	68569.93	19263.12	9953.75	9785.88	4192.27	3048.91	1165.52	853.68
84	B	303506.03	112759.32	41400.07	28637.36	10041.12	7826.01	4470.48	2317.90	504.98	3516.81
84	E	218878.74	172614.65	60488.49	35372.11	19872.13	10682.27	18501.49	828.41	910.30	889.74
84	H	204438.88	180616.10	50622.27	45301.64	29557.36	13893.37	13354.44	2741.08	1155.22	1397.56
84	X	221977.44	166136.99	66897.22	40775.99	20300.27	12492.90	9340.11	1009.30	2261.02	1975.18
84	Y	230221.03	85744.50	30699.60	88181.36	44940.25	23956.70	42581.12	2603.61	1300.69	2280.26
84	Z	256567.91	100714.54	42377.12	51913.48	45541.15	20034.72	18740.22	2496.15	987.40	2297.05
85	A	215008.22	216378.80	53016.96	31975.94	0.00	0.00	5134.28	3834.06	1160.97	373.90
85	B	223507.53	185291.00	70970.22	26726.12	6231.76	14485.32	4911.63	3770.70	1378.88	473.19
85	C	264496.06	140226.27	47130.79	36046.11	13976.48	17790.85	4482.42	1975.43	667.22	1513.37
85	E	301884.66	94000.81	53729.30	37570.29	18535.88	5895.73	9702.30	1119.85	754.86	1293.69
86	A	179810.64	120454.96	23173.76	152316.88	6559.19	0.00	64428.03	6771.02	174.40	636.43
86	B	169023.97	105706.48	16585.31	155987.68	20412.41	3550.89	87160.75	1893.02	85.62	1021.63
86	D	195582.04	95480.08	36112.44	127105.13	21179.88	2850.63	73436.55	4993.01	211.49	819.52
86	F	235036.09	186705.36	60528.80	22865.91	0.00	14711.19	5245.34	2410.11	1759.70	0.00
86	G	243332.42	155580.62	39039.23	23753.44	35821.71	21607.41	8692.07	1428.85	738.22	2087.71
86	H	207228.57	191413.43	72156.74	28751.23	11915.82	15240.16	11445.99	2136.10	1525.49	1325.60
86	i	206683.39	207469.77	58081.09	30242.21	9304.00	7772.87	11904.44	1882.75	1513.32	721.13
86	J	126618.70	169451.24	43268.68	64036.44	168428.33	9106.53	5356.56	1491.44	129.56	963.01

Analysis No.	Run	Si	Al	K	Fe	Ca	Na	Mg	Ti	Ba	P
87	B	231440.64	177864.30	60154.50	27890.71	7529.01	20710.23	4797.62	2924.01	1575.22	469.08
87	C	222742.59	181617.51	63832.09	32038.69	10163.63	15699.39	7160.99	2871.06	1625.77	550.23
87	D	219841.82	168441.93	79292.13	37943.35	9650.60	15732.06	8318.38	3634.08	1610.15	1092.98
87	E	267921.86	105002.95	23374.88	9746.70	28948.38	102732.10	2365.39	382.29	78.72	680.75
88	A	262907.40	159458.86	44752.96	31136.32	11016.62	0.00	7365.54	1797.87	1208.74	98.77
88	B	289764.11	124631.91	19232.06	26612.84	27603.90	18419.06	7086.97	2260.92	540.82	651.74
88	C	234246.03	169951.91	69531.33	24720.32	17408.73	12354.81	5544.27	2130.36	1338.99	524.40
88	D	216282.28	175142.25	66628.87	30537.79	39264.20	3769.94	6973.24	2808.44	1580.09	964.84
88	E	306624.60	100326.33	5814.54	35893.88	7983.78	56801.90	3683.27	54.47	34.93	356.75
89	A	252815.00	163026.04	46557.36	32330.18	20572.96	0.00	5512.79	1785.93	1582.67	0.00
89	B	259468.58	114874.59	36568.98	77421.88	17599.12	0.00	18853.33	2397.99	577.33	2720.56
89	E	221438.68	186837.66	64199.74	23329.97	7313.24	26073.16	4065.48	3621.21	1540.12	374.04
89	F	252741.80	170418.14	47445.54	30574.82	0.00	4033.38	7948.07	5482.01	1504.37	0.00
89	G	324967.21	97166.38	49117.39	8026.48	6497.01	21441.99	2516.01	2255.21	762.12	923.43
89	H	210116.49	183322.33	74884.42	33363.53	16072.41	11811.32	8024.26	4024.47	1467.58	1455.44
90	A	178537.78	124470.90	35073.91	202900.47	0.00	0.00	2822.19	22032.77	1114.63	0.00
90	B	234459.23	159585.55	58560.43	42574.31	18395.20	5634.41	11159.66	3270.81	1659.95	1280.43
90	D	255994.99	82929.66	12948.41	53983.02	99562.54	7932.76	21041.25	3745.76	709.35	3023.86
90	F	326524.41	80664.46	35161.34	48319.19	0.00	3664.10	12364.49	2009.39	1075.07	0.00
90	X	265693.73	97302.57	49546.85	59046.41	18062.18	21465.60	24429.04	1892.55	576.14	401.20
90	Y	271304.20	79226.55	25836.79	80521.17	52452.14	6966.04	19065.11	2042.61	538.68	659.23
90	Z	224662.78	90227.28	48057.49	90929.82	40626.19	42844.38	12674.91	10606.11	1071.87	1143.92
91	A	263669.25	162221.69	50354.06	30719.29	377.48	2668.45	6446.46	1783.80	1523.08	198.20
91	D	233863.04	174972.17	50546.13	37015.21	6120.80	11161.07	12958.80	2174.58	1530.86	660.74
91	E	290671.63	117631.72	4464.61	9363.43	22439.02	71963.38	1900.89	866.87	207.42	964.50
91	F	256262.94	151742.37	64206.33	31136.86	0.00	7762.87	11750.24	3785.31	1525.00	0.00

Analysis No.	Run	Si	Al	K	Fe	Ca	Na	Mg	Ti	Ba	P
91	G	199281.29	110633.83	12304.91	81099.91	4103.84	11345.29	112526.97	4222.41	78.31	474.65
92	A	251630.47	160934.71	54053.37	41913.58	0.00	0.00	6059.85	2502.05	934.22	0.00
92	B	235863.25	171647.86	57298.42	43252.61	5053.96	3433.03	5700.86	6447.60	2978.06	833.99
92	C	223051.06	169131.86	75282.25	43273.22	7859.03	7033.82	8104.98	4373.61	1360.02	1943.76
92	D	323299.52	114271.96	0.00	3230.66	5201.56	56463.78	1144.27	87.81	6.07	628.62
92	E	245199.42	179145.75	37715.95	18827.47	4992.94	31610.00	2760.31	2670.32	982.94	584.82
93	A	241977.06	165741.30	49505.83	28484.81	21647.58	0.00	5057.42	2041.84	1276.34	8995.59
93	B	260009.44	66646.46	27865.32	70176.97	61423.15	31341.86	16418.19	8037.55	436.83	4612.62
93	C	211708.34	167357.17	68535.24	40902.93	25681.68	15449.96	8595.34	3044.38	1409.09	4079.80
93	G	224769.39	191824.73	68591.23	9840.93	8571.11	18555.46	5221.69	3408.97	1507.70	2081.06
93	H	190273.47	110425.23	25147.40	112312.49	9356.01	32836.05	67886.61	3784.93	107.69	2281.58
94	A	279823.78	148450.15	53529.28	25107.26	0.00	0.00	3988.49	2181.83	1314.67	0.00
94	C	272407.96	92206.64	93931.65	44059.86	5543.11	13702.93	15097.32	2476.18	6527.31	416.63
94	D	242868.20	188979.89	53549.86	24754.68	4389.43	0.00	4591.70	2733.72	1509.88	645.78
94	E	250458.72	110184.00	31254.61	46273.68	54031.51	24282.72	17339.67	4368.05	935.88	1696.58
94	F	196593.50	117278.65	4744.84	118499.86	0.00	3237.67	93170.23	2864.90	49.34	0.00
94	G	245026.43	77426.29	43105.24	35761.68	83239.22	29054.52	28363.80	7440.10	601.12	2218.17
94	H	216001.63	92505.99	19275.03	56768.92	119199.44	24932.61	19284.66	10673.95	1318.24	1113.79
95	A	269554.95	128994.21	7297.83	24181.48	66531.87	19871.93	4765.65	838.35	302.18	678.35
95	B	227594.86	168274.53	52731.51	41704.17	14309.72	19703.01	7877.22	3005.96	1506.67	1166.75
95	C	221077.40	172382.28	78369.33	30944.56	8160.68	20698.57	6501.18	4231.04	1722.03	490.02
95	D	206684.16	156567.45	38963.20	79162.42	4282.90	7862.31	43686.89	1525.73	905.25	314.73
96	A	316069.26	123546.22	20913.87	12707.46	10789.57	15991.94	2445.61	530.78	398.34	0.00
96	D	298218.06	120285.67	6949.01	17050.20	15894.92	52189.53	2630.27	643.55	106.71	834.61
96	E	224374.34	84819.53	1666.22	162888.21	11978.17	56508.71	291.45	16297.10	24.34	977.19
96	F	245989.68	192341.98	43268.61	22107.48	0.00	0.00	5922.60	4463.61	1680.91	0.00

Analysis No.	Run	Si	Al	K	Fe	Ca	Na	Mg	Ti	Ba	P
96	G	298986.39	123891.63	24213.96	16665.22	10709.01	33852.98	3887.33	1006.31	253.82	770.05
96	H	282817.12	94029.48	19748.39	73112.30	10228.18	6313.72	32293.93	3206.14	286.11	931.40
97	A	269719.51	160103.82	50334.99	27224.33	0.00	0.00	6521.82	1572.16	1105.24	0.00
97	B	231669.67	176902.85	61861.73	32050.97	12059.76	10343.07	6230.65	2320.19	844.32	718.43
97	C	225263.25	199732.11	62564.25	24308.24	4590.66	6687.46	4803.37	2185.50	890.58	336.37
97	D	242488.90	146162.06	48414.90	50110.50	12844.63	10377.44	17514.74	4723.64	811.45	714.24
97	E	305645.68	133355.05	0.00	4223.27	30217.83	31182.19	738.51	152.38	65.04	519.70
98	A	259903.07	166348.30	48867.48	27887.81	8082.49	0.00	4687.35	1892.51	1416.94	0.00
98	B	256262.08	120898.26	48165.86	47934.68	18240.10	16615.96	17944.88	7628.63	1402.72	821.54
98	C	219616.76	184848.98	65271.45	32828.08	9993.88	11665.31	7386.88	4055.06	1576.10	1018.62
98	D	242793.92	153418.28	49608.47	35564.35	19687.64	15061.25	11351.12	3645.56	1482.56	1106.56
98	E	248133.08	116099.65	31120.09	49527.23	52381.73	17014.99	17306.76	4680.35	1199.88	1589.92
99	A	256382.86	165594.21	56899.82	32146.54	0.00	0.00	8132.07	2073.12	959.53	0.00
99	B	228843.18	182742.68	70823.07	26231.09	3122.54	12146.26	6792.77	3255.81	1442.26	469.99
99	C	222501.68	190122.05	77615.58	24044.36	2885.97	8236.61	6517.44	3214.33	1421.64	812.65
99	D	230486.73	183482.01	69954.05	25497.82	2457.39	11070.48	5973.70	3308.08	1577.72	799.28
99	E	218956.28	191069.93	62481.23	30388.47	3777.71	16367.99	6722.63	2551.32	1274.47	1033.40
99	F	205348.19	147862.34	56525.92	25748.64	99581.45	6378.10	13321.17	560.97	1709.32	0.00
99	G	235857.11	168340.89	76290.28	20954.99	20429.22	8706.69	5456.59	453.72	1130.80	776.77
99	H	212219.64	153764.69	84775.66	39500.25	33099.46	14041.38	12336.81	1664.35	1497.47	1492.91
100	A	233645.54	168413.46	52176.51	32240.54	30764.39	0.00	8080.74	1817.43	1729.14	1219.26
100	D	220268.02	163954.93	56823.56	29591.06	42619.58	15835.19	9475.29	2572.14	1756.66	1267.34
100	E	272508.06	97454.00	101223.21	13574.76	21204.21	30700.52	6452.35	376.48	3063.09	1512.52
100	F	385437.84	70940.72	2351.55	16088.49	0.00	0.00	3212.68	1454.11	514.96	0.00
100	G	225670.04	187847.64	79614.32	11646.18	6611.34	15508.47	5449.60	3127.47	1881.17	470.30
100	H	212663.98	213061.72	64437.64	14033.00	3173.97	20872.54	4022.94	634.07	716.89	305.77

Analysis No.	Run	Si	Al	K	Fe	Ca	Na	Mg	Ti	Ba	P
101	A	255315.66	171623.90	56141.41	26722.00	2260.97	0.00	6358.16	1916.23	1321.47	0.00
101	B	217529.75	177754.87	70322.64	38901.79	17186.92	0.00	4781.39	12840.92	1379.57	517.51
101	C	256160.23	89034.06	13851.25	86363.12	11553.06	19486.41	50313.90	4967.59	131.78	779.53
101	E	185211.84	98078.57	34615.27	135478.96	11237.30	11440.14	74655.13	8065.19	938.26	1523.72
101	F	254026.06	172994.09	57586.36	20408.26	0.00	4905.46	7641.35	3605.13	1452.31	0.00
101	G	235003.04	141115.32	77615.46	14335.72	36877.54	17999.66	13258.65	2099.05	1329.11	2035.47
101	H	230922.19	143994.85	46912.34	33467.52	46270.31	8908.05	13951.27	6465.12	1020.83	6205.51
102	A	247536.80	190238.23	38239.55	29053.18	0.00	0.00	5071.18	3168.56	1031.58	0.00
102	B	205559.67	173065.96	68628.26	47078.49	14902.36	22448.96	11763.40	1617.05	1803.14	2142.58
103	A	153473.94	119340.50	7260.43	66262.94	197317.79	0.00	19446.45	2717.27	2129.39	0.00
103	B	151099.50	79015.14	52443.25	47574.11	212576.92	30080.29	24084.36	2349.39	1780.98	2401.93
103	C	204930.09	73389.35	56010.27	114429.39	54048.46	7138.49	48408.75	9344.27	1716.09	1365.26
103	D	224641.35	172143.55	61382.80	28130.19	33500.02	9521.84	6356.61	2564.13	1281.46	762.34
103	E	208742.93	160296.00	67169.87	29176.61	54370.75	20630.48	7600.77	2479.21	1961.54	939.69
103	F	234577.35	173042.09	47406.62	41028.00	0.00	0.00	18942.85	3780.91	2544.68	0.00
103	H	207273.13	176843.96	68741.72	28226.42	46608.97	5110.91	9508.94	2440.06	1480.54	959.23
104	B	275566.69	102349.15	49368.43	45784.74	29520.52	14326.79	13021.48	1566.25	2281.74	907.94
104	C	332025.30	64721.35	19152.23	13328.54	41277.14	31690.29	8794.05	346.00	681.80	2748.59
104	D	326272.65	73007.60	22221.44	1199.36	22626.86	67205.07	4355.67	95.94	1487.47	343.48
104	E	286818.71	89072.50	56027.71	17313.14	58810.69	3096.07	17462.63	983.40	1067.71	1305.89
104	F	163206.90	150023.95	86763.93	0.00	0.00	127703.84	17132.76	6586.01	663.67	0.00
104	G	205588.52	205677.30	71701.43	19726.79	2759.53	28779.42	4302.04	1898.19	1622.72	198.90
104	H	236132.74	99696.10	31567.80	67517.97	38144.80	16248.07	45316.62	6197.16	549.95	1929.48
104	i	245658.22	124287.60	38723.82	47056.52	37760.65	16434.60	22642.14	2843.11	985.47	1481.75
105	A	219316.46	193566.92	66459.47	34985.55	6025.20	0.00	8003.70	2936.80	2392.92	0.00
105	B	239365.35	156388.34	76393.69	36061.21	20178.57	0.00	7342.35	1421.73	2035.65	578.86

Analysis No.	Run	Si	Al	K	Fe	Ca	Na	Mg	Ti	Ba	P
105	C	238947.84	163363.13	50200.63	23817.62	7242.50	43786.97	6132.78	1117.26	1150.56	596.98
105	D	218548.04	190213.90	53885.11	20991.57	6919.97	39034.30	4572.82	2012.66	1541.92	697.20
106	A	273503.44	125775.05	61894.94	38915.86	13069.45	0.00	7167.74	2998.21	1560.66	1653.57
106	B	276782.60	109602.97	9937.39	22611.50	17164.55	78868.93	9131.63	3117.88	220.44	792.88
106	C	220743.03	179144.29	69378.10	32074.43	6852.55	10147.16	10237.14	7147.17	2064.18	812.32
106	F	261437.23	180204.47	39805.39	19121.17	0.00	1152.89	8623.28	1652.35	1047.12	0.00
106	G	213596.29	91414.66	63526.70	79022.73	20215.15	2870.52	54733.83	24824.04	914.23	1490.67
106	H	260789.66	118713.83	30316.30	46593.25	17835.64	13686.05	17434.55	21138.10	566.78	760.22
107	A	141543.41	117145.58	2407.00	124480.57	37012.89	0.00	133833.05	594.42	357.70	0.00
107	B	181324.33	146562.56	47664.95	40232.99	110049.48	26213.13	10817.73	1358.40	1949.78	1593.43
107	D	231138.08	183702.40	56142.59	21334.63	11051.38	8110.20	5567.84	3032.92	1545.95	621.72
107	E	234576.03	133072.51	60090.74	28583.76	7101.24	79689.47	5680.49	1775.45	899.48	394.10
107	G	190033.75	101275.70	42280.93	31399.10	172792.34	14480.15	16817.69	417.53	1306.61	3568.37
107	H	229098.05	105109.69	71102.45	52562.82	56500.21	15969.22	20576.62	2368.12	1327.55	2304.33
107	J	157581.39	113403.96	7863.26	106535.17	31984.30	0.00	131550.52	959.01	192.81	715.04
108	A	226466.39	177787.35	54825.55	34942.60	25052.23	0.00	7267.30	3736.79	1469.70	0.00
108	B	253592.82	118565.37	9549.28	13902.82	72623.42	63926.49	3231.82	396.96	471.69	2390.90
108	C	209903.37	194818.04	61057.05	30400.87	29832.93	1405.79	8021.79	1273.00	1375.00	1129.67
108	D	214336.33	193689.23	77595.41	25470.95	6577.10	12176.25	4906.20	3517.73	1557.38	717.84
108	E	220980.67	173785.91	72928.12	27975.22	20204.45	16733.10	5513.20	3069.29	1708.15	603.71
108	G	229435.81	186375.67	75292.14	16789.09	9262.56	12292.03	4307.19	286.81	1597.40	636.04
108	i	236492.68	101373.09	11796.17	28651.33	105840.88	54277.39	9491.88	379.05	495.73	2244.90
108	J	236277.47	96686.03	42187.85	52539.28	81040.26	9497.94	24892.44	2883.93	1477.47	3213.88
109	A	241348.15	150467.02	32452.97	51268.34	50523.92	0.00	5202.40	452.87	579.33	0.00
109	C	278892.01	106191.39	78993.24	35978.80	12306.14	11101.58	9724.58	1515.26	1995.14	405.00
109	D	231681.61	169224.50	67294.18	28549.91	4264.42	14362.32	17619.70	1715.78	692.46	438.03

Analysis No.	Run	Si	Al	K	Fe	Ca	Na	Mg	Ti	Ba	P
109	E	262755.21	107503.96	38137.97	65100.96	18821.76	17491.96	18742.21	5560.46	453.53	880.70
109	F	241741.98	199759.66	53259.28	14717.57	0.00	2917.44	3718.01	2552.69	1603.50	0.00
109	G	199094.18	145360.78	76658.44	92898.49	6930.19	9250.32	24116.29	2795.41	1139.01	417.79
109	H	230565.23	192845.64	71535.32	19335.45	4297.74	0.00	7823.74	2747.03	1295.50	254.33
110	A	218636.31	171860.90	63257.13	34187.29	32018.02	4633.89	9509.56	3281.49	1376.66	0.00
110	B	215125.73	189948.40	55809.09	26547.57	36424.16	4066.02	6462.71	1730.17	1442.24	766.25
110	C	202801.46	190797.98	68203.81	24575.87	40610.96	8044.56	7072.28	1754.31	1501.54	858.10
110	D	210029.63	178973.01	72280.13	32837.77	31966.35	7500.31	7232.72	3109.42	1657.24	848.32
110	E	228661.67	146483.52	59336.85	37882.11	31606.81	28319.22	8471.37	3071.64	1349.12	1096.37
110	F	249404.35	183325.12	48863.63	20824.36	0.00	10639.29	6031.28	1742.49	1378.48	0.00
110	G	207904.14	196825.88	70686.36	26751.31	13307.98	13213.20	9172.98	498.99	1543.64	1090.17
110	H	208906.90	180491.51	76437.81	32063.59	10117.85	31845.80	5233.82	1324.99	1347.99	860.05
111	E	212086.53	148895.77	75026.70	46599.81	19038.91	29945.11	12578.76	2647.86	1180.35	4784.68
111	H	280175.09	162671.03	28822.67	15777.18	1013.94	15547.16	2984.71	2161.57	1010.94	379.52
111	X	274038.18	86091.91	76332.80	35983.79	52937.03	0.00	11702.65	682.21	1069.16	3607.68
111	Y	328456.08	112685.08	42214.41	12685.28	4629.17	0.00	2128.02	938.54	725.67	722.10
112	A	251031.38	161963.66	9488.96	60764.48	0.00	1283.00	8830.07	1871.82	1015.90	0.00
112	B	273109.19	87550.11	11882.91	59492.92	31397.62	49539.96	18033.46	2228.67	662.64	1448.17
112	C	166149.53	164725.97	54835.36	43948.28	120527.40	8060.22	8426.29	2366.40	1431.64	1230.94
112	D	303551.79	98699.62	64279.80	7673.17	38465.70	7136.80	4401.36	326.63	200.63	1131.78
112	H	232763.83	197500.08	63306.09	16033.32	6560.10	3237.74	4206.72	2682.60	1228.89	339.12
113	B	288243.99	115232.92	106480.21	8699.30	11128.96	0.00	1929.10	107.68	1976.84	936.32
113	D	251415.13	145199.36	63548.45	27636.86	8467.21	10947.65	21022.76	3276.61	1313.92	529.00
113	E	152099.22	139104.41	136774.19	32268.42	14671.10	119282.87	3982.38	2396.61	849.21	1806.41
113	F	302932.21	113647.03	27138.15	33548.12	0.00	7329.76	18674.22	3901.44	982.66	0.00
113	G	207293.41	167658.05	91902.64	20102.10	21740.55	27103.84	10561.71	2326.17	1527.83	2985.15

Analysis No.	Run	Si	Al	K	Fe	Ca	Na	Mg	Ti	Ba	P
113	H	220842.89	69643.06	49332.49	84086.88	57051.78	22844.43	39143.06	16045.71	1438.28	2894.29
114	A	323870.93	119035.67	34339.11	18419.81	0.00	0.00	3090.60	1772.47	805.79	0.00
114	E	239810.21	183221.77	74009.98	20000.59	3265.10	2009.84	4981.02	1914.18	1410.16	349.29
114	F	366623.59	82936.77	21147.96	14081.08	0.00	0.00	2579.62	927.99	661.16	0.00
114	G	224886.80	188439.43	58911.51	30672.52	17150.90	3529.60	5550.41	2735.40	1363.79	556.20
114	X	230682.88	208173.48	50599.02	17802.91	7943.92	3071.69	4016.76	783.51	1306.76	119.53
114	Y	241954.86	146753.07	48983.79	45243.53	4311.12	13374.80	29320.11	1433.56	684.50	760.10
115	A	219599.03	207207.52	64003.33	26472.39	0.00	0.00	4709.54	3850.10	2855.08	0.00
115	C	209134.71	149928.04	37907.83	68711.52	9315.26	10644.54	45208.00	4081.79	599.07	2455.19
115	D	223192.51	134309.74	50473.29	51854.65	33987.28	36592.30	10956.46	5357.38	1146.91	2446.21
115	G	207652.14	158208.62	120998.32	15721.74	15048.92	32923.28	7393.39	3419.71	1296.21	504.23
116	A	216935.09	208463.42	65760.22	29211.79	0.00	0.00	5718.56	2756.83	1070.66	0.00
116	B	217048.02	193121.11	59896.81	33558.70	6970.88	14266.34	7709.84	1256.59	1984.83	848.95
116	D	234578.58	188670.63	62493.24	18402.68	3508.37	10500.04	7751.56	2053.53	1302.61	400.72
116	E	275118.52	96513.47	30095.75	36809.52	36582.87	49047.86	8953.81	488.90	287.96	1737.80
117	A	256895.11	173000.44	0.00	0.00	0.00	0.00	804.98	2283.86	470.27	0.00
117	B	200752.51	169907.10	42738.84	32468.07	42749.23	52399.58	6276.74	2148.11	1464.80	1319.16
117	C	200516.60	101167.89	56009.10	92569.56	21794.17	14035.25	65089.23	8029.28	337.46	937.17
117	D	222284.30	185438.61	75083.63	21969.60	11195.95	13978.60	4650.97	2495.26	1550.56	982.12
117	E	165901.76	113776.77	43719.18	145331.67	11404.50	9016.19	70048.99	9166.11	203.37	462.24
117	F	173433.91	111832.50	59446.15	44488.81	169470.85	8841.23	14883.83	463.58	1833.67	0.00
117	G	176297.32	138040.42	66613.42	24550.15	145198.28	6711.86	11756.58	514.06	2116.17	3258.01
117	H	204939.57	183837.27	82614.12	21937.03	16784.23	0.00	7245.33	1511.47	1632.67	2078.98
117	i	212147.45	200378.29	62725.03	26324.08	13327.31	15401.50	4540.46	801.80	933.18	907.71
117	J	213963.71	204615.55	67415.10	25822.84	7915.33	3719.66	5219.33	4277.72	1295.24	556.22
118	A	285470.76	133128.14	39056.65	21122.81	20165.37	6393.28	7983.75	2002.61	1581.44	547.94

Analysis No.	Run	Si	Al	K	Fe	Ca	Na	Mg	Ti	Ba	P
118	C	226373.94	185851.45	77482.71	21469.11	2630.90	14378.44	4578.98	3157.00	1381.26	468.97
118	D	193588.31	153034.32	78972.34	45856.71	30658.29	42098.32	11203.74	4080.41	1454.25	2286.98
118	E	190851.61	211640.69	56827.65	46192.42	18933.21	5169.97	8061.48	2263.81	1592.61	987.81
119	A	255232.94	175397.64	67677.92	17206.08	281.90	0.00	4487.91	1967.86	1343.62	147.58
119	C	288801.91	129621.95	20578.56	3715.13	23145.05	51227.08	1511.71	151.69	115.26	677.03
119	D	212848.32	178787.41	84627.40	18290.85	2280.82	46130.18	3392.58	2572.53	1151.79	306.19
119	E	192935.28	212805.82	66654.43	44721.27	8285.15	3905.50	6531.68	4673.84	1293.31	701.51
120	B	218001.73	103754.94	18465.74	84558.73	50135.20	19530.72	45635.24	2588.36	530.79	3481.57
120	C	240734.80	108854.17	27537.31	60181.92	39484.87	30513.73	29593.62	2285.71	728.87	1692.43
120	E	267382.72	150380.13	8575.46	7217.76	22385.12	64113.42	895.12	517.96	62.00	603.40
120	F	210160.19	87375.97	13757.17	150690.37	0.00	11102.37	66258.69	4375.19	296.34	0.00
120	G	194054.73	141504.73	80680.61	65113.21	49136.63	0.00	19859.06	6941.93	1926.52	3302.18
120	H	214001.43	205783.65	60071.68	26103.74	9189.86	10626.60	4267.57	2412.34	1516.73	469.27
120	X	268222.10	126035.37	49355.39	25264.82	31243.13	19963.13	8076.22	934.04	2241.82	812.03
120	Y	236743.16	142715.57	42257.28	34581.43	50096.85	17914.75	9497.01	2106.54	4105.93	1043.52
120	Z	222546.77	181423.11	57076.41	36968.94	24662.22	0.00	7716.47	3045.31	1594.98	1088.56
121	B	229226.87	178315.17	60247.01	31973.59	16059.76	8936.25	5451.35	2376.72	1192.60	573.48
121	C	223085.77	170822.80	63851.78	27385.29	28889.17	17756.62	6988.36	1502.37	1265.86	752.15
121	E	187856.52	212760.87	71959.52	45409.58	3003.25	17808.99	4240.85	2826.59	1496.27	343.26
122	A	358491.15	63574.61	49616.69	23227.33	0.00	0.00	3452.03	2280.24	416.37	0.00
122	B	293449.69	116343.79	55789.30	32751.91	9173.96	474.81	10457.30	2103.41	512.26	506.67
122	C	211815.77	167710.07	73353.32	23242.04	8554.35	56801.71	5859.19	2344.96	1237.30	1041.33
122	E	243460.60	153018.90	47138.56	54690.78	13350.74	5821.22	9921.38	3965.43	681.81	958.99
122	F	218681.08	216443.10	16104.97	43202.50	0.00	1669.25	7178.77	5382.76	1885.21	0.00
122	G	339326.59	80827.12	75199.48	8279.66	6693.01	0.00	2091.13	1789.49	577.73	266.87
122	H	199929.25	222642.31	57808.24	25211.49	4387.56	14420.06	5569.90	3512.85	1724.90	377.01

Analysis No.	Run	Si	Al	K	Fe	Ca	Na	Mg	Ti	Ba	P
123	A	251448.75	198997.64	45148.16	8518.33	0.00	0.00	4660.01	2336.14	1419.13	0.00
123	B	224288.39	178747.42	82419.08	29823.22	4848.67	9317.63	7204.73	2150.39	1385.59	639.53
123	C	277251.51	146735.24	32795.22	10032.03	2924.74	45951.66	3813.56	331.56	253.22	457.15
123	D	220854.77	188118.24	68429.92	23870.97	2923.64	17682.89	5872.10	3183.85	1454.46	503.15
123	E	196955.29	223179.66	66464.02	34164.70	2147.29	4707.29	4853.36	3721.19	1366.93	366.66
123	F	287709.45	99433.41	28994.27	59658.08	8733.12	5618.96	28089.21	1424.15	840.89	0.00
123	G	227957.51	189261.89	67835.80	20412.81	3747.20	14451.15	7853.86	478.88	1637.83	508.64
123	H	305773.73	111529.79	7548.95	12871.32	12102.61	61199.65	2907.21	40.39	453.80	504.19
124	A	333241.70	116945.94	3819.92	1361.59	11283.03	27160.86	1429.37	256.12	54.41	263.15
124	B	230748.82	159342.54	85762.99	40249.69	3689.04	8027.22	10055.57	3370.09	1399.24	637.55
124	C	289325.60	103977.01	111715.94	2612.07	2607.95	26759.29	1241.43	289.60	1260.75	490.05
124	D	256465.59	142434.50	78007.08	14982.34	2423.94	36440.44	3495.36	2447.89	986.58	542.44
124	E	285627.21	143235.54	16636.82	13872.34	5721.63	46192.19	2428.98	629.44	151.33	548.33
125	A	268490.60	163373.03	58437.76	12646.18	1661.64	7598.51	3526.70	2064.69	1334.74	222.61
125	B	227146.14	171496.70	89387.15	26793.41	9548.90	4523.15	7810.05	2218.76	1504.38	1452.05
125	C	282114.66	117677.62	67344.01	30669.31	8572.23	8633.62	6341.94	1783.99	736.66	2891.75
125	D	228649.35	177054.68	75459.00	26160.12	4394.58	13377.32	7047.84	2516.12	1821.60	1353.29
125	E	282993.28	137402.91	41707.52	28465.93	3013.95	17869.72	4921.49	2033.38	575.89	636.90
126	A	316814.26	105102.84	37938.93	12986.59	21708.41	7040.19	6115.11	1256.50	912.50	1033.48
126	B	285828.81	113856.75	68612.75	22421.54	16656.28	10172.94	6013.90	2160.47	1247.67	1441.59
126	E	250246.09	146241.65	6581.64	20517.84	43299.65	51893.87	7105.26	460.42	191.93	2474.50
126	F	202088.65	84800.10	22148.94	133114.27	12065.05	6350.87	80210.93	9717.80	1464.23	0.00
126	G	207600.66	159976.20	77119.75	49717.00	41897.73	0.00	9975.83	2874.11	1402.89	2141.31
126	H	206025.98	172866.94	61316.13	41881.50	35793.11	5655.90	13654.91	3901.42	1640.81	2783.87
126	X	195739.54	144859.59	64084.63	45733.50	70491.60	12157.78	19468.82	947.13	1773.27	4396.64
126	Y	178146.24	79157.92	55931.57	146963.48	33960.12	14.42	70231.90	6150.54	1179.22	3884.45

Analysis No.	Run	Si	Al	K	Fe	Ca	Na	Mg	Ti	Ba	P
126	Z	246650.72	156820.24	57783.82	28275.40	11084.22	18349.75	6665.05	3028.53	1308.75	2528.29
127	A	305091.92	131383.99	4198.55	1161.37	25602.57	37195.16	1306.68	62.34	86.90	462.43
127	D	220754.79	187010.97	68655.38	22840.00	13937.53	15013.20	4873.49	3031.11	1584.68	970.36
127	E	162562.06	181786.82	48749.71	102955.61	19555.88	18028.83	5706.43	19418.21	1249.29	2098.32
127	G	201783.24	191184.95	72595.52	22947.49	21779.91	13457.20	4506.83	3530.05	1580.35	8244.51
127	H	209438.23	190316.47	80204.13	24069.78	14992.39	17780.83	4769.17	582.62	1636.59	1397.01
127	i	210573.77	195271.55	84069.76	22756.87	10340.31	13037.76	4340.40	684.05	1470.63	972.52
127	J	186638.32	187567.94	85957.29	27524.68	22536.63	30509.04	4548.45	3123.46	1347.93	6058.53
128	A	329562.41	135955.78	0.00	0.00	0.00	0.00	5745.71	1409.21	115.74	0.00
128	B	233313.43	184356.46	66963.63	21775.19	7547.26	6044.52	7358.97	1726.56	1327.43	1149.54
128	D	227935.16	172715.18	74428.46	29312.74	10213.94	10195.74	7217.76	3702.96	1908.33	1548.19
128	E	189315.48	203352.13	64444.29	49582.79	11111.88	12132.73	7797.10	3623.57	1213.48	2658.01
129	A	284587.83	105047.87	14007.91	24976.70	59682.67	15577.49	10947.24	4476.13	711.60	1742.35
129	B	204638.79	167228.94	79194.48	27406.53	45670.44	8326.86	7976.47	1819.21	12073.60	1548.05
129	C	207407.30	79284.34	27627.27	82512.92	91205.46	19429.77	46819.32	2918.02	1048.54	4039.39
129	D	277668.89	124502.32	17613.02	10517.58	37531.32	42776.29	2192.10	8242.62	265.35	2188.73
129	F	208459.27	107752.98	82196.40	82628.30	38033.31	21002.23	17008.80	4074.54	1775.68	3371.81
129	G	175055.30	72391.37	46524.46	112130.78	94227.08	19403.11	52478.36	3352.68	1417.44	5108.78
129	H	204792.82	140910.73	97460.46	34791.01	38598.14	35627.03	9190.24	505.59	1474.73	2497.53
129	i	211611.82	201231.15	81451.56	21613.08	4904.74	13977.10	3994.23	416.87	1480.26	526.28
129	J	200136.14	176154.99	94257.49	31855.19	20882.83	19092.78	7531.13	1843.63	402.79	2086.69
130	A	247146.81	184933.93	49375.73	21424.58	4854.16	3768.85	5491.30	1750.18	1268.86	763.45
130	B	219842.02	190851.34	76586.09	24142.72	5560.41	12064.52	5834.43	1734.26	1047.92	1045.11
130	D	267266.59	131969.76	57053.89	24059.40	17932.28	20077.14	6954.59	2119.02	1241.34	2240.56
130	E	270261.60	88100.21	14850.03	50615.04	84544.76	1693.70	16583.22	3151.84	1703.29	2432.76
131	A	258519.21	170203.90	51555.73	18146.15	0.00	14963.88	4069.02	1571.78	1417.12	0.00

Analysis No.	Run	Si	Al	K	Fe	Ca	Na	Mg	Ti	Ba	P
131	B	222307.45	187180.88	68142.31	21622.24	4542.25	27326.07	4278.03	1792.06	1400.11	468.88
131	C	134624.46	90424.06	16824.82	223605.26	7628.38	18270.40	88832.18	973.43	107.13	487.00
131	D	214372.46	184913.76	74518.91	30197.58	3993.83	27705.12	4460.91	2291.20	1555.56	568.76
132	A	332940.50	82515.40	76514.81	8648.47	0.00	5173.00	1558.97	242.65	6847.11	0.00
132	D	254769.17	86663.04	60361.35	64718.37	23455.64	31791.32	22914.62	3221.09	268.94	1679.58
132	F	288250.19	152352.18	35435.37	8570.08	0.00	18076.04	4610.39	1297.24	673.25	0.00
132	G	232096.07	86619.43	23427.46	63865.56	108900.46	7271.73	25372.55	3558.44	672.58	2988.82
132	H	212506.57	196511.94	72333.26	32552.97	5405.82	4724.29	7907.28	4188.53	1562.48	912.81
132	i	212316.16	202691.35	68117.30	20129.76	3477.19	21248.15	6630.65	1916.97	977.62	416.40
133	B	268818.69	108974.49	60131.45	22499.12	27875.38	40343.54	6149.98	1236.09	993.08	1330.78
133	C	163999.37	102000.21	11939.92	169570.15	6082.10	8878.89	94134.18	3225.21	282.57	977.32
133	D	216796.73	177193.50	84644.59	36806.19	6106.41	11303.63	5950.30	4056.44	1496.89	852.94
133	E	232806.79	180445.88	75409.28	19530.79	9959.04	8271.74	4971.41	2035.40	1591.01	563.70
133	F	236414.74	178492.81	70163.47	33648.01	0.00	596.29	8569.21	2161.34	1976.20	0.00
133	G	137950.93	121270.10	9257.68	180226.15	25199.87	2734.77	88739.80	380.55	514.70	409.54
133	H	215454.32	193138.59	76981.90	30338.80	7353.93	7838.49	6574.65	588.94	1563.88	383.92
133	i	218190.82	174973.82	92843.67	32277.57	10565.05	8589.87	6939.89	480.63	1581.77	545.05
133	J	210537.61	179727.59	90843.55	30968.05	6788.28	19738.62	5749.70	3018.24	1642.26	567.19
134	A	265629.18	162044.46	60565.23	19771.42	0.00	4673.30	3904.15	1612.61	1135.86	0.00
134	B	232400.78	171961.22	69549.54	25364.02	10308.75	11013.69	6979.98	1905.87	1759.20	3662.79
134	C	219888.97	185123.46	74066.44	29712.40	5037.38	13289.59	5602.91	4091.18	1352.05	1146.00
134	D	215683.83	182305.18	83980.22	25927.65	12066.78	12613.11	5092.83	1903.33	1462.41	2808.96
134	E	229008.05	185603.81	67504.44	20348.65	5333.88	15499.52	5687.79	2072.58	1911.14	1505.70
135	B	234333.23	181404.50	71151.60	25791.81	2615.03	8286.08	6297.04	1801.69	1378.45	489.60
135	D	217441.57	175036.91	95782.63	27640.17	3475.12	18761.64	5403.57	3064.14	1423.38	451.47
135	E	223537.00	177706.11	82343.24	17060.89	2701.41	32534.89	4035.92	1910.36	1652.73	433.26

Analysis No.	Run	Si	Al	K	Fe	Ca	Na	Mg	Ti	Ba	P
136	A	252433.87	179603.05	48089.80	21536.12	0.00	8929.62	5277.68	1307.43	1522.87	0.00
136	B	229917.37	196724.63	63613.74	16094.86	3890.79	12013.69	5011.00	1180.37	1541.20	392.89
136	D	228203.97	171103.36	91222.19	24045.35	2776.47	12743.83	9565.71	1453.71	774.76	567.75
136	E	220861.93	185364.31	80484.97	13921.60	3289.85	30342.67	4339.76	1306.68	1552.83	778.58
137	B	221208.87	184452.26	67308.53	22798.73	13787.47	18450.37	6196.18	2093.47	1467.77	1056.93
137	C	197784.37	131762.57	34945.50	102673.28	9624.02	10700.13	42553.34	18460.37	703.25	844.30
137	D	210556.12	196709.02	65854.53	21886.07	17455.46	17509.15	5789.74	2384.48	1348.36	814.14
137	E	212602.86	156353.63	73945.83	23395.65	61214.12	0.00	14577.18	2200.82	1827.18	3054.90
138	A	237354.30	153991.52	50626.46	77448.30	0.00	5410.36	3186.69	6008.28	1391.13	0.00
138	B	233694.00	156522.36	96157.24	25833.33	2820.46	23354.12	4848.84	1952.21	1213.10	487.07
138	C	216466.58	192994.61	55063.06	39535.38	4285.60	14679.29	5910.23	4578.82	1608.96	951.24
138	E	269682.16	131940.31	57860.24	20262.16	10419.53	29028.62	7352.59	1734.68	870.72	1111.33
138	F	238969.52	189542.49	53080.15	18437.43	6685.25	12336.82	5076.35	331.19	156.50	459.20
138	G	220629.27	208082.38	69752.01	15091.21	1266.17	11538.91	3980.57	380.06	1500.23	546.21
138	H	220830.21	209411.08	67424.15	23040.15	2409.17	617.76	3889.58	1320.58	1710.20	485.55
139	A	330103.66	112481.23	8304.41	6425.98	9597.14	28929.42	1857.68	402.02	153.16	0.00
139	B	223857.65	182819.51	73859.20	23333.12	6719.26	17709.66	5979.20	1586.96	1169.22	1389.68
139	C	217745.81	196514.79	64201.32	27118.85	2808.21	18521.16	5011.22	2828.99	1049.89	631.82
139	D	216815.93	202601.06	66638.91	22150.55	3693.21	15256.71	4458.91	2128.11	1256.31	588.16
139	E	235741.41	143494.66	58102.12	41772.73	28559.13	8127.15	14672.00	3017.54	910.05	3726.10
139	F	282896.66	111941.58	32333.41	42760.17	11280.62	21247.72	18146.08	781.70	807.28	0.00
139	G	185823.95	139736.64	20188.63	95771.04	9277.57	5409.87	79379.80	192.17	238.68	3046.97
139	H	233223.23	107363.23	69547.30	59440.20	23528.16	34618.61	20620.68	1964.13	893.88	3177.95
139	i	194248.89	175395.20	63199.83	54598.33	4851.81	19688.56	32695.84	1121.96	1216.35	1230.47
139	J	207226.87	189654.97	78213.85	28856.88	4378.99	22917.67	5911.28	4646.64	2378.80	1354.21
140	A	255303.06	159797.78	63567.98	24209.67	0.00	15074.35	5793.47	1750.66	1742.68	0.00

Analysis No.	Run	Si	Al	K	Fe	Ca	Na	Mg	Ti	Ba	P
140	B	225641.48	183717.61	81107.07	20001.74	3831.86	16177.04	4746.06	1722.40	1767.57	813.17
140	D	212653.88	195727.81	71610.64	35730.86	2889.00	13000.40	4627.32	2148.05	1454.49	565.88
140	E	232900.00	179028.03	71669.77	20498.68	4468.50	17287.20	5960.50	1653.07	1634.79	492.82
140	F	216027.75	193530.39	49536.29	66875.92	0.00	2202.28	4103.24	2064.91	1118.32	0.00
140	G	236792.22	174760.07	64777.18	27989.03	5366.17	12502.49	7618.28	627.86	1531.03	1170.20
140	H	209202.22	183681.25	74080.50	34653.52	7981.92	26435.92	6938.65	1303.96	1039.59	1168.04
141	A	309717.82	122415.13	15166.43	7032.97	0.00	47102.73	0.00	191.45	31.23	0.00
141	B	222175.45	199805.16	74777.50	18651.69	2126.50	9069.12	4288.07	1918.01	1713.58	419.10
141	C	211988.33	210558.39	64033.90	28189.99	2277.29	5943.73	4753.00	4196.24	1747.09	440.79
141	D	211251.00	207135.92	75481.64	17791.97	721.69	18632.11	3500.02	2046.73	1597.28	473.46
141	F	282603.10	172300.62	13531.52	23001.46	0.00	207.52	8636.32	371.78	1196.60	0.00
141	G	225594.49	202051.76	66486.40	15739.47	1450.17	11145.22	4902.48	406.68	1503.60	520.12
141	H	217137.20	203642.65	76677.37	25754.84	2276.95	2890.94	4009.20	1428.46	1592.60	687.35
142	A	212479.72	91688.73	34733.32	92461.13	21945.40	2533.00	81210.83	3751.32	3702.35	3407.46
142	B	275428.38	137778.31	21345.78	1877.65	38199.51	44614.32	1866.34	1540.43	45.08	446.59
142	C	206354.17	201687.04	55479.94	34691.58	11736.11	11280.69	9486.61	4263.94	1703.84	887.13
142	D	214861.27	176639.31	82164.30	26212.18	22914.29	7983.68	7742.51	1919.67	1409.25	3075.91
142	E	227277.35	205836.61	50343.57	16899.95	13375.28	1477.11	5417.46	1733.07	2143.51	1294.22
143	A	255335.22	166692.10	67403.90	21395.10	0.00	6640.21	4771.81	2061.20	1840.96	0.00
143	B	228206.60	184612.46	74155.54	17457.34	9365.08	15193.19	4392.20	1471.26	1559.08	647.08
143	C	221336.23	191304.87	69289.47	31398.98	5457.53	6880.06	5221.30	3676.36	1457.96	555.66
143	D	224235.12	120703.20	41326.24	40284.88	76335.82	10376.18	30839.28	2637.69	2303.57	1248.21
143	E	309619.54	113803.11	44488.19	10462.42	21184.23	7944.00	4054.99	1026.97	909.23	1064.39
144	A	278620.50	68206.76	37393.31	40288.84	62947.04	18499.78	28099.70	1439.31	712.43	0.00
144	B	201380.24	74910.36	96187.31	42684.61	98448.32	45207.46	23029.62	3861.68	437.75	1433.29
144	C	258762.70	71200.71	9319.88	63014.88	87099.30	18954.70	27116.02	7515.98	440.56	757.04

Analysis No.	Run	Si	Al	K	Fe	Ca	Na	Mg	Ti	Ba	P
144	E	241307.96	80986.99	15880.80	43804.02	121646.93	10584.68	30453.30	2084.00	647.41	1036.59
144	G	288673.78	119481.08	1298.14	22229.61	17673.82	58622.53	8794.50	443.97	368.39	891.75
144	J	254552.49	151254.82	101852.62	15892.87	6680.99	2725.92	3359.52	281.61	1893.31	630.09
145	A	355555.61	79744.96	17477.53	7843.82	0.00	35094.79	1458.66	146.91	87.26	0.00
145	D	336353.27	75043.85	47237.41	16817.37	13017.00	24080.75	2066.24	661.50	252.96	326.54
145	E	299997.94	107292.21	102603.30	3692.90	3312.56	8424.13	1090.03	95.94	5182.72	472.46
145	F	283801.76	119497.51	27012.61	34601.97	17737.78	15950.74	13209.12	4821.25	889.91	0.00
145	G	211607.94	193458.93	59368.96	42609.46	2812.40	7422.39	16178.67	1876.44	1315.59	445.32
145	H	319558.37	109558.89	29695.92	16615.82	10668.42	13128.15	5505.41	1978.75	611.40	898.72
145	i	281332.15	120658.41	62537.93	15523.29	7823.41	38244.17	2423.15	1236.44	68.28	921.09
145	J	163557.58	134466.49	21467.55	153331.42	11115.40	8861.91	61603.45	6929.32	187.36	584.17
146	A	235272.36	146064.06	15304.91	67669.86	3283.58	0.00	54501.20	363.45	395.47	0.00
146	D	240703.08	93202.32	30023.59	59616.57	77710.66	20227.58	22645.60	3032.20	788.73	1887.97
146	E	290128.56	120511.52	13472.20	9954.93	9431.92	72712.82	2480.03	1632.76	68.70	751.79
146	H	218664.71	193964.38	66983.05	22918.67	7575.03	14636.19	7535.37	2045.54	1596.97	727.56
146	X	336985.69	107130.45	47857.72	5521.61	1450.79	868.91	2943.46	308.12	396.72	20.01
146	Y	257525.25	102329.34	73270.45	46283.82	33747.87	0.00	22719.92	2252.45	943.50	3275.87
146	Z	254977.81	84630.83	21868.86	48933.80	82465.63	19822.00	19899.63	5700.43	918.25	3776.59
147	B	334323.53	92971.35	21035.48	5826.95	9316.62	40653.52	1443.71	172.38	1914.46	544.30
147	C	193804.69	142422.95	58757.77	114478.39	5482.03	34405.04	10443.72	3368.10	1350.85	254.55
147	E	192655.42	182738.79	64714.47	49915.74	17261.59	16771.51	19046.37	2922.06	994.01	1998.40
147	F	246953.30	180673.72	35772.30	30621.10	0.00	0.00	17509.45	2724.41	1224.33	0.00
147	G	287497.60	96224.91	76031.30	19335.04	18021.86	31668.58	4054.75	2649.29	581.40	791.03
147	H	211325.99	207937.30	65717.28	20089.56	1679.89	21434.65	3943.53	3116.19	1247.19	241.86
147	X	165382.47	146182.39	47930.98	11270.07	124764.08	0.00	4956.17	605.69	1395.42	46916.83
147	Y	196296.93	157661.95	40830.38	74088.37	3386.15	3682.92	62387.26	1425.01	634.27	258.40

Analysis No.	Run	Si	Al	K	Fe	Ca	Na	Mg	Ti	Ba	P
147	Z	116513.12	91554.63	16827.89	275809.72	2134.48	6927.91	79663.20	2239.67	46.48	161.78
148	A	263005.00	173983.89	45658.92	22957.66	4889.91	0.00	4221.74	1291.76	1202.88	0.00
148	B	223420.15	168087.27	68772.49	26559.35	33967.72	12235.63	6148.25	1862.52	1413.19	1056.37
148	C	222556.45	114570.80	59175.29	34575.60	76827.85	32216.83	10245.65	4356.25	1275.01	2018.54
148	D	205188.58	112923.66	60679.83	42846.25	114463.77	8314.11	13777.14	4915.06	321.24	2595.64
148	E	192625.35	189300.49	69712.21	35804.03	36379.22	10421.94	7353.66	2774.46	1346.27	3883.42
149	B	295638.62	101871.88	115458.08	2125.22	4952.71	14906.26	360.16	73.63	2678.65	455.17
149	C	280960.29	113431.73	40947.60	16523.30	19525.43	55803.30	2558.08	273.30	1112.74	479.60
149	G	265467.10	93142.63	16057.21	48369.95	74481.61	19244.74	15251.70	3947.41	1376.66	600.61
149	H	194162.96	95152.32	42674.61	145813.90	8768.69	6410.94	55407.28	14286.85	2321.69	370.11
149	i	232940.44	104004.29	20196.36	94768.34	34745.50	16766.48	31181.12	9420.66	588.99	864.18
149	J	255431.70	170380.10	13010.46	22009.13	25509.51	29232.97	3414.89	226.72	90.70	645.99
150	B	225655.01	149469.45	108411.65	25185.65	29046.06	7814.42	5732.87	1842.14	1262.57	465.07
150	C	190963.11	128994.84	58637.96	41677.63	59639.49	45847.70	7843.80	4734.26	1498.17	17977.79
150	D	238389.77	169551.27	79011.47	26428.41	11044.19	0.00	5774.72	4102.27	1373.38	446.17
150	G	221453.77	193333.51	68181.38	18181.40	13832.20	13968.98	5245.41	522.84	1382.04	473.83
150	H	208022.74	155445.05	83466.82	54705.81	22060.71	12269.70	11435.26	3076.56	2552.76	2055.86
151	A	246116.19	170543.35	25674.24	44852.96	0.00	0.00	28305.46	220.82	1373.13	0.00
151	B	213343.18	153675.64	30051.94	64803.02	8851.31	18640.52	45638.57	187.86	1076.60	436.60
151	C	198824.19	142926.22	34892.81	85108.14	10846.78	14169.19	56554.93	661.89	1241.26	483.24
151	E	275434.30	133016.79	39836.91	23537.61	28111.84	11940.61	4638.85	2218.30	5651.79	636.02
151	F	279721.14	150443.43	48417.84	23774.97	0.00	1148.82	8225.64	1391.93	1765.34	0.00
151	F	237455.73	195728.35	43636.64	22591.20	0.00	6522.83	13832.92	261.35	1574.42	0.00
151	G	225623.54	139804.24	63700.35	30649.77	50552.37	9610.03	16829.31	552.25	9729.60	1994.15
151	G	248590.44	141682.04	49246.38	34433.40	21221.47	22932.64	8844.02	3973.46	4902.96	698.48
151	H	186220.00	169380.29	21712.22	88054.36	6545.81	5951.76	60157.09	657.21	1179.63	282.63

Analysis No.	Run	Si	Al	K	Fe	Ca	Na	Mg	Ti	Ba	P
151	H	214155.35	185402.98	74947.73	25154.34	12372.59	17519.02	6776.41	1579.76	4992.95	812.75
151	X	245849.52	166547.04	63155.63	18165.41	13652.59	12977.53	7929.96	919.71	2089.63	436.26
151	Y	204991.75	129842.81	108148.29	36301.37	32590.10	35677.06	17973.01	366.02	2396.61	707.65
151	Z	191820.00	76775.04	49316.87	140474.74	33133.88	19211.13	51768.15	7955.89	2424.75	1771.56
152	A	247829.60	177817.95	47746.73	24465.91	16128.49	0.00	5478.83	1542.19	1406.68	550.22
152	B	223501.75	167824.68	70473.79	27818.50	32190.71	8586.12	6826.02	1837.00	1325.91	2085.30
152	E	194495.22	195686.05	61986.37	34902.36	36968.79	7830.38	6572.38	2739.95	1668.29	3296.74
153	A	287706.73	158272.06	37833.23	18502.70	0.00	0.00	3508.57	1373.26	1159.03	0.00
153	B	244313.33	174086.61	66040.11	17626.87	2952.83	19369.37	2748.91	2420.40	1413.59	445.77
153	C	253463.16	160476.62	63598.68	22011.29	6477.51	13204.72	3225.16	3957.65	1390.73	1734.53
153	D	227136.71	130130.87	51072.94	116157.09	5960.82	4926.56	3851.66	8568.47	1032.88	620.85
154	A	294607.52	150672.30	7586.76	11277.95	35928.23	0.00	2487.22	225.59	441.79	0.00
154	B	275531.57	127250.07	23534.75	19475.64	48678.76	20572.59	6774.87	1060.54	1052.85	541.49
154	C	235875.33	88523.37	31280.92	65248.26	79858.07	28546.38	17083.68	4088.74	1164.68	2908.91
154	D	235313.79	132314.97	11818.82	34220.71	87429.14	29300.45	6588.95	774.87	573.01	1987.75
154	E	279433.91	148661.47	0.00	15804.50	37684.47	24908.30	3241.04	655.03	2100.88	379.58
155	A	255575.41	177554.69	49350.15	26891.93	0.00	0.00	5296.10	3399.22	1406.02	0.00
155	B	231746.63	180521.26	71090.69	27842.65	3843.53	8370.40	5844.53	3526.94	1592.13	589.76
155	D	230099.86	173394.58	71865.97	28350.27	7693.18	16124.83	5845.27	3100.89	1581.51	630.25
156	A	357008.71	113007.52	7792.04	4258.16	0.00	0.00	1932.46	217.66	125.85	0.00
156	B	222623.70	183731.71	68328.60	24927.92	8807.95	19321.25	5792.89	2674.62	1773.42	911.14
156	C	221333.14	150558.77	61277.68	44757.31	36060.68	11468.84	12209.27	4592.20	1615.58	2287.45
156	D	217968.79	158814.01	78581.46	44403.91	24712.85	5585.04	10238.22	4436.80	2123.22	1493.23
156	E	206649.70	214396.04	56127.51	30952.16	5365.82	7316.36	5745.68	5251.72	1503.97	569.31
156	F	238300.55	193156.73	57426.56	21484.10	4589.81	3171.42	5288.87	913.44	1812.75	0.00
156	G	227043.77	200863.57	71887.12	14299.50	4914.10	4942.49	5255.31	505.08	1444.43	490.27

Analysis No.	Run	Si	Al	K	Fe	Ca	Na	Mg	Ti	Ba	P
156	H	213239.55	196191.24	79268.31	24507.63	9349.90	9180.04	5609.32	1818.36	1396.67	511.89
157	A	274256.97	140542.98	29444.12	30273.47	27624.34	0.00	13402.71	1625.71	720.69	0.00
157	B	240929.14	107831.27	40050.13	67478.55	20962.36	11290.85	38284.03	11103.76	502.70	675.43
157	C	315926.72	97058.02	58812.60	3275.65	3750.45	42559.35	253.67	91.51	38.83	311.54
157	D	253831.41	70238.13	46320.30	70562.72	50252.26	13745.75	27902.21	12814.57	3718.79	1333.19
157	E	182866.33	167454.46	46528.83	96611.36	6516.33	2919.94	17716.43	28763.63	1350.99	383.82
157	F	261356.33	178610.30	45894.08	21206.21	0.00	0.00	3469.83	2511.24	1160.50	0.00
157	G	306636.12	90871.81	82134.70	2887.39	4797.15	44410.82	0.00	188.83	27.93	519.16
157	H	138233.17	106280.21	20600.48	233827.24	1602.81	12043.22	22303.43	49383.20	404.87	199.80
157	X	264662.45	97359.69	11747.54	10812.71	99832.84	45920.20	7279.66	158.80	212.68	1537.79
157	Y	310699.03	107682.04	63552.86	1613.52	3098.36	34557.60	0.00	106.59	23.51	367.92
157	Z	185130.29	120484.54	6199.18	119849.96	6964.62	1083.43	12960.20	208.54	8.41	292.14
158	B	294636.38	99402.46	50674.19	15341.67	10672.63	54129.34	3714.03	269.36	594.13	870.96
158	C	307400.23	98368.01	57606.33	1988.69	9070.65	50375.69	817.66	204.34	59.23	363.47
158	D	208446.22	163389.72	71944.11	37019.65	38311.26	17173.97	9771.48	3083.40	1418.48	1375.16
158	E	175235.83	147243.48	65050.47	71911.00	73618.87	12455.54	17358.21	3158.86	1181.83	2772.90
158	F	230196.75	90703.34	28415.61	16515.53	0.00	1391.12	5880.50	154212.00	549.43	0.00
158	G	225787.81	191327.49	64327.77	31162.21	3717.17	7097.73	4731.48	3663.72	1705.63	320.00
158	H	219580.58	195278.57	62621.99	30308.92	2385.97	10646.45	9193.33	2950.58	1323.28	379.54
158	X	231378.28	178866.04	67664.75	26757.86	6433.20	15514.22	6257.59	1095.73	1398.60	497.01
158	Y	218494.55	187092.26	77071.38	26798.98	6097.11	17503.68	4703.66	1724.14	1285.06	656.94
158	Z	223941.96	199938.47	67925.89	26691.03	1825.06	3399.25	4441.19	2558.40	1696.77	237.87
159	A	196728.13	121468.96	6930.94	137479.43	8550.34	0.00	69567.07	482.18	283.72	87.11
159	C	164978.49	116385.35	49723.83	230832.86	4618.33	6931.54	4820.28	5440.07	859.83	342.30
159	D	225792.26	161349.01	82996.12	34854.36	11271.95	15462.94	9617.58	2382.88	1336.24	787.83
159	F	242119.59	173604.43	76123.90	28213.90	0.00	3082.78	5950.19	2279.93	1529.06	0.00

Analysis No.	Run	Si	Al	K	Fe	Ca	Na	Mg	Ti	Ba	P
159	G	201766.67	177020.07	75345.61	68170.39	14806.47	0.00	7831.61	3588.63	1198.04	1051.87
159	H	228873.13	196586.79	71704.78	22735.37	3511.34	1068.63	4645.06	709.38	1579.04	455.37
159	i	274068.35	118604.91	57485.82	32852.89	29032.90	6390.11	10337.14	341.74	1216.74	767.06
159	J	209596.74	200096.00	73512.12	24739.76	8487.55	12486.58	6543.41	2453.25	1970.69	641.62
160	A	254523.56	147093.43	22112.63	52426.20	11176.18	0.00	29845.49	1023.92	586.91	0.00
160	B	227654.03	186386.56	65236.41	24939.79	4366.02	18017.77	3903.85	2134.52	2638.52	523.27
160	D	290762.26	128444.67	20006.44	1405.79	23004.11	54686.32	366.01	90.55	64.75	379.96
160	E	258940.10	96069.73	36064.81	68007.55	49569.23	2729.84	17090.21	8701.27	342.19	1852.53
160	F	289048.62	103639.25	40761.52	63008.83	0.00	1457.82	20680.54	3374.73	450.01	0.00
160	G	230875.50	175071.33	57935.51	33424.93	21763.47	4892.59	6111.52	2828.10	1680.94	524.48
160	H	167729.30	77817.34	66326.19	163520.94	42518.47	1548.66	46048.57	1746.28	353.86	12565.30
160	i	195329.49	96774.18	48379.98	100076.57	20234.13	2437.98	89274.47	1871.01	1580.67	1813.20
161	A	198958.62	238024.77	25593.32	50824.19	0.00	0.00	2559.50	3280.14	1212.19	0.00
161	B	226219.45	154422.29	65251.62	34861.52	28360.40	23782.12	8924.78	806.74	1373.96	1520.79
161	C	217458.76	196386.78	62251.73	25180.71	17053.63	10264.94	4535.72	872.19	1699.40	928.49
161	D	203453.00	201886.76	66485.07	23064.33	16222.46	23681.45	4481.45	2038.46	1353.79	580.63
161	E	176719.84	112947.33	90626.45	57974.64	73151.85	51658.97	12124.43	5047.09	1913.80	3885.52
162	A	197745.30	213985.80	43042.52	66003.82	0.00	0.00	5288.26	5637.80	1174.91	0.00
162	B	221054.60	160721.33	62675.60	41778.46	13713.04	34197.57	9043.07	1248.63	1197.55	645.57
162	C	216885.80	188593.90	73614.26	29173.08	3411.09	22628.24	4769.74	1044.15	1410.30	353.39
162	D	188232.49	110029.66	26416.47	130415.91	3534.72	20122.98	76000.37	2367.75	214.27	139.99
162	E	224443.26	181195.31	74128.63	25190.90	3930.71	23409.91	5006.36	1521.22	1284.92	373.19
162	F	251737.52	179383.64	63578.94	21116.58	0.00	2527.14	4359.18	1057.62	665.65	0.00
162	G	201284.74	110255.15	42296.20	97180.57	2110.09	17258.35	80028.94	756.91	173.75	379.60
162	H	225185.72	150844.29	75187.47	38437.82	18750.12	23195.25	12155.47	1764.17	1345.81	1111.41
163	A	197219.25	205556.65	50627.87	67925.92	0.00	0.00	6826.48	8152.62	1317.82	0.00

Analysis No.	Run	Si	Al	K	Fe	Ca	Na	Mg	Ti	Ba	P
163	E	251906.14	154013.25	50321.97	16967.57	6137.14	45564.63	6115.43	542.98	747.08	640.80
163	F	254493.96	122121.30	100081.46	53838.54	0.00	0.00	10712.15	1575.57	1536.30	0.00
163	G	260229.22	147681.67	72184.27	22876.69	16990.76	0.00	6556.63	2971.64	1366.22	493.93
163	H	252143.87	130108.10	54463.31	47106.05	24675.15	9898.44	14469.35	806.99	1253.97	1860.26
163	i	206947.13	181125.55	82222.18	39908.67	12922.70	11509.37	9099.67	770.15	2634.80	1253.54
163	J	184311.14	175310.60	64842.47	29319.32	25428.80	8654.12	5262.41	3989.74	1804.44	11716.38
164	A	314074.48	133867.57	3408.51	26824.79	0.00	15524.51	853.79	838.02	88.47	0.00
164	B	206409.88	161352.01	56680.13	78384.30	6670.48	15273.31	22235.63	489.90	2013.24	346.10
164	C	224578.16	182617.53	68627.60	34235.64	8400.00	9212.86	6255.86	791.30	3762.61	533.87
164	D	164607.07	123816.03	7242.85	166668.05	7177.75	7201.70	80382.20	2540.67	397.24	367.82
164	E	189944.43	144193.08	36893.30	115945.52	8441.28	10690.44	43040.16	1939.69	1299.69	401.59
164	F	258107.33	132401.27	26249.12	59284.51	0.00	5584.76	40858.86	213.71	2813.12	0.00
164	G	246108.51	79730.84	8889.83	118850.17	14462.69	3002.03	66242.64	1426.46	1203.75	486.37
164	H	264387.14	113529.32	65084.68	49157.83	32278.50	1416.34	10324.25	671.58	2151.46	458.23
164	i	244361.96	122648.08	39233.45	52259.62	39227.30	29711.93	8864.89	2521.31	5074.69	536.35
164	J	233559.58	114030.99	12511.17	108472.92	14738.19	8120.22	46484.58	759.93	1075.63	383.73
165	A	281046.86	109335.01	125939.79	21726.30	0.00	0.00	1159.56	389.06	168.99	0.00
165	B	284608.74	86060.57	147382.04	10507.02	8125.08	12795.61	1856.88	77.42	775.88	710.90
165	C	251965.58	105438.34	28343.47	75649.36	33726.05	31916.94	12446.51	618.19	520.31	1210.93
165	D	261629.31	155820.21	24411.55	10160.55	11346.90	57381.28	2426.43	179.77	490.96	912.11
165	E	304339.31	119916.52	19546.13	6696.62	13644.22	47746.76	1502.11	90.98	17.04	783.85
165	F	213688.49	155658.23	68601.76	81492.45	0.00	18145.80	7681.71	4875.36	1141.21	0.00
165	G	213266.97	193285.10	75607.19	33467.80	9103.94	2590.56	8702.22	1795.16	646.69	969.76
165	H	212555.64	182467.37	65572.54	36146.08	14689.37	19879.11	9015.33	544.51	1336.81	1083.97
165	i	217089.78	200264.98	69640.87	24384.39	11960.70	4108.82	5948.66	419.64	1797.63	535.30
165	J	207293.62	210594.22	71980.93	22997.69	7462.63	7971.09	5391.87	2058.42	1263.52	869.16

Analysis No.	Run	Si	Al	K	Fe	Ca	Na	Mg	Ti	Ba	P
166	A	134100.99	106873.26	13230.46	254557.06	0.00	0.00	65129.01	2984.77	195.73	0.00
166	C	214953.11	106941.38	17364.66	105971.78	16802.18	13999.26	63459.40	2548.90	664.42	684.80
166	E	243617.94	90909.01	25905.00	67409.46	41437.97	27436.04	40629.98	2471.41	902.04	1662.95
166	F	236861.14	196288.80	56940.26	17873.99	0.00	7867.30	3709.64	3761.83	1351.95	0.00
166	G	210219.68	204969.42	70741.35	25361.19	2356.25	15127.89	4346.61	3192.35	2177.45	340.42
166	H	213609.05	209894.15	80571.70	21125.11	2237.13	62.03	4415.25	2166.95	1501.88	569.68
166	i	199794.11	202122.20	73817.08	32885.64	3916.94	19097.42	6830.00	2737.21	1627.08	1142.97
166	J	176475.00	244833.89	66773.77	23889.31	1636.73	20234.98	3622.67	3457.22	1217.25	281.54
167	A	282332.19	172424.40	10143.37	19854.53	1717.87	14457.68	1095.07	428.19	342.51	0.00
167	B	215817.13	130108.00	165632.21	29116.11	7207.00	16901.92	6052.50	945.76	3591.82	374.94
167	C	295427.72	127696.61	8414.80	8288.92	21119.04	51454.05	1615.06	70.47	84.14	527.96
167	D	201763.88	234036.01	46701.30	19688.24	4813.57	19318.76	1860.66	1277.81	1057.78	221.18
167	E	232628.18	191054.17	76516.39	17860.29	2323.06	10768.02	749.50	757.21	1000.97	328.91
168	A	267412.92	152818.40	9482.00	38824.74	4273.01	36811.59	3807.39	1013.26	564.65	111.14
168	B	216438.63	191717.58	66410.19	27034.13	15336.22	11775.57	5190.62	899.52	1813.73	1786.69
168	C	277702.09	141299.96	3317.24	5541.67	29505.83	56996.32	1075.99	47.33	157.16	2254.84
168	E	226459.19	173311.98	71175.23	21590.88	16100.08	21099.94	5517.26	1052.12	1605.49	2344.35
169	C	324142.55	74677.86	0.00	20462.14	29491.38	60520.37	4462.70	186.23	163.99	1444.42
169	D	343123.70	79828.24	35170.43	17257.84	5536.10	11724.32	4591.57	5336.22	813.24	644.56
169	F	238606.56	185401.27	70883.96	23754.78	0.00	3030.43	5463.74	1618.34	1570.54	0.00
169	G	227352.26	182756.19	74502.99	25920.77	4754.97	13045.75	5935.30	1735.67	1284.73	461.20
169	G	212442.15	210927.54	78872.93	22467.94	2437.99	0.00	4721.00	2549.69	1494.04	368.03
169	H	187533.85	118125.93	15702.64	53411.01	6276.41	7385.87	139600.91	5638.13	535.02	746.38
169	H	242296.33	161698.24	52232.82	10726.88	10050.98	50256.20	5312.12	1665.04	1181.49	219.39
169	i	301857.87	64726.25	9021.48	34733.29	5334.42	0.00	90224.39	323.24	191.76	386.81
169	J	218001.30	179195.79	71506.79	28504.09	8702.81	24762.45	7034.92	2575.14	1582.41	1079.00

Analysis No.	Run	Si	Al	K	Fe	Ca	Na	Mg	Ti	Ba	P
170	B	307239.93	101950.80	47103.28	26000.87	27550.99	905.75	5718.81	477.92	873.24	1289.28
170	C	186842.83	184994.26	31288.11	29338.45	53006.04	57969.39	7206.15	674.10	1422.32	805.86
170	D	204939.39	185356.55	52025.81	32638.97	33188.21	22350.73	8899.45	1736.80	1482.49	1507.93
170	F	241643.06	182434.31	70535.30	21354.39	0.00	8270.95	3659.53	1314.01	1430.55	0.00
170	G	215807.77	203372.62	63113.71	24063.25	6295.64	13405.86	4901.83	2475.86	1669.31	333.29
170	H	214886.98	184026.12	75122.37	24447.91	25363.86	12252.90	5453.47	382.10	1464.08	701.74
170	i	220802.62	199335.57	75915.58	19749.06	8188.15	5028.16	4806.72	353.22	1469.14	441.62
170	J	211303.28	211973.25	62198.80	19694.74	6763.21	13872.87	5420.47	1753.28	1295.12	432.84
171	D	279337.86	136527.92	14860.03	6202.02	23635.64	58096.61	1504.62	17.76	936.35	322.09
171	F	280844.37	108233.91	40063.08	55522.66	0.00	14486.77	20622.47	5755.49	267.68	0.00
171	G	291211.79	136599.29	17755.93	7115.10	9488.85	51810.14	1016.59	174.63	104.67	304.70
171	H	294738.41	122691.96	19407.26	31858.48	7632.03	29699.97	7996.25	658.79	289.17	525.25
171	i	234856.55	125058.81	16671.77	99018.62	11162.76	0.00	47470.77	222.01	549.57	611.68
172	B	304360.99	116324.58	58781.95	2780.71	5458.24	27772.20	675.46	19.06	5631.61	293.05
172	G	262452.21	101741.26	106009.01	12619.62	50247.03	2460.35	4655.41	375.31	11232.73	1188.53
172	i	288501.14	68005.67	43479.97	76226.36	14282.82	10323.23	14311.98	16725.76	540.06	1122.57
172	J	183944.40	88260.33	68999.54	144062.69	20985.33	1627.84	48231.60	17267.31	1720.19	1145.57
173	A	201442.27	225047.93	49881.72	45772.84	0.00	0.00	3971.41	2417.07	1278.84	0.00
173	B	214594.05	185635.94	74975.92	29930.37	9027.49	19841.46	6988.51	569.80	1476.18	480.48
173	C	221166.09	214285.31	42522.36	23938.82	6650.53	8431.09	5847.48	601.49	1817.08	468.58
173	D	264196.72	141041.35	12419.93	18086.84	31075.97	55217.31	2729.79	289.45	359.40	839.33
173	E	361468.26	60397.23	9408.38	10766.93	8508.87	49752.95	2440.51	30.14	210.75	344.24
174	B	221110.51	195483.28	74153.67	24743.88	4218.26	9615.09	4595.94	1167.49	1637.87	355.26
174	E	225213.53	207379.64	62744.68	17644.45	2941.83	5616.51	4294.67	1328.67	1531.61	373.40
174	F	286616.90	132828.58	35743.08	25983.62	0.00	28946.85	6972.96	1065.83	539.92	0.00
174	G	213300.73	199486.15	70596.56	28099.10	4690.38	11559.75	4798.45	4019.86	1448.62	404.99

Analysis No.	Run	Si	Al	K	Fe	Ca	Na	Mg	Ti	Ba	P
174	H	228121.51	183489.86	83587.60	29016.00	4702.33	1863.40	4752.68	612.85	1619.55	481.58
174	i	287291.15	118576.83	14100.22	2316.19	24515.14	76941.85	27.96	0.00	47.73	666.88
174	J	208491.84	212050.22	71947.45	24801.29	5591.04	2116.51	6573.68	2732.96	1426.77	534.01
175	A	204235.60	190968.89	55953.14	73220.65	0.00	3425.34	8316.13	2828.66	1034.39	0.00
175	B	235314.67	118686.99	46235.42	45830.03	35284.49	41818.85	13086.58	8304.26	1210.73	2217.95
175	C	218504.15	190390.76	62939.86	27270.23	14794.69	13862.91	6421.14	1096.64	1784.41	757.13
175	D	204423.36	189655.90	55473.43	38690.95	24246.19	15096.28	9492.03	2291.33	1727.91	1323.69
175	E	221965.52	182233.74	65963.39	22445.32	15431.51	17495.88	9304.00	832.40	1631.36	1222.67
175	F	250302.13	132208.50	35208.57	29002.30	46421.40	26358.82	12044.04	607.67	1799.23	1257.17
175	G	247751.79	145026.21	60710.03	26760.07	24932.24	13059.04	12549.75	605.58	1621.22	2117.91
175	H	225806.06	170979.96	66636.15	40160.35	17546.79	0.00	11383.07	1949.54	1872.75	1768.17
175	i	258524.24	94680.90	97879.04	29965.66	21419.00	23568.03	10787.34	960.89	12626.14	2824.66
175	J	281769.62	109230.98	23963.66	17092.69	33087.14	53938.05	6151.61	505.22	434.07	1899.82
176	A	330153.83	116533.16	29244.87	17728.11	0.00	0.00	2530.85	1750.14	842.99	0.00
176	F	148563.70	117669.31	33761.87	141971.63	0.00	9487.50	114240.16	509.88	69.52	0.00
176	F	236852.30	112514.49	36469.16	86227.45	0.00	1632.60	60359.92	1954.18	726.00	0.00
176	G	224541.80	84539.58	59834.46	94348.62	23402.56	0.00	57656.25	7632.75	640.17	1730.91
176	G	134568.98	118485.17	22936.00	166841.31	4225.27	2463.08	119439.05	499.70	59.36	345.96
176	H	178018.35	79597.18	39570.63	187340.75	19455.25	4359.74	63232.39	2314.87	476.42	1116.13
176	H	244315.06	103011.25	19741.40	60497.24	66341.11	19051.97	25171.56	1204.83	1258.69	1970.63
176	i	144465.53	81751.80	39356.14	236937.78	11128.86	0.00	73197.77	569.10	252.65	1076.97
176	i	271623.47	88053.01	24046.21	54935.24	64579.77	174.22	26469.69	1022.50	745.82	1725.14
176	J	168838.80	75730.36	58727.62	187241.82	5769.34	0.00	67913.45	15149.42	1880.66	658.61
176	J	215116.80	167148.89	59449.21	37006.04	24181.46	23462.35	13364.52	2948.80	709.42	1312.94
177	A	245015.78	183561.81	61185.67	24259.23	0.00	0.00	5785.30	2803.49	1673.66	0.00
177	B	255111.30	165635.48	73077.99	17265.90	5302.73	2302.83	5059.27	2842.05	1472.67	499.12

Analysis No.	Run	Si	Al	K	Fe	Ca	Na	Mg	Ti	Ba	P
177	C	235644.97	172108.69	70063.37	25312.74	16276.20	5858.74	6161.34	2223.39	1041.58	587.34
177	D	351510.48	80993.98	25176.53	14266.85	3247.17	22660.62	1933.04	1476.16	540.41	391.13
177	E	238290.80	163962.85	80638.59	25900.63	12734.73	6968.04	6104.71	2314.61	1296.68	556.35
178	A	277794.21	139048.60	48021.85	30678.26	444.01	10056.46	9402.37	1909.75	651.74	122.17
178	B	237733.91	167506.13	83585.40	23444.19	6252.72	7680.93	5649.75	3868.60	1746.99	487.37
178	C	212302.93	148439.34	70330.41	31365.63	43790.08	33175.64	10301.19	3531.75	1421.69	993.59
178	D	216564.35	189182.13	65724.87	26441.00	10568.19	21092.17	6488.36	1800.32	1105.53	623.27
178	E	249161.75	145460.97	74032.36	25791.37	6235.06	26281.48	8323.84	2205.79	937.19	525.44
178	F	289128.08	133645.25	28736.90	31662.27	0.00	22721.39	8216.85	521.07	658.78	0.00
178	G	225370.81	204790.14	75040.75	16207.19	1617.58	1947.29	4377.45	529.09	1490.59	342.89
178	H	223624.79	172329.47	69963.29	29322.29	27100.39	5719.63	9221.34	1899.58	1317.24	676.70
178	i	215524.75	154245.31	67188.27	40384.57	21013.74	34731.19	13341.20	2740.27	1074.62	786.87
178	J	223094.89	151033.20	67166.01	28304.43	31690.05	31898.04	10056.68	3021.19	1332.90	1101.61
179	A	278387.68	77379.51	23990.04	57192.36	50612.11	20761.92	17482.23	5178.23	750.15	1799.88
179	B	256349.07	111560.71	53646.90	47734.86	26346.60	22406.55	15471.17	2780.43	1059.22	1772.99
179	C	335071.79	68178.58	56166.78	10977.10	8958.41	35030.64	3917.50	426.71	244.20	565.01
179	D	226228.45	164899.17	86670.00	30145.01	14977.41	9414.73	6465.49	4510.70	1415.04	497.89
179	F	199702.41	85458.23	68715.48	147673.77	0.00	5667.23	47717.91	11203.27	349.79	0.00
179	G	211788.20	202257.08	67108.03	28037.66	10564.75	4223.76	6803.99	3311.08	1565.03	1010.58
179	H	214376.09	203093.65	62156.90	34496.93	4675.54	7216.15	5984.28	1112.03	1340.00	647.17
179	i	218413.82	204886.21	72559.20	20715.89	1368.33	8953.50	5488.76	330.18	1157.73	469.28
179	J	97661.19	92501.59	31751.50	359460.54	1249.70	0.00	1748.54	33646.91	599.39	189.35
180	A	188333.90	115436.91	0.00	113400.46	145019.94	0.00	364.83	578.11	46.32	779.01
180	B	301732.48	95612.90	126124.93	739.80	7239.35	1991.32	1056.22	40.53	3454.32	396.98
180	F	256233.78	116335.90	68294.94	57109.87	0.00	18945.03	18031.13	3488.04	1410.06	0.00
180	G	208620.52	175947.89	85461.45	44090.83	15817.84	0.00	11995.57	3114.94	1540.28	1325.85

Analysis No.	Run	Si	Al	K	Fe	Ca	Na	Mg	Ti	Ba	P
180	H	211235.40	195209.28	77824.80	34243.86	10746.41	0.00	7420.28	630.98	1444.19	1091.55
180	i	151561.23	135168.81	49623.51	221090.49	6775.42	10463.18	4547.80	4674.22	1106.72	561.17
180	J	202819.79	97048.50	47339.77	95009.95	34524.88	23748.77	51800.81	5832.99	1426.73	1738.98
181	A	234011.72	187160.82	64627.67	27050.99	5558.69	0.00	4511.29	4037.46	1993.63	374.95
181	B	245575.45	177187.01	74337.60	14327.09	6902.74	0.00	3799.42	3848.53	2530.40	632.84
181	D	168776.39	115496.10	5500.92	116266.05	154232.79	8740.32	229.72	495.35	67.63	2328.89
181	F	289151.71	90100.10	41212.52	58377.02	0.00	18053.26	25124.18	3110.32	1915.12	0.00
181	G	275362.32	71132.14	45832.25	58329.11	40790.36	12424.74	26044.49	5614.54	979.60	2454.95
181	H	251720.19	137186.86	64977.31	43669.57	21132.72	2479.08	12567.56	762.73	1371.04	882.33
181	i	214809.31	202847.22	74938.37	21245.58	7217.05	9908.11	4144.09	624.42	1857.64	447.10
182	A	229713.46	186221.09	69525.10	31420.97	5384.83	0.00	5644.10	2716.31	1695.36	218.42
182	D	283793.68	146566.99	19734.64	11877.14	20219.03	28736.75	2036.97	971.25	463.66	457.31
182	E	303825.15	115789.31	5137.63	2426.26	23577.61	59500.22	826.80	183.40	95.12	651.47
182	F	138071.70	184340.77	94010.25	132050.68	0.00	0.00	7285.23	18651.40	1277.77	0.00
182	G	225969.74	159286.40	43200.44	61630.52	24216.53	0.00	16722.52	3959.70	1094.46	1198.04
182	H	222232.62	195883.41	74931.88	21815.14	4887.47	11885.28	3089.98	193.17	456.64	584.63
182	i	214893.20	193597.62	83112.01	29957.18	6493.42	4099.10	5768.96	759.41	1957.45	660.45
182	J	246947.85	174134.04	52984.70	33187.80	2827.21	910.09	11328.38	1408.42	1092.83	421.84

Table 6b: Chemical concentrations (ppm) of minor elements in schist temper particles in Hohokam red-on-buff sherds generated by TOF-LA-ICP-MS.

Analysis No.	Run	Mn	Cr	Rb	Sr	Li	Zr	Zn	V	Ce	Ni
1	A	3737.07	0.00	267.48	212.27	306.40	0.13	355.61	59.41	13.61	0.00
1	B	380.26	0.00	404.51	306.44	52.80	1.65	56.55	84.67	24.48	0.00
1	E	5086.27	0.00	212.11	159.99	282.77	1.31	376.41	35.84	12.36	0.04
1	G	168.94	0.00	361.88	243.82	107.83	1.11	25.11	86.07	9.62	0.00
1	H	369.75	0.00	946.49	274.70	71.72	2.57	87.29	4.01	27.22	0.00
1	X	262.06	0.00	246.99	220.20	210.99	66.18	81.30	79.33	53.93	0.51
1	Y	137.20	0.00	329.38	239.09	129.56	6.45	49.70	66.92	14.98	0.00
1	Z	158.30	0.00	479.15	455.34	237.93	5.40	43.92	67.11	11.15	0.00
2	C	498.03	98.71	462.39	118.92	85.92	12.80	40.27	109.70	17.94	2.60
2	E	65.99	0.00	308.01	71.98	89.16	0.00	21.53	57.47	8.06	0.00
2	F	214.14	0.00	468.99	122.27	147.51	13.93	65.19	77.02	22.07	0.00
2	G	137.46	0.00	484.62	95.74	127.69	1.63	39.10	89.76	12.93	0.00
2	H	199.07	0.00	416.85	166.11	186.13	5.05	25.53	93.02	30.64	0.00
3	A	101.44	0.00	385.16	67.86	102.64	0.00	3.63	68.41	2.27	0.00
3	B	195.84	222.56	181.02	35.44	17.86	113.78	63.10	78.99	2.54	26.96
3	E	426.84	0.00	90.45	524.01	65.33	68.61	106.52	109.04	101.97	0.01
3	F	404.94	1998.41	305.29	317.73	51.01	17.55	130.03	82.96	34.32	1129.85
3	X	594.71	0.00	330.57	197.15	193.35	60.98	113.23	76.17	31.39	0.53
3	Y	130.02	0.00	352.82	90.92	162.35	18.21	26.11	65.77	15.54	0.00
3	Z	12.08	0.00	354.24	59.96	66.61	0.00	0.02	55.17	4.66	0.00
4	A	59.94	0.00	10.96	260.06	84.41	0.00	0.00	8.80	1.05	0.00
4	B	601.14	211.34	51.71	1361.77	27.77	122.24	182.08	78.70	72.61	0.00
4	C	341.27	122.87	328.70	337.84	35.62	37.10	98.98	94.34	25.98	2.47
4	D	84.07	0.00	53.21	438.85	42.94	3.01	20.81	8.11	6.12	0.00
4	E	427.76	0.00	45.43	618.88	35.68	78.52	49.62	104.27	64.54	0.00

Analysis No.	Run	Mn	Cr	Rb	Sr	Li	Zr	Zn	V	Ce	Ni
4	F	1160.12	7276.74	243.60	215.21	0.00	54.25	411.80	132.02	56.03	3880.90
4	G	0.00	0.00	0.00	464.22	25.96	1.58	0.00	0.00	5.84	0.00
4	X	491.36	0.00	412.59	140.46	83.07	15.52	92.15	76.30	26.01	0.54
4	Y	288.78	0.00	153.43	93.93	129.32	70.39	57.87	77.68	37.16	0.00
5	A	107.68	11.33	496.73	119.17	92.32	0.10	14.58	109.94	14.24	0.00
5	E	319.00	0.00	68.83	580.12	32.60	141.87	49.60	68.71	42.54	0.00
5	F	231.73	1907.21	334.83	93.84	59.57	2.93	99.09	86.32	25.73	1049.16
5	G	118.18	0.00	10.48	386.25	2.47	0.81	22.87	11.36	49.35	0.00
5	X	173.46	0.00	340.58	238.27	143.01	13.02	40.12	57.47	297.56	0.36
5	Y	166.46	0.00	410.09	81.22	156.78	3918.00	36.14	101.50	15.02	0.00
5	Z	117.58	0.00	398.60	71.42	154.63	6.63	22.85	91.70	8.41	0.00
6	A	157.86	104.72	429.32	85.75	102.02	0.09	18.16	90.40	2.17	0.00
6	B	9.63	0.00	56.99	413.01	55.71	1.30	0.00	1.72	4.91	0.00
6	D	55.14	27.73	0.23	305.58	20.00	4.79	6.41	0.87	2.68	0.00
6	E	143.54	0.00	370.07	90.60	88.94	0.91	29.08	125.95	9.86	0.00
7	A	856.82	84.51	102.78	575.31	134.62	3.19	108.56	56.61	37.23	0.00
7	B	121.92	0.00	462.99	99.68	35.41	2.35	15.79	98.92	17.05	0.00
7	D	105.33	35.47	278.67	180.23	26.37	2.92	30.27	40.57	16.88	6.48
7	E	0.00	0.00	56.64	255.62	50.58	0.00	3.52	0.00	1.44	0.00
7	G	110.09	0.00	433.99	83.94	45.26	0.00	22.70	75.21	5.41	0.00
7	H	50.88	0.00	332.41	95.25	63.95	0.00	4.73	68.31	8.51	0.00
8	A	704.21	178.02	275.88	333.02	63.97	3.43	153.17	121.86	53.21	0.00
8	B	1215.61	82.90	207.39	811.66	52.90	9.68	37.00	125.69	12.63	0.00
8	C	220.88	514.03	40.80	251.61	18.82	15.28	22.63	597.73	505.67	10.88
8	D	235.90	0.00	378.91	99.83	29.80	48.59	31.40	32.75	83.12	9.27
8	F	41.72	0.00	461.86	80.23	70.05	0.11	14.09	53.68	3.54	0.00

Analysis No.	Run	Mn	Cr	Rb	Sr	Li	Zr	Zn	V	Ce	Ni
8	G	5289.27	0.00	184.43	51.74	833.04	3.00	500.89	69.58	18.06	0.00
8	H	9997.59	0.00	96.66	68.95	462.89	0.00	1011.53	80.24	8.00	41.79
9	A	288.76	0.00	582.26	238.88	150.21	0.45	66.10	109.43	15.42	0.16
9	B	520.89	0.00	391.95	389.32	126.03	5.68	86.71	87.52	45.22	0.00
9	D	563.18	0.00	372.71	423.06	312.04	7.37	92.30	90.32	63.05	0.00
9	E	154.26	0.00	26.96	400.23	46.74	0.00	30.48	8.30	16.75	0.00
10	A	164.08	0.00	56.87	958.68	46.86	7.51	72.09	196.89	15.46	0.56
10	H	929.69	0.00	129.42	700.97	196.97	1576.67	107.04	176.31	87.11	0.00
11	A	602.10	0.00	450.94	136.92	137.84	6.19	123.74	111.04	23.74	1.00
11	B	1051.85	0.00	337.10	301.97	265.38	13.24	179.08	89.23	26.68	0.06
11	C	390.35	70.56	330.91	270.97	153.94	11.43	56.23	68.71	44.16	3.58
11	D	253.83	0.00	358.09	146.73	137.94	1.50	51.56	83.07	18.49	15.43
11	E	743.18	0.00	375.96	302.12	155.36	62.58	115.96	50.52	44.00	0.01
12	A	78.69	91.23	700.72	61.16	95.60	1.35	18.94	120.87	2.43	0.26
12	B	522.98	0.00	461.05	472.86	140.15	9.20	175.50	128.89	59.07	0.00
12	C	229.71	0.00	392.78	385.92	115.48	19.25	87.61	104.16	44.40	0.00
12	D	100.23	0.00	15.45	160.88	114.79	1.15	23.21	3.26	10.80	6.26
13	A	363.95	0.00	380.86	97.08	92.06	9.90	66.13	110.76	16.29	0.13
13	B	227.67	1.92	526.65	51.03	90.04	0.54	87.99	116.81	9.42	0.00
13	C	183.39	43.83	410.72	54.55	131.13	1.07	73.72	106.85	9.04	0.00
13	D	366.19	0.00	344.09	93.71	41.98	0.00	116.83	59.79	75.04	12.71
13	E	289.33	0.00	424.06	142.44	128.42	0.00	58.18	89.67	9.01	0.00
14	A	0.00	0.00	749.74	25.56	0.00	0.00	0.00	126.28	0.00	0.00
14	B	281.41	0.00	503.48	122.61	152.55	1.76	74.99	92.95	18.06	0.00
14	C	199.89	0.68	389.05	160.89	105.44	0.80	63.23	93.90	14.82	0.00
14	D	121.73	0.00	417.27	92.19	101.61	4.04	46.95	97.41	24.59	7.08

Analysis No.	Run	Mn	Cr	Rb	Sr	Li	Zr	Zn	V	Ce	Ni
14	E	795.68	0.00	254.84	299.56	141.34	56.53	98.18	113.87	107.26	0.00
15	A	539.51	105.59	288.09	322.74	91.19	4.37	208.27	82.57	28.60	0.00
15	B	265.37	0.00	585.65	439.96	122.77	1.98	89.15	97.91	36.55	0.00
15	C	263.68	0.00	286.51	430.12	94.66	134.05	75.55	70.46	36.06	0.00
15	E	385.59	0.00	297.47	854.83	262.45	6.17	79.92	56.52	59.38	0.00
15	F	348.37	0.00	358.46	269.98	142.61	1.20	86.77	72.23	47.41	0.00
15	G	393.48	0.00	375.79	1285.27	247.89	102.56	199.60	63.98	181.99	0.61
15	H	287.90	0.00	487.03	177.19	114.54	5.53	97.70	92.62	24.58	0.00
15	i	679.90	0.00	72.81	576.55	227.41	8.40	197.54	59.32	76.06	0.00
16	B	833.96	59.06	202.11	195.39	192.04	65.99	162.80	113.85	50.94	0.00
16	D	1126.69	0.00	177.55	324.80	228.14	62.53	180.40	138.37	116.93	8.78
16	E	383.73	0.00	549.62	149.91	63.23	3.36	88.84	45.04	66.35	0.01
16	J	203.89	0.00	465.06	95.81	177.39	1.67	30.88	84.51	7.07	0.00
17	B	584.80	0.00	509.33	158.15	193.05	0.38	134.20	134.90	36.68	0.00
17	C	132.33	9.10	451.48	66.58	66.33	0.00	32.09	99.92	7.47	0.00
17	D	291.55	0.00	493.82	159.74	139.86	2.62	45.58	82.69	18.13	0.00
17	E	213.62	0.00	495.31	102.22	16.72	1.79	24.29	93.10	7.50	0.00
18	A	126.95	704.31	454.62	42.21	117.93	0.38	57.54	136.72	1.01	0.00
18	B	135.49	4.42	428.26	82.09	93.95	0.67	13.96	91.40	4.58	0.00
18	C	446.08	0.00	140.15	401.66	113.44	27.89	27.24	33.70	41.35	0.00
18	E	741.52	0.00	171.38	853.61	60.85	32.19	107.50	76.44	77.34	0.00
18	F	234.75	0.00	594.06	167.78	151.16	6.39	66.61	80.73	21.62	0.00
18	G	486.25	0.00	550.68	331.49	272.04	5.62	69.86	92.78	63.33	0.00
18	H	312.97	0.00	429.33	221.03	235.99	7.01	46.27	81.08	42.01	0.00
19	A	739.23	3261.77	302.66	264.05	0.00	1.55	116.95	132.49	57.61	0.00
19	B	390.51	246.07	250.26	305.38	183.39	12.94	20.76	56.24	595.47	0.00

Analysis No.	Run	Mn	Cr	Rb	Sr	Li	Zr	Zn	V	Ce	Ni
19	C	291.46	21.58	398.57	165.84	122.16	5.55	47.58	96.77	25.35	0.00
19	D	298.86	0.00	274.98	378.70	228.04	14.26	39.36	74.81	24.18	0.00
19	E	905.36	0.00	272.85	523.97	194.42	19.26	167.05	117.90	87.98	0.00
19	F	1353.08	0.00	428.46	471.15	314.34	0.00	141.90	83.09	25.54	0.00
19	G	1420.32	0.00	278.41	522.91	222.55	1.96	250.92	43.48	17.99	0.00
19	H	2392.21	0.00	78.72	547.62	445.20	45.27	402.09	80.36	43.13	0.00
20	A	538.76	407.10	385.75	253.71	94.25	19.07	55.28	33.17	60.88	0.00
20	B	560.01	152.72	293.00	184.46	125.48	12.70	52.43	91.00	29.74	0.00
20	D	898.73	0.00	153.85	511.28	219.63	73.62	521.52	96.71	462.98	0.00
20	E	204.56	0.00	295.79	64.55	138.65	6.74	16.81	58.79	11.09	0.00
20	G	111.20	0.00	176.41	188.48	102.50	0.06	34.35	18.74	8.38	0.00
21	E	574.75	0.00	95.55	710.65	156.75	77.17	37.50	55.54	61.88	0.00
21	F	743.81	14.65	334.21	379.18	192.16	29.16	114.56	101.32	77.59	0.00
21	H	895.03	0.00	477.11	274.69	306.29	47.06	189.51	148.61	58.04	31.20
21	i	131.24	0.00	443.02	64.28	188.12	2.42	19.88	82.60	4.49	16.00
22	A	217.87	505.05	372.51	154.31	52.21	0.36	88.42	94.76	5.55	0.00
22	C	713.09	502.57	155.01	250.35	82.38	30.93	57.97	89.46	63.62	0.00
22	D	276.10	0.00	409.78	157.96	200.88	16.23	52.82	110.96	20.64	0.00
22	E	906.11	0.00	126.32	894.23	153.00	65.27	118.86	73.78	100.78	0.00
22	F	510.13	0.00	501.35	210.30	115.64	1.10	95.96	70.88	34.33	0.00
22	G	418.78	0.00	525.30	196.19	161.82	5.29	81.55	85.88	40.56	0.00
22	H	420.91	0.00	382.15	193.76	252.34	1.81	97.20	73.16	43.77	25.78
23	B	231.65	171.97	347.27	221.41	79.49	0.68	67.36	76.47	9.76	0.00
23	C	614.94	153.95	171.29	277.12	159.47	98.34	130.75	86.41	86.11	0.00
23	E	110.95	0.00	344.01	127.16	26.06	1.75	43.38	78.62	27.29	0.00
23	F	243.93	0.00	453.66	136.65	162.83	1.15	55.05	71.10	28.29	0.00

Analysis No.	Run	Mn	Cr	Rb	Sr	Li	Zr	Zn	V	Ce	Ni
23	H	633.11	0.00	425.58	298.09	222.55	11.49	182.06	124.54	56.02	0.00
24	A	1361.51	946.62	334.61	217.49	124.77	2.35	241.24	108.07	31.60	0.00
24	C	327.78	47.07	339.31	133.30	167.54	0.00	58.76	57.64	12.17	0.00
24	D	210.97	0.00	352.95	68.09	243.85	5.46	42.23	95.06	16.53	0.00
25	A	333.67	0.00	419.92	51.54	163.78	2.23	30.85	99.23	6.25	0.00
25	B	165.03	0.00	368.95	194.99	159.25	4.59	44.50	77.14	11.31	0.00
25	C	128.16	0.00	373.21	45.07	282.44	3.56	32.64	92.11	5.27	0.00
25	E	244.57	0.00	371.09	114.93	491.77	3.34	38.86	88.16	21.84	0.00
26	A	129.45	0.00	421.93	35.17	0.00	5.11	0.00	11.62	18.55	0.00
26	C	179.27	0.00	283.69	259.47	67.73	8.21	37.55	63.04	26.25	0.00
26	D	295.52	0.00	396.03	145.10	64.17	2.75	36.52	87.90	16.25	0.32
26	E	539.94	0.00	383.43	667.63	72.79	0.00	22.46	66.83	56.97	0.00
27	A	611.58	0.00	433.61	170.90	170.48	2.54	185.02	111.14	46.82	0.00
27	B	991.00	0.00	458.40	114.93	156.15	6.28	65.10	96.69	61.33	9.13
27	C	430.91	0.00	326.20	137.88	115.51	39.17	77.68	116.79	567.09	4.58
27	D	293.97	0.00	414.83	128.02	128.89	2.67	83.66	100.86	24.15	0.00
27	E	226.13	0.00	427.45	81.26	149.23	4.33	100.51	97.28	13.19	0.00
28	A	134.76	0.00	372.59	85.18	99.23	5.20	19.37	98.12	6.03	0.00
28	B	0.00	0.00	7.94	57.03	67.14	10.55	22.78	0.00	1.86	4.22
28	C	2143.09	0.00	215.46	196.34	264.91	39.36	181.81	74.95	45.09	21.61
28	D	197.59	0.00	359.95	109.92	80.98	11.14	74.14	108.94	218.20	1.72
28	E	34.73	0.00	374.82	57.81	0.00	1.25	44.39	87.38	3.56	0.00
28	F	428.70	0.00	427.64	172.62	63.92	2.13	61.12	80.70	109.49	0.00
28	G	577.88	0.00	354.63	380.49	77.05	4.57	62.66	56.80	28.03	0.00
28	H	1268.29	0.00	356.76	812.54	120.34	9.95	86.17	72.74	57.67	0.00
29	A	84.89	0.00	471.86	0.00	0.00	0.00	0.00	56.76	0.00	0.00

Analysis No.	Run	Mn	Cr	Rb	Sr	Li	Zr	Zn	V	Ce	Ni
29	B	1974.08	0.00	130.95	441.88	110.69	72.25	186.13	94.52	74.95	11.09
29	C	1630.59	0.00	318.74	222.71	473.57	3.29	515.87	176.77	31.65	21.69
29	F	586.22	0.00	45.72	1173.74	136.79	14.03	96.60	37.75	30.93	0.00
29	G	46.74	0.00	0.00	679.08	46.22	6.57	2.63	0.00	1.97	13.82
29	H	149.12	0.00	35.17	709.83	91.47	8.74	65.13	21.15	9.05	67.16
29	i	1586.99	0.00	269.09	130.61	128.08	4.87	335.45	136.86	11.72	24.60
29	J	66.99	0.00	545.14	172.88	17.27	1.98	2.87	6.76	7.34	0.00
30	D	13573.83	95.94	118.94	286.98	199.99	180.18	399.24	102.09	146.66	30.23
30	E	555.50	0.00	533.07	187.77	152.05	5.42	122.22	95.22	575.09	0.00
30	G	135.61	0.00	490.18	89.60	77.82	2.54	79.86	75.21	13.73	0.00
30	X	415.38	0.00	167.87	345.14	230.17	11.85	146.61	57.78	58.87	0.07
30	Y	230.87	0.00	470.45	245.92	190.41	5.00	39.16	50.36	41.17	0.00
30	Z	622.19	0.00	264.85	461.02	236.68	81.41	199.84	108.12	123.33	0.00
31	A	4638.63	132.88	105.61	148.86	188.23	14.70	814.88	50.88	32.70	0.00
31	B	233.15	111.78	379.99	85.59	0.00	14.43	62.42	88.97	3.48	16.06
31	C	1597.99	101.40	272.10	107.68	75.35	14.74	152.27	103.64	14.27	17.05
31	D	344.59	81.44	343.91	87.01	72.53	5.83	65.76	80.37	4.96	20.62
31	E	2793.21	0.00	263.31	54.91	40.17	0.00	326.37	63.74	3.20	0.00
31	F	46.87	0.00	504.86	88.27	119.52	3.21	43.63	58.21	8.28	0.00
31	H	423.98	0.00	269.15	73.42	121.95	12.32	206.06	185.50	14.72	0.00
32	A	249.28	296.64	377.75	59.95	73.24	5.19	0.00	85.59	6.51	0.00
32	B	296.54	108.56	359.32	71.34	18.04	24.90	34.95	82.46	16.50	0.00
32	C	4060.98	80.57	19.31	67.67	206.73	3.65	504.16	59.21	3.92	32.12
32	E	192.30	0.00	484.47	38.46	49.70	0.85	27.47	102.70	5.42	0.00
33	B	214.60	0.00	363.59	75.79	46.14	69.22	32.47	81.51	9.38	0.00
33	C	771.00	0.00	374.23	217.01	285.30	6.56	155.00	99.12	63.00	8.97

Analysis No.	Run	Mn	Cr	Rb	Sr	Li	Zr	Zn	V	Ce	Ni
33	D	1226.57	130.38	124.22	445.50	181.57	95.58	213.71	118.01	142.21	28.04
33	E	256.31	0.00	422.53	119.66	103.69	0.91	64.08	98.59	27.93	0.00
34	A	269.29	0.00	25.21	967.62	26.80	6.11	0.00	28.11	42.66	0.00
34	C	1093.53	0.00	136.46	564.12	210.80	84.17	177.37	107.14	143.36	7.69
34	D	1249.01	907.67	38.31	640.45	172.63	83.95	65.73	152.54	73.44	97.35
34	E	550.46	0.00	342.08	309.42	97.64	25.11	65.87	131.12	181.71	0.00
34	F	811.91	0.00	569.26	464.02	113.60	17.14	234.73	111.50	95.89	0.00
34	G	570.79	0.00	536.44	277.21	116.70	10.32	110.84	131.49	48.88	0.00
34	H	744.64	0.00	214.25	517.73	249.14	150.69	396.14	96.32	100.48	0.00
35	A	203.78	0.00	424.67	100.81	100.90	2.80	13.36	83.27	14.87	0.00
35	B	306.74	0.00	399.68	120.67	86.57	4.82	33.76	80.80	37.13	0.00
35	C	622.52	0.00	213.07	482.79	294.64	113.67	139.43	88.50	79.64	8.60
35	D	574.87	15.46	244.59	314.18	79.88	5.14	84.87	78.96	42.80	10.83
35	E	166.79	0.00	360.46	182.45	60.65	3.29	13.51	70.85	19.85	0.00
36	A	1266.37	0.00	280.53	77.46	118.61	35.61	151.63	92.55	46.87	0.00
36	B	235.61	0.00	286.30	66.55	40.83	0.06	38.23	77.13	11.55	0.00
36	C	383.86	0.00	411.19	111.46	109.41	8.52	52.97	88.13	40.92	0.00
36	D	955.24	0.00	421.69	66.42	177.78	32.12	121.43	116.35	38.53	7.96
36	E	6056.51	0.00	34.44	25.20	577.79	2.91	435.85	41.38	9.68	0.00
37	A	721.41	0.00	423.29	160.29	107.40	2.79	274.28	107.72	39.29	0.00
37	C	797.20	0.00	299.89	178.32	132.02	3430.60	119.11	92.20	46.23	0.00
37	E	368.03	0.00	437.05	90.61	167.04	0.00	46.53	91.06	16.46	0.00
38	A	374.93	0.00	390.61	110.08	209.92	8.42	98.61	89.93	26.48	0.00
38	B	270.11	80.08	152.12	247.36	19.87	11.32	20.65	41.66	20.47	0.00
38	C	5255.85	0.00	155.68	220.68	237.21	140.95	779.57	66.91	51.40	11.10
38	D	205.91	105.39	362.90	71.84	87.75	3.03	38.03	82.49	5.02	8.31

Analysis No.	Run	Mn	Cr	Rb	Sr	Li	Zr	Zn	V	Ce	Ni
38	E	36.73	0.00	5.78	472.64	63.44	2.68	0.00	1.79	9.36	0.00
39	A	3516.66	0.00	739.91	270.75	501.31	7.18	510.44	164.15	74.70	0.00
39	B	1040.73	0.00	233.71	735.49	95.06	49.56	124.67	101.41	107.68	0.00
39	C	1066.90	0.00	81.67	596.48	178.86	4.03	97.34	49.02	55.75	0.00
39	F	527.42	0.00	292.30	315.37	160.90	60.32	68.33	85.29	62.17	0.00
39	G	370.78	0.00	584.00	446.28	156.58	6.03	79.77	101.91	52.16	0.00
39	H	419.29	0.00	437.46	226.10	208.73	7.03	40.66	126.11	31.08	0.00
39	i	564.23	0.00	239.87	346.40	293.16	110.36	100.75	91.17	55.87	0.00
39	J	84.69	0.00	497.54	57.81	132.05	0.00	18.93	84.20	6.07	0.00
40	A	2024.52	0.00	78.01	2779.17	132.38	5.25	216.28	154.28	95.57	0.00
40	C	1961.22	0.00	97.98	332.15	161.18	3.69	390.17	229.77	17.43	13.58
40	E	1994.78	0.00	199.33	115.88	463.70	0.49	399.08	240.25	32.36	0.00
40	F	192.30	7.15	0.00	1177.73	58.03	26.99	0.00	0.00	17.23	0.00
40	G	249.26	0.00	43.34	930.60	233.45	5.63	51.34	25.51	4.95	0.00
40	H	523.34	0.00	141.21	292.87	230.44	7.07	95.67	51.69	13.67	0.00
40	i	2410.46	0.00	168.57	150.16	503.15	1.03	420.04	169.38	19.66	55.57
40	J	1910.22	0.00	63.67	1297.94	108.93	12.34	96.76	168.30	34.11	0.00
41	B	133.81	269.79	424.58	139.36	204.47	0.00	33.05	75.07	8.04	90.55
41	D	469.97	0.00	382.98	475.81	197.30	4.57	105.05	97.65	48.38	23.20
41	E	169.90	1334.44	536.22	77.65	51.46	38.72	0.00	121.36	16.97	0.00
42	A	141.88	50.07	436.82	53.10	174.42	2.26	31.44	93.08	3.56	1.56
42	C	0.00	0.00	400.42	119.65	251.99	0.00	28.66	78.80	6.10	0.00
42	D	368.84	0.00	371.06	196.48	137.56	8749.04	80.05	72.89	25.10	41.72
42	E	213.22	1762.11	492.36	84.47	217.00	0.00	0.00	104.51	2.14	0.00
43	A	172.23	22.04	399.40	73.88	94.46	3.03	19.19	86.77	1.90	0.00
43	B	7246.19	330.40	101.56	195.38	267.82	17.40	592.20	51.21	25.47	83.56

Analysis No.	Run	Mn	Cr	Rb	Sr	Li	Zr	Zn	V	Ce	Ni
43	C	289.15	0.00	471.72	187.87	104.18	9.31	97.78	96.88	32.65	0.00
43	D	0.00	0.00	686.93	23.88	306.89	17.40	0.00	105.91	0.00	0.00
43	E	11079.75	625.14	34.53	159.84	931.13	0.00	1188.26	82.89	43.38	0.00
45	A	532.89	794.09	369.02	290.41	175.05	0.00	0.00	100.42	9.17	0.00
45	B	487.73	73.30	404.91	340.56	177.37	19.44	119.70	99.25	396.62	33.31
45	C	70.94	0.00	57.73	343.30	158.22	40.40	138.56	38.95	34.59	0.00
45	D	71.42	0.00	83.53	66.60	133.07	0.00	6.69	17.75	0.46	0.00
45	E	627.50	1522.19	483.03	600.96	365.36	0.00	0.00	151.55	55.88	0.00
45	F	1049.22	0.00	184.81	1053.86	270.70	156.82	148.80	157.32	6213.36	0.00
45	G	139.28	0.00	444.50	156.96	31.54	77.36	97.74	67.02	5.49	0.00
45	H	406.86	0.00	432.90	623.26	205.02	16.76	101.84	104.20	25.24	0.00
46	A	547.89	753.76	337.83	190.41	122.20	0.00	0.00	117.94	250.03	0.00
46	C	472.25	0.00	300.76	74.52	88.81	14.80	164.31	235.76	11.38	0.00
46	D	860.83	0.00	88.01	365.02	214.33	130.66	253.36	88.02	34.92	0.00
46	E	386.51	1141.21	253.97	131.14	164.89	0.00	61.15	299.56	23.95	0.00
46	F	2467.99	2668.59	127.44	262.67	184.37	7.17	389.49	82.83	48.70	1426.89
46	H	484.64	0.00	488.75	120.93	322.62	8.99	144.09	120.96	41.98	5.56
46	X	125.78	0.00	440.71	68.08	154.11	18.44	50.15	94.83	6.66	0.00
46	Y	0.00	0.00	85.09	290.38	126.40	9.08	0.00	3.62	8.70	0.00
46	Z	940.87	0.00	527.01	131.44	223.18	16.15	156.27	143.24	50.35	0.00
47	B	5180.69	0.00	220.22	295.86	1286.88	11.06	976.91	62.01	31.64	0.00
47	C	7065.87	0.00	44.56	137.71	1043.05	18.23	1142.33	53.36	30.78	0.00
47	D	1114.22	0.00	60.49	336.40	201.68	27.46	36.21	116.57	17.50	0.00
47	F	618.19	21.82	418.07	293.97	238.33	9.26	130.78	117.07	68.78	0.00
47	G	181.88	0.00	394.07	143.89	147.42	5.73	262.71	118.46	30.90	0.00
47	H	163.04	0.00	416.11	101.92	129.21	6.94	172.34	74.95	23.53	0.00

Analysis No.	Run	Mn	Cr	Rb	Sr	Li	Zr	Zn	V	Ce	Ni
47	i	132.78	0.00	365.68	221.73	204.99	8.88	89.85	70.55	37.32	0.00
47	J	146.01	0.00	177.38	1116.26	145.38	59.25	146.02	36.62	26.62	0.00
48	A	7300.51	15020.46	548.17	0.00	69.14	205.75	0.00	569.50	15.36	0.00
48	B	3691.38	0.00	421.01	112.39	725.40	31.50	432.62	47.39	21.55	0.94
48	C	5955.52	0.00	50.71	185.81	422.51	49.84	610.28	48.89	29.48	52.29
48	D	5938.75	0.00	191.87	56.87	724.58	0.00	668.37	26.74	9.61	0.00
48	E	10696.07	4232.19	188.16	228.92	222.00	15.88	129.26	155.47	97.38	0.00
48	F	2073.95	3180.27	186.07	284.48	84.11	82.66	239.93	74.13	86.47	1617.36
48	G	1105.82	25.58	275.90	333.28	140.03	46.85	144.16	83.45	98.62	0.00
48	X	1431.65	0.00	497.96	190.81	199.29	3.73	76.78	77.46	41.65	0.00
48	Y	466.87	0.00	369.24	180.19	279.39	1392.25	87.65	75.72	60.94	0.00
48	Z	586.11	0.00	349.54	158.13	253.96	27.81	114.39	97.14	38.66	0.00
49	A	576.71	676.03	382.87	127.69	129.83	12.09	0.00	126.68	36.91	0.00
49	B	299.79	0.00	434.49	94.23	241.64	16.60	111.94	117.84	29.76	0.00
49	C	256.18	0.00	462.54	118.19	209.53	8.85	91.66	101.64	24.10	17.10
49	D	698.44	0.00	316.60	195.84	530.00	0.00	103.59	206.02	98.52	0.00
50	A	794.15	1098.73	249.60	100.83	23.09	4.59	0.00	98.79	7.81	0.00
50	B	159.10	0.00	209.60	377.09	155.30	46.87	0.00	0.00	12.99	0.00
50	D	281.14	161.09	427.21	88.48	225.12	7.69	11.23	76.86	2.43	0.00
50	E	3255.84	2418.59	712.82	87.08	418.23	0.00	124.50	245.15	47.85	0.00
51	A	10318.80	605.63	122.90	473.65	170.49	6.56	796.76	127.64	50.42	0.00
51	C	0.00	561.17	11.06	412.32	84.10	0.00	61.90	3.59	5.37	90.30
51	D	188.49	0.00	380.68	80.03	214.32	7.86	0.00	72.23	8.71	0.00
51	E	215.37	3472.20	60.92	302.98	309.22	0.00	0.00	86.85	16.11	0.00
52	A	455.29	1096.97	358.26	66.90	46.63	2.98	0.00	127.27	5.94	0.00
52	B	787.06	0.00	53.26	643.56	133.67	124.58	0.00	79.20	87.91	0.00

Analysis No.	Run	Mn	Cr	Rb	Sr	Li	Zr	Zn	V	Ce	Ni
52	C	283.14	506.06	366.26	69.43	148.63	13.32	96.90	105.81	22.74	114.30
52	D	579.71	61.47	325.90	140.62	259.53	0.00	0.00	73.36	26.97	0.00
52	E	5938.06	2538.13	414.63	209.78	362.20	74.10	406.71	172.68	68.79	0.00
53	A	673.40	1369.10	357.92	78.90	43.17	4.40	0.00	122.73	6.72	0.00
53	B	171.28	0.00	304.75	83.18	117.81	7.32	0.00	80.84	7.41	0.00
53	C	275.42	983.07	332.88	80.06	224.27	0.00	112.96	72.19	2.84	169.89
53	E	126.34	2205.71	463.26	73.98	33.88	0.00	0.00	119.08	1.10	0.00
54	A	1324.02	1445.24	139.52	454.12	104.70	214.96	0.00	163.45	96.08	0.00
54	C	2203.74	420.47	356.08	731.56	178.70	65.43	374.36	118.29	57.88	56.32
54	F	131.41	0.00	65.91	523.97	119.92	908.22	0.00	11.93	15.58	0.00
54	G	609.44	0.00	417.07	226.74	292.15	481.66	683.85	109.05	35.40	0.00
54	H	4948.19	0.00	84.55	139.79	418.08	21.19	614.73	55.47	34.06	47.46
54	i	149.31	0.00	216.43	100.43	197.03	0.00	5.86	47.58	14.89	42.78
54	J	476.90	0.00	578.30	221.36	234.79	45.25	63.20	102.37	36.55	0.00
55	A	3086.57	9205.44	379.94	282.72	0.00	2.17	0.00	210.97	5.11	0.00
55	B	168.14	0.00	409.02	115.22	97.61	27.15	33.45	123.36	26.02	0.00
55	C	909.36	1446.87	300.23	350.12	91.99	22.75	111.15	116.96	41.21	124.28
55	D	572.92	314.98	410.40	103.11	188.43	156.37	56.67	103.38	27.96	0.00
55	E	629.16	1695.73	168.51	626.92	111.31	231.08	0.00	138.38	92.39	0.00
56	A	1110.94	2513.26	160.50	84.28	40.76	57.01	0.00	142.28	20.43	0.00
56	C	777.17	1446.88	186.65	180.22	156.66	91.55	130.80	93.15	57.24	116.50
56	D	442.08	318.85	44.00	348.15	132.50	24.38	0.00	23.74	14.59	0.00
56	E	1533.70	3882.84	123.07	349.79	12.38	95.42	0.00	75.06	68.82	0.00
56	F	101.84	0.00	511.63	87.14	126.94	0.00	13.15	41.23	6.92	0.00
56	G	113.91	0.00	470.92	85.88	166.01	0.93	39.05	52.46	5.08	0.00
57	A	5220.47	12934.77	289.75	152.98	604.42	84.79	1123.68	147.71	116.02	159.18

Analysis No.	Run	Mn	Cr	Rb	Sr	Li	Zr	Zn	V	Ce	Ni
57	B	0.00	0.00	142.83	250.75	188.35	88.41	372.10	41.42	28.88	46.55
57	C	0.00	0.00	424.49	75.94	206.13	922.90	78.53	94.10	76.88	3.86
57	D	21.55	0.00	404.89	61.65	148.13	5.30	46.07	95.98	8.60	10.29
57	F	139.36	0.00	533.74	107.68	300.13	17.59	31.44	87.45	43.68	0.00
57	G	64.49	0.00	468.86	49.50	197.62	3.70	24.83	79.93	6.08	0.00
57	H	51.04	0.00	325.06	70.51	232.94	2.66	18.11	70.03	7.33	3.78
58	A	105.39	3820.99	334.58	118.25	134.48	155.17	191.37	103.43	8.03	39.83
58	C	3421.18	0.00	42.27	87.26	1871.07	0.00	822.61	134.99	15.08	62.77
58	E	1329.65	6.27	405.29	161.16	231.19	20.85	151.22	111.53	32.44	23.93
58	F	620.41	0.00	229.63	353.50	198.59	136.20	248.92	79.97	114.91	0.00
58	H	398.02	0.00	431.63	132.63	232.36	4.10	176.36	104.08	31.64	0.00
59	B	0.00	0.00	377.04	96.39	74.53	0.00	13.09	86.11	0.00	1.59
59	C	11321.35	261.71	49.70	119.47	1339.84	0.00	1524.93	1.11	12.93	88.56
59	D	283.28	123.19	231.09	267.64	104.79	43.14	111.86	62.98	40.94	18.44
59	E	9321.03	152.90	82.59	90.91	982.37	13.07	801.07	55.66	17.76	68.55
59	F	268.54	1563.51	335.88	139.56	136.28	187.21	127.28	86.06	8.40	758.86
59	G	458.29	0.00	380.63	443.51	259.32	3.02	83.80	81.12	26.55	0.00
59	H	565.49	343.30	416.12	76.47	313.77	2.90	66.77	66.24	10.40	118.81
59	X	2662.25	0.00	215.57	86.18	381.22	7.28	341.23	47.92	7.75	0.00
59	Y	82.21	0.00	473.57	91.70	192.89	0.00	23.61	77.46	3.54	0.00
59	Z	154.59	0.00	462.94	83.31	278.44	4.75	40.35	92.45	6.47	0.00
60	A	5160.83	8717.23	66.51	349.92	220.75	30.83	884.68	120.23	41.83	62.15
60	B	11940.24	0.00	33.85	178.36	475.67	362.48	969.90	18.20	25.14	3.82
60	C	123.75	72.90	377.65	123.42	248.73	0.58	68.12	87.04	3.65	20.55
60	D	707.61	23.32	177.19	389.21	127.57	61.88	145.63	73.77	77.78	3.50
60	E	330.66	245.57	269.08	228.69	278.46	10.78	0.00	89.87	9.20	23.01

Analysis No.	Run	Mn	Cr	Rb	Sr	Li	Zr	Zn	V	Ce	Ni
60	F	900.50	0.00	389.59	294.29	109.77	0.00	0.00	0.00	33.25	0.00
60	G	236.31	0.00	423.92	122.92	130.47	119.15	59.35	80.18	19.91	0.00
60	H	293.75	0.00	268.10	138.46	127.57	0.38	25.27	52.66	5.39	0.00
61	A	1786.32	8535.90	132.34	523.18	138.52	153.71	208.68	201.53	184.36	39.04
61	B	0.00	0.00	0.00	861.79	8432.51	230.42	106.67	248.48	0.00	0.00
61	C	1631.97	431.23	60.54	447.41	383.61	0.00	289.21	0.00	157.49	52.57
61	E	9127.54	170.17	51.98	102.44	1341.60	10.33	1172.67	70.94	36.82	33.14
61	G	313.93	0.00	461.05	112.97	282.35	7.59	27.36	94.64	26.13	0.00
61	H	358.24	0.00	474.55	121.53	199.32	8.86	70.50	98.72	65.10	0.22
62	A	977.67	19340.42	26.35	642.10	72.19	0.00	0.00	202.89	37.41	48.60
62	B	0.00	0.00	282.54	144.36	83.21	48.12	54.79	80.21	0.00	0.00
62	C	0.00	295.99	500.53	91.13	0.00	785.68	258.91	85.72	21.48	42.35
62	D	8613.50	0.00	10.39	60.39	73.15	75.53	2077.18	66.41	6.32	14.15
62	E	59.32	0.00	433.13	72.04	131.53	11.76	29.56	132.02	6.43	0.00
63	A	1722.83	2076.93	46.61	1184.77	14.01	0.00	86.60	227.01	53.22	1.19
63	B	5834.48	0.00	0.43	255.26	179.10	0.00	455.65	97.81	7.56	0.00
63	C	2296.84	4.14	12.13	394.25	17.81	8.22	54.67	108.67	12.69	9.51
63	D	0.00	85.00	0.00	1508.92	50.30	6.28	19.95	0.00	22.06	0.00
63	E	948.35	1281.44	0.00	417.84	237.58	96.02	0.00	0.00	41.24	0.00
63	F	34.93	0.00	207.67	147.17	1.49	0.92	14.44	68.30	1.80	0.00
63	G	0.00	0.00	146.29	81.67	4.95	0.00	16.36	61.09	2.20	0.00
63	H	130.83	0.00	273.94	165.15	68.32	6.62	61.31	34.88	17.40	0.00
64	A	14084.38	3815.38	18.06	139.61	491.22	0.00	1245.78	92.61	15.43	5.09
64	B	23.54	0.00	456.20	170.30	118.49	27.92	32.99	112.76	19.42	0.00
64	C	102.30	218.50	661.97	107.61	221.69	0.00	129.51	78.82	0.00	0.00
64	D	222.38	0.00	385.54	175.44	143.05	13.93	67.57	93.07	23.76	0.00

Analysis No.	Run	Mn	Cr	Rb	Sr	Li	Zr	Zn	V	Ce	Ni
64	E	185.75	0.00	449.17	107.30	188.77	12.16	26.85	75.89	10.70	0.00
65	A	407.29	4338.72	437.45	105.18	208.11	30.42	0.00	155.16	14.45	0.00
65	B	310.24	0.00	204.56	110.37	103.16	0.00	36.53	312.84	20.42	0.00
65	C	409.91	0.00	359.84	153.74	166.50	60.60	83.55	103.52	13.00	6.17
65	D	160.12	117.59	530.76	56.12	48.50	131.98	174.09	72.96	6.11	0.55
65	E	243.13	0.00	597.72	51.37	179.66	3.68	91.62	65.42	3.28	0.00
66	A	5973.41	2705.91	346.36	620.90	285.71	1248.60	732.55	109.05	647.46	0.00
66	B	24.77	0.00	487.85	207.98	117.20	0.00	0.00	119.83	6.96	0.00
66	E	465.34	0.00	109.78	712.02	98.58	30.67	84.96	16.84	206.88	0.00
66	G	833.95	0.00	360.70	274.51	316.37	1617.33	205.44	105.24	139.47	0.00
66	H	285.82	0.00	361.60	149.61	266.82	3.74	72.45	66.60	24.66	0.00
67	A	697.73	10842.59	356.65	100.73	204.42	0.00	0.00	237.85	72.27	0.00
67	B	0.00	0.00	374.34	73.69	115.95	1934.08	0.00	70.43	16.19	0.00
67	C	581.01	0.00	270.63	170.85	163.81	0.00	157.72	121.50	19.34	0.00
67	D	190.62	0.00	610.30	66.04	291.67	5.21	50.57	88.23	101.18	0.00
67	E	1617.97	0.00	143.58	386.77	116.14	139.08	304.52	72.48	72.40	0.00
67	F	8619.76	0.00	114.45	358.63	770.63	8.10	996.20	69.05	67.34	0.00
67	G	10457.45	0.00	87.04	251.77	832.95	8.03	929.72	62.96	71.16	0.60
67	H	571.10	0.00	253.25	307.56	314.40	57.40	109.37	86.93	60.55	0.00
68	C	468.36	0.00	78.23	568.44	101.43	43.80	132.63	139.53	56.07	0.00
68	D	774.80	106.23	180.11	350.87	66.67	20.12	128.57	52.95	23.49	0.00
68	H	3.98	0.00	168.56	517.94	36.57	2.59	0.00	18.00	25.36	0.00
68	i	182.67	0.00	84.10	407.35	110.64	32.71	14.81	84.53	30.88	155.11
68	J	73.76	0.00	132.40	437.53	24.85	5.58	0.00	7.62	25.51	0.00
69	A	370.45	13535.13	362.51	335.30	0.00	152.85	0.00	270.06	37.25	0.00
69	D	137.37	0.00	408.45	385.76	238.09	7.09	8.10	78.46	22.24	0.00

Analysis No.	Run	Mn	Cr	Rb	Sr	Li	Zr	Zn	V	Ce	Ni
69	E	3866.39	0.00	448.21	191.27	521.77	15.73	962.67	82.08	14.85	29.56
69	F	218.13	0.00	619.27	857.13	274.68	98.14	63.81	80.30	92.94	0.00
69	G	71.64	0.00	324.40	161.37	61.09	30.96	98.99	58.30	9.64	0.00
70	A	8508.01	5587.87	30.69	358.72	282.06	27.06	492.67	169.98	82.98	0.00
70	B	74.36	0.00	474.27	76.55	118.29	41.89	0.00	116.57	0.00	0.00
70	C	163.07	0.00	467.09	44.85	57.29	4.47	81.61	102.45	1.07	0.00
70	D	2143.10	0.00	130.15	427.73	256.56	57.78	0.00	1689.11	5427.92	0.00
70	G	94.15	0.00	501.69	39.70	123.50	0.15	21.85	76.99	4.39	0.00
70	H	77.41	0.00	81.96	32.72	138.51	0.00	22.88	16.03	2.12	30.60
71	A	376.81	4694.59	417.35	126.77	11.17	283.22	0.00	200.64	6.76	0.00
71	B	0.00	0.00	395.21	138.73	151.00	19.69	13.58	111.01	20.53	0.00
71	C	444.84	0.00	391.12	125.99	168.38	20.91	79.88	98.38	20.17	0.00
71	D	312.55	0.00	401.17	104.29	267.99	121.35	64.12	176.17	63.89	0.00
72	A	1449.55	0.00	326.48	596.22	70.54	31.95	199.41	0.00	204.65	125.80
72	D	3207.84	0.00	829.95	346.24	1449.11	4.68	669.55	69.11	59.82	0.00
72	E	107.80	0.00	409.61	139.20	185.63	1677.45	22.10	57.53	26.12	0.00
72	F	956.22	1763.55	325.59	63.26	119.62	99.09	140.76	156.98	14.53	827.33
72	G	305.25	0.00	647.27	173.95	163.67	80.14	63.34	79.14	35.71	0.00
72	H	534.42	543.51	432.00	180.73	445.34	6.01	114.13	64.73	35.02	85.79
72	Z	727.75	0.00	167.24	521.83	193.02	79.93	140.70	74.23	64.96	0.00
73	B	460.05	0.00	346.74	249.40	344.87	312.00	106.15	103.01	109.60	0.00
73	D	178.09	0.00	428.40	109.24	567.20	2.77	34.76	101.35	55.95	0.00
73	E	191.23	0.00	404.63	196.87	313.70	4.80	42.29	88.75	62.58	0.00
73	F	371.26	0.00	473.58	88.89	328.39	6.08	43.58	88.24	51.02	0.00
73	G	421.72	0.00	383.27	274.61	402.90	4.97	78.37	78.24	84.14	0.19
73	H	180.95	0.00	524.42	95.49	305.12	10.25	33.69	95.56	61.26	0.00

Analysis No.	Run	Mn	Cr	Rb	Sr	Li	Zr	Zn	V	Ce	Ni
74	A	113.79	0.00	465.98	183.75	212.27	4.69	95.13	66.62	27.25	0.00
74	B	650.06	0.00	328.16	202.32	333.18	3.61	170.18	75.03	34.29	0.00
74	C	69.37	0.00	398.48	57.30	63.86	2.44	56.80	63.64	3.18	0.04
74	D	639.42	0.00	384.78	50.14	402.83	0.00	50.72	58.38	6.76	0.00
74	E	90.34	0.00	351.27	57.97	166.82	4.04	24.48	57.02	6.46	0.00
75	A	0.00	0.00	1007.14	30.04	820.54	4.02	36.98	86.42	273.84	0.00
75	B	108.21	0.00	558.23	83.49	367.08	3.75	83.38	95.88	188.90	0.00
75	C	160.98	0.00	577.01	161.70	351.53	1.77	87.95	98.22	376.25	0.00
75	D	366.80	0.00	344.35	315.71	281.72	65.28	52.44	74.03	60.34	0.00
75	E	350.95	0.00	517.90	221.70	219.06	3.39	61.31	100.18	49.42	0.00
75	F	1031.35	0.00	268.68	232.93	318.26	1282.50	27.95	90.00	65.31	0.00
75	G	177.24	0.00	269.60	66.94	175.31	8.63	22.49	41.67	15.71	0.00
75	H	1503.53	0.00	151.45	238.48	103.68	32.42	105.69	144.97	27.91	0.00
75	i	276.86	0.00	311.46	122.04	181.66	8.16	108.33	64.18	46.19	0.00
75	J	318.90	0.00	359.95	363.95	305.91	31.37	70.44	73.32	37.57	0.00
76	A	1022.16	469.76	110.83	185.99	520.73	4.63	161.52	339.99	65.13	9.24
76	C	458.84	0.00	161.55	404.76	0.00	79.16	205.09	92.25	237.67	0.00
76	D	391.38	0.00	127.88	218.53	177.91	62.84	98.14	102.17	81.02	0.01
76	E	1061.19	0.00	316.50	116.58	54.85	17.66	206.82	203.48	113.30	0.00
76	F	1281.95	8554.22	97.07	540.49	129.47	66.15	0.00	102.70	60.80	0.00
76	G	72.26	0.00	205.77	339.07	55.78	4.58	0.00	13.66	18.86	0.00
76	H	1326.10	0.00	269.64	206.80	153.54	55.53	164.98	170.23	46.14	0.00
77	A	274.98	463.95	508.38	310.94	0.00	45.23	105.87	43.90	66.09	0.00
77	C	378.07	0.00	266.71	221.97	78.11	15.86	86.17	78.49	61.92	0.00
77	D	881.58	0.00	369.83	375.96	322.12	2.79	124.50	86.08	49.14	0.00
77	E	216.20	0.00	546.91	176.91	110.62	1.55	41.71	31.87	42.99	0.00

Analysis No.	Run	Mn	Cr	Rb	Sr	Li	Zr	Zn	V	Ce	Ni
78	A	35.25	1036.91	626.25	80.86	115.02	2.22	0.00	47.77	40.45	0.00
78	B	201.72	0.00	449.37	129.41	69.64	719.43	44.32	53.33	98.10	0.00
78	E	220.53	0.00	521.48	231.10	167.89	4.70	32.31	49.06	66.46	0.00
78	F	673.13	0.00	426.12	388.35	208.53	0.00	0.00	43.50	232.02	0.00
78	G	167.22	0.00	295.22	164.39	145.21	0.00	31.49	27.75	67.78	0.24
78	H	144.55	0.00	530.44	80.63	211.00	0.42	23.47	55.00	15.98	0.00
78	i	183.11	0.00	230.21	76.02	198.81	2.64	39.74	36.10	24.67	0.00
78	J	299.65	0.00	469.63	242.44	195.74	3.67	41.50	52.74	114.91	0.00
79	A	2593.82	673.31	344.71	587.88	1243.06	15.93	449.17	50.58	100.38	0.00
79	B	3907.01	0.00	409.84	241.86	490.53	4.32	507.69	80.41	80.92	0.16
79	C	456.13	0.00	464.00	319.45	145.97	8.06	226.69	114.88	194.69	0.00
79	D	349.10	0.00	362.04	375.09	179.11	3.93	70.66	75.67	47.23	0.00
79	E	1781.91	0.00	507.49	433.20	741.72	6.71	431.21	100.20	139.44	0.02
79	F	2063.09	0.00	253.91	203.21	341.48	1247.16	229.06	45.91	32.21	0.00
79	G	160.28	0.00	442.39	220.25	143.24	2.82	37.21	84.48	20.83	0.00
79	H	73.62	0.00	93.39	423.54	70.48	0.07	25.33	23.61	16.01	0.00
80	A	112.58	862.19	202.78	293.59	332.38	7.92	22.03	43.13	11.68	0.00
80	B	5892.78	0.00	49.48	133.09	612.09	8.73	788.21	31.38	15.35	0.17
80	C	153.17	0.00	415.23	137.66	132.83	1.24	43.88	88.08	28.41	0.00
80	D	82.60	0.00	326.38	266.39	217.23	5.06	9.03	29.65	9.19	0.00
80	E	460.21	0.00	270.49	163.82	252.95	11.36	99.67	67.85	47.81	0.00
81	B	342.54	0.00	79.52	381.97	167.45	26.62	49.04	62.85	63.30	0.00
81	E	404.29	0.00	91.18	383.50	205.91	19.08	76.29	66.34	49.86	0.00
81	G	7.95	0.00	11.92	549.93	63.74	8.22	0.00	0.00	7.94	0.00
81	H	13.22	0.00	28.72	235.85	46.25	9.84	6.52	9.69	9.90	0.00
81	J	527.68	0.00	95.76	868.75	81.93	59.85	127.84	122.31	74.05	65.30

Analysis No.	Run	Mn	Cr	Rb	Sr	Li	Zr	Zn	V	Ce	Ni
82	A	0.00	1197.09	469.16	173.86	344.59	179.38	0.00	55.02	5.81	0.00
82	E	133.43	0.00	505.78	113.16	131.16	1.82	39.53	81.12	7.48	0.00
82	F	455.87	0.00	376.04	174.85	138.71	2.62	240.10	103.44	27.41	2693.23
83	B	659.99	0.00	54.77	941.44	163.33	6.33	133.63	47.40	57.24	0.00
83	C	757.85	0.00	398.98	328.55	0.00	18.05	121.86	46.72	78.67	0.00
83	F	422.54	0.00	356.09	188.06	211.13	99.22	190.49	88.10	105.26	1915.92
83	G	398.22	0.00	191.65	186.51	207.05	71.99	64.57	45.27	38.39	0.00
83	H	136.69	0.00	392.75	145.02	165.65	0.00	37.46	49.49	3.79	0.00
84	B	375.37	0.00	267.96	82.33	146.46	1.29	58.44	64.02	20.87	0.00
84	E	1504.90	0.00	386.31	125.69	484.79	3.27	107.22	43.68	15.45	0.00
84	H	1112.20	322.79	359.18	171.95	222.54	7.44	104.59	81.76	33.90	52.16
84	X	320.06	0.00	472.10	239.98	170.37	12.28	110.12	88.78	31.03	0.00
84	Y	1641.32	0.00	294.13	227.91	400.48	41.54	359.76	91.55	49.03	0.00
84	Z	672.69	5.32	173.11	319.90	145.31	82.50	103.85	69.70	84.25	0.00
85	A	45.95	614.22	799.43	33.14	720.85	12.44	37.47	104.98	21.89	0.00
85	B	150.11	0.00	502.42	48.80	380.60	3.13	47.19	102.68	11.39	0.00
85	C	273.50	0.00	260.94	86.62	192.76	12.78	111.18	74.10	30.97	0.00
85	E	222.55	0.00	228.29	96.23	256.23	52.60	52.17	71.46	41.29	0.00
86	A	2883.35	670.11	525.49	147.38	2411.76	0.84	693.87	81.84	9.69	0.00
86	B	4907.70	0.00	83.48	255.42	1070.50	2.93	1011.74	69.01	13.56	0.20
86	D	3056.18	0.00	477.77	225.46	1156.44	0.00	789.24	94.42	17.41	0.45
86	F	329.73	1346.67	382.34	79.83	168.99	0.02	20.54	56.64	39.69	0.00
86	G	633.32	0.00	174.86	291.98	193.45	21.54	43.87	36.95	28.46	0.00
86	H	337.74	0.00	410.24	138.68	178.83	7.06	74.98	58.96	18.04	0.00
86	i	589.32	0.00	405.23	91.66	178.30	2.05	95.38	58.77	9.31	89.97
86	J	0.00	0.00	1335.76	759.64	140.36	0.08	0.00	0.00	42.58	0.00

Analysis No.	Run	Mn	Cr	Rb	Sr	Li	Zr	Zn	V	Ce	Ni
87	B	140.45	0.00	330.48	81.33	180.91	226.49	24.06	83.02	9.68	0.00
87	C	249.56	0.00	379.87	80.35	292.70	0.00	42.33	80.18	16.57	0.00
87	D	345.38	0.00	455.20	85.63	234.66	0.99	90.70	113.43	25.33	0.00
87	E	29.92	0.00	23.88	275.40	0.00	12.53	0.00	0.00	14.54	0.00
88	A	378.29	2182.21	472.31	114.49	4.07	2.87	48.41	122.80	27.45	2.61
88	B	225.45	151.09	338.22	148.84	29.72	13.19	56.30	64.82	36.27	0.39
88	C	200.35	0.00	475.08	109.54	126.00	0.07	40.28	86.86	12.79	0.00
88	D	262.54	0.00	396.22	203.23	69.88	0.00	48.88	81.50	27.94	0.00
88	E	270.48	0.00	9.71	81.95	10.73	1.30	31.19	8.33	5.45	0.00
89	A	408.68	2376.58	359.43	217.68	74.09	3.98	39.76	116.91	36.19	1.18
89	B	1347.81	43.39	551.25	151.10	565.99	22.44	489.14	70.04	75.33	0.48
89	E	87.38	0.00	425.79	84.28	90.80	3.17	19.30	86.50	6.01	0.00
89	F	555.55	0.00	467.53	49.18	287.73	13.10	312.63	125.19	40.59	2440.53
89	G	120.23	0.00	241.13	46.71	106.11	2.66	26.00	35.75	9.99	0.00
89	H	342.47	6.29	518.23	85.47	220.86	7.76	76.59	103.88	45.92	0.00
90	A	1750.36	2217.14	242.96	43.47	144.07	2.01	60.63	224.97	12.73	0.03
90	B	428.86	42.61	434.97	168.15	336.42	19.45	104.06	94.15	38.37	0.31
90	D	918.79	0.00	120.39	490.88	180.17	65.22	133.58	80.60	143.64	0.05
90	F	891.59	1369.52	290.83	128.85	346.56	9.53	464.30	98.73	81.69	719.43
90	X	733.76	0.00	294.38	217.32	440.82	179.17	125.52	106.53	62.69	0.00
90	Y	712.24	0.00	110.39	286.77	359.60	113.89	90.76	92.58	51.25	0.00
90	Z	823.01	0.00	173.72	398.38	328.10	56.80	98.10	117.60	50.47	0.00
91	A	297.90	1559.82	358.84	66.79	217.38	2.06	82.38	113.32	11.71	0.00
91	D	783.60	0.00	305.57	76.03	312.75	0.00	106.94	80.29	23.82	0.00
91	E	304.91	0.00	16.87	313.50	0.00	9.24	27.53	6.61	7.92	0.00
91	F	605.27	0.00	504.08	197.80	221.37	15.34	340.28	130.08	103.03	941.03

Analysis No.	Run	Mn	Cr	Rb	Sr	Li	Zr	Zn	V	Ce	Ni
91	G	9957.11	0.00	81.44	23.32	241.26	40.10	1460.59	49.73	12.26	7.03
92	A	796.54	9577.04	409.43	48.27	113.47	10.28	33.92	181.59	15.54	0.00
92	B	275.48	419.64	368.83	50.14	83.06	2.24	106.30	154.99	10.11	0.56
92	C	497.21	69.36	483.49	55.96	139.34	0.87	405.86	130.25	49.46	0.00
92	D	51.86	0.00	6.38	21.39	63.35	0.00	14.06	8.26	4.66	0.00
92	E	68.39	0.00	273.19	60.81	0.00	1512.08	26.93	59.18	5.21	0.00
93	A	334.65	1575.00	360.95	244.50	99.79	1.78	43.57	99.14	15.33	0.00
93	B	717.60	12.09	93.69	439.99	143.70	428.32	137.83	92.08	89.26	0.46
93	C	442.16	0.00	319.72	205.91	182.50	6.72	101.76	96.23	26.07	0.00
93	G	196.81	0.00	360.47	94.04	205.13	0.00	27.47	55.57	24.11	0.00
93	H	4645.94	2.14	143.77	102.25	1260.43	40.90	815.16	66.74	20.37	2.11
94	A	434.54	4249.56	390.42	80.78	104.47	2.79	46.35	111.73	7.84	0.00
94	C	692.99	0.00	490.98	104.92	122.21	14.83	129.12	29.98	14.11	0.00
94	D	185.64	49.68	431.73	74.58	26.62	0.00	34.77	95.77	5.20	0.03
94	E	537.28	0.00	163.65	254.16	155.01	84.14	87.60	86.85	67.83	0.12
94	F	7532.60	0.00	113.64	18.16	1320.30	0.00	1504.82	80.26	6.73	1460.65
94	G	1302.97	0.00	187.29	471.95	352.07	96.56	207.68	103.12	268.73	0.00
94	H	876.48	0.00	49.70	673.61	496.51	143.44	90.15	93.62	60.99	0.00
95	A	434.70	1754.69	39.44	693.01	64.27	14.36	42.82	44.09	48.36	0.00
95	B	468.67	144.07	393.45	120.81	70.49	5.93	98.23	90.79	62.92	0.69
95	C	229.34	0.00	490.44	50.33	233.26	0.45	49.60	101.87	10.86	0.00
95	D	4489.85	120.96	295.38	37.72	178.99	0.00	243.88	73.29	3.19	0.10
96	A	222.96	1902.56	200.31	337.30	70.30	11.40	15.67	86.33	62.54	0.00
96	D	188.81	2.31	63.92	355.71	131.97	1.90	62.04	24.66	13.71	0.00
96	E	408.94	0.00	1.45	246.24	0.00	5.37	45.58	118.24	2.99	0.10
96	F	410.61	0.00	443.80	82.87	615.30	12.74	248.44	85.58	41.15	2558.85

Analysis No.	Run	Mn	Cr	Rb	Sr	Li	Zr	Zn	V	Ce	Ni
96	G	471.81	0.00	142.49	169.94	196.93	112.69	67.55	10.27	2.32	1.38
96	H	1255.30	38.45	162.69	64.59	447.00	47.92	371.84	66.05	22.54	4.16
97	A	309.65	2764.42	354.19	118.21	31.36	4.75	19.11	82.50	33.64	0.00
97	B	226.05	59.24	263.48	134.84	112.00	0.83	56.33	66.16	36.06	0.22
97	C	154.31	0.00	245.99	114.96	95.91	0.00	39.13	51.97	11.09	0.00
97	D	658.16	56.76	417.64	110.98	152.58	346.32	81.58	100.81	46.77	0.00
97	E	38.29	0.00	0.00	137.78	0.00	4.61	24.81	4.25	21.73	0.00
98	A	548.72	3074.68	352.97	130.08	13.70	6.36	32.77	115.88	59.30	0.00
98	B	493.36	0.00	284.90	213.81	136.75	92.06	94.12	98.78	36.96	0.27
98	C	293.33	0.00	398.01	138.96	133.25	2.11	86.33	98.57	44.93	0.00
98	D	536.14	0.00	305.84	211.02	252.63	34.13	75.75	91.58	62.09	0.00
98	E	986.72	0.00	196.34	414.91	31.13	83.70	102.25	84.70	114.01	0.00
99	A	381.51	2483.74	494.14	55.54	72.29	1.79	39.06	116.95	39.22	0.00
99	B	168.55	0.00	497.58	76.19	95.71	3.24	50.75	75.28	28.72	0.00
99	C	222.88	0.00	488.42	69.30	112.52	4.29	34.17	75.71	15.30	0.00
99	D	219.47	0.00	506.76	54.82	113.66	0.00	36.09	81.28	8.35	0.00
99	E	223.05	0.00	464.61	60.82	103.05	1884.46	88.40	79.62	120.32	0.00
99	F	673.26	0.00	397.40	574.29	227.40	10.34	84.00	60.00	30.46	0.00
99	G	179.22	0.00	355.25	93.10	213.76	14.41	74.07	61.17	6.68	0.42
99	H	430.28	0.00	447.48	228.05	301.56	22.91	140.16	95.70	34.00	0.00
100	A	548.16	4118.02	313.44	258.03	105.09	1.93	35.16	108.81	34.27	0.00
100	D	337.02	0.00	319.84	202.72	149.19	12.03	42.32	69.54	23.91	0.00
100	E	358.81	0.00	225.48	337.31	0.00	13.92	57.37	12.18	19.01	0.00
100	F	297.84	0.00	164.19	44.89	250.26	8.31	257.21	49.93	20.97	3370.55
100	G	123.07	0.00	406.05	88.79	207.13	0.00	45.34	64.61	6.23	0.00
100	H	96.10	0.00	418.88	65.78	745.78	0.20	22.43	11.08	3.18	0.19

Analysis No.	Run	Mn	Cr	Rb	Sr	Li	Zr	Zn	V	Ce	Ni
101	A	266.89	1949.31	374.81	52.73	277.19	3.69	29.16	105.63	8.56	0.00
101	B	110.44	0.00	412.35	117.57	251.34	3.50	34.00	92.97	9.20	0.00
101	C	3363.97	29.71	78.90	110.46	373.05	0.00	488.10	47.24	7.45	0.00
101	E	3984.16	0.00	351.68	117.26	848.14	3.64	648.44	77.60	17.92	0.36
101	F	324.82	0.00	395.67	190.66	191.73	4.14	133.74	76.73	71.07	1004.32
101	G	511.34	0.00	412.20	273.19	215.97	4238.39	67.30	58.05	40.55	0.00
101	H	418.74	86.15	340.55	380.08	314.28	53.78	129.17	65.75	33.46	0.00
102	A	343.84	3909.28	343.59	88.53	201.69	329.35	34.21	61.67	9.65	0.00
102	B	424.34	0.00	375.54	141.99	304.62	15.41	118.32	93.05	28.27	0.00
103	A	2793.52	12625.84	267.46	2464.77	61.10	96.95	80.94	126.06	157.80	0.00
103	B	1547.89	0.00	224.23	2138.63	319.97	34.39	170.84	81.60	94.24	0.00
103	C	1390.88	0.00	643.82	433.38	360.32	24.04	263.84	185.19	38.48	0.02
103	D	224.64	0.00	376.77	332.17	56.23	12.81	47.90	80.48	22.65	0.00
103	E	448.49	0.00	421.97	524.72	101.85	25.18	33.30	70.17	32.84	0.00
103	F	1786.89	0.00	444.43	1497.64	427.71	65.68	462.27	120.41	164.64	4938.72
103	H	448.76	133.38	423.73	529.21	164.13	7.37	96.89	85.63	47.85	0.89
104	B	467.39	0.00	146.95	330.88	139.32	123.71	61.63	58.87	34.37	0.00
104	C	446.41	0.00	70.78	511.07	137.09	52.08	26.56	27.52	25.90	0.00
104	D	0.00	0.00	24.46	2029.01	0.00	38.60	107.39	0.00	3.49	0.00
104	E	1554.35	0.00	256.75	428.83	103.44	14.41	84.92	37.11	31.01	0.00
104	F	3141.30	29456.41	414.43	67.91	427.19	86.47	0.00	16.47	0.00	0.00
104	G	33.48	0.00	407.38	57.36	147.10	9.71	0.00	69.36	0.71	0.00
104	H	2291.11	0.00	140.74	308.02	195.19	130.07	333.03	70.96	82.84	1.95
104	i	749.12	0.00	181.37	254.93	269.91	94.74	107.94	95.08	78.18	193.54
105	A	405.92	1943.03	410.22	185.54	208.81	0.00	68.01	138.64	18.45	0.00
105	B	221.93	0.00	361.57	161.33	194.77	5.26	64.83	113.08	15.70	0.00

Analysis No.	Run	Mn	Cr	Rb	Sr	Li	Zr	Zn	V	Ce	Ni
105	C	191.56	0.00	372.85	70.97	0.00	9.15	45.62	55.40	9.04	0.00
105	D	91.35	0.00	385.95	88.24	0.00	1.67	6.41	67.66	8.30	0.00
106	A	561.24	1978.02	396.86	269.24	281.90	0.00	103.14	96.61	55.50	0.00
106	B	620.32	0.00	45.28	279.12	181.21	14.15	114.21	28.97	73.81	0.00
106	C	557.46	0.00	503.09	100.82	309.68	4.82	90.30	133.78	13.06	0.00
106	F	397.97	0.00	350.11	144.25	312.25	7.13	149.75	47.17	13.91	1301.87
106	G	5033.23	0.00	807.55	169.58	635.65	61.77	585.78	151.18	38.15	0.00
106	H	987.91	150.81	185.55	253.93	363.14	117.27	181.88	99.72	90.56	3.34
107	A	8652.54	2060.82	12.89	406.96	597.51	7.31	1103.47	37.46	54.54	89.67
107	B	781.80	0.00	343.83	1038.36	179.04	184.12	117.12	89.54	160.23	0.00
107	D	214.43	0.00	421.75	151.34	64.13	10131.07	25.12	86.48	63.70	0.05
107	E	100.47	0.00	488.60	60.68	45.21	0.00	16.53	88.43	4.64	0.00
107	G	1455.93	0.00	206.32	1481.24	169.27	70.78	165.21	52.10	356.82	0.07
107	H	1212.00	0.00	283.99	505.41	303.79	59.13	182.35	121.14	143.45	0.00
107	J	11067.01	0.00	51.19	263.10	658.95	0.97	1183.82	39.14	49.70	0.00
108	A	544.49	2381.99	488.44	270.96	408.53	0.00	31.33	118.90	671.98	0.00
108	B	303.88	0.00	120.80	520.07	37.54	53.11	17.49	10.16	64.79	0.00
108	C	275.65	0.00	323.53	224.78	292.10	6.14	45.76	62.93	33.52	0.00
108	D	114.57	0.00	461.93	66.29	219.39	5.09	22.50	94.79	46.29	0.00
108	E	151.98	0.00	411.33	123.63	341.60	4.71	37.88	83.95	24.02	0.00
108	G	94.36	0.00	319.17	97.21	164.73	0.53	7.06	52.12	7.81	0.00
108	i	926.34	0.00	42.85	766.21	288.18	6.08	73.41	26.76	134.90	0.00
108	J	969.45	0.00	284.95	509.62	366.40	67.45	135.03	100.52	111.75	0.00
109	A	1040.75	1535.00	266.26	684.13	240.35	1.39	31.73	36.62	17.70	0.00
109	C	166.06	0.00	375.17	96.22	64.56	56.14	70.76	57.78	28.04	0.00
109	D	1025.70	0.00	500.03	54.30	233.31	3.71	88.84	49.21	2.89	0.00

Analysis No.	Run	Mn	Cr	Rb	Sr	Li	Zr	Zn	V	Ce	Ni
109	E	485.87	0.00	192.25	141.52	136.12	102.76	119.16	119.80	54.79	0.00
109	F	180.10	0.00	410.34	97.39	163.29	4.65	127.17	66.98	6.50	1304.39
109	G	1115.20	0.00	725.43	45.39	600.21	0.00	227.05	89.56	4.91	0.00
109	H	162.78	193.79	512.06	65.59	414.27	16.21	52.51	78.65	8.31	0.00
110	A	615.44	3363.56	501.41	291.24	253.44	9.45	24.21	114.31	93.82	0.00
110	B	232.39	21.57	433.54	195.24	20.11	4.12	32.73	97.08	62.73	0.05
110	C	261.77	0.00	441.00	221.46	52.87	2.63	38.20	95.32	82.65	0.00
110	D	479.14	0.00	427.42	192.55	86.99	5.61	62.27	93.88	35.22	0.00
110	E	459.80	4.32	320.57	183.93	157.22	30.48	67.04	100.30	37.81	0.00
110	F	397.42	0.00	321.74	112.90	260.91	13.47	42.11	76.64	17.67	0.00
110	G	557.67	0.00	319.94	60.32	303.08	0.00	154.06	83.43	18.23	0.91
110	H	238.20	0.00	357.29	63.38	334.61	0.00	75.48	88.60	6.05	0.00
111	E	635.50	0.00	416.51	144.07	287.99	6.89	108.17	100.51	47.54	0.00
111	H	125.08	676.95	267.96	45.20	46.67	0.00	35.13	35.62	1.11	308.80
111	X	235.19	0.00	382.61	526.75	489.41	13.75	174.71	61.57	29.85	0.00
111	Y	47.63	0.00	267.37	56.73	39.35	0.00	23.47	29.04	1.15	0.00
112	A	2708.38	20765.19	130.11	672.63	541.22	126.11	0.00	133.09	22.93	0.00
112	B	362.50	0.00	179.70	224.51	0.16	88.97	76.62	102.15	77.75	0.64
112	C	210.14	0.00	360.51	497.26	192.92	4.00	48.08	86.92	13.98	0.00
112	D	153.24	0.00	239.02	239.36	17.09	4.08	17.94	18.92	19.62	0.00
112	H	82.00	140.25	526.05	74.85	244.25	0.00	63.45	68.48	3.18	0.00
113	B	74.52	0.00	333.21	189.41	35.68	4.01	30.55	16.47	15.23	0.00
113	D	210.30	0.00	302.41	74.79	156.64	14.29	54.73	78.82	7.67	0.00
113	E	147.97	0.00	356.60	110.78	324.82	0.00	33.61	35.05	6.76	0.00
113	F	797.31	0.00	214.76	319.69	323.97	111.69	292.94	91.74	127.24	2696.50
113	G	548.01	0.00	410.45	200.31	323.99	0.50	136.07	85.85	41.70	0.00

Analysis No.	Run	Mn	Cr	Rb	Sr	Li	Zr	Zn	V	Ce	Ni
113	H	1023.53	24.73	232.54	570.98	473.96	395.43	240.01	180.23	78.68	0.00
114	A	229.74	2509.50	259.56	42.96	117.29	0.00	4.57	56.40	2.29	0.00
114	E	68.58	0.00	428.37	57.97	134.41	3.94	27.41	61.65	19.68	0.00
114	F	217.14	2319.45	194.06	42.22	74.92	2.13	117.73	37.79	35.73	1151.20
114	G	192.54	196.47	421.81	141.26	121.88	19.39	44.06	69.41	39.57	123.36
114	X	34.25	0.00	346.52	121.62	69.45	0.68	40.00	60.79	30.01	0.00
114	Y	1143.69	0.00	375.94	40.33	171.05	3.21	364.08	49.10	4.31	0.00
115	A	295.03	2941.74	394.20	90.01	56.70	0.00	0.58	69.39	5.72	0.00
115	C	3708.21	0.00	272.28	68.53	1206.31	8.06	365.90	64.55	72.09	0.04
115	D	453.44	0.00	248.54	216.20	117.20	240.19	93.02	82.71	49.29	0.06
115	G	175.73	0.00	441.34	80.28	380.01	28.66	0.00	65.51	17.97	0.00
116	A	343.38	2180.76	356.73	103.53	213.03	0.00	44.29	93.85	19.11	0.00
116	B	280.30	0.00	326.24	126.60	249.88	4.28	76.52	73.81	32.28	0.07
116	D	333.90	0.00	361.68	66.71	233.51	4.60	33.71	64.58	7.51	0.00
116	E	665.95	0.00	115.27	309.36	130.63	25.19	118.43	60.80	39.12	0.00
117	A	0.00	79173.15	182.36	279.51	0.00	88.90	0.00	0.00	5.76	0.00
117	B	337.24	0.00	261.74	285.54	51.74	1.67	59.19	79.69	119.29	0.00
117	C	2661.60	0.00	192.07	129.77	246.32	2.83	752.60	80.58	50.22	0.00
117	D	112.57	0.00	355.41	95.71	100.16	8.95	14.32	68.22	32.28	0.00
117	E	2709.28	0.00	227.86	62.34	1268.14	3.38	693.25	73.06	13.85	0.00
117	F	1319.77	0.00	332.69	1083.17	503.73	11.85	23.24	77.73	169.44	0.00
117	G	671.64	0.00	341.16	771.46	428.22	8.03	72.33	67.24	118.85	0.00
117	H	259.29	0.00	353.73	170.07	318.47	25711.66	57.37	52.86	60.71	2.09
117	i	174.55	0.00	504.69	165.26	158.58	452.73	52.42	63.56	24.78	0.00
117	J	424.34	0.00	571.57	63.82	242.39	3.33	78.12	75.47	20.34	0.00
118	A	199.55	1097.18	326.08	308.41	168.18	46.92	30.06	61.03	32.99	0.00

Analysis No.	Run	Mn	Cr	Rb	Sr	Li	Zr	Zn	V	Ce	Ni
118	C	88.52	0.00	414.60	46.68	158.47	3.15	51.89	90.81	1.95	0.00
118	D	1073.24	0.00	404.77	145.33	220.81	4.49	290.16	102.10	50.11	0.00
118	E	370.90	0.00	326.49	112.00	260.98	8.06	139.60	74.55	23.87	0.00
119	A	57.49	1089.15	452.31	48.19	117.00	4.46	17.96	102.19	2.77	0.00
119	C	76.30	0.00	41.68	273.14	39.86	0.00	5.36	4.07	3.76	0.00
119	D	0.00	0.00	352.15	52.67	73.83	2.81	0.00	62.88	2.72	0.00
119	E	230.48	0.00	458.24	68.02	208.55	3.01	50.36	90.59	15.96	0.00
120	B	3985.68	19.16	98.46	322.79	534.76	119.47	456.50	77.81	107.92	0.70
120	C	2317.68	0.00	115.36	227.60	351.30	74.70	331.01	71.90	59.60	0.00
120	E	11.67	0.00	27.00	285.55	148.57	166.91	18.97	0.00	5.75	0.00
120	F	7564.55	1314.30	140.88	77.36	1508.96	34.34	1530.29	128.21	39.86	811.75
120	G	586.40	479.89	305.47	170.71	277.04	22.20	171.92	130.23	63.26	20.54
120	H	147.29	321.47	407.12	87.64	171.78	1.56	30.80	78.96	5.26	63.91
120	X	248.84	0.00	242.22	249.06	190.75	96.60	78.85	59.67	42.31	0.00
120	Y	332.11	0.00	226.23	529.95	225.91	55.18	120.21	71.63	42.90	0.00
120	Z	315.09	83.27	382.07	184.30	216.03	20.25	62.62	99.35	26.77	0.00
121	B	161.93	2.30	362.12	121.97	151.72	1481.30	32.93	71.03	16.57	0.30
121	C	234.71	0.00	322.85	244.89	149.74	17.61	58.81	42.86	27.44	0.00
121	E	72.09	0.00	458.41	55.87	197.99	1.38	52.73	82.29	3.17	0.00
122	A	0.00	4778.39	306.37	33.35	43.94	22.86	31.40	61.98	6.48	0.00
122	B	229.60	0.00	289.85	66.85	119.66	116.83	56.22	61.54	32.86	0.00
122	C	136.08	0.00	435.08	58.49	271.63	0.00	201.93	52.92	31.25	0.00
122	E	209.03	0.00	273.78	130.98	220.89	74.57	109.13	78.88	36.20	0.00
122	F	818.25	0.00	453.66	77.41	610.65	39.27	591.55	143.08	27.85	8312.99
122	G	103.75	0.00	224.05	41.94	252.13	0.00	2.80	22.14	2.30	0.00
122	H	142.27	224.48	403.65	59.43	222.24	0.00	39.07	74.53	9.79	0.00

Analysis No.	Run	Mn	Cr	Rb	Sr	Li	Zr	Zn	V	Ce	Ni
123	A	35.63	3235.25	308.22	42.79	65.33	15.15	20.28	87.02	14.03	0.00
123	B	266.85	0.00	467.11	56.74	238.34	5.68	73.15	95.08	13.03	0.00
123	C	61.14	0.00	208.21	32.01	174.00	0.00	19.26	32.30	2.84	0.00
123	D	161.21	0.00	438.90	49.96	177.80	5108.97	27.06	80.17	11.07	0.00
123	E	126.86	0.00	524.92	40.52	166.45	2.44	28.93	74.19	2.73	0.00
123	F	1452.11	0.00	327.56	237.77	268.84	1073.27	248.77	119.34	162.74	0.00
123	G	271.91	0.00	480.09	58.59	128.07	2.42	52.04	61.53	9.38	0.36
123	H	167.25	0.00	34.97	114.47	166.19	0.00	43.95	7.89	14.14	0.21
124	A	11.33	1695.56	25.66	152.12	64.40	6.85	17.25	8.81	10.17	0.00
124	B	300.25	0.00	523.64	44.46	354.38	26.32	90.88	120.96	11.88	0.00
124	C	11.31	0.00	383.69	29.96	138.65	7.45	7.91	2.76	1.48	0.00
124	D	31.11	0.00	358.64	56.86	287.62	6.86	56.41	67.83	4.39	0.00
124	E	108.85	0.00	78.33	148.94	202.79	6.08	60.54	17.00	8.36	0.00
125	A	101.57	1579.61	392.92	73.98	139.33	32.17	84.56	81.63	7.36	0.00
125	B	323.11	0.00	499.00	94.74	333.12	3.73	52.60	94.54	22.44	0.00
125	C	405.60	0.00	401.82	77.09	227.96	8.58	131.44	101.99	249.39	0.00
125	D	355.37	0.00	435.58	51.52	331.49	2.89	61.86	80.66	9.09	0.00
125	E	254.94	0.00	318.18	36.78	164.80	0.00	57.61	53.48	10.39	0.00
126	A	171.77	1288.14	235.49	146.04	124.60	5.15	24.77	48.88	18.74	0.00
126	B	281.15	0.00	329.30	118.66	249.66	7.00	29.34	76.31	41.24	0.00
126	E	319.30	0.00	16.59	403.84	121.02	5.74	54.20	13.36	33.28	0.00
126	F	4928.45	1096.45	217.09	317.80	699.07	7.52	883.87	98.35	47.93	521.96
126	G	443.72	227.68	459.61	228.59	152.50	5.04	62.29	63.81	29.58	0.00
126	H	640.42	318.80	357.50	257.51	278.97	4.97	90.68	94.22	51.25	14.65
126	X	870.99	0.00	321.36	424.47	273.19	11.97	190.08	80.93	71.83	0.00
126	Y	2233.18	0.00	755.56	240.61	430.00	10.38	596.83	89.94	36.08	0.00

Analysis No.	Run	Mn	Cr	Rb	Sr	Li	Zr	Zn	V	Ce	Ni
126	Z	226.71	64.41	389.50	97.52	207.32	3.31	33.51	78.92	13.48	0.00
127	A	68.01	907.63	18.06	354.37	170.43	1.25	17.87	7.75	8.50	0.00
127	D	168.08	0.00	335.78	166.28	157.65	7.68	53.96	80.32	11.24	0.00
127	E	559.53	0.00	323.63	214.65	195.26	12.21	87.60	137.28	39.25	0.00
127	G	869.36	0.00	502.94	129.78	229.51	9.00	17.74	88.04	208.33	0.00
127	H	109.46	0.00	447.86	121.84	285.28	5.43	20.18	90.00	54.64	0.00
127	i	73.22	0.00	573.23	102.83	301.82	0.85	13.70	88.08	27.59	0.00
127	J	169.92	0.00	461.09	143.89	298.40	2.86	1.80	75.76	80.92	0.00
128	A	463.24	15972.26	22.33	309.76	0.00	517.79	0.00	11.15	26.11	0.00
128	B	289.97	0.00	401.02	79.81	377.35	2.77	69.99	78.53	22.47	0.00
128	D	357.88	0.00	479.63	65.39	181.08	9.78	72.07	87.79	28.01	0.00
128	E	489.82	0.00	435.68	128.07	529.15	4.05	228.08	89.74	70.56	0.00
129	A	296.81	1552.43	87.33	563.75	159.69	115.63	57.24	62.62	105.20	0.00
129	B	267.28	0.00	419.56	619.35	226.45	16.08	101.02	81.67	36.99	0.00
129	C	3567.47	12.51	135.58	517.89	360.53	55.07	449.49	85.38	80.25	0.25
129	D	84.06	0.00	27.76	367.43	71.58	12.46	34.51	3.84	17.49	0.00
129	F	1797.34	0.00	484.90	380.75	351.31	60.41	423.05	263.99	251.97	48.57
129	G	3023.71	0.00	187.51	530.24	456.89	60.52	631.17	136.72	148.38	0.00
129	H	357.89	0.00	393.57	233.89	257.32	94.44	93.02	79.30	62.36	0.00
129	i	88.91	0.00	503.79	78.29	239.36	0.00	20.22	72.57	5.45	0.00
129	J	244.63	0.00	1557.43	164.01	242.87	21.32	123.73	34.05	36.92	0.00
130	A	149.37	1883.48	326.84	77.80	124.73	2.30	45.04	80.51	13.42	0.00
130	B	181.25	0.00	338.50	76.10	188.44	3.37	64.21	71.38	10.17	0.00
130	D	189.51	0.00	294.16	144.63	87.75	5.58	79.56	69.38	25.67	0.00
130	E	773.25	0.00	121.59	843.99	305.92	148.33	130.40	64.47	48.14	0.02
131	A	196.71	2819.45	367.08	57.15	109.12	3.65	17.05	96.33	12.88	0.00

Analysis No.	Run	Mn	Cr	Rb	Sr	Li	Zr	Zn	V	Ce	Ni
131	B	65.20	0.00	352.81	49.80	153.45	9.03	8.99	77.07	3.21	0.00
131	C	8055.78	0.00	19.07	53.15	871.80	8.24	756.95	55.51	36.38	0.00
131	D	72.56	0.00	444.66	20.67	133.41	6.06	20.71	86.16	3.47	0.00
132	A	311.34	5353.15	125.94	287.96	0.00	0.20	0.00	22.71	10.79	0.00
132	D	304.86	0.00	276.46	127.80	172.99	156.55	103.36	109.22	63.04	0.00
132	F	313.63	2236.23	279.77	37.62	325.74	31.37	0.00	37.23	1.41	0.00
132	G	391.71	0.00	32.75	234.49	132.55	116.30	0.85	68.05	86.31	0.00
132	H	288.18	0.00	462.23	87.78	153.09	9.85	44.93	114.39	21.56	0.00
132	i	95.36	0.00	516.84	41.68	264.11	3.60	5.97	82.63	2.84	37.66
133	B	199.66	0.00	286.49	130.79	104.95	1638.58	21.81	59.28	34.06	0.00
133	C	6264.61	0.00	127.14	51.77	1640.27	5.10	916.61	104.51	4.99	0.08
133	D	209.84	0.00	414.60	46.07	410.55	2.59	49.24	132.27	14.37	0.00
133	E	187.34	0.00	480.62	67.83	255.99	3.34	32.36	94.00	6.07	0.00
133	F	637.43	0.00	443.65	77.44	382.12	0.00	49.30	98.21	7.46	27.74
133	G	10328.07	0.00	2.21	73.70	643.36	0.34	1045.90	35.70	4.56	0.05
133	H	299.00	0.00	468.42	54.93	298.99	0.00	40.50	96.63	1.88	0.00
133	i	169.16	0.00	628.18	67.83	344.45	183.14	21.13	86.52	12.35	0.00
133	J	126.63	0.00	664.28	49.81	221.83	0.00	45.45	100.68	9.31	0.00
134	A	301.04	3601.66	400.46	64.92	131.01	1.48	28.59	100.49	8.36	13.99
134	B	210.98	0.00	479.49	145.56	638.16	6.11	59.40	102.86	12.10	0.00
134	C	90.36	0.00	522.89	69.07	514.79	3.17	26.87	98.85	2.89	0.00
134	D	70.50	0.00	459.70	116.34	288.05	4.40	25.96	95.13	4.27	0.00
134	E	158.07	0.00	425.29	80.82	164.73	4.04	37.21	84.99	7.82	0.00
135	B	148.79	0.00	428.01	38.67	312.29	10.51	28.82	95.17	5.47	0.00
135	D	42.10	0.00	392.92	33.82	400.21	14.22	12.31	95.71	7.07	0.00
135	E	73.45	0.00	472.34	34.83	221.53	0.00	0.00	87.72	1.13	0.00

Analysis No.	Run	Mn	Cr	Rb	Sr	Li	Zr	Zn	V	Ce	Ni
136	A	346.86	3184.01	309.84	103.49	156.56	0.00	57.20	86.87	37.40	0.00
136	B	99.03	0.00	374.38	59.67	291.68	1.89	29.66	70.41	9.76	0.00
136	D	527.86	0.00	405.46	45.94	239.09	0.00	55.97	53.85	1.46	0.00
136	E	0.00	0.00	480.94	37.54	229.04	0.00	0.00	80.29	4.96	0.00
137	B	199.79	0.00	433.20	141.27	252.55	13.73	41.39	89.85	50.39	0.00
137	C	2659.26	0.00	179.03	112.21	350.26	26.17	459.53	70.94	59.48	0.00
137	D	151.44	0.00	378.18	310.78	166.53	2.54	34.59	80.20	12.50	0.00
137	E	1108.40	0.00	378.16	816.51	236.96	6.78	92.82	79.92	88.43	0.00
138	A	205.54	2021.77	321.94	94.23	215.38	0.83	6.92	153.22	6.39	0.00
138	B	108.54	0.00	531.05	46.46	227.08	29.34	23.82	117.16	3.84	0.00
138	C	206.83	0.00	329.40	114.53	191.60	9.64	51.04	71.89	16.46	0.00
138	E	221.17	0.00	327.63	162.19	206.89	43.65	32.73	100.13	161.46	0.00
138	F	284.10	0.00	1632.64	102.70	167.13	9.16	70.65	24.46	80.28	0.00
138	G	89.18	0.00	377.16	61.15	113.96	1.06	23.62	56.72	5.55	0.19
138	H	90.83	0.00	433.38	73.87	102.92	1.40	27.38	78.55	2.66	0.19
139	A	266.45	2660.49	28.57	323.29	64.78	8.63	17.85	21.54	16.56	0.00
139	B	446.43	0.00	297.11	128.32	176.06	8.15	53.04	125.69	210.00	0.00
139	C	166.05	0.00	278.14	74.62	224.17	6.03	30.62	112.59	10.63	0.00
139	D	121.45	0.00	375.63	51.60	162.65	2.86	27.37	76.34	7.13	0.00
139	E	1206.70	30.92	508.01	184.35	267.86	24.69	157.06	115.75	242.60	0.01
139	F	2592.72	0.00	171.05	287.08	296.11	155.71	83.52	67.36	85.13	0.00
139	G	5291.57	0.00	69.60	61.06	873.70	4355.03	814.57	31.74	38.79	0.27
139	H	695.75	0.00	310.93	202.93	360.92	123.76	179.50	104.21	96.48	0.84
139	i	1773.77	0.00	242.12	113.18	534.28	3.67	211.55	64.49	14.21	0.00
139	J	193.96	0.00	538.73	66.48	210.82	7.80	61.96	110.43	22.64	0.00
140	A	335.82	2368.05	369.67	59.10	173.25	5.50	32.69	83.14	21.21	0.00

Analysis No.	Run	Mn	Cr	Rb	Sr	Li	Zr	Zn	V	Ce	Ni
140	B	106.42	0.00	393.33	53.08	234.79	1.43	20.93	82.40	8.88	0.00
140	D	144.73	0.00	428.68	51.84	195.21	6.20	34.39	80.62	9.16	0.00
140	E	174.55	0.00	475.09	40.76	251.89	89.16	33.31	83.17	128.40	0.00
140	F	316.04	0.00	346.99	74.44	117.64	184.74	17.98	94.81	14.30	0.00
140	G	402.81	0.00	349.67	51.75	187.83	23.43	78.22	80.99	45.13	0.57
140	H	296.69	0.00	387.96	66.50	122.61	22.89	52.47	66.97	37.82	0.21
141	A	393.96	7668.88	18.91	317.88	115.65	365.08	0.00	29.88	2.70	0.00
141	B	99.23	0.00	387.15	42.44	223.37	15.38	18.88	73.58	3.54	0.00
141	C	142.40	0.00	368.76	34.12	256.40	3.78	39.31	73.24	8.67	0.00
141	D	34.45	0.00	376.30	36.84	151.78	3.00	0.00	77.28	39.55	0.00
141	F	1040.34	0.00	301.95	291.27	279.94	1.04	28.17	81.23	37.60	0.00
141	G	1735.02	0.00	434.05	32.91	130.38	0.55	45.37	69.05	13.03	0.44
141	H	122.55	0.00	463.98	45.96	115.15	2.13	43.92	89.07	3.95	0.17
142	A	3003.73	1946.33	614.02	482.61	361.71	3.29	642.68	69.68	23.17	0.00
142	B	81.72	0.00	25.39	453.55	133.89	1.17	13.06	0.00	3.58	0.00
142	C	331.91	0.00	280.58	123.64	362.51	42.67	59.61	60.52	1.97	0.00
142	D	262.98	0.00	356.67	222.17	259.74	27.17	57.00	85.09	21.13	0.00
142	E	195.15	21.57	313.63	149.18	139.07	9.19	34.77	71.22	21.33	0.10
143	A	192.28	1666.63	397.84	127.83	164.30	2.18	11.53	80.16	7.96	0.00
143	B	137.94	0.00	480.73	111.64	148.50	3.03	7.51	79.14	6.34	0.00
143	C	115.72	0.00	425.34	76.31	177.58	4.91	24.18	84.58	10.58	0.00
143	D	513.41	0.00	166.55	479.08	201.73	90.04	39.82	61.58	44.89	0.00
143	E	90.08	0.00	338.54	140.65	98.34	1.89	15.52	51.04	14.10	0.05
144	A	511.19	4142.84	82.79	834.88	183.60	49.35	41.89	123.58	106.64	0.00
144	B	608.54	0.00	106.74	634.48	222.05	80.04	31.77	113.00	137.25	0.00
144	C	580.57	0.00	47.85	733.98	121.36	70.26	51.57	123.74	82.44	0.00

Analysis No.	Run	Mn	Cr	Rb	Sr	Li	Zr	Zn	V	Ce	Ni
144	E	448.67	64.58	42.14	4184.99	87.98	147.74	34.57	108.85	85.69	0.47
144	G	132.43	50.24	32.49	236.88	99.45	27.79	19.99	45.48	17.01	1.90
144	J	73.72	0.00	485.17	57.97	54.94	0.00	20.20	25.92	13.60	0.00
145	A	228.11	3197.89	68.77	64.91	134.89	0.00	0.00	24.71	6.13	0.00
145	D	36.41	0.00	132.14	27.89	163.08	4.38	0.00	19.78	2.70	0.00
145	E	51.59	0.00	543.57	148.45	46.64	0.00	14.78	9.83	10.95	0.00
145	F	608.02	2627.57	192.80	187.16	179.28	139.16	5.96	161.14	470.29	0.00
145	G	510.20	94.11	475.82	44.87	195.92	6.83	42.11	117.31	8.70	0.00
145	H	229.92	0.00	168.56	127.51	108.80	34.23	128.03	40.66	18.50	0.00
145	i	123.15	0.00	131.58	46.52	112.38	4.51	209.74	24.32	15.81	142.18
145	J	3455.76	0.00	148.54	68.76	427.81	44.37	380.66	66.45	79.01	57.52
146	A	3606.30	1276.07	277.14	84.40	205.99	0.68	359.16	29.08	54.90	0.58
146	D	768.20	0.00	154.08	542.25	174.27	79.86	107.78	88.87	96.60	0.00
146	E	130.75	0.00	14.47	111.89	108.30	1.90	7.67	17.88	14.97	0.00
146	H	207.77	318.08	409.99	120.72	115.67	3.76	45.13	66.31	11.58	0.00
146	X	0.00	0.00	457.33	19.20	310.88	0.00	0.00	50.77	0.00	0.00
146	Y	569.42	0.00	335.30	292.41	498.28	71.56	202.86	69.37	62.70	0.00
146	Z	562.57	165.96	73.42	596.80	49.21	552.33	81.77	76.44	105.20	0.00
147	B	66.53	0.00	35.76	464.64	0.00	13.43	0.00	5.90	36.14	0.00
147	C	638.97	0.00	410.35	60.33	120.45	0.00	54.14	93.58	2.80	0.00
147	E	1190.62	0.00	601.88	132.31	317.31	7.09	133.88	88.34	25.26	0.00
147	F	1434.01	2109.49	334.60	57.28	252.69	4.66	171.27	64.68	1.14	907.01
147	G	129.88	578.47	205.92	91.29	0.00	86.15	0.00	37.38	39.97	0.00
147	H	95.15	318.70	447.82	69.78	70.10	3.59	13.98	70.49	1.63	0.00
147	X	806.88	0.00	320.20	120.57	117.32	0.00	3.84	44.75	71.00	0.00
147	Y	5437.23	0.00	299.96	87.05	295.36	0.00	294.20	45.30	1.54	0.00

Analysis No.	Run	Mn	Cr	Rb	Sr	Li	Zr	Zn	V	Ce	Ni
147	Z	8287.73	100.67	134.87	31.85	283.20	0.68	449.53	62.74	4.66	0.00
148	A	128.80	1018.63	390.49	76.86	75.34	1.65	51.96	78.05	9.30	0.39
148	B	184.13	0.00	382.67	242.88	140.03	2.53	79.65	59.83	10.20	0.00
148	C	755.58	0.00	334.93	419.49	153.38	56.10	74.66	82.57	723.52	0.00
148	D	747.18	0.00	691.22	581.88	373.61	35.08	141.38	47.04	50.87	0.00
148	E	197.11	0.00	605.95	249.40	233.41	4.58	36.01	90.76	90.86	0.00
149	B	10.10	0.00	176.76	200.78	0.00	2.02	0.00	0.51	4.60	0.00
149	C	107.91	0.00	149.16	538.07	133.08	9.09	18.35	15.18	23.28	0.00
149	G	228.56	52.04	77.08	527.20	92.53	84.55	27.32	90.76	41.72	0.00
149	H	1575.79	0.00	207.44	152.65	173.86	8.84	317.75	206.48	18.54	32.84
149	i	958.99	0.00	99.63	302.38	122.79	43.39	212.01	162.26	72.68	199.40
149	J	126.72	0.00	32.81	222.46	221.18	2.98	0.19	22.28	10.64	0.00
150	B	140.52	0.00	413.62	120.11	93.04	0.48	0.00	80.80	15.87	0.00
150	C	2018.29	0.00	307.68	423.52	118.66	2133.90	46.04	90.90	102.81	0.00
150	D	88.88	0.00	574.90	61.94	181.83	5.16	24.40	95.22	6.22	0.00
150	G	199.87	0.00	408.38	79.67	283.54	0.90	38.69	69.91	11.10	0.18
150	H	448.23	0.00	555.54	89.03	256.14	12.44	142.07	189.09	45.37	0.00
151	A	2020.07	1083.37	408.62	162.82	366.68	1.27	367.30	20.04	16.79	0.48
151	B	3545.88	0.00	173.65	191.34	744.73	2.22	469.36	23.43	25.01	0.00
151	C	4209.79	0.00	310.53	228.96	380.91	64.51	551.15	29.13	20.71	0.00
151	E	241.82	90.59	349.71	674.05	143.53	1.12	42.30	67.64	64.17	0.00
151	F	579.77	1130.49	423.65	147.61	199.60	13.79	149.23	38.87	9.78	618.71
151	F	1141.81	0.00	343.90	89.76	131.42	0.00	120.66	32.49	6.76	0.00
151	G	679.39	0.00	310.26	948.94	269.49	38.23	126.59	73.13	143.10	0.24
151	G	389.10	0.00	346.15	569.36	0.00	32.02	15.98	90.62	63.65	0.00
151	H	3958.85	0.00	368.88	86.55	597.13	2.52	677.07	23.02	7.02	202.84

Analysis No.	Run	Mn	Cr	Rb	Sr	Li	Zr	Zn	V	Ce	Ni
151	H	327.07	0.00	439.77	484.33	136.84	6.83	58.33	71.40	56.04	0.00
151	X	192.82	0.00	456.19	234.35	234.87	0.59	75.55	78.90	24.26	0.00
151	Y	1379.02	0.00	396.53	437.20	527.51	104.66	189.55	19.80	48.65	0.00
151	Z	1505.98	0.00	495.02	463.79	349.27	30.17	379.79	169.46	82.25	0.00
152	A	294.73	987.87	467.86	185.40	259.62	3.11	71.59	86.27	30.84	0.33
152	B	203.58	0.00	539.29	223.32	245.36	11.60	39.17	102.26	36.50	0.00
152	E	218.49	12.12	475.68	272.21	133.80	6.87	31.14	78.10	32.42	0.00
153	A	116.31	1320.10	417.93	38.19	179.70	1.57	54.11	40.49	6.66	0.50
153	B	177.94	0.00	390.36	67.32	234.06	1.53	2.00	79.37	5.85	0.00
153	C	112.67	0.00	360.59	87.33	135.01	2.45	20.02	85.08	32.43	0.00
153	D	158.42	112.23	302.40	78.18	202.64	4.61	37.67	108.76	9.01	0.09
154	A	143.58	1078.50	41.81	1123.84	133.19	4.28	77.38	23.61	26.39	0.41
154	B	134.96	0.00	42.34	1088.95	95.04	18.37	54.64	40.24	22.44	0.00
154	C	582.32	0.00	115.14	638.74	145.46	51.84	232.45	151.39	81.07	0.00
154	D	371.49	39.03	33.82	1839.75	115.54	7.15	85.72	56.45	50.87	0.05
154	E	73.01	196.15	9.01	1150.96	70.27	11.48	6.22	23.63	12.57	0.00
155	A	192.43	978.22	556.60	26.97	140.31	1.96	72.15	93.36	18.27	0.34
155	B	321.24	0.00	524.54	42.04	77.03	0.96	24.69	86.96	16.75	0.00
155	D	234.91	0.00	443.86	92.26	218.32	1.67	34.98	86.98	14.36	0.00
156	A	123.14	1466.32	50.56	77.98	37.21	0.22	71.59	6.93	26.62	0.51
156	B	166.10	0.00	469.56	111.31	83.08	2.96	43.37	93.67	18.25	0.00
156	C	474.95	8.93	440.00	289.66	159.46	32.19	114.39	110.32	92.48	0.03
156	D	410.33	0.00	506.67	237.44	197.69	13.62	121.01	118.42	50.46	0.00
156	E	188.94	123.27	514.32	77.06	92.20	3.23	49.60	82.19	7.28	0.00
156	F	201.33	0.00	476.98	124.77	102.84	1.34	21.59	80.34	45.94	0.00
156	G	114.03	0.00	466.01	70.24	71.39	0.89	29.30	63.78	15.76	0.08

Analysis No.	Run	Mn	Cr	Rb	Sr	Li	Zr	Zn	V	Ce	Ni
156	H	133.39	0.00	439.37	110.53	116.29	12.85	30.37	80.68	29.68	0.00
157	A	497.00	1110.92	278.02	192.22	154.14	91.16	83.57	67.13	55.64	0.37
157	B	3302.44	0.00	200.91	195.35	267.94	45.10	419.85	64.78	40.87	0.00
157	C	25.34	0.00	402.65	6.34	21.37	1.52	0.00	0.61	4.18	0.00
157	D	818.98	0.00	174.42	259.24	285.65	64.09	95.66	104.54	108.66	0.00
157	E	1467.75	140.00	255.53	73.02	132.52	2.58	205.60	81.57	407.95	0.00
157	F	199.08	2192.13	291.74	62.82	60.24	3.00	93.31	66.82	1.75	1103.52
157	G	0.00	0.00	329.44	7.23	0.00	1.62	0.00	0.00	0.85	0.00
157	H	2127.33	212.48	180.51	24.46	117.83	2.71	400.13	149.92	2.66	104.31
157	X	263.00	0.00	49.98	634.20	98.97	0.42	84.69	14.99	131.05	0.00
157	Y	0.00	0.00	215.30	3.64	36.92	0.00	0.00	0.00	0.73	0.00
157	Z	112122.60	0.00	32.93	1.97	143.19	13.54	73.52	9.88	0.29	0.00
158	B	172.13	0.00	110.99	106.32	59.77	3.07	33.55	39.95	72.10	0.00
158	C	41.04	1.20	195.14	40.81	15.72	0.00	6.25	5.30	7.98	0.00
158	D	361.69	0.00	436.81	378.16	191.18	5.58	50.67	95.56	32.75	0.00
158	E	744.52	87.29	484.36	551.62	197.96	10.81	164.02	129.10	76.53	0.00
158	F	141.34	1059.89	311.58	37.81	74.70	25.49	104.09	234.30	1438.04	495.08
158	G	130.70	84.33	500.56	48.93	27.71	2.84	10.82	94.84	26.26	0.00
158	H	155.33	23.50	658.11	43.47	74.62	31.62	55.52	78.51	1.88	70.38
158	X	153.27	0.00	576.77	48.86	218.58	2.01	49.64	112.36	12.91	0.00
158	Y	122.96	0.00	412.70	68.36	222.53	3.75	33.24	93.60	10.35	0.00
158	Z	222.56	0.00	457.89	39.61	58.85	1.59	24.96	74.51	1.05	0.00
159	A	7284.41	1320.78	94.78	118.69	645.68	1.33	740.38	66.31	14.38	0.49
159	C	128.84	142.66	370.95	35.93	59.66	7.79	14.69	155.43	102.17	0.00
159	D	263.65	0.00	615.29	69.71	120.19	2.84	49.18	111.75	17.44	0.00
159	F	298.00	0.00	494.57	42.73	133.84	0.00	29.63	102.28	6.46	22.95

Analysis No.	Run	Mn	Cr	Rb	Sr	Li	Zr	Zn	V	Ce	Ni
159	G	239.56	0.00	508.54	73.16	89.76	9.05	40.58	109.73	11.34	0.00
159	H	81.82	0.00	530.39	40.25	56.78	102.73	16.04	102.67	1.63	0.16
159	i	612.73	0.00	414.13	99.58	304.94	7.45	122.57	80.32	22.96	0.00
159	J	175.48	0.00	537.25	72.01	189.68	3.17	18.27	90.36	7.73	0.00
160	A	2174.65	2048.84	242.75	131.31	277.59	19.57	204.77	55.61	30.34	0.69
160	B	90.75	0.00	388.38	84.45	175.60	0.48	10.56	85.61	5.44	0.00
160	D	0.06	0.00	34.11	486.40	124.44	0.00	0.00	0.31	1.06	0.00
160	E	682.79	159.97	206.84	179.98	164.21	72.72	82.54	85.53	63.73	0.00
160	F	822.24	0.00	182.81	245.19	287.53	147.09	65.07	101.14	80.83	203.72
160	G	181.73	0.00	356.09	279.60	386.88	14.37	8.14	76.75	3.84	0.00
160	H	3178.46	0.00	1139.56	165.76	753.22	17.41	679.09	153.08	46.49	0.00
160	i	4214.97	0.00	179.73	229.95	322.00	29.58	412.08	174.78	42.62	0.00
161	A	340.36	5327.93	468.47	75.07	12.30	0.00	16.71	102.26	5.24	108.92
161	B	509.27	0.00	326.75	191.55	231.94	7.14	67.61	69.20	35.41	0.00
161	C	212.30	0.00	356.60	169.41	77.73	5.71	12.49	77.03	16.82	0.00
161	D	161.43	0.00	380.61	141.40	78.28	1.72	24.38	66.50	23.68	0.00
161	E	739.13	0.00	550.21	523.13	219.38	4.15	218.22	155.36	239.09	0.00
162	A	344.54	2877.23	550.49	35.38	178.92	0.00	55.48	111.32	33.80	68.10
162	B	284.54	0.00	333.92	75.91	186.00	230.05	72.52	84.56	64.64	0.00
162	C	105.61	0.00	410.84	33.81	152.55	3.67	32.79	100.77	4.51	0.00
162	D	4272.94	0.00	115.32	14.24	299.60	24.23	449.09	56.34	4.48	0.00
162	E	122.88	0.00	416.89	33.80	138.64	5.54	41.81	90.35	2.76	0.00
162	F	336.22	0.00	481.86	20.93	223.50	9.50	8.43	99.80	7.45	0.00
162	G	4894.75	0.00	112.37	29.49	373.88	0.38	666.49	35.44	10.16	0.56
162	H	391.03	0.00	354.98	136.28	205.53	209.51	93.02	89.21	34.58	0.00
163	A	355.54	1713.91	588.36	80.10	121.35	0.00	53.99	123.94	32.83	47.62

Analysis No.	Run	Mn	Cr	Rb	Sr	Li	Zr	Zn	V	Ce	Ni
163	E	232.01	0.00	303.00	75.47	122.12	1.12	25.72	47.41	8.59	0.00
163	F	1142.79	0.00	330.38	168.73	605.94	0.00	37.80	87.94	14.70	225.32
163	G	202.16	0.00	401.56	123.25	131.01	6.87	35.64	88.07	37.24	0.00
163	H	388.91	0.00	302.32	191.68	153.10	73.99	105.21	107.04	68.61	0.00
163	i	404.51	0.00	535.80	185.15	212.05	0.00	110.76	130.39	42.81	0.00
163	J	188.09	0.00	415.59	94.04	196.75	41251.77	72.33	126.11	55.21	0.00
164	A	288.00	4626.25	19.99	303.58	142.25	0.00	29.11	35.65	11.18	38.24
164	B	766.24	0.00	165.36	84.21	51.28	3.65	106.25	98.35	7.59	0.13
164	C	91.44	0.00	197.84	115.10	36.71	0.00	26.54	89.75	19.56	0.00
164	D	4366.96	9.50	21.45	51.62	178.30	7.96	488.91	70.74	8.42	0.28
164	E	4174.31	0.00	107.97	90.37	108.33	0.24	263.90	81.47	27.00	0.00
164	F	477.41	0.00	58.54	232.95	147.99	0.00	123.33	52.10	7.04	96.27
164	G	685.92	0.00	39.26	152.57	220.50	2.95	306.55	130.01	16.49	0.53
164	H	192.27	0.00	191.72	184.43	200.45	7.29	134.99	126.20	24.55	0.05
164	i	385.06	0.00	106.45	563.19	101.42	28.70	48.69	120.91	53.14	0.00
164	J	518.07	0.00	44.00	129.63	203.11	0.00	168.31	148.54	10.33	0.00
165	A	292.63	2993.27	719.95	100.78	47.25	0.00	6.36	25.94	12.73	3.18
165	B	49.19	0.00	548.83	79.44	36.50	6.31	15.24	11.28	14.87	0.00
165	C	1084.42	0.00	95.58	370.01	161.06	29.40	172.25	124.96	54.87	0.00
165	D	93.57	0.00	127.18	239.85	176.96	3.09	58.27	19.92	8.44	0.00
165	E	33.32	0.00	22.43	110.24	130.01	5.00	45.38	8.63	5.96	0.00
165	F	414.48	0.00	376.80	143.92	202.16	2.00	95.47	155.85	57.19	12.65
165	G	283.80	0.00	665.99	78.32	280.49	20.82	75.52	87.27	62.27	0.00
165	H	255.93	0.00	423.70	147.33	173.13	15.36	85.50	127.24	94.21	0.01
165	i	172.80	0.00	499.95	119.10	201.18	6.66	45.71	87.51	9.50	0.00
165	J	132.53	0.00	467.37	93.68	170.54	1.29	19.87	73.67	16.11	0.00

Analysis No.	Run	Mn	Cr	Rb	Sr	Li	Zr	Zn	V	Ce	Ni
166	A	6822.82	2278.40	103.63	121.94	1167.18	0.00	873.37	55.23	44.39	32.37
166	C	5345.90	0.00	269.32	133.20	610.65	3.66	697.58	88.53	13.24	0.45
166	E	2978.05	0.00	102.66	320.09	466.70	264.24	514.43	120.97	89.38	0.00
166	F	168.80	1128.10	409.67	39.53	172.79	3.84	0.00	78.98	1.51	0.00
166	G	89.29	0.00	495.29	40.15	218.57	7.00	14.66	71.17	2.32	0.00
166	H	63.97	0.00	484.67	47.80	190.75	4.97	25.00	87.69	1.64	0.00
166	i	304.47	0.00	498.06	96.93	245.97	4.20	333.73	122.33	19.71	27.46
166	J	62.28	0.00	507.47	44.16	165.12	1.26	35.36	74.07	2.33	0.00
167	A	128.86	1725.53	42.64	694.02	180.97	0.00	9.49	18.65	10.61	16.28
167	B	0.00	0.00	563.41	44.85	68.09	122.54	20.53	19.15	18.22	0.00
167	C	71.18	0.00	20.74	445.76	140.40	6.43	16.61	13.55	5.35	0.00
167	D	316.14	0.00	299.79	35.46	50.34	195.40	30.88	32.23	13.47	0.25
167	E	6.63	0.00	383.89	28.34	34.99	95.52	21.33	23.39	1.24	0.00
168	A	572.12	3019.38	97.36	775.86	289.13	0.00	17.70	34.09	26.19	2.35
168	B	146.43	0.00	353.20	249.02	151.99	230.50	50.30	72.20	18.15	0.00
168	C	83.57	0.00	10.08	526.96	93.77	0.00	0.00	10.16	10.62	0.00
168	E	245.51	0.00	375.75	211.23	173.58	3.02	55.24	72.92	18.78	0.00
169	C	391.36	0.00	30.23	305.84	123.85	0.00	27.77	43.34	22.22	0.00
169	D	2475.15	0.00	232.25	15.75	173.47	135.03	35.16	49.59	11.67	0.67
169	F	253.24	0.00	433.90	63.85	141.08	0.00	35.83	88.51	10.57	23.18
169	G	115.83	0.00	357.20	65.01	234.81	1.23	13.24	69.36	4.73	0.00
169	G	52.81	0.00	410.87	66.23	125.39	0.00	7.61	77.30	2.52	0.00
169	H	10740.20	0.00	107.67	50.54	399.78	1.37	731.93	84.08	10.34	0.40
169	H	702.24	0.00	214.79	185.49	136.89	19.70	49.16	36.15	2.45	0.00
169	i	7342.08	0.00	12.52	32.91	193.38	0.00	605.33	42.06	2.41	0.00
169	J	184.58	0.00	371.61	118.84	292.66	6.03	42.80	75.57	15.61	0.00

Analysis No.	Run	Mn	Cr	Rb	Sr	Li	Zr	Zn	V	Ce	Ni
170	B	202.12	0.00	208.11	184.09	179.59	1.69	47.11	52.46	28.20	0.00
170	C	173.13	90.00	257.73	354.29	104.55	0.00	73.99	57.49	20.33	0.00
170	D	368.45	0.66	346.76	237.29	137.31	1.82	108.78	86.19	54.03	0.43
170	F	142.09	0.00	411.12	79.26	61.56	0.18	11.23	60.92	3.03	22.87
170	G	58.61	0.00	436.59	80.86	114.71	2.03	21.57	66.90	0.96	0.11
170	H	109.20	0.00	464.59	224.00	116.68	3.58	62.42	74.02	19.05	0.01
170	i	55.22	0.00	512.43	107.69	59.23	5.75	42.20	71.38	3.15	0.00
170	J	53.42	0.00	422.90	97.66	126.97	5.27	32.09	51.27	3.20	0.00
171	D	60.16	0.00	26.19	730.38	104.49	7.90	24.76	2.57	9.75	0.00
171	F	640.34	0.00	420.66	345.46	147.99	22.95	72.71	95.14	20.99	9.49
171	G	35.00	0.00	31.92	283.52	126.12	3.61	0.00	4.51	3.22	0.00
171	H	256.16	0.00	114.62	144.41	121.64	53.31	35.44	65.16	26.96	0.00
171	i	880.66	0.00	35.86	119.57	109.56	2.58	161.99	71.41	29.25	0.00
172	B	0.89	0.00	71.61	197.70	35.87	5.56	0.00	5.14	6.88	0.00
172	G	187.01	0.00	142.18	1453.51	119.55	5.75	13.34	26.70	47.86	0.00
172	i	438.93	0.00	189.52	252.28	165.91	12.33	222.05	276.71	82.68	0.00
172	J	2002.77	0.00	434.12	376.07	110.16	21.07	324.26	191.91	31.07	0.00
173	A	200.03	2779.47	535.69	46.30	78.98	0.00	56.28	86.46	3.82	79.77
173	B	252.73	0.00	382.71	136.97	76.24	6.22	250.59	65.22	12.47	0.00
173	C	138.22	4.89	384.40	94.36	71.55	0.00	217.93	88.36	3.92	0.78
173	D	262.07	0.00	76.15	438.83	121.75	13.18	167.16	21.21	26.94	0.05
173	E	169.30	0.00	11.62	103.16	103.52	5.15	104.97	5.12	2.30	0.71
174	B	111.71	0.00	401.48	51.46	115.98	7.07	17.57	78.34	4.29	0.00
174	E	118.23	0.00	391.92	53.30	138.56	6.25	34.22	84.90	4.27	0.06
174	F	525.44	0.00	149.79	239.21	146.88	8.10	74.11	46.74	34.72	43.09
174	G	140.95	0.00	470.60	29.38	193.44	8.35	29.69	89.34	3.01	0.07

Analysis No.	Run	Mn	Cr	Rb	Sr	Li	Zr	Zn	V	Ce	Ni
174	H	153.38	0.00	551.84	35.37	130.37	4.13	24.04	113.29	4.27	0.01
174	i	109.50	0.00	6.07	295.67	80.39	3.35	0.00	0.00	3.06	0.00
174	J	219.81	0.00	479.68	66.79	159.18	0.00	8.90	85.78	6.65	0.00
175	A	491.21	1804.51	636.89	83.42	257.24	0.00	51.86	130.60	35.83	20.32
175	B	676.45	0.00	244.26	265.65	137.59	12.65	133.41	114.67	113.80	0.00
175	C	257.98	16.91	453.96	123.75	129.68	12.06	38.55	100.19	32.34	0.19
175	D	541.81	43.55	415.37	200.15	130.21	12.29	128.80	89.86	104.46	0.36
175	E	338.12	0.00	406.50	157.77	83.87	4.25	58.47	111.53	75.27	0.00
175	F	868.50	0.00	227.12	557.00	302.12	99.54	59.22	64.35	200.12	0.00
175	G	544.48	0.00	277.48	263.96	375.68	55.63	101.47	73.36	79.19	0.00
175	H	373.23	0.00	485.59	185.73	199.80	31.19	214.01	119.82	63.48	0.52
175	i	604.11	0.00	267.61	616.82	250.19	9.55	1517.11	74.07	92.72	0.00
175	J	407.89	0.00	97.71	232.22	130.17	6.44	341.70	32.67	66.56	0.00
176	A	323.94	1850.57	241.98	45.95	75.06	0.00	52.33	57.54	9.33	170.93
176	F	6592.28	0.00	117.41	33.95	563.86	0.00	817.25	37.08	8.23	20.64
176	F	2626.78	0.00	212.91	183.54	479.99	43.31	429.65	98.50	38.71	43.38
176	G	2632.97	0.00	420.67	144.08	237.54	22.11	462.11	179.70	39.17	0.00
176	G	6661.71	0.00	117.41	21.04	449.42	159.33	831.59	27.76	5.86	0.11
176	H	2782.78	0.00	344.18	131.95	589.27	16.23	752.03	148.83	51.27	0.50
176	H	920.79	0.00	103.33	389.89	271.36	126.98	152.25	138.97	111.54	0.36
176	i	3775.80	0.00	276.21	78.49	513.65	1.58	937.28	147.31	34.64	0.00
176	i	933.68	0.00	109.61	347.47	284.05	112.45	152.48	140.75	84.32	0.00
176	J	2329.59	0.00	459.20	181.53	690.05	6.34	518.69	143.69	22.05	0.00
176	J	438.58	0.00	369.35	168.96	392.33	45.68	39.92	69.73	27.16	0.00
177	A	452.92	1194.49	468.83	79.62	95.43	0.00	71.32	91.30	4.87	100.30
177	B	136.07	0.00	430.79	66.16	119.90	1.34	18.65	95.35	27.30	0.00

Analysis No.	Run	Mn	Cr	Rb	Sr	Li	Zr	Zn	V	Ce	Ni
177	C	279.49	0.00	490.76	156.22	103.72	309.87	38.98	101.82	62.23	0.00
177	D	295.20	38.95	208.80	25.37	150.37	0.00	0.00	34.84	2.18	0.27
177	E	250.94	0.00	424.07	146.06	100.22	59.98	28.54	65.95	24.82	0.00
178	A	581.91	1484.87	347.55	109.95	115.46	0.52	117.38	86.86	637.94	70.43
178	B	178.25	0.00	553.95	84.49	87.73	308.69	39.20	108.06	19.16	0.00
178	C	462.99	0.00	392.29	214.73	115.11	40.46	52.55	104.28	95.72	0.00
178	D	329.31	0.00	514.46	160.12	169.08	0.00	54.30	71.69	27.90	0.03
178	E	194.60	0.00	471.09	53.00	76.49	7.39	37.27	82.93	45.97	0.00
178	F	736.73	0.00	210.62	135.81	286.56	29.80	0.00	63.11	41.80	0.00
178	G	114.60	0.00	455.43	31.90	100.31	0.00	29.18	66.10	0.96	0.00
178	H	405.92	0.00	525.45	123.92	88.74	12.01	55.62	111.70	36.51	0.08
178	i	428.15	0.00	405.76	140.75	195.39	31.27	42.10	109.24	96.60	0.00
178	J	432.81	0.00	394.99	227.45	204.70	32.23	76.15	64.87	39.63	0.00
179	A	893.89	1217.73	131.59	289.72	162.62	156.41	297.78	118.01	265.40	57.23
179	B	1224.77	0.00	267.43	179.12	305.88	276.71	349.67	120.56	101.64	0.01
179	C	116.50	0.00	302.52	352.72	234.55	13.34	84.11	9.40	9.53	0.00
179	D	192.31	7.22	619.14	63.47	91.30	4.41	41.88	120.31	10.23	0.00
179	F	4195.73	0.00	1799.64	52.19	214.22	2.83	747.38	218.41	35.58	0.00
179	G	292.26	0.00	413.62	95.82	103.87	2.14	143.56	110.86	25.41	0.00
179	H	232.28	0.00	384.02	83.63	167.06	102.17	61.59	94.50	16.59	0.00
179	i	148.82	0.00	647.15	73.14	56.17	0.00	22.36	68.86	174.64	0.00
179	J	267.06	0.00	214.82	33.17	39.32	0.00	63.72	266.09	8.29	0.00
180	A	3683.97	685.87	0.00	1222.10	36.50	6.03	7.65	46.05	568.58	34.67
180	B	74.71	0.00	348.25	136.61	6.74	1.07	8.84	7.41	7.39	0.00
180	F	1010.70	0.00	265.32	577.50	485.80	142.35	111.82	120.92	93.50	0.00
180	G	486.02	0.00	518.25	177.03	250.14	1.55	101.36	130.40	32.05	0.00

Analysis No.	Run	Mn	Cr	Rb	Sr	Li	Zr	Zn	V	Ce	Ni
180	H	383.71	0.00	449.61	100.30	220.91	823.77	96.37	118.79	19.86	0.46
180	i	426.69	0.00	305.28	98.12	162.30	3.81	211.44	206.25	13.47	0.00
180	J	3127.57	0.00	230.79	401.35	491.98	45.31	516.45	131.85	54.87	0.00
181	A	296.19	1088.83	457.97	127.57	161.60	0.00	56.90	106.54	16.53	0.00
181	B	117.08	0.00	423.24	138.37	179.50	7.27	6.73	80.93	8.10	0.00
181	D	4664.30	0.00	8.73	1278.68	46.34	18.42	24.04	53.67	1475.53	0.02
181	F	1254.36	0.00	128.04	373.67	206.30	168.62	138.36	80.45	114.09	55.27
181	G	1124.28	0.00	422.44	152.27	404.72	43.46	128.87	176.67	63.57	0.23
181	H	415.10	0.00	403.17	149.89	221.79	40.84	76.47	111.21	22.70	0.10
181	i	83.93	0.00	500.84	88.77	161.41	4.67	21.08	89.63	5.84	0.00
182	A	388.58	1016.54	510.25	86.28	152.03	0.00	78.60	113.12	22.51	0.00
182	D	58.42	0.00	147.11	233.27	80.78	1.53	35.25	30.06	6.59	0.00
182	E	114.36	51.47	16.05	308.09	89.29	2316.86	22.22	2.12	90.60	0.06
182	F	2453.72	0.00	288.76	111.36	526.34	0.00	26.25	186.05	43.94	1080.97
182	G	379.71	0.00	235.17	102.84	380.42	57.00	224.71	90.98	27.53	0.81
182	H	263.91	0.00	672.14	46.62	218.64	0.00	55.28	47.20	5.41	0.26
182	i	201.70	0.00	382.82	43.86	240.74	5.71	50.99	115.92	11.01	0.00
182	J	773.05	0.00	342.27	42.86	153.77	0.00	70.09	53.86	3.79	0.00