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COARSE ORANGE POTTERY EXCHANGE IN SOUTHERN VERACRUZ: A COMPOSITIONAL PERSPECTIVE ON CENTRALIZED CRAFT PRODUCTION AND EXCHANGE IN THE CLASSIC PERIOD

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THESIS

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A thesis submitted in partial fulfillment of the
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Wesley Durrell Stoner

ABSTRACT OF THESIS

COARSE ORANGE POTTERY EXCHANGE IN SOUTHERN VERACRUZ: A COMPOSITIONAL PERSPECTIVE ON CENTRALIZED CRAFT PRODUCTION AND EXCHANGE IN THE CLASSIC PERIOD

This research seeks to elucidate the role of relatively large-scale ceramic production industries located at the Classic period center of Matacapan in the Sierra de los Tuxtlas, Southern Veracruz, Mexico. Arnold et al. (1993) have suggested that the specialized production at Comoapan, the largest production locality at Matacapan, was oriented toward supplying the region with ceramics. This production locality overwhelmingly specialized in manufacturing one standardized ware, Coarse Orange, into necked and neckless jars, which are found in many parts of the region.

The compositional techniques of instrumental neutron activation analysis (INAA) and petrography were employed to investigate the distribution of this ware. Control groups were sampled from known production loci at Matacapan. The data does reveal strong evidence that Coarse Orange was traded from Matacapan to other sites in the Tuxtlas. Comoapan was the most likely producer for this trade. Equally as important, this research yielded several different compositional groups, which indicates sites that either did not interact with Matacapan to procure this ware, or who produced their own varieties of Coarse Orange. While Matacapan seems to have had economic influence over parts of the Tuxtlas, the distribution of non-Matacapan compositional groups is useful to delineate areas of the Tuxtlas who display minimal economic interaction with this regional center.

KEYWORDS: Ceramics, Craft Specialization, Compositional Sourcing, Political Economy, Prehistoric Exchange

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Dedicated to my wife: Rebecca Kneedler

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I must thank the Instituto Nacional de Antropologia e Historia of Mexico and the regional office in Veracruz for granting me permission to sample archived ceramics and take the material out of the country for analysis.

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Finally, my wife, Rebecca Kneedler, provided the emotional and financial support to see this project through to the end.

None of the individuals credited in this section, however, are responsible for any of the mistakes in the interpretations that may still exist in the thesis. Any errors are my sole responsibility.

Table of Contents

LIST OF TABLES

LIST OF FIGURES

LIST OF MAPS

LIST OF FILES

Chapter 1

INTRODUCTION

Mesoamerican research has emphasized ceramic specialization as an important aspect in regional political economies. However, the precise role of specialized ceramic production in Mesoamerica is not well understood because of the difficulty in linking specific production loci to the distribution of their wares (Bey and Pool 1992). Even when the difficult task of identifying ceramic production loci based solely on material remains is overcome, it remains difficult to recognize direct relationships between producers and consumers to reconstruct exchange networks. These limitations complicate archaeologist's ability to decipher the organization of regional ceramic economies, and what influence they may have in broader political economic relationships.

In the complex societies of Mesoamerica, regional centers often possessed the largest-scale (in terms of gross output [Pool 1992:278]) and most intensive crafts producers in the region. This probably resulted for a number of reasons. First, these centers were often areas of dense population aggregation, which correlates with high demand. Second, these "urban" populations often comprised a complex organization of various specialists (e.g., ritual, craft, administrative, agricultural specialists). Ceramic specialists, for example, worked part or full-time to provision those who did not make pottery themselves. This interaction between many different urban specialists formed an integrated organic unit, which defined the economic complexity within many Mesoamerican centers. Third, centers were often the location of marketplaces, ceremonial rituals, and other civic activities that incorporated the surrounding communities into a common sociopolitical unit. Central-places were aptly named due to their central location among regional settlements. Depending on the forms of economic integration operating within a region (Polanyi 1957, Sahlins 1972, Prior 1977, Hirth 1998) and available modes of transportation (Hassig 1985, Drennan 1984) urban centers and rural hinterlands were often united through exchange relationships, thus expanding the demand crowd for centrally located craft specialists.

For the above reasons, craft specialization is often seen in its largest scales and most intensive forms in regional centers. Brumfiel has repeatedly noted that, in the Basin of Mexico, craft activity focused on the most influential sites in the market and political hierarchies (1987, 1991). As specialized craft activities moved to these centers, rural sites typically refocused on agricultural production. This situation often results in unequal exchange between urban centers and rural agriculturalists that become dependent on crafts produced in the former (Rowlands 1985). However, in the archaeological record we cannot assume from hierarchical settlement pattern data, and a concentration of large-scale craft activities in regional centers, that this pattern is pervasive throughout a region. Mesoamerican centers rarely enjoyed complete and pervasive economic control over their surrounding region; such monopolistic mercantile behavior generally did not prevail in this area of the world (Sanders and Webster 1988). Competition for a craft's market originated from smaller centers within site hierarchies, and from considerable rural craft production. Furthermore, large-scale urban craft production may simply reflect the need to satiate the demands of the site's large population, which is often composed of various interacting specialists.

Brumfiel demonstrates the tendency for commercial activity to focus on political and market centers by indicating a decreasing emphasis on commercial activity in rural sites with the forming of the Aztec Triple Alliance (1987, 1991). The flow of tribute wealth to the highest ranking sites in the Triple Alliance, and the shift of market activity to the same sites (a related process) caused an influx in craft specialization in these centers, while rural sites became agricultural specialists and raw material extractors. I test the centrality of economy in a different, more direct, manner in this research. Beginning from known cases of relatively large-scale production in the subject region's principal center, I seek to map the distribution of commodities through compositional techniques. Doing so should directly assess economic relationships between sites of different rank within a settlement hierarchy.

To facilitate accurate interpretation of regional patterns of economic interaction, steps should be taken to incorporate sourcing techniques for the reconstruction of exchange relationships. Doing so will allow archaeologists to attach more meaning to the craft industries in question (i.e., their intended market), which will reflect back on the choices that specialists made within their broader socioeconomic context. Compositional studies of ceramics have been used in a variety of cases to identify intraregional and interregional economic interaction (e.g. Rands and Bishop 1980; Hodge et al. 1992, 1993; Neff and Bove 1999; Stoltman 1989, 1991; Stoltman et al. 1992). The premise behind these approaches is that ceramics produced within a single production locus will share more compositional similarity with each other than with ceramics produced at other localities using different resources. Archaeological ceramics retain the mark of decisions made by potters during the manufacturing process (Lemonnier 1986; Gosselain 1992; Schiffer and Skibo 1987, 1997; Sillar and Tite 2000). Ceramics also vary compositionally due to natural fluctuations in clay chemistry and mineralogy (e.g. Carpenter and Feinman 1999, Rands and Bishop 1980, Glascock 1992). Because pottery sherds preserve this natural and cultural information, stylistically homogeneous ware groups can be divided into different compositional subsets that reflect the geographic context in which they were made. Thus, composition provides a way to associate ceramics found in the archaeological record (the context of consumption) with production units and their location in space and time. This provides the basis to reconstruct the centrality of ceramic economies. If a centralized pattern of production and exchange were present, ceramics of the same compositional groups as those found in production contexts in the center should be found throughout the region. Of course, this conclusion must be tempered with supplementary information on ceramic production at rural sites, transportation routes, and the distribution of other compositional groups.

Compositional techniques of instrumental neutron activation (INAA) and petrographic analysis are employed in this study to determine the degree of centralization in the production and distribution of a single ceramic ware, Coarse Orange necked and neckless jars, found in many parts of the Sierra de los Tuxtlas region in Classic period southern Veracruz, Mexico. This study specifically asks the questions: Did Coarse Orange production located in the region's principal center, Matacapan, reach a regional market?; If so, how did the centralization of this specific aspect of the regional economy influence site level economic relationships (Santley and Arnold 1996, Killion and Urcid n.p.). Matacapan hosted what is possibly the largest-scale (again referring to gross output) ceramic production entity known to the Gulf Lowlands of Mesoamerica: Comoapan. If previous estimates of Comoapan are correct (Arnold et al. 1993), ceramics were produced at Matacapan to be traded throughout the region. This would be expected if the general process Brumfiel suggests for the Basin of Mexico also operated in the Tuxtlas.

After Matacapan developed as the region's principal center – an indication of political centralization – several large-scale production entities developed at the site's southern extent (Comoapan included). The development of relatively large-scale and intensive ceramic production could have been designed to supply inhabitants of rural sites with ceramics in return for food, raw materials, and other goods generated in the countryside. This research tests that assumption by establishing compositional sub-groups within the Coarse Orange ware category, and mapping their distribution to sites of all ranks in the Tuxtlas. Determining Matacapan as the source of ceramics found at lower order sites throughout the region would suggest that along with political centralization came a certain degree of economic centralization. Although not directly testable with the data collected in this research, the centralized pattern mentioned above may indicate Matacapan's trade of secondary goods (commodities manufactured by human labor) for primary goods (food and raw materials) generated by rural sites. At the very least it would represent centralized production of commodities that rural sites needed for some reason, probably to meet utilitarian needs. This urban/rural pattern may or may not characterize much of Mesoamerica. It certainly does not characterize, for example, the distribution of utilitarian ceramics in the region surrounding Palenque (Rands and Bishop 1980), or the Guatemala Highlands known through ethnographic research (Reina and Hill 1978). On the other hand, there are several Mesoamerican examples where centrally produced ceramics reached a rural consuming population in the hinterland (e.g., Rattray et al 1992; Hodge et al. 1992). Since this study begins with known centralized production loci, it should present a model that others can use for regional comparisons of political economy and specialized craft economies.

The Study

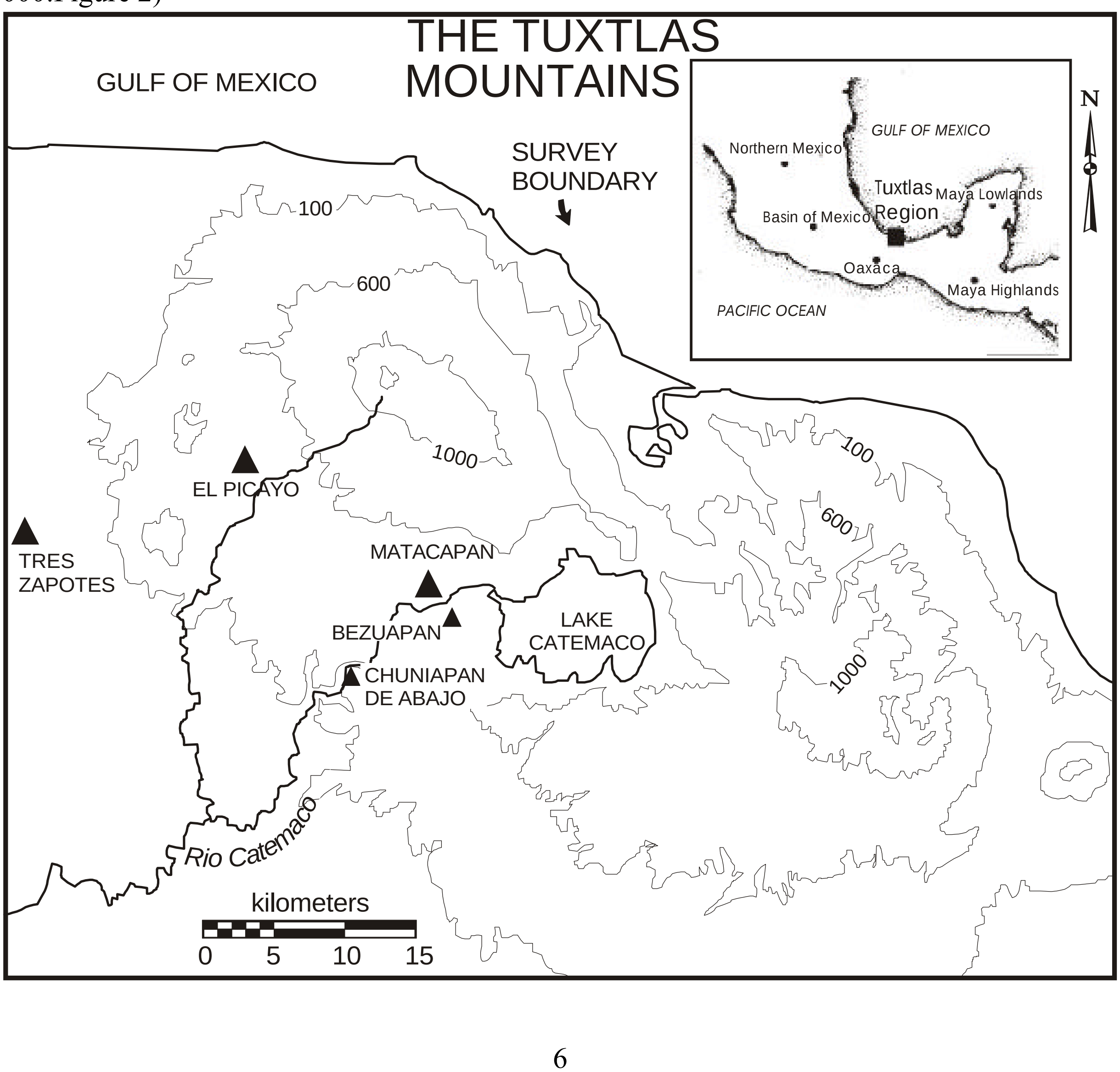
Coarse Orange jars (Figure 1.1) were very common in Classic period southern Veracruz (Map 1.1). Presence of this ware, along with several others including Fine Orange, Fine Gray, and Tuxtlas Polychrome, was used to define Classic period occupation in the Tuxtlas. Coarse Orange was probably used for storage within the household. However, many of these vessels were painted with geometric patterns, most frequently in black, brown, red, and white colors. One Coarse Orange vessel on display at the INAH Museum in Santiago Tuxtla was found with a burial inside, suggesting that this ware served ritual functions as well. Although Coarse Orange most frequently appears in utilitarian forms (e.g. jars) the frequent decoration and at least one instance of funerary use indicate that this ware may have retained some prestigious worth. Although all of the possible production loci are not known, the data currently suggest that Matacapan had played an important role in supplying the region with this ware.

Matacapan was a principal Classic period center within the central Tuxtlas region (Map 1.1)(Santley 1994, 1991;, 1992; Santley and Arnold 1996; Santley et al. 1985; Santley et al. 1984). This characterization derives primarily from settlement analysis (Santley 1991, 1994; Santley and Arnold 1996). In addition, relative differences in specialized craft production among sites in the region (Santley et al. 1989, Arnold et al. 1993, Arnold and Santley 1993) and data suggesting the Tuxtlas' involvement in an interregional exchange system (Santley and Pool 1993, Santley and Alexander 1992, Spence 1992, Rattray 1988, 1990) reinforce the interpretation, currently under investigation, of Matacapan as an economic center. Further, examinations of Middle Classic ideology and identity (Pool 1992; Santley, Pool, and Ortiz 1987) indicate that Matacapan also held ceremonial importance for surrounding sites. Overall, interpretations of Matacapan's role in the region focus on its economic influence and its ethnic, ideological, and material affiliation with the great Classic Period center of Teotihuacan.

Figure 1.1. Coarse Orange sherds (picture supplied by C.A. Pool).

Matacapan produced pottery on many levels of organization and intensity (Santley et al. 1989). Potters made ceramics on both large and small scales in their homes, one production area was associated with an elite residence in the center of the site, and several independent domestic workshops were situated toward the southern border of the site. Although ceramic production occurred at 23% of Middle Classic sites within the Tuxtlas Survey (contains less than half of the study area, but the most is currently known about sites within this survey), the largest-scale ceramic production known to the region was centered at Matacapan. El Salado practiced specialized ceramic production, but it was primarily associated with manufacture of containers for boiling salt brine from a local spring (Santley et al. 1988).

Map 1.1. Showing the Tuxtlas and their position within Mesoamerica (After Arnold 1991:Figure1; Santley and Arnold 1996:Figure 4; Santley et al. 1997:Figure 7.1; Pool and Britt 2000:Figure 2)



Apomponapam, Teotepec, Isla Agaltepec, Santa Rosa Abata, Chuniapan de Abajo, Site 11 and Site 94 from Santley and Arnold's Tuxtlas survey (Santley and Arnold 1996) also evidence specialized ceramic production. However, all but Site 11 focused on producing wares other than Coarse Orange. Site 11 was very close to Matacapan and may have even been an outlying barrio of the larger center.

Of the varied ceramic production localities within Matacapan, the most notable for its size, output, and standardization was Comoapan: the largest producer of Coarse Orange known to the region (Pool 1990:222-230; Santley et. al 1989:120). Together, Area 199 (another major specialist in Coarse Orange manufacture that was not excavated) and Comoapan generated 62.7% of Coarse Orange sherds from surface collections found at Matacapan (Santley et al. 1989:123); Coarse Orange composed 63.4% of the ceramic assemblage found at Comoapan and 44.7% of the Area 199 collections (Pool 1990:242). Comoapan's 36 kilns, several waster dumps, high overall density of ceramic sherds and wasters, and standardization of vessels point toward specialized production.

Current evidence suggests that these industries were oriented toward exchange of ceramics beyond Matacapan. First, less than a quarter of the sites in the Middle Classic Tuxtlas show evidence of ceramic production (Santley and Arnold 1996:236). Given that ceramics, particularly the Coarse Orange type (Santley 1991:8-12), appear at every archaeological site throughout the Classic Tuxtlas, site level ceramic exchange was likely. Furthermore, evidence for specialization in Coarse Orange production was infrequent at rural sites in the Tuxtlas (Arnold et al. 1993, Santley 1991).

Second, estimates of late Middle Classic production output of Coarse Orange made at Comoapan exceeded one-half million vessels (based on rim counts from excavation and systematic surface collections, and assuming a 20% firing loss), which alone could have supplied the entire population of Matacapan with ceramics (Arnold et al. 1993:184). Because Comoapan was not alone in provisioning this large site, it is likely that part of this output transcended Matacapan's boundaries. Arnold et al. (1993) thus argued production of Coarse Orange at Comoapan was oriented toward provisioning the Tuxtlas with ceramics. The frequent occurrence of Coarse Orange throughout the region and the apparent scarcity of specialized Coarse Orange production outside of Matacapan also support this interpretation. For these reasons, Arnold and his associates see Matacapan as a center focused on controlling the Tuxtlas economy.

Third, Santley (1994:261) later suggested that Comoapan Coarse Orange production served primarily as an export industry in a dendritic central-place economy. Settlement analysis and variation in the mode of craft production seem to support Santley's conclusion of a dendritic organization. However, that Coarse Orange was exchanged to distant regions in significant amounts is highly unlikely. Whether used for utilitarian or prestigious functions, Coarse Orange jars are bulky commodities. Traders from Matacapan and other parts of the Tuxtlas certainly could have employed these vessels as containers to transport more important commodities, such as liquidambar or honey (Arnold et al. 1993:175) – two goods that were listed as tribute given from the Tochtepec province of the Late Aztec Empire (Stark 1978). However, it is difficult to believe the exchange of these preciosities from the Tuxtlas to other regions in the Classic period would have occurred in such a quantity to merit the Comoapan production locality exclusively for this purpose. Nevertheless, if the primary purpose of Comoapan were to manufacture ceramics for export, they would rarely be found *within* the region.

Although Matacapan was a likely source for at least some of Coarse Orange ceramics found throughout the Tuxtlas, several questions remain unanswered. Was the Coarse Orange market controlled by Matacapan, or was production and distribution dispersed throughout the Tuxtlas? How much competition did Matacapan have for the Coarse Orange market? Where were other major producers located within the region? What proportion of sites within the region were integrated under Matacapan's economic influence? How might ceramic production at Matacapan have complemented other economic activities elsewhere in the Tuxtlas?

Research performed in the Basin of Mexico provides a model that addresses these questions (Brumfiel 1987, 1991; Hodge et al. 1992, 1993; Minc 1994). Brumfiel demonstrates a shift in the focus of craft production and consumption in the region with a change in the political and market hierarchy. Sites that had displayed high levels of commercial activity in the Early Aztec Phase of the Late Postclassic declined in their focus on craft production and marketing in the Late Aztec Phase with the political integration of the Basin by the Triple Alliance (Tenochtitlan, Texcoco, Tlacopan). The theoretical explanation for this is that the centralization of the market hierarchy on a single or small number of sites will suppress craft production and consumption at lower ranking sites in the region. Central-place theory and center-periphery models suggest that the suppression of secondary production (items manufactured by human labor) outside of central-places is complimented by an increase in primary production (agricultural production and raw material extraction) aimed toward generating surplus that supports the center.

If this situation were evident in the Classic period Tuxtlas, increasing craft activity at Matacapan following its rise to political prominence would have been oriented toward a regional market and exchanged for agricultural surplus and various other raw materials valued in Mesoamerica (e.g. liquidambar, honey, basalt, cotton, cacao, feathers). The problem with inferring this from settlement data and information on the variability in scale and intensity of craft production in the Tuxtlas is that it over-generalizes political economic relationships. Matacapan might have had considerable competition for dominance in the region's economy by other political factions or simply from continuing rural production that was less effected by Matacapan's political influence. The only way we can tell if Matacapan was successful in commanding the market for Coarse Orange is to test the hypothesis by reconstructing the exchange of Coarse Orange vessels produced there. Compositional perspectives therefore provide a valuable tool for assessing regional political economy.

Previous compositional research on Matacapan wares has determined that production and distribution of fine paste pottery was decentralized (Pool and Santley 1992; Pool 1990:318-319). However, investment in the production of fine paste ceramics was not nearly as high as Coarse Orange. I refer here to the social organization of labor, not the raw number of vessels produced at Matacapan. In total, more fine paste vessels were probably produced at Matacapan than Coarse Orange, but the latter was manufactured in a relatively larger-scale and higher intensity at Comoapan than fine paste ceramics made at other production loci throughout the site. Based on research described above, it is thought that the reason for more intensive production of Coarse Orange reflects the producers attempt to reach a broader regional market. The fact that Comoapan was situated right next to the Rio Grande de Catemaco offers some support for this claim.

This study has the advantage of beginning with known cases of Coarse Orange production. Most compositional studies can, at best, restrict the range of compositional groups to indicate broad zones of production and distribution. Ceramics were sampled from secure production contexts at Matacapan and will act as "control groups" to source ceramics throughout the region. Based on stylistic attributes and chemical and mineralogical composition, it may be possible to source ceramics to specific production localities at Matacapan.

Regarding the distribution of Coarse Orange production in the Sierra de los Tuxtlas, the following hypotheses were constructed. Material correlates are discussed for each hypothesis at the end of Chapter 4.

Hypothesis 1: Matacapan was the sole producer of Coarse Orange found within the Tuxtlas. This would suggest that Matacapan was certainly influential within the regional political economy. Trade of Coarse Orange vessels under this hypothesis may have served to centralize the flow of various perishable goods from the countryside (i.e. food, salt, cotton, honey, cacao, feathers, etc.). No inhabitant of Matacapan would have needed to procure ceramics from elsewhere, and obsidian likely flowed directly into Matacapan from central Mexican sources. Textiles were also produced in domestic contexts at Matacapan (Hall 1997). The most likely goods traded into Matacapan in exchange for Coarse Orange would have been perishable, and thus difficult to detect archaeologically. This hypothesis fits the models of unequal exchange described above.

Hypothesis 2: Coarse Orange produced at Matacapan reached an intermediate distribution, primarily servicing the central Tuxtlas. It is very likely that the movement of Coarse Orange from Matacapan was restricted by transportation limitations. River transport was easily accessible to Matacapan because they were situated next to the largest river in the Tuxtlas: Rio Grande de Catemaco. If river transport was important, Matacapan produced Coarse Orange would have traveled further to the south than east or west. Political or economic boundaries may also limit the extent of Coarse Orange trade from Matacapan under this hypothesis.

Hypothesis 3: Access to Matacapan pottery varied with position in the settlement hierarchy. A 5-tiered settlement hierarchy developed in the Middle Classic period Tuxtlas. Interacting primarily with level 2 centers, for example, would have considerably reduced the cost of administration for Matacapan. Therefore economic trade may have followed the political hierarchy down site rank. The result may be a higher concentration of Matacapan produced Coarse Orange in large and small centers rather than hamlets and villages. Conversely, if centralized marketplaces existed in the Tuxtlas, Matacapan-produced Coarse Orange would be more prevalent in nearby sites regardless of settlement hierarchy. Hinterland settlements tend to attend the market closest to them where they can get the goods they require (Plattner 1989). A market held at Matacapan could have supplied a large radius of consumers surrounding Matacapan. So distance, rather than site rank, would have been a factor in who had access to Matacapan ceramics if a central market existed in this center.

Hypothesis 4: Production of Coarse Orange at Matacapan was geared toward export beyond the Tuxtlas. This hypothesis supports Santley's (1994) dendritic market argument, and would reveal very few Matacapan produced Coarse Orange vessels throughout the Tuxtlas. If Matacapan was a node of the larger dendritic economy proposed for the Classic period in Mesoamerica (Santley and Alexander 1996), it would have most likely been a bulking area for local products to be exchanged to other regions (most likely Teotihuacan). Matacapan-produced Coarse Orange may be evident at break-of-bulk points along the Rio Catemaco, though.

Hypothesis 5: Production of Coarse Orange was dispersed throughout the Tuxtlas and no centralized distribution took place. This hypothesis would suggest that all production that took place at Matacapan was primarily for consumption at Matacapan. Proving this hypothesis does not mean that Matacapan was not influential throughout the Tuxtlas, but it does make it less likely that Matacapan was a controlling economic center.

These hypotheses were designed to delineate the possible distributions for ceramics produced at Matacapan, at the Comoapan locality in particular. Rejection of any number of these hypotheses will certainly refine our knowledge of this important ceramic production facility and the role of Matacapan in the region. Hypotheses 1 and 2 would indicate different degrees of a centralized economy with regard to Coarse Orange. Support for these hypotheses would suggest that the development of a political hierarchy and the centralization of ceramic production at Matacapan did somewhat suppress commercial activity in rural sites, as predicted by Brumfiel (1991) for the Basin of Mexico. Hypothesis 5, on the other hand, represents a decentralized economy, and that there was no suppression of craft activities in the hinterland.

Organization of this Text

This thesis proceeds to recount previous research performed on this topic at theoretical, methodological, and empirical levels of analysis. Chapter 2 lays out the theoretical framework employed in this case to understand different types of craft specialization systems. First, because of the reliance on material science in this and most archaeological studies, a description of the physical and cultural processes that make sourcing possible is the first priority for this chapter. Second, I delineate the terminology previously utilized in the discourse on craft specialization, with an emphasis on ceramic production and exchange. Moreover, contextualizing these variables on a regional scale requires a slightly higher-level consideration of theory that unites production and exchange on broader scales of analysis.

Chapter 3 presents a geological overview of the Tuxtlas Mountains. A good working knowledge of the region's geology is crucial for my ability to identify raw material sources for the Coarse Orange sampled. Clay and volcanic ash resource variability are described at some length.

Chapter 4 deals with the previous research performed in the Tuxtlas that directly impacts the current study. Foremost among these concerns is a detailed summary of ceramic production in the Tuxtlas. I attempt to contextualize the range of variability in ceramic production scale and intensity and describe how this variability patterns over the landscape.

Chapter 5 details the methodology employed: petrography and instrumental neutron activation analysis. This discussion begins from the premises discussed in the beginning of Chapter 2 and presents critical knowledge of the techniques and their ability to detect exchange in the archaeological record.

Chapter 6 presents the results of the compositional analyses. I introduce the chemical results first because they provide structure in the data from which the petrographic analyses stem. The objective of this chapter is to delineate specific recipes employed within the stylistically defined Coarse Orange ware group. Furthermore, Chapter 6 evaluates the significance of the geographic patterns and defines zones of production and distribution for Coarse Orange.

Finally, Chapter 7 discusses the theoretical, methodological, and substantive significance of this research. It is hoped that future studies within and outside of the Tuxtlas can benefit from the data generated in the course of this research. Specifically, studies of craft specialization can benefit because this research models the distribution of ceramics produced in one of the largest-scale ceramic industries known to pre-industrial Mesoamerica. This model can be used in other regions of Mesoamerica as a basis to evaluate different cases of ceramic economy that resemble this one. The mix of techniques described in the methodology chapter has been proven successful prior to this research, but I hope to build on our knowledge of these techniques through this study. Finally, the empirical data generated by these compositional techniques will prove useful for researchers in the Tuxtlas and for those who wish to compare other regions with ceramic compositions of the Tuxtlas for the purpose of modeling interregional exchange or cross-cultural variation in production technology.

Chapter 2

CERAMIC PRODUCTION AND DISTRIBUTION IN PREHISTORY

As outlined in the previous chapter, this thesis investigates the role of comparatively large-scale and intensive ceramic production at a large Classic period center through a regional analysis of commodity distribution. It has been suggested that Matacapan headed aspects of the regional ceramic economy in the Tuxtlas (Arnold et al. 1993, Santley 1994). Part of the reason for settling Matacapan (argued to have originally been a Teotihuacan enclave) could have included access to high quality clays and its position at the confluence of the Rio Grande de Catemaco, and Rio San Joaquin. Canoe transportation would have been very important for trade in the absence of draft animals or more sophisticated technology (Hassig 1985, Drennan 1984). As the political hierarchy centered on Matacapan, large-scale ceramic production facilities developed toward the southern extent of the site.

The data collected on ceramic production at Matacapan, however, cannot stand alone to explain this aspect of the region's economic system. If Matacapan influenced the region's ceramic economy then vessels produced in this center should have made their way to other sites in the region. Using compositional techniques it is possible to estimate the number and location of ceramics producers to measure site level economic networking. Maximizing the utility of the compositional approach, however, requires the appropriate mix of theory and methods. Outlined in this chapter is a framework that permits inferences about regional economic configuration from the proposed methods.

In the following sections, I evaluate theoretical assumptions introduced in the previous chapter and hope to arrive at a framework that facilitates our understanding of the regional importance of centralized economies. To do so, I establish a link between archaeological material and exchange using a technological choice framework (Sillar and Tite 2000). Next, the concept of craft specialization is divided into measurable variables that each tells something different about specialized economies in the archaeological record. Finally, I look at how producers and consumers pattern over the landscape through various theoretical perspectives on regional economy. To understand these regional patterns, I evaluate the concept of "central-place" as put forth and debated in previous literature.

From Artifact to Exchange: Sources of Compositional Variability in Archaeological Ceramics

Archaeologists have considered two types of "sources" in previous literature: raw material sources, and the cultural source of manufacture. Determining the origin of ceramic production or the location of raw material procurement requires the ability to associate artifacts found in consumption contexts with their geographic location of manufacture. The often-cited "Provenience Postulate" developed for chemical analysis at Brookhaven National Laboratory (Rands and Bishop 1980) states: "there exist differences in chemical composition between different natural sources that exceed, in some recognizable way, differences observed within a given source" (Weigand et al. 1977). Although this statement must be modified for use in conjunction with petrographic analysis, the general premise holds. Ceramics reflect the location of raw material and the cultural inputs of their origin. The first modification needed is the change of "chemical composition" to simply read "composition". Second, I recognize that not all variation in ceramic composition results from natural differences in materials used. The behavioral input of potters also generates variation in final ceramic composition (Rands and Bishop 1980; Arnold et al. 1991; Carpenter and Feinman 1999; Stoltman 1989, 1991).

Natural variation in resource availability is the more straightforward to identify. The chemical and mineralogical compositions of each raw material used in pottery production contributes to the overall composition of the finished product. Since clay and temper compositions vary stratigraphically and horizontally, the use of that material to manufacture ceramics locks the location of resource procurement into the artifact. Archaeologists have employed chemical and mineralogical techniques to match the fingerprint of ceramic composition to materials found on the contemporary landscape (Neff 1999, Glascock 1992, Harbottle 1982, Rands and Bishop 1980, but see Neff et al. 1988, 1989; Arnold et al. 1991). The distribution of clays and temper resources stays relatively resilient to change over thousands of years, so this retro-diction of resource use seems reliable. The possibility that raw materials were transported over long distances, though, complicates the one-to-one correlation of raw material zones with the location of production.

The depositional history of a region greatly determines the variability that permits sourcing. Clays deposited in large basins tend to be homogeneous over large areas, whereas fluvial clays, deposited by rivers, may be more diverse and can vary compositionally between river drainages. Despite a region's geological variability, the material used in ceramic production depends on its availability to potters. If suitable clay is buried too deep under other geological formations, those clays may not be accessible. Prehistoric potters in mountainous environments, such as the Tuxtlas, most likely took advantage of outcrops of clay exposed by rivers carving out drainages. Marine deposits such as the Concepcion that occurs in much of the Tuxtlas, may be hundreds of meters thick and cover many square kilometers. Each clay outcrop, however, can differ compositionally depending on the depth of the exposure within the formation. A site's spatial proximity to a clay outcrop should reveal the likely source of procurement, which provides the basis for comparison between ceramic and clay compositions for sourcing.

Although possible, it was unlikely that people transported clay across the landscape considering its relatively low value-to-bulk ratio. In Mesoamerica, where transport was primarily accomplished by human porter (Drennan 1984, Hassig 1985, Stein 1999), and throughout most of the non-industrialized world, 33% of potters tended to procure their clays from within 1 km of their homes and 84% from within 7 km (Arnold 1985). Temper was gathered from within 1 km by 52% of potters, and from within 6-9 km by 97% of potters (Arnold 1985). Of course, these thresholds ethnographically determined by Arnold do not apply to the modern industrial world economy – where large quantities of low-value, bulky materials are transported over long distances using efficient modern technology. They do, however, provide archaeologists with the means to logically associate ceramic compositional variation with the location of ceramic production in pre-industrial societies through the distribution of modern clay and temper resources (e.g., Hodge et al. 1992; Neff and Bove 1999; Neff et al. 1999; Pool 1992; Day et al. 1999). One may also argue that the same principle can be made to suggest that bulky ceramics would not have been traded far. However, the ceramics bear more value than raw clays, and they may contain even more valuable materials.

According to the adjusted "Provenance Postulate" defined above, ceramics can also be sourced without prior knowledge of clay composition. Since ceramic compositions reflect the material used and because potters tend to obtain materials locally (Arnold 1985), the geographic distribution of ceramic compositions forms the basis to infer exchange when compared between sites. Delineating geographic zones of ceramic consumption based on compositional variation of the paste will refine the range of distribution for a ware. Therefore, we may infer production of that chemical or mineral group somewhere within its geographical boundaries. Ceramics from known production localities can serve as "control groups" that make the production source retrodiction more precise (Day et al. 1999; Rattray et al. 1992).

Arnold et al. (1991) argue that the seemingly simple task of matching ceramic to raw material composition is not as straightforward as it seems. Many ceramics result from the producer's mixing clays with temper, which can confuse chemical detection of material procurement location (Neff et al. 1988, 1989; Arnold et al. 1991). The cultural behavior of tempering clay obscures a ceramic's compositional signature, so a simple comparison to natural clay chemistry becomes complicated. However, the decision to temper a ceramic was made by the ancient potter and should reflect the individual and cultural identity of that person as well as the potter's knowledge of the different performance characteristics of the materials they selected. Sociolcultural differences in ceramic production have been shown to vary between specific produciton loci – therefore the combined chemical/mineral approach to ceramic composition can illuminate interaction at the level of the production entity (Burton and Simon 1993, 1996; Carpenter and Feinman 1999; Day et al. 1999; Stoltman et al. 1992). Although tempering has been referred to as "noise" that obscures chemical analysis (Rands and Bishop 1980, Arnold et al. 1991, Neff et al. 1996), it has otherwise proven very useful for sourcing in its own right (Day et al. 1999; Stoltman 1989, 1991; Pool 1992:297; Chapter 5 this volume).

According to Shanks and Tilley (1987:130-131) artifacts embody the culture of the individuals that produce them. That is, a producer infuses his or her product with cultural information because that person's identity affects every aspect of their behavior in practice (see Giddens 1979, for discussions on practice and social structure). Technological choice (see Sillar and Tite 2000, Lemonnier 1986, Gosselain 1992, Pool 2000, Cumberpatch et al. 2001, Schiffer and Skibo 1987, 1997) begins with this premise and outlines a more specific framework for understanding the behavioral inputs to archaeological material. Rather than the general statement that artifacts embody the culture of their creators, technological choice invites us to appraise more precisely which cultural inputs appear at each stage of manufacture by considering the decisions producers make within their broader social context. The selection of suitable materials, the mixing of temper with clay, the preparation of both clay and temper, the firing technology used, vessel form, post-firing treatments, decoration, the organization of labor, and the marketing of a craft are all choices made by potters or their patrons that create culturally diagnostic variation useful for sourcing.

Cumberpatch (2001) and Pool (2001) have noted that the context within which potters make technological choices resembles Giddens' (1979) consideration of structure. Although potters are subjected to performance considerations (Schiffer and Skibo 1997, 1987), consumer preference (Pool 1992), social custom (Reina and Hill 1978), and the available modes of exchange (Hirth 1998, Polanyi 1957), technological choices recursively structure other social behaviors. There exist a wide range of social and technological possibilities for ceramic production, but success in the ability of a craft producer to market their wares depends largely on the general acceptance of their wares by the consuming population.

All things considered, potters develop a way of manufacturing pottery, a *recipe* (Arnold et al. 1991; Stoltman et al. 1992), through experimentation with the physical and chemical properties of the available material and other cultural knowledge that circulates through social channels. These recipes change over time, but decisions made during the early stages of manufacture (e.g. choice of material, preparation of the paste, firing procedure) tend to resist the abrupt and frequent shifts seen with the more flexible pottery components of decoration and aesthetic style. Because of this resilience, a single production locality may utilize a certain production recipe over long spans of time (e.g., Cleland and Shimada 1998). Information about ceramics manufacture was broadly disseminated in prehispanic Mesoamerica, but each location of production existed within a specific sociocultural, economic, and geological context that strongly conditioned the recipes potters used and the strategies employed to organize labor and the marketing of the final product.

This research employs compositional techniques that are designed to characterize both the natural and cultural inputs into ceramic composition. This combination maximizes the effectiveness of archaeological sourcing (Rands and Bishop 1980, Rands and Weimer 1992, Day et al. 1999). Clay chemistry in a region with homogeneous geology is not very informative for reconstructing exchange. The cultural inputs to ceramic composition, however, may vary despite homogeneous material availability. Culturally generated variation between ceramic recipes, on the other hand, should not be utilized for sourcing in isolation because recipes may be so variable that they differ within a single production locality. This would obviously inhibit source retro-dictions. Chemical groupings, most sensitive to geological variation, are employed as "knowns" to structure the data, and petrography, more sensitive to cultural inputs, is used as an interpretive tool to find culturally significant patterns within chemical groups (Rands and Bishop 1980, Rands and Weimer 1992, Day et al. 1999, Stoltman et al. 1992).

Specialized Production and Exchange

Given the emphasis on specialized craft manufacture in this and previous research within the Tuxtlas, a discussion of craft specialization must precede my consideration of regional economies. There are numerous ways in which craft specialization can fit into the political, economic, and social aspects of a region. Decisions made about the social organization of production and distribution should reveal themselves in the patterns of archaeological remains. Archaeologists best conduct this analysis by breaking the catchall phrase of "craft specialization" down into its component parts (Earle 1981, Clark 1986, Brumfiel and Earle 1987, Clark and Perry 1990, Costin 1991, Pool 1992, Clark 1995, Rice 1996, 1998, P. Arnold 2000, Feinman 1999, Balkansky et al. 1997). Drawing primarily upon Pool (1992), Costin (1991), Clark (Clark and Perry 1990; Clark 1995), and Brumfiel and Earle (1987) I briefly present the dimensions of craft production and distribution that concern this research. Summaries of variable definitions are supplied in Table 2.1, which should be used as a glossary when reading this text.

In the current context, craft specialization denotes a particular organization of labor in which producers generate an exchangeable surplus alienable from the context of production for use in broader social and economic arenas. More simply put, Rice (1996) defines specialization as a "small number of producers producing for a larger number of consumers". Both definitions emphasize the inseparable connection between production and exchange[1]. Craft specialization varies in so many dimensions, however, that a more detailed characterization is necessary.

I wish to begin my consideration of craft specialization with Brumfiel and Earle (1987; and Earle 1981) who distinguished independent and attached varieties, utilitarian and wealth good production, and delineated a more active framework for understanding its political significance. Costin (1991:11) refers to this distinction between attached and independent

[1] Exchange is used, in this research, in Polanyi's (1957) sense as the transmission of a good from one person to another. This can include foods, money, crafts, or information among a multitude of other things.

production as the *context* of ceramic specialization, which associates production with the "sociopolitical component of the demand for their wares"[2].

Table 2.1. Definitions of terms employed in this text.

Characteristic of Production		Description and Source
	Scale	Gross size or amount of inputs (labor, energy, capital) or outputs (products and by-products) (Pool 1992:278).
	Intensity	Needs to be seperated into intensity and efficiency. Efficiency measures production with regards to outputs and inputs. High efficiency characterizes production where outputs outweigh inputs (Torrence 1989:86). Intensity, on the other hand, emphasizes labor inputs per production entity (Torrenceand 1989:86; Pool 1992:278). Technology, labor organization, and specialization are some ways to increase efficiency (Pool 1992:278; Rice 1987:190). Simply increasing the amount of labor input into production can increase intensity.
	Size	The spatial extent of the production entity (Pool 1992:279).
	Segregation of Activities	Degree to which each stage of manufacture is carried out within a discreet activity area in the production loci. Furthermore, this variable also refers to the separation of ceramic production activities from other domestic behaviors (Pool 1992:279-280).
	Location of Production	A potter's position on the landscape. This variable measures the degree to which regional craft activities are dispersed or nucleated within a small number of areas (Pool 1992:280).
	Context	The social setting of production. This is divided into attached and independent varieties of production (Brumfiel and Earle 1987; Costin 1991).
Characteristic of Distribution		Description and Source
	Range and Direction	Range measures how far a product will travel from the locus of production, while direction obviously refers to the path the vessel takes to arrive at the place of consumption (Pool 1992:282).
	Scale	Total amount of pottery exchanged within a system (Pool 1992:282).
	Pervasiveness	This variable refers to the degree of penetration a vessel has through the different levels of the settlement hierarchy. If produced at a center, for example, a high degree of pervasiveness will be evidenced by the presence of this commodity at all site ranks including the smallest.
	Centralization	The degree to which distribution is regulated or administered by a central authority (Pool 1992:282). This depends heavily upon the mechanisms of exchange (e.g., redistribution, marketplaces, reciprocity).
	Competition	Connected to nearly all of the other variables, competition refers to the relationships among all of the producers of a commodity within a region and their relative success in provisioning the consuming population with ceramics.

Attached craft specialization, or some variant, has been discussed extensively (Brumfiel and Earle 1987, Santley et al. 1989, Clark and Perry 1990, Costin 1991, Pool 1992, Clark 1995). To avoid opening a subject that could easily fill the remainder of this thesis, I will define

[2] Clark (1995) warns against the reliance on the concept of demand rooted in formal economics. Although Costin does seem to rely on the presence of a market economy, it is apparent that Costin (1991:11) intended to identify different types of production with their context of consumption. Clark and Perry (1990) prefer to attend the rights to the product of labor. This perspective is taken here, in combination with Costin's ideas about attached and independent specialization. Costin (1991) and Clark (1995) are not mutually exclusive.

attached specialization generally as production or service provided to an elite patron, where the elite owns the rights to the product of labor (see Brumfiel and Earle 1987:5, Clark and Perry 1990:298, Costin 1991:5, Clark 1995). Attached specialists typically produce prestige goods that their elite patrons can display as symbols of office to legitimate their authority. Elites also employ prestige wealth in exchanges that cement political relationships (Brumfiel 1987, Arnold et al. 1993:186-187). Attached specialists are in demand in societies where tight control over wealth and prestige is necessary to promote political and ceremonial legitimacy. Therefore, goods fabricated by individuals for an elite patron do not circulate through open markets where they would be accessible to all consumers (Hirth 1998). My research discusses an example of attached specialization, though, that made decorated utilitarian vessel forms (storage jars) (Chapter 6). This suggests first that their exist gradations between the ideal types "utilitarian" and "prestige" goods. Second, elite patrons may employ utilitarian craft specialists. After all, even elites need ordinary household utensils.

An extreme example of attached craft specialization comes from the Late Horizon Andes. The Inka commandeered the labor of thousands of women from conquered territories to weave prestigious cloth in Cuzco and other administrative centers (Morris 1993, Murra 1989). The Inka, however, only attempted to control prestige wealth and left independent specialists to produce unfettered by administration (Costin and Hagstrum 1995). The Inka case is one where extensive market systems did not exist, and production and exchange of utilitarian crafts appears to have moved through more localized social systems, but were sometimes co-opted by imperial administrators to finance expansion and the large elite social sectors.

Independent specialization is usually seen as the production of utilitarian items for an “unspecified demand crowd that varies according to economic, social and political conditions” (Brumfiel and Earle 1987:5). Under this form of production, the producers themselves maintain ownership of the products of their own labor (Clark and Perry 1990). Independent specialization is usually found in regions where a sufficiently large demand exists (Costin 1991:12) to support part or full-time investment in craft production as a significant portion of the household economy. Marketplaces, efficient modes of transportation (i.e., rivers), regional political integration, and dense populations all ease producers’ ability to subsist on their craft by increasing access to a large consuming population. Economic central-places (discussed below) provide many of these things, creating a strong attraction for both independent and attached craft specialists to immigrate (Santley and Arnold 1996; Brumfiel 1987b, 1991).

To understand the impact of either the independent or attached producer class of craft specialization on the regional economy, it is useful to designate the relative *scales* (the gross size or amount of production [Pool 1992:278]) and *intensities* (which measures labor input per unit of production [Pool 1992:278]) of production and distribution. Specialization implies production on a scale sufficient to provision consumers outside the context of manufacture. The quantity of crafts turned out by the producers reflects the number of individuals consuming that craft, and therefore correlates with the scale and possibly the *range* of distribution (Pool 1992:279). Because specialists derive at least part of their livelihood from craft production, steps are often taken to maximize output and increase efficiency (part of the intensity variable; see Table 2.1), thus achieving an economy of scale designed to provision a large number of consumers.

Costin (1991) used the term "intensity" differently. Her use of the term invokes Rice's (1987:183-191) discussion of full-time versus part-time production. Full-time specialization is seen as relatively more intense production than part-time because the potters derive his/her entire livelihood from their craft activities. By devoting all of their time to the craft, production can become more efficient. The intent is not to confuse full-time and part-time production with intensity as previously defined above. One does make production more intense (Torrence 1989:86; Pool 1992:278) by changing from part to full time production, but this does not necessarily make production more efficient. Any reference to the proportion of time the specialist devotes to production will be named explicitly. Seasonal variation in ceramic production due to climate, precipitation, and fuel availability makes any determination of the amount of time annually devoted to production tentative.

Pottery makers who attempt to maximize the efficiency of production by increasing labor inputs or utilizing a better technology are increasing the intensity with which they produce (Pool 1990:278). High intensity production is usually seen as the potter's attempt to capitalize on the availability of a large body of potential consumers. Potters at Huaca de la Luna in the ancient site of Moche in Peru, for example, employed mold technology to facilitate efficient production of standardized vessels (Uceda and Armas 1998). By decreasing inputs in relation to outputs, the high intensity specialist can afford to offer lower "priced" commodities to consumers. The market for utilitarian goods is frequently dominated by mass-production because of the low cost to the consumer. How many modern carpenters go to blacksmiths to purchase hand-hammered nails? Therefore, ceramic specialists who can cheaply reproduce high quantities of vessels may dominate the market for utilitarian ceramics. This is one possible explanation for the intensification of Coarse Orange production in the Late Middle Classic at Matacapan.

There are several ways one can intensify production. First, specializing in a single variety of a product permits one to attain more efficient production due to a higher level of expertise and repetition. Many potters, for example, may produce a single ware in a restricted number of forms (e.g. Reina and Hill 1978, D. Arnold 1985). This facilitates routinization of production steps and allows more product to be generated at lower costs because the potter does not need to switch procedures and techniques from one batch to the next. Routinization has been shown to increase the standardization of vessel measurements (D. Arnold 1985). Stark (1996) and Feinman et al. (1984, 1992) demonstrate that the ratio of potters to consumers correlates with the standardization of ceramic assemblages. This hypothesis, however, is confounded by several other factors that also co-vary with metric standardization. Intended market, differences in manufacturing technique, and the potter's subjective opinion of how much variability is acceptable (Arnold and Nieves 1992), as well as the skill level of the potter (Longacre 1999), all affect the relative standardization of the ceramic assemblage. Although tentative, a measure of the standardization of ceramic assemblages is the best current way to assess the relative ratio of potters to consumers for any given product.

The *location of production* on the landscape is perhaps the most important variable to the current research. Costin also notes the importance of this variable, but instead refers to it as "concentration" (1991:25). This variable very closely weds production to distribution. The centralization of large-scale intense production at urban centers, for example, supports the urban-rural pattern introduced in the first chapter (discussed further below). If production of a certain ware were dispersed throughout a region, a centralized economic pattern for the distribution of this ware would be highly unlikely.

Location of production entities correlates highly with the *centralization* of distribution (Pool 1992:282). Polanyi (1957) first summarized differences in how exchange was instituted and defined market exchange, redistribution, and reciprocity. Each of these categories has been sub-divided into more specific types of exchange (Sahlins 1972, Earle 1977, Renfrew 1977, Hirth 1998). The point to be made for this paper is that each method of distribution corresponds to a different configuration of specialized production. Marketplace exchange is the most centralized form of market exchange (Hirth 1998, Blanton 1996, Plattner 1989). Marketplaces host a huge variety of goods that attract consumers from miles around. Although consumers may have to travel some distance to reach a market, all of their needs can be satisfied with a single trip. Large markets in urban centers draw in craft specialists because of the nucleated demand and means of exchange markets provide. Large marketplaces are thus indirectly evidenced by a difference in the scale and social context of craft production between urban centers and the rural countryside. A region united by itinerant merchants, on the other hand, would facilitate more dispersed production locations along major trade routes (Renfrew 1977). Barter is the most decentralized form of "market" exchange where transactions take place on an individual basis not tied to any particular location on the landscape.

If goods were exchanged primarily through balanced reciprocity (Sahlins 1972) a very dispersed pattern of production would appear within a region – this pattern might be difficult to distinguish from individual and dispersed barter exchange because the only difference is a delay in the return transaction. Community level specialization may actually be united through reciprocal relationships; this is evident in many Andean settlements (Meyer 2002) where kin groups interact to share resources found at different levels of the vertical archipelago. However, centralized redistribution may appear distinct from other forms of exchange. In centralized redistribution an official, elite, chief, or aggrandizer mobilizes the labor of a broader social group. If this labor mobilization takes the form of material commodities, these goods should be seen to flow into some central location. The Inka employed a redistributive economy that centralized wealth through force and territorial control (D'Altroy 1992). Earle argues (1977; and Daltroy 1992) that this redistribution was established under the ideology of multiple relations of centralized asymmetrical reciprocity. I would like to emphasize that both of these types of exchange display an inwardly focused economy where the centers are primarily consumers (see Rands and Bishop 1980 for an example from Palenque). Markets contrast this pattern because material flows out of centers in balanced transactions for something that rural producers bring there. Because the flow of goods into Matacapan is not known, the precise mechanism through which commodities were exchange is very difficult to assess.

Finally the *range* and *direction* of distribution characterize the distance commodities travel from the location of production to consumption (Pool 1990:282). As I discuss below, if the specific location of production can be identified, the range and direction of distribution may facilitate our ability to distinguish the zones of production and exchange. Conversely, the boundaries of these ranges may correlate with political boundaries or separate sub-regions that compete economically (Hodge et al. 1992). It should be noted that the range of distribution for a commodity might not be continuous across a landscape. Political control and economic interaction are often spotty, as demonstrated by the 'swiss-cheese' organization of the Aztec Empire (Berdan and Smith 1996). If the Aztecs were unable to conquer a territory, economic relationships were shut off. Hassig (1985) notes that enemy territories would kill Mexica merchants who wandered into their territory. Political integration therefore opens previously inaccessible market provinces.

Falling under the variable of direction, it is important to note whether goods are flowing into or out of centers. Palenque (Rands and Bishop 1980) was primarily a consuming population. This "inward looking" direction of distribution fits well with the idea that Maya centers were regal-ritual centers rather than mercantile based (Sanders and Webster 1988). Matacapan was most likely an "outward looking" center due to its heavy emphasis on ceramic production (Santley 1994, Arnold et al. 1993, Pool 1990, Pool and Santley 1992). The distribution of Coarse Orange should help to differentiate between these two interpretations.

Range and direction of distribution can also be affected by available modes of transportation. In Mesoamerica, rivers were often employed for faster and more efficient travel (Hassig 1985). Rivers directly channel the flow of goods in regions that utilize canoe transportation. Commodity distribution in these areas should follow the contours of major rivers. Marketplaces, on the other hand, draw upon a consuming population completely surrounding the center, unless interfered with by natural topography or political boundaries. Thus, marketplace exchange should not be restricted by the course of rivers. Centralized redistribution operates on a different rationale than any type of market exchange. Nevertheless, expansionistic empires, for example, may target certain areas for tribute extraction because of their position close to important resources, as with the Aztec empire (Berdan and Smith 1996). Alternatively, conquest may follow routes of transportation, and *vice versa*, to facilitate logistics – as with the Inka road system. With centralized redistribution, goods flowing out of centers should map onto territories integrated within the redistributive network. Again, the type of data needed to assess this for the Tuxtlas region is lacking.

Craft specialization within the regional political economy

Now that I have identified several dimensions of craft specialization that are of concern, I can move on to consider some broader aspects of regional economics. The compositional techniques employed in this thesis should allow me to assess the degree of centralization of Coarse Orange production and exchange in the Tuxtlas.

This study draws heavily on the concept of "central-place" (C. Smith 1976, Sanders and Webster 1988). While central-place systems are usually used to describe a market hierarchy (C. Smith 1976, M. Smith 1979, Santley 1994, Blanton et al. 1996), they appear independently of marketplaces in many societies (Sanders and Webster 1988). Therefore, central-places are not necessarily established through economic dominance. Centers are initially defined in the archaeological record according to their elevated position within the overall site hierarchy – where site hierarchy is ascertained using some measure of site or population size as well as concentration of civic-ceremonial or administrative architecture (Santley 1991, 1994; Santley and Arnold 1996, Sanders et al. 1979). Stark (1999) employs a related term, capital zone, in her distributional survey of la Mixtequilla to describe dense concentrations of occupation. The root definition of "central-place" simply refers to a location on the landscape that was held to be important for some social, religious, or economic reason. These are places with relatively high population density, which often host a range of specialized professionals that interact to fulfill positions in each major sector of society: economic, ceremonial, and political.

Central-places' roles in regional economies are still not well understood, partly because of this great diversity. Regardless of the function of centers, they are all very active in the regional organization of commodity production and distribution. Population contrasts between the centers and the countryside make central-places major consumers, major producers, or both based on demographics alone. Regal-ritual centers (Sanders and Webster 1988), for example, house elites who integrate the region through ceremonial display. While they may contain attached specialists who provision elites with various goods, no large-scale independent producers should occur within these sites. Elites in regal-ritual centers probably mobilize (Earle 1977) most of their utilitarian goods and food from supporters throughout the countryside. Rands and Bishop (1980) show that utilitarian ceramics produced in the countryside around Palenque, presumably a regal-ritual Mayan center, flowed into this center. Previous research on the ceramic production system at Matacapan (Santley et al. 1989, Pool 1990, Pool and Santley 1992, Arnold et al. 1993, Santley 1994), however, suggests that Matacapan was probably not exclusively a regal-ritual central-place – although it certainly did have ceremonial functions.

Matacapan instead invested considerable energy into various craft specializations. Although craft production occurred frequently in other centers, villages and hamlets in the Tuxtlas, Matacapan clearly invested more labor in ceramic production than any other site. The general pattern of larger-scale and more intense production in the region's principal center than at any other site supports the pattern observed in the Basin of Mexico. Brumfiel (1991, 1987) argues that high-ranking sites in political and market hierarchies tend to absorb commercial activity in the surrounding region. Craft specialists were taking advantage of the diversity of goods, the high populations, and access to an efficient mechanism of exchange in large market centers in the Basin of Mexico. As a result, craft production in large market centers tends to suppress commercial activity in the hinterland sites, which turn to agricultural specialization. Hinterland dwellers then need to rely on centrally produced goods for their utilitarian and service needs.

Although Brumfiel’s argument that commercial activity in central-places suppresses rural production has been supported in many cases, it oversimplifies regional relations of production and distribution. Very rarely does a center completely divert control over the region’s craft economy away from rural sites and smaller centers. Rural production generates competition for the urban craft economy and works to decentralize commercial activity away from the principal center. Furthermore, the apparent difference in scale and intensity of production between rural and urban sites may result simply from difference in demand as seen by varying population densities. The tension between rural and urban production can be seen in the regional distribution of commodities by delineating zones of production and exchange defined by compositional patterns.

A “zone of production and exchange”, as used in ceramic sourcing studies, is a definite geographical space that delineates the core distribution of a particular compositional group. Production of the ware in question is presumed to occur somewhere within that geographic zone. Centers are usually credited with this production, but in the case of an “inward-looking” (Rands and Bishop 1980), or decentralized economy, production could be distributed throughout the countryside. If production data are available, archaeologists can be more precise in identifying possible centers of production within these zones. Constructing fall off curves (Renfrew 1977) from the presumed origin of a ware is one potentially revealing way to define centers of production. Renfrew states that a center of production will contain the highest proportion of a commodity and that frequency will "fall-off" as one moves from the center of production out (1977). The reason for this fall-off in frequency is the cost of transportation and the demand of settlements that exist closer to the center. As sites close to the center consume the product in question, less is available for sites further away. In short, sites that contain a heterogeneous compositional profile are thought to have been situated somewhere between two major centers of production. Alternatively, they could have produced ceramics locally using different clays. A detailed analysis of ceramic production evidence should provide the means to discriminate between these two alternatives.

Feinman et al. (1984, 1992) posit a framework that is very useful for testing the degree of economic centralization using compositional perspectives. They suggest that the number of producers manufacturing a ceramic should be evident in the overall variability of the assemblage. This derives from the likelihood that every producer generates a product that is in some way different from another producer making the same craft. Added up, all of these producers in combination will affect the variability within the total assemblage. The more potters manufacturing Coarse Orange, for example, the higher would be the variability of that ware. We can employ this principle to understand variability within each compositional group (Feinman et al. 1992) to determine the relative number of producers making each variety of that ware. If Coarse Orange were produced in a small number of relatively large-scale specialized workshops, one would expect that group to be comparatively homogeneous in relation to a compositional group produced by many small-scale producers. A coefficient of variation is employed to test the nature of Coarse Orange production in the Tuxtlas.

Feinman et al. (1984) further argue that with political integration comes a decrease in competition among producers in a region. Zones of production and exchange can evidence competition for a ceramic's "market" within a region. If Feinman et al. (1984, 1992) are correct, many individual zones of production and exchange would indicate a lot of competition, and thus a lack of political integration. Conversely, a single compositional group for the ware in question would suggest either homogeneity in raw materials and recipes employed to produce that ware, or complete political integration of the entire region. Again evidence of the patterning of known production localities should help to discriminate between these two possibilities.

All of these concepts converge on an approach to regional settlement that attempts to discern the nature of differential site development. We can determine the role of ceramic production at Matacapan by mapping the geographic distribution of zones of production and exchange. If this site possessed control over the Coarse Orange economy in the Tuxtlas they should be the center of a large zone of production and exchange that covers much of the region. Of course, this will not determine the direction of exchange: either inward toward Matacapan or outward from Matacapan to the surrounding region. Differences in the scales of production provide clues to who were the major suppliers of Coarse Orange in the region, but do not, by themselves, reveal the direction of resource flow. Investigating the modes of transportation is another approach. Access to efficient modes of transportation may facilitate the likelihood that a site could be the center of production for a particular compositional group. Finally following Feinman et al. (1984, 1992), a high degree of compositional homogeneity indicates production of a ware in a small number of relatively large-scale industries. None of these approaches provides unambiguous evidence for the organization of ceramic economies, but the more variables one uses the stronger the argument becomes.

Mapping zones of compositional production and exchange in this way provides the means to measure the degree of centralization of the ceramic economy in question. Obviously, compositional groups not matching that for Matacapan did not originate from this center. Instead, zones of production and exchange differing from Matacapan indicate areas of the Tuxtlas that did not fall within Matacapan's influence. Different zones could correspond to different polities or different market territories; the important point is that they represent the boundaries for the exchange of the ceramics in question. These boundaries cannot otherwise be reconstructed within a homogeneous stylistic group of ceramics. Although many studies must be conducted with various commodities to paint a complete picture of ancient economics, this research begins by evaluating the distribution of a single common ceramic ware in the Tuxtlas. At the very least, I should be able to determine whether or not Matacapan was a center with regard to Coarse Orange production and distribution. I should also be able to determine the degree of economic influence they had within the region by delineating areas of the Tuxtlas that did not engage in Coarse Orange exchange with Matacapan. I detail two Mesoamerican examples of economic reconstruction using compositional techniques below.

Pottery exchange, economic competition, and political integration in the Basin of Mexico

A comparison of Postclassic central Mexico with the Classic period Tuxtlas is appropriate in this research for several reasons. First, settlement patterns between the two cultures were similar. Both possessed hierarchical site rankings based on overall size, suggesting that centers drew upon a supporting hinterland: whether they were integrated through market exchange or some other form of social interaction. Second, the Aztec displayed heavy dependence on both markets and tribute (a form of centralized redistribution). This should minimize the bias otherwise introduced by comparison with a primarily marketing society. Third, Postclassic central Mexico has undergone several compositional studies that address similar question to this research.

Several factors, however, prevent a direct comparison between the two regions. First, although the Valley of Mexico and the Tuxtlas cover similar areas, the former was the center of Mesoamerica's largest expansionistic empire. The Tuxtlas were involved in a Classic period world-system (Santley and Alexander 1996), but they were considered part of the "periphery" rather than the core. Second, the Valley of Mexico was integrated through a complex market system, while data to evaluate this possibility are not available for the Tuxtlas. Regardless, the intraregional patterns of production and exchange in the Postclassic Valley of Mexico remain a valid comparison to intraregional patterns in the Tuxtlas. I am only concerned with exemplifying site level interaction where compositional research has been performed previously.

The Aztecs employed an extensive market system to integrate the diverse economies in the empire and demanded tribute from their periphery (Carrasco 1999, Blanton 1996, M. Smith 1979, Brumfiel 1991, Hodge et al. 1992, Hodge and Minc 1993). The capital cities of Tenochtitlan/Tlatelolco and Texcoco sponsored daily markets, and smaller centers throughout the Basin of Mexico held periodic markets that met every 5, 7, 9, or 13 days (Hassig 1985). The benefactors of market systems were the rulers of towns where they were held (Blanton 1996). Aztec *tlatoque* (rulers) taxed transactions that took place in the marketplace, and strictly forbade exchanges outside the market (Blanton 1996:52). Furthermore, the Aztec bypassed local rulers by establishing markets at tribute collection points (Hicks 1987:101). Subjects in tribute provinces could bring locally produced goods and exchange them in the market for items required by the Aztec for tribute. Furthermore, the influx of wealth at centers due to tribute fostered craft production and exchange (Brumfiel 1991). These activities in combination contributed to enhanced commerce in centers as opposed to the rural countryside.

Periodic markets located at each major center in the Basin of Mexico controlled a hinterland radius of about 10 km, and each market territory specialized in the production of a slightly different gamut of goods (Blanton 1996:51). Of course, the daily markets at Tenochtitlan/Tlatelolco and Texcoco centralized high proportions of economic activity and hosted the greatest variety of goods from all over Mesoamerica.

Brumfiel (1980, 1987, 1991) has argued that the clustering of large populations at urban centers and the development of this market hierarchy led to the suppression of craft production in smaller sites throughout the Basin of Mexico. Her examples from Xico, Huexotla, and Xaltocan support this trend by showing a decrease in commercial activity as they came under the influence of the Triple Alliance. The reasons behind this suppression of rural craft production were discussed in the previous section.

Crafts producers would have left these rural sites for the economic advantages of urban markets (e.g. higher demand, more efficient methods of exchange and transportation). Xaltocan, in particular, was a marketing center in the Early Aztec phase of the Late Postclassic period, but, with their incorporation into the empire and obligation to give tribute to their new rulers, market activity declined and shifted to the Aztec capitals (Brumfiel 1991). Whether the emigration of craft specialists caused this decline in market activity or vice versa is not important. The salient point is that the political integration and the development of large urban centers tend to centralize economic production and exchange so that a decrease in craft production was seen in rural areas. The marketplace at Tenochtitlan/Tlatelolco attracted buyers and sellers from all over the empire (Blanton 1996). It follows that the largest-scale and most intensive producers of various commodities would have been located there. This feature can be diagnostic of marketing systems, and may provide a way to assess the presence or absence of marketplaces. But, it must be demonstrated that commodities produced in the center were traded to other communities. Furthermore, we must not assume that this effect was pervasive throughout a whole territory without the empirical evidence to support it.

The Basin of Mexico was very fragmented politically and ethnically prior to Aztec incursions (Brumfiel 1994, 1987:677-678). Even under Mexica rule (the ethnic group that dominated the Aztec empire), ethnic factions continued to have provincial influence in their local economies. Although the Aztecs greatly centralized the economy, smaller centers continued to exhibit specialized economic activities and local spheres of exchange. This raises the question of whether or not commodities found throughout the Basin were created at a single site or dispersed throughout various localities. Mary Hodge and Leah Minc have conducted several studies on various ceramic wares encompassing stylistic and compositional approaches that address this question.

Hodge and Minc (1990) began to reconstruct patterns of exchange by sampling decorated ceramics and separating them into distinct wares and types from the Early Aztec to the Late Aztec period. This treatment of exchange relations strongly reflected the changing configuration of political integration. The Early Aztec patterns reflected political fragmentation of the eastern Basin of Mexico through a distribution of wares that suggests neighboring city-states exchanged with each other much more frequently than with those more distant. The authors also propose that this pattern reflects the layout of overlapping local market systems (1990:429-432). Early Aztec wares "fall-off" in frequency with increasing distance from areas of greatest concentration – indicating decentralized market exchange occurring within a series of small overlapping market territories. Further, Hodge and Minc (1990:432) argue that the distinct patterning of Early Aztec wares indicates confederation boundaries in the eastern half of the Basin. This coincides with Feinman et al.'s (1984) argument for a correlation between commercial activity and political integration.

In the Late Aztec period, when all polities in the Basin of Mexico were integrated under a single political regime, two distinct ceramic production and exchange systems were observed. First, Tenochtitlan Black-on-Orange and Black-on-Red were distributed through the entire Valley of Mexico. They thought that this indicated centralized production and exchange of these wares focused on Tenochtitlan, but later adjust this conclusion using compositional perspectives (Hodge et al. 1992, 1993). They also conclude that Black-and-White-on-Red displayed a localized distribution in the southern portion of the study area. It was argued that the political unification of the Basin encouraged exchange between previously confederated areas. Following Brumfiel's (1983, 1991) assertion that craft production was suppressed in rural areas in the eastern Basin of Mexico during the Late Aztec period and the recognition that ethnohistoric documents suggest that craft specialists moved to the capital (Sahagún 1950:82 Book 9:80), these data seem to support the idea that large market centers absorb a majority of craft production within a region. To test the hypothesis that Tenochtitlan centralized the regional production and distribution of Black-on-Orange wares, compositional analyses were conducted.

Contrary to their previous conclusions (1990), the Black-on-Orange wares yielded four distinct compositional groups in the eastern Basin, including a Tenochtitlan group with restricted distribution; this suggests four distinct zones of production and distribution with some interaction between them. These data tend to refute the pattern expected: that Tenochtitlan was the origin of this ware and traded it to the entire Basin. Hodge et al. (1992, 1993) emphasize the importance of considering economic competition and factionalization even when all other data point to a very centralized economy. Although some Tenochtitlan Black-on-Orange was exchanged to other parts of the Basin, they had to compete with other producers. Texcoco, Tenochtitlan's political ally to the northeast, seemed to have considerable influence in the eastern side of the Basin of Mexico. This may have corresponded to their high-ranking daily market, second in size only to the market at Tenochtitlan/Tlatelolco. So even in politically unified regions, economic competition exists.

One possible explanation for the competition within a politically unified territory is the indirect nature of Aztec political administration. The Aztecs relied heavily upon preexisting hierarchies to mitigate the responsibilities of direct territorial control (Hassig 1985, 1988; Luttwak 1976). The Aztecs left local rulers in place but secured their political loyalty through threats of force (Hassig 1988), elite gift giving (Brumfiel 1987), and by backing local elite's power and tribute collection abilities. The relative political autonomy given to local elite would have corresponded with some economic autonomy as well. The city-state model proposed for the Basin of Mexico (Charlton and Nichols 1995) may provide a good explanation of this relative political and economic autonomy.

Economic competition, and specialization in ancient Oaxaca

The Valley of Oaxaca evidenced a long history of occupation. Settlements clustered distinctly in the three arms of the Valley. While Monte Alban integrated the Valley politically in the Classic and Early Postclassic periods, the Late Postclassic was divided into small semi-autonomous polities and petty kingdoms (Kowalewski et al. 1989; Marcus 1989; Feinman et al. 1992) I wish to present two studies (Feinman et al. 1984, 1992) that attempt to reconstruct pottery economics in the regions. This example, again, does not provide a direct comparison of economies to the Tuxtlas, but it does show how the concepts discussed above can be applied to a regional economy.

Feinman et al. (1984:301; 1992), argue that population, household time budgets, and political consolidation all positively influence the scale of pottery production but correlate negatively with the level of competition in a region. They argue that these things can be inferred through the standardization of ceramic assemblages and the amount of work investment. Although I generally agree with their statements, I prefer to look at the model as a reflexive relationship between variables. The decisive power of the potter and political elite make craft specialization an active influence in other aspects of the political economy (Brumfiel and Earle 1987). Increasing the scale and intensity of ceramic production is one strategy employed to out-compete other potters in the region. Suppressing the competition in effect creates a dependence on centers for that ware.

Centralizing control of the economy in this way provides a path to regional political consolidation. Feinman et al. (1984), following Brumfiel (1980), suggest that political integration actually enhances the centralization of economy and decreases the level of economic competition in an area. They employ the production step measure, which provides a quantification of the amount of labor invested in ceramic production from raw material procurement to decoration, and construct an analysis of ceramic heterogeneity/homogeneity to characterize the relative specialization in ceramic production throughout the Valley, over time. They argue that a homogeneous ceramic assemblage indicates large-scale production by a small number of specialized producers. This argument is persuasive because each potter potentially manufactures vessels differently from each other. When considering an assemblage of pottery that derives from a number of producers, individual variability should appear in the complete assemblage as relative heterogeneity compared to assemblages that derive from only a few potters. In addition, the routinization of procedures involved in specialized production may also facilitate a homogeneous assemblage. These inferences are not without problems, though. It should first be noted that potter skill positively correlates with metric standardization of vessels

(Longacre 1996). This is true irrespective of scale or intensity of production. Second, an attempt to maximize output of pottery in large-scale industries may also increase variability due to hasty execution. Dropping, for a moment, the notions of scale and intensity of production, I believe that the raw number of potters manufacturing ceramics will affect the variability of the final product because of individual differences in procedure, as Feinman et al. (1984) suggest. This does provide a means to measure the general nature of ceramic production (e.g. specialized versus unspecialized) from the composition of a sample of sherds.

Feinman et al. (1984) further argue that increased investment in decorating pottery represents a high level of economic competition in a politically fragmented region. Although problematic for several reasons, their results are revealing. Feinman et al. (1984) show that vessel standardization increased with political integration by Monte Alban. Much like Brumfiel (1987, 1991) they argue that large-scale production is responsible for ceramic standardization because it suppresses competition throughout the Valley, and that political integration was the impetus for this centralization of commerce.

Later, Feinman et al. (1992) follow up their previous research with a petrographic, stylistic, and technological analysis on pottery firing. This study focuses on the politically balkanized Late Postclassic period. Although the region was not incorporated under a single polity in this time period, there were several important centers in each arm of the Valley. The densest population was evident in the Tlacolula arm of the Valley (Feinman et al. 1985), which was also the driest and had the poorest soils for agriculture. Miriam Stark (1992) has argued that areas of marginal agricultural activity spawn community specialization in craft production as an alternative. Laura Finsten argued that Tlacolula was the most commercialized arm of the Valley because of low returns to agricultural labor (1983). Later investigations identified 7 out of 16 Monte Alban V production loci in this arm (Kowalewski et al. 1989 Figure 10.9, Feinman et al. 1992:240).

To test the hypothesis that Tlacolula was the most commercialized area in the Valley of Oaxaca, Feinman et al. (1992) turn to compositional and technological analyses to measure the degree of standardization in the Postclassic gray wares. If larger-scale industries produced ceramics in Tlacolula, ceramics sampled from that sub-region should evidence greater standardization (1992:241). A few potters producing with similar recipes in large-scale industries should reveal greater paste homogeneity through petrographic analysis than a large number of producers manufacturing ceramics with different recipes. Feinman et al. (1992:243) note that even if each small-scale producer manufactured standardized pottery, the shear number of producers in this case would introduce significant variability in recipe when examined on a regional scale. The authors conclude that ceramics from the Tlacolula arm of the Valley had more standardized pastes, were fired at an average of 100 degrees hotter temperatures (i.e. suggesting kiln use), and were traded to other parts of the region. Mass-production of Tlacolula wares was further evidenced by a vessel form analysis that showed the majority of Tlacolula wares were "stackable", thought to facilitate transportation.

Summary

The theory discussed above and the two case studies delineated here supply a number of hypotheses that can be tested in the current research. Matacapan displays some instances of the largest-scale ceramic production in the Tuxtlas. Comoapan was the largest scale producer of Coarse Orange at Matacapan, which presents the possibility that it was also the largest single producer of Coarse Orange in the Tuxtlas. If this last statement is true, it is likely that Comoapan supplied a major portion of the Tuxtlas with Coarse Orange. The compositional signatures of Coarse Orange sampled throughout the region in this situation should not only match compositions of the Comoapan "control group" but these wares should also display less variance than ceramics not originating from Matacapan. If there was a large-scale ceramic manufacturer outside of Matacapan that employed different recipes detectable through the combined approaches of INAA and petrography, the current analysis should reveal a compositional group equally homogeneous to Matacapan. If these non-Matacapan groups pattern distinctly over the landscape, we may infer that Matacapan had competition for the production and distribution of Coarse Orange in the Tuxtlas. Further, these compositional zones of production and exchange should help locate unknown centers of production through the use of fall-off analysis.

If Matacapan did indeed dominate the Coarse Orange market, the majority of sherds sampled should fall into the Matacapan compositional group. This would also bolster an argument that Matacapan was the dominant economic center in the Tuxtlas and they integrated the region under one political hierarchy (Santley 1994). Conversely, compositional zones with distinct geographic patterns would indicate areas in political and/or economic competition with

Matacapan. More specific hypotheses, along with their compositional correlates, are developed further at the end of Chapter 4 (see also end of Chapter 1).

Chapter 3

RESOURCE PROCUREMENT IN THE TUXTLAS ENVIRONMENT

The Sierra de los Tuxtlas is an isolated range of volcanic mountains situated on the otherwise flat lowlands of the southern Gulf Coast of Veracruz. The settlement patterns in the Middle Classic Tuxtlas owe much to this environmental setting. The Tuxtlas add diversity to the relatively homogeneous environment in the surrounding tropical lowlands. The mountains host fertile alluvial soils, basalt outcrops, tertiary clay formations that produce fine pottery, some moderately prestigious materials, and many sources of water and water transportation. Matacapan sits close to the origin (Laguna Catemaco) of the Tuxtlas' largest river, Rio Catemaco, which not only provides a source of water but also a route of transportation connecting the region to the southern lowlands – which possibly facilitated interaction between these areas.

Beyond Matacapan, various physiographic and geological zones divide the region. This natural heterogeneity provides insight into economic interaction through compositional analyses of clays, ceramics.

Physiography

Four major volcanoes constitute the Sierra de los Tuxtlas massif but hundreds of small cinder cones, many of which erupted within the last 10,000 years (Santley et al. 2000), dot the landscape. Moving from northwest to southeast, three shield volcanoes protrude from the landscape: San Martín Tuxtla, Santa Marta, and San Martín Pajapan. The fourth volcano is an eroded cone, Pelon, which lies south of the previously mentioned shields (Pool 1990:141; Reinhardt 1991). The highest peaks in the Tuxtlas – San Martín Tuxtla and Santa Marta – reach 1700m above sea level.

Volcan San Martín Tuxtla is the youngest volcano in the region, and the most recently active (Santley et al. 2000; Reinhardt 1991). To the southwest sits a smaller and older volcano, Cerro el Vigia. Williams and Heizer (1965:4) determined that this volcano supplied most of the material (basalt) for stone monuments found at Tres Zapotes.

Several rivers dissect the Tuxtlas Mountains. The region's largest, Rio Grande de Catemaco, originates at Laguna Catemaco, Mexico's third largest lake. This river has cut into a valley full of alluvium and volcanic ash deposits, which runs southwest (south of Volcan San Martin and west of Laguna Catemaco). To the north and west of Laguna Catemaco, several smaller rivers drain the San Martin volcano and Cerro el Vigia. These mountain drainages generally run south toward Santiago and San Andres Tuxtla and west toward Tres Zapotes.

Climate and Vegetation

The Tuxtlas host a tropical climate. Temperatures are hot (mean annual temperature between 22 and 25 degrees C) and humidity is high (Garcia 1970, Vivó Escoto 1964:207). The Tuxtlas experience heavy rains, which average over 1800 mm per year in the southwest Tuxtlas (Vivó Escoto 1964 Figure 10, Pool 1990:144). However, rain does not fall evenly all over the Tuxtlas. Because wind currents move from the Gulf southward towards the Tuxtlas, the northern slopes of the volcanoes get the heaviest rain: up to 4000 mm per year. Santiago Tuxtla, San Andres Tuxtla, and Tres Zapotes fall under the rain shadow created by the Volcan San Martin Tuxtla and receive about half the total rainfall that of the northern slopes of San Martin. While orographic precipitation is more consistent year-round, rainfall in the southern Tuxtlas occurs on a more seasonal schedule: occurring most heavily during June through December. Heavy rains would make it very difficult to produce pottery during these seasons because of the difficulty involved in drying fuel and vessels (P. Arnold 1991; also see D. Arnold 1985). January through March are considerably dry for the region, although polar air masses from the north often drop temperatures and cause intensive rain during these winter months (Gomez-Pompa 1973:82, Pool 1990:145). Pottery production was probably at a high in the dry season due to availability of dry fuel (P. Arnold 1991) and because annual agricultural demands were not yet that time consuming (Killion 1990).

Given the variability in rainfall and elevation, the Tuxtlas are home to a variety of vegetation. Most of the Tuxtlas, at elevations below 900 m, are tropical forest. Gomez-Pompa (1973:105) refers to this vegetation zone as “selva”, which is dominated by several species of tree. Forest, on the other hand, is usually dominated by one or two tree species (Gomez-Pompa 1973:105; Pool 1990:145).

Gomez-Pompa (1973) divides the Tuxtlas into three vegetation zones: high evergreen selva, high semi-evergreen montane selva, and low evergreen selva. In the high evergreen zones (below 700 m elevation and between 2500 and 5000 mm of rainfall) dominant tree species grow-up to 25 m tall and include *Bernoullia flammea, Brosimum alicastrum* (breadnut tree or Ramon), *Ficus tecolutensis* (*cedro,* which is not like the cedar tree in the United States and Canada), and *Pseudolmedia oxyphyllaria* (Gomez-Pompa 1973:111). These trees grow in brown andosols in the Tuxtlas that derive from volcanic ash weathering. High semi-evergreen montane selva (between 700-900 m elevation in areas of more than 1800 mm precipitation) is dominated by *Brosimum alicastrum* and grows in more rocky well-drained soils than the high evergreen selva. Low evergreen selva is only found at the summit of the volcan San Martin Tuxtla and possibly Santa Marta. This selva is similar to a "cloud forest" with small but very dense forest and many epiphytes, mosses and lichens (Pool 1990:146; Gomez-Pompa 1973:119).

Gomez-Pompa also notes the presence of a transitional zone of vegetation between the high semi-evergreen and low evergreen selvas. This zone contains *Liquidambar macrophylla* (sweet gum), *Quercus skinneri* (mountain oak), *Ulmus Mexicana* (Mexican elm) and *Meliosa Alba* (Gomez-Pompa 1973:104). Liquidambar resin was used by Aztec doctors as an expectorant and oinment, and would be mixed with salt and white jade to become a tooth filling (Lackey 1986:214). Stark (1978:204) observes that *xochiocotzol*, liquidambar, was a major tribute demand of the Tochtepec province (which may have included the Tuxtlas [c.f., Berdan 1996) by the Postclassic Aztecs.

Aside from non-domesticated plant species, several domesticated species were cultivated in the region. Maize, beans, and squash were staple foods grown in Veracruz, and throughout Mesoamerica. Other domesticated and non-domesticated foods that grew in southern Veracruz were tomatoes, guava, avocado, cacao, amaranth, chile peppers, papaya, and peanuts, among others (Coe 1994). Cotton, which was the favored fiber for spinning weaving thread for cloth weaving, grew well in the hot humid climates of southern Veracruz (Stark et al. 1998).

Geology

The geology of the Tuxtlas is very important to my consideration of pottery economics. First, high-quality clay was, and still is, available for making pottery. Selection of clay will affect the chemical and mineralogical composition of the pot. Second, the alkali basalt volcanic ash used as a temper differs from other types of volcanic ash typically found in Mesoamerica. It is crucial to understand these resources because they provide essential data for sourcing ceramics in the region. Third, proximity to clay outcrops provides information that helps elucidate the reasons for one site to specialize in pottery production while another did not. I will begin with a geological overview of the region, followed by more specific discussions of clay and ash resources.

Ríos-Macbeth (1952:328) identifies the geological formations of the Tuxtlas as, from oldest to most recent: La Laja, Depósito, Lower Concepción, Upper Concepción, and Filisola. Because of the slight gradational transitions between the La Laja, Depósito, Lower Concepción and Upper Concepción "formations", they are perhaps better characterized as biostratigraphic zones (Pool 1990:149; Strachan 1986:32; Kohl 1980:30). Plio-pleistocene and newer volcanic rocks have formed on top of these older horizons (Pool 1990:148). Pool (1990:307-314) established that Coarse Orange was manufactured from Concepción clays rather than the smectite clays found around basalt outcrops that were probably used for other wares, including Coarse Brown. Since the Concepción zone provided the source of clays used by prehistoric Coarse Orange potters (Pool 1990:307-314) and modern potters (P. Arnold 1987:76) in the Tuxtlas, I will describe these strata at some length.

The Concepción strata are Tertiary marine sediments composed primarily of kaolinite clay minerals. Concepción clays are distinguishable from Filisola because the latter contain more sands and sandstone. Filisola sands are the most accessible Tertiary formations in the Tuxtlas because they are the most recent. The Concepción, however, outcrops at several places where river valleys cut through Filisola and volcanics to the Concepción. The Concepción strata gradually transition into Filisola, thus clays taken from the top of the Upper Concepción should portray some of the characteristics of Filisola strata. This provides an interesting source of stratigraphic variation that may benefit my ability to source Coarse Orange. Those latest Upper Concepción clays should have large, rounded, quartz and sandstone inclusions; therefore, ceramics made from these clays will also possess these minerals and rocks. One problem with this assumption when considering ceramics is the possibility that some quartz or sandstone was added as temper. Many of the petrographic characteristics previously argued by archaeologists to indicate the addition of temper (Stoltman 1989, 1991) do not apply here because the Filisola sands may be fine enough to add without crushing the temper first. Crushing, however, would still be beneficial because it would add strength to the paste (Skibo 1992). Stratigraphic variation between Concepción and Filisola deposits may still be evident in the ceramics by comparing natural inclusions in the clay matrix. Upper Concepción clays that occur close to the

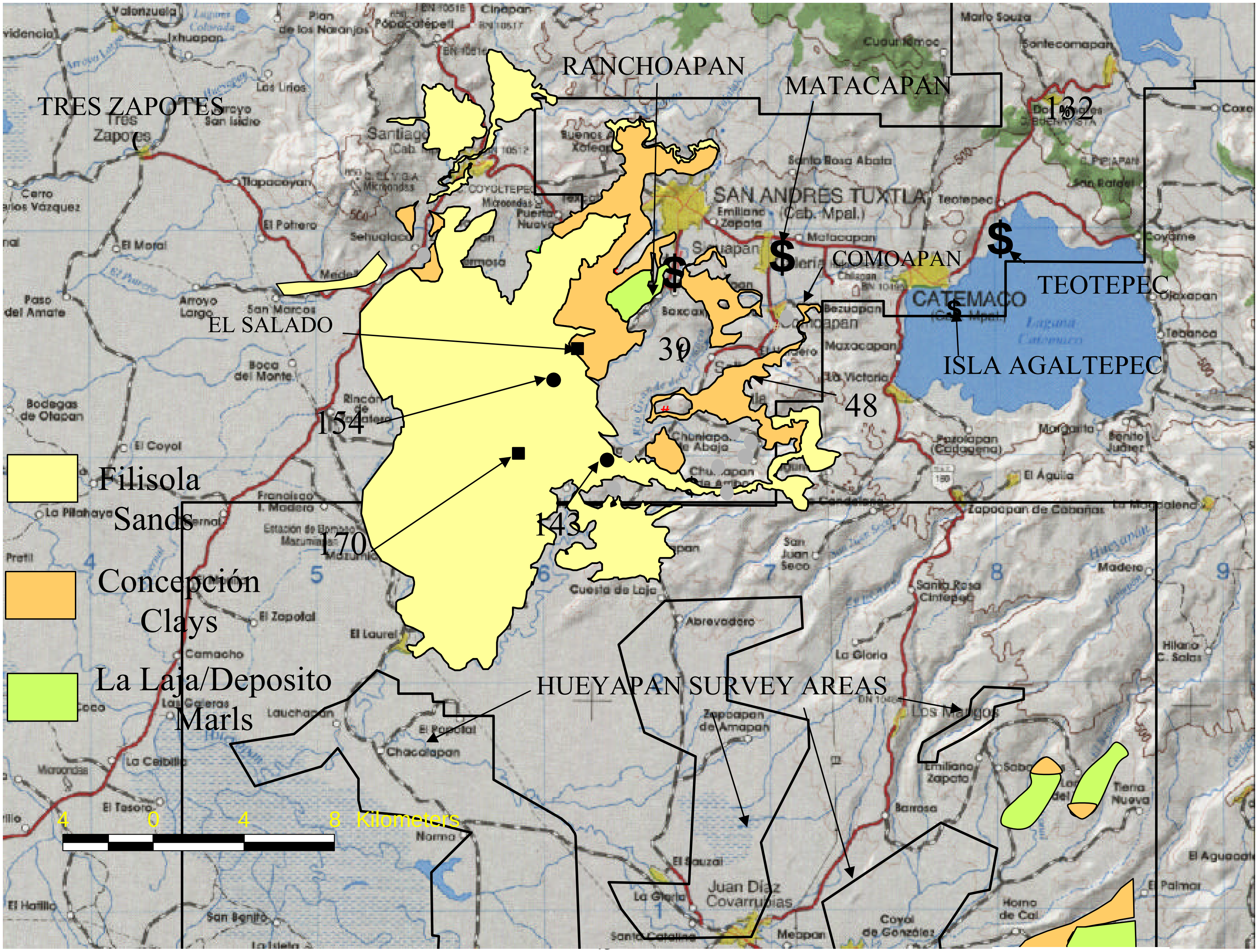
Filisola transition should possess some of the coarser quartz and sandstone grains that appear in the Filisola formation. Upper and Lower Concepción are also distinguishable by their calcium content. Lower Concepción generally has higher concentrations of calcium, which may result from dilution of calcium in Upper Concepción by frequent inclusions of quartz sand.

The clay formations discussed above appear on the surface in distinct areas of the Tuxtlas (Map 3.1). These outcrops can be examined in relation to human habitation to determine the sites that had access to specific resources. The central Tuxtlas around Matacapan is primarily composed of tephra and alluvium that overlay the tertiary marine deposits. However, the Upper and Lower Concepción, are exposed in the valley directly adjacent to the western extent of Ranchoapan. Ceramic production at Ranchoapan would have certainly utilized these resources. On the other side of this outcrop, El Salado, a major producer of ceramics was closest to Upper Concepción deposits. Matacapan was also within one kilometer of these outcrops and a small Upper Concepción resource just north of San Andres. Comoapan occurred right next to a Lower Concepción outcrop that extends south. In general, Matacapan was within 1 or 2 kilometers of all of the major clay outcrops in the central Tuxtlas. However, El Salado and Ranchoapan were other known ceramic producing sites that could have accessed these same resources. Site 132, Teotopec, and Isla Agaltepec could have also procured these resources, but they would have traveled considerably further than the aforementioned sites.

Further south, Upper Concepción clays appear to the north and south surrounding Chuniapan de Abajo. Apomponapam was situated in between this outcrop and another just to the east where both Upper and Lower Concepción appear. Apomponapam displayed evidence of production.

Sites 170 and 154 to the west of the surveyed area were not very close to any of the Concepción outcrops mention above. Further to the west, Tres Zapotes was even farther removed from the nearest Concepción clays available near Matacapan. These distant sites would be the most valuable indicators of trade from Matacapan because of their unlikely exploitation of the same resources.

Map 3.1. Showing the distribution of Concepción sedimentary outcrops (Pool and Santley 1992: Figure 9.1; Rios-Macbeth 1952)



Moving into the Hueyapan survey area, only two small outcrops of La Laja and Lower Concepción occur to the far eastern extent of the sampled collections. Settlement in the western half of the Hueyapan survey falls onto the lower lying alluvium where Concepción outcrops were more rare. I suggest that ceramic production in the eastern half of the survey area would be more prominent than in the west for this reason.

In all, many sites in the Tuxtlas had access to clay that could yield Coarse Orange compositions similar to that produced at Matacapan. However, the reader should bear in mind that the Concepción formation varies within stratigraphic levels as well as over space. Mineralogical and chemical results should be useful in identifying sub-groups within these resources and in the ceramics sampled. Clays taken close to the Filisola outcrops should evidence a coarser texture than those from the lower Concepción. Furthermore, data on ceramic production presented in the next chapter will also provide the means to reduce possible sources of Coarse Orange production for the sherds sampled.

Pool initiated a geological survey in 1987 with the objective of chemically characterizing the region's natural clay resources to better understand pottery resource procurement in the Tuxtlas. Pool aimed his reconnaissance at detecting chemical variation within the Concepción formation using X-ray fluorescence analysis. This yielded compositional variation in the following elements measured in his study: major elements Si (silicon), Ti (Titanium), Al (aluminum), Fe (iron), Mn (manganese), Mg (magnesium), Ca (calcium), Na (sodium), K (potassium), P (phosphorous), and trace elements Zr (zirconium), Y (yttrium), Sr (strontium), Rb (rubidium), Zn (zinc), Cu (copper), Ni (nickel), Cr (chromium), and V (vanadium) (Pool 1990:308). Pool's statistical analysis isolated four clay groups based on chemical composition (Map 3.1). Group S (named for its proximity to the modern community of Sehualaca) scored negatively on the first principal component, which was most strongly influenced by Ca, Na, and V. PC 1 separates Group S (lower concentrations of Ca, Na and V) from Group C and M, based on relative concentrations of Ca. Pool notes that Groups S clays are coarser than Group C or M. This might be explained by their vertical position within the Concepción formation. Since these clays were situated stratigraphically close to the Filisola formation one would expect them to be lower in Ca and have more coarse quartz and sandstone inclusions, as seen above.

Group R, situated near the modern community of Ranchoapan, had a very distinct composition which Pool argues resulted from contamination by basalt (1990:310). Only two samples were assigned to the R group, and both contained "large portions of basalt grains in their coarse fractions" (Pool 1990:310).

Group M, named for proximity to the modern community of Miltepec, was distinguished from the other groups because they scored lowest on PC 1 and probably contained more Ca than any other clay. Group C, named for proximity to the modern community of Comoapan, scored in-between Groups M and S on PC 1 (Pool 1990:376). Potters at Matacapan preferred this last group, Group C, during the Classic period (Pool 1990:309-310).

Looking at how these clay groups pattern over the landscape should enhance our ability to more specifically identify the source of pottery production. Group S clays pattern to the west of the study region. Of the sites sampled in this study, El Salado, Tres Zapotes, Site 154, and Site 170 were situated in the best position for exploiting this clay resource. However, Site 154, Site 170, and El Salado all could have also easily accessed Group C or M clays. Group C occurred entirely to the eastern side of the study area and Group M seemed to divide the major occurrences of Groups C and S. These "border" communities represent the best opportunities for inferring the specific choices potters made when producing Coarse Orange. Because of their placement within reach of all four clay groups, their preference of clay for pottery manufacture, or ceramic procurement through trade, should be evident in the composition of ceramics. Matacapan had immediate access to at least two resources. Since production contexts were sampled at Matacapan, their selection of materials for Coarse Orange production can be evaluated here. Pool (1990:310) has previously argued that they used Group C clays.

Group Z was also defined by Pool, but it is best referred to as a sub-group of S that clusters entirely in the eastern half of the study region (Pool 1990:310). Although I did not perform INAA on any of these Group Z clays, I mention its occurrence here because a difference may be evident in the mineralogy or texture of ceramics made using these clays as seen by the petrographic point-counting.

Volcanic ash presents an entirely different situation than clay resources. My major concern for the volcanism of the Tuxtlas for this research is in the distribution of ash exploded from the volcanoes. The Strombolian eruptions, low in SiO_2, that occurred most recently in the Tuxtlas were of a very explosive and gaseous variety (Santley et al. 2000). This translates into a polymineralic ash that is basically exploded basalt and contains high quantities of plagioclase, pyroxenes, and olivine. Due to the Strombolian nature of the eruptions, little to no quartz should be evident in the ash found in the central Tuxtlas.

At least 10 eruptions have occurred within the Tuxtlas since 5300 B.P. (Reinhardt 1991). Each eruption was brief and involved a relatively small amount of magma emerging from the surface. The ash fall for each of these eruptions probably varied in geographic extent, but were somewhat localized. Pool and Britt (2000:146 – from Reinhardt 1991:Figure 14) show the ash fall for a recent eruption of Cerro Puntiagudo. This ash achieved one-meter thickness within about 50 square kilometers downwind from the volcano. Ash from this eruption was blown primarily to the west. Considering volcanoes cover the landscape, ash would have been available to nearly all of the inhabitants of the Tuxtlas. On the other hand, only the ash from the most recent eruptions would not be covered by alluvium or tephra deposited by lava flows. Because of the relatively localized distribution of ash fall, one might expect a chemical or mineralogical difference in the ashes available over the Tuxtlas.

Reinhardt (1991) determined chemical variation within the ash found in the Tuxtlas. However, it was due primarily to weathering and was not indicative of any particular geographic location. The chemistry or mineralogy of the ash itself may not provide additional variation useful for sourcing within the Tuxtlas. Many of the volcanoes in the region may have also shared magma chambers that would also yield similar chemical signatures. However, the proportion of ash added to clay and the size of ash particles are cultural influences that will assist petrographic sourcing. The possibility of identifying ash from different eruptions is considered further in Chapter 6.

In sum, although there is not a great amount of diversity in the raw materials available for pottery production in the Tuxtlas, enough variability exists to identify sub-groups of the Coarse Orange ware if it was produced locally at many places on the landscape. The fact that variability exists in the raw clay and temper materials also would validate the conclusion of centralized production and exchange of Coarse Orange focused on Matacapan if a single compositional groups was found for the ware.

Chapter 4

THE CERAMIC ECONOMY OF THE TUXTLAS

Southern Veracruz has a long history of archaeological research. The major aspects of Tuxtlas prehistory that have been investigated to date cover the areas of settlement patterns (Santley 1991, Santley 1994, Santley and Arnold 1996), settlement chronology (Ortiz Ceballos 1975; Pool and Brit 2000; Drucker 1943; Weiant 1943; Stirling 1943; Blom and LeForge 1929), economy (Santley 1982, Santley et al. 1984, Santley et al. 1985, Santley et al. 1989, Santley et al. 1988, Santley 1994, Pool 1990, Pool and Santley 1992, Arnold et al. 1993, Arnold and Santley 1993), ethnicity and ideology (Pool 1992b, Santley et al. 1987a, Santley et al. 1987b, Santley 1989, Spence 1996, Valenzuela 1945), the region's geology and people-land interaction (Pool 1990, Reinhardt 1991, Killion 1990), the organization of ceramic production (Arnold 1991, Arnold et al. 1993, Pool 1990, Santley et al. 1989), obsidian working (Santley 1989, Santley and Pool 1993), and textiles (Hall 1997). The majority of this research was conducted at Matacapan, but intensive site surveys have been conducted to better understand the role of rural sites in the Tuxtlas. Bezuapan, La Joya, and Tres Zapotes have also undergone recent excavation and intensive survey (Pool and Britt 2001, Santley et al. 1997, Pool [ed]. 2002).

While Matacapan and the Tuxtlas are fairly well known prehistorically and historically, there are considerable gaps that hinder archaeological research. We know little about ceramic production and distribution outside of Matacapan. What evidence we do have comes from general and intensive surface inspection. Future research should target rural sites for excavation to better understand the region's pottery economics. My research should be able to identify zones of production and exchange through the patterning of compositional groups, but it is also desirable to delineate the comparative scale and intensity of specific production loci throughout the Tuxtlas.

This chapter will first briefly discuss the history of research projects centered on the Tuxtlas. Second, I will consider the developmental trajectory of Classic period settlements in the region. Third, I will talk about ceramic production and distribution at some length. This will lead me to conclude the chapter with an evaluation of our current knowledge regarding the Classic period Tuxtlas, followed by hypotheses for testing in this research.

History of research

Following an initial period of archaeological investigation in the Tuxtlas (Kerber 1882 Melgar 1869, Blom and LeFarge 1926:506), the next period of research involved an intensive examination of several sites. Stirling (1943;Weiant 1943) initiated investigations during 1938 at Tres Zapotes for the Smithsonian Institution and the National Geographic society. Drucker signed onto the project in 1939 and designed the first stratigraphically based ceramic chronology for the Tuxtlas region (Drucker 1943, Weiant 1943, Coe 1965:684-686). World War II disrupted research in the region, but investigations resumed in the 1960's. In 1960 Heizer and Williams (1965) conducted a technological and chemical analysis of basalt. Ortiz (1975) excavated ceramics from El Picayo, Tres Zapotes, and Matacapan. The ceramic typology for later research at Matacapan was patterned after Ortiz's analysis of ceramics there and at El Picayo and Tres Zapotes.

Valenzuela (1945) was the first to excavate at Matacapan. He found a *talud-tablero* structure (Mound 2, a "temple mound") and several triangular figurine heads fashioned in Teotihuacan style near Mound 3. This was the first indication that Matacapan had ties with central Mexico during the Classic period (Santley et al. 1987a, Santley et al. 1987b, Pool 1992, Spence 1996). Valenzuela (1945:95) additionally provides evidence of an early Postclassic component at Matacapan, as a Toltec style Tlaloc censer and beads and a copper bell were discovered near Mound 4.

In more recent years, Santley (1982) initiated intensive research at Matacapan. The Matacapan project conducted by the University of New Mexico (hereafter referred to as the New Mexico project) sought to determine the nature of Teotihuacan influence at Matacapan and to uncover evidence of long-distance exchange. This project mapped the central $5km^2$ of Matacapan, made 5500 surface collections with systematic transect survey, and excavated 83 stratigraphic test pits (Pool 1990:168; Santley et al. 1984, 1985). The New Mexico Project was successful in several regards (see Pool 1990:168-182 for a more detailed description of the following). First, a detailed ceramic sequence was identified (Santley et al. 1985; Pool 1990:168). Second, the site's occupational history was detailed (Santley et al. 1985; Pool 1990:174). Third, Teotihuacan influence was better understood (Santley et al. 1987a, Santley et al. 1987b, Pool 1990:177-179, Pool 1992b). And fourth, evidence for long-distance exchange was uncovered (Santley 1989). I will detail a few of these accomplishments below.

Pool (1990) conducted a geological survey and study of ceramic production and exchange centered on Matacapan in 1986. With the data gained from sampling clay sources all over the central Tuxtlas surrounding Matacapan, Pool was the first to initiate a source database that could be used to chemically test economic exchange in the Tuxtlas. The results of his examination of Fine Orange distribution, however, showed that it was produced and distributed locally throughout the central Tuxtlas. The exchange of Coarse Orange, perhaps the most intensively produced ware at Matacapan, has not previously been subject to compositional analyses.

After excavations at Matacapan ceased (partially due to the leveling of mounds at the site to make way for tobacco crop irrigation), Arnold and Santley (Santley and Arnold 1996; Santley 1991, 1994) began a more systematic reconnaissance of the Tuxtlas region surrounding Matacapan. A diachronic view (based on the previously established ceramic chronology) of settlement for the central Tuxtlas was detailed for the first time. This evidence points toward Matacapan's supremacy throughout the Classic period in the central Tuxtlas. Sociopolitical domination of the Tuxtlas thus refocuses away from Tres Zapotes at the end of the Formative period to Matacapan during the Classic. El Picayo to the west of Matacapan, however, is not well known through archaeological research (but see Ortiz 1975, Valenzuela 1945) and may have been very influential in the Classic period. This broader look at the Tuxtlas prehistoric settlement sets up the research conducted here.

Recent research by Killion and Urcid (Urcid et al. 2001) has begun to explore the lowlands south of the Tuxtla Mountains in and around the Hueyapan River drainage. Since results have not yet been published, I cannot discuss it at length here. There does seem to be a substantial Classic period occupation in this area. Just south of the Hueyapan survey area was Laguna de los Cerros, a large Classic period center (Cyphers n.d., Borstein 2001). Exchange relationships between Laguna de los Cerros and Matacapan should provide clues as to how Matacapan interacted with the surrounding lowlands. Analysis of Coarse Orange found at Laguna de los Cerros, should be undertaken in future research.

Tres Zapotes has recently seen a systematic survey under the direction of Pool (1997, 2000, ed. 2002). The substantive objectives of this research project were to investigate the organization of craft production at Tres Zapotes and to reconstruct the settlement history of the site. These results are incorporated below.

Research at Bezuapan (Pool and Britt 2000, Pool 1997) provided significant information for the Tuxtlas as a whole. Stratigraphic excavations at this site, situated immediately to the southeast of Matacapan, have modified the chronology for the Formative to Classic period transition. Based on shifts in ceramic technology in relation to volcanic episodes in the Tuxtlas, the early Early Classic period (Ortiz 1975; Santley et al. 1985, 1985) was redefined as the Terminal Formative (100-300 A.D.) in the Tuxtlas. The beginning of the Early Classic period was moved up to 300 A.D., which defined the independent development of Chuniapan de Abajo and Matacapan as Classic period centers within the Tuxtlas.

Some aspects of this brief overview will be expanded upon in the following sections. I pay particular attention to the various interpretations of ceramic production and exchange.

Development of Sociopolitical Organization in the Classic Period Tuxtlas

At the end of the Terminal Formative period (100 B.C. – 300 A.D.) the Tuxtlas saw a decline in settlement density and complexity. A region dominated throughout the Formative by complex and internally stratified sites became less densely populated and the regional hierarchy greatly diminished. A volcanic eruption, which dated to A.D. 260?114 (Pool and Britt 2000), forced a brief occupational hiatus in the Central Tuxtlas – where Matacapan would subsequently come to power (Santley and Arnold 1996: 232-233). The beginning of the Early Classic period (300 – 450 A.D.) saw the development of the southern Tuxtlas where Chuniapan de Abajo and Chuniapan de Arriba emerged as small centers (in that order). The central Tuxtlas subsequently became re-occupied and Matacapan emerged as a small center (Santley and Arnold 1996: 234) during the later half of the Early Classic. Several rural sites arose surrounding Matacapan at this point; they most likely emerged to meet the demands of the burgeoning center.

The early Middle Classic period (450 – 550 A.D.), corresponds with a boom in population and the emergence of a rank ordered site hierarchy within the region. Matacapan became the primary center flanked to the east by Teotepec and to the west by Ranchoapan, the other two large centers in the region. El Picayo, about midway between Matacapan and the center of Tres Zapotes (which declined in size since its apogee in the Formative period), also developed into a large center. Several small centers rose in the Classic Tuxtlas that were each nestled amid even smaller villages and hamlets. The late Middle Classic (550 – 650 A.D.) and early Late Classic (650 – 800 A.D.) continued the ranked site hierarchy centered on the principal center, Matacapan. The late Middle Classic, however, saw the rise of the Comoapan ceramic production facility, a primary interest in this study, so economic intensification may have been a goal of Matacapan.

The hierarchical settlement pattern in the Tuxtlas is consistent with many presumptions made by central-place theory; small centers were located some distance from large centers and rural sites typically occur in-between. This suggests that each center was sustained by its own hinterland – this pattern may emerge in the compositions of Coarse Orange ceramics as independent spheres of interaction around centers. We still do not know whether centers interacted economically. However, Santley (1994) argues that the Tuxtlas settlement resembles a dendritic central place system – meaning goods would have flown from the smallest of rural sites up the site hierarchy to small centers and finally to Matacapan. Another presumption of the dendritic CPT model, however, is that goods produced in the principal center would be exported to other regions. If Santley were correct about the dendritic central-place pattern, Matacapan would have drawn upon the entire region to accumulate resources to sustain their population and to exchange with other regions in Mesoamerica. Thus, economic interaction within the Tuxtlas would have been one-way and inwardly focused on Matacapan. An alternate perspective would see Matacapan as outwardly focused in the Tuxtlas (i.e. it supplied the Tuxtlas with crafts in exchange for agricultural surplus and different raw materials such as salt, liquidambar, wood, and basalt).

During the entire Middle Classic period and into the early Late Classic, Matacapan sat atop the Tuxtlas settlement hierarchy as the largest and most internally stratified site. Ranchoapan, which occupied less than half the total area of Matacapan, was the second largest center in the Tuxtlas (Santley and Arnold 1996:234-235). Santley estimated the population of Matacapan to have been around 35,000 persons in the late Middle Classic, a significant portion of the 53,000 persons estimated to inhabit the total Tuxtlas Regional Survey area (Santley and Arnold 1996:234). Matacapan began to decrease in size in the early Late Classic, but Fine Gray production actually increased (Santley 1994:239). This suggests that economy was partly divorced from political organization at Matacapan.

Within Matacapan, architecture and artifact patterns revealed a stratified and horizontally differentiated society. At its core, Matacapan displayed a large open central plaza (Santley et al. 1987). The function of this plaza remains inconclusive. However, it probably served several administrative, ceremonial, and economic functions. Among these possibilities are a marketplace and a civic-ceremonial plaza where periodic rituals took place. The site's largest temple mounds surrounded the central plaza – adding to the probability of its ceremonial function (Santley et al. 1985).

Regional population declined, the site hierarchy became less ranked, and Matacapan lost power in the late Late Classic (800 – 1000 A.D.). Ranchoapan became the primary administrative center in the Tuxtlas survey area, and Matacapan became virtually abandoned.

In sum, the Tuxtlas settlement history seems to accord well with some central-place models. Santley's application of a dendritic central-place model argues that Matacapan dominated the region through economic control. Santley draws upon knowledge of the extensive economic practices of pottery production (discussed further below) and obsidian working to support his claim that power in the Tuxtlas comes from management of production and exchange. However, the fact that Matacapan remained influential economically after it began to decline politically raises questions about the origin of political power in the region. If political domination were solely dependent on economic control, we might expect to find the intensification of Fine Gray production to correlate with increasing political control. Instead, this economic intensification comes with the beginning of Matacapan's political decline in the early Late Classic. Perhaps economic importance switched from pottery to obsidian manufacture. Ranchoapan, which supplanted Matacapan in the late Late Classic as the principal center, manufactured many more obsidian tools than Matacapan (Santley 1991). If for some reason control over the obsidian economy became more important than pottery for achieving political economic power, a switch in site hierarchy would have followed. This shift in economic focus could have easily happened if ceramic manufacture increased in the Tuxtlas countryside. Materials for ceramic manufacture were widely availably in the Tuxtlas, but all obsidian was imported from regions to the west (Stark 1990). Controlling the flow of obsidian products would have been easier than controlling ceramic economics in the Tuxtlas.

The Political Economy of the Tuxtlas

As outlined in Chapter 2, specialized ceramic production has been refined as an analytical category so that researchers can dissect different instances of craft production and compare them according to their component parts. Although less is known about ceramic production in rural sites in the Tuxtlas, comparison is still possible based on surface collection data at rural sites in the Tuxtlas and surface collections and excavation at Matacapan.

<u>Ceramic Production</u>

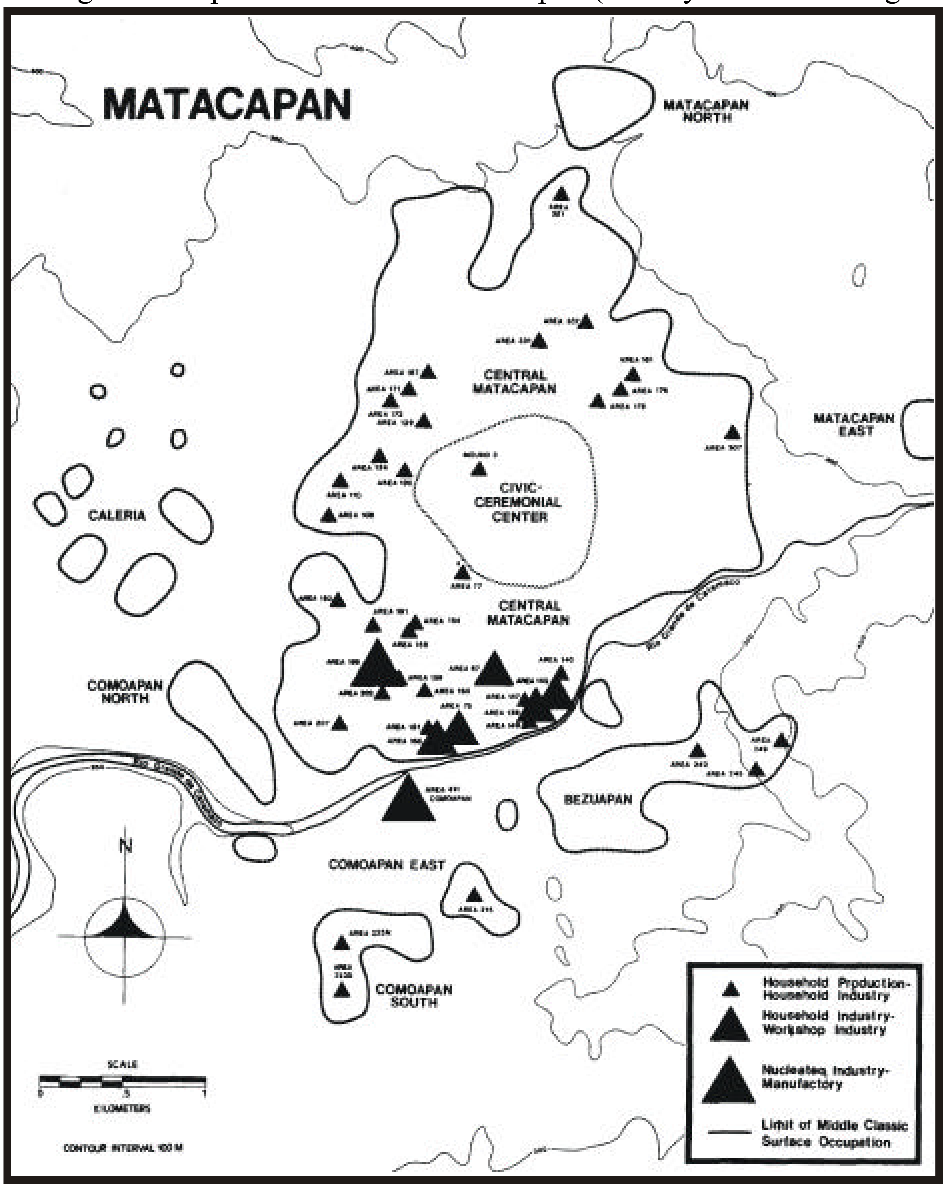
So far as is currently known, the largest scale and most intensive ceramic production in the Tuxtlas region took place at Matacapan. Ceramics at this center were produced on a scale and intensity that range from domestic level manufacture for household consumption to more intensive production that suggests intent for exchange (Santley et al. 1989), as opposed local consumption. Production activities within Matacapan were highly differentiated and probably hosted a diversity of occupational roles for the residents at this center. Among these economic opportunities would have been at least part-time specialization in ceramic production. The intensity of production at Comoapan, Area 199, the Fine Gray areas to the southeast of the civic ceremonial center, and the attached workshop behind Mound 3 may have provided opportunities for individuals to work full-time (for at least part of the year) at ceramic production to derive a living.

All production loci were identified based on presence of ceramic wasters (over-fired, warped, and or vitrified sherds), kiln debris, or high density of either ceramic remains (Santley et al. 1989:112). Because high density (defined as the upper tercile of densities at Matacapan [Pool and Santley 1992:212; c.f., Santley et al. 1989:112]) of sherds is an indirect measure of ceramic production, this evidence was combined with presence of kiln debris to securely define production loci.

In all, 22% of the surface surveyed at Matacapan met with the ceramic production criteria defined for the site (Santley et al. 1989)(see Map 4.1 showing locations of production loci). However, only 3% of the total area surveyed consisted of firing contexts.

I will now discuss these production loci more specifically using data presented in Santley et al. (1989) and Pool (1990). Pool's treatment of the ceramic production system at Matacapan is more amenable to discussion here since he reduces the site into major areas of ceramic production that he investigated: the central locality, the Comoapan locality, the western locality, the southeastern locality, and the southwestern locality. More specific production localities and excavation proveniences are listed in the discussion below. I will not spend a proportionate amount of time on each locality because not all loci are equally well known and because the central focus of this thesis is on the distribution of Coarse Orange, in which only Comoapan, the central locality (Mound 3), and the southwestern locality specialized.

Map 4.1. Showing ceramic production loci at Matacapan (Santley et al. 1989: Figure 2).



The central locality (Map 4.1) was identified as an attached workshop (Brumfiel and Earle 1987; Costin 1991; Pool 1992, 2002) because of its position within the “Teotihuacan barrio” on a terrace behind Mound 3, an elite residence (Santley et al. 1984, Arnold and Santley 1993:242). Pit 6 within operation I-B targeted this production locus, and uncovered a kiln and associated refuse (Santley et al. 1984; see also Pool 1990:219). This attached producer specialized in fabricating Coarse Orange (Arnold and Santley 1993:242; Pool 1990:221). Coarse

Orange type comprised 38.9 % of all rim sherds found by stratigraphic excavations, followed by 21.3% brown-slipped Fine Orange (Pool 1990:221). The Coarse Orange produced behind Mound 3 was somewhat standardized in that 77 % of Coarse Orange rims were Form 38 (a globular jar with an everted lip) (Pool 1990:221). This suggests that the elite patrons of production at this facility had a high demand for use of these utilitarian jars. Perhaps they were used to store food or drink involved in ceremonial displays of conspicuous consumption. Although these Coarse Orange vessels were more finely crafted and more finely tempered that those made at other loci at Matacapan, the context of use for these jars is not currently known and could have functioned in both serving (M. Smith 1987) and utilitarian contexts. The likelihood that ceramics produced behind Mound 3 served utilitarian as well as prestige purposes contrasts Brumfiel and Earle's (1987) and Costin's (1991) assertion that attached specialists produce only luxury crafts. The second most frequent ware produced there, brown-slipped Fine Orange hemispherical bowls and flat-bottomed dishes, were, however, serving wares – conforming to the idea that attached specialists were employed to enhance the prestige of the elite. Although everyone at the site, not just elites, used serving wares, brown slipped Fine Orange was not common at other parts of the site. Other production refuse was found behind Mound 22 (thought to have been an administrative structure) but no kiln was present. This could have also been an attached workshop that was specialized in Fine Buff production (Santley et al. 1989:120).

The Comoapan locality is located on the southern terrace of the Rio Catemaco just north of the modern community of Comoapan. Kiln walls were evident from surface inspection in the streets and yards of the modern community (Pool 1990:222). Thirty-six updraft kilns, made of fiber or ash tempered mud, dot the 4 ha area that constitutes Comoapan. Kilns occurred in 13 clusters associated with refuse middens and waster dumps (Pool 1990:223-224; Santley et al. 1989:119). It was originally argued that Comoapan represented the highest level of ceramic production scale and intensity in van der Leeuw's (1976) scheme because of the apparent absence of domestic contexts (Santley et al. 1989:119). This earliest article, however, left room to interpret Comoapan as a nucleated industry in domestic contexts, which Pool later argues to better represent Comoapan (Pool 1990:229-231). Ceramic production at Comoapan may have occurred near household contexts, but modern occupation within the village prevented further exploration for household remains. Using van der Leeuw (1977), Peacock's (1982), and Santley et al.'s (1989) terminology Pool (1990) sees the Comoapan production locality as a nucleated industry, which occurs within a community that specialized in pottery production. Pool thus includes the probability that domestic contexts were located within proximity to Comoapan. Santley (1994), however, categorizes Comoapan as a manufactory that occurs separate from any residential occupation. Although Pool (1990:229) describes a U-shaped drain found in Pit 62 of the Comoapan excavations, which resembles household drains in Oaxaca as noted by Feinman (1999), more conclusive data of the social contex of ceramic production here must be delayed until more data becomes available. Pool (1990:229-231) leaves the interpretation open to either being a drain for a small shelter or part of a sluiceway used for levigating clays.

There is no evidence that Comoapan was administered by elites or controlled in any way. Miriam Stark (1991:73) comments that urban craft specialization "entails state control over production". While the presence of markets and certain resources may be provided by the state, there is no evidence of state control in this case of highly specialized ceramic production. No administrative structures were present, the site was separated from any elite structures by about .5 km, and there was no evidence that Coarse Orange was a "state ware" of any sort (such as the state ceramic producers that were established throughout the Inka Empire [Hayashida 1998]).

Comoapan apparently represents an instance of independent craft specialization organized for efficiency and high output. Due to its independent status, it is possible that formal economic principles of cost efficiency for production may have applied in this case. Arnold et al. (1993) argue that the scale of production at Comoapan suggest that it was oriented toward exchange of pottery throughout the Tuxtlas (discussed further below). It is likely that the opportunity for this degree of craft specialization at Matacapan drew producers from all over the Tuxtlas into Matacapan. Santley (1994) and Santley and Arnold (1996) suggest that immigrating artisans may explain part of the rapid increase in population at Matacapan beginning in the early Middle Classic. While it is not known that producers at Comoapan manufactured ceramics full-time and year-round, it is possible that Comoapan may have employed an economy of scale and organized labor to increase the efficiency and scale of production. Whether full or part-time, production at Comoapan required considerable commitment by a large number of producers who worked together in the same space that was apparently exclusively devoted to this economic pursuit.

Sherds at this production locality reached high densities. Frequencies averaged 263 sherds per 3 m x 3 m collection square (29 per sq m) compared to the average of 61 sherds per collection unit (7 per sq m) for the entire transect survey. The highest individual frequency for a collection unit from Comoapan reached 1875 sherds (Pool 1990:223). Several excavation units placed in the Comoapan locality exposed the kilns and provided stratigraphic information regarding scale and intensity of production and variability in product. Sherd densities for excavated contexts within a waster dump that covered Pits 61, 63 and part of 60 at Comoapan averaged 5364 sherds per cubic meter (Pool 1990:228). Other excavated contexts within kilns and from intermediate contexts at Comoapan averaged 517.76 sherds per cubic meter.

Comoapan specialized in the production of Coarse Orange jars. Sixty-six percent of all excavated rim sherds were of the Coarse Orange ware. Of these, almost all took the form of storage jars (37% of rim sherds were Form 23, necked jars; and 51% were Form 38, neckless jars). This also points to the standardization of the Coarse Orange vessel form at Comoapan. Comoapan produced Fine Orange, Fine Gray, and Coarse Brown to a lesser extent (Pool 1990:226-229; Santley et al. 1989:119-123).

Although probably not directly controlled by the state, Comoapan could have benefited political elite at Matacapan. First, the exchange of Comoapan ceramics to other sites in the region would have centralized the flow of food, crafts, and other materials that rural sites and smaller centers generated in return for Matacapan produced ceramics. Furthermore, if a marketplace were active in the open plaza at the center of the site, political administration could have benefited from the taxation of transactions. At the very least, Comoapan supplied pottery to other specialized producers (e.g. of obsidian, agricultural products, textiles) within Matacapan, contributing to the internally stratified economy of this Classic period center. Comoapan's position at the triple-confluence of Río Bezuapan, Río Catemaco, and Río San Joaquin provided them with a constant water supply necessary for pottery production. It would have also supplied a mode of canoe transportation for the distribution of Coarse Orange (or the products they carried) to other parts of the Tuxtlas (Pool 1990, Arnold et al. 1993, Santley 1994). All of these facts make Comoapan a likely supplier for at least some of Coarse Orange found throughout the Tuxtlas.

The western locality, Area 120, (originally excavated as part of the Tulane project [Pool et al. 1987]) sits to the southwest of the Matacapan's center on the west bank on the Río San

Joaquin (Map 4.7). This small production area was associated with Mound 61, a residential compound excavated by the New Mexico project (Santley et al. 1985:18-20). A single ruined kiln, similar to those found at Comoapan, straddles excavation Pits 86 and 88. High sherd densities and several over-fired sherds also mark this locality as a production context. Sherd densities reach a maximum of 838 sherds per cubic meter in refuse pits (context D1) (Pool 1990:233), but lower densities are more common. Excavations also recovered some unfired clay in a waste pit in Pit 89. This "waste pit" is thought to have served as clay storage.

Fine Buff occurs most frequently at this production locality, and accounts for 29.3% of all excavated sherds. Because ceramic production focused on this fine ware and only produced a very small amount of Coarse Orange, the western locality is not suspected to have played an important role in provisioning the Tuxtlas with the latter (Santley et al. 1989:123). In fact, it is possible that this production locality procured Coarse Orange from other loci at Matacapan. The Coarse Orange sampled from this locality did come from production contexts, though.

The southeastern locality, Area 149, also surveyed and excavated by the Tulane project, was on the north side of the Rio Catemaco just south of a major zone of residential occupation. Highest surface sherd densities averaged 441 sherds per 3 m x 3 m collection square in block N2920-E4123 and 679 per square in block N2749-E3943 (Pool 1990:238). Fine Gray comprised 35.4% of all surface collections made at this locality.

Excavation units were placed in the surface collection block with the highest sherd densities. Four contiguous units were placed just north of Area 149. Excavations revealed fragments of 2 kilns (the *arcos* and *ombligos* were recovered, as well as an *in situ* wall of one kiln). The first kiln occurred in Pits 93, 95, and 96. A second kiln was found in the northeast corner of Pit 94 (Pool 1990:238). The upper few strata contained most of the evidence for pottery production in the form of ceramic dumps. Fine Gray, like the surface collections, dominated this assemblage at 62.9%, and they produced only very small amounts of any coarse ware. In lower strata the proportion of Fine Orange rises to 36.0% (Pool 1990:239). Given this locality's specialization in the fine wares, it is unlikely that they produced Coarse Orange for export to other sites. If they did, it was in small quantities.

The southwestern locality was located on the western bank of the Río San Joaquín about 1 km NNW of Comoapan. Areas 199 and 202 together formed this production locality. Area 199 seemed to be the more intensive producer of ceramics with an average frequency for the two collection blocks being 379 sherds per unit. The densities of sherds, however, were highly variable (standard deviation of 213) and one collection square reached 803 sherds (Pool 1990:241). Area 202 averaged 269 sherds per collection (Pool 1990:242; Santley et al. 1989:122-123). These production areas are intriguing because they also specialized in Coarse Orange production (44.7% of the assemblage), but since they were not excavated I did not sample them.

As should be evident from the above discussion, the ceramics production system at Matacapan was very complex and differentiated. Each production entity seems to have concentrated on one or two wares, although, they also seem to have produced other wares as well (Table 4.1 reproduced from Pool 1990:344). Some production loci were more highly specialized than others. For instance, Comoapan was the most specialized producer of Coarse Orange. This locality also produced the most standardized pottery, considering 89% of all Coarse Orange produced there fit into two form categories – both of which were utilitarian jars (*ollas*). The southeastern locality, which transformed from a household industry to a workshop over time (Pool 1990:246), specialized in the production of fine wares. Potters at the Southeastern Locality produced on a smaller scale than Comoapan, but the Upper Southeastern locality was a larger-scale industry than most others at Matacapan. Both of these producers made pottery for a large body of consumers, but Comoapan was probably more oriented toward provisioning households to meet their mundane ceramic needs. The Southeast localities made fine serving wares, while Comoapan primarily made storage vessels.

Sherd densities per production locality provide a general means to differentiate scales of production between loci. Table 4.2 (after Pool 1990:table 5) summarizes sherd densities from excavated contexts at Matacapan. Comoapan is clearly the largest-scale producer at Matacapan. The central and western localities manufactured pottery at a much lower scale than either of the larger industries to the south of the site. This means that Comoapan produced a much higher quantity of Coarse Orange than any other excavated entity at Matacapan, and the southeastern locality did the same with Fine Gray and Fine Orange serving wares. Production at the central locality was obviously targeted toward a different audience since it was attached to an elite residence. The western locality was probably oriented toward provisioning local residents mainly with serving wares.

Table 4.1. Showing relative specialization in ware by production locality (after Pool 1990:Table 6).

	Locality									
Vessel Class	Central		Comoapan		Western		Southeast Upper		Southeast Lower	
	F	%	f	%	f	%	f	%	f	%
Fine Gray Dishes	0	0.0	50	1.6	136	4.1	1853	**23.4**	413	**11.6**
Fine Gray Bowls	7	2.9	15	0.5	224	6.8	439	5.6	135	3.8
Fine Gray Restricted Bowls	3	1.2	6	0.2	71	2.1	1465	**18.5**	3.7	8.6
Fine Orange Plates	5	2.1	13	0.4	121	3.7	149	1.9	383	**10.7**
Fine Orange Dishes	24	10.0	280	8.7	212	6.4	133	1.7	62	1.7
Fine Orange Bowls	49	**20.3**	54	1.7	1046	**31.7**	405	5.1	632	**17.7**
Coarse Brown Necked Jars	29	12.0	292	9.1	325	9.9	283	3.6	218	6.1
Coarse Orange Neckless Jars	70	**30.3**	1054	**32.9**	47	1.4	37	0.5	10	0.3
Coarse Orange Necked Jars	18	7.5	850	**26.5**	62	1.9	152	1.9	47	1.3
TOTAL EXCAVATED RIMS	241		3206		3297		7906		3564	

Table 4.2. Showing sherd densities from excavated contexts at Matacapan (after Pool 1990:Table 5).

Locality	Maximum Sherd Density
Comoapan Locality	5364 per m^3
Southeastern Locality, Upper Unit	4650 per m^3
Southeastern Locality, Lower Unit	2825 per m^3
Central Locality	865 per m^3
Western Locality	838 per m^3

Efficiency is difficult to assess because it involves making inferences about ratios of labor input to total output. Instead, I briefly consider intensity as amount of labor inputs per unit production. Rice (1987:190) states that one can achieve intensification "by changing production from part time to full time, increasing the number of producers, or using more efficient techniques". Thus here, and as argued by Torrence (1989:86), I measure intensity as labor inputs. Pool (2000) argues that kilns were used in prehistoric pottery industries because they produce a more uniform firing color and reduce firing loss by more precisely controlling temperature fluctuations, rate of temperature increase, and firing atmosphere. These factors will make pottery production more efficient, however, Pool (2000) found that kilns involve more material and labor investment than open firings. Investment in kiln technology thus provides one way to measure intensity, and possibly efficiency.

Comoapan, by far, employed the most kiln technology per unit production in Matacapan, and possibly the Tuxtlas, if not all of Mesoamerica. This could have made pottery production at Comoapan very efficient by reducing firing loss and increasing standardization of appearance through reducing color variability. It certainly represented elevated labor inputs and possibly the cooperation of many potters within the community. One issue affecting these interpretations, though, is their chronology. It is not definitely known that all kilns were employed at the same time. Arnold et al. (1993) argue that the spatial organization of kilns suggests that most, but not all of these kilns were simultaneously used. Kilns and associated waster dumps seemed spaced out into discreet units of Operation VI. If kilns were constructed to replace earlier ones that eventually failed then there may be more overlap of kilns within the same areas rather than spaced out into discreet units.

Not much data exists to evaluate the segregation of activity areas at these different production loci. However, the grouping of kilns and associated waster dumps at Comoapan appear discretely from any evidence of domestic activities (except for a possible household drain or sluiceway found in Pit 62 [Pool 1990:229]). Feinman (1999) argues that the modern community of Comoapan may cover Classic period occupation. Even though this is certainly true, the firing areas at Comoapan were certainly well segregated from domestic contexts. The ratios of ceramics to obsidian, figurines, and ground stone at domestic contexts in Matacapan are 42:1, 333:1, and 1986:1 respectively. At Comoapan these same ratios were 124:1, 524:1, and 8127:1. Domestic areas outside of Compoapan thus display "3 times as much obsidian, 1.5 times as many figurines, and over four times as much ground stone relative to sherds" (Arnold et al. 1993:177). This may suggest that Comoapan served primarily as a ceramic production area, and few, if any domestic activities occurred there. This dilution of common household materials, however, may result from an inundation of domestic artifacts by ceramic production byproducts. On the other hand, some obsidian and groundstone implements could have been employed in ceramic production (Arnold et al 1993:177). Ceramic production activities at the southwestern, central, and western loci were all intermingled with other domestic activities. Production at the southeastern locality, although still situated near a housemound, was more segregated than other areas. Higher degrees of segregation could indicate more importance placed on pottery production at Comoapan and the Southeastern locus.

Coarse Orange was selected as the focus of this study because it was the most intensively produced ware at the largest-scale ceramic industry in the region's hypothesized principal economic center. The ware is found throughout the region, and not produced on a comparatively large-scale at any other known site (with the possible exception of Site 11, which may be an outlying community of Matacapan). This is strong evidence that the ware was exchanged to some extent. However, this assumption cannot be made based on theoretical inference. In a move toward empirical justification, I discuss evidence of pottery production at other sites in the region.

As mentioned in the introduction only 23% of sites in the Classic Tuxtlas show evidence of specialized ceramic production (Santley and Arnold 1996:236). This evidence derives from surface collections made during the 1991 and 1992 Tuxtlas survey. Of the 14 sites sampled in this study (not including Matacapan) only 6 display evidence of specialized ceramic production (a higher proportion of sites than in the region as a whole). This does not preclude the possibility that all sites sampled produced pottery on a small-scale and at low intensity. Archaeological detection of this type of production is very difficult. Judgment of specialized ceramic production presence was made based on high densities of ceramics and the presence of wasters (Coarse Orange sums are reported in Table 4.3 for specialized ceramic production sites). Although these survey data are not directly comparable to excavations at Matacapan, the survey strategies conducted at these smaller sites (except Site 132) were similar to those undertaken at Matacapan. I cannot assume that all of the ceramics found at these sites were from production contexts; therefore, part of the Coarse Orange profile found at these sites may have arrived through exchange. One might assume that Ranchoapan's proximity and political association with Matacapan influenced the percentage of Coarse Orange at that site. Apomponapam (Site 118), on the other hand, clearly did not produce Coarse Orange in high quantities. Teotepec was a large center in the Middle Classic, thus it is possible that the inhabitants of this site produced ceramics on a significantly large scale. However, little direct evidence was found that they specialized in Coarse Orange production. Given its upper position in the settlement hierarchy, Matacapan probably interacted closely with the population of Teotepec.

Table 4.3. Showing total ceramics at producing sites, the proportion of Coarse Orange at those sites, and the number of waster sherds (Robert Santley and Santley et al. 1988).

Site	Total ceramics	Coarse Orange	% Coarse Orange	Coarse Orange wasters
45 (Ranchoapan)	777	178	23%	2
118	1351	37	3%	2
124 (Isla	327	52	16%	0
132	147	26	18%	2
141 (Teotepec)	1266	282	22%	2
El Salado	Ca. 39,000		< 7.9% (see below)	

Unfortunately not much is known about these ceramic-producing sites. However, based on a general understanding of ceramic production in the Tuxtlas we can evaluate the degree of centralization regarding the production of Coarse Orange. Due to the high degree of ceramic craft specialization at Matacapan and the smaller scale of production outside of Matacapan, the pattern of production localities in the region seems to support a highly centralized economic model. As Matacapan developed in the region, its increasing population, likely presence of some centralized mechanism of exchange, its positioning close to major sources of river travel, its proximity to excellent clay resources, and the assumed development of agricultural surplus and an administrative/elite social class would have provided an attractive pull drawing ceramic producers into the urban environment. In this context crafts producers could support themselves with the trade of their wares, relying less on other types of economic pursuits, such as agricultural production, or at least diversifying the household economy. Santley and Arnold (1996) argue that immigrating craft specialists partially explain the increase in population at Matacapan during the late Middle Classic. If craft producers were leaving the countryside for the advantages of "urban living" (*sensu* Brumfiel 1987b, 1991), this would have created the dearth of relatively large-scale craft production evident in rural contexts. Although considerably more craft activity probably occurred than was evidenced by the intensive site surveys detailed above, there is a considerable gap in the frequency and scale of ceramic production between centers and rural sites. Matacapan, of course, displayed the highest investment in ceramics production, but Ranchoapan and Teotepec, two other large centers, also seemed to have specialized in ceramic production to some extent. Apomponapam also specialized in ceramic production, but did not focus on Coarse Orange production. Isla Agaltepec was a small center that probably only produced a small amount of ceramics (based on low quantities of ceramics from surface collections). Site 132 produced ceramics. Local population, and therefore demand, at Site 132 was relatively low – explaining the low output of ceramic production there.

El Salado, due to its apparent high investment in ceramic production and because more information is available for this site, deserves more consideration than the other sites. Although this site was a relatively large-scale producer of ceramics, it specialized in Coarse Brown and Coarse Reddish-Brown production, which formed 88.4 % of the ceramics recovered from the Classic period at this site (Santley et al. 1988:4). Manufacture of these wares may have been associated with the preparation of salt, which can be reduced by boiling water from a local salt spring. El Salado produced primarily necked globular jars and *cazuelas*, both of which may have been used to boil salt brine. Thus, the high densities of ceramics at this site may have been used locally for the specialized purpose of salt production. Fine paste wares constitute 3.7% of the total Classic period ceramics. While no mention is made of Coarse Orange in their 1988 report, Coarse Orange production could have constituted only a maximum of 7.9% (100% - (88.4% [Coarse Brown] + 3.7% [fine paste serving wares])) of the total Classic period ceramics at El Salado. Although it was possible that El Salado was producing their own Coarse Orange, it was unlikely that they were doing so for trade to other sites because of the a lack of emphasis of Coarse Orange compared to other wares.

Tres Zapotes will be treated separately in this thesis because I noted inconsistencies in how Coarse Orange was identified at this site compared to the New Mexico project. While Coarse Orange was intended to indicate a fine clay tempered with fine to medium sized volcanic ash, many of the ceramics classified on the Tres Zapotes project contained medium to coarse sized quartz grains. Large quartz grains were rare in the paste of sherds sampled from the collections to the east. As I will demonstrate in Chapter 6, I believe this reflects a difference in production recipe between the two sites rather than classification error.

Hoag's (2002) distributional analysis of kiln debris and daub suggests that craft production was mainly undertaken in household contexts at Tres Zapotes. In all, Tres Zapotes had 14 Classic period production loci (Pool 2002). Of these, 3 were attached producers, or what Pool terms elite household production, and the rest were independent. Tres Zapotes thus had a greater focus on attached specialization than Matacapan (which only contained one definite attached specialist). Two independent producers stand out as being relatively larger-scale producers than the rest at Tres Zapotes: Areas A29b and B29. B29 had a density of 161.9 sherds per m^2 and A29b displayed 114.9 sherds per m^2. While these were of smaller scale than many of the Matacapan production areas, they were larger-scale than some of the other producing sites identified by the New Mexico Project. Matacapan, in total, had a higher number of smaller and moderate to low intensity production loci than Tres Zapotes.

Among the larger industries at both sites, production specialization was much greater at Comoapan (where Coarse Orange was 84% of the total assemblage) and Area 199 at Matacapan than the most specialized industries at Tres Zapotes (highest specialization was 32% of any of the larger assemblages). Furthermore, the Coarse Orange ware was not among the largest-scale produced wares at Tres Zapotes. Pool attributes the differences in organization of ceramic production between the two sites to a higher degree of political centralization at Matacapan than at Tres Zapotes in the Classic period and access to kaolinitic clays (Pool 2002)

The nucleation of ceramic production at Matacapan supports the assumptions made by central-place models: that craft production will be drawn into urban centers. However, the development of Matacapan did not completely suppress production in the Tuxtlas. If there is any truth to the centralized interpretation of Tuxtlas economy, we should see evidence of exchange from Matacapan to other sites despite low-level investment in rural Coarse Orange production. I examine direct and indirect evidence of ceramic exchange below.

Ceramic Exchange

Only one study has been conducted to date that investigates direct evidence of ceramics exchange in the Tuxtlas region. Pool (1990; Pool and Santley 1992) employed X-ray fluorescence spectrometry to characterize the chemical composition of fine paste ceramics from Matacapan and clays in the Tuxtlas; these were then compared to neutron activation data on fine paste ceramics from El Picayo and Matalapan. Fine Gray and Fine Orange serving wares were produced with some intensity at Matacapan. Fine Orange most frequently occurred in what Pool and Santley (1992) refer to as household industries, but there was a lot of this production at Matacapan and other sites in the Tuxtlas. Fine Gray production mostly occurred in domestic workshop contexts at Matacapan. Although it did not produce on the scale and intensity of Comoapan, the southeastern locality did manufacture enough ceramics that suggest Matacapan may have exchanged these ceramics to other sites in the region. Furthermore, the collective output of all the fine paste ceramic artisans at Matacapan does add up to a significant amount potentially for trade.

Pool and Santley (1992) conclude that exchange of Fine Orange ceramics had a limited distribution around the three sites sampled: Matacapan, El Picayo, and Matalapan. Ceramics from each of the sites reflect use of chemically distinct clays (Matacapan and Matalapan were similar, but different enough to define a Matalapan subgroup. The presence of Fine Orange production there further suggests local production). Despite the lack of interaction among these centers, literally hundreds of small and mid sized sites occurred within the 15 km buffer zones that separate them. Thus interaction between centers and their rural hinterland has yet to be determined for any ceramic ware. Perhaps each site provided its own hinterland with ceramics. Otherwise, the inverse could be true: rural sites provisioned the centers with ceramics, as demonstrated in the Palenque region (Rands and Bishop 1980). Although Fry (1981) suggests from his data at Tikal that coarse vessels should not surpass fine portable serving vessels in the range of their distributions, it is thought that the distribution of Coarse Orange in the Tuxtlas will more resemble Reina and Hill's (1978:207-229) ethnographic account of the regional distribution of utilitarian ceramics in Guatemala. Household potters in Chinautla, Guatemala market their *tinajas*, *ollas*, and *comales* to a regional crowd without the assistance of modern transportation technology. In the Chinautla case, itinerant merchants often provide the primary mechanism of exchange and travel by foot over the often-rough terrain of the mountain environment.

Indirect indicators of ceramic exchange in the Tuxtlas mainly derive from the scale and intensity of pottery production at Matacapan. Because I have described this above, an extensive discussion is not needed here. Arnold et al. (1993:175) argue that Coarse Orange was exchanged through two markets. First, they were traded to consumers throughout the Tuxtlas. Second, they were used to transport other wealth goods such as liquidambar or honey within the Tuxtlas and beyond the region to other areas along the coast and possibly to highland central Mexico. The administration of such economic activities rested at Matacapan, however, not in central Mexico as previously suggested (Santley 1982).

Arnold et al. (1993:184) calculated that Comoapan manufactured over a half-million vessels generating several million liters of storage space. When considering production output together with the consumption needs of Matacapan's large population, Arnold et al. (ibid.) suggest that Comoapan alone produced more vessels than the inhabitants of Matacapan could have consumed. Assuming that the sherds recovered at Comoapan only represented the 20% of total vessels manufactured that were lost due to manufacturing and firing errors, a generic estimate of sherds that left Comoapan was estimate at a density of 5509.05 sherds per 3 x 3 m collection square. When compared to the total non-production contexts Coarse Orange sherd density figure – 5,216 – the output of Comoapan Coarse Orange more than met the demand of all local consumers at Matacapan. Considering there were more production facilities that produced Coarse Orange at Matacapan than just Comoapan, including large-scale production at Area 199, many of the ceramics produced at Comoapan probably circulated through a regional market

(Arnold et al. 1993:184). This research is complimented by the dearth of large-scale specialized Coarse Orange production outside of Matacapan and the frequent occurrence of the ware at every Classic period site in the Tuxtlas.

Santley (1994) proposed a competing hypothesis to that suggested by Arnold et al. (1993). He argues that the Tuxtlas economy was organized as a dendritic system that drew up labor and material resources throughout the region to manufacture goods for export to other regions. The Tuxtlas rank order settlement system extends out from the principal center, with large centers close to Matacapan and site size decreasing with distance from this primate center. Dendritic centers are primarily exploitative in that resources drawn in from the hinterland are not directly reciprocated by the center in exchange. Instead, the centers engage in mutually beneficial, although often asymmetrical, exchange relationships with centers in other regions. Thus, centers in dendritic systems are mutually supportive of one another's hierarchy. Santley uses the presence of Comoapan to suggest that Matacapan was exporting ceramics to central Mexico and other surrounding regions. If Santley is correct about the dendritic system in the region then Coarse Orange from Matacapan should be rare in the Tuxtlas. Surplus Coarse Orange produced at Comoapan, in particular, would have been traded to other regions, leaving rural settlements in the Tuxtlas to produce their own ceramics.

There are a limited number of possible patterns the distribution of Coarse Orange can display in this research:

Hypotheses for Testing

Hypothesis 1: <u>Matacapan was the sole producer of Coarse Orange found within the Tuxtlas.</u> Data supporting this hypothesis should yield a single homogeneous compositional grouping for all of the Coarse Orange sherds sampled from sites throughout the Tuxtlas. This compositional group will closely match the elemental and petrographic characteristics of ceramics found in production contexts at Matacapan. This scenario corresponds to a very centralized economy integrated under a single political hierarchy. Competing polities likely would have inhibited "free trade" of Matacapan-produced commodities into their supporting hinterlands. In the absence of political or economic competition, Matacapan would have easily monopolized production and distribution of these utilitarian ceramics to most of the sites in the Tuxtlas. Of course, there must be some limit to the range of distribution for Coarse Orange.

This interpretation would suggest that Comoapan was not designed primarily for export beyond the Matacapan polity, as Santley's (1994) argument of a dendritic system suggests. However, it would suggest that Matacapan was indeed an economic center and dominated economic interaction with the other inhabitants of the region.

Hypothesis 2: Coarse Orange produced at Matacapan reached an intermediate distribution, primarily servicing the central Tuxtlas. Compositions of ceramics found relatively near Matacapan will match Matacapan control groups, however, ceramics found at sites further away will form distinct compositional profiles. Both hypotheses 1 and 2 support Arnold et al. (1993), but suggest different ranges of distribution. This scenario supports an intermediate level of economic centralization for the distribution of Coarse Orange, and it may delineate other zones of production and exchange that compete for consumers in the Tuxtlas. Several suggestions could be made as to why Matacapan only served a proximate market. First, limitations in transportation efficiency may have inhibited trade of the bulky utilitarian goods; thus frequencies of occurrence for Coarse Orange fall off with distance from the center of production (Renfrew 1977). Potters in highland Guatemala market their utilitarian ceramics to a broad region without the use of modern transportation, however; so limited transportation may not be the best explanation if this compositional pattern were evident. Second, many other sites might have produced Coarse Orange and out-competed Matacapan for local consumers. And third, political factionalization in the Tuxtlas might have created discrete zones of production and distribution for this ware. All three of these explanations would likely combine to form the most complete interpretation of this scenario.

This outcome to the compositional study would also indicate that Matacapan served the Tuxtlas as an economic center, but that there were limits to its influence.

Hypothesis 3: Access to Matacapan pottery varied with position in the settlement hierarchy. Hamlets, small villages, large villages, small centers, and large centers have been sampled. If the economic influence of Matacapan was pervasive, then all ranks within the range of distribution should reveal ceramics of Matacapan origin. However, if centers and more rural settlements had differential access to Matacapan pottery we should see compositional disparities in ceramics between sites at various levels in the hierarchy. If rural producers have moved to centers to take advantage of the mechanisms of distribution among other things, then a dearth of production in the countryside would have needed to be supplemented by exchange from centers to rural sites. This would have facilitated homogeneous compositional profiles for the majority of the Tuxtlas, while ceramic compositions at small rural sites would vary considerably if each were producing their own ceramics. Variations in paste recipe revealed through petrography would be the best indicator of this scenario considering many of these sites had access to the same or similar raw materials.

Hypothesis 4: Production of Coarse Orange at Matacapan was geared toward export beyond the Tuxtlas. If this hypothesis holds true, as Santley's (1994) dendritic central-place model predicts, few Coarse Orange ceramics found within the Tuxtlas should match compositional data from Matacapan. However, some intraregional trade should have existed. Sites situated along routes of water travel and/or small centers may have served as break-of-bulk points; ceramics from these sites will display Matacapan provenience. The direction and adherence to routes of water travel are the most important indicators of this scenario since relying strictly on negative evidence to suggest export could also reflect patterns of local production and distribution -- unless Matacapan was the only producer. If this hypothesis can be proven, it would support the view that Matacapan drew upon the resources of the Tuxtlas primarily to engage in interregional exchange.

Hypothesis 5: Production of Coarse Orange was dispersed throughout the Tuxtlas and no centralized distribution took place. In this case, the composition of Coarse Orange will vary considerably among sites of all ranks. Few if any of the sampled ceramics will match compositions of ceramics made at Matacapan. Results supporting this hypothesis will closely resemble the material correlates of hypothesis 4, but Matacapan-produced Coarse Orange should be absent from break-of-bulk sites. This scenario is the most decentralized case possible for the distribution of Coarse Orange. Decentralization does not necessarily suggest political factionialization as with Hypothesis 2. It may, however, indicate a high degree of economic competition. On the other hand, the fact that a utilitarian ware was produced as needed at the location of its use simply suggests that the technology and information regarding Coarse Orange production was widespread and everyone knew how to make this variety of jar. It also implies that Matacapan did not use this ware to gain politically or economically. There should not only be a great number of different recipes employed in this scenario, but variability within groups would also be high.

This scenario would indicate that Matacapan was not an economic center, at least as far as Coarse Orange is concerned. Coarse Orange, however, was one of the most intensively produced commodities that originate from Matacapan. It was obviously important to sites in the central Tuxtlas for either utilitarian or social purposes. Coarse Orange is perhaps one of the best tests of the degree of influence Matacapan had in the region's economy. For this reason I suggest that a local configuration for the production and exchange of Coarse Orange would indicate that Matacapan's economic importance to sites throughout the region has been overstated by previous works. Comoapan is certainly a large ceramic production location, but perhaps it was established to meet the demands of the site itself.

Chapter 5

SAMPLING AND METHODS

To investigate differential patterns of ceramic production and exchange within the region, I selected samples from sites in the western and southern Tuxtlas and from different levels of the settlement hierarchy (see Table 5.1 for a list of proveniences). I employed a randomized systematic sampling strategy to select 15 Coarse Orange sherds from each site (Map 5.1). For all sites but Matacapan, all boxes of ceramics stored in San Juan de Ulua, Veracruz were set aside for each site. Ceramics from every box were sampled to ensure full representation of the entire site's surface (collections from larger sites were boxed according to transects, smaller sites may have been contained in a single box). Next all of the Coarse Orange sherds contained within each box were laid out into rows. I divided the total number of sherds present by the number desired for the sample to derive a sampling interval (e.g., I would sample every third sherd if 15 specimens were desired from a total of 45 sherds). Finally, an element of randomness was added by selecting the first sherd in the sequence with a deck of cards (cards numbering 1 through 10 were taken out, shuffled and the top card numbered the first sherd to initiate the systematic sample). From Matacapan, individual production areas were sampled. The same sampling procedure was followed, but instead of separating all sherds from a site, sherds from each production area test pit were selected.

Ninety of these samples were immediately sent for preparation into thin sections, while the others were sent to the Archaeometry Lab at the Missouri University Research Reactor. After thin-sections were made, the remaining portions of the sampled sherds were sent to MURR as well for INAA.

Compositional analysis using petrographic point counting and instrumental neutron activation analysis (INAA) was then conducted. This methodology served two purposes: 1) to increase the dimensions of compositional variability available for analysis; and 2) to control for elemental dilution or enrichment caused by ash tempering.

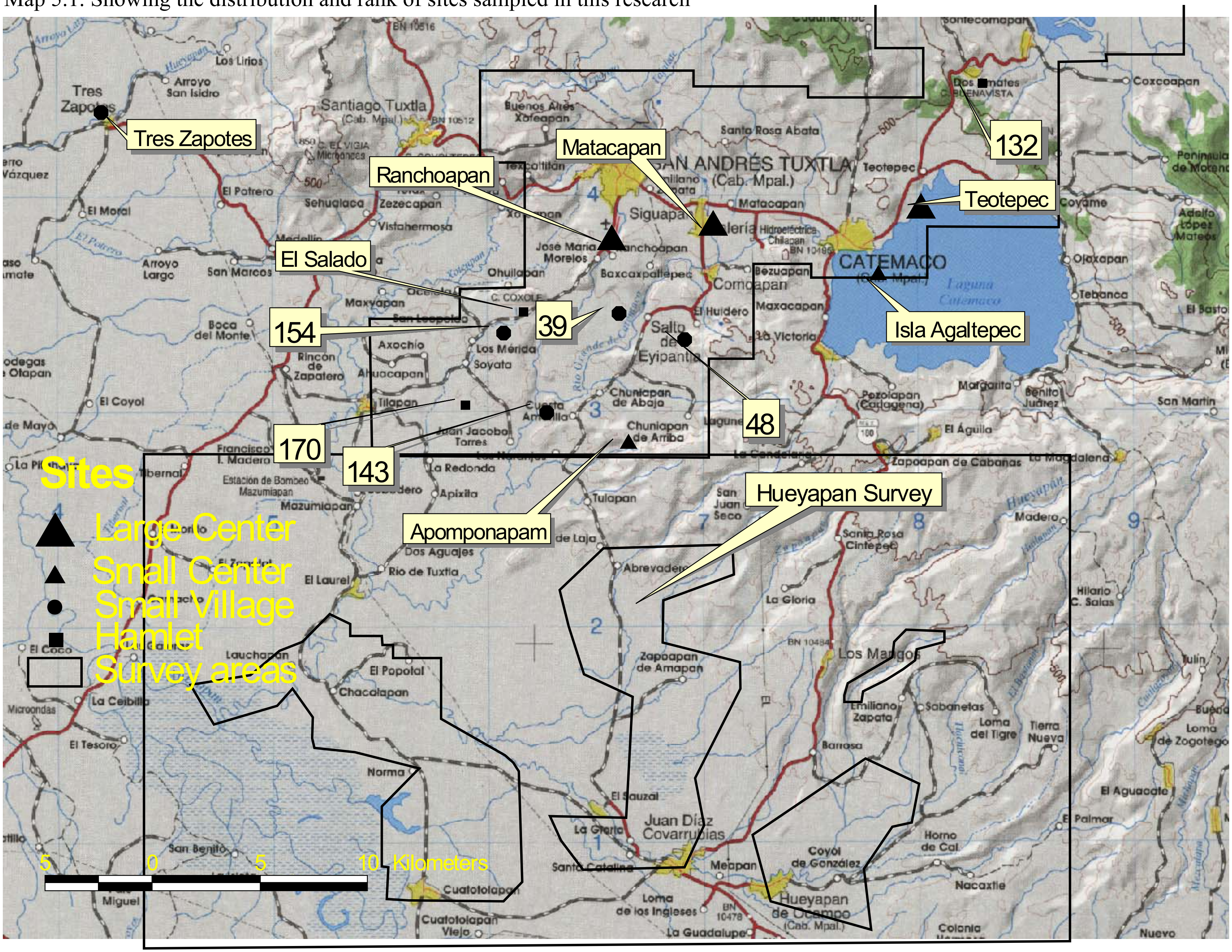
Table 5.1. List of Sites/Production Loci Sampled

Site/Production Loci	n
Matacapan	24
Pit 6 (behind Mound 3)	5
Pit 93 (Area 149)	3
Pit 94 (Area 149)	1
Southeastern Locality (Powdered sherds)	5
Western Locality (Powdered sherds)	4
Comoapan	6
Apomponapam (Site 118)	15
El Salado	14
Ranchoapan	15
Isla Agaltepec	15
Teotepec	15
Tres Zapotes	15
Hueyapan Area	30
Site 39	15
Site 48	15
Site 132	15
Site 143	15
Site 154	15
Site 170	15

Because INAA is a bulk analysis technique (in other words the entire sherd is powdered and irradiated), it is very sensitive to the mixing of clays and temper. However, the kind, amount, and mineralogical composition of temper are difficult to identify unless chemical signatures are obtained for the clay, temper, and ceramic. Such data is not available at this point. Furthermore, the particular strategies for mixing and firing these ceramics cannot be identified with bulk techniques. Collapsing all of these variables into one bulk analytical category diminishes the quantity and quality of information we can glean from our material. Petrography is useful for identifying the actual behavior of pottery manufacture, while INAA is valuable for characterizing the finished product as a whole (Bishop and Rands 1980, Bishop, Rands, and Holley 1982, Day et al. 1999).

The issue of volcanic ash as “noise” for chemical comparison of ceramics to natural clays using bulk chemical techniques has been discussed previously (Neff et al. 1988, 1989, Neff and Bove 1999). Basaltic rock ash, because of the frequent inclusion of feldspars, olivine, and various pyroxenes, will enhance elemental concentrations of some elements (e.g. Na, K, Ca, Mg, Fe, Rb) and dilute concentrations of others (e.g. Zn, Co, V, Mn, Ti, Sc). Petrography becomes very useful for determining exactly which minerals are included in the ash so that we may factor in the influence of temper to the bulk analysis.

Map 5.1. Showing the distribution and rank of sites sampled in this research



Tempering ceramics, however, should not be seen as “noise”, as suggested by Neff et al. (1996). Instead I follow Burton and Simon (1996), Day et al. (1999), Carpenter and Feinman (1999), Rands and Weimer (1992), and Stoltman et al. (1992) in arguing for an approach to the cultural behavior of tempering that contributes to the overall sourcing of ceramics. I wish to elaborate this debate briefly. Neff et al. (1996) are correct to suggest that temper, such as volcanic ash, can detract from the ability to source ceramics to natural clay sources by enhancing or diluting concentration of certain elements. On the other hand, some tempers, like quartz, are neutral to the resultant chemical signature derived from INAA; they are composed of silicon (Si) and oxygen (O), two elements not included in minor and trace element analyses. Although Neff et al. (1996) are right that temper will confound elemental concentrations of clays, adding temper to paste is an influence that allows us to more specifically identify production loci by comparing the composition to other ceramics rather than raw material sources. Adding cultural variability to the natural variation in regional clay chemistry generates more interpretive power.

I join Burton and Simon (1993, 1996) in their criticism of viewing the cultural behavior of tempering in ceramic production as “noise”. If the ultimate objective of sourcing techniques is to identify the location of manufacture as well as resource procurement (both of which are valid anthropological concerns) cultural inputs to ceramics manufacture should be considered (see also Pool 1992:297).

Petrography has been proven as a sourcing technique in its own right (e.g. Sheppard 1936, Bishop and Rands 1980, Stoltman 1989, 1991, Day et al. 1999, Betts 1991, Peacock 1982). Petrography is especially useful when combined with chemical results. Because INAA is a bulk analysis technique, it cannot separate the chemical contribution of clay and temper unless the compositions of those components are known. Petrography provides a more direct method for evaluating the contributions of clay and temper to the mineralogical composition of ceramics, and complements the chemical analysis. In particular petrography may be able to detect differences in the behavior of preparing and mixing clay and temper from the same source that are culturally diagnostic. The limitation of petrography is that several sites may utilize the same production recipe, or the same production locality may employ several different recipes. Crosschecking mineralogical and bulk chemical results, thus, goes beyond ensuring the integrity of chemical data (Neff et al. 1989). In essence, each technique makes up for the limitations of the other. Petrography can find sources of cultural variability within broadly defined resource zones, while INAA enhances the integrity of the data and provides the means to discriminate among production loci that share the same recipe. Several authors have made this point (Bishop and Rands 1980, Neff et al. 1989, Arnold et al. 1991, Stoltman et al. 1992, Burton and Simon 1996, Carpenter and Feinman 1999, Day et al. 1999), but the argument usually centers on the benefits of one technique over the other rather than the complementary relation of the two employed together.

In combining these analytical techniques, I first assess the chemistry of ceramics and then use chemical groups as "knowns" from which the petrographic analysis will stem[3]. By using chemical groups as knowns, the petrographic data can be used to look for cultural variation within each natural resource geographically determined by INAA (i.e., within each chemical group). This group refinement procedure would be very useful to differentiate among prehistoric production entities from different sites that exploited the same natural resources (see Rands et al. 1992 and Day et al. 1999 for very similar methodology). Conversely, chemical groups (i.e., groups that reflect natural sourcing) give the compositional data secure analytical structure. These techniques cannot account for all variability in the archaeological ceramics, but they do consider more data than either technique employed on its own.

Chemical Analysis

Instrumental neutron activation analysis (INAA) is a technique that uses radioactive decay to measure the chemical signature of lithic and ceramic artifacts (Glascock 1992, 2000). Because of the nature of this analytical technique, a nuclear reactor is needed to irradiate powdered samples with neutron bombardment (Glascock 2000). The following elements were measured: short-lived -- aluminum (Al), barium (Ba), calcium (Ca), dysprosium (Dy), potassium (K), manganese (Mn), sodium (Na), titanium (Ti), and vanadium (V); middle-count -- arsenic (As), lanthanum (La), lutetium (Lu), neodymium (Nd), samarium (Sm), uranium (U), and ytterbium (Yb); long-count -- cerium (Ce), cobalt (Co), chromium (Cr), cesium (Cs), europium (Eu), iron (Fe), hafnium (Hf), nickel (Ni), rubidium (Rb), antimony (Sb), scandium (Sc), strontium (Sr), tantalum (Ta), terbium (Tb), thorium (Th), zinc (Zn), and zirconium (Zr).

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[3] It is, however, suggested that petrographic analysis be conducted blindly – only bringing in the chemical results after point counting is finished. This methodology ensures that investigator bias does not enter the formula (Stoltman 1989).

Although this research focuses on ceramic sourcing, a few words about obsidian sourcing using INAA should help illuminate the analysis of ceramics discussed below. Obsidian material sources are relatively homogeneous internally and distinct from one another. Since obsidian flows only protrude to the surface at distinct places within a given area (see Stark 1990:263 and Cobean et al. 1991 for locations of obsidian sources in central Mexico), the chemical signature of obsidian can be sourced to a specific point on the landscape. The identification of obsidian procurement sources therefore is a fairly straightforward task of matching obsidian artifacts found at archaeological sites to the chemical signature of their outcrops on the natural landscape.

Because clay resources are more widely distributed and the cultural inputs to pottery manufacture are more variable, sourcing archaeological ceramics is not as straightforward. Most regions studied in Mesoamerica contain many suitable sources of clay and temper. These raw material sources tend to be widespread in any region; however, they may vary in chemistry and mineralogy both stratigraphically and horizontally over a landscape. This compositional variability of pottery's material origin gives archaeologists meaningful data to make source retro-dictions, but it also creates heterogeneity that can complicate pottery sourcing. Clay chemistry often changes gradually over space and through the stratigraphic column (see Pool 1990 for an example in the Tuxtlas). Because of these natural gradations, statistical procedures must be used to cluster ceramics of like chemistry (Glascock 1992, Neff 1994, Neff and Bove 2000) (discussed below).

The presumption with ceramic sourcing in this study follows an adjusted "Provenience Postulate" (Weigand et al. 1977, Bishop 1980) proposed by Pool (1990:315), which states:

1) Chemical and petrographic variation among clay sources are greater than the variation within clay sources.
2) These differences are recognizable in the compositional profiles of ceramics made of clay from a particular source.
3) Potters exploit the most appropriate nearby clays for the manufacture of particular pastes.

As Pool notes, the first two points above simply restate the "provenience postulate" while the third incorporates Arnold's (1985) work on the distance potters travel to procure their material.

It is assumed that potters will select the best clays to manufacture any given vessel while balancing the cost of procurement (Arnold 1985). That is, one will not travel 10 km for slightly better clay than is available 1 km away. Because of the diversity and availability of clay within the Tuxtlas, Arnold's (1985:24-25) 1 km threshold for clay procurement seems to be appropriate for this study. Ash temper is widespread and most potters would not have to walk far to procure this ubiquitous material. Furthermore, different ash deposits may mix together in streams and rivers. Because of the tendency to exploit local resources, pottery manufacture at different points on the landscape should reflect the natural variation of raw material chemistry. If ceramics made from non-local clays are found at a site, exchange can be inferred. Many studies of archaeological ceramics gather the chemical composition of both clays and ceramics for sourcing comparison. However, considering the likelihood that potters exploited local resources in ancient Mesoamerica, disparate material use can be inferred from chemical differences observed in the ceramics themselves. The latter approach can be used to identify zones of production by mapping the distribution of ceramic chemical groups over a landscape. Both approaches to interpreting chemical data involve the inherent assumption that variation in geology correlates with variation in ceramics produced at different locations.

Given the benefits of using compositional variability for sourcing ceramics with INAA, researchers have concentrated on refining our knowledge of economic interaction over the past 30-40 years. Stylistic markers of ceramic traditions are too easily copied to define economic interaction. The decoration, form, and general recipe of Coarse Orange could have been duplicated at many different locations within the Tuxtlas, yielding a seemingly singular ceramic tradition when examined macroscopically. What style does symbolize is the sharing of ideas over broad cultural spaces. We often see, in archaeology, the broad dissemination of a single pottery style or design over large geographic spaces (e.g., Harbottle et al 1976, Kolb 1986, Rands and Bishop 1980, Santley 1994, Neff and Bove 1999). However, exchange in these cases may be obscured by local imitations of the same ceramic ware. Compositional techniques, INAA among them, have been designed to refine zones of production and exchange to more accurately characterize regional economies.

Neutron activation for this research took place at the Missouri University Research Reactor (MURR) under the direction of Hector Neff and Michael Glascock. Powdered clay samples from Pool's (1990) XRF analysis were also irradiated to secure comparability between INAA and XRF data sets and to characterize the geological variation of the region. Chemical groupings for the Coarse Orange ceramics were compared to the clay groups to identify the natural sources of clay used in Coarse Orange manufacture. Following Neff et al. (1994)

compositional profiles were made for each site, showing the relative contributions of each chemical group to the assemblages made from consumption contexts at each site. As shown by the previous research mentioned above, this enables us to identify broad zones of production and exchange and the source of ceramics found at each site.

MURR data processing and my own statistical analysis both involved transforming the data from parts per million (ppm) of the element (as opposed to their oxides) to log base 10 concentrations. This step is necessary to ensure variables that have very high ppm values (major and minor elements) do not dominate the variability evident in trace elements. Principal components analysis (PCA) was employed to reduce the data into major axes of variation based on a variance/co-variance matrix. Without performing this multivariate statistical procedure we would be limited to visually comparing two elements at a time. PCA is an ordination procedure that combines the variation observed in each individual variable based on their relationship in multidimensional space (Davis 1986, Shennan 1997:265-287, Glascock 1992). Each principal component explains a portion of the total variance in the chemical data. The first principal component explains the most variability, followed in diminishing quantities by the second, third, and so on. For this reason the majority of variability in the ceramic's chemistry can be explained with a few new variables extracted out of a correlation or covariance matrix of the relationships between the original variables. These principal components are used for all subsequent statistical procedures.

Neff's analytical procedure involved "pattern recognition followed by group evaluation based on Mahalanobis distances" (Neff personal communication 2002). Clustering procedures also have been traditionally used in chemical studies of ceramics. Glascock (1992) explains the MURR procedure as first employing average-link agglomerative cluster analysis based on squared Euclidian distance. Many others use this course of action to establish prior group membership (Hodge et al. 1992, Hodge and Minc 1993, Day et al. 1999, Pool and Santley 1992). Hierarchical dendograms provide the basis for assigning samples to groups. Hodge et al. (1992) suggest that only samples that have a much higher probability of belonging to one group over another are included to make up the "core" of each group. Those that have roughly equal probabilities of membership in more than one group remain unassigned unless some justification for inclusion in a single group can be made. After initial groupings are designated using cluster analysis, Mahalanobis distances are employed to determine posterior probabilities for best group membership. This procedure allows for deviations from the hyperspherical shapes defined by Euclidean measures (Neff and Bove 1999:104). Final groupings are displayed on an RQ-mode principal component plot for visual inspection. Combining the R and Q modes allows us to simultaneously see the cases and how they are influenced by the variable loadings.

After chemical groups are identified, these groups are plotted on a map of the region to allow visual assessment of trade. Clays, because they were sampled individually, are plotted by their specific UTM coordinates. Ceramic compositions, because they were sampled at sites, are expressed as the site's compositional profile for Coarse Orange (see also Neff et al. 1994). The clustering of these profiles is used to delineate zones of production and exchange.

Petrographic Analysis

A sub-sample of 95 sherds was examined petrographically. Methods for petrographic analysis followed Stoltman (1989, 1991, 1999), Betts (1991), and Day et al. (1999). This methodology combines qualitative and quantitative petrographic data through mineral identification and grain size measurements derived from point counting. Behavioral and technological variation between production localities influences the ratio of temper to clay, the kind of temper, the size of temper particles, the angularity of grains, the mineral constituents of paste and temper, and the restructuring of minerals upon firing (Stoltman 1989, Carpenter and Feinman 1999, Rice 1987:93-96). Petrography is capable of identifying these variables, and thus targets cultural as well as natural variation in ceramics manufacture (Rands and Bishop 1980).
As mentioned above, I intend to use the petrographic data as a tool to refine the broad chemical groups defined by INAA. Rands and Weimer (1992) and Day et al. (1999) use similar methodology. Rands and Weimer (1992) use petrographic data (and stylistic data, not discussed here) to interpret chemical data previously defined as the Macro-Palenque group in the western Maya Lowlands (Rands and Bishop 1980, Bishop 1975). They regard chemical procedures as the most powerful analytical techniques employed to characterize archaeological ceramics, but they do recognize the benefits of adding petrographic analyses to chemical data to refine group designation.

> Suppose, for example, that clearcut petrographic distinctions are present but were not reflected in the initial partitions of the chemical data set. This could suggest that the level of discrimination was "inappropriate" in the statistical analyses of

> the chemical data and that, to facilitate archaeological understandings, a different (perhaps more refined) level might be sought. (Rands and Weimer 1992:34)

Rands and Weimer use Q-mode principal component analysis[4] to assess "structure in previously formed groups and [to isolate] phenomena that new groups should satisfy (1992:53)". Q-mode analysis is a procedure that allows comparison of relationships between cases. I employ a Q-mode analysis but use statistical measures to determine group membership (described below).

Petrography is used in the current research to refine chemical groupings. The chemical variation of clays in the Tuxtlas makes it difficult to designate more than broadly defined chemical groups within the Coarse Orange ware. Although the differences in scale and intensity of ceramic production mentioned in the previous chapter facilitate interpretation, it would not be wise to conclude that one site provided all of the ceramics of a particular chemical group, if other sites had access to the same clay and temper resources. Bringing cultural influences to bear on the refinement of chemical groups should strengthen my interpretive power. This approach actively investigates the use of different production recipes (Arnold et al. 1991) not as a problem to be overcome, but as a way to make more specific inferences about the location of pottery production.

Day et al. (1999) demonstrate this dual-approach (see also Stoltman et al. 1992, but see criticisms of the acid-extraction method above) for the island of Crete. INAA has divided the island of Crete into three broad compositional zones. The ceramics defining these zones were thought to have been produced at major Bronze Age sites on the island, and they formed three "control groups" to which subsequent chemical fingerprints could be compared to infer their origin. However, Day and Wilson (1998) suggested that these major sites were actually ceremonial centers, which consumed pottery but did not produce it. Day et al. argue that petrographic analysis has identified individual production centers within those original chemical groupings. The petrography made clear distinctions between groups of ceramics where the chemical data did not.

I believe that the Tuxtlas presents a similar case to Bronze Age Crete, as far as the relative contributions of INAA versus petrography. One major difference exists between the two cases, though. Matacapan was a center for the production of Coarse Orange and not strictly a

[4] Q-mode analysis in this case utilizes ternary diagrams to plot the factor scores for individual cases on the first three principal components.

consuming ceremonial center. Matacapan provides a true case for a "control group" as defined chemically and mineralogically by analysis of ceramics that were obtained from secure production contexts. This was not the case with Crete. Despite this advantage, we cannot assume, via central-place theory, that Matacapan was the sole supplier of Coarse Orange in the region. Indeed, we currently do not know if Matacapan traded any ceramics beyond the site's boundaries. Chemical groups help us address this problem, but several producing sites had access to the same clay and temper resources as Matacapan. These sites may yield chemically similar ceramics, but it is possible that their production recipes will vary. Alternatively, if Coarse Orange was used for similar purposes across the Tuxtlas, it may be that a particular recipe provided optimal performance characteristics for this use (Schiffer and Skibo 1987, 1997), and recipes may be similar for that reason. The application of petrography is essential to substantiate any conclusions that Matacapan was supplying the region with ceramics. Furthermore, combining the two techniques will allow me to more specifically evaluate economic interaction on an individual site basis.

Stoltman (1989, 1991) provides the methodological basis for my petrographic analysis. He advocates the use of several indexes characterizing the texture and mineral composition of ceramics. Geologists often use textural measures to characterize sediment according to relative proportions of clay, silt, and sand. These are size designations for the constituent parts of the sediment in question, and these provide an excellent means to differentiate between different sediment textures. Stoltman notes that natural clays occurring over a broad area display different textural properties that pattern distinctly over a region's natural geography. The area of study in this research is smaller, but textural variation in clays may also occur within the Tuxtlas. Pool's (1990) research on clays in the Tuxtlas suggest that clays from the top of the Upper Concepcion will contain more quartz and sandstone inclusions than lower deposits. Outcrops will therefore vary texturally with their vertical position within this Tertiary clay formation. Because clay sources contain different proportions of clay, silt, and sand sized particles, ceramics will also display these qualities. Furthermore, the addition or removal of mineral aplastics (anything above clay sized particles) will culturally influence the texture of the ceramic; this potter-infused variation may yield very specific source predictions.

As mentioned above, potters will select the kind of temper, amount of temper, size of temper particles, the raw clay used, and firing technology early on in the production process.

Petrography is the most sensitive analytical technique to these cultural inputs. Stoltman's preferred procedure is to count points in the ceramic paste using a petrographic microscope. In my research, a 0.66 mm grid interval was set up on each thin section. The mineral falling under each point was identified, and it was measured using the Wentworth scale of grain size (Stoltman 1991:108). Clay particles are not distinguishable using a petrographic microscope, so each clay grain was simply defined as part of the clay matrix. Natural inclusions in the clay, however, were identified as silt (0.002–0.0624mm), very fine sand (0.0625-0.124mm), fine sand (0.125-0.249mm), medium sand (0.25-0.499mm), coarse sand (0.5-.99mm), very coarse sand (1.0-1.99mm), or gravel (> 2.0mm). At least 100 points were counted for each sample.

Aplastics added as temper were also identified for size and mineral composition. Presence of volcanic ash was one of the criteria for selecting my sample, so every sherd had temper added to the clay to produce the ceramic. Temper can be identified based on either a bimodal distribution of grain size or the angularity of grains. The natural process of sediment deposition does not tend to sort clay aplastics bimodally according to size. That is, one will not normally find high proportions of silt and coarse sand with few particles of intermediate size in naturally occurring clays. If the frequency of the grain size modes within the thin section is bimodal cultural addition of material can be inferred. However, if there is a gradual transition of inclusions from small to large this most likely reflects natural deposition of sediment. The distribution of grain sizes in my sample was determined after all data was collected. Natural sediment deposition also does not usually consist of very angular minerals. Potters, on the other hand, often crush temper before it is added to the clay. Frequent occurrence of very angular particles may suggest the addition of temper. I made the assessment of angularity as I collected the point counts. As discussed in the next chapter, non-volcanic ash particles were very rarely angular and usually appeared as round to very round grains on the scale of sphericity. Because the most frequently occurring non-ash particle in the Coarse Orange ceramics was quartz sand, however, the roundness of grains could be indicative of its source as river or beach sand. Although this keeps the assumption that it was temper valid, I believe that quartz was natural to the clays because of their selection from the upper strata of the Concepcion formation.

I will present the results of the petrographic study in ternary diagrams that display the proportions of clay, silt, and sand sized particles in the *clay matrix* and the proportions of clay, temper, and all larger than clay sized natural inclusions in the *paste* of the ceramic. Clay grain size composition is a measure of the natural clays used for manufacture of a ceramic, while paste is most sensitive to the potter's addition of temper. It is important to use these measures of grain size and proportion when investigating ceramics tempered with the same material. Temper mineral identification is insufficient to differentiate between groups of ceramics in this case. However, the qualitative aspect of the paste and temper may provide insight to understand the chemical difference derived from INAA. The difference between Group 1 and Group 5 ceramics (discussed below) was thought to have derived from the potter's choice of clays. Thus, qualitative variation of mineral inclusions are included in the statistical analysis.

The petrographic data are analyzed in a similar way as the INAA data: using principal components analysis and distance measures to determine groups of composition that vary significantly enough to suggest distinct sources of production[5]. The types of data processed, however, differ slightly. The point counts are first expressed as percentages of a whole. . Principal component analysis omits cases with missing values, which would eliminate about half my petrographic data. Therefore, to avoid losing data in the transformation to log base 10 concentrations the quantity of 1 was added to all point count valuesAdding 1 to all data shifts the distribution up and over in principal component space, but should not affect the relations between groups. After the principal components were extracted, hierarchical cluster analysis (based on Ward's method[6]) was used to initially explore the data. Following that, a prior probability of K-means clustering was established based on Squared Euclidean distances (see Garraty and Stark 2002:33 for an explanation of this procedure). I use this procedure because it best determines how many groups, resulting from cultural or natural inputs, should be recognized. The level of specificity is a frequent problem in defining compositional groups (Rands and Weimer 1992). By running a series of K-means cluster solutions and summing the squares of the errors observed in each solution, I establish a rationale for the selection of number of groups based on minimizing error. As more clusters are allowed in the solution, the error necessarily drops. A sample of 90 sherds with a cluster solution of 90 will have a sum of squared errors (SSE) of zero because each sample forms its own group. When deciding how many clusters are to be used it is important to plot the SSE for each solution and select the case that departs from the downward slope of the line made when SSE is plotted against cluster

[5] Each group defined by these procedures should be seen as a potential source of production.
[6] Ward's method uses the same procedure as K-means cluster analysis. To minimize error in group clusters it uses a sum of squared error.

number. Because this involves a blind assessment of the data, I prefer to first investigate the patterning of clusters with an agglomerative hierarchical cluster analysis to ensure the appropriate cultural sensitivity of the resultant groups.

Mahalanobis distances were then employed to determine the probability of best group membership. This multidimensional distance measure ensures that the hyperspherical tendencies of Euclidean distances do not artificially define compositional groups in the data. Prior to running this statistic, however, samples that had very high prior probabilities of core group membership were removed from the core groups. Posterior probabilities are greatly affected by the measures used to infer prior probabilities. Thus, the probability of posterior assignment to groups will be inflated by high prior probabilities.

Like the chemical groups, petrographic groups were mapped over the landscape to assess zones of production and exchange. Particular attention will be paid to Matacapan samples and those from other producing sites. Known production loci are anticipated to form the center of the geographic patterns evident for compositional groups. Ceramics of like composition that occur outside the main spatial clustering of that group provide the strongest evidence for trade.

Chapter 6

COARSE ORANGE EXCHANGE

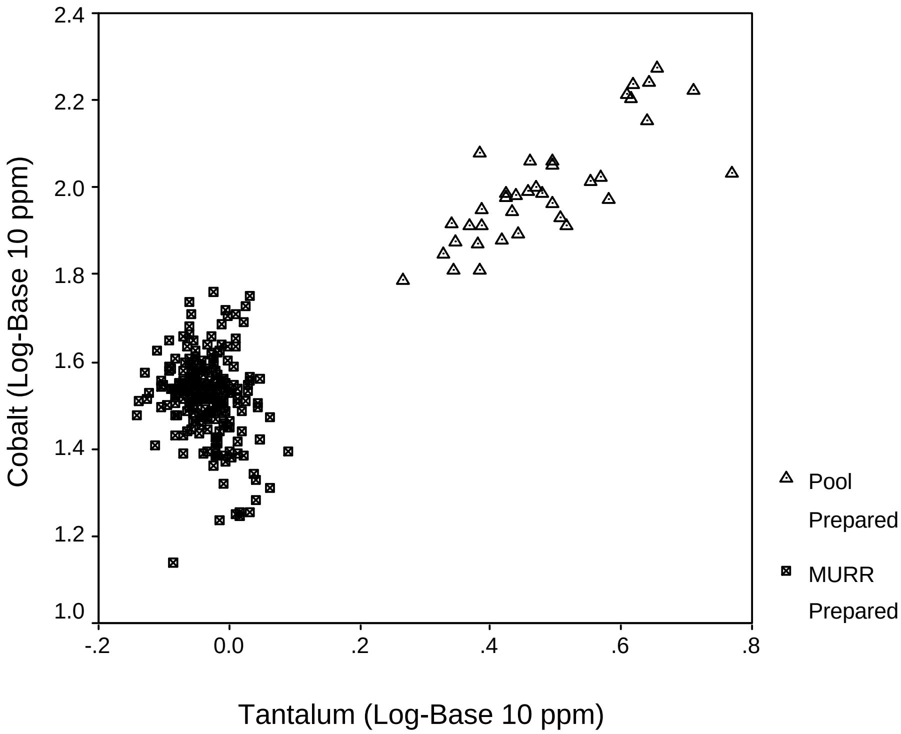
Compositional groups from the chemical and petrographic analyses show interesting geographic patterns that divide the Tuxtlas into two major zones of production and exchange, with some minor zones present as well. In this chapter, I discuss the results of both analyses and attempt to identify cultural patterns that can shed light on the hypotheses constructed in Chapter 4.

The first batch of chemical results raised suspicions that variable preparation of specimens contaminated a portion of the sample. Clays and some of the Matacapan ceramics taken from Pool's dissertation research were already powdered as part of his original study. Pool's use of tungsten-carbide tools (which have both tantalum and cobalt in them) to powder those samples raised the levels of tantalum (Ta) and cobalt (Co) counted by MURR (see Figure 6.1). With this in mind, Ta and Co were removed from consideration in the final dataset.

Since this research uses multiple data sets, a few words about how I correlate group names is necessary. First, effort will be made to preserve Pool's (1990) original clay distinctions. However, the MURR groups showed correlation with, but did not match exactly, Pool's groups (discussed below). To show this correlation, while keeping them distinct, Pool's groups C, M, S, and Z will be identified with subscript labels that designate the X-ray Fluorescence technique Pool employed: Group C_{XRF}, Group M_{XRF}, Group S_{XRF}, and Group Z_{XRF} respectively. Only two clay groups resulted from the MURR analysis, but they mostly correlate with Group C_{XRF} and Group S_{XRF}; I therefore utilize the names Group C_{NAA}, and Group S_{NAA} to refer to these clay groups derived from the analysis at MURR (discussed further below).

As for the ceramic groups identified by MURR, I employ Neff and Glascock's (2002) original names. But, to keep them distinct from my petrographic groups, I add the subscript "NAA" for all MURR groups (e.g., Group 1_{NAA}). Since I had chemical results for my entire petrographic sub-sample, the two datasets were easily searched for correlations. Petrographic groups were assigned the MURR group number to which they most strongly correlated. Differences do exist between the datasets, so the petrographic groups are identified with a "PET" subscript (e.g., Group 1_{PET}). More specific group comparisons are made below.

Figure 6.1. Showing the effect of variable sample preparation.



Results of Chemical Analysis

The principal component loadings from the MURR Data reveal the major axes of variation within the overall chemical compositions of the Tuxtlas ceramics and clay (Table 6.1). As apparent from the component loadings, Calcium (Ca) and Strontium (Sr) are the strongest elements contributing to the first principal component. Because it corresponds to previous analyses (Pool 1990, Pool and Santley 1992) and it independently reproduces the groupings evinced by the first principal component, Ca is used in subsequent discussions to best represent the first principal component axis. Chromium (Cr) is the strongest element contributing to the second principal component, and will be used in subsequent discussion to represent this axis of variation.

Two clay and five ceramic groups emerged from the final chemical analysis at MURR. The separation of groups can be seen in principal component space (Figure 6.2) and by isolating the strongest elements on the first two principal components, calcium and chromium (Figure

Table 6.1. The Principal Component Loadings for the Chemical Analysis based on Co-variance Matrix.

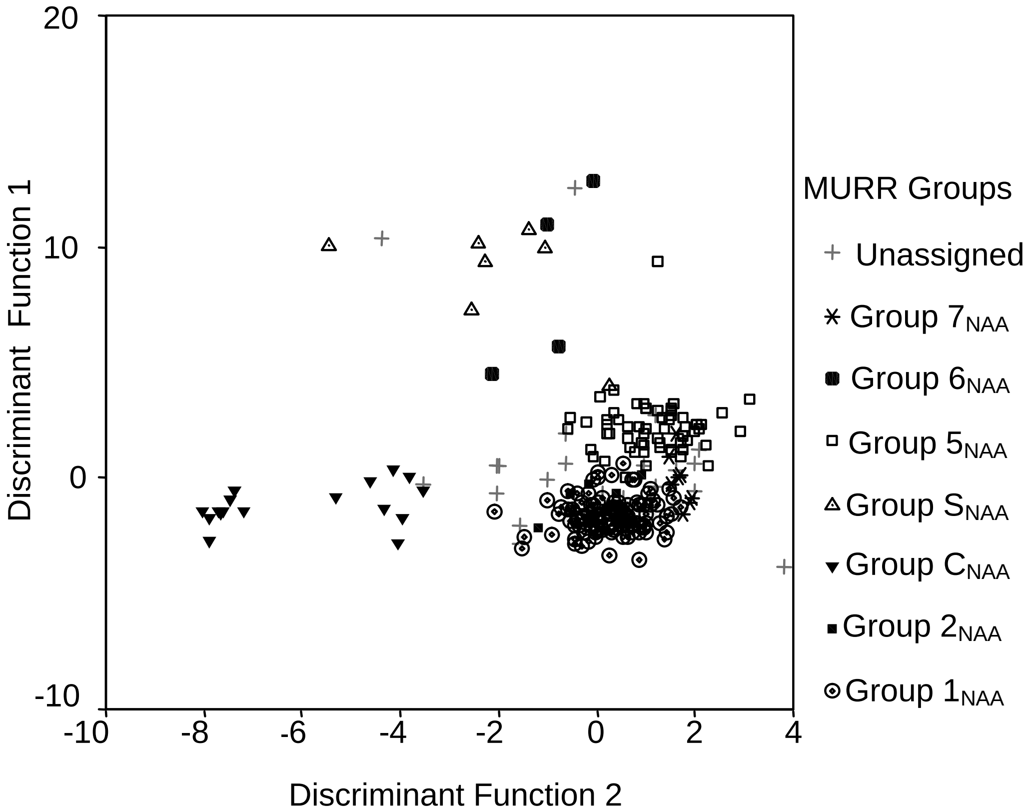
	Raw Component				Rescaled Component			
Element	PC1	PC2	PC3	PC4	PC1	PC2	PC3	PC4
As	.119	-.090	-.141	.051	.546	-.410	-.646	.232
La	.026	.003	.013	.023	.557	.067	.270	.488
Lu	.047	-.006	.018	.018	.693	-.085	.262	.272
Nd	.026	.006	.012	.033	.364	.089	.170	.454
Sm	.030	.006	.014	.030	.522	.109	.238	.522
U	-.008	-.072	-.004	.019	-.065	-.603	-.035	.155
Yb	.057	-.006	.021	.025	.738	-.076	.279	.325
Ce	.016	.004	.008	.025	.301	.071	.158	.467
Cr	-.097	.187	-.001	.029	-.437	.844	-.003	.132
Cs	-.046	-.125	.067	.054	-.270	-.729	.392	.314
Eu	.032	.025	.011	.030	.503	.394	.172	.462
Fe	-.031	.049	-.009	.018	-.453	.711	-.132	.269
Hf	.057	.005	.013	.000	.733	.059	.163	.003
Ni	-.052	.190	-.002	.035	-.239	.875	-.007	.163
Rb	-.017	-.088	.062	.029	-.137	-.704	.498	.231
Sb	.043	-.067	.012	.035	.389	-.603	.104	.316
Sc	-.018	.052	.011	.012	-.260	.771	.162	.185
Sr	-.179	-.040	-.023	-.014	-.870	-.194	-.113	-.069
Tb	.040	.011	.004	.033	.506	.138	.055	.420
Th	.004	-.012	.009	.008	.103	-.351	.265	.221
Zn	-.009	.010	.002	.015	-.106	.126	.019	.185
Zr	.049	.010	.011	.006	.504	.102	.116	.065
Al	.016	.011	.014	.006	.380	.272	.333	.133
Ca	-.223	-.113	-.035	.000	-.855	-.431	-.132	-.002
Ba	.085	.030	.004	-.070	.513	.183	.022	-.424
Dy	.058	.010	.024	.018	.681	.120	.286	.210
K	-.014	-.061	.047	-.003	-.138	-.582	.452	-.026
Mn	-.060	.058	-.031	.055	-.424	.415	-.220	.393
Na	-.090	-.022	-.003	.007	-.720	-.173	-.023	.057
Ti	.008	.046	.012	-.005	.101	.602	.161	-.061
V	-.030	.032	.006	.013	-.440	.462	.087	.193

6.3). Group C_{NAA} and Group S_{NAA}, the clays, were preserved in the final analysis regardless of the removal of contaminating elements Ta and Co. Group 2_{NAA}, however, collapsed into the larger Group 1_{NAA} (Figure 6.3), and will be treated as part of Group 1_{NAA} in subsequent analyses. Producers of Group 1_{NAA} (which from this point on includes Group 2_{NAA}) and Group 7_{NAA} Coarse Orange ceramics appear to have preferred Group C_{NAA} clays, and producers of Group 5_{NAA} and Group 6_{NAA} Coarse Orange appear to have preferred Group S_{NAA} clays.

The ceramic groups show less compositional separation than clays. This is expected of bulk analytical techniques when different clay sources were tempered with a common material, volcanic ash in this case (see Neff et al. 1989, 1988). Ash was available over much of the region, making this temper available to all potters in the study area[7]. Regardless of the effects of ash in this study, it does not prohibit the delineation of chemical compositional groups that reflect choice of natural clays.

[7] Tuxtlas volcanic ash differs extremely from other ash found in Mesoamerica (Pool et al. 2001), though, making it a good diagnostic for interregional sourcing.

Figure 6.2. Showing the final groupings of all clay and ceramic groups.



I must foreshadow the petrographic results here because they inform the "anomalous" (Neff and Glascock 2002) separation of the 4 Group 6_{NAA} specimens and a subset of the unassigned samples. Group 6_{NAA} appears strongly associated with Group S_{NAA} clays. The petrographic results suggest that this is because each of those 4 sherds were very lightly tempered with volcanic ash and contained many larger sized quartz inclusions. In fact, these ceramics were probably manufactured using a relatively unmodified version of the Group S_{NAA} clays. This possibility is explored below. Likewise, all of the Pit 6 ceramics from Matacapan were unassigned because the producers of this ware, attached specialists located within the elite core of Matacapan, employed a very distinct recipe of fine textured clay with comparatively little volcanic ash temper. The scatter plots present an ambiguous picture regarding which clay was used to produce these ceramics, but its distinctiveness (Figure 6.4) merits a Group designation of its own: from here on out considered to be the Pit 6 Group. A cross tabulation of each site's compositional profile is given in Table 6.2.

Figure 6.3. Showing the separation of chemical groups based on calcium and chromium.

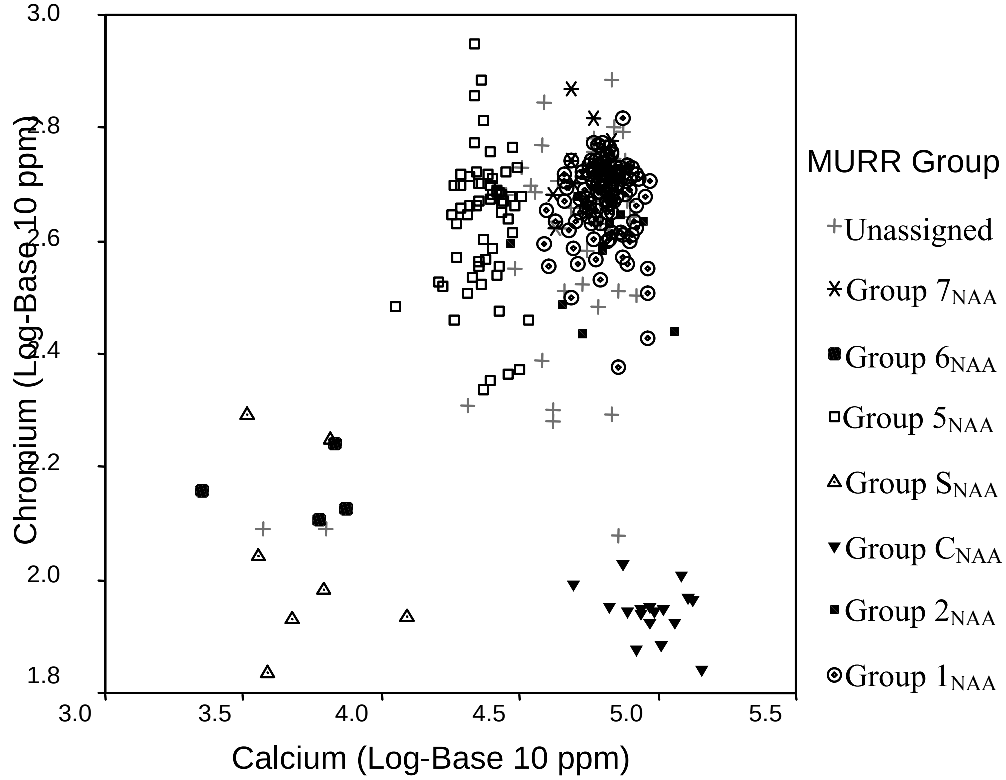
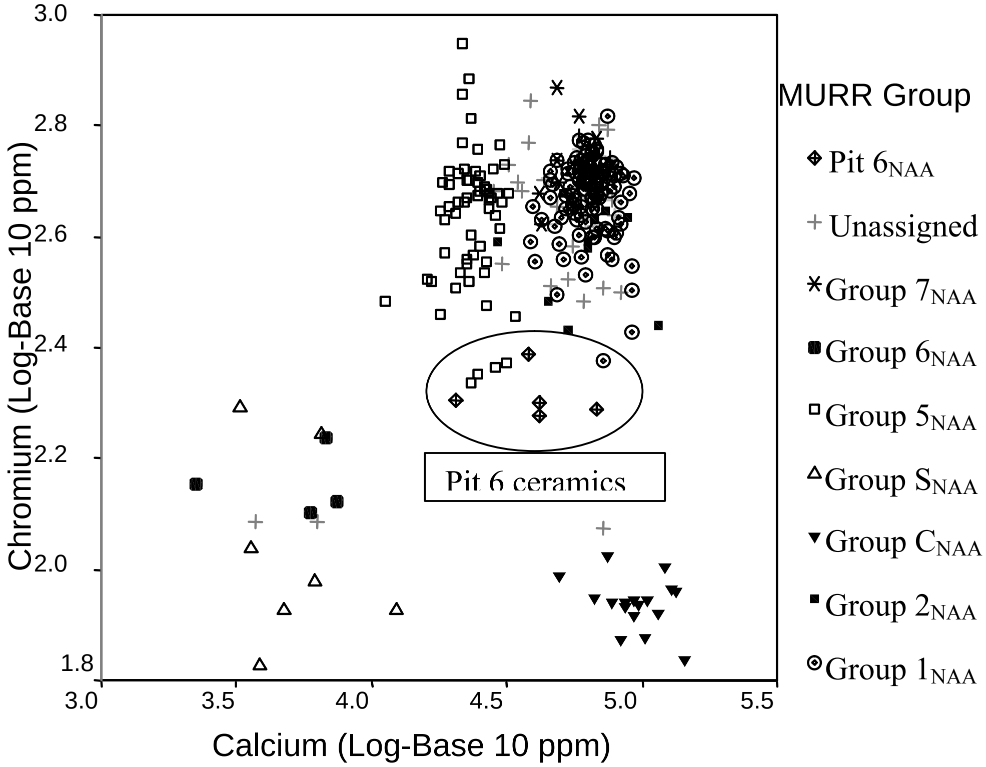


Table 6.2. Cross tabulation of groups sorted by site

	GROUP DESIGNATION								
	1 (and 2)	3	4	5	6	7	Pit 6	Unassigned	Total
SITE Clays	1	17	7					3	28
132	8			1				5	14
143	11			2				2	15
154	1			11		3			15
170	1			13				1	15
39	6			8				1	15
48	9							6	15
APOMPONAPAM (118)	8			3				4	15
AGALTEPEC (124)	11			1				3	15
RANCHOAPAN (45)	12					1		2	15
TEOTEPEC (141)	7			2		3		3	15
EL SALADO	11			2				1	14
HUEYAPAN AREA	20			4	4			2	30
MATACAPAN	--	--	--	--	--	--	--	--	--
Comoapan	6								6
Pit 6							5*		5
Pits 93 and 94 (SE locality)	5					1		3	9
Western Locality	4								4
TRES ZAPOTES	1			14					15
Total	122	17	7	61	4	8	5	36	260

* This total is affected by the petrographic analysis

Figure 6.4. Same as 6.3 but showing the separation of Pit 6 ceramics.



Pool (1990) previously identified more diversity among the clays than reported by MURR. Clays from three of Pool's groups (C, M, S) were sent to MURR but only two groups were detected. This difference originates mostly from the analytical techniques employed. Pool distinguished Group M_{XRF} clays through visual inspection of the correspondence between stratigraphic and geographic locations of his sample, on the one hand, and Q-mode principal component scores on the other (Pool and Santley 1992:223). These procedures differed from the 90% confidence interval employed at MURR to define groups. Under MURR's analysis, Group M_{XRF} appears as a subgroup of Group C_{NAA}. I use MURR's two clay group distinction for the rest of this thesis for simplicity. The utility of identifying clay subgroups for reconstructing Coarse Orange exchange can be evaluated when the sample size and geographic extent of the survey is larger.

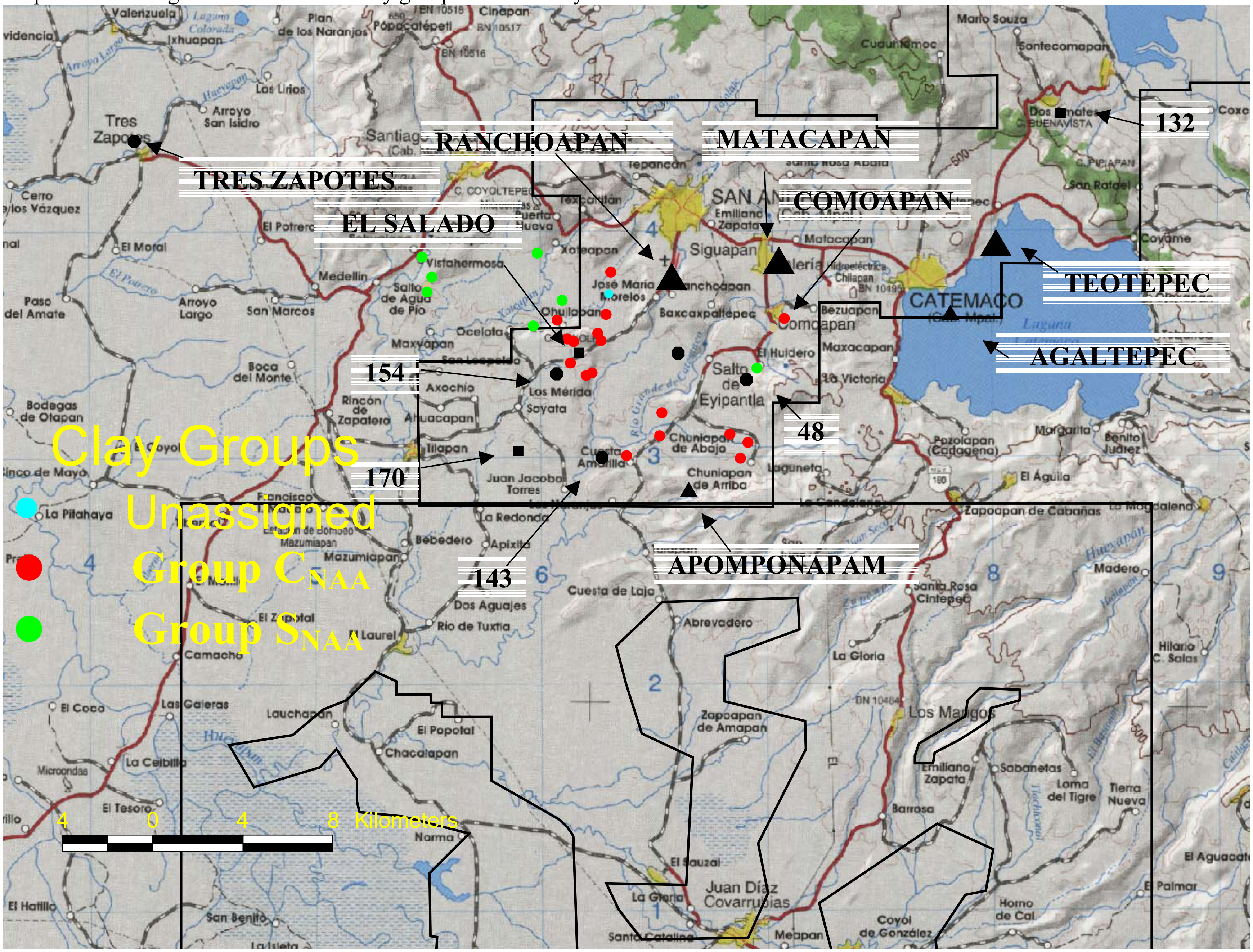
The MURR clay groups closely, though not perfectly, replicate Pool's clay groups (Table 6.2). Considering the gradual nature of the transition between clay chemistries in the Tuxtlas the very clear-cut separation of two clay groups suggests that two compositionally distinct strata were available to potters for clay procurement. These were major outcrops occurring in two different mountain drainages where erosion exposed different stratigraphic levels of the Concepción formation. Recall that as one goes deeper into the Concepción stratigraphy, clays become richer in calcium. This explanation suggests use of at least two disconnected resources for making prehistoric pottery that existed in spatially discrete locations on the landscape.

Table 6.3. List of MURR groupings versus Pool's XRF designations

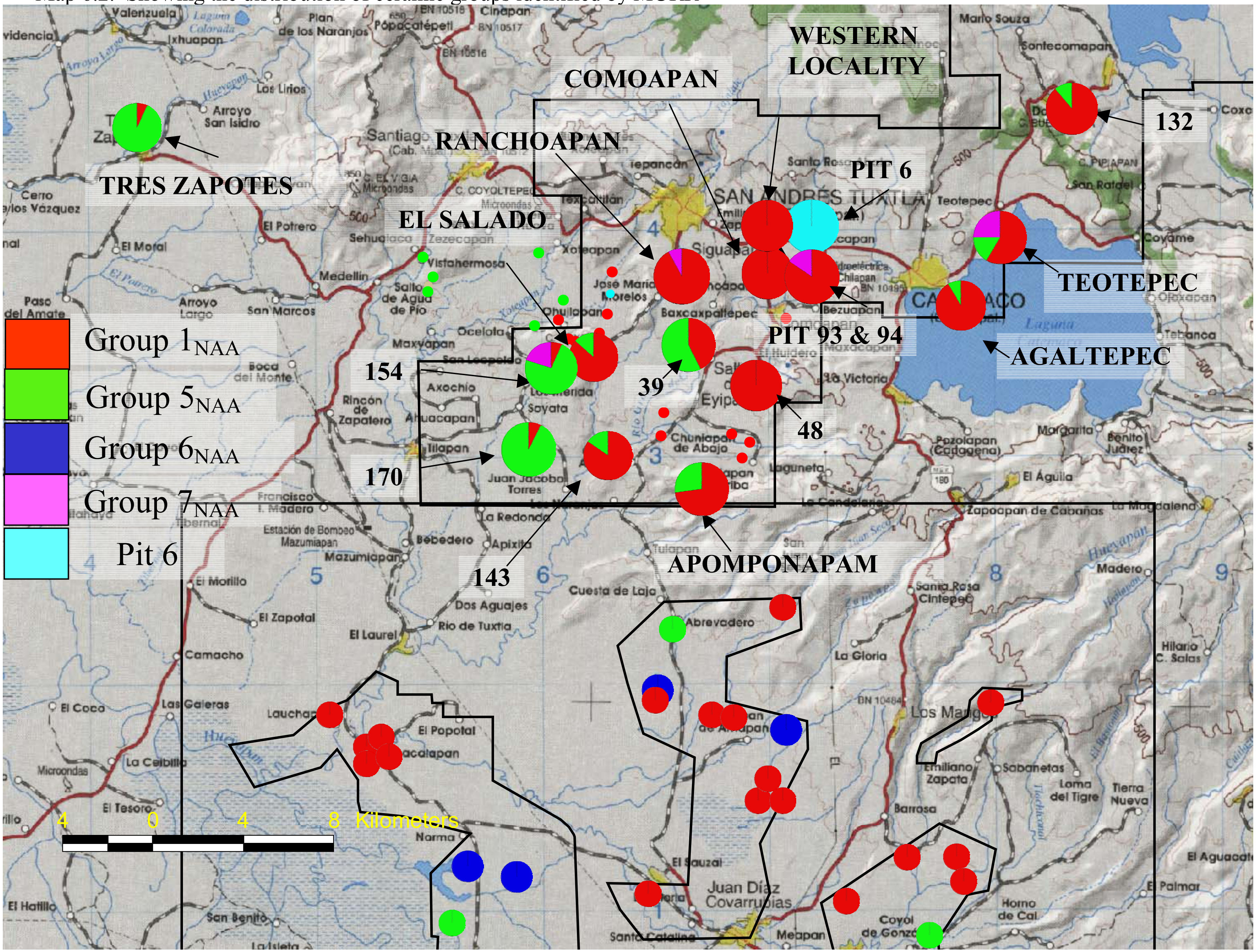
MURR Group	Sample #	Pool's Group
Group C_{NAA}	PK307	Group S_{XRF}
Group C_{NAA}	PK310	Group S_{XRF}
Group C_{NAA}	PK317	Group C_{XRF}
Group C_{NAA}	PK318	Group C_{XRF}
Group C_{NAA}	PK319	Group C_{XRF}
Group C_{NAA}	PK320	Group C_{XRF}
Group C_{NAA}	PK321	Group C_{XRF}
Group C_{NAA}	PK322	Group C_{XRF}
Group C_{NAA}	PK323	Group C_{XRF}
Group C_{NAA}	PK324	Group C_{XRF}
Group C_{NAA}	PK326	Group C_{XRF}
Group C_{NAA}	PK327	Group C_{XRF}
Group C_{NAA}	PK329	Group M_{XRF}
Group C_{NAA}	PK330	Group M_{XRF}
Group C_{NAA}	PK332	Group M_{XRF}
Group C_{NAA}	PK333	Group M_{XRF}
Group C_{NAA}	PK337	Group S_{XRF}
Group S_{NAA}	PK311	Group S_{XRF}
Group S_{NAA}	PK312	Group S_{XRF}
Group S_{NAA}	PK316	Group S_{XRF}
Group S_{NAA}	PK325	Group C_{XRF}
Group S_{NAA}	PK331	Group M_{XRF}
Group S_{NAA}	PK336	Group S_{XRF}
Group S_{NAA}	PK338	Group S_{XRF}

The clay groups pattern distinctly from east to west (Map 6.1). Group C_{NAA} clusters in the eastern portion of the study area around Matacapan, and includes Group M_{XRF} samples from the nearby drainage. Group S_{NAA} clays appear further to the west and southwest in the Tuxtlas.

Map 6.1. Showing the distribution of clay groups identified by MURR



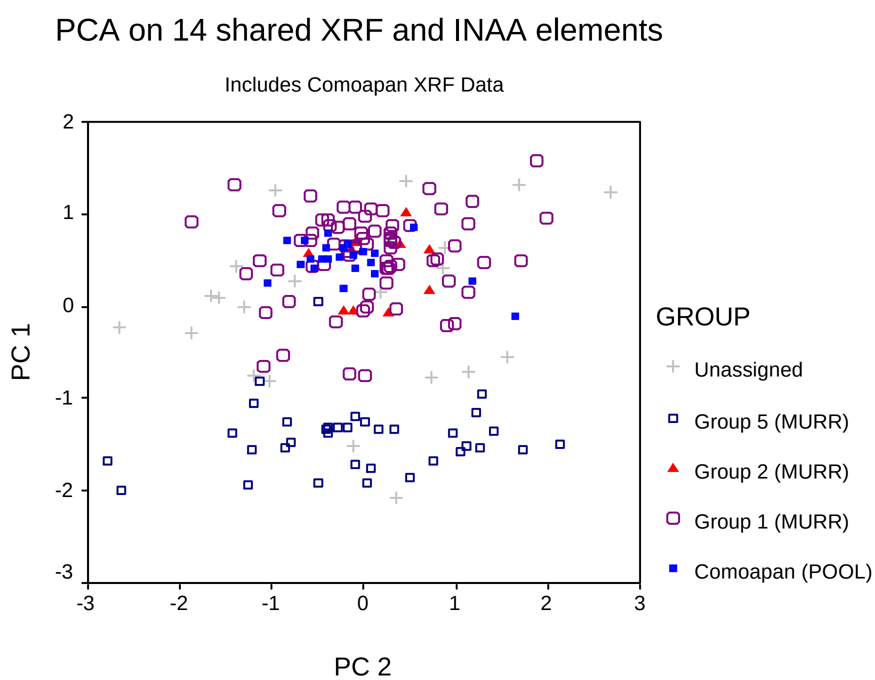
Map 6.2. Showing the distribution of ceramic groups identified by MURR



Map 6.2 illustrates the geographic patterning of ceramic compositions. A point of clarification is needed here. Because site names were given to artifact concentrations in the Hueyapan survey to the south, one sherd was instead selected from a randomized systematic sample of the collections. The smaller "pie charts" to the south represent single samples, while the larger pie charts within the northern survey boundary represent about 15 samples each. The ceramic groups generally coincide with the east to west division of clay chemistry noted by Pool (1990; Pool and Santley 1992) (Map 6.2). This reinforces my suggestion that the variation observed among the ceramics analyzed by MURR probably resulted from the potter's selection of one of these two groups of clays. However, significant exceptions do occur and will be discussed in the next section.

To further examine the potential role of Comoapan in the intraregional exchange system, I conducted an additional principal components analysis that included Pool's XRF data on 23 samples from Comoapan (Figure 6.5), using 14 elements held in common between the INAA and XRF datasets. The 14 variables utilized were sufficient to replicate the division between Group 1_{NAA} and Group 5_{NAA} ceramics. Furthermore, all of the Matacapan and Comoapan ceramics collapsed into Group 1_{NAA}. So, every production locus at Matacapan apparently utilized the same clay resources – as evidenced by the homogeneous compositional profile constructed for Matacapan.

Figure 6.5. Bi-plot showing the placement of Comoapan ceramics into Group 1_{NAA}



Discussion of Chemical Results

In this discussion, I draw upon archaeological evidence for ceramic production and the geographic distribution of clays in relation to the distribution of ceramics to determine possible exchange relationships in the Tuxtlas. I use Arnold's 1 km and 7 km thresholds to structure the analysis of exchange for each compositional group. Ceramics found at sites greater than 7 km from the clays used in their production are the best candidates for exchange. Clay, particularly wet clay, is very bulky, and distances greater than 7 km are farther than a potter would normally walk in one day to procure clay resources and still return to their homes. Since clays were available to the majority of the central Tuxtlas, it is thought that a 1 km threshold may also be informative for reconstructing exchange. Maps 3.1 and 6.1 should be consulted for distance to clay sources. After these broad patterns are discussed, I turn to relative emphasis on ceramic production by site to further inform exchange interpretations.

Group 1_{NAA} ceramics primarily cluster in the eastern portion of the Tuxtlas Survey, while Group 5_{NAA} generally concentrates in the west. In the southern half of the study area, however, the east/west geographic distribution does not hold. Group 1_{NAA} dominates the specimens sampled from all parts of the Hueyapan survey, but Group 5_{NAA} is peppered throughout. Group 6_{NAA} occurs exclusively within the Hueyapan survey in the south. Conversely, Group 7_{NAA} does not occur out of the Tuxtlas Survey boundaries.

Group 1_{NAA}

Ceramics of the Group 1_{NAA} composition are potential products of Matacapan, and were produced using Group C_{NAA} clays. Sites that possessed this ceramic and that occurred further than 7 km from known Group C_{NAA} clay outcrops include Tres Zapotes, Site 132, and many of the specimens found in the western and central Hueyapan Survey areas. Tres Zapotes probably produced most of their own ceramics. However, due to their distance from Group C_{NAA} clays, the 1 of 15 (7%) Coarse Orange sherds sampled from this site with Group 1_{NAA} composition very likely arrived through exchange. Site 132 produced some of its own ceramics, but Coarse Orange does not seem to be a major emphasis for production (Table 4.3). This site sits along the most intuitive route of travel connecting the central Tuxtlas and the Gulf Coast, however, making it a probable trade location. Site 132 is thus a possible recipient of Coarse Orange through exchange. The cluster of Group 1_{NAA} ceramics found in the western and central Hueyapan Survey area were probably traded in from other areas of the Tuxtlas. Downriver transportation connects possible sources of Group 1_{NAA} ceramics in the central Tuxtlas with the western Hueyapan Survey area.

Teotepec, Isla Agaltepec, almost all of the Hueyapan Survey area, and Sites 154, 170, and 39 sat between 1 and 7 km from Group C_{NAA} clay outcrops. Because of the diversity of Coarse Orange compositional groups at Teotepec, its location on the shores of Laguna Catemaco near the origin of Rio Grande de Catemaco, and its rank of "large center" (Santley 1991), Teotepec may have been a center for trade. This increases the likelihood that some Group 1_{NAA} arrived through exchange, though it is also highly likely that they produced some of their own Group 1_{NAA} ceramics. Although Santley (1991) identified Isla Agaltepec as a specialized producer, no Coarse Orange waster sherds were found there, making it a likely recipient of trade. Due to a general absence of any known Concepción clay outcrops in the central and western Hueyapan areas, they also probably procured many of their Group 1_{NAA} ceramics through river trade. Both Sites 154 and 170 yielded no evidence of specialized ceramic production. Their distance from Group C_{NAA} clay sources did not preclude them from producing their own Group 1_{NAA} ceramics. However, the general lack of evidence for specialized production and high proportion of Group 5_{NAA} ceramics made these sites likely consumers of Group 1_{NAA} produced elsewhere. Site 39 was about 1-2 km from Group C_{NAA} clays and 2-4 km from Group S_{NAA} clays. However, no specialized production was apparent there. Site 39 actually contained a greater proportion of Group 5_{NAA} ceramics. Furthermore, Site 39 sat just upriver from a large waterfall, Salto de Eyipantla; it would have thus been an important stopping point for canoe travelers trading wares downriver. Therefore, many of the Group 1_{NAA} ceramics found here probably resulted from trade.

Matacapan, Ranchoapan, El Salado, Apomponapam, and Sites 48 and 143 were all situated less than 1 km away from Group C_{NAA} clay sources. Of these, all but Sites 48 and 143 displayed evidence for specialized production (Santley 1991). The fact that the closest clay source to Site 48 is of the Group S_{NAA} variety further places this site as a strict consumer of imported ceramics. Site 143 may have produced their own Group 1_{NAA} ceramics at a very small scale, but they situated themselves right next to the Rio Grande de Catemaco and could have easily procured ceramics through river trade.

Known producers of Coarse Orange within 1 km of a clay source were the least likely to receive Coarse Orange through exchange. Ranchoapan did consume a fair percentage of Coarse Orange ceramics, and they produced at least some of these. El Salado did not specialize in Coarse Orange production, but they did produce other ceramics on a large scale and intensity. It is likely that some Group 1_{NAA} Coarse Orange was produced locally. Apomponapam likely produced most of their Group 1_{NAA} Coarse Orange. Coarse Orange only composed 3% of all ceramics found at the site, but Coarse Orange wasters were found locally. Small-scale low intensity production could have easily supplied this low quantity of vessels.

Only production contexts were sampled from Matacapan, but the relative scale and intensity of production there make it unlikely that they relied on other sites to provision any locally consumed Coarse Orange ceramics.

Group 5_{NAA}

Group S_{NAA} clays were used to produce Group 5_{NAA} ceramics. Sites greater than 7 km from sources of Group S_{NAA} clay that consumed Group 5_{NAA} ceramics include Teotepec, Isla Agaltepec, Site 132, and all of the Group 5_{NAA} ceramics found within the Hueyapan Survey. The Concepción clays that outcrop in the eastern side of the Hueyapan area come from the lower portion of the stratigraphic column, which probably results in elemental concentrations indicative of Group C_{NAA} clays. All sites falling beyond this threshold provide the best cases for the eastward trading of Group 5_{NAA} Coarse Orange.

Apomponapam, El Salado, and Sites 39, 143, 154, and 170 all fell in between 1 and 7 km of the nearest Group S_{NAA} clay source. The only known specialized producers of these 6 sites were El Salado and Apomponapam. Both of these production sites specialized in producing wares other than Coarse Orange, and they both had access to the finer textured Group C_{NAA} clays, which they apparently preferred due to the dominance of Group 1_{NAA} in the site assemblage. Again, the other sites in this category likely procured many of their ceramics through trade, though small-scale production is possible.

Identifying centers of Group 5_{NAA} production is difficult. They were obviously in the western half of the study area, but regional survey has not yet been conducted there. Therefore, we know little about the settlement hierarchy in the west, or sites other than Tres Zapotes that may have produced ceramics. At this point, Tres Zapotes seems the most likely producer of

Group 5_{NAA} ceramics. El Picayo was, however, a larger center then Tres Zapotes in the Classic period that was not sampled. El Picayo's position about halfway between Matacapan and Tres Zapotes may have made it an important mediator of interaction between the east and west halves of the study area.

Group 6

Group 6_{NAA} Coarse Orange was obviously locally produced and consumed within the center of the Hueyapan Survey area. As will be discussed in the petrography section, these are most likely a very lightly tempered version of the Group 5_{NAA} ceramics made from Group S_{NAA} clays.

Group 7_{NAA}

The Southeastern Locality (Pits 93 and 94) at Matacapan, and possibly Teotepec, manufactured Group 7_{NAA} ceramics. For reasons mentioned above, Site 154 was an unlikely producer of this ceramic. The sample from Ranchoapan only contained one of these ceramics, but Ranchoapan could have made it locally. The fact that Matacapan and Teotepec possessed the highest proportions of this small group is not surprising. Both Matacapan and Teotepec were listed as large Middle Classic centers by Santley and Arnold (1996). There was probably a lot of interaction between these centers, so both could have produced Group 7_{NAA}.

Summary

The Tuxtlas was thus divided into two major zones of production and exchange as seen by the chemical data. Group 1_{NAA} ceramics were the most frequently encountered to the east and were exchanged in low quantities to the west. The direction of Group 1_{NAA} Coarse Orange ceramics trade seemed to flow mainly to the south from the central Tuxtlas rather than the west. The expected impacts of river transportation on the pathways of exchange reinforce this interpretation based on the southwestward direction of water flow in the Tuxtlas. Furthermore, the highest frequency of known ceramic production occurs in the central Tuxtlas. This could simply represent the higher investment in central Tuxtlas research, but I believe that if ceramics were produced on equivalent scales and intensities to the south, different recipes would be evident within the Hueyapan Survey boundaries. Perhaps Group 6_{NAA} would be more prevalent.

Group 5_{NAA} seems to have had more success in penetrating the apparent east/west economic boundary. However, only 4 0f 20 (13%) of the ceramics found in the entire Hueyapan Survey area were from Group 5_{NAA}, suggesting that producers of Group 5_{NAA} were not influential in the southern portion of the study area. The exchange of these ceramics to the east does not conform to river transportation routes. While Tres Zapotes was probably a center of production and exchange of this group, lack of information west of the Tuxtlas Survey limits interpretation of this assumption. El Picayo, not sampled, could have also produced these ceramics.

Within these two major zones of production and exchange, it is difficult to assess whether each site produced its own Coarse Orange, or procured it through exchange. The criteria for determining specialized production by Santley et al. (1989) may have neglected very low scale production at every site. Furthermore, distance from clay sources is only really convincing for the greater than 7 km threshold. Even in these cases, further geological survey may yield previously unidentified outcrops of Concepción clay.

Group 7_{NAA} and Group 6_{NAA} Coarse Orange identified through the chemical analysis were produced at very low scales and intensities. Because three of the four sites that possessed Group 7_{NAA} ceramics were the only three large centers discovered in the Tuxtlas Survey, this group might indicate exclusive interaction at the highest level of the site hierarchy.

Above, I have interpreted the chemical results for Coarse Orange sourcing using as many variables as possible. Without relying on the site hierarchy to presume control over exchange, much of the chemical data indicates possible low quantity exchange between major compositional zones. Trade within compositional zones is also likely. However, the chemical results alone do not rule out the possibility of local production in all of the sites mentioned above. The petrographic results are informative to better interpret exchange relationships. I further explore evidence for exchange within compositional zones after the presentation of the petrographic results.

Petrographic Results

The petrographic point counting analysis provides data to address several limitations within the chemical data set. First, is there a mineralogical explanation for the chemical differences observed above? Second, is the distribution of ceramic groups observed on the maps above due to exchange or the use of similar raw materials in local production loci over a broad area? Finally, can the petrographic identification of varying production recipes provide a more specific characterization of exchange relationships than the broad groups defined by INAA?

To address the first question, I examined the qualitative data for patterns that might explain the elevated levels of Ca (the greatest contributor to PC 1) in Group 1_{NAA} ceramics. While conducting the point counting analysis, the most obvious variation in mineral composition came in the form of quartz and muscovite inclusions in the clay matrix. It should be stressed again that the chemical difference between Group 1_{NAA} and Group 5_{NAA} ceramics seemed to be due largely to the use of different clays. Therefore, I look toward clay minerals and naturally occurring aplastics in the clay matrix, rather than tempering agents, to explain these differences.

Two major categories of clay texture appeared through petrography: the finer variety yields few mineral inclusions sized larger than silt and very few silt-sized grains (which correlate with the geographic distribution of Group 1_{NAA} ceramics). The other category had high quantities of both silt and fine-to-coarse sand minerals (which correlate with the distribution of Group 5_{NAA} ceramics). The major minerals observed in the latter group were quartz, metamorphosed quartz, muscovite, and opaque minerals (see Table 6.1).

Table 6.4. Major clay constituents by site.

		Specimen		quartz %	muscovite %	metamorphic quartz %	opaque minerals %
SITE	Apomponapam	1		14.95	.00	.00	1.87
		2		8.99	3.37	.00	2.25
		3		9.78	.00	.00	4.35
		4		8.82	.98	.00	.98
		5		4.92	4.10	.00	.82
		Total	N	5	5	5	5
			Mean	9.4932	1.6899	.0000	2.0528
	Isla Agaltepec	1		18.35	22.02	1.83	1.83
		2		16.16	6.06	1.01	3.03
		3		9.09	26.14	.00	2.27
		4		2.17	30.43	.00	6.52
		5		6.06	1.01	.00	4.04
		Total	N	5	5	5	5
			Mean	10.3671	17.1320	.5690	3.5400
	132	1		10.89	18.81	.00	2.97

TABLE 6.4 CONT.

	2		3.26	.00	.00	3.26
	3		5.10	1.02	.00	6.12
	4		4.27	3.42	.00	2.56
	5		10.99	2.20	2.20	3.30
	Total	N	5	5	5	5
		Mean	6.9033	5.0898	.4396	3.6429
Teotepec	1		2.33	4.65	.00	6.98
	2		6.78	4.24	.00	6.78
	3		3.13	.00	.00	6.25
	4		4.90	.00	.00	4.90
	5		16.67	.00	.00	7.29
	Total	N	5	5	5	5
		Mean	6.7598	1.7777	.0000	6.4400
143	1		19.19	5.05	.00	1.01
	2		2.25	11.24	.00	3.37
	3		11.63	2.33	.00	5.81
	4		7.27	.00	.00	.00
	5		7.92	.00	.00	5.94
	Total	N	5	5	5	5
		Mean	9.6521	3.7224	.0000	3.2271
154	1		10.58	16.35	.96	3.85
	2		22.68	9.28	3.09	3.09
	3		15.63	16.67	.00	.00
	4		8.33	.00	.00	4.63
	5		14.89	1.06	.00	.00
	Total	N	5	5	5	5
		Mean	14.4219	8.6710	.8109	2.3137
170	1		20.63	3.17	1.59	1.59
	2		15.93	7.96	.88	.88
	3		13.68	15.79	5.26	6.32
	4		12.07	6.03	.00	2.59
	5		18.85	.00	2.46	9.84
	Total	N	5	5	5	5
		Mean	16.2340	6.5926	2.0389	4.2421
39	1		17.17	15.15	.00	5.05
	2		18.37	10.20	.00	3.06
	3		9.52	1.90	.00	6.67
	4		13.33	1.11	.00	4.44
	5		11.30	1.74	.00	1.74
	Total	N	5	5	5	5
		Mean	13.9401	6.0221	.0000	4.1924
Ranchoapan	1		9.18	5.10	.00	6.12
	2		14.13	9.78	.00	2.17
	3		13.04	1.09	.00	2.17
	4		8.42	1.05	1.05	2.11
	5		8.55	.85	.00	4.27
	Total	N	5	5	5	5
		Mean	10.6651	3.5758	.2105	3.3698
48	1		9.92	.83	.00	1.65
	2		12.50	7.69	.00	4.81
	3		11.36	23.86	.00	.00
	4		3.70	9.26	.00	1.85
	5		2.06	6.19	.00	.00
	Total	N	5	5	5	5
		Mean	7.9093	9.5654	.0000	1.6625
EL SALADO	1		12.00	4.00	.00	5.00
	2		11.40	2.63	.00	5.26
	3		5.31	1.77	.00	5.31
	4		5.50	4.59	.00	.00
	5		20.87	.00	.87	.87
	Total	N	5	5	5	5
		Mean	11.0175	2.5977	.1739	3.2885
HUEYAPAN AREA	1		28.08	20.55	2.05	5.48
	2		12.64	28.74	.00	4.60
	3		15.56	22.96	2.22	3.70
	4		10.81	9.01	1.80	1.80
	5		11.96	.00	.00	10.87
	6		12.63	1.05	1.05	3.16
	7		9.76	.00	.00	6.10
	8		11.24	.00	.00	2.25
	9		11.32	.00	.00	6.60
	10		4.44	.00	.00	3.33

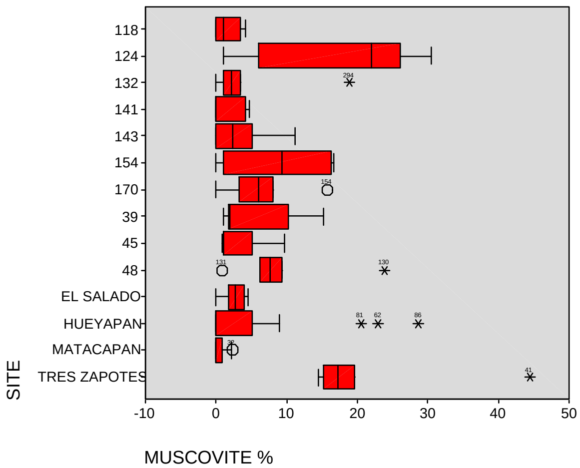
TABLE 6.4 CONT.

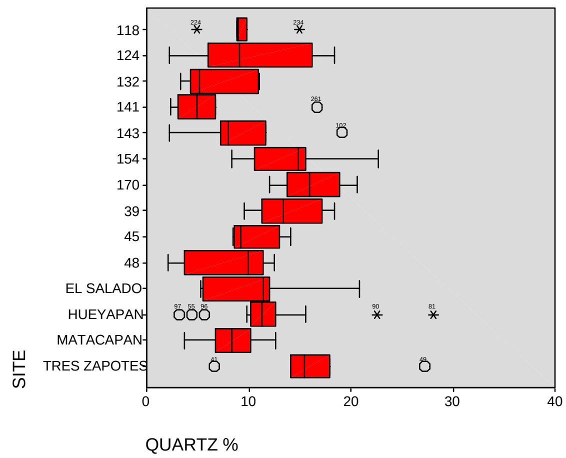
	11		22.52	.90	.00	2.70
	12		10.87	.00	.00	3.26
	13		10.67	.00	.00	1.33
	14		3.16	.00	.00	1.05
	15		5.65	.00	.00	4.03
	Total	N	15	15	15	15
		Mean	12.0866	5.5473	.4754	4.0183
MATACAPAN	1		5.26	2.11	.00	6.32
	2		3.66	.00	.00	2.44
	3		4.40	.00	.00	2.20
	4		8.33	.00	.00	1.85
	5		6.09	.00	.00	1.74
	6		9.52	.95	.00	3.81
	7		10.53	.00	.00	1.05
	8		9.84	.00	.00	1.64
	9		7.48	.93	.00	.00
	10		11.61	.00	.00	.00
	11		8.27	2.26	.00	2.26
	12		12.69	.75	.00	2.24
	13		7.30	.00	.00	.73
	14		9.16	.76	.00	1.53
	15		11.27	.00	.00	2.11
	Total	N	15	15	15	15
		Mean	8.3595	.5172	.0000	1.9939
TRES ZAPOTES	1		14.13	15.22	1.09	2.17
	2		6.67	44.44	2.22	11.11
	3		15.45	17.27	2.73	6.36
	4		27.18	14.56	.00	2.91
	5		17.95	19.66	2.56	5.13
	Total	N	5	5	5	5
		Mean	16.2770	22.2312	1.7201	5.5379
Total	N		90	90	90	90
	Mean		10.8321	5.9367	.4105	3.4192

None of the minerals evident in the coarser category of sherds are rich in calcium. This would be expected if the ceramics belong to the calcium depleted Group 5_{NAA}. Of the visible paste constituents in the finer category of sherds (which I later show to correlate highly with chemical Group 1_{NAA}), most to all inclusions were silt sized particles and consisted of mainly quartz (SiO_2) and opaque minerals, which are typically Fe and Mg rich. Neither of these minerals explains the elevated levels of calcium in Group 1_{NAA} ceramics. I suggest that the lower levels of Ca in the chemical Group 5_{NAA} ceramics derives from the depletion of Ca due to frequent inclusion of fine to coarse sand-sized quartz and very high quantities of muscovite in the paste of the coarser textured clays (see Figures 6.6 and 6.7).

Returning to Pool's (1990) geological survey, Concepción clays gradually transition into the more recent Filisola formation, the latter of which consists of quartz sands and sandstone. Again, Concepción clays generally become depleted in Ca as one moves from deeper to more recent deposits. I argue that the clays available in the western half the study area were taken from Concepción outcrops closer to the Filisola formation than outcrops in the eastern zone. This would explain the Ca depleted chemistry for Group 5_{NAA} ceramics and Group S_{NAA} clays mentioned above, as well as provide the most promising interpretation for the coarser texture observed in a number of these ceramics.

Figures 6.6 and 6.7. Showing percent of quartz and muscovite in the ceramic paste.





The other possibility is that calcareous minerals are finely divided into the clay matrix of Group 1 ceramics so they are not detectable in thin section. It should be noted that several cloudy, inclusions occur in the matrix of a very small proportion of the finer paste samples. These resemble calcined calcite, but I am reluctant to make that conclusion without definitive features of the mineral readily detectible.

To delineate useful compositional groups based on mineralogy, I first explore the data through two ternary diagrams that show the relative contributions of volcanic ash (the primary temper), silt, sand sized inclusions, and clay to the overall composition of the ceramic. Figure 6.8 plots percent of clay, silt sized inclusions, and sand sized inclusions to achieve a textural index of clay matrix. This measure approximates the texture of clays used for manufacture, and thus provides a way to estimate differences between production loci based on selection of raw material. The large quartz grains occurring in the minority of the sample are rounded to sub-rounded, suggesting no crushing of an additional temper. However, the possibility still exists that quartz sand was used in place of volcanic ash as temper. If this were true, the measure of clay matrix texture could reflect a small amount of temper in a fraction of the samples.

Coarser sherds appear more variable than the finer sherds that cluster in the lower left corner of the ternary diagram. Returning to Feinman et al. (1984) this may indicate that there were a higher number of small-scale producers who manufactured the coarser ceramics than those finer ceramics that are similar to the Matacapan ceramics.

Volcanic ash was the primary tempering agent in all sherds, but the quantity of larger quartz inclusions does vary negatively with the amount of ash (r=-.652, p<.001, n=37)(Figure

Figure 6.8. Showing the texture of clays used to produce Coarse Orange

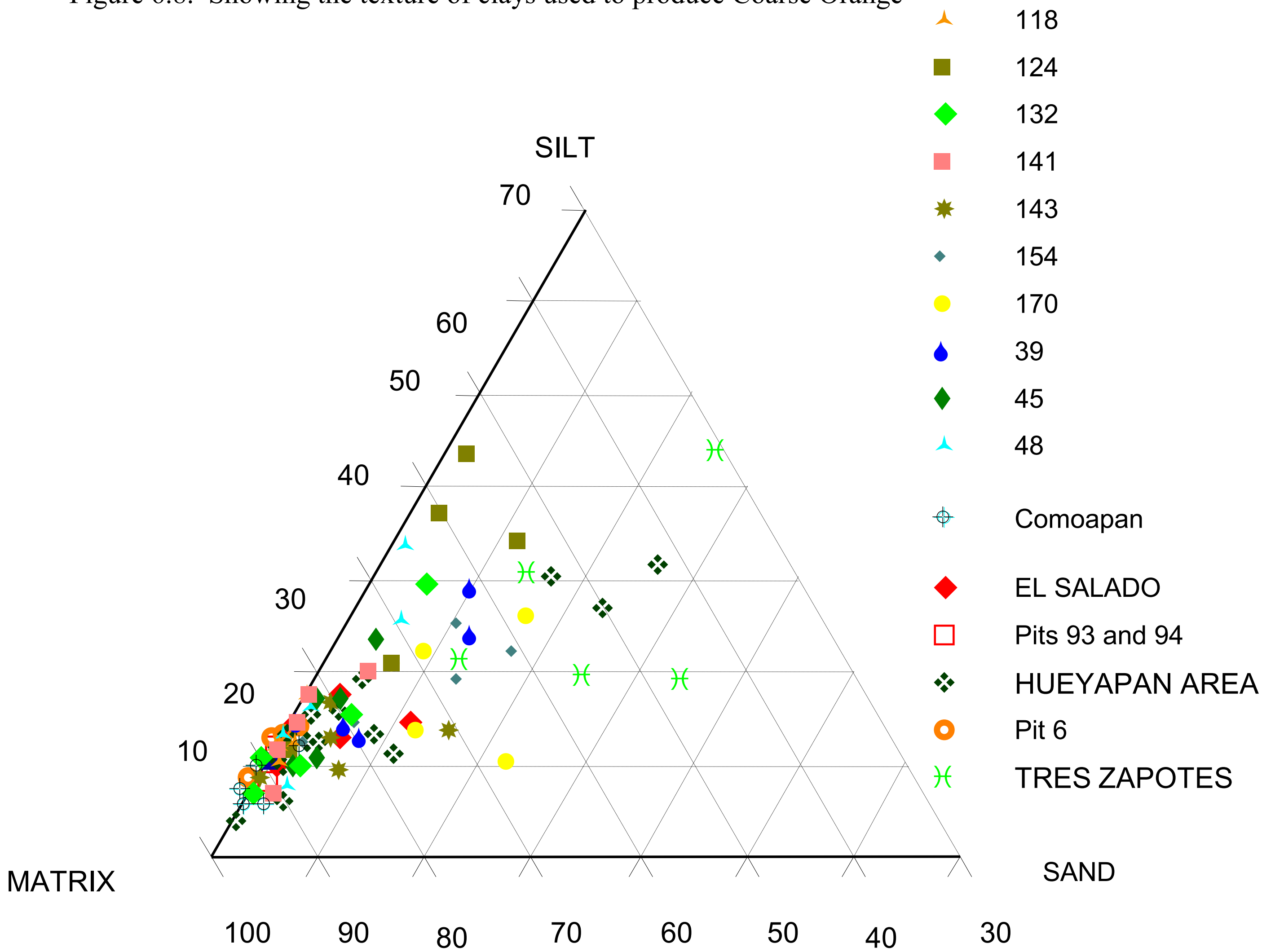
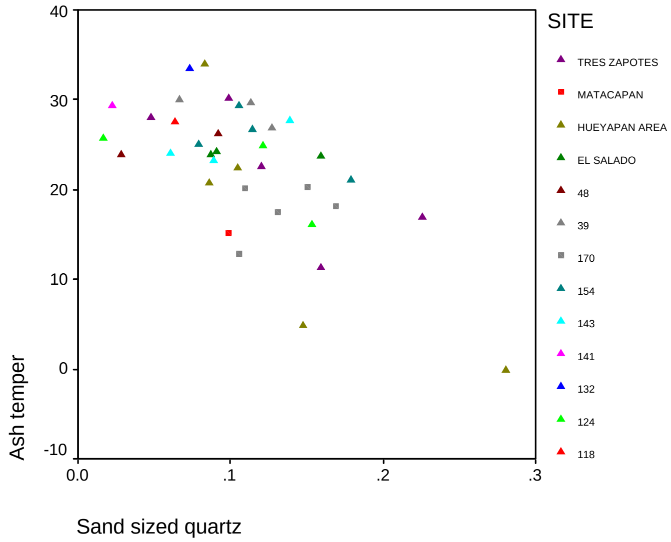


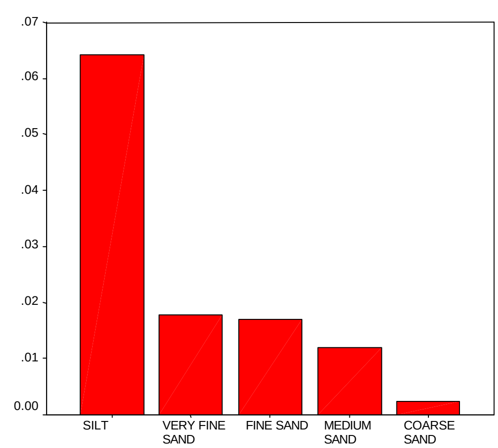
Figure 6.9. Scatter plot of sherds with larger sand sized inclusions versus temper.



6.9). This correlation was run on 37 cases that had at least one fine to coarse sand sized grain. The moderate, but strongly significant, inverse correlation between larger quartz sand inclusions and volcanic ash temper suggests that potters were either assessing the texture of the clays and adding more or less ash to achieve the desired plasticity, or they were adding both tempers to texturally similar clays. The latter possibility exists as the chance that both materials were mixed together in some common medium (e.g. a river where fluvial action would mix the two), or it could have been an intentional action of the potters to use both tempers.

Because the frequency of quartz in each grain size category decreases gradually with an increase in particle size (Fig 6.10), I do not believe that quartz was added intentionally. If quartz sand were added as temper one would expect a bimodal distribution between silt natural inclusions and the larger medium to coarse sands (Stoltman 1989). Regardless, the classification of large quartz as temper would only slightly change the overall picture of the compositional variation of the sample. The combination of sand sized quartz and ash into a single temper category would cause a loss of valuable data that appear when the variables remain separate. Maintaining this distinction holds significance for identifying sources of production.

Figure 6.10. Showing the distribution of quartz over the size categories.



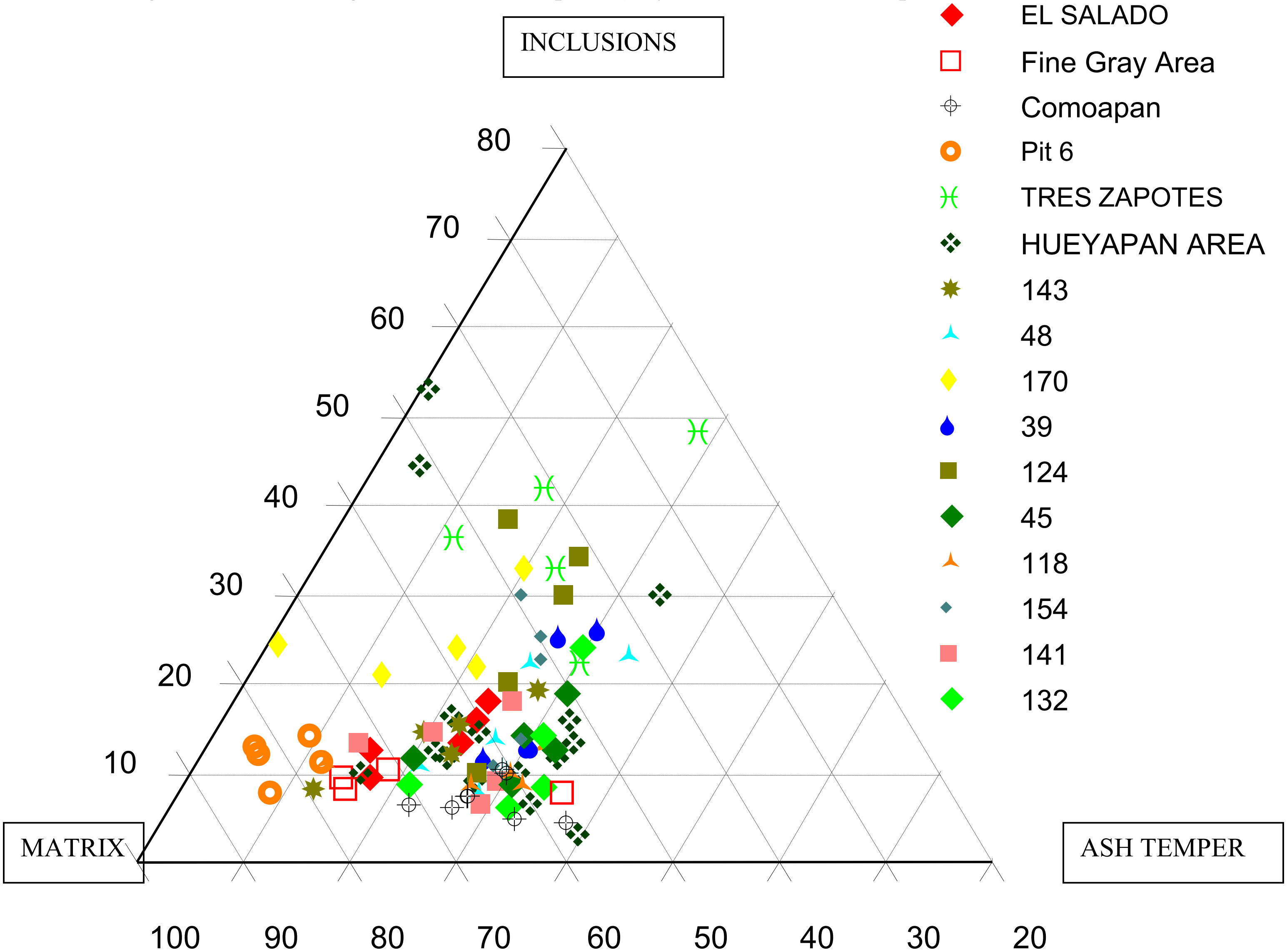
It should be evident that significant differences in clay texture occur within and between sites. All of the Matacapan sherds fall into the main cluster of finer textured ceramics. Outside of that grouping, much of the sample was made from coarser grained clays, and the textures within the coarser group were more variable. The reader should note that diverse ceramic textures within a site suggest that site procured ceramics from a multitude of sources, or many local potters were utilizing many recipes. The compositional range of Isla Agaltepec (Site 124) ceramic pastes cover the majority of diversity within the entire sample. Ceramics that came to rest at Agaltepec may have come from several disparate sources producing Coarse Orange. Teotepec (Site 141), Apomponapam (Site 118), and Ranchoapan (Site 45) on the other hand, display more homogeneous paste textures, which suggest that they were either producing their own pottery or exchanging goods with a common site. Ranchoapan and Teotepec were large centers in the region and Apomponapam was considered a small center (Santley 1994:251). No Concepción outcrops occur within 5-6 km of Teotepec or Isla Agaltepec, so these are good candidates to support exchange from Matacapan. Although the textural data from ceramic paste supports the conclusion that Matacapan was supplying some sites with Coarse Orange, it does not rule out the existence of several other production loci.

Turning to the measure of paste texture (i.e. the whole ceramic composition, including the addition of temper), patterns become clearer (Figure 6.11). The addition of temper is more of a cultural indicator of pottery manufacture than the natural variation of paste texture. Therefore, this ternary diagram would be expected to yield more clear distinctions between individual production loci than that described above.

Site 170 emerges as its own cluster in this diagram. Although no solid evidence of pottery production occurs at this site (Santley 1991), this pattern suggests that they produced their own pottery or procured all sampled ceramics from a single source.

Several sites had paste compositions that closely resemble those of Comoapan, and indicate possible exchange relationships. A very interesting pattern emerges when we consider that Pit 6 ceramics (the attached specialist area at Matacapan) are distant from almost all other ceramic paste compositions. The Fine Gray area (Pits 93 and 94 from Area 149) Coarse Orange ceramics at Matacapan were also slightly dislocated from the center of that cluster. I suggest that this difference occurs because, of the three production entities examined petrographically, only Comoapan was actively producing Coarse Orange for trade. The reader should note that Comoapan samples were positioned a little lower than the main cluster. All of the Matacapan ceramics were thin-sectioned by a different company than the remainder of the specimens. Differential preparation may have slightly influenced the amount of mineral plucking involved in the specimens. Comoapan ceramics do, however, overlap with petrographic compositions found at number of other sites.

Figure 6.11. Showing the texture of the paste (clay and volcanic ash temper combined)



The attached specialists (Pit 6), or their elite patron, was not apparently exchanging Coarse Orange beyond the site, but rather using all of the pottery or exchanging it within Matacapan[8]. Similarly, production of Coarse Orange that took place at the Fine Gray area (i.e., the Southeastern locality) was specialized in fine paste wares. If this locality were producing any ware explicitly for inter-site exchange, it would have been Fine Gray. However, a few Coarse Orange vessels produced in this locality do overlap with paste compositions found at other sites.

[8] It should be mentioned that no non-production context sherds were sampled from Matacapan, which precludes our detection of within site exchange.

Petrographic Group Evaluation

The above diagrams were submitted to give the reader an overall, visual impression of the petrographic data. What follows is a more detailed statistical analysis that is designed to classify the mineral compositions of the ceramics into groups that will be used to identify exchange.

Three principal components were extracted from the variance-covariance matrix of the grain size data (listed in Table 6.4) that explained 73% of the total variation observed in the sample. Experiments were undertaken that extracted as many as 8 principal components (93% of the variance), but those tests did not reveal clear groupings. I believe that the weaker principal components, explaining only a small proportion of the total variance, measure the differences between ceramics that correspond with subtle variation of production and can differ from one firing episode, or even one pot, to the next within a single production locality.

Table 6.5. Principal component loadings based on a variance co-variance matrix

	Raw Component			Rescaled Component		
Clay Aplastics	PC1	PC2	PC3	PC1	PC2	PC3
Silt	.127	-.015	-.033	.605	-.072	-.157
Very fine sand	.185	.066	.049	.637	.228	.167
Fine sand	.309	.014	.106	.902	.041	.310
Medium sand	.273	-.009	.061	.868	-.029	.195
Coarse Sand	.134	.018	-.007	.670	.091	-.034
Ash Temper						
Silt	-.102	.030	.103	-.457	.133	.462
Very fine sand	-.158	.044	.153	-.531	.146	.515
Fine sand	-.148	.104	.151	-.528	.372	.537
Medium sand	-.080	.181	.052	-.344	.781	.226
Coarse sand	.021	.291	-.102	.066	.907	-.318
Very coarse sand	.161	.085	-.130	.589	.312	-.477

These minor fluctuations should be seen as noise in this research because they do not reproduce the major social and cultural trends observable at the site level. If archaeological contexts could be controlled on a level in which we could isolate individual firing episodes, this minor variation might be significant to address other questions. It only serves to obscure sourcing in this case.

These principal components were entered into a K-means clustering procedure, modeled after Garraty and Stark (2002). The K-means clustering was run 11 times with different numbers of cluster solutions (2-12 cluster solutions). I calculated the sum of squared errors (SSE) for each cluster solution and plotted them on a scatterplot (see Figure 6.12). The best solution is thought to be the point that departs from the downward sloping line. Higher cluster solutions that do not reduce error significantly do not reflect significant patterns in the data. I determined that the 5-cluster solution was the last point falling in line with the downward linear trend.

To maintain clarity, the MURR group names were preserved in petrographic groups that correlated highly with them. Where no clear correlation between the two datasets occurred, a new number was given to the petrographic group. In all cases, the subtext "NAA" and "PET" maintain the distinction between sets of data, but similar group numbers demonstrate correlation. Table 6.5 is a cross tabulation of chemical and petrographic results.

Figure 6.12. Plot of the sum of squared errors for group membership.

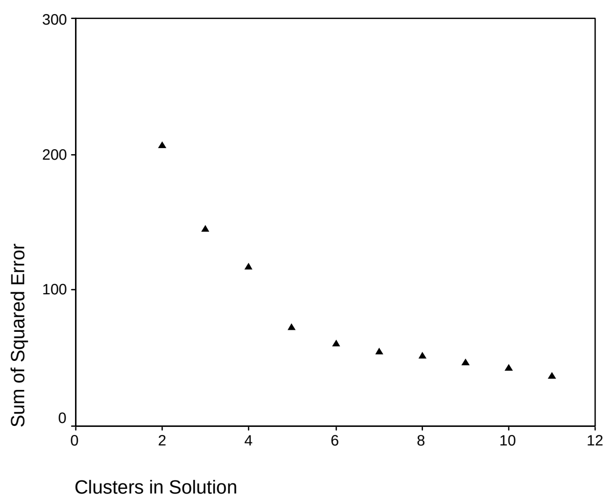


Table 6.6. Correlations between INAA and petrographic datasets.

		PETROGRAPHIC ANALYSIS						Total
		Group 1_{PET}	Group 5_{PET}	Group 6_{PET}	Group 8_{PET}	Pit 6_{PET}	Unassigned	
MURR ANALYSIS	Group 1_{NAA}	33	2		1	1	4	41
	Group 5_{NAA}	1	15		5		1	22
	Group 6_{NAA}			2				2
	Group 7_{NAA}	4						4
	Pit 6_a					5		5
	Unassigned	11			2	1	2	16
Total		49	17	2	8	7	7	90

a. Remember that Pit 6 ceramics were not identified using the statistical procedures employed at MURR. Instead, I isolated these ceramics based on examination of the Q-mode principal component plot, macroscopic inspection of Pit 6 sherds, and knowledge of the social and geographic context of production. Pit 6_{PET} was identified statistically, though.

To further exemplify the relationship between chemical and petrographic data, I conducted a Cramér's V test on all assigned groups. This is a contingency test designed to evaluate the presence and strength of the relationship between two nominal variables. There is a relationship between petrographic and chemical data, significant to a .001 level. This is a strong, positive relationship measuring .799 in magnitude. From the above relationships, it should be evident that Groups 5_{PET} and 8_{PET} were generally discrete production recipes within the broader class of chemical Group 5_{NAA} ceramics. Group 1_{PET} is a recipe that correlates strongly with Group 1_{NAA}. Group 6_{PET} specimens interestingly fell into the Group 6_{NAA} chemical group, indicating that both techniques independently identified this subset of the Coarse Orange ware. The mineralogy did not distinguish a correlate of Group 7_{NAA}. Neff and Glascock (2002) note that Group 7_{NAA} was most likely a subset of the larger Group 1_{NAA}, so this result is not surprising. Finally, Pit 6_{PET} forms a distinct production recipe that the attached producers at the Central Locality in Matacapan utilized. In all, the above associations hold true in 87% of the cases.

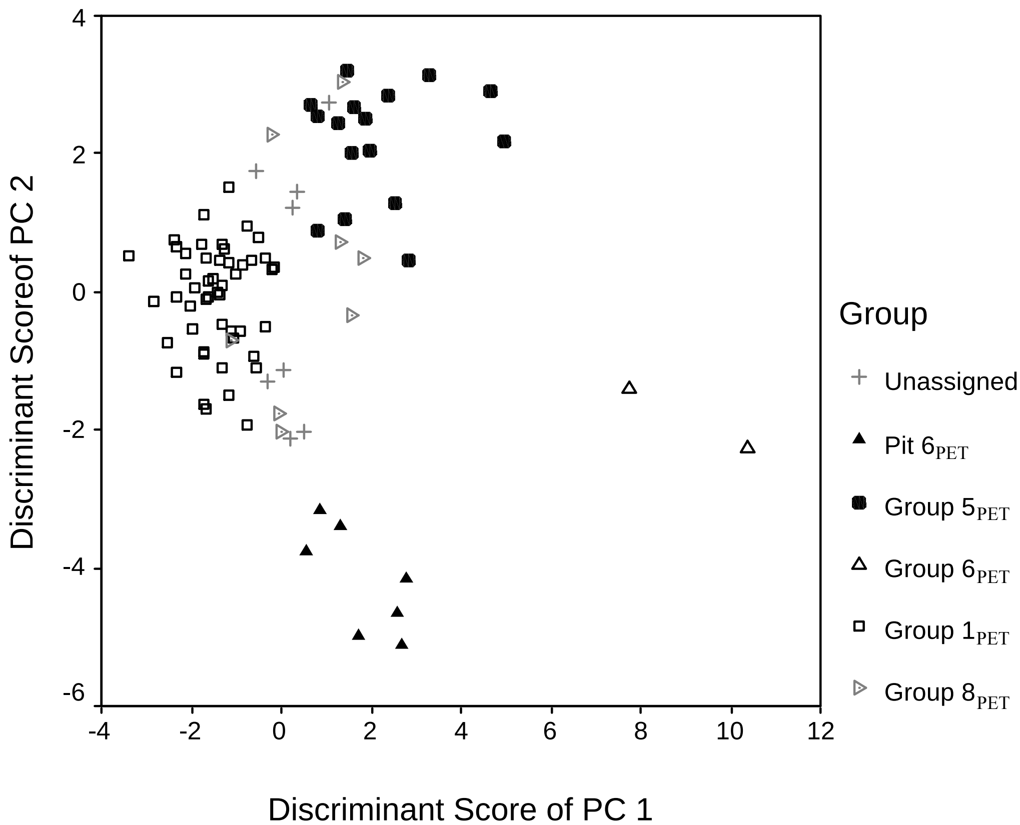
The final compositional groupings, based on Mahalanobis distance measures, are seen in Figure 6.13. The frequency of group occurrence by site or production locality is presented in Table 6.7.

Map 6.3 shows how these groups plot over the landscape. Many of the patterns are repeated from the chemical results, but there are some significant differences that will be discussed below.

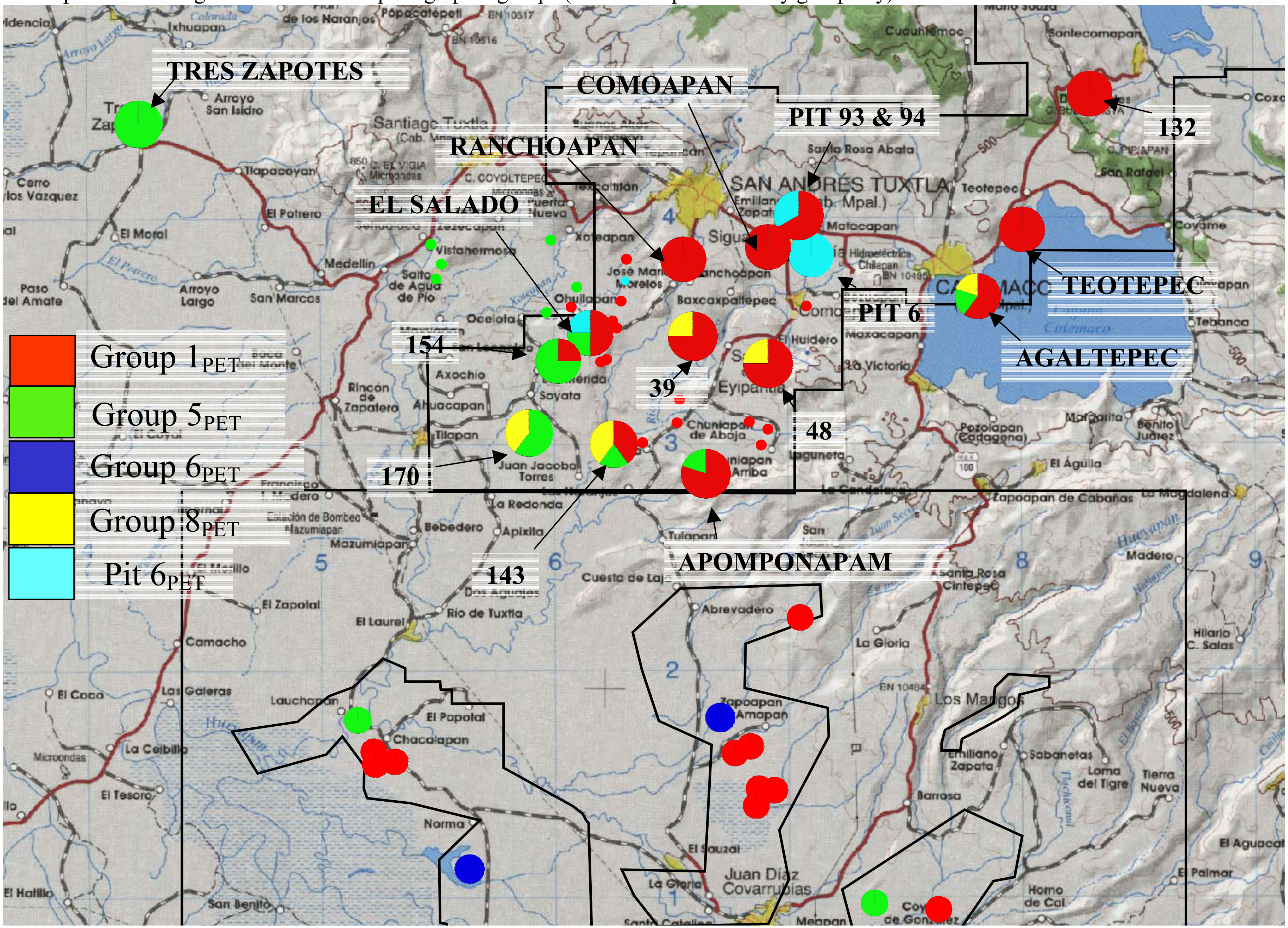
Table 6.7. Petrographic groups by site (based on 90% confidence interval using Mahalanobis distances).

			PETROGRAPHIC GROUPS					
			Group 1_{PET}	Group 5_{PET}	Group 6_{PET}	Group 8_{PET}	Pit 6_{PET}	Unassigned
SITE	Comoapan	Count	6					
		% of Site	100.0%					
		% of Group	11.8%					
	Pits 94&93	Count	2				2	
	(SE Locality)	% of Site	50.0%				50.0%	
		% of Group	3.9%				25.0%	
	Pit 6	Count					5	
	(Central Locality)	% of Site					100.0%	
		% of Group					62.5%	
	Hueyapan	Count	10	2	2			
		% of Site	71.4%	14.3%	14.3%			
		% of Group	19.6%	12.5%	100.0%			
	El Salado	Count	2	1			1	1
		% of Site	40.0%	20.0%			20.0%	20.0%
		% of Group	3.9%	6.3%			12.5%	25.0%
	Tres Zapotes	Count		5				
		% of Site		100.0%				
		% of Group		31.3%				
	39	Count	3			1		1
		% of Site	60.0%			20.0%		20.0%
		% of Group	5.9%			12.5%		25.0%
	45	Count	5					
		% of Site	100.0%					
		% of Group	9.8%					
	48	Count	3			1		1
		% of Site	60.0%			20.0%		20.0%
		% of Group	5.9%			12.5%		25.0%
	118	Count	4			1		
		% of Site	80.0%			20.0%		
		% of Group	7.8%			12.5%		
	124	Count	3	1		1		
		% of Site	60.0%	20.0%		20.0%		
		% of Group	5.9%	6.3%		12.5%		
	132	Count	5					
		% of Site	100.0%					
		% of Group	9.8%					
	141	Count	5					
		% of Site	100.0%					
		% of Group	9.8%					
	143	Count	2	1		2		
		% of Site	40.0%	20.0%		40.0%		
		% of Group	3.9%	6.3%		25.0%		
	154	Count	1	3				1
		% of Site	20.0%	60.0%				20.0%
		% of Group	2.0%	18.8%				25.0%
	170	Count		3		2		
		% of Site		60.0%		40.0%		
		% of Group		18.8%		25.0%		
Total		Count	51	16	2	8	8	5
		% of Site	56.7%	17.8%	2.2%	8.9%	8.9%	5.6%
		% of Group	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Figure 6.13. Final groupings based on posterior probability using Mahalanobis distance.



Map 6.3. Showing the distribution of petrographic groups (consult Map 6.1 for clay group key)



Discussion of Petrographic Results

The petrographic groups strongly reproduce the chemical results. Group 8_{PET} was not detected by INAA while Group 7_{NAA} was not detected through petrography. The two compositional techniques are highly complimentary in this study. They both recognized major patterns, but each individually identified subsets of variation within those major patterns.

Group 1_{PET}

Beginning with the finer paste Coarse Orange, Group 1_{PET} was the most common variant found in the region. This was the production recipe used by potters at Comoapan and some of the potters in the Southeastern locality at Matacapan. Inclusion in this group requires a low score on PC 1 and an intermediate score on PC 2. The principal component loadings suggests that members in this group have a high proportion of fine and medium sand ash temper and contain very few larger than silt-sized grains in the clay matrix. Inspection of the raw percentage data confirms this. There were several very fine sand inclusions, but grains larger than that were rare in the clay matrix. These potters are obviously taking very fine textured clay and improving its workability, and technological performance characteristics (Schiffer and Skibo 1987, 1997), by adding fine to medium volcanic ash.

Group 1_{PET} is the most widespread version of Coarse Orange in the Tuxtlas, paralleling the distribution of Group 1_{NAA} ceramics. Since this group is best seen as a replication of the chemical results, an extended discussion of its geographic distribution will add nothing to what has already been presented in the discussion of Group 1_{NAA} above. However, it is significant that the high correlation between datasets makes it possible to predict chemical group membership in the field through the mineralogical characteristics observable using a hand lens (absence of sand sized quartz and abundance of fine to coarse sized volcanic ash).

Pit 6_{PET}

Pit 6_{PET} was a combination of fine textured clay tempered very lightly with volcanic ash. PC 2 separates these ceramics based on very small amounts of ash temper. The temper added was of the smaller ash grains, and potters only added a little. The clays utilized in this production recipe are among the finest textured, with very rare muscovite inclusions that are visible, low amounts of quartz, and almost no sand sized particles compared to other groups. The fineness of these ceramics may suggest a different use from the dominant Coarse Orange recipes in the Tuxtlas. All five Pit 6_{PET} ceramics were unassigned in the chemical data. But, as seen above, all five Pit 6 ceramics were distinguishable in the chemical dataset through Q-mode analysis. I suggest that Pit 6_{PET} should be considered its own group for these reasons.

In addition to the central locality sherds, the compositional group Pit 6_{PET} comprises two sherds from Pit 93 and one from El Salado. Recall that Pit 6 was the attached specialist discussed in Chapter 4. The elite patrons of this facility was probably not exchanging their Coarse Orange with any other site. Why were these potters then specializing in a somewhat utilitarian ware? Did it enhance the patron's prestige to have an abundance of these vessels lying around? Possibly. When we consider that the Pit 6 locality ceramics were the most highly decorated Coarse Orange at Matacapan (Pool 1990:Table 15) they may have been displayed in public social events (e.g., ceremonies, rituals, feasts), even though they primarily took a utilitarian form. What they used those vessels for is perhaps the better question. Located within the large ceremonial center of Matacapan, the ceramic workshop could have provided vessels to be used for storage of food and liquid in preparation for ceremonial or civic displays. Depending on the frequency of such occasions, many vessels may have been needed. To have an attached specialist producing these vessels would reduce the elite's reliance on procuring them from independent producers. The single Pit 6_{PET} Coarse Orange found at El Salado could have been produced locally or traded from the Fine Gray areas at Matacapan, but would probably not have come from the Central locality.

Group 5_{PET}

Moving to the coarser textured Coarse Orange, Group 5_{PET} was the most common and had the widest distribution. Sherds of this group scored high on PC 1 and PC 2. This suggests that they had many sand sized inclusions in the clay and frequent medium and coarse sand sized ash temper. The percentage data confirm the presence of abundant sand sized particles in the clay matrix, but temper ranges widely. These sherds have many very large volcanic ash grains (coarse sand to very coarse sand). Moreover, they tend to score higher on PC 2 because of a greater proportion of medium sand and coarse sand. Considering both quartz sand and temper together, Group 5_{PET} makes the coarsest Coarse Orange. Clay point counts are lowest in this recipe because of its coarseness. The clay itself contains muscovite all through its composition, possibly representing its association with Group S_{NAA} clays.

Over 82% of Group 5_{PET} ceramics correspond to Group 5_{NAA} and two were placed into Group 1_{NAA}. Because it predominantly replicated Group 5_{NAA}, an extended discussion of the spatial patterning of Group 5_{PET} is not necessary (refer to the discussion of Group 5_{NAA} above).

Group 6_{PET}

Group 6_{PET} consists of only two ceramics located in the Hueyapan survey area, which were also identified as Group 6_{NAA} in the chemical analysis. They score very high on PC 1, suggesting they were made of very coarse clays and/or they had a very little amount of ash temper added. Indeed, examination of the raw data show high proportions of silt sized quartz and muscovite and larger sized quartz grains. Very light ash tempering further reinforces their extreme score in PC 1. One sample, PK 81, had no ash temper according to the point counts[9]. The other sample, PK 62, had only 7 ash point counts. These variants were restricted to settlements in the Hueyapan Area, and were perhaps tempered with sand sorted from river sediment. Two large angular quartz grains were counted, signifying that the sand might have been crushed before adding to the clay. Another possibility is that the clays available to parts of the south were very coarse. The Concepción outcrop to the east of the Hueyapan Survey (see Map 3.1) were probably more finely textured because they are close to the contact with La Laja/Deposito marls.

In sum, Group 6_{PET} was definitely a local variant of Coarse Orange produced in small quantities and restricted to the Hueyapan River area. It is likely that these are outliers of Group 5_{PET} with very little temper. These two sherds were very similar to clay Group S_{NAA} in the chemical analysis, probably because there was insufficient temper to pull the chemical signature of these sherds away from, the natural clays.

The conscious balance of ash and sand is very interesting in all of these recipes. These two sherds testify to this balance with plentiful coarse inclusions in the clay and very low levels of ash temper. Producers of Coarse Orange must have been very cognizant of the texture of their clays and added temper to increase workability and "green strength" as needed.

[9] Ash tempering was evident in small quantities, but no point on the grid fell on an ash grain.

Group 8_{PET}

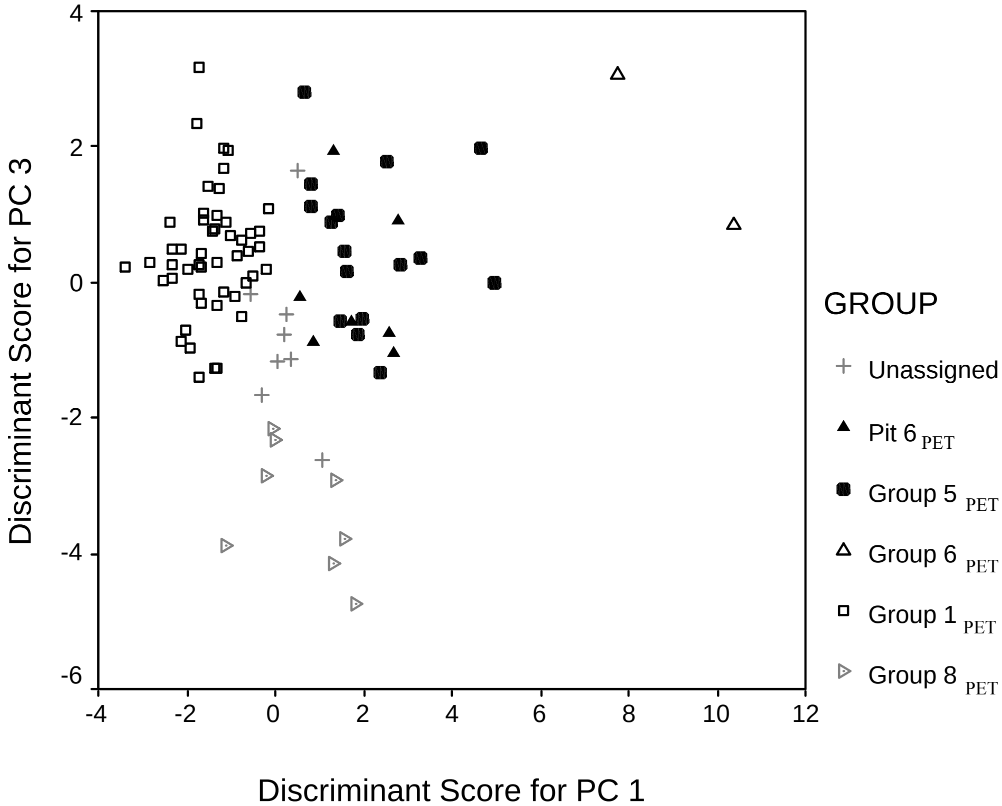
Group 8_{PET} was distinguished because of its intermediate loading on PC 1; which is positively influenced by the amount of silt and sand in the clay matrix and/or the addition of very coarse sand temper. Inspection of the raw percentage data confirms their intermediate composition of sand inclusions. Most of the sand-sized particles were quartz, but muscovite was abundant as silt-sized grains and sandstone was also apparent in several sherds. This group is interesting because it had no corollary in the chemical dataset. The majority of Group 8_{PET} ceramics were chemically characterized as Group 5_{NAA}, but further examination of the mineral characteristics of both groups suggest that they do not belong together.

Sherds of Group 8_{PET} were tempered with the coarsest grain ash in the entire sample. They have a high proportion of coarse and very coarse sand volcanic ash, where members of other groups tend to contain more fine to medium sand sized ash. Principal component 3 (Figure 6.14) best exemplifies the separation of Group 8_{PET} ceramics based on their abundance of larger sized ash temper (consult the moderate negative loadings for CS and VCS in Table 6.4).

Ceramics of this recipe display a fairly well defined zone of distribution that sits at the southern end of the Tuxtlas Survey. Sites 170, 154, 39, 48, Apomponapam, and Isla Agaltepec possessed this ware, but none demonstrate high enough proportions to suggest that they were the center of production and distribution of this variety of Coarse Orange. Instead, it is likely Coarse Orange was produced in low quantities at several of these sites. The remainders of ceramics these sites consumed were most likely procured through trade.

In sum, it appears as though the Group 8_{PET} results from the mixture of clays of Group S_{NAA} composition with a very coarse volcanic ash temper. Group 8_{PET}, however, cannot be associated with any other compositional group. Perhaps ash formed this geographic pattern due to the most recent volcanic eruption of Cerro Puntiagudo. The low quantity of ceramics produced with this recipe reflects the lack of specialized production by sites in this area. This variant of Coarse Orange, however, was produced on small-scales toward the southern extent of the Tuxtlas Survey.

Figure 6.14. Final groupings based on posterior probability using Mahalanobis distance. PC 1 and PC 3.



Who Supplied the Region with Coarse Orange?

To answer the question of who supplied what compositional groups to sites in the Tuxtlas I examine several lines of evidence. In any intraregional sourcing study where it is possible that several sites had access to chemically similar raw material, it is nearly impossible to completely and unambiguously reject the possibility that all sites were producing their own ceramics. The more variables employed, the stronger a case is presented for exchange. I explore 6 variables in this section to determine the most likely suppliers of each compositional group: fall-off curves (Renfrew 1977), distance from clay source, routes of river transportation, variability in production scale and intensity, homogeneity/heterogeneity of composition (Feinman et al. 1984, 1992), and site position in the settlement hierarchy (Santley 1994). Since it is fairly obvious that the smaller compositional groups were local variants of the larger groups, I restrict the following discussion to Group 1_{NAA} and Group 5_{NAA}. I devote more attention to Group 1_{NAA} since

Comoapan exclusively produced this type of ceramic. Any inference made for the center of Group 5_{NAA} ceramic production would be purely speculation since not many sites in the western portion of the study area were sampled.

Many of the following sections are merely restatements of what has been presented above, so extended discussions are not necessary.

Compositional Variation

According to Feinman et al. (1984; but see Pool 1992 for other sources of variation not related to number of producers), ceramics produced by a small number of large-scale producers should display less variability than ceramics produced by many small-scale potters. I used the coefficient of variation to assess the variability within each major compositional group. I expected that the addition of a common temper should pull the ceramic specimens together in their chemistry, so the ceramics should display less variability than the clays used in their manufacture. Furthermore, if Comoapan provisioned a large portion of the Group 1_{NAA}/Group 1_{PET} ceramics found in the Tuxtlas, as suggested by the data above, then Group 1_{NAA}/Group 1_{PET} ceramics should display lower coefficients of variation than the Group 5_{NAA}/Group 5_{PET} ceramics. The latter ceramic composition was primarily found at sites that did not produce ceramics or that manufactured Coarse Orange on a much lower scale and intensity than production at Comoapan (see Chapter 4). I first conduct this test using the chemical groups. I then run the same test on the petrographic groups using only temper variables. Using the texture index of clays merely measures the variability of the natural clays, and not the variability infused by the potters. For each test I have selected the primary contributors to the first two principal components as variables.

As evidenced by the chemical C.V.s in Table 6.8, both ceramic groups were generally less variable than their corresponding clays (i.e., Group 1_{NAA} ceramics to Group C_{NAA} clays, and Group 5_{NAA} ceramics with Group S_{NAA} clays). The addition of temper to clay, therefore, does reduce the elemental differences between samples. Therefore, the C.V. of the chemical data should provide a good assessment of the relative number of producers of each group. More importantly, Group 1_{NAA} ceramics display less compositional variability than Group 5_{NAA} ceramics. Following Feinman et al. (1984) Group 1_{NAA} seems to have been produced by fewer potters who manufactured Coarse Orange on a larger scale than the more numerous and smaller scale producers of Group 5_{NAA} ceramics. However, the relative C.V.s of the ceramics could merely reflect the C.V.s of the clays. Although this compromises the value of using C.V.s on the chemical data, I believe the results are still informative. One way to overcome these limitations is to use the purely cultural influence of temper addition.

Table 6.8. Coefficients of variation within variables of the chemical data between groups.

MURR Group	Ca	Cr	Sc	Ni	Sr
Group 1_{NAA}	.184	.197	.076	.256	.217
Group 5_{NAA}	.286	.303	.116	.381	.366
Group C_{NAA}	.261	.130	.091	1.15*	.341
Group S_{NAA}	.491	.312	.256	.785	2.82*

* Outliers probably affected these values.

Turning to the petrographic C.V.s (Table 6.9), Group 1_{PET} ceramics display less variability regarding the size and frequency of volcanic ash temper than Group 5_{PET}. This again points to a fewer number of potters making Group 1_{NAA}/Group 1_{PET} on a larger scale than the more numerous but dispersed production of Group 5_{NAA}/Group 5_{PET}. All of this data, though tentative, points to the possibility that Comoapan was responsible for much of the Group 1_{NAA}/Group 1_{PET} Coarse Orange in the region.

One additional possibility that affects the utility of this test is that most of the unassigned specimens cluster around Group 1_{NAA}. Including these unassigned cases may affect the variability of Group 1_{NAA}/Group 1_{PET}.

Table 6.9. Coefficients of variation within variables of the petrographic data between groups.

PETROGRAPHIC GROUP	VERY FINE SAND TEMPER	FINE SAND TEMPER	MEDIUM SAND TEMPER	COARSE SAND TEMPER
Group 1_{PET}	.640	.282	.185	.352
Group 5_{PET}	1.0	.474	.171	.534

Fall-off Curves

I use Renfrew's (1977) fall-off principle here simply as an attempt to identify the centers of production for each major compositional group. To identify this center I look for sites that have the most homogeneous ceramic profiles close to the middle of each compositional zone. These sites have a higher chance that they were major producers than sites that display heterogeneous ceramic profiles near the border of compositional zones. Heterogeneous profiles could signify that they were the recipients of ceramics from two or more other loci. Of course, heterogeneity does not rule out local production with different raw materials. Examining the shape and extent of each compositional zone as mapped on the landscape may also delineate important political and/or economic boundaries.

Based on their homogeneous compositional profiles for both Group 1_{NAA} and Group 1_{PET}, Matacapan, Ranchoapan, Site 132, and several unidentified possibilities in the Hueyapan Survey could have been major producers of this sub-group for exchange. Site 48 was homogeneous compositionally, but evidence presented above suggests that it was a highly unlikely center of ceramic production. Teotepec was a large center, but the chemical data show a very heterogeneous compositional profile, suggesting that they procured many ceramics from other sites. Not much is currently known about the Hueyapan settlements, but it is possible that large-scale production took place there. Distance from Group C_{NAA} clay resources make it unlikely that Hueyapan settlements were centers of Group 1_{NAA} and Group 1_{PET} production. Matacapan and Ranchoapan are the best-*known* possibilities as centers of Group 1_{NAA} ceramic production that could have been on the scale to allow provisioning of large parts of the region. Due to their spatial proximity, in addition to a comparative site level specialization in ceramic production by Matacapan and obsidian working by Ranchoapan, it is very likely that these two sites interacted intensively. Beginning from this likely center and moving southwest, Group 1_{NAA} generally declines in frequency until it hits the east to west boundary between El Salado and Site 154. Only a few Group 1_{NAA} ceramics passed this border. However, to find even a few Group 1_{NAA} ceramics as far away as Tres Zapotes suggests that one or more sites was involved in exchange further than their immediate surroundings.

Fall off in frequency of Group 1_{NAA} ceramics from Matacapan certainly includes this site as a possible center of production that provisioned parts of the region. However, this is not solid evidence against local production at every site.

Differential Production Scale and Intensity

If difference in production scale and intensity can be taken to represent relative emphasis on trade outside the site boundaries, Matacapan was by far the most probable center of Group 1_{NAA}/Group 1_{PET} production. This, however, would be a circular argument and should not be relied upon to independently signify Matacapan's dominance of the Group 1_{NAA}/Group 1_{PET} Coarse Orange market. Nevertheless, it should be mentioned again here that Matacapan did evidence the highest investment in ceramic production of any other known site in the Tuxtlas.

Settlement Hierarchy

The settlement hierarchy has already been described briefly in Chapter 4. The assumption employed here is derived from central-place theory as employed in archaeology. This generally states that larger sites in the settlement hierarchy indicate possible market centers. Of course there are many problems with this assumption, including the fact that market centers need not produce any commodities at all. Nevertheless, this is one more dimension of variability that may prove informative coupled with other lines of evidence.

The largest sites that possessed a high proportion of Group 1_{NAA}/Group 1_{PET} ceramics were Ranchoapan, Matacapan, and Teotepec. These three large centers all display evidence of ceramic production. Matacapan appears to be much more specialized in ceramic production than the other two. Ranchoapan specialized primarily in obsidian tool production. Teotepec displays a very diverse compositional profile, supporting the central-place assertion that it may have been a market center. However, this also suggests that because they were procuring ceramics made in other sites it is probable that Teotepec did not even produce enough locally to provision the local population.

The only compositional groups that shows a bias toward appearing in a particular site rank were Group 7_{NAA} and Pit 6_{PET}. Pit 6_{PET} was probably exclusively used on site at Matacapan due to the attached nature of production. Group 7_{NAA}, however, did not occur at a single site. Instead, Group 7_{NAA} occurred primarily at large centers (Ranchoapan, Matacapan, and Teotepec). Although it is unlikely that this variant of Coarse Orange was highly valued over others, it may point to somewhat exclusive interaction at the highest social levels. Perhaps it was the contents of the ceramic vessels that were traded between large centers.

All other ceramic groups seemed to have been equally traded to all site ranks. This indiscriminant distribution may be indicative of some type of centralized market exchange where consumers come to a marketplace to procure their crafts. Other types of exchange, including itinerant merchant trade, may show more exclusive distributions. I do not use this variable to suggest that marketplaces existed in the Classic period Tuxtlas. Although more evidence exists that does support this hypothesis, we are far from identifying marketplaces in this region.

Distance from Clay Resource

Distance from clay resources, as discussed above, is a better indicator of sites that did not produce a certain ware than those who did. Tres Zapotes and some of the settlement in the western half of the Hueypan Survey area may be ruled out as producers of the Group 1_{NAA}/Group 1_{PET} ceramics. However, further geological reconnaissance may indicate that Group C_{NAA} clays occur near these areas.

Of the Group 5_{NAA}/Group 5_{PET} ceramics, Matacapan should be eliminated as a producer simply because the major production facilities were sampled and none of them used the Group S_{NAA} clays that make Group 5_{NAA} ceramics. Isla Agaltepec, Teotepec, and Site 132 should also be eliminated as centers of production for this sub-group of Coarse Orange because of distance to these clay resources. The eastern half of the Hueyapan Survey probably did not have direct access to Group S_{NAA} clays because the Concepción outcrop that occurs there is from the lower stratigraphic layer. However, these clays have not yet been analyzed.

River Transportation

Proximity to major routes of water transportation could have been a determinant of decisions to emphasize ceramic production at certain sites, particularly the Comoapan production facility. Water is needed for ceramics production, and canoe travel would facilitate the ability to distribute the pottery (Hassig, 1985, Drennan 1984). The Rio Grande de Catemaco, the Rio Hueyapan, and Laguna Catemaco probably were influential for determining location of ceramic production because of this. The Comoapan production locality was situated right next to the Rio

Grande de Catemaco. As mentioned above, the major distribution of Group 1_{NAA}/Group 1_{PET} ceramics tend to follow this river to the southwest. Of course, several other sites could have also easily used this transportation route, or another of the navigable rivers in the Tuxtlas.

Laguna Catemaco may have also been important for exchange transport. Teotepec would have likely been the center to integrate lake settlements, and the ceramic production located there may have been targeted toward provisioning other sites along the shores.

Group 5_{NAA}/Group 5_{PET} ceramics produced in the west would not have been traded to the east through river transportation. Interestingly, a good proportion of these ceramics did end up at sites in the far eastern portion of the study area.

One final comment may bolster an argument for Matacapan as the center of Group 1_{NAA}/Group 1_{PET} ceramics. Group 7_{NAA} Group 6_{NAA}, and Group 8_{PET} together cover a major portion of the study area. I have suggested previously that these were local recipes that were produced at low intensities. It is possible that these were the only locally produced ceramics in sites that possess them – leaving all of the Group 1_{NAA}/Group 1_{PET} ceramics found at these same sites to represent exchange with centralized producers. This is an extreme interpretation, but one that should not yet be thrown out.

Evaluation of Hypotheses

The hypotheses outlined at the end of Chapter 4 can now be evaluated. Since each hypothesis considers culturally significant issues, I discuss each one separately.

<u>Hypothesis 1, Matacapan was the sole producer of Coarse Orange found within the Tuxtlas</u>, is rejected by the compositional data. The compositions of Comoapan ceramics closely resemble the dominant chemical and petrographic groups determined for Coarse Orange. However, there were clearly other producers of Coarse Orange that used recipes very different from those employed at Matacapan.

<u>Hypothesis 2, Coarse Orange produced at Matacapan reached an intermediate range, primarily servicing the central Tuxtlas</u>, is not rejected by this data. The distribution of Matacapan wares was restricted either by limitations in transportation or by economic competition from other localities. The fact that the zone of Matacapan's potential economic

influence extends much further south and east than west reflects possible trade routes delineated by the southward meandering of the mountain's rivers. The frequency of the Group 1_{NAA}/Group 1_{PET} compositional group also falls off with distance from Matacapan, which would be expected if Matacapan were the center of production. The constraint to the western range of Group 1_{NAA}/Group 1_{PET} reflect the use of two distinct sets of clay sources to make ceramics within each zone of production and distribution. It also reflects an emphasis on Coarse Orange production at sites to the west that may have been in political and economic competition with Matacapan. Potential acceptance of this hypothesis could place Matacapan as an economic center in the Classic period Tuxtlas region, at least regarding ceramics. This supports Arnold et al. (1993) and their interpretation of the role of Comoapan in the region.

Hypothesis 3, Access to Matacapan pottery varied with position in the settlement hierarchy is not supported by the data. The distribution of ceramic compositions is influenced much more by geography than site rank. Any correlation would be influenced by more factors than can be controlled for here. The fact that sites of different rank in the central Tuxtlas had equal access to potential Comoapan exports indicates many possible situations. First, Matacapan was successful in suppressing rural pottery production in a restricted portion of the Tuxtlas that would have created dependency on Comoapan as the region's principal supplier of Coarse Orange and potentially other wares. I believe this was possible for sites immediately surrounding Matacapan. Second, Coarse Orange may have been traded down the settlement hierarchy from Matacapan, ultimately reaching small rural hamlets through second order centers. Markets might have existed at large and small centers throughout the region, Teotepec being the second most likely possibility besides Matacapan. And finally, Matacapan did not exclusively deal with large sites in the region.

Hypothesis 4, Production of Coarse Orange at Matacapan was geared toward export beyond the Tuxtlas, cannot be assessed fully with these data. However, it appears unlikely particularly if Comoapan was the principal producer of Group 1_{NAA}/Group 1_{PET} Coarse Orange because sherds of this composition are widely distributed in the Tuxtlas. A complete absence of sherds that matched Matacapan control groups could have signified the possibility that Comoapan only exported ceramics, or it may have suggested that they traded no ceramics at all. This was not evident in the data. Ceramics matching the Matacapan control group do appear along the major rivers, possibly suggesting break-of-bulk points on the way out of the region, but its distribution is not limited to routes of transportation out of the Tuxtlas. Even if they were, that would also suggest some intraregional exchange. The possibility is still strong, however, that Classic period Tuxtlas ceramics made it outside of the region as storage containers for other goods (e.g., liquidambar and honey). This is mildly supported by the presence of Group 1_{NAA}/Group 1_{PET} ceramics on the alluvial floodplains to the south. If this were true, the distinctiveness of Tuxtlas volcanic ash should provide solid evidence for future sourcing.

Hypothesis 5, Production of Coarse Orange was dispersed throughout the Tuxtlas and no centralized distribution took place, cannot be unconditionally rejected. Nevertheless, site ceramic profiles become more heterogeneous as one moves away from Matacapan, and the frequency of Group 1_{NAA}/Group 1_{PET} declines. The considerable variation in Coarse Orange composition does represent a good amount of local production, but all zones of production and distribution mentioned in the text seem to be nucleated around centers. This could just be happenstance, but the differential evidence for scale and intensity of production between urban and rural sites promote the interpretation of at least some centralized production and exchange within each compositional group. Considering the coefficients of variation of the two main Coarse Orange groups, Group 1_{NAA}/Group 1_{PET} was produced by a relatively smaller number of specialized producers, which may indicate centralized production. I make this inference because Group 1_{NAA}/Group 1_{PET} is more homogeneous than any other group. Group 1_{NAA}/Group 1_{PET} was also distributed on a greater scale than other groups. The distribution of Group 5_{NAA}/Group 5_{PET} may also have been centralized to some degree; however, a center of production for this ware has not yet been determined. Despite some very strong arguments for centralized production and distribution, this hypothesis cannot be fully rejected.

These hypotheses were designed to cover the major possibilities for the production and distribution of Coarse Orange in the Tuxtlas, with a particular interest in Matacapan's role in this economic system. The rejection of three and possibly four of these hypotheses suggests that the one remaining hypothesis not rejected provides the most likely explanation for Matacapan's role in the region's Coarse Orange industry.

It seems that Hypothesis 2 – "Coarse Orange produced at Matacapan reached an intermediate market, primarily servicing the central Tuxtlas" – has the most evidence stacked in its favor. Excavations should be conducted at other sites with evidence for Coarse Orange production in order to obtain samples from production contexts to more adequately test Hypothesis 5. This suggests that the Coarse Orange produced at Matacapan, and Comoapan in particular, was centralized to some degree in its distribution. However, Matacapan clearly did not completely dominate the Coarse Orange economy in the Tuxtlas.

Chapter 7

CRAFT SPECIALIZATION AND INTRAREGIONAL INTERACTION IN THE TUXTLAS

With regard to the central question posed at the beginning of this research – what was Matacapan's role in the regional Coarse Orange economy – the data suggest that Matacapan did organize production of this ware for the partial purpose of provisioning other sites within the region. Their ability to control the Coarse Orange market was, however, attenuated by production at other sites. The most intensive zone of interaction in which Matacapan probably participated is delineated by the geographic distribution of Group 1_{NAA}/Group 1_{PET} Coarse Orange (Maps 6.2 and 6.3), but some Matacapan products could have reached at least as far as Tres Zapotes, who otherwise probably produced the majority of their own ceramics. This conclusion supports Arnold et al. (1993) who suggested that Comoapan was oriented toward provisioning the Tuxtlas with ceramics. However, this conclusion is contingent upon our ability to demonstrate that the Group 1_{NAA}/Group 1_{PET} ceramics found at other sites were not locally produced using the same raw material.

The techniques employed herein may not be able to unconditionally reject this local production hypothesis, but other data presented in Chapter 6 and Chapter 4 make Matacapan the most likely source of exchanged Group 1_{NAA}/Group 1_{PET} Coarse Orange in the Tuxtlas. Local versus centralized production and distribution of Coarse Orange should become more apparent through more compositional research of other wares in the future. If, for instance, compositional variation in Coarse Brown, Fine Orange, and Fine Gray sampled from the same sites show the same geographic distributions as Coarse Orange, localized production would be the most likely interpretation. This situation would indicate that the primary determinant of compositional groups in relation to geography was raw material availability and not exchange. If these other wares do not display the same compositional distribution as Coarse Orange, as would be expected judging from the differences in scale and intensity of production, then the centralized production and exchange of Coarse Orange would be further supported.

The apparent east-to-west division between Group 1_{NAA}/Group 1_{PET} and Group 5_{NAA}/Group 5_{PET} compositional zones could represent several things. First, it may reflect the natural transition in available clays originally observed by Pool (1990). If this were true, it could indicate local production of Coarse Orange at the site level. Alternatively, the compositional border could indicate different polities or relatively independent economic systems. Although the former may be true, I believe the latter is more likely. There appear to be at least two distinct polities in the northern portion of the study area since the Formative period. Santley et al. (1997) indicate that the settlement in the eastern Tuxtlas (i.e., those sites that fall within the Tuxtlas Survey) was organized differently from contemporaneous sites to the west. Tres Zapotes, the largest Epi-Olmec site in Olman (the Olmec heartland), appears to have had very little influence on the organization of sites to the east. This compositional boundary in the Classic period suggests, at the very least, that the two zones of Coarse Orange composition were economically independent. This conclusion, however, may not apply to other commodities. Although not supported by Pool and Santley (1992), fine paste ceramics may have been exchanged more readily because of their presumed higher value. Other prestige items may also show more interaction between compositional zones delineated here.

There was certainly Coarse Orange exchange between the east and west of the study area, but it was of very low volume. In fact, Group 5_{NAA}/Group 5_{PET} Coarse Orange seems to have been traded more heavily to the east than possible Matacapan exports were traded to sites in the west like Tres Zapotes.

Turning to Santley's (1994) contention that Comoapan served primarily as an export industry for trade to other regions in a dendritic central-place system, the data indirectly suggest that this was not the case. If Coarse Orange production, the primary ware produced at Comoapan, were oriented toward export beyond the Tuxtlas, one would not expect to find that these ceramics were traded to other sites within the region. If the interpretation posited here, that Matacapan produced Coarse Orange for intraregional exchange, is correct it is unlikely that Comoapan primarily served as an export industry, as suggested by Santley (1994). This does not mean that Matacapan did not participate in the broader dendritic system thought to operate in the Classic period Mesoamerican world-system (Santley and Alexander 1996), but it does suggest that Coarse Orange was not the focus of interregional exchange or primarily used as containers that held other commodities for export (Arnold et al. 1993). The *primary* focus of Comoapan exchange was oriented within the region.

This data also elucidates a related issue discussed by Arnold et al. (1993). Although it is recognized that Teotihuacan influence was certainly part of the reason for founding Matacapan, Arnold et al. (1993) argue that later in the Classic period, this center became more autonomous and focused within the region. Based on the potential distribution of ceramics produced at Comoapan found in this study, Matacapan does seem to be focused on the Tuxtlas economy rather than as a bulking center for interaction with Teotihuacan. Material interaction between Matacapan and Teotihuacan has elsewhere been characterized as low intensity exchange (Santley and Pool 1993, Santley and Alexander 1996). Since Comoapan emerged after Teotihuacan's control over Matacapan is presumed to have waned, a general trend of increasing autonomy and focus within the region is apparent from Early Classic to early Late Classic periods.

This study is but one piece of the Tuxtlas' political economic puzzle. With more research on production and exchange systems in the future, we should be able to complete the puzzle. To achieve a better knowledge of the Tuxtlas political economy, more compositional research is recommended on different ceramic wares. Archaeologists should also attempt to delineate the unknown boundaries of the compositional groups identified herein. Other issues that need to be addressed include determining the mechanisms of exchange operating in the Formative and Classic period Tuxtlas, relations of production and exchange between social classes, and how economy links up with other aspects of society. To address many of these questions, more excavation is needed from other regional centers and rural sites. We cannot determine political economy from the top down.

Turning to the broader archaeological significance of this study, these compositional data conditionally support Brumfiel's (1987, 1991, 1980) assertion that craft specialization at economic centers suppresses commercial activity at rural sites. It does appear that Matacapan partially had this effect in the central Tuxtlas. The dynamic population increase at Matacapan has been suggested to represent immigration of craft specialists (Santley and Arnold 1996). If potters left the countryside during the Middle Classic to relocate at Matacapan it would have created a void to be filled by economic dependence on Matacapan for both utilitarian and prestige goods. Whether the nature of interaction was capitalist or communal, ceramics were a tool of everyday life for the Classic period Tuxtecos, and those who did not produce it themselves would need to procure it from others. Given the utilitarian and possibly ceremonial uses of Coarse Orange, these Matacapan wares could have easily satisfied many functional roles throughout the countryside. These conclusions have significance for Mesoamerica, in general, in that they support the idea that intensification of ceramic production in centers for trade to other sites in the region was a source of economic power. Even though suitable clay resources were widely distributed throughout Mesoamerica, the sociopolitical organization of settlements can still have a dramatic impact on the degree of economic centralization in a region.

Conversely, the fact that one of the largest ceramic production entities known in all of Mesoamerica, Comoapan, did not completely dominate the regional ceramic market suggests that archaeologists should reconsider the possibility that any industry in pre-Hispanic Mesoamerica could have had such a pervasive effect on regional economies. The largest-scale production loci at Matacapan did not completely suppress production of Coarse Orange in sites supposedly subordinate to Matacapan's political influence. The same craft was produced at small scales in many areas throughout the region, and at moderate scales in other parts to the east (i.e., Tres Zapotes [Pool 2002]).

The significant exceptions to this urban\rural pattern of centralized economy raised by evidence for significant Coarse Orange production outside of Matacapan provide important considerations when interpreting hierarchical settlement patterns and large-scale urban craft production. These apparent imperfections in Matacapan's control over the region's craft economy further demonstrate the benefits of compositional techniques and substantive reconstruction of commodity flow for refining blanket theories of central-place/hinterland interaction. Given the dearth of data often found in the archaeological record regarding specific economic relationships, we are forced to generalize our interpretations about the organization of prehistoric societies. This can lead to visions of very centralized economic interaction judging from indirect evidence. The example of Matacapan was one such case where settlement patterns and ceramic production in the region's principal center suggested a very centralized economy. The distribution of Coarse Orange supports the notion of a centralized economy in the Classic period Tuxtlas, but generates notable exceptions that should be considered as areas that lay outside of Matacapan's political and/or economic influence. Comoapan may have been very influential in parts of the region, but at best only supplied a restricted portion of the Tuxtlas with ceramics. Thus, we must not presume that the development of large central-places absorbs all of the craft production in an entire region. Using compositional techniques at least provides the means to delimit the possible range of influence. Archaeologists should consider these general exceptions when relying on central-place theory and other hierarchical models to explain regional political economies.

The combination of chemical and mineral compositional analyses with ceramic production evidence provides sourcing data on a level of specificity that can prove very sensitive culturally. The combination of chemical and petrographic analyses allowed discrimination between individual production loci at Matacapan. The possibilities of this dual approach have been noted before (Rands and Bishop 1980, Neff et al. 1988, 1989, Stoltman et al. 1992, Rands and Weimer 1992), but this study enjoys sampling from known production loci that act as control groups (see Day et al. 1999). The possibilities of directly sampling production contexts when available are exciting and this type of work should be conducted in all cases where production loci have been successfully identified.

APPENDIX A CHEMICAL DATA

anid	site_name	chem02_2	as	la	lu	nd	sm	u	yb	ce	co	cr	cs	eu	fe	hf	ni
PK002	EL SALADO	Unassigned	3.7286	28.4251	0.3377	27.7874	5.4879	2.94	1.7854	59.5589	32.9438	465.3206	5.9329	1.2946	57417.7	3.99	187.
PK003	EL SALADO	Group 1	1.8478	28.6035	0.2944	24.5557	5.7034	1.72	1.9566	60.1846	33.0894	499.0142	4.7661	1.4252	59071.6	5.021	127.
PK004	EL SALADO	Group 1	2.9666	28.7281	0.2786	25.6453	5.64	2.58	2.2487	59.1519	30.0636	395.5052	6.1544	1.3602	56732.1	4.3283	131.
PK005	EL SALADO	Group 1	1.8075	29.9262	0.3448	30.2172	6.0127	2.49	2.0489	62.845	26.0165	369.9848	5.7224	1.4115	56362.6	4.7528	95.
PK008	EL SALADO	Group 1	2.5159	28.3036	0.3016	18.7184	5.5098	2.66	1.8133	60.2429	33.7152	533.7271	5.599	1.3559	59971.9	4.1484	186.
PK009	EL SALADO	Group 1	4.0398	27.0783	0.3098	27.0758	5.4172	2.65	1.8037	56.8013	27.1176	353.7897	6.26	1.2437	53606.2	3.8645	91.
PK011	EL SALADO	Group 1	1.3843	27.8719	0.3044	27.7999	5.5809	2	1.7963	58.3187	31.5164	407.2806	4.2067	1.373	57772.3	4.0136	151.
PK012	EL SALADO	Group 1	1.5204	26.2866	0.2503	25.6594	5.2713	2.29	1.8575	55.737	32.6925	477.3981	6.0443	1.324	59176	4.0317	156.
PK039	TRES ZAPOTES	Group 5	2.9764	34.5002	0.3999	37.1308	7.4043	1.86	2.7049	85.2391	45.3784	477.3237	2.8924	1.9175	64700.3	6.1596	238.
PK042	TRES ZAPOTES	Group 5	1.894	32.2654	0.3192	26.164	6.4789	2.92	2.2565	66.2535	33.6213	497.7682	3.5974	1.6099	60883.2	5.8365	184.
PK043	TRES ZAPOTES	Group 1	0	30.0701	0.3004	22.8631	6.1556	3.5	2.0975	64.7035	35.6205	505.4122	4.0939	1.5439	63708.9	5.0614	180.
PK044	TRES ZAPOTES	Group 5	2.6843	30.4551	0.3734	28.15	6.0216	2.75	2.6312	54.4136	39.3709	590.3455	3.4302	1.5299	56806.3	5.7268	273.
PK045	TRES ZAPOTES	Group 5	0	36.2108	0.4562	32.2528	7.198	1.87	2.7507	73.1956	39.9406	477.827	3.4063	1.9635	61635.6	6.0366	207.
PK047	TRES ZAPOTES	Group 5	3.6805	30.4431	0.4142	24.708	5.919	2.76	2.4746	65.013	28.709	356.6594	3.2582	1.554	48474.9	6.3208	152.
PK048	TRES ZAPOTES	Group 5	3.0902	29.7375	0.3785	28.7384	6.464	1.68	2.4188	61.7888	48.3327	768.8478	1.958	1.5961	73098.5	5.7048	359.
PK051	TRES ZAPOTES	Group 5	2.4874	33.2424	0.3674	36.0839	6.4736	1.17	2.5002	55.619	41.2047	569.9665	2.1977	1.7102	60996.3	5.4326	259.
PK053	HUEYAPAN AREA	Group 1	3.0331	28.9678	0.2631	27.6616	6.0189	2.79	1.9021	58.0034	35.1037	518.1603	4.9213	1.491	61145	4.7613	175.
PK056	HUEYAPAN AREA	Group 1	0	26.3507	0.2631	27.8534	5.5515	2.28	1.9856	58.6973	29.2549	468.6857	5.7632	1.3785	59163.3	4.7838	134.
PK058	HUEYAPAN AREA	Group 1	0	28.4052	0.3545	29.285	5.754	2.99	2.0423	56.9085	31.9912	477.4809	3.9566	1.4804	58431.4	4.4388	146.
PK060	HUEYAPAN AREA	Group 1	2.1293	30.5481	0.383	29.5358	6.1553	3.86	2.342	63.1746	25.4431	385.4631	4.185	1.4173	55206.5	5.2659	122.
PK069	TRES ZAPOTES	Group 5	2.7885	34.4575	0.3563	33.7543	7.1808	2.48	2.6118	101.9142	57.3722	466.0179	2.8791	1.8479	61037.8	6.1184	220.
PK070	TRES ZAPOTES	Group 5	3.2401	32.5752	0.3618	29.6212	6.7067	2.71	2.6247	65.8318	38.5163	464.1781	3.0842	1.8192	68560.4	6.0877	224.
PK072	HUEYAPAN AREA	Group 5	7.6846	37.0185	0.3529	39.4585	7.4965	2.71	2.6294	71.4197	39.0948	460.0233	2.7324	1.9243	55966.2	5.7173	186.
PK074	HUEYAPAN AREA	Group 1	5.5524	29.0895	0.3134	29.3126	6.0263	4.05	1.9449	60.1596	34.2415	523.1089	1.5866	1.5209	64690.6	5.333	154.
PK075	HUEYAPAN AREA	Group 5	2.2083	28.6512	0.4225	20.5304	6.1483	1.8	2.4076	61.28	33.9504	518.4164	2.678	1.549	53213.8	6.8688	174.
PK076	HUEYAPAN AREA	Group 6	3.8234	38.5305	0.5193	35.1195	7.7802	3.52	3.3315	74.9247	20.5333	172.9411	5.3031	1.8428	51226.2	8.0698	24.
PK087	HUEYAPAN AREA	Group 1	0	30.2039	0.3071	31.4839	6.0146	2.45	2.0771	61.9973	33.1826	484.6499	5.0341	1.5087	60716.1	4.8548	160.
PK088	HUEYAPAN AREA	Group 5	6.6359	29.1079	0.2914	27.0267	6.1308	1.21	2.0963	64.7775	42.3682	482.1225	3.6529	1.6336	65749	6.0525	179.
PK089	HUEYAPAN AREA	Group 1	2.8413	30.2455	0.2817	31.857	5.9635	2.1	2.1833	64.1889	35.7876	524.4132	3.5433	1.496	63632.7	4.4029	131.
PK091	HUEYAPAN AREA	Group 6	2.0514	36.5192	0.3609	39.3517	7.2612	2.46	2.6355	80.6277	18.0248	142.9139	3.3115	1.7182	34118.3	5.1376	58.
PK092	HUEYAPAN AREA	Group 1	3.1165	27.9275	0.3111	25.0026	5.6883	2.38	1.9754	58.71	30.8745	455.8531	4.5321	1.4133	58106.6	4.9243	125.
PK093	HUEYAPAN AREA	Unassigned	2.2726	40.054	0.5741	47.3028	10.4559	2.36	4.2348	88.6513	45.329	355.9701	4.2228	2.8537	62648.1	6.6235	114.
PK094	HUEYAPAN AREA	Group 1	5.534	27.8741	0.3504	26.1656	5.573	2.77	2.0415	59.1755	26.8393	451.2686	2.6538	1.3317	57314.2	5.5704	131.
PK101	143	Group 5	5.7616	34.2038	0.4267	31.4388	7.2997	2.77	2.7192	115.7961	50.4147	458.3242	2.6357	1.8831	71785.2	7.312	152.

APPENDIX A CONT.

PK103	143	Group 1	0	31.2073	0.2683	28.8315	6.371	2.28	2.074	63.8391	38.3649	503.1642	2.3851	1.6101	65488.2	4.6686	195.
PK105	143	Group 1	0	28.8574	0.272	29.5488	5.8485	2.04	1.8836	60.9138	34.652	490.0569	4.8706	1.4142	62188.4	4.2332	14
PK107	143	Group 1	0	29.1134	0.3318	33.6393	5.98	1.81	1.9074	60.5429	34.8893	498.8055	4.8713	1.4827	63317.2	4.5096	173.
PK108	143	Group 1	1.5388	28.6385	0.3552	23.5865	5.7529	2.34	2.1149	57.5721	26.8552	430.0044	5.6691	1.3753	54800.7	4.8942	13
PK109	143	Group 1	2.7281	29.9418	0.3058	31.0718	6.078	2.71	2.2654	63.0372	35.2041	498.0203	4.6747	1.5098	61448	4.9909	183.
PK110	143	Group 1	0	29.6351	0.2991	27.1969	6.0107	2.45	1.9988	61.0106	30.2098	541.6691	5.029	1.4865	60165.5	5.009	133.
PK112	143	Group 1	2.2625	29.0747	0.2715	30.2044	6.0095	2.31	2.1499	59.2536	39.6523	587.7772	4.1898	1.4941	63550.3	4.507	17
PK114	143	Unassigned	0	27.6045	0.333	26.6904	5.6778	2.85	2.0235	57.4591	44.3951	697.4131	2.3319	1.3924	62731.7	4.9959	315.
PK115	143	Unassigned	2.9823	26.7029	0.2624	26.9162	5.4237	2.22	1.691	55.1649	42.0976	634.4518	4.8294	1.3171	60575.6	4.2907	245.
PK118	48	Group 1	0	29.4694	0.3286	25.8378	6.0226	2.33	2.1895	59.1482	30.7971	429.8887	3.4387	1.4163	58263.9	4.886	112.
PK122	48	Group 1	0	28.3289	0.3286	26.2694	5.864	2.95	1.9927	58.1184	35.4381	510.1186	4.3712	1.4687	60142.1	4.7569	197.
PK123	48	Group 1	1.7518	28.2177	0.2911	27.6998	5.8673	2.77	2.0868	58.5566	30.4978	391.4541	3.9252	1.3769	58273.3	5.1411	124.
PK124	48	Group 1	2.8684	27.8533	0.2974	25.1616	5.7777	3.18	1.9735	58.7376	38.0155	536.0062	4.2237	1.4084	64436.1	4.1537	15
PK125	48	Unassigned	0	27.0682	0.3781	24.091	5.9711	2.39	2.2254	57.4403	39.7856	605.787	2.464	1.4687	68284.7	4.6153	191.
PK126	48	Unassigned	0	28.8348	0.2873	25.4395	5.9655	1.82	2.0191	66.3658	51.0322	569.7932	3.4477	1.4422	61641.3	4.9156	193.
PK127	48	Group 1	0	26.6052	0.2972	24.9904	5.4429	2.28	1.8505	55.9654	34.446	519.054	4.0966	1.4364	60421.3	4.5416	20
PK128	48	Group 1	2.3262	30.7931	0.3786	20.8765	6.1301	2.75	2.3542	64.2812	30.6128	416.0615	4.9343	1.5229	60041.6	5.5579	151.
PK132	48	Group 1	1.8366	29.0654	0.2873	24.8818	5.9295	2.43	1.9925	60.5082	36.3729	520.3311	4.5367	1.5106	64330.3	4.4446	22
PK134	48	Unassigned	2.1377	26.5662	0.3413	17.8308	5.4585	1.82	1.9642	58.3258	38.6434	505.4901	2.6417	1.4166	62162	4.601	25
PK137	170	Group 5	1.6304	34.5303	0.4219	29.9141	7.2336	1.97	3.0548	59.1631	28.0234	401.0061	4.1748	1.8713	51094.7	6.5856	155.
PK138	170	Group 5	2.5835	29.871	0.3622	26.9507	6.2649	2.11	2.7291	70.0328	45.0551	526.1321	2.6714	1.6838	62207.4	7.1062	168.
PK139	170	Group 5	0	30.7107	0.4078	32.0063	6.5717	1.43	2.6087	78.0519	38.8787	447.5263	3.169	1.7521	61635	6.4653	248.
PK140	170	Group 5	3.8905	24.9246	0.384	23.1305	5.4936	3.14	2.7116	60.3555	24.6154	224.3126	2.3605	1.3592	49905.7	6.3457	201.
PK142	170	Group 5	0	39.0977	0.4251	36.1115	7.6574	1.77	3.0008	73.3726	24.6805	298.9703	3.5095	2.0069	56239.7	7.0329	102.
PK144	170	Group 5	0	32.3113	0.354	29.4504	6.6305	1.88	2.6879	67.4741	41.0586	472.9174	2.5847	1.7309	50008.8	6.2414	21
PK146	170	Group 5	4.2226	30.6266	0.3718	30.1873	6.2012	3.24	2.4886	62.2942	32.8368	466.2383	5.187	1.5439	59156.7	4.746	228.
PK147	170	Unassigned	3.6408	30.8889	0.3859	24.9379	6.6078	1.99	2.4103	64.4237	32.3958	483.1126	2.2936	1.6097	64292.4	5.4062	182.
PK151	170	Group 5	3.6099	30.5322	0.4047	28.1166	6.239	2.17	2.6517	60.0371	35.8362	458.7298	2.9077	1.6458	50633.7	7.6617	243.
PK153	170	Group 1	0	29.4756	0.2654	30.1387	5.8489	3.28	2.0672	64.0174	43.6001	546.7657	2.9842	1.5416	64748.6	4.6484	254.
PK158	39	Group 1	2.9942	26.328	0.2609	25.5159	5.5324	1.72	1.8835	56.9496	40.3753	593.3257	2.6536	1.5056	65245.3	4.534	186.
PK164	39	Group 5	0	27.7899	0.3453	29.3228	6.02	2.03	2.3357	45.212	29.0522	484.3448	2.171	1.5481	55856.2	7.8187	179.
PK165	39	Group 1	3.5252	28.4538	0.3711	26.4842	6.0217	2.33	2.0197	59.5436	37.4253	560.1417	2.3057	1.5006	66956.7	4.578	155.
PK166	39	Group 1	2.097	28.491	0.2779	33.3235	5.9504	2.65	2.0894	58.6158	36.4012	552.2433	1.7892	1.5175	64874.9	5.0256	197.
PK171	39	Group 1	2.4635	28.1158	0.2848	26.9107	5.8659	3.01	2.2685	59.7304	36.3494	548.5395	4.635	1.4724	67839.1	4.2312	189.
PK173	39	Group 5	3.7743	39.2749	0.3903	37.7714	7.5286	2.13	3.0019	71.6311	34.5063	331.2614	4.0696	1.9128	57230.6	6.5809	10

APPENDIX A CONT.

PK177	39	Group 5	0	29.8758	0.344	22.7184	5.9006	3.32	2.5083	55.244	29.7035	357.6133	2.856	1.6039	53367.4	6.316	14
PK179	?	Group 5	0	33.0808	0.3726	39.4482	6.7301	2.1	2.6491	74.0041	42.2659	538.0709	2.2523	1.7185	61649.4	5.974	249.
PK180	39	Group 5	2.2881	28.998	0.3418	23.4883	5.836	1.93	2.555	60.0658	35.0752	369.2626	2.3045	1.5204	51528.6	7.4161	204.
PK182	39	Group 5	2.0428	32.057	0.3979	31.9127	6.8905	1.77	2.6617	56.8865	31.7629	411.3073	2.6276	1.7735	61476.9	7.0523	19
PK184	124	Group 1	0	30.442	0.3855	31.5381	6.1834	3.98	2.1837	64.6422	36.0662	446.8065	5.0872	1.4444	63340.4	4.5134	17
PK190	124	Group 1	0	31.1188	0.3261	28.3437	5.7643	3.63	2.1869	64.7875	22.9819	267.8505	7.8891	1.2989	53614.2	4.5613	114.
PK192	124	Unassigned	1.9826	30.7448	0.3539	31.2955	5.9034	3.14	2.1585	62.8492	26.1376	425.1579	5.2813	1.4414	55775.9	5.4348	89.
PK193	124	Unassigned	4.6076	29.4376	0.3461	28.3052	5.7671	4.26	2.2597	63.0285	27.6709	316.2487	5.6467	1.3116	53460.9	4.133	130.
PK194	124	Group 1	2.1646	29.0363	0.3153	30.0086	6.0986	2.66	2.0744	62.197	35.0738	522.2077	5.0573	1.5282	64721.3	5.0577	20
PK195	124	Unassigned	3.6427	29.668	0.3396	32.5426	5.804	3.49	2.2061	62.6559	32.8588	304.3998	3.4847	1.2691	95785	4.4433	125.
PK196	124	Group 1	0	28.3634	0.2118	26.5028	5.5623	2.51	1.8851	58.2825	40.4315	508.8904	4.2139	1.3939	62285.4	4.0444	245.
PK197	124	Group 1	2.9191	31.1629	0.3607	26.7657	6.192	2.92	2.4451	65.1292	20.8153	237.256	8.078	1.4119	50927	5.8536	97.
PK198	124	Group 1	0	30.2235	0.3382	26.9624	6.008	2.91	2.3286	62.3081	30.5139	397.7761	6.7393	1.491	57718.1	5.1189	15
PK199	124	Group 1	3.2565	27.1024	0.2501	28.0282	5.4377	2.89	1.9141	57.3481	33.2645	494.1527	5.0229	1.3366	60793.2	4.0639	139.
PK201	45	Group 1	2.0463	28.8	0.297	28.7987	5.7748	2.74	2.1288	58.6859	29.023	417.6735	4.7889	1.4013	57443	4.4911	150.
PK203	45	Group 1	5.1341	30.182	0.3624	27.2509	6.0283	3.41	2.356	61.0471	26.5713	361.3831	6.3834	1.4368	55143.7	5.3021	147.
PK205	45	Group 7	0	29.4679	0.3466	27.5967	5.917	3.18	2.3805	61.0803	31.3361	418.0722	1.5442	1.4198	64670	4.5785	209.
PK206	45	Group 1	4.1735	29.9347	0.3294	21.8107	5.9956	3.38	2.0926	61.6362	30.7062	435.8497	4.545	1.508	60687.6	4.95	135.
PK207	45	Group 1	0	30.8687	0.3227	33.404	6.373	3.48	2.6499	64.0207	24.6354	313.4452	5.5487	1.4218	54674.8	5.5155	125.
PK208	45	Group 1	0	27.283	0.2319	27.2807	5.4359	3.06	1.7121	57.5966	33.3987	502.7304	4.3774	1.3635	59832.1	4.7025	186.
PK211	45	Group 1	0	28.7897	0.2896	28.016	5.9223	2.34	1.9865	60.3515	35.3158	565.4099	4.7106	1.5305	63820.4	4.7139	208.
PK212	45	Group 1	0	28.3234	0.2972	28.2455	5.6448	2.36	2.0122	57.0617	31.4553	479.0444	2.6051	1.4107	60656.4	4.1016	143.
PK213	45	Group 1	3.2787	28.4881	0.3019	24.8743	5.7307	2.88	2.2134	59.0666	27.9036	405.4752	4.0751	1.3464	58393	4.2751	153.
PK214	45	Group 1	2.894	29.4571	0.3151	30.9492	6.2068	4.39	2.5857	60.4443	32.7562	521.8265	4.9621	1.5096	63159.3	4.5889	16
PK220	118	Group 1	0	28.4434	0.2962	30.0457	5.8532	2.14	2.0781	59.0121	30.7743	507.1734	5.3558	1.4927	57978.9	4.8654	147.
PK221	118	Group 1	0	28.1741	0.3226	38.8889	5.8932	2.03	2.1984	58.3717	35.1945	548.5058	3.7481	1.4606	62281.4	4.6906	172.
PK223	118	Group 1	0	27.9672	0.2908	27.4167	5.637	3.06	2.2951	56.7332	31.4193	509.6066	3.96	1.3541	57963.5	4.759	15
PK225	118	Group 5	0	27.4769	0.3502	22.9783	5.4573	2.29	2.9304	50.6905	25.6929	234.6356	2.7535	1.3969	47365	5.3632	9
PK227	118	Group 1	0	28.0896	0.3127	29.4809	5.716	2.18	1.8317	57.3861	35.5446	591.8768	3.9667	1.4571	62280.8	4.7221	176.
PK232	118	Group 1	0	29.9611	0.3235	28.4836	5.8742	2.59	2.1911	61.0939	35.2451	446.425	4.7427	1.503	60390.8	4.9006	144.
PK233	118	Unassigned	0.7962	26.7656	0.2485	26.3963	5.568	2.27	1.6328	56.9346	24.9073	550.9418	5.4437	1.4181	55135.6	4.4686	108.
PK236	118	Group 5	2.0581	30.6169	0.3292	29.3756	6.2564	1.76	2.3198	77.3529	56.5122	503.7277	2.1966	1.6527	68610.9	5.6981	162.
PK237	118	Group 5	4.4381	30.9665	0.3729	32.5351	6.491	2.15	2.3348	76.9536	51.0254	503.4518	2.6758	1.6883	72558.9	6.078	161.
PK238	118	Group 1	3.5376	26.797	0.2996	27.0952	5.5745	2.49	1.7506	54.6716	32.0383	466.506	4.7641	1.3393	59520.4	4.5301	132.
PK239	154	Group 5	6.5012	31.4649	0.4429	29.9201	6.9445	1.84	3.3158	58.2973	31.335	523.324	4.0612	1.7804	61313.9	7.3105	163.

APPENDIX A CONT.

PK241	154	Group 7	3.267	27.6647	0.3051	29.7156	5.6325	2.16	1.8901	57.9344	45.9532	736.3458	1.571	1.3304	64698.8	4.2141	279.
PK245	154	Group 7	3.1058	30.3397	0.2867	30.7152	6.3396	2.51	1.6982	59.4627	53.58	656.1908	1.1681	1.6843	71419.4	4.413	261.
PK246	154	Group 5	2.8768	23.447	0.2483	22.5945	4.4361	1.84	1.5151	47.3942	29.0137	427.0104	1.6345	1.1551	57523.7	4.6585	122.
PK248	154	Group 5	3.4291	34.0213	0.4177	34.3884	7.3606	2.1	2.8585	65.0104	43.1343	522.6585	3.2525	1.8817	56778.3	7.069	171.
PK249	154	Group 7	0	31.3038	0.3181	30.3828	6.0583	3.34	2.462	65.7394	39.5627	548.3131	1.3291	1.4759	63674.2	4.5039	181.
PK250	154	Group 5	3.2385	28.4551	0.3077	27.1548	5.4508	2.42	2.069	46.0597	24.2443	371.3243	2.2786	1.3086	46774.4	6.8564	153.
PK251	154	Group 5	5.3687	31.9111	0.396	33.4807	6.5497	2.33	2.9161	61.5557	29.6234	330.8401	4.1704	1.5172	48779.8	7.4259	112.
PK252	154	Group 5	3.619	25.8633	0.2863	23.2355	4.754	1.78	2.0647	56.3016	27.5226	303.8876	1.9929	1.202	44026.5	5.0649	108.
PK255	154	Group 5	3.804	31.4758	0.297	39.3211	5.9142	1.76	2.2987	61.5002	33.9659	480.1563	1.8494	1.8083	70132.5	6.8189	225.
PK256	141	Group 1	1.5905	29.4938	0.3364	26.8273	5.9424	2.44	1.9875	64.859	34.1055	515.2092	4.0399	1.5445	64464.6	5.2005	217.
PK257	141	Group 1	2.7381	31.7861	0.3643	31.9109	5.94	2.52	2.4758	67.8495	34.4483	467.4549	3.4455	1.5835	63964.2	5.427	178.
PK258	141	Group 1	3.0166	30.844	0.3534	32.0094	6.2071	3.08	2.4436	65.5063	30.1398	455.3473	5.4162	1.4846	61719.8	4.836	136.
PK259	141	Group 5	1.8084	30.8537	0.3542	29.9602	5.6274	1.92	2.5588	62.3687	48.8719	720.6069	1.2489	1.5483	71280.2	5.8191	459.
PK260	141	Group 1	1.8942	31.3975	0.3538	30.5801	6.322	2.38	2.286	66.3778	32.0061	493.9485	5.0867	1.5382	62121.4	5.633	167.
PK262	141	Group 1	1.9354	28.0104	0.328	26.579	5.8865	2.33	2.0114	58.204	33.2215	521.7913	4.4508	1.4052	60964.9	4.957	235.
PK266	141	Unassigned	1.2178	31.6315	0.3519	31.6215	5.6384	2.88	2.4844	66.8746	36.5895	498.7234	1.8409	1.681	67660.9	5.5271	296.
PK271	141	Group 1	1.318	26.5665	0.2958	29.8166	5.4749	2.37	2.0215	54.3633	32.4093	548.4754	3.421	1.3643	59239.7	5.2526	19
PK273	141	Unassigned	1.4295	29.2911	0.3113	28.2474	6.3115	2.08	2.1804	63.2326	28.4774	381.1498	5.0586	1.5073	60206.4	5.6131	130.
PK276	141	Group 5	4.1212	32.3722	0.3858	27.9494	7.0589	2.18	2.7967	67.6746	27.5667	344.0485	5.3588	1.5923	59602.7	6.6181	126.
PK280	132	Unassigned	1.0457	32.7564	0.3847	30.4181	6.3417	4.32	2.6731	65.7194	23.9391	322.6133	9.0967	1.4223	54549.4	4.8417	109.
PK281	132	Group 1	0	31.3112	0.3339	28.0804	6.6737	2.67	2.1609	65.3181	32.4976	470.3384	3.3024	1.5054	64138.2	4.859	167.
PK282	132	Unassigned	0	31.4001	0.3211	27.5276	5.6712	2.03	2.3155	63.0697	32.7058	452.6675	2.7135	1.6378	63894.8	5.3321	176.
PK287	132	Group 1	0	28.5942	0.2949	28.6754	5.9646	2.16	1.961	59.8646	33.4924	510.49	5.5033	1.485	62597.4	4.2579	176.
PK288	132	Group 1	2.8617	31.1529	0.3496	33.1633	6.5347	3.07	2.5346	64.6187	31.1935	428.7894	3.9216	1.5148	61908.7	5.2499	143.
PK289	132	Group 1	1.5379	30.9501	0.3138	32.2336	6.4228	2.21	2.2971	63.3124	34.3465	476.1208	4.5531	1.5055	63724.4	4.6119	170.
PK291	132	Group 1	0	28.2849	0.2958	31.4465	6.0078	2.07	1.8566	59.2728	37.8884	524.206	4.0911	1.4607	65653.4	4.602	266.
PK292	132	Group 1	3.6926	29.3387	0.3146	31.9144	6.4867	2.87	2.2989	59.2679	32.7917	464.5635	4.3608	1.4759	60915.2	5.113	184.
PK293	132	Group 1	2.0942	30.3202	0.3565	31.731	5.7095	2.76	2.457	61.9229	33.3451	532.499	4.116	1.5784	64186.6	4.929	170.
PK296	EL SALADO	Group 5	4.3491	37.5474	0.3992	37.7748	7.214	2.66	2.8826	76.9107	44.6608	648.3635	4.5337	2.0492	60294.9	5.0326	297.
PK297	MATACAPAN, Op. IXB	Group 2	1.9903	31.4507	0.3445	27.696	6.6142	3.25	2.2903	67.0998	82.1108	271.3154	3.0046	1.4885	55237.2	5.9271	116.
PK298	MATACAPAN, Op. IXB	Group 2	0	31.3034	0.3284	30.9258	6.3596	3.12	2.0227	64.7787	70.7505	430.5728	2.6724	1.4494	59840.1	4.4403	160.
PK299	MATACAPAN, Op. IXC	Group 2	1.0939	28.2081	0.3224	30.3099	5.3016	2.87	2.4101	60.7222	61.6812	305.4019	3.4505	1.3394	52158.9	5.2336	164.
PK300	MATACAPAN, Op. IXC	Group 2	4.1505	31.8444	0.3698	29.8715	5.746	3.53	2.1184	66.4585	82.3793	477.1989	2.5161	1.5177	66541.2	5.0209	145.
PK301	MATACAPAN, Op. IXC	Group 2	0	30.7717	0.3623	34.3284	6.7231	2.42	2.429	61.6989	97.3655	390.8671	4.2749	1.5291	56042	6.1798	168.
PK302	MATACAPAN, Op. VIII	Group 2	3.2122	30.326	0.2892	26.7971	5.4899	3.74	2.4182	61.4762	82.3304	427.438	4.721	1.486	62091.9	4.6484	191.

APPENDIX A CONT.

PK303	MATACAPAN, Op. VIII	Group 2	0	28.7767	0.2931	28.5683	6.0922	3.36	2.0212	58.6809	89.0202	441.2927	5.6828	1.3859	59698.9	4.5236	170.
PK304	MATACAPAN, Op. VIII	Group 2	0	30.213	0.303	32.8352	5.3457	3.42	2.0563	64.1692	120.3365	380.0653	4.9976	1.5007	58112.5	5.2756	151.
PK305	MATACAPAN, Op. VIII	Group 2	1.4896	30.1053	0.3479	29.0133	6.0215	4.51	2.076	64.0049	95.7488	388.9752	5.5843	1.4719	59273	4.9117	16
PK307	N/A CENTRAL TUXTLAS	Group 3	10.1486	29.8112	0.3831	26.6564	6.3086	4.84	2.6524	64.0342	93.9449	82.4407	6.2725	1.3748	40332.2	6.4752	[illegible]
PK308	N/A CENTRAL TUXTLAS	Unassigned	2.784	38.9308	0.4943	34.005	7.6958	4.13	3.4394	74.8839	78.5353	121.5353	7.0428	1.7178	38997.2	6.4402	90.
PK309	N/A CENTRAL TUXTLAS	Unassigned	2.4039	39.2182	0.4962	36.3256	6.3782	3.58	3.4087	76.0272	115.1305	121.8778	6.6631	1.711	43865.3	6.6161	[illegible]
PK310	N/A CENTRAL TUXTLAS	Group 3	11.3604	26.5549	0.3632	28.397	4.959	4.03	2.2641	57.3744	112.7052	75.3294	5.1709	1.2139	39009.3	6.256	[illegible]
PK311	N/A CENTRAL TUXTLAS	Group 4	0	32.2985	0.5199	30.1414	5.8103	3.49	3.2272	63.7198	188.2255	176.124	4.4671	1.5841	40209.2	11.8523	25.
PK312	N/A CENTRAL TUXTLAS	Group 4	2.646	27.5223	0.2049	20.4821	4.0124	3.81	1.6267	43.6469	174.253	109.4528	3.0434	1.0986	38307.3	5.3056	47.
PK316	N/A CENTRAL TUXTLAS	Group 4	13.5759	33.0842	0.4195	35.3439	6.6568	3.69	2.8665	68.6583	160.4075	84.6047	4.4357	1.8348	42521.6	7.5211	[illegible]
PK317	N/A CENTRAL TUXTLAS	Group 3	2.1252	26.9785	0.3659	28.9688	5.2019	3.69	2.4074	58.6554	64.6714	90.5663	8.8891	1.126	39413	4.2506	45.
PK318	N/A CENTRAL TUXTLAS	Group 3	6.5569	26.7724	0.3349	26.273	5.5153	3.99	2.3756	56.7218	85.7825	91.4863	6.1062	1.2244	38615.5	5.1249	65.
PK319	N/A CENTRAL TUXTLAS	Group 3	11.2398	29.6363	0.4227	27.5606	5.4987	2.86	2.7688	62.6857	95.1288	85.6204	6.9488	1.3267	40264.6	6.0994	[illegible]
PK320	N/A CENTRAL TUXTLAS	Group 3	6.0307	28.8928	0.4085	24.5228	5.7378	8.35	2.1991	61.0162	81.8401	87.82	7.4356	1.2303	38885	5.1793	63.
PK321	N/A CENTRAL TUXTLAS	Group 3	10.6756	27.3498	0.3904	24.8765	5.1574	4.24	2.4248	57.9678	100.6875	74.2688	4.685	1.2836	38338.6	8.672	17.
PK322	N/A CENTRAL TUXTLAS	Group 3	9.7361	29.5426	0.3841	30.787	5.6881	2.27	2.7359	61.871	76.3622	86.4093	6.4084	1.3702	42539.2	5.6821	[illegible]
PK323	N/A CENTRAL TUXTLAS	Group 3	9.2348	30.1266	0.3736	27.0192	5.5396	2.73	2.7402	62.482	91.9718	104.8913	6.608	1.31	42015.3	5.9745	70.
PK324	N/A CENTRAL TUXTLAS	Group 3	10.7553	27.5553	0.334	29.4911	5.6407	4.04	2.5847	58.729	105.2773	86.8985	5.3905	1.2611	37098.8	7.4197	56.
PK325	N/A CENTRAL TUXTLAS	Group 4	7.1634	31.952	0.3897	31.8928	6.4432	3.66	2.4716	58.7214	166.6647	84.9063	5.2397	1.4803	40600.2	7.3701	84.
PK326	N/A CENTRAL TUXTLAS	Group 3	8.5204	28.0217	0.3773	27.0399	5.1261	4.16	2.5293	58.8058	103.2158	82.7407	6.2538	1.249	36916.4	5.5711	[illegible]
PK327	N/A CENTRAL TUXTLAS	Group 3	7.8862	27.9282	0.3533	26.4744	5.3709	5.65	2.4953	58.3969	64.9201	100.3206	6.9882	1.1972	40016.8	4.9457	[illegible]
PK328	N/A CENTRAL TUXTLAS	Unassigned	6.665	32.8823	0.3972	31.5021	6.5409	6.27	2.4754	67.3598	108.5165	118.223	7.9303	1.2909	46569.9	5.5282	53.
PK329	N/A CENTRAL TUXTLAS	Group 3	5.7501	31.2097	0.3868	30.4574	5.9757	4.42	2.9542	66.3185	98.0064	88.1419	5.8305	1.4305	35808.6	6.8543	[illegible]
PK330	N/A CENTRAL TUXTLAS	Group 3	11.5595	29.1294	0.35	28.4561	5.9253	3.26	2.5254	62.8597	87.8368	88.0769	6.3772	1.3708	31491.5	5.8238	[illegible]
PK331	N/A CENTRAL TUXTLAS	Group 4	11.6608	29.4333	0.3285	27.7531	6.1462	2.59	2.7866	62.5962	163.2088	95.2007	4.659	1.4155	39236.2	9.3191	41.
PK332	N/A CENTRAL TUXTLAS	Group 3	10.7562	29.4844	0.3133	21.005	5.8973	3.55	2.6633	62.3312	115.123	87.1453	6.2459	1.3612	37548.5	5.9258	24.
PK333	N/A CENTRAL TUXTLAS	Group 3	3.571	28.4173	0.3901	25.6158	5.5355	2.1	2.6771	67.5646	97.2946	97.2503	10.1205	1.1503	41955.6	5.1189	4
PK334	N/A CENTRAL TUXTLAS	Group 2	5.2202	27.9183	0.2706	24.6315	5.5098	1.73	2.0309	66.6304	75.4986	274.7195	4.7709	1.3692	48954.6	4.5576	88.
PK335	MATACAPAN	Unassigned	0	29.9214	0.1494	34.902	6.5519	1.12	1.3774	61.7141	58.101	763.6403	0.4897	1.8657	82156.6	3.7133	251.
PK336	N/A CENTRAL TUXTLAS	Group 4	14.1707	45.348	0.488	50.9171	12.0479	4.3	4.0652	62.6689	142.7496	67.5279	3.2702	3.0912	33190.2	4.5117	73.
PK337	N/A CENTRAL TUXTLAS	Group 3	12.4953	25.3083	0.2788	19.3394	5.0659	2.37	2.203	52.8378	74.0422	68.3117	4.6052	1.1608	32775.4	5.7886	[illegible]
PK338	N/A CENTRAL TUXTLAS	Group 4	5.4571	32.8412	0.255	24.8305	5.3936	1.99	2.0353	71.3936	173.2287	196.0094	2.9072	1.4347	44875.4	8.3086	74.
PK006	EL SALADO	Group 1	3.6473	28.3311	0.2756	25.7839	5.6891	2.65	1.9757	61.2058	34.9808	476.8629	3.3391	1.4709	61702.1	4.8683	22
PK007	EL SALADO	Group 1	4.144	30.9623	0.3448	32.5836	6.3225	2.45	2.2365	64.1052	29.3679	366.2893	3.831	1.4753	58041.6	4.8801	167.
PK010	EL SALADO	Group 1	1.7338	28.2225	0.3034	26.342	5.6529	2.89	2.0734	60.4448	37.8164	566.3349	4.0179	1.43	63321.1	4.5128	203.

APPENDIX A CONT.

PK013	EL SALADO	Group 1	0	29.9938	0.3701	28.7862	5.7774	3.14	2.1741	63.9084	24.291	319.7401	6.0513	1.3194	52565.6	4.2168	156.
PK014	EL SALADO	Group 5	0	42.843	0.461	47.3323	9.8138	2.96	3.1994	97.8747	28.235	320.9768	4.5275	2.4008	45767.5	6.5312	156.
PK015	MATACAPAN	Unassigned	1.7197	29.2494	0.2594	27.9642	6.5062	2.3	1.7691	60.507	40.9764	620.7953	3.491	1.6328	64880.1	4.6791	220.
PK016	MATACAPAN	Group 7	0	28.7869	0.2988	23.3814	6.3551	1.84	1.9327	63.165	36.0668	533.5404	1.3528	1.5041	63775.3	5.0817	21
PK017	MATACAPAN	Unassigned	2.5826	26.686	0.3113	26.0304	5.5155	1.99	2.5493	61.3517	29.9822	419.2499	3.2446	1.3678	57980.5	4.9329	187.
PK018	MATACAPAN	Group 1	2.7214	28.3313	0.2764	28.873	5.6529	2.88	1.9319	59.0108	31.8964	461.9372	4.0917	1.4408	57624.2	4.6969	154.
PK020	MATACAPAN	Group 1	1.6874	29.1716	0.3036	27.6685	6.3741	2.38	2.0381	58.3504	31.8969	468.846	4.2112	1.4471	60189.7	4.7395	151.
PK021	MATACAPAN	Group 1	1.6779	28.1734	0.2585	27.4306	6.3521	2.04	1.9948	57.4632	34.0085	513.3884	3.5249	1.4376	60531.6	4.4956	197.
PK022	MATACAPAN	Group 5	3.0742	32.9659	0.3905	28.4202	7.1382	2.42	2.9299	70.2371	19.215	202.2255	2.1331	1.5037	53575.8	6.6292	9
PK023	MATACAPAN	Unassigned	1.7407	31.7763	0.3993	30.85	6.86	2.79	2.7128	65.015	17.7113	194.7567	7.0855	1.4351	49460	5.9367	76.
PK027	MATACAPAN	Unassigned	2.0148	28.2055	0.3779	25.2558	6.3284	2.07	2.0962	61.2753	24.5771	323.6657	3.7402	1.3852	52337.8	5.0536	136.
PK030	MATACAPAN	Group 1	2.0027	28.1264	0.2762	25.2725	6.2178	2.72	1.9188	58.9059	31.8928	493.5883	4.7315	1.4164	59640.3	4.7656	156.
PK031	MATACAPAN	Group 1	1.72	27.1605	0.2995	31.4721	5.9836	2.63	1.833	56.0762	35.196	534.231	3.983	1.3912	60573	4.4261	183.
PK032	MATACAPAN	Unassigned	5.3072	31.9925	0.3509	33.3969	6.3547	2.49	2.7266	63.8157	18.0181	199.7009	5.1261	1.4381	47806.3	6.0483	88.
PK033	MATACAPAN	Unassigned	3.7474	30.6299	0.3809	29.9917	6.8584	2.15	2.7394	65.7483	21.3395	244.2286	3.1588	1.4466	60442.8	6.2031	133.
PK036	MATACAPAN	Unassigned	6.2819	32.4903	0.4044	27.9695	6.3227	3.31	2.4733	64.2071	17.5143	189.33	3.9225	1.4144	49733.8	5.9009	66.
PK037	MATACAPAN	Group 1	3.1002	28.5018	0.2806	25.6011	6.2001	2.94	1.8206	57.3032	35.4466	538.2097	4.0448	1.4777	63286	4.3377	185.
PK041	TRES ZAPOTES	Group 5	0	29.1913	0.4004	30.8031	6.3063	2.51	2.7728	48.2801	30.095	286.7176	3.0821	1.5817	51788.8	6.1796	14
PK046	TRES ZAPOTES	Group 5	3.7927	34.1856	0.3889	32.1676	7.2751	2.21	2.8872	68.8492	47.9816	887.6307	3.0957	1.8412	67637.4	5.3301	368.
PK049	TRES ZAPOTES	Group 5	0	24.3023	0.3042	25.7663	5.1172	1.76	2.0501	53.4711	33.8631	498.1872	2.2219	1.3005	50498	7.5327	203.
PK050	TRES ZAPOTES	Group 5	0	23.7195	0.3453	23.9838	5.1276	2.44	2.1971	42.1642	24.4158	334.7259	3.0105	1.2869	53421.6	4.8699	220.
PK052	TRES ZAPOTES	Group 5	0	27.7099	0.349	24.1224	5.7283	2.57	2.5552	68.3469	36.4469	452.5593	2.5064	1.4685	53401.2	6.5361	234.
PK054	HUEYAPAN AREA	Group 1	0	28.1507	0.3155	28.0798	5.654	2.55	2.3133	59.9144	33.4671	473.7957	5.1318	1.4102	58904.8	4.831	181.
PK055	HUEYAPAN AREA	Group 1	0	27.626	0.2739	22.5805	5.6319	2.3	1.9111	57.4606	43.2043	655.5347	4.1338	1.4932	67155.4	4.2387	254.
PK059	HUEYAPAN AREA	Group 1	1.6283	29.4427	0.3088	24.0022	5.9159	2.28	2.2563	62.4341	40.0427	488.1609	2.2054	1.5278	65944.6	4.8665	160.
PK062	HUEYAPAN AREA	Group 6	6.3094	42.9989	0.4611	39.5252	8.0073	2.89	3.1665	77.2291	17.1703	127.023	4.3713	1.8705	50737	7.4921	81.
PK066	HUEYAPAN AREA	Group 1	0	28.0893	0.2972	30.4316	5.6857	1.65	2.0712	59.3632	36.6658	573.5153	4.1606	1.4571	62981.4	4.755	257.
PK068	HUEYAPAN AREA	Group 1	0	28.9971	0.2996	29.8937	5.7715	3.04	2.1981	60.3125	38.2413	519.894	3.4087	1.523	62850.5	4.6181	222.
PK071	HUEYAPAN AREA	Group 1	0	30.2297	0.3501	26.0144	6.0564	2.2	2.3335	63.6778	35.8086	527.0825	3.7557	1.5124	64829.3	4.9936	230.
PK081	HUEYAPAN AREA	Group 6	5.5702	33.0827	0.4239	32.0836	7.0326	2.74	2.9805	70.7968	13.7776	132.4697	4.1533	1.7355	33919.4	7.473	3
PK083	HUEYAPAN AREA	Group 1	0	28.325	0.2442	30.0423	5.9308	2.58	2.1425	61.031	39.2378	583.6846	3.7887	1.5312	67076.6	4.4015	208.
PK084	HUEYAPAN AREA	Group 5	0	29.8118	0.3686	23.1471	6.1023	2.39	2.5893	66.2087	37.9394	483.2547	3.2174	1.5715	56052.3	6.0903	247.
PK086	HUEYAPAN AREA	Group 5	3.6604	24.5332	0.2898	19.523	4.8128	2.43	2.4896	44.5775	37.3966	475.5552	2.9032	1.2988	60310.6	5.3638	187.
PK090	HUEYAPAN AREA	Group 1	0	28.6861	0.3029	27.3642	5.798	3.05	2.2835	59.5177	34.4536	492.3547	4.5442	1.477	63709.7	4.7395	180.
PK095	HUEYAPAN AREA	Group 1	0	29.1803	0.3108	26.6561	5.8692	2.91	2.2823	61.118	29.5554	424.6232	5.0542	1.4428	57515.3	4.964	188.

APPENDIX A CONT.

PK096	HUEYAPAN AREA	Group 1	0	30.2256	0.3596	27.3467	5.854	3.18	2.1535	64.1683	27.7524	361.2538	5.5664	1.4031	59208.5	4.7522	156.
PK097	HUEYAPAN AREA	Group 1	0	33.6797	0.3492	34.0403	6.6857	4.21	2.4657	72.3897	35.8405	447.0955	2.6563	1.6642	67481.6	4.9976	173.
PK098	143	Group 1	2.5935	28.987	0.3355	24.2932	5.606	3.2	2.523	64.2597	30.2551	439.591	4.8896	1.3924	58046.1	5.1725	255.
PK099	143	Group 1	2.5631	30.1823	0.3459	28.6199	5.8824	2.53	2.106	66.2278	25.7714	338.2318	5.8175	1.4229	54275.5	5.2778	169.
PK100	143	Group 1	2.6126	27.9511	0.3306	24.4314	5.6288	3	1.8079	63.8906	36.2309	539.4922	4.2639	1.4225	62582.9	4.8303	300.
PK102	143	Group 5	3.566	27.2382	0.3333	24.3173	5.6623	1.58	2.1927	63.1249	41.6591	488.304	2.1859	1.4843	64275.9	6.5776	375.
PK117	143	Group 1	4.5015	27.5059	0.3259	22.9701	5.5525	2.56	1.781	56.544	34.7214	514.7769	4.1012	1.4312	63236.4	4.3982	213.
PK119	48	Group 1	2.649	27.4391	0.309	25.186	5.5268	2.8	1.8889	55.594	34.4771	555.6992	3.0653	1.3771	59191.7	4.4803	209.
PK121	48	Unassigned	3.4822	28.5453	0.244	26.5625	5.606	2.89	1.8454	60.8582	36.8892	557.3906	4.4783	1.4947	64827.3	4.1387	213.
PK130	48	Unassigned	1.9863	26.3521	0.3038	26.1808	5.426	2.73	1.7993	66.3722	54.4199	588.9077	3.3173	1.3747	66729.1	5.0137	45
PK131	48	Unassigned	0	27.7667	0.3299	25.4297	5.6696	2.09	2.2404	66.463	32.8691	436.0378	3.5803	1.4374	60654.5	5.2205	289.
PK136	48	Group 1	3.4287	30.3481	0.3147	24.6012	5.9946	3.34	2.2859	69.6951	31.9564	401.2813	4.4849	1.5375	59913.6	5.333	213.
PK148	170	Group 5	3.9095	32.0989	0.4086	34.0352	6.5779	2.14	2.7573	60.848	32.2522	441.7286	3.4358	1.6646	53688.9	7.6655	242.
PK149	170	Group 5	1.7885	29.9625	0.3616	24.8211	6.2758	2.03	2.4792	58.3629	37.0834	496.1364	3.5379	1.6282	61059	7.6085	285.
PK150	170	Group 5	1.6811	38.4127	0.4533	35.3374	7.7003	2.48	3.5054	99.9594	35.38	384.0771	4.0661	1.9427	49679.3	6.8281	186.
PK154	170	Group 5	2.7519	33.1911	0.4137	30.7872	6.5604	2.78	2.6741	71.3435	22.0334	216.7247	2.6465	1.7266	47724.4	7.0445	95.
PK155	170	Group 5	3.0147	35.5137	0.4624	37.8747	7.2621	2.5	3.0749	63.6187	32.5658	440.5415	3.7566	1.7446	46543.3	6.7483	199.
PK157	39	Group 5	4.2788	30.9189	0.401	26.8914	6.4447	1.72	2.6142	63.1318	43.402	511.4922	2.2632	1.6982	66046	7.2637	23
PK167	39	Unassigned	3.3972	28.0826	0.3071	26.8074	5.8323	2.52	1.9805	56.2777	36.1738	524.1555	2.3294	1.4591	63647.3	4.7402	233.
PK168	39	Group 1	0	28.8208	0.277	26.667	5.6826	2.34	2.0283	57.129	29.931	427.4485	5.0758	1.4174	58269.3	4.9052	124.
PK174	39	Group 1	0	29.1188	0.3283	29.0062	5.8668	2.36	2.3091	56.8607	38.0017	539.4466	3.002	1.5396	65501	4.8951	245.
PK181	39	Group 5	3.3292	48.681	0.408	58.1494	10.2426	1.83	3.1389	80.8202	27.2309	363.7177	3.4565	2.4823	50744.5	7.0092	216.
PK183	124	Group 1	0	29.1278	0.3155	28.3662	5.7237	3.47	1.728	56.8016	33.0874	459.4197	4.7306	1.4321	62189.9	4.3912	132.
PK185	124	Group 1	3.693	27.5878	0.3198	24.4181	5.6172	2.24	1.8642	56.6714	31.4625	397.049	5.0787	1.34	56722.7	4.3229	149.
PK186	124	Group 1	0	27.6317	0.2868	26.5616	5.5104	2.95	1.7234	52.3362	34.9131	530.9136	4.0587	1.3843	59966.2	4.3666	142.
PK187	124	Group 5	0	33.2256	0.3717	35.374	6.7239	1.85	2.6701	66.1304	24.2823	231.0935	4.881	1.6234	50753.2	5.9092	108.
PK189	124	Group 1	2.693	26.2103	0.2637	25.642	5.2544	2.33	1.7349	50.9875	33.226	485.74	3.7721	1.2807	58376.2	4.4609	174.
PK200	45	Group 1	2.7354	28.4201	0.3126	27.7915	5.9454	2.55	1.9021	56.2828	30.5338	412.2929	4.6548	1.353	57917.3	4.4326	147.
PK209	45	Unassigned	0	29.723	0.3386	33.0619	6.0057	2.27	2.0574	56.9334	35.0447	509.0506	2.5352	1.4737	63720.8	5.0764	200.
PK210	45	Unassigned	0	26.8998	0.2716	24.2047	5.3613	2.62	1.7363	55.6263	37.2477	546.8436	4.3545	1.3022	59132.1	4.4884	173.
PK215	45	Group 1	3.6787	28.5256	0.3223	30.2397	5.8159	2.69	2.2071	55.9905	32.2719	451.13	4.3242	1.3977	59114.7	4.8014	158.
PK216	45	Group 1	0	28.227	0.3238	30.7655	5.7586	3.08	2.0459	56.0382	28.3372	409.911	4.6393	1.3546	55436.3	4.6217	10
PK222	118	Unassigned	3.0136	28.1918	0.3027	24.8758	5.5517	2.87	1.978	51.9787	32.3347	466.8272	3.4655	1.3781	60480.4	4.5234	161.
PK224	118	Unassigned	2.7329	30.7369	0.3608	32.5796	6.1758	2.73	2.294	58.6484	24.7946	332.2616	5.2058	1.4073	53957.2	5.0917	130.
PK226	118	Group 1	0	27.8	0.3032	29.1702	5.5312	1.88	1.8199	56.0425	34.3579	506.5995	4.2117	1.4081	60362.7	4.5148	14

APPENDIX A CONT.

PK234	118	Group 1	0	27.9129	0.2912	26.9694	5.6828	2.39	2.1997	57.5988	36.1146	516.4559	4.0908	1.4204	61892.3	4.5442	150.
PK235	118	Unassigned	0	28.1666	0.2981	25.8329	5.7407	1.94	1.7824	52.6797	38.6598	557.3619	3.5426	1.3845	63754.4	4.495	24
PK242	154	Group 5	2.6858	27.0989	0.3612	24.7528	5.3254	2.39	2.0123	50.2835	23.4637	287.2617	3.9326	1.2872	40968.7	7.1217	109.
PK243	154	Group 5	2.4485	31.4613	0.3949	30.5703	6.6574	2.15	2.4559	78.4317	52.2315	525.5425	3.7505	1.7563	56112.7	5.3963	163.
PK247	154	Group 5	0	31.7421	0.3812	33.164	6.4042	2.3	2.6539	60.1572	33.764	434.6215	2.8139	1.7187	57162.8	6.0123	214.
PK253	154	Group 5	6.9236	26.8242	0.3312	25.9253	5.4539	1.94	2.2773	49.1129	24.1997	343.0072	2.8577	1.3306	60266.3	5.9304	242.
PK254	154	Group 1	0	27.9716	0.3207	26.7256	5.8056	2.52	2.5349	53.9007	33.6828	472.3237	3.3188	1.4304	60106.4	4.7386	199.
PK261	141	Unassigned	3.5568	26.316	0.3123	25.4361	5.3986	1.6	1.637	50.4682	34.2741	476.778	3.4206	1.3294	59905.9	4.7095	127.
PK269	141	Group 7	3.7794	32.3137	0.3543	27.6508	6.5435	3.57	2.7095	63.7265	36.2454	478.2019	1.171	1.626	68277.8	5.1234	196.
PK270	141	Group 7	2.0122	30.4876	0.3599	25.9925	6.4345	3.63	2.1745	61.1239	34.4303	500.955	1.4057	1.4616	64030.1	4.5157	237.
PK272	141	Group 1	0	30.384	0.3695	28.5676	6.155	2.74	2.2675	61.249	26.401	358.4001	3.496	1.4298	58527.2	5.8081	169.
PK275	141	Group 7	0	30.181	0.3163	34.3702	6.0052	2.77	1.9878	57.1732	40.638	599.6257	1.4899	1.4909	67494.3	3.8889	20
PK283	132	Group 5	6.6928	39.1282	0.3092	38.0346	7.3384	2.07	2.1875	84.5964	43.2067	580.4113	2.9732	1.9301	66142.1	5.1699	247.
PK286	132	Unassigned	0	28.8095	0.2998	29.3941	5.8977	2.82	2.0431	56.3352	33.7475	472.332	4.5035	1.4299	63380.9	4.3328	170.
PK290	132	Unassigned	0	30.2579	0.3352	28.7617	6.0759	3.67	2.0872	63.2914	34.4726	415.2572	4.9989	1.459	60995.6	4.4544	181.
PK294	132	Unassigned	0	26.7189	0.365	26.5655	6.286	2.06	2.2555	56.1538	39.211	534.9909	2.0519	1.5071	68322.2	5.0019	172.
PK295	132	Group 1	0	28.5233	0.2927	24.086	5.9757	2.8	1.7825	58.8193	38.0697	562.6459	3.1666	1.4943	67156.1	4.1427	202.

APPENDIX A CONTINUED

anid	site_name	chem02_2	rb	sb	sc	sr	ta	tb	th	zn	zr	al	ba	ca	dy	k	mn	na	ti	v
PK002	EL SALADO	Unassigned	98.8827	0.5085	19.5161	492.934	0.8798	0.6842	8.1005	113.9615	124.3515	73233.2	636.3	77635.7	4.0005	13766.93	1112.48	6349.12	4949.002	170.2015
PK003	EL SALADO	Group 1	68.0653	0.532	20.9899	523.3976	0.9151	0.7874	7.6956	103.7569	131.1318	78917.8	353.9	64442.9	4.1243	15877.84	990.71	8955.86	5469.9785	174.0407
PK004	EL SALADO	Group 1	76.1386	0.5618	20.2872	612.2151	0.8243	0.7599	8.1549	105.7423	125.9205	80579.2	450.6	78404.6	3.3889	17002.24	1010.71	7078.62	4256.5425	178.1427
PK005	EL SALADO	Group 1	81.2239	0.5372	20.0348	390.9008	0.9626	0.6749	9.0681	126.4412	149.3297	83670.5	321.5	74352.6	3.5977	18435.65	862.68	6591.68	6157.8516	195.5663
PK008	EL SALADO	Group 1	70.746	0.5662	21.3832	549.8746	0.8327	0.5897	7.9574	102.5687	97.6545	76439.6	504.8	79899.3	3.0583	18451.85	1050.87	8312.97	5853.9297	187.8918
PK009	EL SALADO	Group 1	83.5543	0.5972	19.5031	453.5588	0.8245	0.7013	7.8713	115.5536	100.3269	77811	372.6	92157.2	3.1684	17581.72	988.1	6853.21	5346.4316	181.8353
PK011	EL SALADO	Group 1	58.3555	0.4795	20.7214	512.2989	0.8017	0.7395	7.7601	116.3153	127.2424	73426.5	586.5	74133.6	3.0662	16687.17	1190.3	6552.19	5205.7021	168.2717
PK012	EL SALADO	Group 1	102.304	0.4007	20.9887	520.6556	0.7486	0.7532	7.6783	100.9619	132.4538	74549.2	371.6	89987.5	3.2651	17111.79	1049.48	8073.27	5784.5869	204.0282
PK039	TRES ZAPOTES	Group 5	41.1641	0.3705	24.2619	295.9776	0.9405	0.9958	7.5781	116.1659	186.0286	91445.3	607	29443.5	5.1824	9989.93	1279.4	5539.4	6157.3853	192.4429
PK042	TRES ZAPOTES	Group 5	74.1214	0.5561	24.9848	220.683	0.9987	0.8144	9.6174	108.7902	131.1695	92265.9	502.6	24563.7	4.7415	13732.72	723.75	8744.12	6738.5737	221.8974
PK043	TRES ZAPOTES	Group 1	61.6846	0.4779	22.6719	267.553	0.9845	0.8335	8.1993	99.3513	167.8141	80864.8	305.5	45968.6	3.6817	14823.35	1072.78	8242.47	6542.2158	182.8695
PK044	TRES ZAPOTES	Group 5	48.0212	0.5004	22.8372	142.3327	0.8751	0.8872	7.2561	104.8665	164.5184	84746.9	637.3	21461.7	4.6325	11354.63	744.55	3578.72	5937.9409	151.941
PK045	TRES ZAPOTES	Group 5	53.8154	0.4516	24.5389	247.3021	0.997	0.9253	7.959	133.7101	127.3858	93687.4	479.5	26863	4.7228	8208.86	1274.71	5646.97	5766.0015	207.0684
PK047	TRES ZAPOTES	Group 5	64.8423	0.4139	21.0242	252.0248	0.9778	0.785	7.7654	97.157	197.4396	94478.7	664.6	22319.2	4.8273	13472.88	668.1	5099.01	6548.6841	164.3359
PK048	TRES ZAPOTES	Group 5	33.1634	0.4063	26.303	195.688	0.9706	0.8202	8.2586	105.8114	152.9892	78485	352.6	23067.8	3.9393	6335.5	986.42	4819.2	5987.7368	219.9766
PK051	TRES ZAPOTES	Group 5	42.6465	0.4384	23.1356	208.6533	0.9392	1.1218	7.3843	105.4502	109.8245	85366.7	621.6	24571.2	4.7411	9642.11	872.09	3877.83	6426.9419	168.2687
PK053	HUEYAPAN AREA	Group 1	69.3063	0.4657	21.5778	408.766	0.7947	0.7108	7.7022	87.1329	96.7992	76493.5	513	71810.3	3.8218	14465.67	1004.48	9182.43	5257.6807	210.343
PK056	HUEYAPAN AREA	Group 1	77.2277	0.5478	21.295	308.2813	0.9244	0.7688	8.0323	86.8076	150.8748	80747.6	471.3	65799.2	3.7127	16820.96	847.33	7968.43	6358.7104	190.35
PK058	HUEYAPAN AREA	Group 1	63.6076	0.4645	20.9698	492.5294	0.8668	0.7732	7.2839	95.132	131.5184	74045.3	670.9	70067.3	3.5213	14270.51	1123.59	8893.66	5808.147	184.4613
PK060	HUEYAPAN AREA	Group 1	64.472	0.556	19.3437	349.3542	0.9496	0.7736	8.7113	104.1409	137.9511	82767.4	467	49309.5	4.4542	18581.03	793.46	7815.11	5929.3677	145.8464
PK069	TRES ZAPOTES	Group 5	67.3463	0.5547	24.004	262.5117	0.9487	0.9635	8.1689	113.5608	170.625	82981.5	816.7	27720.3	4.2933	11795.11	1448.9	6185.14	5921.2354	176.6708
PK070	TRES ZAPOTES	Group 5	39.9003	0.6035	26.2859	154.8013	0.9234	0.9063	8.1445	103.133	172.2967	90149.5	478.6	27313.6	4.3244	7836.68	938.57	5858.93	7535.4727	220.815
PK072	HUEYAPAN AREA	Group 5	45.8769	0.6212	22.2972	309.6773	0.9081	1.0926	8.3146	109.3542	150.2878	85596.2	445.9	30133.1	5.5377	7765.5	1242.51	6036.54	5902.0615	186.8867
PK074	HUEYAPAN AREA	Group 1	34.682	0.3505	22.7135	312.3675	0.9504	0.6663	8.3144	93.4336	160.1485	82150.6	382.4	45867.4	3.6333	11600.38	934.66	7725.75	6646.2114	192.2073
PK075	HUEYAPAN AREA	Group 5	55.5498	0.4821	22.685	126.7826	0.8619	0.9369	6.8266	83.9526	180.2056	79653.3	466.8	20874	4.304	10565.3	686.13	3523.51	6313.1387	156.1573
PK076	HUEYAPAN AREA	Group 6	90.0444	0.8188	22.0149	0	1.1538	1.0332	9.7649	122.5223	215.3468	107925.5	667	6748.7	6.071	16209.56	620.31	3335.35	7912.5527	153.8965
PK087	HUEYAPAN AREA	Group 1	74.6815	0.5178	21.4667	336.0258	0.8246	0.8254	8.1294	89.2992	137.3192	79259.6	240.6	60176	3.9795	16446.2	1020.34	8936.26	5361.1221	179.1643
PK088	HUEYAPAN AREA	Group 5	60.4246	0.5473	20.5519	339.9498	0.9695	0.8396	7.6879	99.7483	129.0201	76415.6	306.6	28097.1	3.7074	13117.57	1127.5	9113.59	6856.8916	180.8755
PK089	HUEYAPAN AREA	Group 1	51.9516	0.5163	22.9308	500.7604	0.8362	0.8031	8.173	123.5847	135.7941	79000.6	697.4	72494.9	3.9603	13405.05	1029.39	7429.02	6070.915	176.1115
PK091	HUEYAPAN AREA	Group 6	45.3979	0.7216	12.5525	0	1.0788	0.9694	6.8292	62.9479	167.2061	66672.5	459.9	2220.4	5.2424	7342.93	245.75	1919.22	4826.1348	125.6732
PK092	HUEYAPAN AREA	Group 1	72.0539	0.4544	21.0165	475.3214	0.9209	0.7673	8.05	94.5935	159.5304	77200.7	485.6	55216.7	3.7563	16837.55	965.55	9089.72	6710.1128	192.0683
PK093	HUEYAPAN AREA	Unassigned	46.8204	0.5541	28.4644	211.7903	0.8486	1.4299	8.1273	113.1762	179.8026	97611.2	256	30168.7	7.364	8111.65	1194.31	5250.03	5996.6519	192.8261
PK094	HUEYAPAN AREA	Group 1	50.8309	0.4726	19.9493	291.011	0.9588	0.7571	8.0606	90.2365	149.3511	86628.8	701.4	39320.4	3.6384	10143.05	749.74	8088.37	5851.6099	162.6119
PK101	143	Group 5	54.9921	0.8024	21.4677	203.4162	0.9912	0.8484	7.5483	94.8895	183.9807	78426.6	277.6	21892.3	5.034	10092.19	1518.54	4811.34	5598.4692	148.8607

APPENDIX A CONT.

PK103	143	Group 1	36.0777	0.4079	22.2156	445.7942	0.9017	0.7455	8.3126	112.0635	137.2098	82385.3	453.9	58331.8	3.4377	13013.63	1091.94	8587.64	6797.0317	195.8959
PK105	143	Group 1	66.3517	0.4959	21.4214	496.7743	0.8277	0.7143	7.3726	96.1292	99.3482	72216	268.3	79346.3	3.9108	12513.02	1020.63	9402.15	5415.9004	184.7801
PK107	143	Group 1	69.2671	0.4798	21.8312	510.1284	0.9183	0.7988	7.8131	103.1607	94.4031	80706.4	372.6	70103.5	3.4228	14175.08	1057.19	9511	4753.2744	184.981
PK108	143	Group 1	66.2724	0.5773	19.2451	393.6473	0.8517	0.7251	7.8276	97.8533	137.7903	72831.6	305.3	81295.8	3.9607	14194.3	804.11	8555.21	5569.9712	186.2587
PK109	143	Group 1	70.3398	0.5281	22.0693	429.5667	0.8778	0.8362	7.9518	99.0873	140.1295	80998.3	290.6	60586.3	3.9322	13057.76	1007.53	9378.86	5803.0352	181.711
PK110	143	Group 1	76.4488	0.5607	21.2057	365.6012	0.8808	0.6634	7.7073	91.3099	120.0375	77211.8	391.3	77071.5	3.7244	14107.9	942.05	9009.96	6690.0884	188.4274
PK112	143	Group 1	56.6388	0.4649	22.5132	353.7304	0.8796	0.749	7.6387	94.7373	126.1167	74264.8	244.2	60912	3.1131	15544.75	1126.95	9328.4	6130.4155	193.9469
PK114	143	Unassigned	53.5854	0.348	19.1996	371.5527	0.8789	0.7541	7.5606	81.135	95.6611	70982.6	545.1	38902.5	3.8976	12162.89	1006.55	6995.08	5774.5615	175.0211
PK115	143	Unassigned	68.5604	0.4526	19.0102	463.6277	0.775	0.59	7.1858	89.8366	105.3569	68855.1	261.7	69494.5	3.2135	14894.43	1052.09	8005.91	5104.6318	161.1211
PK118	48	Group 1	54.4378	0.4448	20.238	311.4606	0.8621	0.7284	8.0619	96.4627	98.8957	78600.9	226.7	50589.5	3.7924	13019.32	904.24	8135.13	5105.7021	166.1711
PK122	48	Group 1	65.0381	0.509	21.4898	436.2687	0.8694	0.7698	7.3102	91.3217	166.4831	77905.3	297.1	62254.6	3.5311	13855.56	1022.05	9802.44	5654.7085	188.1322
PK123	48	Group 1	63.3203	0.5644	20.6589	235.9757	0.9702	0.7608	8.3632	101.9742	182.4426	82040.2	422.1	38656.1	4.1413	17192.59	885.01	8514.17	6106.8867	166.0178
PK124	48	Group 1	65.0405	0.581	21.8525	425.4054	0.8487	0.792	7.7037	89.8122	103.068	81032.9	328.3	69940.3	3.5607	14320.9	1135.87	7952.98	4710.1475	203.6762
PK125	48	Unassigned	49.7572	0.4347	23.6263	352.1208	0.858	0.7888	7.4556	93.7095	163.4037	83873.5	216.7	58944.1	4.2199	8402.42	1053.28	7790.78	5572.7217	148.8338
PK126	48	Unassigned	44.7509	0.5186	21.0785	341.3516	0.8729	0.7443	7.7342	81.04	151.7857	82436.4	263.6	58437.4	3.8033	8996.57	1408.76	7774.63	4532.6714	199.8029
PK127	48	Group 1	64.5579	0.4632	21.5185	361.7985	0.8126	0.7755	7.0024	90.6476	134.4781	69442.5	274.7	83491.5	3.102	13060.9	1013.15	10345.9	5641.7603	204.8541
PK128	48	Group 1	70.8289	0.577	20.859	331.774	1.045	0.7598	8.913	94.86	156.796	78812.7	291.3	47525.3	3.9555	13034.96	875.95	8258.3	5248.9404	162.9281
PK132	48	Group 1	68.5153	0.4045	22.9591	421.7843	0.8872	0.6939	7.6629	105.0552	159.694	75974.3	261	70072.2	4.6483	11851.86	975.76	10298.98	5832.4219	206.7157
PK134	48	Unassigned	48.4529	0.3805	21.1056	351.831	0.9037	0.6818	7.4374	92.8312	121.0142	79152.2	348.6	43682.2	2.9685	12587.46	1101.07	8828.88	4542.4961	202.1949
PK137	170	Group 5	77.3098	0.6025	25.1074	223.6553	0.9966	1.0432	8.2124	111.1931	189.656	90241.7	829.1	23512.1	5.5034	17378.84	440.81	4413.61	6356.5229	167.9198
PK138	170	Group 5	53.8725	0.5889	24.2693	118.6406	1.0195	0.8338	7.7307	92.3226	246.5667	77050.3	562.8	21975.7	4.1209	11874.21	1259.12	5135.21	6442.1787	194.3955
PK139	170	Group 5	66.0331	0.4868	23.2108	169.6616	1.0164	0.9566	8.0851	110.1014	203.1721	91944.2	574.5	26942.6	4.651	12683.66	776.36	4690.75	7272.8027	175.8548
PK140	170	Group 5	55.7676	0.599	25.7824	225.9852	0.9134	0.7001	8.6481	103.8722	163.2981	107586.4	557.4	24516.8	3.9593	12921.88	729.73	4095.45	5682.436	161.0287
PK142	170	Group 5	59.6674	0.4663	22.8328	312.3555	1.2298	1.0549	8.9971	112.0355	181.2492	98048.1	345.6	26466.4	5.1061	11623.92	586.55	5600.88	7402.7354	206.9112
PK144	170	Group 5	56.0828	0.5823	23.9455	204.3515	0.8857	0.8329	7.7737	100.2805	199.8866	81688.9	584.3	24582.1	3.9931	11765.4	1062.75	4941.3	5533.9551	147.1498
PK146	170	Group 5	72.0798	0.7746	24.8051	214.8687	0.85	0.7222	8.1333	112.7062	134.2372	101100.2	476.1	22282	4.3493	14623.46	668.85	4336.53	6288.8042	204.2812
PK147	170	Unassigned	48.7632	0.4234	22.907	302.5732	0.972	0.9234	8.572	120.8564	205.0526	83783.2	472.9	36139.7	4.4916	11848.38	879.19	8274.07	6502.0542	172.7103
PK151	170	Group 5	55.7233	0.4747	20.403	118.5392	0.8525	0.8405	6.6689	95.0326	249.4687	76613.4	463.2	21004.8	4.0959	13237.36	711.29	3928.84	5520.3374	159.688
PK153	170	Group 1	51.0059	0.3416	21.1242	348.368	0.9254	0.7406	7.6068	93.979	129.5433	77572.3	227.9	63325.8	3.0404	11646.03	1012.62	8870.19	5613.6953	199.524
PK158	39	Group 1	46.6713	0.3634	23.011	505.6645	0.8248	0.731	6.8808	92.541	100.4418	75857.4	205.1	62492	3.2672	8848.86	1096.06	10327.36	5050.1479	198.2221
PK164	39	Group 5	43.5293	0.3974	20.9139	266.3443	0.8785	0.8371	7.3811	80.9989	236.1627	80966	629.1	26628.2	4.0024	10703.84	676.19	5281.49	6282.6826	180.1418
PK165	39	Group 1	43.3677	0.4928	23.4372	390.3313	0.8799	0.9932	7.7699	106.7414	146.0988	79203.4	342.5	65150.3	3.4787	11943.65	1120.34	7643.21	6921.0518	193.6006
PK166	39	Group 1	43.471	0.4315	23.2791	432.4967	0.9831	0.8515	7.9077	98.5277	171.8633	80289.8	154.1	57110.1	3.7283	11467.97	1004.72	8275.44	4863.3096	182.7759
PK171	39	Group 1	68.9101	0.4933	23.248	423.3557	0.8681	0.6819	7.8348	101.1633	123.3207	79394.3	0	67061.6	3.1246	14858.12	1014.27	9425.17	5889.8887	198.552
PK173	39	Group 5	78.499	0.6374	21.5575	223.3404	0.9646	0.9884	8.0943	113.3651	247.3932	93956.2	528.5	23049.6	4.9883	13483.65	1128.48	4551.17	7396.3008	163.09

APPENDIX A CONT.

PK177	39	Group 5	64.2686	0.5402	21.268	556.6324	0.9272	0.7436	7.596	114.8119	198.0807	95351.6	623.8	26586.3	3.9932	16508.2	640.75	7606.01	6781.4712	174.0927
PK179	?	Group 5	50.1498	0.4718	21.6791	429.5456	0.8888	0.9068	7.3681	95.8422	194.1419	83312	457.7	31039.8	4.1948	8688.28	1181.61	5948.61	4953.626	207.2254
PK180	39	Group 5	57.6973	0.472	19.5056	292.3895	0.9724	0.7743	7.1958	89.0104	322.0223	81365.8	616	23991.1	4.5698	11869.49	990.24	5465.62	6298.7969	153.0424
PK182	39	Group 5	54.9634	0.5151	20.996	232.1148	0.9481	0.9033	7.3282	101.6201	166.1765	88798.3	511.4	29726.3	4.1142	11645.85	781.09	5166.61	7104.3315	179.9745
PK184	124	Group 1	75.2707	0.5449	19.9487	384.7394	0.9725	0.8052	8.7079	101.5754	186.6834	79715.2	244.8	65398.3	2.7375	15524.1	1261.75	7917.79	4819.6724	179.7104
PK190	124	Group 1	104.0274	0.7684	18.2953	679.6312	0.9429	0.6957	9.5692	119.7105	120.1976	82266.7	341	92388.4	3.3544	20490.68	866.91	6741.6	3294.0635	154.1503
PK192	124	Unassigned	81.5978	0.3873	20.3397	436.4642	1.0279	0.8221	8.069	69.9066	213.3947	77742.9	432.3	61325.9	2.759	14017	1471.58	9071.29	5145.2676	171.5394
PK193	124	Unassigned	83.6348	0.6464	18.5943	628.5118	0.8638	0.7511	8.7286	115.4832	161.6834	77429.9	293.7	83522.3	2.7022	14110.63	1633.03	5889.43	2879.9805	134.9958
PK194	124	Group 1	69.9983	0.4782	22.2106	384.6588	0.9261	0.7655	7.8979	100.6964	168.22	80884.7	174.8	56802	3.349	14444.72	1159.33	8350.16	5879.4541	159.6866
PK195	124	Unassigned	52.4911	0.7432	17.552	384.5824	0.9268	0.6134	9.0199	107.0487	141.9838	83253.8	253.8	60349.3	2.4204	9935.96	2054.49	4459.55	3644.0579	166.9956
PK196	124	Group 1	55.4964	0.4834	19.9	745.4004	0.8695	0.7202	7.3249	114.9862	151.0085	72326.6	255.4	92887	2.278	11538.52	1333.31	8096.55	4018.053	184.8174
PK197	124	Group 1	100.5821	0.7041	17.4285	399.2411	0.9773	0.8174	9.0102	103.5335	148.3332	80658.7	333.1	71538.6	4.3243	18562.72	735.69	8051.01	4202.3994	142.9856
PK198	124	Group 1	87.0545	0.4519	20.5743	389.9534	0.9867	0.759	8.3571	99.7698	142.0036	76403.5	430.8	67001.2	3.2277	13051.86	1027.04	8303.72	4557.6084	169.3266
PK199	124	Group 1	76.5864	0.6071	20.5467	504.8385	0.8641	0.8472	7.529	116.4027	125.7071	78730.9	378.8	70917.8	2.2743	13516.54	1208.47	8369.07	4348.0591	186.5665
PK201	45	Group 1	61.1843	0.5554	20.4162	525.2653	0.8892	0.7473	7.4158	90.7431	123.3522	76471.4	286.4	83456.5	3.4607	12322.3	887.83	8985.22	5289.6694	198.481
PK203	45	Group 1	85.7319	0.5509	19.0217	322.7315	0.9495	0.7134	8.4327	98.5819	152.5287	81580.8	246.3	51128.1	4.3936	17101.54	852.45	8571.21	5047.6812	167.51
PK205	45	Group 7	38.6948	0.4055	22.0022	305.9926	0.8935	0.7279	8.9934	127.3423	131.2308	89391.2	301.1	42635.3	3.7933	9871.17	882.34	5949.67	5562.708	175.0306
PK206	45	Group 1	69.7834	0.6053	21.8103	359.3427	0.9404	0.7366	8.0624	95.9358	176.6919	86444.5	186.7	59708.4	3.7736	15655.42	883.17	8008.31	5453.0122	179.0811
PK207	45	Group 1	77.9526	0.6268	18.8866	279.8335	1.027	0.7495	8.7434	107.2828	158.0782	84180.5	237.7	48448.8	3.8853	18527.21	818.16	8753.02	5065.2974	160.0037
PK208	45	Group 1	69.8008	0.4668	21.3636	421.4283	0.8834	0.6228	7.5843	91.2263	177.9903	77646.2	237.1	60271.7	3.3308	14489.34	931.27	9262.83	5375.0649	175.4098
PK211	45	Group 1	81.8922	0.4645	22.9716	413.7964	0.8809	0.8601	7.6552	96.7991	185.6485	82361.8	272.9	67463.3	3.352	15230.58	1012.48	9321.46	5249.9028	206.7695
PK212	45	Group 1	47.0916	0.4085	21.6695	474.507	0.8679	0.6223	7.8807	109.3082	147.6362	79104.1	203.1	75667	3.1555	9002.78	925.11	6616.16	4831.6211	202.1424
PK213	45	Group 1	55.5499	0.4718	20.3484	523.8772	0.8747	0.6361	8.1432	93.5831	151.5295	81808.7	429.3	80949.9	4.5184	14459.06	735.85	7358.93	4622.3745	204.2043
PK214	45	Group 1	72.9314	0.6252	22.2554	406.0428	0.8706	0.7658	7.9352	110.0223	123.5368	80359	246.5	64346.9	4.2974	15672.54	884.74	9433.94	6480.6836	177.5759
PK220	118	Group 1	71.2224	0.4272	21.5729	460.8607	0.9524	0.812	7.6431	88.0779	121.0403	75900.5	361.5	67872.4	3.654	16863.76	912.36	9124.46	6416.9312	188.2304
PK221	118	Group 1	64.8886	0.455	22.2097	441.5789	0.8958	0.7722	7.3475	101.4687	174.7564	81006.5	568.1	59303.3	4.1495	15388.82	985.15	10856.1	5688.0327	194.9364
PK223	118	Group 1	62.7357	0.3584	20.6107	296.8336	0.8807	0.7466	7.2518	92.1666	142.8331	77238.8	537.6	62046.7	3.7492	16036.52	873.68	9467.83	5064.1606	174.4147
PK225	118	Group 5	55.433	0.5078	25.2077	287.2549	0.7681	0.8235	7.0177	98.3497	204.7595	92209.1	698.2	31338.5	4.344	13145.43	955.35	4703.11	4710.6421	139.4034
PK227	118	Group 1	62.735	0.4757	22.036	480.4182	0.8493	0.8079	7.2375	101.5533	156.4926	77261.4	333.2	58761.7	3.8355	15386.57	925.66	11232.01	5912.9731	195.8298
PK232	118	Group 1	63.0817	0.5969	19.5365	512.8156	1.0172	0.667	8.0264	108.9125	103.3544	72751.4	359.4	67899.7	3.71	12459.9	970.98	9975.77	5887.7012	188.429
PK233	118	Unassigned	82.3163	0.4769	22.8864	555.3793	1.0028	0.6133	8.0791	92.3902	168.2298	76656.1	292.5	76431.3	4.0391	23344.8	735.74	9705.26	5553.3691	197.0542
PK236	118	Group 5	44.9283	0.5408	22.4515	264.9635	1.0753	0.7282	7.6799	75.7981	141.4841	78577.5	605.9	23083.5	3.5651	7843.28	1596.34	5457.94	6966.8701	162.5475
PK237	118	Group 5	53.4154	0.5858	23.6418	290.1063	1.0205	0.7697	7.8146	84.7012	131.0829	84944.9	626.2	22687	4.4462	9884.63	1067.26	5514.84	7658.8491	185.3087
PK238	118	Group 1	71.4461	0.5254	21.0451	445.8799	0.9656	0.7063	7.4	90.0581	88.6497	73770.3	433.4	65215.7	3.2639	14056.59	863.64	9001.27	5601.3667	183.0125
PK239	154	Group 5	69.223	1.1347	21.9164	84.1377	1.1048	1.0094	8.506	109.5654	145.9623	79783.5	494.7	19242	6.2093	14803.89	496.15	5020.54	6087.7905	184.4562

APPENDIX A CONT.

PK241	154	Group 7	35.1852	0.4417	21.4472	349.0376	0.8678	0.6022	7.8609	92.496	121.3945	67786.6	513.6	48702.3	3.8011	11404.53	747.79	5846.22	5416.9072	165.2524
PK245	154	Group 7	28.166	0.3753	20.7453	507.7798	1.0624	0.7186	7.191	103.817	124.4493	74740.3	703.6	58691.2	3.8962	8476.6	1177.41	8366.24	5642.2529	196.4183
PK246	154	Group 5	34.4205	0.5205	18.4855	246.7982	1.0023	0.5011	7.2184	62.4489	138.6517	74895.3	653.8	18489.8	3.1851	8984.72	586.47	4842.53	6191.3438	145.3897
PK248	154	Group 5	59.0601	0.6868	23.7447	126.6044	1.0199	1.0704	7.2312	108.5981	150.4433	82661.9	402.3	24183	5.2781	11535.64	1600.83	4660.01	7041.0942	163.5475
PK249	154	Group 7	33.7132	0.564	21.0311	378.5373	0.9475	0.6738	8.3215	88.3164	121.4137	77889.5	889.9	48874.1	4.0909	11402.69	807.62	5418.84	5641.25	178.4989
PK250	154	Group 5	47.1998	0.468	18.9866	185.666	0.9589	0.6551	7.2536	96.9829	161.9152	87067.5	574.2	18642.1	4.2681	16828.69	417.85	4392.88	6247.9546	140.3241
PK251	154	Group 5	75.0943	0.6726	19.5655	194.5071	1.155	0.824	8.0589	91.9211	138.9893	86382.2	525.5	16743.5	4.6369	14420.72	1025.96	4579.4	6308.2617	163.4735
PK252	154	Group 5	40.8466	0.4404	16.3383	100.3199	0.9673	0.6348	7.0461	72.9874	119.9777	79196.4	502.4	11144.1	3.8024	11985.32	512.92	3679.1	5331.8193	124.1227
PK255	154	Group 5	33.6654	0.315	22.8554	240.5284	1.0667	0.6125	7.4969	0	138.2804	85727.6	692	25241.1	4.3174	8429.16	799.04	6165.17	6781.29	260.9064
PK256	141	Group 1	65.4652	0.5989	22.845	366.3568	0.9862	0.6109	8.3114	86.5507	138.6254	78599.6	293.6	53236.2	4.1742	13289.67	870.2	9447.53	5400.3569	177.8644
PK257	141	Group 1	52.2515	0.3951	22.4372	285.5014	1.0284	0.7298	8.4477	92.219	132.1858	84180.2	308.5	45457.5	4.1022	13819	967.14	7399.86	6184.2842	190.1451
PK258	141	Group 1	83.4713	0.6362	21.9855	355.2119	0.8981	0.6216	8.9376	100.3303	137.6553	79165.8	254.1	56076.4	3.894	19606.51	829.14	9107.28	4968.8218	182.369
PK259	141	Group 5	31.8151	0.3688	21.3831	66.5914	1.0534	0.714	7.8743	85.0049	112.865	82074.4	324.3	21574.3	4.6725	8830.96	717.55	5758.23	6358.6079	191.2426
PK260	141	Group 1	78.4843	0.7253	21.983	195.5186	1.1097	0.6801	8.6448	95.4232	170.0249	85008.6	323.9	46427.1	4.0556	16522.53	849.37	7408.15	5877.7993	197.3695
PK262	141	Group 1	73.0065	0.4667	21.8246	382.5362	0.8911	0.5476	7.5107	90.5808	100.7702	80552.2	254.8	61495.6	3.6653	15348.76	874.02	8988.63	5678.4355	189.3679
PK266	141	Unassigned	44.0241	0.3744	22.9659	240.8661	1.0765	0.5963	8.9868	197.8454	139.7793	86768	350.2	34426.6	3.9604	11124.47	1115.53	7978.04	6854.5298	177.2872
PK271	141	Group 1	62.295	0.2823	21.6116	359.0254	0.9784	0.4734	7.3634	89.464	91.8894	79548.3	244.6	48678.3	3.4734	12715.61	692.34	8711.43	7103.9858	196.0891
PK273	141	Unassigned	77.2194	0.5676	21.9634	301.6853	0.9827	0.656	8.7289	157.0888	121.5161	85242.5	285.3	54925	3.9644	14794.15	865.72	9445.45	6036.1089	186.0069
PK276	141	Group 5	67.8592	0.8234	21.5067	224.5347	1.0463	0.7585	8.7882	99.8532	180.549	90324.9	356.5	26353.7	4.9675	14353.24	821.12	7402.02	5730.5649	227.8831
PK280	132	Unassigned	217.9744	0.464	20.5641	495.9978	1.0072	0.6436	9.5355	79.5368	115.3707	89632.7	353.7	72560	4.3153	16232.66	750.37	7986.27	4811.6655	186.2009
PK281	132	Group 1	58.2222	0.5343	22.254	279.7147	1.0592	0.6816	8.6679	103.2027	99.026	89208.2	312.2	52621.8	4.5382	14958.8	972.04	6473.28	5963.9536	181.8619
PK282	132	Unassigned	59.0391	0.6133	23.0758	278.7199	1.0304	0.6974	8.4614	104.2332	106.8586	87653.7	293.6	48406.2	4.5426	17163.78	926.9	7909.58	6595.0459	171.5798
PK287	132	Group 1	73.8824	0.546	22.8776	480.6394	0.825	0.6323	7.638	94.3589	120.6662	82368.7	204.5	85534.8	3.728	14026.98	939.8	8822.53	5566.5371	210.4893
PK288	132	Group 1	66.2419	0.7654	21.5668	247.7819	0.9799	0.6107	8.7498	99.012	152.9435	85844.2	225	42728.1	4.3219	13073.66	875.65	8214.54	5719.1689	172.2325
PK289	132	Group 1	61.6203	0.5754	22.8754	370.9439	1.0008	0.7131	8.8329	94.2649	103.7021	87609.5	226.5	68520	3.9206	14711.67	958.27	7506.19	5097.1509	185.8062
PK291	132	Group 1	67.4378	0.4215	22.9956	354.4638	0.8865	0.5635	7.6302	90.4715	106.1533	83358	240	58816.3	3.4822	15831.88	950.92	9615.8	6571.6841	198.2297
PK292	132	Group 1	70.1851	0.4721	21.7027	299.4255	0.9142	0.6926	7.8253	79.7113	132.9502	86375.6	289.8	56135.3	4.2228	16256.48	869.96	9425.47	6163.3052	201.401
PK293	132	Group 1	67.0935	0.569	23.4182	373.2804	0.9312	1.0115	8.0466	100.956	155.21	84610.4	265.9	59856.5	4.027	15561.74	890.24	8412.98	5505.2148	187.593
PK296	EL SALADO	Group 5	73.7187	0.618	23.6193	225.3725	0.8084	0.8987	8.6162	112.0383	152.8131	85820	733.3	23381.9	5.2493	15868.88	1151.02	3656.2	5819.645	191.6827
PK297	MATACAPAN, Op.	Group 2	57.1927	0.5375	19.9541	470.885	2.3354	0.6402	9.269	91.265	141.5636	88011	318.4	52770.7	4.3051	14185.9	704.22	8423.78	5801.3101	164.785
PK298	MATACAPAN, Op.	Group 2	47.1123	0.6705	21.4011	539.2273	2.1304	0.6803	8.769	77.0593	109.4623	85674.5	280.2	88026.9	3.7945	12974.99	899.41	7199.92	5342.8188	202.5717
PK299	MATACAPAN, Op.	Group 2	53.677	0.5063	18.2807	413.9224	1.8481	0.5995	8.6896	99.7714	122.1936	75106.6	389.6	45225.4	4.6599	12499.11	566.04	6475.66	5602.6152	140.7954
PK300	MATACAPAN, Op.	Group 2	46.1953	0.4516	22.6864	386.3435	2.1827	0.6123	8.9841	183.914	131.0912	86606.4	267.3	50825	4.1603	11156.11	833.71	8630.49	5932.7749	201.075
PK301	MATACAPAN, Op.	Group 2	60.7451	0.5762	20.0874	246.6801	2.6483	0.6461	7.4969	166.5062	140.0219	80806.2	359.1	29130.7	3.7498	15143.98	936.81	10667.83	6181.9155	201.7372
PK302	MATACAPAN, Op.	Group 2	70.1666	0.4873	21.2805	384.0816	2.4281	0.5361	8.1642	104.8119	98.6922	84688.4	257.6	67017.9	4.1274	14225.92	840.01	8439.67	5741.479	197.6247

APPENDIX A CONT.

PK303	MATACAPAN, Op.	Group 2	73.0366	0.5441	20.8231	442.0001	2.4427	0.5907	7.7971	113.2409	115.175	83686.9	278.5	73639.1	3.9091	17158.6	846.63	9392.62	5207.8984	187.4082
PK304	MATACAPAN, Op.	Group 2	74.9575	0.5266	20.3843	379.7154	2.4255	1.0073	8.4699	84.5562	121.2083	76979	319.9	63473.6	3.7476	16175.78	798.75	9388.89	6516.2163	190.1816
PK305	MATACAPAN, Op.	Group 2	83.8295	0.6792	21.0152	383.5237	2.7452	0.6393	8.2476	93.01	102.8055	84131.5	425.1	62584	4.0746	16374.93	810.08	8260.46	5405.4233	171.4033
PK307	N/A CENTRAL	Group 3	93.0432	0.815	14.4031	392.0894	3.8082	0.7709	8.4866	86.8604	125.9251	75062.1	441.5	93227	4.4315	18909.46	516.27	6136.87	4890.2139	128.1308
PK308	N/A CENTRAL	Unassigned	124.6889	0.735	21.5173	0	2.7609	0.7499	10.8681	116.831	176.3602	125528.4	426.5	3721.2	5.5603	17170.58	233.05	1419.85	7070.8745	180.7272
PK309	N/A CENTRAL	Unassigned	105.1961	0.7455	21.01	0	2.8831	0.7706	10.6552	183.2736	127.1396	120355.9	462.7	6326.5	5.3545	16013.38	279.52	3962.36	7078.1602	175.4431
PK310	N/A CENTRAL	Group 3	75.5032	0.9035	12.9764	267.2481	3.1168	0.6624	7.7339	86.1105	156.4293	70593.9	414.5	103568.7	3.9438	15317.93	509.12	8056.16	4743.2036	112.5658
PK311	N/A CENTRAL	Group 4	66.6828	0.5381	14.7044	0	4.5181	0.8378	7.7472	117.6383	257.7086	72750.3	478.7	6568.4	5.2667	16752.37	354.24	7653.25	5870.4663	144.7973
PK312	N/A CENTRAL	Group 4	47.1138	0.7191	13.827	0	4.4013	0.4899	9.1165	58.6472	97.4359	89343.1	407.3	3579.8	3.4396	9230.28	123.09	3535.66	5258.583	129.6854
PK316	N/A CENTRAL	Group 4	67.9842	1.1022	14.0663	0	4.1334	0.9163	8.2725	68.0599	170.6548	83144.1	511.1	4740.7	5.5723	13060.05	506.67	7984.4	4464.7002	118.2594
PK317	N/A CENTRAL	Group 3	117.8145	1.0996	14.4165	376.4976	2.2112	0.6472	8.1005	111.0011	90.2677	74273	262.2	133631.5	3.5912	23485.84	1053.1	5873.9	3729.8071	167.5729
PK318	N/A CENTRAL	Group 3	84.9257	0.7224	13.3574	358.3638	3.2162	0.7481	7.8787	74.3381	113.6311	72585.4	338	128186.9	3.6601	15838.8	468.13	6716	4282.1982	128.6544
PK319	N/A CENTRAL	Group 3	88.5769	0.9631	14.8948	272.7491	2.6498	0.6694	7.9271	138.0039	139.4295	76889.6	464.3	86806.1	4.5028	18890.94	446.14	7315.25	5084.3179	137.0871
PK320	N/A CENTRAL	Group 3	101.3417	0.7763	14.2233	344.9615	3.2926	0.5942	8.6398	125.3933	152.0479	78585.7	438.6	105183.9	4.0583	17967.14	377.04	6915.77	4682.8931	141.6063
PK321	N/A CENTRAL	Group 3	73.7868	0.8796	12.0973	311.1347	2.9445	0.7129	6.9824	70.7115	192.1156	61684.6	508.9	83710.5	3.8586	14865.36	563.38	8721.38	3895.7747	105.981
PK322	N/A CENTRAL	Group 3	83.6295	0.874	17.3162	310.1749	2.6101	1.1739	8.5794	112.406	103.4104	69019.5	372	97447.7	3.9364	16689.65	432.34	7606.1	4329.5439	159.0668
PK323	N/A CENTRAL	Group 3	90.2165	0.8547	14.3044	301.6266	3.13	0.7197	8.5253	81.1416	122.1402	69899.3	345.1	74252.5	3.846	16617.12	509.89	6953.16	4664.3823	136.4966
PK324	N/A CENTRAL	Group 3	79.5569	0.7894	13.2125	172.2281	3.7061	0.5933	7.7288	99.3903	147.1943	66663.9	383.5	76849	3.9681	15285.59	373.19	6409.3	3927.8022	120.8176
PK325	N/A CENTRAL	Group 4	66.0666	0.7368	13.862	0	5.1196	0.7386	8.2059	73.3942	132.7389	74414	414.7	12438.5	4.7748	14653.24	155.52	8501.26	4811.6802	131.7898
PK326	N/A CENTRAL	Group 3	81.3753	0.9892	13.186	307.3429	3.5821	0.6286	8.3327	71.8551	154.9422	68072.1	321.9	115625	3.6769	13329.52	457.44	5470.98	4623.3633	131.7007
PK327	N/A CENTRAL	Group 3	96.7865	0.717	13.8749	454.623	2.409	0.7115	8.3758	79.4791	124.7996	69640.3	246.4	122544.2	3.3182	17425.78	419.2	7218.01	3917.0999	130.9705
PK328	N/A CENTRAL	Unassigned	92.9965	0.8429	15.5565	207.6139	5.8906	0.675	9.9607	88.5047	130.8166	79804.1	281.3	72172.1	3.598	15938.15	705.68	4856.62	3993.5261	156.8848
PK329	N/A CENTRAL	Group 3	91.5934	0.8052	14.9734	277.0564	2.8735	0.7267	8.03	76.9531	175.7706	74759.3	517	67133.7	4.2663	16774.81	383.62	8597.44	3912.2603	118.9105
PK330	N/A CENTRAL	Group 3	91.6401	0.7703	14.8784	512.535	2.7143	0.7545	8.3647	91.5329	196.72	74009.7	439.4	94312.5	4.0444	17807.37	322.35	8218.81	4327.9092	131.4107
PK331	N/A CENTRAL	Group 4	67.3841	0.9241	14.7482	0	4.0611	0.8552	8.2652	76.7599	270.5634	71169.9	466.1	6198.5	4.278	13382.33	345.22	7547.59	4596.6787	122.741
PK332	N/A CENTRAL	Group 3	90.0576	0.8425	15.1905	183.1874	3.1114	0.7785	8.3089	100.2304	171.383	72993	395.5	86772.1	3.9436	16642.96	517.32	6117.77	4784.8857	134.7326
PK333	N/A CENTRAL	Group 3	102.1634	1.4016	15.2181	223.4428	3.0046	0.7373	9.3234	105.2391	135.1948	78058.7	386.4	48990.1	3.536	17598.62	380.55	6387.72	3525.7903	149.951
PK334	N/A CENTRAL	Group 2	50.6006	0.6074	16.7519	602.2365	2.2147	0.8467	7.5419	84.4553	142.1897	61101.5	219.8	113833.9	2.6845	6001.51	1040.05	3773.88	4256.6123	176.8868
PK335	MATACAPAN	Unassigned	11.9286	0	28.4902	678.9103	0.9424	0.6388	5.5803	106.2904	97.5532	64846	0	68003.8	1.8255	7311.9	1300.01	13826.77	7047.4497	241.1651
PK336	N/A CENTRAL	Group 4	63.998	0.7294	9.675	50.4866	4.3668	1.5571	8.6898	59.337	174.981	70290.6	452.8	3839	7.7725	13394.67	470.83	5471.48	2724.7224	87.5714
PK337	N/A CENTRAL	Group 3	63.2603	0.8191	11.9858	214.2053	2.3952	0.6391	6.7653	81.5843	183.1232	55648.1	410.3	144284.4	3.5114	12656.98	340.27	6817.62	3877.6252	103.7228
PK338	N/A CENTRAL	Group 4	49.0176	0.3503	15.921	64.3532	4.1464	0.6813	8.3336	79.9876	198.8307	67995.8	0	3242.8	1.4745	7536.58	2188.38	2020.67	3854.906	159.1443
PK006	EL SALADO	Group 1	51.5414	0.509	21.6643	378.8864	0.9364	0.6804	7.9454	126.3921	123.9975	77648.5	428.8	70004.1	3.9306	13282.9	1017.37	9781.89	6540.0083	172.8336
PK007	EL SALADO	Group 1	56.0889	0.5337	19.9484	480.262	0.9518	0.7111	8.2412	119.6687	128.373	81621.3	513.2	60019.7	3.7904	13165.69	912.81	8525.35	5968.8438	174.0367
PK010	EL SALADO	Group 1	61.4124	0.4168	22.0271	501.8992	0.8829	0.6382	7.3942	97.3633	152.0991	76662.6	356.3	62756.4	3.2646	12457.72	793.93	9569.33	6180.3911	195.1611

APPENDIX A CONT.

PK013	EL SALADO	Group 1	81.8502	0.6373	19.1589	744.2888	0.9501	0.7119	8.8115	128.346	113.0832	79132.2	530.3	91095.8	3.8035	20336.88	1019.59	7276.88	5227.356	188.7979
PK014	EL SALADO	Group 5	80.4495	0.5671	20.3481	188.0881	1.0035	1.2038	7.9075	111.4142	161.3544	93691	478.8	20282.2	6.788	14822.14	518.77	5557.75	6308.9644	172.9567
PK015	MATACAPAN	Unassigned	52.3248	0.5137	24.0323	471.8729	0.8849	0.6644	7.6036	110.0339	118.0105	72171	185.3	74336.5	2.8644	12649.86	928.4	8348.85	4862.2651	191.8169
PK016	MATACAPAN	Group 7	34.064	0.407	23.111	480.252	0.9603	0.8383	8.1727	127.1827	166.1428	74547.8	257	77791.6	3.0562	10935.13	854.18	8126.23	5466.0103	178.4452
PK017	MATACAPAN	Unassigned	55.5987	0.5208	20.8732	468.0103	0.9074	0.6955	8.5152	101.9666	118.1371	73049	435.5	44579.1	4.0229	11772.76	755.96	6111.41	4452.7393	127.2285
PK018	MATACAPAN	Group 1	73.6944	0.4698	21.161	458.9217	0.8289	0.7036	7.5608	79.0428	123.1314	70295.5	216.7	66302.9	2.8874	15558.17	841.34	8623.51	5169.9702	165.6878
PK020	MATACAPAN	Group 1	67.2694	0.46	21.6777	423.6189	0.9711	0.7015	7.7854	79.0845	139.11	72768.9	242.9	69594.8	3.441	8911.09	807.28	8115.35	5648.5679	195.557
PK021	MATACAPAN	Group 1	50.3031	0.3885	21.6864	444.0165	0.8525	0.7072	7.4857	72.6397	139.508	69985.1	198.4	78695.9	2.791	12574.33	832.54	8085.53	5305.5396	179.0142
PK022	MATACAPAN	Group 5	51.9296	0.6353	18.1977	290.6907	1.0947	0.9725	10.0472	117.8334	164.6946	80044.4	278.7	20622.5	4.4151	11824.3	541.82	6275.64	4794.8354	120.2113
PK023	MATACAPAN	Unassigned	89.0236	0.7755	16.9241	340.2074	1.0265	0.7728	9.0544	69.5594	147.9575	77286.2	336.5	68482.5	3.982	16613.07	522.44	7137.08	4930.3174	165.1539
PK027	MATACAPAN	Unassigned	61.9684	0.5355	18.7067	433.9588	0.9551	0.7516	8.5793	110.8062	120.9245	74408.4	315.8	45608.9	3.356	12143.61	624.04	5866.57	4797.5	127.5821
PK030	MATACAPAN	Group 1	71.8304	0.5575	21.2654	434.8603	0.962	0.7325	7.7869	79.539	127.6719	72823.2	208.5	63944.7	2.6389	13713.19	805.85	8064.11	4951.8882	164.6182
PK031	MATACAPAN	Group 1	61.1696	0.5074	21.6645	540.6547	0.8391	0.6804	7.0995	94.3751	146.4871	69046.7	210.2	64296.5	3.3998	12082.51	884.3	9303.03	5355.8853	183.4575
PK032	MATACAPAN	Unassigned	72.484	0.8805	16.7061	288.6602	1.0349	0.8434	9.2084	84.9434	138.3698	77963.3	229.6	42006.1	4.5184	14655.84	518.75	6333.12	4869.3223	116.391
PK033	MATACAPAN	Unassigned	51.0439	0.8896	18.1486	322.3334	1.0975	0.8252	9.2962	115.5684	193.2566	71718.2	201.8	38220	3.9208	11769.84	597.84	6557.07	5562.0815	114.4704
PK036	MATACAPAN	Unassigned	71.1494	0.7252	17.6457	279.3257	1.0344	0.8485	9.3764	96.2524	147.9319	88655.6	340.3	41455.3	5.0503	16838.16	638.96	7061.49	5656.4932	131.0908
PK037	MATACAPAN	Group 1	62.3688	0.4744	21.9525	502.8072	0.8908	0.6986	7.2611	78.8761	112.0147	74063	260.1	73364.2	4.2985	17372.01	995.69	8497.31	5839.2358	187.308
PK041	TRES ZAPOTES	Group 5	58.7042	0.58	27.308	246.6702	0.7217	0.6815	6.9979	114.0879	148.5053	87288.6	678.7	34029.8	4.8843	10955.37	745.44	5304.08	5043.6484	166.8616
PK046	TRES ZAPOTES	Group 5	41.3727	0.5904	25.9168	142.3194	0.8713	0.8573	8.1423	118.4664	146.3549	90687.5	353.4	21704.1	4.9439	9392.93	698.05	4840.97	6581.9048	219.7277
PK049	TRES ZAPOTES	Group 5	41.4651	0.3563	23.5527	217.5012	0.7549	0.6226	7.0772	126.659	163.7666	76527.5	826.7	18283.2	3.9477	8678.8	520.06	3763.6	6178.5791	182.0472
PK050	TRES ZAPOTES	Group 5	66.2329	0.7271	26.4462	129.3935	0.8517	0.6337	8.0617	162.7717	98.3806	91477.6	1009.9	15897.8	3.8713	9158.21	457.4	2875.28	6265.6748	181.2352
PK052	TRES ZAPOTES	Group 5	54.0972	0.3664	21.635	156.6933	0.9535	0.7007	7.3788	99.8775	139.9521	79173.2	642.1	19428.5	4.5251	10446.39	570.85	4113.25	6212.749	157.8405
PK054	HUEYAPAN AREA	Group 1	74.472	0.5518	20.7178	357.7719	0.9112	0.6233	7.9257	97.7086	126.6694	80477	421.7	67918.2	4.1992	15862.56	899.5	9212.99	5728.2144	198.4004
PK055	HUEYAPAN AREA	Group 1	62.9752	0.4061	23.1201	551.2975	0.8636	0.6551	7.1164	103.6747	74.7098	75838.9	414.8	74006.2	3.7535	13659.89	1149.62	9528.67	5785.7793	192.1942
PK059	HUEYAPAN AREA	Group 1	40.8419	0.3863	22.0859	357.4648	0.904	0.6385	7.9983	106.4659	116.9218	82519.6	445.4	54155.5	4.1884	11299.19	1423.12	8538.85	5551.8052	202.0336
PK062	HUEYAPAN AREA	Group 6	82.0989	0.8424	20.0488	114.1578	0.9683	0.9053	9.2234	106.8509	172.6128	115566.3	660.7	5899.6	6.2832	16806.02	604.28	3612.93	6280.7998	173.8788
PK066	HUEYAPAN AREA	Group 1	61.3591	0.4567	22.0035	410.9683	0.8657	0.6453	7.2905	98.303	103.0401	78948.4	310.6	67495	3.6956	16633.92	968.47	9933.19	5791.9189	192.3303
PK068	HUEYAPAN AREA	Group 1	62.3392	0.389	22.3216	618.349	0.8162	0.7084	7.3282	95.1337	148.2085	76032.3	447.8	65937	3.8631	14754.04	1088.85	9766.68	4770.7778	186.5973
PK071	HUEYAPAN AREA	Group 1	60.7167	0.4598	22.3739	402.6049	0.9337	0.702	8.1437	95.9688	134.8291	83130.8	352	53189.3	3.9516	14840.67	969.16	8281.09	5255.2832	175.5088
PK081	HUEYAPAN AREA	Group 6	81.1714	0.7917	17.1709	132.1456	0.8201	0.9172	7.9808	82.1336	180.3238	91737.9	822.1	7370.6	5.9232	18967.12	473.05	5604.25	6207.5259	168.3527
PK083	HUEYAPAN AREA	Group 1	59.9431	0.4528	23.1625	492.3714	0.8676	0.6873	7.365	102.2206	114.4569	77413.7	308.1	66927.1	4.0472	14596.99	1482.36	9906.39	6571.9971	219.6696
PK084	HUEYAPAN AREA	Group 5	60.6639	0.4965	21.1662	263.2841	0.8091	0.7925	6.9852	111.1253	157.2808	79452.4	766.4	26167.9	4.5853	13154.94	1177.07	5367.1	5836.6436	166.1021
PK086	HUEYAPAN AREA	Group 5	37.2907	0.5009	26.2474	321.5779	0.7439	0.5717	7.5125	100.3757	131.7989	98472.6	1092	32170	4.0416	11597.77	731.96	5149.9	5916.1904	227.8224
PK090	HUEYAPAN AREA	Group 1	68.8237	0.4368	21.8616	449.0605	0.8182	0.6892	7.6376	106.7597	117.3453	82001.5	430.8	63438.2	3.6602	16141.96	1216.01	9718.97	6619.0747	202.7554
PK095	HUEYAPAN AREA	Group 1	68.4425	0.5499	20.2481	361.5275	0.9197	0.7658	8.3036	92.6718	119.1958	77797.1	553.4	61736.3	3.8415	15788.21	738.9	8731.82	5553.2925	178.0454

APPENDIX A CONT.

PK096	HUEYAPAN AREA	Group 1	80.1823	0.5419	19.9446	555.3071	0.9285	0.7001	8.7125	105.0624	126.9191	83202.1	384.5	77404.9	3.9656	16630.08	1026.95	8796.89	5406.3457	200.6306
PK097	HUEYAPAN AREA	Group 1	44.9581	0.3081	23.0893	369.9707	1.0756	0.6764	9.5474	100.7335	145.6339	89308.4	437	52143.8	4.4308	12507.35	988.75	8177.11	6766.9014	234.139
PK098	143	Group 1	72.0207	0.4924	20.1976	431.0326	0.9386	0.6881	8.1586	87.5373	159.905	78938.3	468.3	55991.9	4.2307	15551.13	680.91	8688.41	5655.9883	182.0583
PK099	143	Group 1	82.0482	0.6336	18.8306	405.2779	0.9612	0.8816	8.6085	69.0938	168.1619	80798.4	397.2	62262.7	3.8587	18254.96	805.68	7985.97	5178.1895	160.6139
PK100	143	Group 1	66.226	0.4371	21.9342	519.4062	0.8726	0.7544	7.6119	77.6599	184.4858	74163.6	341.5	61559.9	3.7948	13272.95	777.88	9210.02	5580.3203	164.9953
PK102	143	Group 5	40.8908	0.5146	21.7428	143.5977	0.9596	0.7925	7.013	104.5633	184.4571	80819.7	562.4	25905.6	4.0415	9609.89	1122.76	4948.15	6209.4072	178.9462
PK117	143	Group 1	60.728	0.6676	21.4958	463.7772	0.88	0.8678	6.9488	120.4561	103.2206	78264.7	425.6	67351.7	3.5756	13858.15	802.94	9004.24	6096.8237	199.7352
PK119	48	Group 1	49.5056	0.3087	20.785	367.1558	0.8863	0.9297	6.5583	0	93.3462	78633.5	359.9	62353	3.7391	15473.01	795.33	9354.29	5714.6084	186.0844
PK121	48	Unassigned	62.7397	0.6391	22.8855	313.6259	0.889	0.7167	7.4498	209.7784	114.2428	79075	357.6	69554.7	3.7588	15268.25	973.03	10465.38	5781.7905	203.4925
PK130	48	Unassigned	50.5115	0.4667	21.0003	399.2838	0.8705	0.8797	7.8424	84.6943	125.1464	74151.3	248.2	37848	3.373	9728.41	1980.03	7912.09	3760.6001	162.756
PK131	48	Unassigned	54.6199	0.4977	20.6594	341.7617	0.9347	0.8328	8.5874	75.5843	165.0951	82536.2	381.5	79117.8	3.6856	15396.02	1068.16	8274.69	5706.5762	170.2836
PK136	48	Group 1	64.3674	0.5104	21.4036	450.5157	1.0296	0.848	8.3395	75.4455	132.8109	78928.7	362.4	58197.1	3.8518	16140	715.8	9192.94	6842.0513	176.9592
PK148	170	Group 5	62.3896	0.5637	20.7004	195.6796	0.9596	0.9562	7.9437	76.9097	234.316	81317.5	465.3	17817.9	4.4381	11052.85	720.48	3433.64	5660.3926	156.5269
PK149	170	Group 5	57.0295	0.7258	22.2373	109.6984	0.9101	0.83	7.6526	74.5203	160.0496	79963.3	479	19508	4.3937	11114.37	655.38	3988.03	6629.1919	153.9596
PK150	170	Group 5	71.2684	0.634	23.9556	251.0065	1.0673	0.966	8.438	130.6547	152.4133	91373.1	566.9	25289.1	5.5379	17040.01	608.22	5705.09	6658.0044	174.0449
PK154	170	Group 5	61.4931	0.3418	20.7502	272.4609	1.0872	0.779	7.8634	110.1025	208.1518	96434.8	709.6	23434.9	4.8469	18451.35	480.69	5403.06	5780.9595	145.051
PK155	170	Group 5	66.3046	0.67	20.5395	0	0.9499	0.8023	7.3952	114.7705	177.0195	90311.6	503.4	20316.1	5.4475	14634.56	614.69	3685.36	6837.3047	145.3207
PK157	39	Group 5	42.0128	0.6111	21.5617	129.7085	0.9753	0.9599	7.2921	0	167.417	86064	427.5	25294.3	4.7548	10002.68	765.1	5100.26	6369.5874	187.5819
PK167	39	Unassigned	53.1031	0.5075	21.8126	336.4635	0.786	0.9182	7.2154	0	122.4839	81036	403.8	65494.6	3.7161	15531.07	668.55	8997.18	5896.2617	191.5511
PK168	39	Group 1	74.5425	0.4576	20.5228	410.2505	0.832	0.564	7.7074	0	0	84540.4	380.2	57724.8	3.9199	14291.96	806.1	8700.98	5782.0259	172.9768
PK174	39	Group 1	54.8129	0.5147	21.9473	334.0521	0.9553	0.849	7.3455	0	122.5265	83281.7	350.3	56633.3	3.8576	11586.55	1026.97	9034.11	6140.0864	201.1268
PK181	39	Group 5	58.9133	0.6347	19.7368	272.5995	0.9025	0.965	6.9886	114.4478	204.1614	93303.2	579.8	22284.8	6.1029	14089.57	584.03	5017.43	6932.4756	158.0285
PK183	124	Group 1	71.0214	0.519	20.7809	467.7137	0.9001	0.8242	7.4271	0	126.8273	79321.1	310.7	83561.6	3.6626	16601.13	928.13	10432.12	5121.6182	194.4337
PK185	124	Group 1	69.2484	0.4906	19.2479	457.8526	0.7876	0.8996	7.6433	116.4692	122.9158	78860.7	366.8	64868.3	3.9718	17883.7	931.16	8165.81	5252.999	182.6657
PK186	124	Group 1	69.8444	0.517	20.5176	530.558	0.7839	0.727	6.5618	0	131.3028	73275.9	331	62547.3	3.0978	15983.45	822.02	9793.26	5679.0488	198.095
PK187	124	Group 5	70.2745	0.6444	19.2197	260.4311	1.0513	0.7848	8.0632	107.0968	166.0308	85995.1	482	28793.2	5.075	18075.32	487.17	9857.94	6548.1919	219.489
PK189	124	Group 1	59.4894	0.3781	19.7604	340.1875	0.9008	0.7801	6.658	0	123.7605	76730.5	337.3	61385.7	3.139	14476.12	726.63	9965.29	5458.6367	198.6323
PK200	45	Group 1	67.5979	0.4601	19.6125	459.788	0.9408	0.8574	7.3628	0	126.0464	84382.9	407.1	72900.4	3.6086	15742.48	960.41	8429.2	5761.7783	175.7172
PK209	45	Unassigned	38.1925	0.4093	22.2614	206.976	0.961	0.9066	7.4134	0	116.6395	78106.4	295.2	45131.8	4.269	12030.11	763.35	8265.76	5861.6387	188.1372
PK210	45	Unassigned	55.8347	0.4856	20.2857	297.436	0.9596	0.3651	6.9708	0	83.3246	73256.1	349.4	57782.1	3.5444	15552.45	738.21	8542.14	6490.3428	179.4898
PK215	45	Group 1	63.2459	0.423	19.9901	343.0968	0.8932	0.9159	7.396	0	120.0043	79067.3	354.9	59630.4	3.5351	15512.03	743.56	9272.6	5414.6387	188.3842
PK216	45	Group 1	59.3573	0.4987	19.2052	494.4261	0.9056	0.9158	7.8289	0	113.7035	78974.4	364.4	67926.2	3.4866	16344.44	654.13	8352.97	5447.9556	188.775
PK222	118	Unassigned	63.9829	0.4726	21.2611	334.598	0.7261	0.9032	6.9442	0	109.6952	77582.4	555.2	61308.9	3.3964	14382.79	677.85	9203.13	5557.5986	180.3917
PK224	118	Unassigned	82.599	0.7887	18.854	257.9054	0.9241	0.6065	7.9815	0	117.6659	85042	660.6	53434.6	4.4296	18498.19	581.85	7572.63	5056.4341	169.8525
PK226	118	Group 1	59.5557	0.5107	20.5231	490.035	0.8445	0.8458	6.9491	0	139.2178	76892.5	339.9	75899.6	3.4852	16000.61	749.04	9597.08	6310.4087	198.2577

APPENDIX A CONT.

PK234	118	Group 1	63.3211	0.4815	22.2062	351.9278	0.8859	0.7985	7.1313	0	125.9269	74452.5	350	65392.6	4.1524	17738.57	949.13	9532.73	5989.0063	205.2978
PK235	118	Unassigned	58.9379	0.4417	22.4665	480.0736	0.8079	0.9027	6.5565	0	111.9545	75119.6	391.4	59031.4	3.6471	14249.08	1008.05	8698.51	5665.6992	188.9215
PK242	154	Group 5	65.8684	0.6405	20.1485	118.5514	0.9868	0.9273	7.8244	0	135.4294	91558	453.1	18118.7	3.93	15401.63	547.06	5526.9	5848.9058	148.3441
PK243	154	Group 5	59.5047	1.0459	27.1232	75.284	0.9904	1.2024	8.3683	0	0	96891.9	650.8	28009	4.7207	14203.8	994.01	5828.61	7264.3193	207.2361
PK247	154	Group 5	58.0729	0.4603	23.9598	348.3434	1.008	1.056	6.8846	0	131.0551	88554.1	544	28777.1	4.4245	12630.19	613.89	5813.66	6918.0625	175.1554
PK253	154	Group 5	57.0724	0.5688	20.0222	129.3545	0.9812	0.8619	8.1016	0	141.7167	87939.3	689.5	21076.6	3.7238	15899.44	392.87	4612.3	6623.5415	197.5714
PK254	154	Group 1	49.9842	0.4255	19.9458	405.2752	0.9221	0.9046	7.2385	0	161.4699	76362.1	448.9	55593.5	4.0451	14081.59	916.91	9596.97	5911.3623	180.3516
PK261	141	Unassigned	57.5681	0.1977	20.8939	419.897	0.8517	0.8029	6.8561	0	154.5579	76060.2	249.6	56651.3	3.4096	13557.39	917.55	10463.43	6106.6753	209.256
PK269	141	Group 7	30.9209	0.4717	24.6694	121.6611	1.1114	1.0392	8.3405	0	95.5787	95772.5	166.5	41915.1	4.5132	8604.76	902.4	5721.63	6465.1045	225.7289
PK270	141	Group 7	35.8183	0.396	23.4028	150.0384	0.9109	1.0391	8.554	0	86.9894	90429.2	143.5	49708.5	3.897	10095.12	792.04	5643.02	5458.73	199.6736
PK272	141	Group 1	64.7079	0.6613	20.5632	249.5325	1.1169	0.5896	9.3568	0	144.8547	87932.8	330.6	39826.4	4.7599	13017.18	580.28	7115.45	6466.5034	150.5347
PK275	141	Group 7	32.2871	0.599	24.3766	363.4179	0.9431	0.8761	7.3283	0	68.4559	88494.5	205.6	68431.4	3.866	10259.22	846.73	6797.49	6333.5371	198.5391
PK283	132	Group 5	42.3605	0.4881	23.4257	317.0873	0.997	1.0727	6.7715	0	178.8216	80606	333.5	29923	5.0019	10122.14	1038.14	7066.27	6045.9976	234.5706
PK286	132	Unassigned	59.389	0.1283	22.4666	340.9514	0.8924	0.9585	7.5452	0	168.4074	77823.8	278.9	63086.3	3.7385	15836.51	778.57	8889.23	5621.0869	187.6495
PK290	132	Unassigned	83.6377	0.6741	20.3848	360.1701	0.941	0.8353	8.5085	0	125.5968	91284.8	245.3	66430.7	4.0559	10962.23	1228	7309.25	6329.5181	184.8597
PK294	132	Unassigned	39.4325	0.36	23.9656	138.4277	0.9448	0.9737	8.0146	0	102.964	93643.2	237.8	31823	4.0854	11085.03	1003.72	6911.84	6774.2939	190.1032
PK295	132	Group 1	50.3842	0.4025	24.1828	364.7242	0.9209	0.9027	6.8397	0	153.3005	80196.9	193.3	65512.8	3.5726	11544.84	1047.36	9237.12	5900.3774	210.3997

APPENDIX B PETROGRAPHIC DATA (Clay Attributes)

ANID	SITE	OTHER	% CLAY	% SILT	vfs %	fs %	ms %	cs %	QUARTZ %	OPAQUE MINERALS %	MUSCOVITE %	BIOTITE %	METAMORPHOSED QUARTZ %
6.00	EL SALADO	LINE 9	81.58	12.28	4.39	.88	.88	.00	11.40	5.26	2.63	.00	.00
7.00	EL SALADO	LINE 9	88.99	9.17	1.83	.00	.00	.00	5.50	.00	4.59	.00	.00
10.00	EL SALADO	LINE 9	79.00	17.00	3.00	.00	.00	1.00	12.00	5.00	4.00	.00	.00
13.00	EL SALADO	LINE 9	85.84	13.27	.00	.88	.00	.00	5.31	5.31	1.77	1.77	.00
14.00	EL SALADO	LINE 7	73.91	13.91	2.61	6.09	1.74	1.74	20.87	.87	.00	.00	.87
15.00	MATACAPAN	94-0-3-2, AND 8696	88.42	10.53	1.05	.00	.00	.00	10.53	1.05	.00	.00	.00
16.00	MATACAPAN	93-1-8-0, AND 6248	87.70	11.48	.82	.00	.00	.00	9.84	1.64	.00	.00	.00
17.00	MATACAPAN	93-2-8-0	90.65	7.48	.93	.93	.00	.00	7.48	.00	.93	.00	.00
18.00	MATACAPAN	63-3-6-0	90.74	9.26	.00	.00	.00	.00	8.33	1.85	.00	.00	.00
20.00	MATACAPAN	63-3-6-0	92.17	5.22	1.74	.87	.00	.00	6.09	1.74	.00	.00	.00
21.00	MATACAPAN	63-3-2-0	93.90	4.88	1.22	.00	.00	.00	3.66	2.44	.00	.00	.00
22.00	MATACAPAN	6-0-6-0	89.55	14.18	1.49	.75	.00	.00	12.69	2.24	.75	.00	.00
23.00	MATACAPAN	6-0-6-0	91.24	8.03	.00	.00	.00	.00	7.30	.73	.00	.00	.00
27.00	MATACAPAN	93-2-12-0	89.29	9.82	.00	.00	.00	.89	11.61	.00	.00	.00	.00
30.00	MATACAPAN	63-1-4-0	84.76	11.43	1.90	.95	.00	.00	9.52	3.81	.95	.00	.00
31.00	MATACAPAN	63-1-4-0	86.32	11.58	2.11	1.05	.00	.00	5.26	6.32	2.11	.00	.00
32.00	MATACAPAN	6-2-6-0	87.22	11.28	1.50	.00	.00	.00	8.27	2.26	2.26	.00	.00
33.00	MATACAPAN	6-2-6-0	87.79	12.21	.00	.00	.00	.00	9.16	1.53	.76	.00	.00
36.00	MATACAPAN	6-2-6-0	86.62	12.68	.70	.00	.00	.00	11.27	2.11	.00	.00	.00
37.00	MATACAPAN	63-3-6-0	93.41	6.59	.00	.00	.00	.00	4.40	2.20	.00	.00	.00
41.00	TRES ZAPOTES	C14,M1,R2	31.11	43.33	5.56	5.56	3.33	.00	6.67	11.11	44.44	.00	2.22
46.00	TRES ZAPOTES	B21,C1,R1	66.30	20.65	4.35	5.43	2.17	1.09	14.13	2.17	15.22	.00	1.09
49.00	TRES ZAPOTES	C13,M2,R1	46.60	18.45	9.71	9.71	11.65	1.94	27.18	2.91	14.56	.00	.00
50.00	TRES ZAPOTES	C13,M2,R1	54.70	18.80	3.42	7.69	10.26	2.56	17.95	5.13	19.66	.00	2.56
52.00	TRES ZAPOTES	C14,M1,R8	55.45	30.00	3.64	5.45	3.64	1.82	15.45	6.36	17.27	.00	2.73
54.00	HUEYAPAN AREA	MN 627	76.09	18.48	5.43	.00	.00	.00	11.96	10.87	.00	.00	.00

APPENDIX B CONT.

55.00	HUEYAPAN AREA	MN 232	90.00	5.56	2.22	2.22	.00	.00	4.44	3.33	.00	.00	.00
59.00	HUEYAPAN AREA	MN 327	84.27	12.36	1.12	.00	.00	.00	11.24	2.25	.00	.00	.00
62.00	HUEYAPAN AREA	MN 532	49.63	25.93	5.93	11.85	5.93	.00	15.56	3.70	22.96	.00	2.22
66.00	HUEYAPAN AREA	CA 707	80.19	15.09	3.77	.94	.00	.00	11.32	6.60	.00	.00	.00
68.00	HUEYAPAN AREA	MN 234	77.89	12.63	9.47	.00	.00	.00	12.63	3.16	1.05	.00	1.05
71.00	HUEYAPAN AREA	CA 636	88.00	9.33	2.67	.00	.00	.00	10.67	1.33	.00	.00	.00
81.00	HUEYAPAN AREA	MN 760	44.52	32.88	8.22	11.64	6.16	2.05	28.08	5.48	20.55	.68	2.05
83.00	HUEYAPAN AREA	MN 831	82.93	14.63	2.44	.00	.00	.00	9.76	6.10	.00	.00	.00
84.00	HUEYAPAN AREA	MN 252	72.97	9.91	2.70	3.60	4.50	.90	10.81	1.80	9.01	.90	1.80
86.00	HUEYAPAN AREA	MN 1090	52.87	29.89	5.75	5.75	1.15	4.60	12.64	4.60	28.74	.00	.00
90.00	HUEYAPAN AREA	MN 236	83.78	11.71	3.60	.00	.00	.90	22.52	2.70	.90	.00	.00
95.00	HUEYAPAN AREA	TR 941	84.78	11.96	3.26	.00	.00	.00	10.87	3.26	.00	.00	.00
96.00	HUEYAPAN AREA	MN 250	88.71	10.48	.00	.81	.00	.00	5.65	4.03	.00	.00	.00
97.00	HUEYAPAN AREA	MN 987	95.79	3.16	.00	1.05	.00	.00	3.16	1.05	.00	.00	.00
98.00	143	LINE 17	80.23	16.28	2.33	.00	1.16	.00	11.63	5.81	2.33	.00	.00
99.00	143	LINE 8	90.91	8.18	.91	.00	.00	.00	7.27	.00	.00	.00	.00
100.00	143	LINE 17	83.17	8.91	2.97	2.97	1.98	.00	7.92	5.94	.00	.99	.00
102.00	143	LINE 17	70.71	13.13	9.09	5.05	1.01	1.01	19.19	1.01	5.05	.00	.00
117.00	143	LINE 4	82.02	12.36	4.49	1.12	.00	.00	2.25	3.37	11.24	.00	.00
119.00	48	LINE 2	69.23	25.00	1.92	2.88	.96	.00	12.50	4.81	7.69	.96	.00
121.00	48	LINE 2	88.66	7.22	2.06	2.06	.00	.00	2.06	.00	6.19	.00	.00
130.00	48	LINE 30	64.77	32.95	2.27	.00	.00	.00	11.36	.00	23.86	.00	.00
131.00	48	LINE 9	85.12	12.40	.83	.00	.00	.00	9.92	1.65	.83	.00	.00

APPENDIX B CONT.

136.00	48	LINE 15	82.41	15.74	.00	.93	.00	.93	3.70	1.85	9.26	.00	.00
148.00	170	LINE 2	69.05	21.43	3.97	1.59	.00	1.59	20.63	1.59	3.17	.00	1.59
149.00	170	LINE 2	74.14	12.93	2.59	3.45	3.45	.00	12.07	2.59	6.03	.00	.00
150.00	170	LINE 10	72.57	20.35	3.54	1.77	.00	1.77	15.93	.88	7.96	.00	.88
154.00	170	LINE 22	57.89	25.26	10.53	4.21	2.11	.00	13.68	6.32	15.79	.00	5.26
155.00	170	LINE 23	67.21	9.84	4.92	8.20	8.20	1.64	18.85	9.84	.00	.00	2.46
157.00	39	LINE 7	61.62	28.28	6.06	2.02	.00	2.02	17.17	5.05	15.15	.00	.00
167.00	39	RED 2	80.00	12.38	6.67	.00	.95	.00	9.52	6.67	1.90	.00	.00
168.00	39	LINE 7	85.22	13.91	.87	.00	.00	.00	11.30	1.74	1.74	.00	.00
174.00	39	LINE 13	81.11	13.33	4.44	1.11	.00	.00	13.33	4.44	1.11	.00	.00
181.00	39	LINE 14	64.29	23.47	4.08	2.04	2.04	4.08	18.37	3.06	10.20	.00	.00
183.00	124	NORTH SHORE	86.87	11.11	2.02	.00	.00	.00	6.06	4.04	1.01	.00	.00
185.00	124	NORTH SHORE	57.61	35.87	2.17	4.35	6.52	.00	2.17	6.52	30.43	2.17	.00
186.00	124	NORTH SHORE	60.23	36.36	1.14	2.27	.00	.00	9.09	2.27	26.14	.00	.00
187.00	124	NORTH SHORE	55.05	43.12	.92	.00	1.83	.00	18.35	1.83	22.02	1.83	1.83
189.00	124	NORTH SHORE	72.73	20.20	5.05	1.01	.00	1.01	16.16	3.03	6.06	1.01	1.01
200.00	45	LINE 88, AREA 2	84.62	10.26	4.27	.85	.00	.00	8.55	4.27	.85	.00	.00
209.00	45	LINE 17	72.83	22.83	4.35	.00	.00	.00	14.13	2.17	9.78	.00	.00
210.00	45	LINE 16	87.37	9.47	2.11	1.05	.00	.00	8.42	2.11	1.05	.00	1.05
215.00	45	LINE 98, AREA 2	79.59	16.33	4.08	.00	.00	.00	9.18	6.12	5.10	.00	.00
216.00	45	LINE ?, AREA 2	81.52	16.30	1.09	1.09	.00	.00	13.04	2.17	1.09	.00	.00
222.00	118	RED PHOTO 3	88.24	9.80	.98	.00	.98	.00	8.82	.98	.98	.00	.00
224.00	118	RED PHOTO 3	87.70	11.48	.82	.00	.00	.00	4.92	.82	4.10	.00	.00
226.00	118	RED PHOTO 3	85.87	11.96	1.09	1.09	.00	.00	9.78	4.35	.00	.00	.00
234.00	118	??	82.24	16.82	.93	.00	.00	.00	14.95	1.87	.00	.00	.00

APPENDIX B CONT.

235.00	118	??	87.64	11.24	1.12	.00	.00	.00	8.99	2.25	3.37	.00	.00
242.00	154	RED	60.82	21.65	11.34	3.09	3.09	.00	22.68	3.09	9.28	.00	3.09
243.00	154	RED	67.71	18.75	4.17	5.21	4.17	.00	15.63	.00	16.67	.00	.00
247.00	154	RED, WEST SCATTER	79.79	13.83	.00	3.19	2.13	1.06	14.89	.00	1.06	1.06	.00
253.00	154	RED, WEST SCATTER	65.38	25.00	3.85	2.88	.96	2.88	10.58	3.85	16.35	.00	.96
254.00	154	RED, WEST SCATTER	85.19	12.04	1.85	.93	.00	.00	8.33	4.63	.00	.00	.00
261.00	141	BLUE 1, AREA 1	76.04	19.79	3.13	2.08	.00	.00	16.67	7.29	.00	.00	.00
269.00	141	BLUE 1, AREA 7	82.20	16.95	.85	.00	.00	.00	6.78	6.78	4.24	.00	.00
270.00	141	BLUE 1, AREA 7	90.63	6.25	2.08	.00	1.04	.00	3.13	6.25	.00	.00	.00
272.00	141	BLUE 1, AREA 13	84.88	13.95	1.16	.00	.00	.00	2.33	6.98	4.65	.00	.00
275.00	141	BLUE 1, AREA 8	88.24	10.78	.98	.00	.00	.00	4.90	4.90	.00	.00	.00
283.00	132	BLUE 1	87.91	16.48	2.20	3.30	.00	1.10	10.99	3.30	2.20	.00	2.20
286.00	132	BLUE 1	89.74	10.26	.00	.00	.00	.00	4.27	2.56	3.42	.00	.00
290.00	132	BLUE 1	92.39	6.52	1.09	.00	.00	.00	3.26	3.26	.00	.00	.00
294.00	132	BLUE 1	65.35	28.71	1.98	3.96	.00	.00	10.89	2.97	18.81	.00	.00
295.00	132	BLUE 1	86.73	9.18	2.04	2.04	.00	.00	5.10	6.12	1.02	.00	.00
90	90	90	90	90	90	90	90	90	90	90	90	90	90

APPENDIX C PETROGRAPHIC DATA (TEMPER ATTRIBUTES)

Case Summaries

ANID	SITE	OTHER PROVENIENCE	%SILT	%VFS	%FS	%MS	%CS	% VCS	% TOTAL VOIDS
6.00	EL SALADO	LINE 9	.00	13.89	27.78	27.78	30.56	.00	1.90
7.00	EL SALADO	LINE 9	.00	.00	37.50	45.83	12.50	4.17	4.29
10.00	EL SALADO	LINE 9	3.13	6.25	28.13	37.50	25.00	.00	5.00
13.00	EL SALADO	LINE 9	13.64	13.64	40.91	31.82	.00	.00	1.44
14.00	EL SALADO	LINE 7	.00	2.78	22.22	52.78	19.44	2.78	3.75
15.00	MATACAPAN	94-0-3-2, AND 8696	3.64	7.27	18.18	54.55	16.36	.00	6.83
16.00	MATACAPAN	93-1-8-0, AND 6248	3.45	3.45	48.28	27.59	17.24	.00	3.21

APPENDIX C CONT.

17.00	MATACAPAN	93-2-8-0	9.52	19.05	28.57	38.10	4.76	.00	5.19
18.00	MATACAPAN	63-3-6-0	2.38	14.29	28.57	33.33	21.43	.00	.00
20.00	MATACAPAN	63-3-6-0	5.71	.00	22.86	54.29	17.14	.00	7.41
21.00	MATACAPAN	63-3-2-0	1.92	9.62	21.15	38.46	28.85	.00	.00
22.00	MATACAPAN	6-0-6-0	.00	56.25	18.75	25.00	.00	.00	1.32
23.00	MATACAPAN	6-0-6-0	7.14	.00	50.00	42.86	.00	.00	3.16
27.00	MATACAPAN	93-2-12-0	.00	.00	65.00	30.00	5.00	.00	2.22
30.00	MATACAPAN	63-1-4-0	6.67	6.67	42.22	37.78	6.67	.00	7.41
31.00	MATACAPAN	63-1-4-0	12.20	17.07	9.76	43.90	17.07	.00	4.86
32.00	MATACAPAN	6-2-6-0	.00	33.33	11.11	55.56	.00	.00	1.39
33.00	MATACAPAN	6-2-6-0	10.53	5.26	36.84	42.11	5.26	.00	5.06
36.00	MATACAPAN	6-2-6-0	.00	12.50	37.50	50.00	.00	.00	5.63
37.00	MATACAPAN	63-3-6-0	.00	10.87	28.26	45.65	15.22	.00	1.44
41.00	TRES ZAPOTES	C14,M1,R2	2.86	.00	14.29	45.71	25.71	11.43	10.07
46.00	TRES ZAPOTES	B21,C1,R1	.00	2.50	25.00	50.00	22.50	.00	7.04
49.00	TRES ZAPOTES	C13,M2,R1	.00	.00	28.57	57.14	9.52	4.76	7.46
50.00	TRES ZAPOTES	C13,M2,R1	.00	.00	13.33	33.33	46.67	6.67	9.59
52.00	TRES ZAPOTES	C14,M1,R8	.00	3.13	6.25	37.50	43.75	9.38	4.05
54.00	HUEYAPAN AREA	MN 627	2.17	10.87	30.43	32.61	23.91	.00	9.74
55.00	HUEYAPAN AREA	MN 232	6.38	10.64	27.66	42.55	12.77	.00	4.86
59.00	HUEYAPAN AREA	MN 327	2.50	17.50	17.50	40.00	22.50	.00	5.84
62.00	HUEYAPAN AREA	MN 532	.00	14.29	71.43	14.29	.00	.00	7.14
66.00	HUEYAPAN AREA	CA 707	2.78	11.11	22.22	44.44	19.44	.00	4.70
68.00	HUEYAPAN AREA	MN 234	4.00	6.00	38.00	32.00	20.00	.00	2.01
71.00	HUEYAPAN AREA	CA 636	.00	13.79	41.38	31.03	13.79	.00	3.70
81.00	HUEYAPAN AREA	MN 760	.00	.00	.00	.00	.00	.00	9.32
83.00	HUEYAPAN AREA	MN 831	2.33	4.65	34.88	44.19	13.95	.00	8.76
84.00	HUEYAPAN AREA	MN 252	.00	3.45	10.34	51.72	24.14	10.34	5.41
86.00	HUEYAPAN AREA	MN 1090	6.67	11.11	33.33	37.78	8.89	2.22	4.32
90.00	HUEYAPAN AREA	MN 236	3.13	9.38	31.25	50.00	6.25	.00	4.03
95.00	HUEYAPAN AREA	TR 941	3.45	13.79	27.59	44.83	10.34	.00	4.72
96.00	HUEYAPAN AREA	MN 250	.00	4.00	24.00	60.00	12.00	.00	2.61
97.00	HUEYAPAN AREA	MN 987	5.45	23.64	40.00	27.27	3.64	.00	8.54
98.00	143	LINE 17	3.85	3.85	26.92	38.46	26.92	.00	4.24
99.00	143	LINE 8	.00	.00	17.65	52.94	29.41	.00	3.79
100.00	143	LINE 17	.00	6.25	21.88	59.38	12.50	.00	5.00

APPENDIX C CONT.

102.00	143	LINE 17	.00	.00	5.26	28.95	36.84	28.95	4.20
117.00	143	LINE 4	.00	17.39	13.04	47.83	21.74	.00	3.45
119.00	48	LINE 2	.00	2.70	13.51	48.65	35.14	.00	6.00
121.00	48	LINE 2	5.13	7.69	30.77	41.03	15.38	.00	8.11
130.00	48	LINE 30	.00	4.17	27.08	43.75	25.00	.00	7.48
131.00	48	LINE 9	.00	.00	15.15	30.30	48.48	6.06	3.73
136.00	48	LINE 15	2.94	8.82	29.41	47.06	11.76	.00	2.74
148.00	170	LINE 2	.00	.00	7.14	21.43	50.00	21.43	7.23
149.00	170	LINE 2	.00	.00	23.53	47.06	29.41	.00	7.64
150.00	170	LINE 10	.00	.00	.00	20.83	58.33	20.83	11.04
154.00	170	LINE 22	.00	4.17	8.33	45.83	29.17	12.50	10.53
155.00	170	LINE 23	.00	.00	25.81	38.71	25.81	9.68	12.07
157.00	39	LINE 7	.00	.00	9.52	38.10	47.62	4.76	7.74
167.00	39	RED 2	2.22	2.22	37.78	35.56	22.22	.00	6.79
168.00	39	LINE 7	.00	2.86	34.29	40.00	22.86	.00	3.23
174.00	39	LINE 13	5.00	5.00	32.50	45.00	12.50	.00	3.70
181.00	39	LINE 14	.00	2.78	5.56	36.11	38.89	16.67	6.21
183.00	124	NORTH SHORE	2.63	2.63	31.58	39.47	21.05	2.63	3.50
185.00	124	NORTH SHORE	.00	3.13	15.63	43.75	34.38	3.13	4.58
186.00	124	NORTH SHORE	6.67	6.67	23.33	50.00	13.33	.00	5.60
187.00	124	NORTH SHORE	.00	4.76	4.76	23.81	38.10	28.57	6.43
189.00	124	NORTH SHORE	.00	12.12	18.18	48.48	21.21	.00	8.28
200.00	45	LINE 88, AREA 2	3.33	10.00	23.33	50.00	13.33	.00	1.99
209.00	45	LINE 17	2.38	11.90	26.19	50.00	9.52	.00	8.11
210.00	45	LINE 16	.00	9.30	20.93	48.84	20.93	.00	5.48
215.00	45	LINE 98, AREA 2	2.44	7.32	24.39	53.66	12.20	.00	3.47
216.00	45	LINE ?, AREA 2	2.17	8.70	28.26	47.83	13.04	.00	1.43
222.00	118	RED PHOTO 3	7.69	5.13	28.21	46.15	12.82	.00	6.58
224.00	118	RED PHOTO 3	.00	5.56	11.11	44.44	38.89	.00	3.45
226.00	118	RED PHOTO 3	2.44	7.32	21.95	24.39	31.71	12.20	5.00
234.00	118	??	.00	11.63	27.91	46.51	13.95	.00	6.25
235.00	118	??	.00	2.33	30.23	51.16	16.28	.00	2.94
242.00	154	RED	.00	7.69	42.31	38.46	3.85	7.69	5.38
243.00	154	RED	.00	2.86	14.29	51.43	31.43	.00	11.49
247.00	154	RED, WEST SCATTER	.00	.00	15.38	56.41	25.64	2.56	13.07
253.00	154	RED, WEST SCATTER	.00	2.86	31.43	57.14	8.57	.00	6.08

APPENDIX C CONT.

254.00	154	RED, WEST SCATTER	.00	2.33	27.91	41.86	25.58	2.33	2.58
261.00	141	BLUE 1, AREA 1	2.86	5.71	25.71	40.00	25.71	.00	4.38
269.00	141	BLUE 1, AREA 7	6.25	12.50	15.63	50.00	15.63	.00	7.36
270.00	141	BLUE 1, AREA 7	.00	10.00	37.50	37.50	15.00	.00	9.33
272.00	141	BLUE 1, AREA 13	.00	26.67	6.67	33.33	33.33	.00	3.81
275.00	141	BLUE 1, AREA 8	5.56	8.33	19.44	52.78	13.89	.00	6.71
283.00	132	BLUE 1	6.52	13.04	23.91	34.78	21.74	.00	.00
286.00	132	BLUE 1	6.06	12.12	18.18	42.42	21.21	.00	5.63
290.00	132	BLUE 1	5.41	2.70	45.95	24.32	21.62	.00	5.15
294.00	132	BLUE 1	2.27	9.09	20.45	38.64	20.45	9.09	.00
295.00	132	BLUE 1	2.33	.00	41.86	39.53	16.28	.00	2.05
90	90	90	90	90	90	90	90	90	90

References

Andrle, Robert F,

1964 A Biogeographical Investigation of the Sierra de los Tuxtla in Veracruz, Mexico. Unpublished Ph.D. dissertation, Department of Geography, Lousiana State University, Baton Rouge.

Arnold, Dean

2000 Does the standardization of ceramic pastes really mean specialization? In *Journal of Archaeological Method and Theory*, v. 7, no. 4, pp. 333-375.

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

Arnold, Dean, Hector Neff, and Ronald L. Bishop

1991 Compositional Analysis and "Sources" of Pottery: An Ethnoarchaeological Approach. In *American Anthropologist*, vol 93:70-90.

Arnold, Philip J. III

1999 On typologies, selection, and ethnoarchaeology in ceramic production studies. In *Material Meanings: Critical Approaches to the Interpretation of Material Culture.* Salt Lake City : The University of Utah Press, pp. 103-117.

1996 Craft specialization and social change along the southern Gulf Coast of Mexico. In *Craft Specialization and Social Evolution: In Memory of V. Gordon Childe*. Philadelphia : Museum of Archaeology and Anthropology, University of Pennsylvania. -- University Museum Monograph ; v. 93, pp. 201-210.

1991 *Domestic Ceramic Production and Spatual Organization: A Mexican Case Study in Ethnoarchaeology,* Cambridge University Press, Cambridge.

1988 *The Production and Consumption of Ceramics in the Sierra de los Tuxtlas, Veracruz, Mexico*. Research Paper Series, No. 1, Latin American Institute, University of New Mexico, Albequerque.

Arnold, Philip J. III, Christopher Pool, Ronald R. Kneebone, and Robert S. Santley

1993 Intensive Ceramic Production and Classic Period Political Economy in the Sierra de los Tuxlas. In *Ancient Mesoamerica* 4:175-191.

Ball, Joseph W.

1993 Pottery, potters, palaces, and polities: some socioeconomic and political implications of Late Classic Maya ceramic industries. In *Lowland Maya Civilization in the Eighth Century A.D.* -- Washington, D.C. : Dumbarton Oaks, pp.243-272.

Berdan, Frances

1996 The Tributary Provinces. In *Aztec Imperial Strategies.* Dumbarton Oaks, pp. 115-136.

Berdan, Frances and Michael Smith

1996 *Aztec Imperial Strategies.* Dumbarton Oaks.

Betts, Ian M.

1991 Thin-Section and Neutron Activation Analysis of Brick and Tile from York and Surrounding Sites. In *Recent Developments in Ceramic Petrology*, edited by A. Middleton and I. Freestone. British Museum Research Laboratory, Occasional paper no. 81. Pp. 39-62.

Bey, George and Christopher A. Pool

1992 *Ceramic Production and Distribution: An Integrated Approach*. Westview Press, Boulder, CO.

Bishop, Ronald L.
1980 Aspects of Ceramic Compositional Modeling. In *Models and Methods in Regional Exchange*. SAA Papers No. 1. The Society for American Archaeology, Washington D.C. Pp 47-66.
Bishop, Ronald L. and Robert L. Rands
1980 Resource Procurement Zones and Patterns of Ceramic Exchange in the Palenque Region, Mexico. In *Models and Methods in Regional Exchange*. SAA Papers No. 1. The Society for American Archaeology, Washington D.C. Pp 19-46.
Bishop, Ronald L., Robert L. Rands, and G. R. Holley
1982 Ceramic Compositional Analysis in Archaeological Perspective. In *Advances in Archaeological Methods and Theory*, vol. 5, pp. 283-314. Edited by M. B. Schiffer. Academic Press, New York.
Bishop, Ronald L. and Hector Neff
1989 Compositional Data Analysis in Archaeology. In *Archaeological Chemistry IV: Advances in Chemistry Series 220.* Edited by R.O. Allen. Washington D.C., American Chemical Society, pp. 57-86.
Bishop, Ronald L., Garmen Harbottle, and E. V. Sayre
1982 Chemical and Mathmatical Procedures Employed in the Maya Fine Paste Ceramics Project. In *Analysis of Fine Paste Ceramics.* Edited by J. A. Sabloff, pp. 272-282. Memoirs of the Peabody Museum 15(2). Harvard University, Cambridge.
Blanton, Richard
1996 The Basin of Mexico Market System and Growth of Empire. In *Aztec Imperial Strategies*, pp.47-84. Dubarton Oaks.
Brumfiel, Elizabeth M.
1994 Ethnic groups and political development in ancient Mexico. In *Factional Competition and Political Development in the New World*. Cambridge: Cambridge University Press, pp. 89-102.
1991 Tribute and commerce in imperial cities: the case of Xaltocan, Mexico. In *Early State Economics*. New Brunswick Press. Political and Legal Anthropology Series; v. 8., pp. 177-198.
1987 Elite and Utilitarian Crafts in the Aztec State. In *Specialization, Exchange and Complex Societies.* Cambridge University Press, Cambridge. Pp. 102-118.
1998 The multiple identities of Aztec craft specialists. In *Craft and Social Identity*. Washington, D.C.: American Anthropological Association, -- Archeological Papers of the American Anthropological Association; no. 8, pp. 145-152.
1980 Specialization, market exchange, and the Aztec state: a view from Huexotla. In *Current Anthropology*, v. 21, no. 4, p. 459-478.
Brumfiel, Elizabeth M., and Timothy Earle
1987 *Specialization, Exchange and Complex Societies.* Cambridge University Press, Cambridge.
Brumfiel, Elizabeth M., and Mary Hodge
1996 Interaction in the Basin of Mexico: the case of Postclassic Xaltocan. In *Arqueología Mesoamericana: Homenaje a William T. Sanders* -- Mexico: Instituto Nacional de Antropología e Historia, pp. 417-437.
Burton, James H. and Arleyn W. Simon.

1993 Acid Extraction as a Simple and Inexpensive Method for Compositional Characterization of Archaeological Ceramics. In: *American Antiquity* -- Washington, D.C, v. 58, no. 1, pp. 45-59.
1996 A Pot is not a Rock: A Reply to Neff, Glascock, Bishop, and Blackman. In: *American Antiquity* -- Washington, D.C. v. 61, no. 2, pp. 405-413.

Carpenter, Andrea J. and Gary M. Feinman
1999 The Effects of Behaviour on Ceramic Composition: Implications for the Definition of Production Locations. In *Journal of Archaeological Science,* 26, 783-796.

Charlton, Thomas H., Deborah L. Nichols, and Cynthia Otis Charlton
1991 Aztec craft production and specialization: archaeological evidence from the city-state of Otumba, Mexico. In *World Archaeology* -- London, v. 23, no. 1, pp. 98-114.

Carrasco, Pedro
1999 *The Tenochca Empire of Ancient Mexico.* University of Okalahoma Press, Norman.

Clark, John E., and William J. Parry
1990 Craft specialization and cultural complexity. In *Research in Economic Anthropology* -- Greenwich, v. 12, pp. 289-346.

Cleland, Kate and Izumi Shimada
1998 Paleteada Potters: Technology, Production Sphere, and Sub-culture in Ancient Peru. In *MASCA Research Papers in Science and Archaeology*, Suppliment to vol. 15, pp. 111-148.

Cobean, Robert H., James R. Vogt, Michael D. Glascock, and Terrence L. Stocken
1991 High-precision Trace-Element Characterization of Major Mesoamerican Obsidian Sources and Further Analysis of Artifacts from San Lorenzo Tenochtitlan, Mexico. In *Latin American Antiquity* vol 2(1): 69-91.

Coe, Michael
1994 *Mexico: From the Olmecs to the Aztecs*. Thames and Hudson.

Costin, Cathy L.
2000 The use of ethnoarchaeology for the archaeological study of ceramic production. In *Journal of Archaeological Method and Theory,* v. 7, no. 4, pp. 377-403.
1991 Standardization, labor investment, skill, and the organization of ceramic production in late Prehispanic highland Peru. In *American Antiquity,* v. 60, no. 4, pp. 619-639.

Costin, Cathy and Melissa Hagstrum
1995 Standardization, Labor Investment, Skill, and the Organization of Ceramic Production in Late Prehispanic Highland Peru. In *American Antiquity* – Washington D.C., v. 60, no. 4, pp. 619-639.

Cumberpatch, C. G.
2001 Comments on 'Technological choices in ceramic production,' Archaeometry, 42(1), 1-76, 2000. In *Archaeometry* v. 43, no. 2, 2001, pp. 269-271.

Curet, Antonio
1993 Regional studies and ceramic production areas: an example from La Mixtequilla, Veracruz, Mexico. In *Journal of Field Archaeology* -- Boston, v. 20, no. 4, pp. 427-440.

Currie, Elizabeth J.
1995 Archaeology, ethnohistory and exchange along the coast of Ecuador. In *Antiquity*, v. 69, no. 264, 1995. pp. 511-526.

D'Altroy, Terence N
1992 *Provincial Power in the Inka Empire.* Smithsonian Institution Press, Washington.
D'Altroy, Terence N., and Ronald Bishop
1990 Provincial organization of Inka ceramic production. In *American Antiquity* -- Washington, D.C, v. 55,no. 1, pp. 120-138.
Day, Peter M., Evangelia Kiriatzi, Alexandra Tsolakidou, and Vassilis Kilikoglou
1999 Group Therapy in Crete: A Comparison Between Analyses by NAA and Thin Section Petrography of Early Minoan Pottery. In *Journal of Archaeological Science*, 26, 1025-1036.
Drennan, Robert D.
1984 Long-Distance Transport Costs in Pre-Hispanic Mesoamerica. In *American Anthropologist* 86:105-112.
Druc, Isabelle C.
1998 From clay to pots: a petrographical analysis of ceramic production in the Callejón de Huaylas, north-central Andes, Peru. In *Journal of Archaeological Science*, v. 25, no. 7, pp. 707-718.
Drucker,
1943 *Ceramic Sequences at Tres Zapotes, Veracruz, Mexico.* Bureau of American Ethnology Bulletin 141. Smithsonian Institution, Washington.
Earle, Timothy
1981 Comment on P. Rice, Evolution of Specialized Pottery Production: A Trial Model. *Current Anthropology* 22(3):230-231.
1977 A Reappraisal of Redistribution: Complex Hawaiian Chiefdoms. In *Exchange Systems in Prehistory*. Edited by T. Earle and J. Erickson, pp. 213-229. Academic Press, New York.
Feinman, Gary M.
1999 Rethinking our Assumptions: Economic Specialization at the Household Scale in Ancient Ejutla. In *Pottery and People: A Dynamic Interaction*, edited by J. M. Skibo and G. M. Feinman, pp. 81-98.
Feinman, Gary M., Stephen A. Kowalewski, Sherman Banker, and Linda M. Nicholas.
1992 In *Ceramic Production and Distribution: An Integrated Approach* -- Boulder : Westview, pp. 235-259.
Feinman, Gary, Stephen Kowalewski, and Richard E. Blanton
1984 Modelling Ceramic Production and Organizational Change in the Pre-Hispanic Valley of Oaxaca, Mexico. In *The Many Dimensions of Pottery*, pp. 297-333. Eds S.A. van der Leeuw and A.C. Pritchard.
Foster, George M.
1969 The Mixe, Zoque, and Popoluca. In *The Handbook of Middle American Indians, vol. 7 Ethnology, Part 1.* Evon Z. Vogt (ed.). Pp. 448-472.
Franke, Evan.
1995 Ceramic craft specialization at Chiji Jawira, Tiwanaku: organization and technology. In *Current Research in Andean Antiquity, Steward Journal of Anthropological Society* -- Urbana, v. 23, no. 1-2, pp. 111-119.
Freter, Ann Corinne

1996 Rural utilitarian ceramic production in the late Classic Period Copan Maya state. In Arqueología Mesoamericana: Homenaje a William T. Sanders. Mexico : Instituto Nacional de Antropología e Historia, pp. 209-229.

Garcia, E

1970 Los Climas del Estado de Veracruz. *Anales del Instituto de Biologia*, *Universidad Nacional de Mexico, Serie Botanica,* 41:3-42.

Giddens, Anthony

1979 *Central Problems in Social Theory: Action, Structure, and Contradiction in Social Analysis.* University of California Press, Berkeley.

Glascock, Michael D.

1992 Characterization of Archaeological Ceramics at MURR by Neutron Activation Analysis and Multivariate Statistics. In *Chemical Characterization of Ceramic Pastes in Archaeology.* Wisconsin, Prehistory Press, pp. 11-26.

Gosselain,

1992 Bonfire of the Enquires: Pottery Firing Temperatures in Archaeology – What for?. In *Journal of Archaeological Science*, vol 19, no. 3, pp 243-259.

Hall, Barbara

Spindle Whorls and Cotton Production t Middle Classic Matacapan and the Gulf Lowlands. In *Olmec to Aztec.* University of Arizona Press, pp. 115-136,

Halperin, Rhoda

1994 Concept of Equivalencies in Economic Anthropology. In *Research in Economic Anthropology*, vol. 14, pp. 255-298.

Harbottle, Garman

1982a Chemical Characterization in Archaeology. In *Contexts for Prehistoric Exchange.* Academic Press, pp 13-38.

1982b Provenience Studies Using Neutron Activation Analysis: the Role of Standardization. In *Archaeological Ceramics*, edited by J.S. Olin and A. D. Franklin, pp 67-77. Smithsonian Institution Press, Washington D.C.

Hassig, Ross

1985 *Trade, Tribute, and Transportation: The Sixteenth Century Political Economy of the Valley of Mexico*. Norman University Press.

1988 *Aztec Warfare.* University of Oklahoma Press, Norman.

Hicks, Frederick

1987 First Steps Toward a Market-Integrated Economy in Aztec Mexico. In *Early State Dynamics* (Henri J M. Classen and Peiter van de Velde, eds.): 97-107. Studies in Human Society 2.

Hirth, Kenneth

1996 Political Economy and Archaeology: Perspectives of Exchange and Production. In *Journal of Archaeological Research* 4(3), pp. 203-239.

1998 The Distributional Approach: A New Way to Identify Market Behavior Using Archaeological Data. In *Current Anthropology* 39:451-476.

Hoag, Elizabeth

2002 Interpreting Burned Earthen Artifacts: A Spatial and Quantitative Analysis of Daub and Kiln Debris from Tres Zapotes. In *Settlement Archaeology and Political Economy at Tres Zapotes, Veracruz, Mexico.* Pool, Christopher (ed.). University of California, Los Angeles.

Hodge, Mary G., and Leah Minc
1993 Spatial patterning of Aztec ceramics: implications for prehispanic exchange systems in the Valley of Mexico. In *Journal of Field Archaeology* -- Boston, v. 17, no. 4, pp. 415-437.
Hodge, Mary G., Hector Neff, M. James Blackman, Leah D. Minc
1993 Black-on-orange ceramic production in the Aztec empire's heartland. In *Latin American Antiquity* -- Washington, D. C., v. 4, no. 2, pp. 130-157.
1992 Compositional perspective on ceramic production in the Aztec empire. In *Chemical Characterization of Ceramic Pastes in Archaeology* -- Madison : Prehistory Press, pp. 203-220. -- Monographs in World Archaeology ; no. 7.
Inomata, Takeshi
2001 Power and ideology of artistic creation: elite craft specialists in Classic Maya society. In *Current Anthropology*, Chicago, v. 42, no. 3, 2001. pp. 321-349.
Killion, Thomas
1990 Cultivation Intensity and Residential Site Structure: An Ethnoarchaeological Examination of Peasant Agriculture in the Sierra de Los Tuxtlas, Veracruz, Mexico. *Latin American Antiquity* 1:191-215.
Kolb, C. C.
2001 Comments on 'Technological choices in ceramic production,' Archaeometry, 42(1), 1-76, 2000. In *Archaeometry,* v. 43, no. 2, 2001, pp. 273-277.
Kowalewski, Stephen
1990 Evolution of Complexity in the Valley of Oaxaca. In *Annual Review of Anthropology*, vol. 19, pp 39-58.
Kowalewski, Stephen, Gary Feinman, L. Finsten, R. E. Blanton, and L. M. Nicholas
1989 *Monte Alban's Hinterland, Part II: Prehispanic Settlement Patterns in Tlacolula, Etla, and Ocotlan, the Valley of Oaxaca, Mexico.* Memoirs of the Museum of Anthropology, No. 23. University of Michigan, Ann Arbor.
Lemonnier,
1986 Study of Material Culture Today: Toward and Anthropology of Technical Systems. In *Journal of Anthropological Archaeology*, vol. 5, no. 2, pp. 147-186.
Longacre, W. A.
1999 Standardization and Specialization: What's the Link? In *Pottery and People: A Dynamic Interaction,* University of Utah Press, Salt Lake City, pp. 44-58.
Losch, August
1954 *The Economics of Location.* Translated by W.F. Stolper. New Haven, CT: Yale University Press.
Marcus, Joyce
1989 From Centralized Systems to City-States: Possible Models for the Epiclassic. In *Mesoamerica after the Decline of Teotihuacan, A. D. 700-900, ed R. Deihl and J. Berlo, pp. 201-208. DORLC, Washington D.C.*
Matson, Frederick R.
1965 Ceramic Ecology: An Approach to the Study of the Early Cultures of the Near East. In *Ceramics and Man*. Edited by F. R. Matson. New York, pp. 202-217.
Morris, Craig

1993 The Wealth of a Native American State: Value, Investment, and Mobilization in the Inka Economy. In *Confugurations of Power: Holistic Anthropology in Theory and Practice.* Cornel University Press.

Murra, John V.

1989 Cloth and its Function in the Inka State. In *Cloth and Human Experience*. Smithsonian Institution Press, Washington D.C., pp. 275-302.

Murray, G. E.

1961 *Atlantic and Gulf Coast Geology of North America.* Harper and Brothers, New York.

Neff, Hector

2001 Comments on 'Technological choices in ceramic production,' Archaeometry, 42(1), 1-76, 2000. In *Archaeometry,* v. 43, no. 2, 2001, pp. 278-281.

1993 Theory, Sampling, and Analytical Techniques in the Archaeological Study of Prehistoric Ceramics. In *American Antiquity*, 58(1), pp. 23-44.

1994 RQ-Mode Principle Components Analysis of Ceramic Compositional Data. In *Archaeometry*, 36(1), pp. 115-130.

Neff, Hector, R.L. Bishop, E.V. Sayre

1988 A Simulation Approach to the Problem of Tempering in Compositional Studies of Archaeological Ceramics. In *Journal of Archaeological Science,* vol 15, 159-172.

1989 More Observations on the Problem of Tempering in Compositional Studies of Archaeological Ceramics. In *Journal of Archaeological Science,* vol16, 57-69.

Neff, Hector and Frederick Bove

1999 Mapping Ceramic Compositional Variation and Prehistoric Interaction in Pacific Coastal Guatemala. In *Journal of Archaeological Science*, vol. 26, no. 8, pp. 1037-1051.

Neff, Hector and Michael Glascock

2002 Instrumental Neutron Activation Analysis of Ceramics and Clays from the Sierra de Los Tuxtlas, Vera Cruz, Mexico. Report prepared by the Missouri University Reactor for Wesley Stoner.

Neff, Hector, Michael Glascock, Ronald L. Bishop, and James M. Blackman

1996 Assessment of the Acid-Extraction Approach to Compositional Characterization of Archaeological Ceramics. In *American Antiquity*, vol. 61, no. 2, pp. 389-404.

Ortiz-Ceballos, Ponciano

1975 La Ceramica de Los Tuxtlas. Unpublished Thesis, Universidad Veracruzana, Jalapa, Mexico.

Peacock, D. P. S.

1982 *Pottery in the Roman World: An Ethnoarchaeological Approach*. Longman, London.

Plattner, Stuart

1989 Markets and Marketplaces. In *Economic Anthropology*. Stanford University Press, Stanford. Pp. 171-208.

Pool, Christopher A.

2002 Ceramic Production at Terminal Formative and Classic Period Tres Zapotes. In *Settlement Archaeology and Political Economy at Tres Zapotes, Veracruz, Mexico.* Pool, Christopher (ed.). University of California, Los Angeles.

2001 Comments on 'Technological choices in ceramic production,' Archaeometry, 42(1), 1-76, 2000. In *Archaeometry,* v. 43, no. 2, 2001, pp. 295-299.

2000 Why a Kiln? Firing Technology in the Sierra de los Tuxtlas, Veracruz (Mexico). In *Archaeometry*, vol. 42, no. 1, pp. 61-76.
1992a Integrating Ceramic Production and Distribution. In *Ceramic Production and Distribution: An Integrated Approach.* Westview Press, Boulder. Pp. 275-313.
1992b Strangers in a Strange Land: Ethnicity and Ideology at an Enclave Community in Middle Classic Mesoamerica. In *Ancient Images, Ancient Thought: The Archaeology of Ideology.* Edited by Sean A. Goldsmith. University of Calgary, Alberta.
1990 *Ceramic Production, Resource Procurement, and Exchange at Matacapan, Veracruz, Mexico.* Dissertation published through UMI Dissertation Services.

Pool, Christopher A. and Georgia Mudd Britt
2000 A Ceramic Perspective on the Formative to Classic Transition in Southern Veracruz, Mexico. In *Latin American Antiquity* 11(2): 139-162.

Pool, Christopher A., and Robert S. Santley
1992 Middle Classic Pottery Economics in the Tuxtla Mountains, Southern Veracruz, Mexico. In *Ceramic Production and Distribution: An Integrated Approach.* Edited by George J. Bey III and Christopher A. Pool, pp.205-234. Westview Press, Boulder, CO.

Polanyi, Karl
1957 The Economy as an Instituted Process. In *Trade and Market in the Early Empires*. Edited by K. Polanyi and H. Pearson. Pp. 243-269. Free Press, Glenco, IL.

Rattray, Evelyn C.
1990 New Findings on the Origins of Thin Orange Ceramics. In *Ancient Mesoamerica*, vol. 1, no. 2, pp. 181-195.

Rattray, Evelyn C. and Garman Harbottle
1992 Neutron Activation Analysis and Numerical Taxonomy of Thin Orange Ceramics from the Manufacturing Sites of Rio Carnero, Puebla, Mexico. In *Chemical Characterization of Ceramic Pastes in Archaeology.* Prehistory Press, pp. 221-231.

Rands, Robert L. and Ronald Bishop
1980 Resource Procurement Zones and Patterns of Ceramic Exchange in the Palenque Region. In *SAA Papers,* no. 1, pp. 19-46.

Reina, Ruben, and Robert Hill
1978 *The Traditional Pottery of Guatemala.* University of Texas Press, Austin.

Reinhardt, Bently
1991 *Volcanology of the Younger Volcanic Sequence and Volcanic Hazards Study of the Tuxtla Volcanic Field, Veracruz, Mexico.* Masters Thesis written in partial fulfillment of the requirements for the degree of Master of Science at Tulane University.

Renfrew, Colin
1977 Alternative Models for Exchange and Spatial Distribution. In *Exchange Systems in Prehistory*. Academic Press, pp 71-90.

Rice, Prudence M.
1996 Recent ceramic analysis: 2, composition, production, and theory. In *Journal of Archaeological Research,* v. 4, no. 3, pp. 165-202.
1991 Specialization, standardization, and diversity: a retrospective. In *Ceramic Legacy of Anna O. Shepard* -- Niwot : University Press of Colorado, pp. 257-279.

Rios Macbeth, Fernando
1952 Estudio Geológico de la Región de los Tuxtlas. *Boletín de la asosciación Mexicana de geólogos petroleros,* 4:324-376.

Rowlands, Michael

1985 Center and Periphery: A Review of a Concept. In *Centre and Periphery in the Ancient World.* Cambridge University Press, pp. 1-11.

Ruggles, Amy J. and Richard L. Church

1996 Spatial Allocation in Archaeology: An Opportunity for Reevaluation. In *New Methods, Old Problems: Geographic Information Systems in Modern Archaeological Research*. Edited by Herbert D. G. Maschner. Center for Archaeological Investigations, Occasional Paper No. 23. Southern Illinois University.

Sahagún, Fray Bernardino de

1950-82 *Florentine Codex: A History of the things of New Spain.* (Arthur J.O Anderson and Charles Dibble eds. and trans.) School of American Research and the University of Utah, Santa Fe.

Sahlins, Marshal

1972 *Stone Age Economics.*

Sanders, William T., and David Webster

1988 Mesoamerican Urban Tradition. In *American Anthropologist*, vol. 90, no. 3, pp. 521-546.

Santley, Robert S.

1994 The Economy of Ancient Matacapan. In *Ancient Mesoamerica*, 5: 243-266. Cambridge University Press.

1991 *Final Field Report: Tuxlas Region Archaeological Survey, 1991 Field Season.* Department of Anthropology, University of New Mexico, Albuquerque. Submitted to the National Science Foundation, Washington D.C.

1982 *Final Field Report : Matacapan Project,1982 Field Season*. A report to the National Science Foundation and El Instituto Nacional de Antropologia e Historia.

Santley, Robert S. and Phillip J. Arnold III

1996 Prehispanic Settlement Patterns in the Tuxtla Mountains, Southern Veracruz, Mexico. In *Journal of Field Archaeology,* 23, pp. 225-249.

Santley, Robert S., Philip J. Arnold III, and Christopher A. Pool

1989 The Ceramics Production System at Matacapan Veracruz, Mexico. *Journal of Field Archaeology* 16: 107-132.

Santley, Robert S., and Ronald R. Kneebone

1993 Craft specialization, refuse disposal, and the creation of spatial archaeological records in prehispanic Mesoamerica. In *Prehispanic Domestic Units in Western Mesoamerica* -- Boca Raton : CRC Press, pp. 37-63.

Santley, Robert S., Stephen A. Nelson, Bently K. Reinhardt, Christopher A. Pool, and Phillip J. Arnold.

2000 When Day Turned to Night: Volcanism and the Archaeological Record from the Tuxtla Mountains, Southern Veracruz, Mexico. In *Environmental Disaster and the Archaeology of Human Response.* Maxwell Museum of Anthropology, University of New Mexico, Anthropological Papers no. 7.

Santley, Robert S, Ponciano Ortiz-Ceballos, and Trevor Kludt

1988 Prehistoric Salt Production at El Salado.

Santley, Robert S., Ponciano Ortiz Ceballos, and Christopher A. Pool

1987 Recent Archaeological Investigations at Matacapan, Veracruz: A Summary of the results of the 1982 and 1986 Field Seasons. *Mexicon* 9:41-48.

Santley, Robert S., Ponciano Ortiz Ceballos, Phillip J. Arnold III, Ronald R. Kneebone, Michael P. Smyth, and Janet M. Kerley

1983 *Final Field Report, Matacapan Project: 1983 Season*. A report to the Instituto Nacional de Antropologia e Historia.

Santley, Robert S., Ponciano Ortiz Ceballos, Phillip J. Arnold III, Ronald R. Kneebone, Michael P. Smyth, Janet M. Kerley, Michael Berman, Barbara A. Hall, Verinoca Kann, Christopher A. Pool, Zenaido Salazar B., and Claire Yarborough

1985 *Final Field Report , Matacapan Project: 1984 Season.*. A report to the Instituto Nacional de Antropologia e Historia.

Santley, Robert S. and Christopher A. Pool

1993 Prehistoric Exchange Relationships among Central Mexico, the Valley of Oaxaca, and the Gulf Coast of Mexico. In *The American Southwest and Mesoamerica: Systems of Prehistoric Exchange*, edited by Jonathon Ericson and Timothy G. Baugh, pp. 179-211. Plenum Press, New York.

Santley, Robert S. and Rani Alexander

1996 Teotihuacan and Middle Classoc Mesoamerica: A Pre-Columbian World System? In *Arquelogia Mesoamericana: Homenaje a William T. Sanders*. Instituto Nacional de Antropologia e Historia, Arquelogia Mexicana, pp. 173-194.

Sayre, E. V.

1975 *Brookhaven Procedures for Statistical Analysis of Multivariate Archaeometric Data.* Brookhaven National Laboratory, New York, unpublished.

Schiffer, Michael, and James Skibo

1987 Theory and Experiment in the Study of Technological Change. In *Current Anthropology*, vol. 28, no. 5, pp. 595-622.

1997 Explanation of Artifact Variability. In *American Antiquity*, vol. 62, no. 1, pp. 27-50.

Shanks, Michael and Christopher Tilley

1987 *Reconstructing Archaeology: Theory and Practice.* Cambridge University Press, Cambridge.

Sillar, Bill and Michael S. Tite

2000 The Challenge of 'Technological Choices' for Materials Science Approaches in Archaeology. In *Archaeometry*, vol. 42, no. 1, pp. 2-20.

Smith, Carol

1976 Regional Economic Systems: Linking Geographical Models and Socioeconomic Problems. In *Regional Analysis, Volume 1: Economic Systems.* Edited by Carol Smith. Academic Press.

Smith, Michael

1979 The Aztec Marketing System and Settlement Pattern in the Valley of Mexico: A Central Place Analysis. In *American Antiquity*, vol 44, no.1, pp. 110-125.

Stark, Barbara

1999 Formal Architectural Complexes in South-Central Veracruz, Mexico: A Capital Zone?. In *Journal of Field Archaeology*, vol 26(2), pp. 197-225.

1996 Problems in Analysis of Standardization and Specialization in Pottery. In ?

1978 An Ethnohistoric Model for Native Economy and Settlement Patterns in Southers Veracruz, Mexico. In *Prehistoric Coastal Adaptations*. Academic Press, pp 211-238.

Stark, Barbara, Lynette Heller, and Michael A. Ohnersorgen

1998 People with Cloth: Mesoamerican Economic Change from the Perspective of South-Central Veracruz. In *Latin American Antiquity* vol. 9(1),pp. 7-36.

Stark, Miriam T.

1995 Economic intensification and ceramic specialization in the Philippines: a view from Kalinga. In *Research in Economic Anthropology* -- Greenwich, v. 16, pp. 179-226.

1991 Ceramic production and community specialization: a Kalinga ethnoarchaeological study. In *World Archaeology* -- London, v. 23, no. 1, pp. 64-78.

Stein, Gil J.

1999 Rethinking World-Systems: Power, Distance, and Diaporas in the Dynamics of Interregional Interaction. In *World-Systems Theory in Practice: Leadership, Production, and Exchange*. Rowman and Littlefield, Lanham. Pp. 153-177.

Stein, Gil J., and M. James Blackman

1993 Organizational context of specialized craft production in early Mesopotamian states. In *Research in Economic Anthropology* -- v. 14, pp. 29-59.

Stirling, Matthew

1943 *Stone Monuments of Southern Mexico.* Bureau of American Ethnology, Bulletin 138, Smithsonian Institution Press, Washington D.C.

Stoltman, James, James H. Burton, and Jonathon Haas

1992 Chemical and Petrographic Characterizations of Ceramic Pastes: Two Perspectives on a Single Data Set. In *Chemical Characterization of Ceramic Pastes in Archaeology.* Wisconsin, Prehistory Press, pp. 85-92.

Stoltman, James

1989 A Quantitative Approach to the Petrographic Analysis of Ceramic Thin Sections. In *American Antiquity*, vol. 54, pp. 147-160.

1991 Ceramic Petrography as a Technique for Documenting Cultural Interaction: An Example from the Upper Mississippi Valley. In *American Antiquity*, vol. 56, no. 1, pp 103-120.

Strachan, Betsy

1986 *The Biostratigraphy and Paleoecology of Miocene Benthic Foraminifera from the Salina Basin, State of Veracruz, Mexico.* Unpublished M. S. thesis, Tulane University, New Orleans.

Tomkins, Peter and Peter M. Day

2001 Production and exchange of the earliest ceramic vessels in the Aegean: a view from early Neolithic Knossos, Crete. In *Antiquity*, v. 75, no. 288, pp. 259-260.

Torrence, Robin

1989 In *What's New: A Closer look at the process of innovation.* Unwin Hyman.

Uceda, Santiago and Jose Armas

1998 An Urban Pottery Workshop at the Site of Moche, North Coast of Peru. In *MASCA Research Papers in Science and Archaeology*, Suppliment to vol. 15, pp. 91-110.

Valenzuela, Juan

1945 Las Exploraciones Efectuadas en Los Tuxtlas, Veracruz. In *Mexico*. Museo Nacional de Arquelogia, Historia, y Etnografia. Ep. 5, t. III, pp. 83-107.

Vivo Escoto

1964 Weather and Climate of Mexico and Central America. In *Handbook of Middle American Indians*, vol. 3. Robert West (ed.), pp. 187-215. University of Texas Press, Austin.

Wattenmaker, Patrica.
1994 Political fluctuations and local exchange systems in the ancient Near East: evidence from the Early Bronze Age settlements at Kurban Höyük. In *Chiefdoms and Early States in the Near East: the Organizational Dynamics of Complexity* -- Madison : Prehistory Press, pp. 193-208. -- Monographs in World Archaeology ; no. 18.
Weiant, C. W.
1943 *An Introduction to the Ceramics of Tres Zapotes, Veracruz, Mexico.* Smithsonian Institution Press. Bureau of American Ethnology, Bulletin 139.
Weigand, Phil C., Garman Harbottle, and Edward V. Sayre
1977 Turquoise Sources and Source Analysis: Mesoamerica and the Southwestern U.S.A. In *Exchange Systems in Prehistory*. Academic Press, pp. 15-34.
Williams, Howel and Robert F. Heizer
1965 Sources of Rocks Used in Olmec Monuments. In *Sources of Stones Used in Prehistoric Mesoamerican Sites.* Berkely, pp. 1-39.

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RESEARCH INTERESTS

Complex societies, economic anthropology and archaeology, political systems, geoarchaeology, chemical and minerological analyses of artifacts, ceramic and lithic analyses, warfare, Mesoamerica.

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2001- present Teaching Assistantship awarded for the Fall 2001 through Spring 2003 school years – Department of Anthropology, University of Kentucky.

2000-2001 Research Assistant for the Kentucky statewide GIS project – Department of Anthropology, University of Kentucky; Kentucky Heritage Council; Kentucky Archaeological Survey.

1999-2000 Research Assistant, Archaeology – Wilbur Smith Associates, Lexington, KY.

OTHER RESEARCH AND FIELD EXPERIENCE

2000-2001 Field worker – Kentucky Archaeological Survey, Lexington, KY.

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PUBLICATIONS

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2000 El Fenomeno Teotihuacano en Tres Zapotes y Matacapan: Una Discucion Comparativa. Proceedings of the 2nd Mesa Redonda de Teotihuacan, Teotihuacan, Mexico. November 2000. (In Press).

CO-AUTHORED PAPERS PRESENTED AT PROFESSIONAL CONFERENCES

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2000 *Distribution of Prehistoric Archaeological Sites and Historic Structures in Central Kentucky*. Poster presented at the University of Kentucky GIS Poster Day.

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Petrographic analysis – Trained at the University of Kentucky by Dr. Kevin Henke (Department of Geology) and Dr. Christopher A. Pool (Department of Anthropology). This training also involved basic crystallography and mineral chemistry.

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