THE FLORIDA STATE UNIVERSITY

COLLEGE OF ARTS AND SCIENCES

OBSIDIAN ARTIFACTS FROM SAN ANDRES
LA VENTA, TABASCO, MEXICO

by

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A Thesis submitted to the
Department of Anthropology
in partial fulfillment of the
requirements for the degree of
Master of Science

Degree Awarded:
Spring Semester, 2002

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This thesis is dedicated to Dr. George A. Llano, friend and scholar.

ACKNOWLEDGMENTS

This thesis was made possible through the support, encouragement, and effort of numerous individuals. I would like to thank Dr. Mary Pohl, my committee chair, for her generosity in offering the obsidian collection from San Andrés for analysis and for her assistance throughout my graduate studies at the Florida State University. My appreciation goes to Dr. Michael Faught for helping me keep things in perspective and to Dr. Rochelle Marrinan for her support and guidance both in and out of the field. I would like to thank Dr. J. Kathryn Josserand for her counsel and editing.

I am particularly grateful to Dr. John E. Clark of Brigham Young University, for his insight and assistance in this project, and for allowing me to use the facilities of the New World Archaeological Foundation Laboratory in San Cristóbal de las Casas, Chiapas, Mexico. Additionally, I am grateful for the support and cooperation provided by Dr. Rebecca González Lauck of the Centro Instituto Nacional de Antropología e Historia Tabasco, and director of the Proyecto Arquelogíco La Venta. My gratitude also goes to Dr. Michael Glascock of the Missouri University Research Reactor (MURR) for the neutron activation analysis of San Andrés obsidian artifacts.

I would also like to acknowledge the assistance of Dr. Kevin Pope and Chris von Nagy of the Early Agriculture on the Gulf Coast Lowlands of Mexico Project, and the financial support provided by the project which was funded by National Science Foundation (NSF) Archaeology Program Grant BCS-9617389. NSF Grant SBR-9802366 also provided valuable funding assistance for the neutron activation analysis procedures at MURR.

Thank you to all who read, edited, and improved this thesis. Finally, it has been a privilege to work and study with my fellow classmates.

ABSTRACT

This thesis is an examination of Formative period obsidian artifacts (1400 to 400 cal BC) from San Andrés, a subsidiary site located five kilometers northeast of the major ceremonial center of La Venta in westernmost Tabasco, Mexico. The primary objectives of the analysis were to determine the source and the method of manufacture of each piece in the collection (636 pieces). An examination of use-wear patterns and an evaluation of the relationships of the artifacts to associated cultural material were used to infer the functions of the obsidian specimens. The data produced by the analysis are significant because they provide an unprecedented opportunity to study the social, political, and economic interaction between La Venta, a prominent Middle Formative period urban core, and San Andrés, an agriculturally based site within the polity's riverine support network.

Obsidian is not native to the region, therefore, examination of the acquisition, production, redistribution, and use of this exotic material can offer evidence of societal organization along the southern Gulf Coast during the Formative period. Compositional testing of 32 selected specimens using neutron activation analysis identified nine sources present at San Andrés; the results were extrapolated to the remainder of the collection through macroscopic visual identification. Paredón, in Hidalgo, Mexico, and San Martín

Jilotepeque, in the Guatemala Highlands, were the dominant sources through four Formative period occupational periods extending from 1400 to 400 cal BC. These two sources demonstrate long term traditions of obsidian acquisition by residents of San Andrés. The modest quantity of obsidian recovered at the site (504.8 grams) reinforces a regional pattern that indicates that relatively small amounts of obsidian were used during the Formative period.

A lack of production debitage at San Andrés and the presence of obsidian workshops at La Venta suggest that the importation of the raw material was controlled by elite factions in the La Venta urban center. Prismatic blades appear to have been produced at La Venta and were the standard item distributed to San Andrés, where residents later recycled the limited lithic material and extended its use-life through bipolar reduction. Changes over time in the quantity of obsidian recovered at the site correspond to population fluctuations associated with the rise, reign, and ruin of La Venta as an urban center.

The obsidian implements, in combination with artifactual, botanical, and faunal material, indicate a pattern of feasting events associated with elite factions. Additionally, an interpretation of the primary obsidian sources may indicate the existence of two separate trade networks: one connected the La Venta and San Andrés area to the northern Basin of Mexico, by way of El Viejón, Veracruz, and the other linked them to the Upper Grijalva River Basin and Highland Guatemala through the site of San Isidro, Chiapas. Evidence of feasting events and obsidian acquisition procedures provide additional measures of the socioeconomic relationship between La Venta and San Andrés.

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CHAPTER 1

INTRODUCTION

This thesis focuses on the analysis of the Formative period (2000 cal BC to cal AD 150) obsidian artifacts recovered at San Andrés, a subsidiary site located five kilometers northeast of the major urban Middle Formative center of La Venta, Tabasco, Mexico (Figure 1). Examination of each of the 636 obsidian specimens in the Formative period assemblage was undertaken to determine the source of each sample, its method of manufacture and function, and its relationship to associated cultural material. This comprehensive type of analysis is the first of its kind to be performed on an obsidian collection from a Formative period site in the Gulf Coast region of Mexico.

The research presented in this thesis is the result of archaeological investigations undertaken by the "Early Agriculture on the Gulf Coast Lowlands of Mexico Project" in 1997, 1998, and 2000. This project was directed by Drs. Mary Pohl, of Florida State University, and Kevin Pope, of Geo Eco Arc Research, at the invitation of the "Proyecto Arqueológico La Venta," headed by Dr. Rebecca González Lauck, of the Instituto Nacional de Antropología e Historia, Tabasco, Mexico. The examination of San Andrés included excavation and wet sediment cores that produced evidence relating to Archaic and Formative period environmental evolution, human occupation of the site, agricultural practices, and cultural activities (Pope and Pohl 1998; Pope *et al*. 2000; Pope *et al*. 2001; von Nagy 1999; von Nagy *et al*. 2001).

The excavations provided the stratigraphic and chronological control that is essential for studying cultural context and allowed each obsidian specimen to be assigned both temporally and spatially. Stratigraphic excavations of natural levels were subdivided into 20 cm. increments, and recovery procedures included wet screening of most excavated earth through 3 mm mesh (Pope *et al*. 2001:1). Soil samples were taken at 20 cm intervals, and all cultural features were processed by flotation (von Nagy *et al*. 2001:4). Significant radiocarbon dating and fine-grained ceramic analysis by von Nagy secured chronology (von Nagy *et al*. 1999, von Nagy *et al*. 2000). These data enabled a quantitative analysis of the obsidian on a diachronic basis and placed each specimen in a depositional context.

Radiocarbon dates in this thesis have been calibrated, and a uniform format has been used for the presentation of these dates. Single dates (e.g., 900 cal BC) are median sigma dates, and range dates (e.g., 1200 to 300 cal BC) are the outer 1 sigma dates. Calibrated dates are given as provided by the authors cited, and dates that required calibration have been determined by OxCal v. 3.5 (Bronk Ramsey 2000) using an estimated sigma range of 100 years. Details of the San Andrés and La Venta radiocarbon dates are presented in Appendix A.

The scarcity of stratified, *in situ*, Formative period cultural deposits has impeded the study of Gulf Coast societies (Diehl 2000:19-20). Therefore, the information derived from this analysis is significant because it allows archaeologists, for the first time, to begin a chronological observation of the internal social, political, and economic relationships of the La Venta polity.

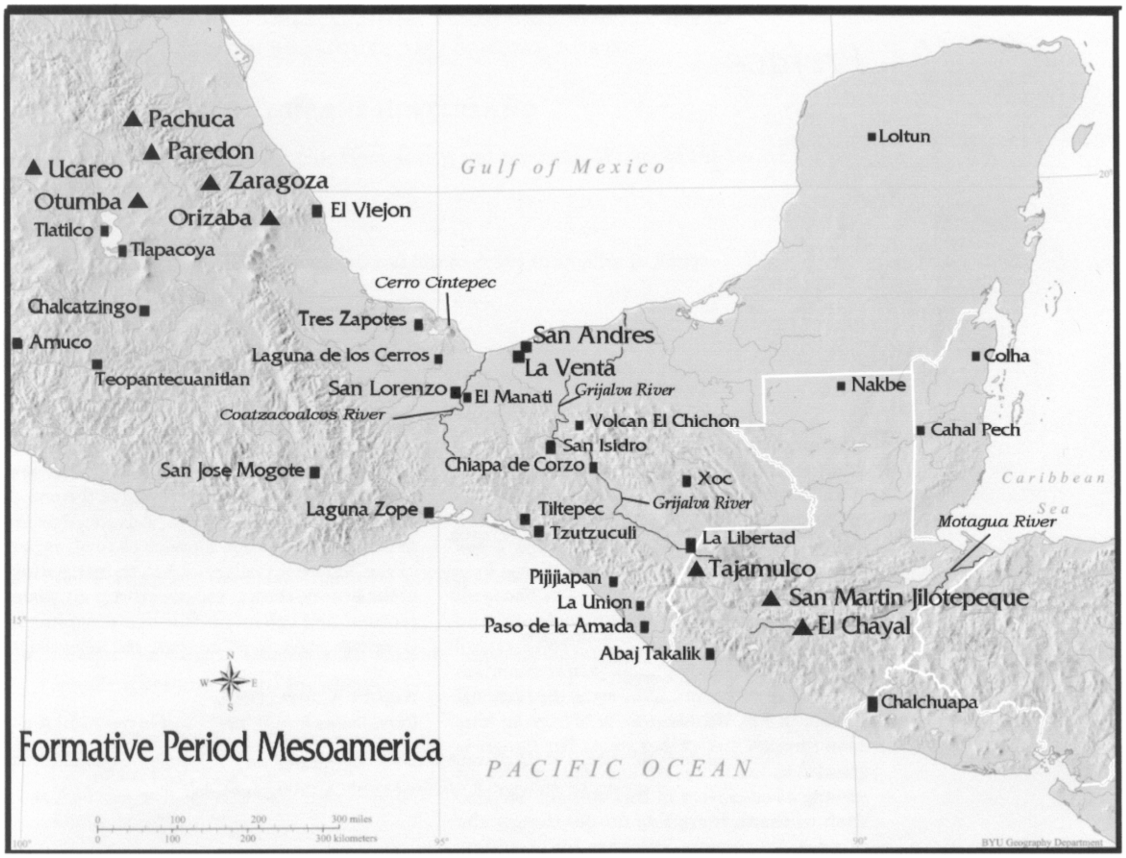


Figure 1. Formative period Mesoamerica (after Clark and Pye 2000:8).

For Precolumbian Mesoamericans, obsidian would have been equivalent in significance to steel in modern industrialized society (Cobean *et al*. 1971:666). Chipped stone was the material of choice for tools that were used for cutting, slicing, scraping, and chopping. Other materials used in the production of these types of tools include chert and chalcedony, but along the Gulf Coast during the Formative period these alternate materials were used far less than was obsidian. Coe and Diehl (1980:246) note that only a few pieces of chert or chalcedony were present in the chipped stone collection recovered at San Lorenzo, an Early Formative period site on the Coatzacoalcos River in Veracruz, and they consider these materials to be insignificant. Hester *et al*. (1971)

report that 99% of the chipped stone assemblage recovered at Tres Zapotes, another Formative period site near the coast, consisted of obsidian.

Obsidian's versatility in both utilitarian and ritual contexts makes it a valuable tool for archaeological analysis of prehistoric Mesoamerican society. Obsidian appears to have been used by every member of society regardless of age, sex, or social status, thus, it can provide insights into the lifeways and cultural patterns of the Precolumbian inhabitants of San Andrés. Obsidian can furnish evidence of the past independently and in conjunction with other associated artifacts to provide a better understanding of ancient cultures (Braswell 2001:218). This study used an inclusive approach in the analysis of the obsidian collection from San Andrés.

The analysis of Formative period obsidian material along the southern Gulf Coast is meaningful for several reasons. First, the alluvial plain surrounding San Andrés contains no natural stone other than river gravel (Sisson 1976:17); thus, all lithic material had to be imported to the site. Second, the transportation of stone into the San Andrés-La Venta region is of interest to the anthropologist because it had implications for the social organization, ideology, political authority, and economic prospects of Formative period people. The presence of any lithic material in the La Venta polity is significant, and the presence of obsidian at San Andrés is particularly notable when one considers that the material was imported from various localities over 300 miles away.

The sources of the obsidian artifacts recovered at San Andrés provide evidence of possible intra-regional and inter-regional socioeconomic relationships. In this San Andrés project, 32 obsidian specimens were selected from the assemblage and submitted for compositional testing through neutron activation analysis in an attempt to determine their source. The results were extrapolated, by means of visual attributes, to the remainder of the collection. Nine sources were identified at San Andrés. Nevertheless, three of the sources, Paredón in Hidalgo, Mexico, and San Martín Jilotepeque and El Chayal in Guatemala, accounted for over 93% of the total assemblage (Figure 1).

La Venta evolved into the dominant center of Mesoamerica during the Middle Formative period (ca. 1000-400 cal BC) (González Lauck 1996:73), a transitional phase in Mesoamerican cultural development toward state level society. Trade goods from distant locales reached La Venta and subsidiary sites such as San Andrés. Evidence of this interchange is seen in ceramic artifacts found at La Venta and San Andrés. These artifacts reveal ceramic styles, forms, and designs associated with the Basin of Mexico, the Grijalva River drainage in Chiapas, the Yucatán Peninsula, and the Maya Lowlands of Petén, Guatemala (von Nagy *et al*. 2001:8). The sources of obsidian found at San Andrés also reflect this wide-ranging Mesoamerican interaction sphere. These relationships, together with the large number of obsidian sources represented at this subordinate site, suggest that the materials acquired by La Venta's exchange networks were shared with inhabitants of San Andrés.

From a technological standpoint, obsidian artifacts retain visual evidence of their method of manufacture, thus providing insight into the development of production industries. The types of products, raw nodules, cores, or finished products, can provide evidence not only of the level of technology, but in some cases, of the level of sociopolitical development within the community. For example, Clark (1987:274) says that complex chiefdoms were the simplest level of sociopolitical organization in which early prismatic blades were imported as elite sumptuary goods. The blades may have then been redistributed as gifts to selected members of the local society (Clark 1987:262; Jackson and Love 1991:48). Additionally, lithic workshops can be detected through the remains of production debitage, and the products of these areas may be traced to localities throughout the polity, providing an idea of the distribution systems employed. A lack of debitage at San Andrés suggests production occurred elsewhere, and Chávez (1990:25) has indicated obsidian workshops were located in La Venta center, implying redistribution of finished products from the center to a secondary site.

This analysis concludes that obsidian use at San Andrés was conservative. Inhabitants continually recycled the existing imported material. They accomplished this through bipolar reduction, a method of extending the effective life of obsidian blades or flakes by literally smashing the obsidian in order to create a new sharp edge (Chapter 4, Bipolar Percussion).

The possible functions of the implements and their relationship with associated artifacts can enlighten archaeologists about the activities that occurred at the site (Clark 1988:33-42). One method of identifying such activities is to examine obsidian tools for use-wear. A number of pieces examined in this study did indeed have patterns indelibly registered on their surfaces. These imprints were macroscopically analyzed in an attempt to determine the types of tasks and materials on which the tool was used. Based on associated cultural material, limited use patterns, and light cutting wear it would appear the primary role of the excavated San Andrés obsidian artifacts was for use in large-scale food preparation associated with a series of feasting events.

The San Andrés obsidian artifacts indicate that over the course of the Middle Formative occupation the majority of the obsidian came from either the northern Basin of

Mexico or the Guatemalan Highlands. This obsidian could have been acquired through two distant trade nodes with acknowledged cultural connections to La Venta. El Viejón, along the western Gulf Coast, and San Isidro, on the upper Grijalva River, may have been the transit points for the obsidian that has been recovered at San Andrés.

This thesis is organized in the following way. Chapter 2 discusses the Middle Formative period along the Gulf Coast of Mesoamerica and reviews the archaeological investigations of the La Venta urban center and its sociopolitical setting as it is understood today. The geological evolution of the region is also considered. Changes in the geomorphology of the area led to the formation of numerous riverine sites, one of which was San Andrés; it was the support network created by these riverine sites that enabled the ascendancy of La Venta (Rust 1992:126).

Chapter 3 is a review of the archaeological investigations at San Andrés; it is followed Chapter 4 on Precolumbian obsidian in Mesoamerica. Portions of this chapter explore the multiple purposes volcanic glass played in the lives of the ancient inhabitants of Mesoamerica, as well as its significance to archaeological investigation. Since sourcing of obsidian is crucial to this thesis, the methodology employed is explained and discussed in Chapter 5. Previous Formative period obsidian source studies are also reviewed, and their results are compared with findings from this work. Chapter 6 considers possible scenarios for the importation of obsidian to San Andrés and implications of the reduction techniques, functions, and relationships to associated depositional material. Chapter 7 concludes the thesis with a review of the findings and considerations for future investigation.

This thesis is the initial stage of a long-term project to examine Formative period obsidian artifacts throughout Mesoamerica. Extended investigation, analysis, and corroboration will be required to support or refute the conclusions reached in this report. For example, the methodology used in this investigation can be applied to obsidian recovered from the La Venta urban core to produce evidence that will further refine our understanding of the relationships between these two sites.

CHAPTER 2

MIDDLE FORMATIVE GULF COAST MESOAMERICA

This chapter will provide an overview of social, political, and economic development that occurred along the southern Gulf Coast of Mesoamerica during portions of the Formative periods (2000 to 400 cal BC). The major Middle Formative period urban center of La Venta is discussed, and a review of the archaeological exploration of the site is presented.

Mesoamerica is a term used to describe a geographical region of the New World whose people shared a similar worldview and a fundamental cultural affinity at the time the Spaniards arrived in the early 1500s (Kirchoff 1943). The cultural practices of this region included the use of a ritual calendrical system, a rubber-ball game, ritual personal bloodletting, human sacrifice, and maize-centered agricultural systems, and an ideology incorporating all these elements (Clark and Pye 2000a:9; Weaver 1993:1). This integrated set of customs differentiated Mesoamerica from other contemporaneous cultural areas, such as the American Southeast, the Amazon Basin, or the Andes of South America. The map presented in Figure 1 shows Mesoamerica during the Formative period, with the sites discussed in this thesis identified.

The Formative period saw the development of the Mesoamerican cultural area in the context of the rise of complex societies. At the beginning of the Formative period (ca

1800-2000 cal BC), Mesoamerica was occupied by groups of semi-sedentary agriculturists, hunters, and foragers (MacNeish 2001:30-33; Weaver 1993:25). By the end of the period (cal A.D. 150), the sociopolitical environment had evolved from the establishment of rank societies to paramount chiefdoms, and eventually to incipient regional state-like organizations (Clark 2001:278-279). Brumfiel (1994:6,12) has suggested that the sociopolitical and economic changes that took place in Mesoamerica during the Formative period were due to localized regional development that was predicated on a combination of social factors, environmental resources, and factional competition. The transitions that occurred during the Formative period were neither universal nor uniform; they occurred sporadically, in diverse places, and for numerous and varied reasons (Clark and Blake 1994:17).

The southern Gulf Coast of Mexico was an early center of social differentiation that began in the Early Formative period (1500 cal BC) at San Lorenzo (Coe 1994:8,9). Along the southern Gulf Coast, economic expansion through the import and export of goods was associated with the establishment of a complex political system and increased social stratification. The elites were able to demonstrate their authority through differential access to exotic elite items and raw materials. Emergent elites created social distance through the construction of ceremonial centers containing public and private art and architecture, in an attempt to legitimize the right to authority, power, and wealth (Chase and Chase 1992:4-6; Grove and Gillespie 1992:191).

During the Middle Formative period in ancient Mesoamerica (ca 1000 to 400 cal BC), the chronological focus of this thesis, people along the southern Gulf Coast of Mexico built the major ceremonial center of La Venta, one of the Western Hemisphere's first cities (González Lauck 1996a:75). The primary occupation of La Venta ranged from around 1200 to 400 cal BC (González Lauck 1996b:73). The demise of La Venta marks the boundary between the Middle Formative and the Late Formative periods around 400 cal BC.

Sociopolitical Organization

Determining the sociopolitical organization of a prehistoric people is speculative due to the paucity of corroborating information, but the evidence that exists indicates that Gulf Coast societies were deeply stratified by the Middle Formative period. Based on evidence from major centers such as San Lorenzo and La Venta (Figure 1), it appears the highest levels of the elite, generally referred to as paramounts, directly or indirectly controlled the procurement of food supplies and raw materials, beneficial craft production, and long distance exchange (Clark 1996:189). Subordinate levels of elite, possibly kin group members who maintained relationships with the paramounts, may have regulated less exotic or necessary items (von Nagy *et al*. 2001:2).

Clark and Blake (1994:17) argue that under proper technological or environmental regional conditions, egalitarian societies can evolve into rank societies. They propose that the motivation for change was competition among factional leaders attempting to accumulate "prestige or social esteem." These individuals are referred to as political elites, aggrandizers, accumulators, or Big Men (Brumfiel 1983:8; Clark and Blake 1994:17; Hayden and Gargett 1990:4; Sahlins 1974:117,135-138). The spark required to start this competition in Formative period Mesoamerica is thought to have been an agricultural surplus resulting from reliable long-term food production (Brumfiel

1994:6), what Sahlins called a “fund of power” (Sahlins 1968:68,230).

The rise of political complexity was accompanied by a rise in long distance acquisition and exchange that, regardless of the items procured, brought a degree of influence due to the attraction these items had for varying levels of the society (Henderson 1992:160). The attraction and retention of loyalists by aggrandizers is a fundamental activity in generating and preserving political power (Brumfiel 1994:6). Hayden and Gargett (1990:5) predict that successful competition for followers will exist only when local resources are abundant and access to exchange networks is present.

The objectives and procedures used by competitive individuals to reach their desired goals are exemplified by a form of social transformation known as factional competition (Brumfiel 1994:1; Vincent 1996:222-223). Factions are fluid groups of people recruited opportunistically, vertically cross-cutting various levels of a stratified society, by leaders contesting specific, usually economic, issues. Factions are characterized as informal organizations led by authority figures whose function is to gain access to limited raw materials or human resources. The purpose of most factions is similar, to oppose each other in order to gain advantages within a larger social unit (e.g., kin, ethnicity, village, chiefdom). Thus factions may cut across ‘horizontal’ divisions within a society, such as those of class, religion, or gender (Brumfiel 1994:8; Vincent 1996:223).

Janet Bujra (1973), in her article “The Dynamics of Political Action: A New Look at Factionalism,” illustrates that factional leaders are usually from the “dominant” or elite sectors of the society. Burja posits that separation between social levels inhibits competition, while social equality generates it. Conflicts will occur between social equals, and the leaders of these conflicts tend to be from elite levels of society because they have the ways and means to recruit and hold followers. These competing leaders are likely to share similar public goals and are not seeking to change the basic structure of society. Burja explains that these ambitious leaders are competing not necessarily for political power, but for wealth, influence, and prestige.

The sociopolitical transformations of Middle Formative period societies along the Gulf Coast, and specifically at La Venta, conform to the canons established for political factionalism (Brumfiel 1994; Clark and Blake 1994; Fox 1994; Hayden and Gargett 1990). If competitiveness was the motivating factor, and access to surplus resources was the spark, what was the device that permitted factional leaders to build prestige and maintain the coalitions that placed them in positions of authority? Clark (1999) provides an answer with an analogy of Marcel Mauss'(1990) discussion of the Melanesian Maori's "spirit of the gift." The premise is that participants in gift exchange are obligated to bestow gifts, to accept them, and to compensate the giver in a way deemed appropriate within the society. These conventions may have been the device, the social stimulation that allowed political competition to persist.

One of the primary mechanisms for the accumulation of prestige was the sponsorship of feasting events and associated activities of ritual drinking and gifting that advanced the agendas of factional leaders. Feasting activities could validate the establishment of marriage or military alliances, initiate the mobilization of group labor, reward loyal behavior, or present a forum for the politically motivated redistribution of wealth (Dietler and Hayden 2001a:17). The presence of particular types of ceramic vessels and the locations of roasting pits, hearths, lithic tools, and refuse deposits suggest ways in which feasting traditions structured the varying social levels of clans, lineages, and polities. Feasts were closely connected to the procedures of social and cultural change within ancient and modern societies (Dietler and Hayden 2001b:16,17).

Botanical and faunal evidence can indicate the foods consumed at feasting events. In addition, the size of the reconstructed ceramic vessels can suggest the quantities prepared. Feasts may have been arranged to coincide with communal events, such as planting and harvesting periods, or with political events. A cross section of the society could be present, including faction leaders and members, possible new constituents, and distinguished guests (Brumfiel 1994:6). Guests might have included other aggrandizers who represented distant polities, trade partners, clients, allies, and patrons willing to affiliate themselves with the local faction (Dietler 2001:68-69).

Feasting, drinking, and gifting were tools used by aggrandizing individuals involved in factional competition to accumulate prestige and goodwill, which in turn resulted in the maintenance or expansion of the faction's influence internally and externally. This renown was amassed in a variety of ways: in the power to import exotic goods, resources, or technology over great distances; in the generosity to sponsor great feasting, drinking, and gifting events, and in the politically motivated "altruism" to redistribute wealth.

La Venta

The beginning of the Middle Formative period in Mesoamerica (ca 1200 cal BC) is closely associated with the rise of La Venta as a significant cultural, commercial, and population center (Figures 1 and 2). The site, located in the present-day town of La

Venta in the municipality of Huimanguillo in western Tabasco, Mexico, provides one of the earliest examples of planned architecture in ancient Mesoamerica. Monumental architecture around broad courtyards makes up the central ceremonial zone. The entire site sits atop an elevated salt-dome in the humid tropical alluvial plains of the southern Gulf region (González Lauck 1996b:73), and the central pyramid can be seen from the surrounding countryside.

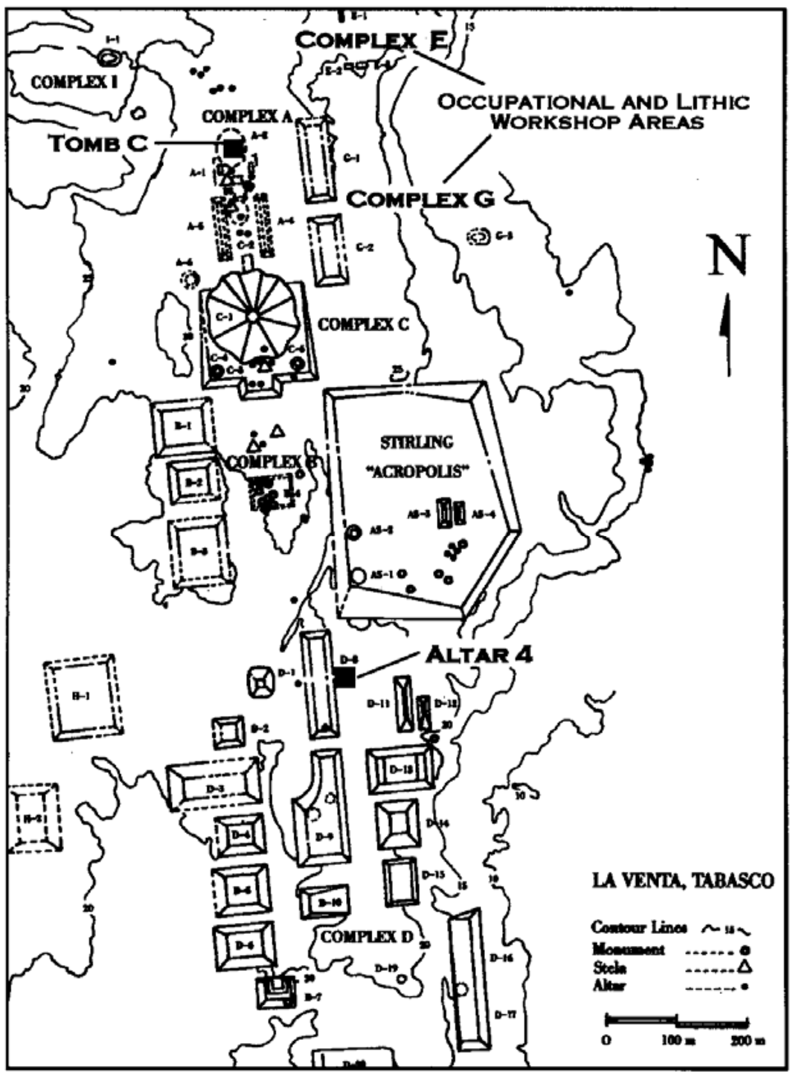


Figure 2. Map of La Venta center (after Gonzalez Lauck, 1996:74).

The archaeological zone of La Venta is a primary source for information pertaining to Middle Formative period life on the southern Gulf Coast (González Lauck 2001:799). The wealth, power, and control required to build large-scale monumental structures, to obtain the amounts of exotic sumptuary goods, and to master diverse art forms are attested to in the archaeological record of the site (González Lauck 1996b; Grove 1997; Stuart 1993). A potential indication of La Venta's far-reaching influence is a distinctive series of similar monumental stone carvings that were sculpted across Mesoamerica during an interval in the Middle Formative period (970 to 800 cal BC) (Clark and Pye 2000b:227). All these sculptures contain comparable subject matter, art style, and iconographic detail and appear to have been rendered according to the artistic canons developed by artisans at the La Venta ceremonial center (González Lauck 2001:800). The stylistic and iconographic similarities are seen in the portrayal of clothing, headdresses, body positions, and accouterments exemplified in Figure 3 (Clark and Pye 2000b:228).

Notable examples of this temporally limited and shared style are found at Chalcatzingo, Morelos (Grove 1984:49-68), and Amuco, in Guerrero (Grove and Paradis 1971). The Soconusco Coast of Pacific Chiapas and Guatemala furnish examples of these sculptures at Pijijiapan, Tzutzuculi, and Abaj Takalik. The sites of Xoc, in central Chiapas, and Loltún, in northern Yucatan, demonstrate the scattered distribution of the sculptures. The most distant image was found at Chalchuapa, El Salvador, 660 kilometers away from La Venta (Clark and Pye 2000b:226-230). This distance, like all those presented in this thesis, is straight-line or air distance. The actual topographical distance would be far greater.

Figure 3. Monolithic Sculptures from 970 to 800 cal B.C.
(Clark and Pye 2000:228; Drucker, Heizer, and Squire 1959:217)

These sculptural examples appear to be evidence of significant and widespread interaction between the people of La Venta and those in distant dispersed locations. The reason for this interaction may have been the procurement of exotic raw materials, such as jade or obsidian, or plants, such as cacao (Grove 2001:557). The appearance of the stylistically and thematically similar monumental carved stone images may have been a public symbol of participation in the Mesoamerican exchange and acquisition system. These shared symbols appear to indicate some level of Gulf Coast influence within the territory designated by the location of the stone carvings (Grove 2001:557). This type of public display could have contributed to the status and legitimacy of the local leadership and at the same time would have increased the prestige of the distant city-state of La Venta and its representatives (Helms 1993:28-51).

The network of transportation routes implied in this dispersal of stone carvings would have been used to move raw materials and finished products throughout the region. Threads of this network reached into most Formative Mesoamerican villages, facilitating an open communication system among cooperating nodes. Regions were joined in an active but variable exchange system. As the trade and exchange of ideas, technologies, and commodities increased across Mesoamerica, a symbol-laden ideological complex appears to have coalesced at major centers along the transportation network. Niederberger (1996:83) refers to this complex, found throughout the sphere of interaction, as a "pan-Mesoamerican ideological horizon." Stark (2000:40-43) has indicated that one possible reason for the development of this symbol system was an attempt to keep distant trade partnerships active and viable. Clues as to where these symbolic devices originated and how and why they radiated throughout Mesoamerica are meager and their interpretations are even more tenuous.

Record of Investigation at La Venta

The archaeological investigation of La Venta began in 1925, when Frans Blom and Oliver La Farge visited the site during their survey of southeastern Mexico for Tulane University. They partially unearthed Colossal Head 1 and Stelae 1 and 2, as well as Altars 1, 2, 3, and 4 (Blom and Farge 1926:81-90), and they attributed the monumental sculpture to the well-known Maya civilization.

Matthew Stirling began excavations at La Venta in 1942. His findings here and at the nearby sites of Tres Zapotes and San Lorenzo led him to propose that these large Gulf Coast sites were part of an archaeological culture that pre-dated the Maya (Stirling 1939, 1943). This temporal interpretation brought him scorn from Mayanists, who refused to accept the possibility of an earlier civilization. Ultimately Stirling was vindicated, but not until over a decade later, when radiocarbon dating proved the antiquity of the Gulf Coast people (Drucker *et al*. 1957).

Philip Drucker of the University of California had worked with Stirling in the field, and in 1952 Drucker published *La Venta, Tabasco, a Study of Olmec Ceramics and Art*. In the same year, he, along with Eduardo Contreras, surveyed a large portion of western Tabasco, including the area of La Venta (Drucker and Contreras 1953). In 1955, Robert Heizer and Robert Squier joined Drucker to initiate a large-scale, multi-year investigation of the site core and its support areas. The excavations moved large amounts of earth and uncovered abundant caches and offerings. Jade and greenstone beads, celts, figurines, ceramics, and other artifacts of exquisite artistry were revealed in the profuse offerings (Drucker and Heizer 1956; Drucker *et al*. 1957; Drucker *et al*. 1959). Additionally, they exposed tons of basalt, serpentine, and clay, that had been imported from great distances and transformed at La Venta into architectural and sculptural masterpieces (Stuart 1993:102-109; Williams and Heizer 1965).

These early investigators observed the contemporary surrounding swampland and suggested that the massive ceremonial complex that extended for one and a half miles in a linear north-south fashion was a secluded religious sanctuary, isolated from outside intrusion by bogs and marshes (Drucker *et al*. 1959:8). The ceremonial complex, they claimed, was uninhabited except for a few members of a priestly ruling class, who controlled a widely scattered population of farmers. These commoners were invited into the site only periodically to attend ceremonies and pay tribute to the gods and priests in the form of manual labor (Drucker 1960:59). Drucker also concluded that the widely distributed population lived and worked a substantial distance away in the uplands to the west, toward the older Gulf coast center of San Lorenzo. According to Drucker, this land was the nearest arable terrain to La Venta (Drucker and Contreras 1953; Drucker *et al*. 1959:170).

Excavations at La Venta during the 1950s and 1960s had yielded a rich archaeological record of monumental sculpture, finely crafted exotic goods, buried monumental offerings, and unrivaled architectural accomplishments (Heizer 1968; Heizer, Drucker *et al*. 1968; Heizer, Graham *et al*. 1968), but it revealed little about the lives of the people who lived and worked there. The intrusion of oil drilling and the construction of a petrochemical plant in and around the ancient site by PEMEX, the

Mexican government's giant petroleum conglomerate, prevented further investigation of the site; thus, the concept of a "vacant ceremonial center" remained for decades.

In 1984, Rebecca González Lauck, of Mexico's National Institute of Anthropology and History, initiated the "Proyecto Arqueológico La Venta" (PALV) and implemented a series of new investigations in the site center and the outlying regions. One of the most rewarding efforts of her investigations has been the expanded scope of the examination of residential areas in the site center, as well as in the surrounding countryside (Pope *et al*. 2001; Raab *et al*. 1995; Rust and Sharer 1988; Stokes 1999). Over one hundred Precolumbian settlement areas have been located within a twenty-kilometer radius of the site's core, and 58 of these have been determined to have existed during La Venta's ascendancy (González Lauck 1996b:80) (Figure 4).

The PALV projects also included an examination of the geological and environmental fluctuations that affected the formation of past and present landscapes (Rust 1992:124; Salas 1990). The results of these inquiries have opened new avenues of exploration not previously considered and have provided significant new insights into the lifeways of La Venta's urban, suburban, and rural residents.

In 1986 and 1987, William Rust, of the Department of Anthropology at the University of Pennsylvania, under the auspices of PALV, opened fourteen test excavations around the perimeter of the La Venta ceremonial district. In Complexes G and E (Figure 2), less than 120 meters from the central Pyramid C-1, he found permanent settlement features that included urn burials, ceramic offerings, house floors, storage pits, and a serpentine and greenstone workshop. This evidence produced radiocarbon dates that ranged from 1400-1120 to 910-750 cal BC (Rust 1992:125; Rust and Sharer

1988:103). For the first time, evidence was presented that indicated a substantial Middle Formative occupation of the ceremonial center. This information, combined with additional recovered evidence, showed conclusively that La Venta was not an empty center, as had been claimed by Drucker, but had evolved into a permanent and vigorous domestic settlement (Rust 1992:125; Rust and Sharer 1988:102).

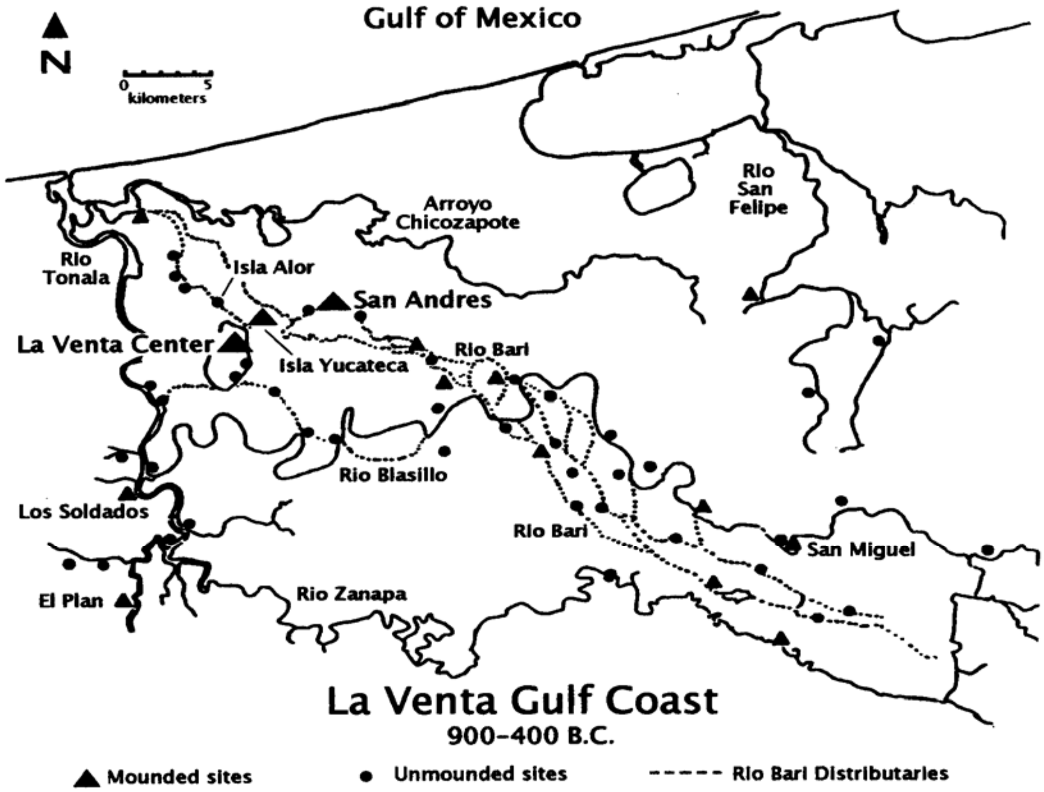


Figure 4. River levee occupational sites (adapted from Rust and Leyden 1994:182)

The discovery of residential settlements within the site core resulted in an expanded investigation into the surrounding region in an attempt to locate possible "sustaining areas" (González Lauck 1996b:80). Part of this investigation was conducted by Rust in the western uplands that Drucker had proposed as the agricultural and support zones for La Venta (Drucker 1960:60), but the results showed no occupational evidence contemporaneous with La Venta. Food production areas had to exist in order to support the now-known population of the La Venta center. If they were not in the uplands, where were they?

González Lauck noted the existence of an extinct river system from Stirling's report (Stirling 1943:50). Locally referred to as the Río Palma, it is directly north of La Venta and contains evidence of small settlements on its elevated banks (González Lauck 1996b:80). Rust turned his attention to this zone, and by using aerial photography of the region, he was able to plot the course of the ancient riverbed. His investigation focused on the levees of what he termed the "Río Barí." These levees, visible in the photographs, were present on both sides of the extinct river course and are now located in swampy lowlands. Surveys and test excavations located nine Formative period settlement areas, ranging from two to twelve kilometers away from the main center of La Venta (Figure 4). Five of these sites showed extended occupation periods during the Middle Formative period (1360 to 725 cal BC). Earlier scattered and isolated occupations dated back to 2050 cal BC. Following an extended hiatus, intermittent occupation is seen again in the Late Classic to Late Postclassic periods (cal AD 600 to 1521) (Rust and Sharer 1988; Salas 1990).

During Rust's exploration of the extinct river system area, he found evidence of earlier than expected agriculture. This discovery eventually led to the investigation of San Andrés, one of the elevated Río Barí Paleo levee sites. Mary Pohl, of the Florida State University, and Kevin Pope, of Geo Eco Arc Research, began their investigation of

San Andrés in 1997 (Pope *et al*. 2001). Work at this site has provided new evidence involving aspects of the daily life of La Venta's elite and supporting populations. Thickly stratified, *in situ,* deposits, including floors, hearths, and middens were recovered through archaeological excavation. Paleoecological data were also collected, through coring.

The Geoarchaeology of La Venta and Environs

The archaeological and paleoecological records of the site of San Andrés are crucial to this thesis in order to explain the context of the obsidian finds. To interpret the evidence from this site, it is necessary to understand the geology and hydrology of the landscape, the environment of the region, and how they changed over the millennia. The data have been recovered from a series of four deep sediment cores taken near La Venta and San Andrés.

During the Early and Middle Formative periods (2000 to 400 cal BC), significant topographical changes occurred in the La Venta area; as a result, subsequent human activity was substantially altered (Pope *et al*. 2001:3). Around 1800 cal BC, sea levels began to rise, inundating the coastal lowlands and causing the suspension of any notable human occupation for the ensuing four to five hundred years (Pope *et al*. 2000:4). The rise of sea level initiated further hydrographic activity in the area that eventually led to the formation of the Barí, a new river system within the Mezcalapa River Delta (Pope *et al*. 2000:3). Between 1000 and 900 cal BC, slightly elevated river levees and sandy point bars were created by the riverine action. The appearance of these landforms, one of which was to become San Andrés, stimulated a rapid expansion of settlement in the areas to the north and east of La Venta (Figure 4). Population densities reached their peak between 800 and 600 cal BC, a period of time when San Andrés and other riverside sites were characteristically composed of closely spaced hamlets (von Nagy *et al*. 2001:3). Around 500 cal BC, the intrusion of the Grijalva River system affected the course of the Río Barí and coincided with a significant decline in occupation at the riverine sites. By 400 cal BC, San Andrés was essentially abandoned (von Nagy 1999:13), paralleling the documented abandonment of La Venta center (González Lauck 1996b:75). Thus the rise and fall of La Venta along with its subsidiary centers was closely associated with changes in the river systems of the area.

CHAPTER 3

THE ARCHAEOLOGICAL INVESTIGATION OF SAN ANDRES

The lack of prior investigation and comparative data from Formative period Gulf Coast residential sites (Diehl 1989:25; Rust and Sharer 1988:102; von Nagy *et al*. 2001:2) has made the recent work at San Andrés particularly significant. Prior to 1984, few if any settlement studies had been conducted in the area surrounding the Gulf Coast center of La Venta. Then, under the auspices of Dr. Rebecca González Lauck, director of Proyecto Arqueológico La Venta (PALV), a concerted effort was made to determine the settlement patterns of La Venta and its surrounding "support zones" (Raab *et al*. 1995; Rust and Sharer 1988). These investigations have shown that during the Middle Formative period (1200 to 400 cal BC) La Venta was surrounded by a dense riverine settlement (Rust 1992:124-125). The farmers in these support locations must have provided sustenance to a burgeoning residential population of merchants, craftspeople, and elite, located in and around the elevated ceremonial district of La Venta (Rust 1992:125).

Settlement patterns reflected social differentiation in the Middle Formative period. San Andrés was one of nine sites identified by Rust (1988) as occupational sites located along the levees of the abandoned Río Barí. Rust proposed that around 900 cal BC, there were two basic site-types that had developed in the riverine support area: those with central mounds and those without central mounds (Rust 1992:126; Rust and Sharer 1988:104). This division now appears too simplistic, but the evidence of hierarchical settlement patterns remains significant. Rust concluded that mounded sites contained obsidian artifacts, groundstone manos and metates, figurines, and notable ceramic storage and serving vessels. Rust determined that these items exhibited a strong affinity to the material culture of La Venta and were suggestive of close elite sociopolitical affiliations between the central and outlying sites (Rust 1992:126). Von Nagy *et al*. (2001:1) further indicated that the greenstone, ceramic figurines, and imported Maya pottery connected San Andrés to La Venta's "gifting economy." They believed that the abundant ceramic record and related cultural material suggested elite ritual feasting, and self aggrandizement activities that are customarily associated with complex or paramount chiefdoms (von Nagy *et al*. 2001:1).

San Andrés is a type-site for Rust's category of sites with central mounds. To date, no intensive examination has been made of the mound structures themselves; their actual function is unknown. Isla Alor, a contemporaneous site located approximately eight kilometers downstream, is an example of a moundless site (Stokes 1999:4) (Figure 4). Both sites had dietary staples that included maize, fish, and turtle. Nevertheless, faunal material from dogs, crocodilians, and deer are common at mounded sites but have not been detected at unmounded ones. This contrast may be an indication of stratification within the La Venta region's social structure (Rust 1992:126).

During the 1997, 1998, and 2000 field seasons, the "Early Agriculture on the Gulf Coast Lowlands of Mexico Project," under the direction of Pohl and Pope, surveyed the site of San Andrés and excavated at eight locations at the site (Pope *et al*. 2000; Pope *et* *al*. 2001:1370). The placement of the eight excavation units was intended to provide a partial cross-section of this Río Barí levee site. The excavation program was designed to reach the stratigraphic levels of earliest occupation at the site and attempt to recover a "statistically significant sample" of the deeply buried cultural materials (von Nagy *et al*. 2001:4). Most of the test units extended far below the water table; four of them reached depths of 5 to 7 meters and required the use of pumps and scaffolding.

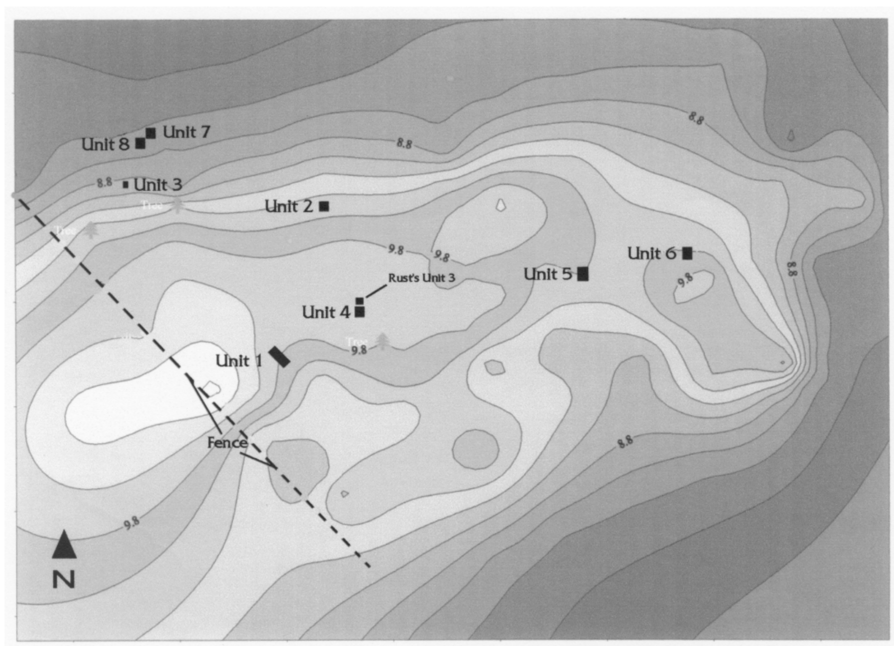


Figure 5. Preliminary map of San Andrés. Elevations are in meters (Heide and Perrett 2001).

Excavation followed the natural stratigraphy, which was further subdivided into 20 cm increments except where an archaeological feature indicated reduced excavation increments should be followed. Recovery procedures included wet screening of most excavated earth through 3mm mesh (Pope *et al*. 2001:1). Soil samples were taken at 20 cm intervals, and all cultural features were sampled for flotation (von Nagy *et al*.

2001:4). Micro-botanical, macro-botanical, and faunal remains were well preserved in the waterlogged soils and provided information on the environment and subsistence.

During the process of excavation, substantial amounts of Formative period cultural materials were recovered. This occupational evidence was retrieved from a series of midden deposits and trash-filled pits in Units 1, 7, and 8, providing an excellent opportunity to examine the material culture of the Formative period inhabitants of this site. A large ceramic sample recovered and subsequently analyzed by Christopher von Nagy of Tulane University has provided the chronological model for the site as noted above (von Nagy 1999; von Nagy *et al*. 2001). The Formative period obsidian artifacts recovered during the excavations are the focus of this thesis.

A chronology for San Andrés was determined by using a series calibrated radiocarbon dates on organic material taken from the excavations and core samples (Appendix A). These dates were then correlated with stratigraphic and ceramic cross-ties to produce a precise history of occupation at San Andrés. Three major occupational periods separated by two lengthy hiatuses have been determined (Table 1).

The excavations, together with the cores, have produced evidence of a subsistence base at San Andrés that would have provided the surplus on which a social hierarchy was built. Rust's original dates for early maize have been pushed back through pollen evidence to before 5000 cal BC. The crop continued to be significant through the Middle Formative occupation. Manioc (*Manihot* sp.) is documented by 4600 cal BC, and sunflower (*Helianthus annuus*) and cotton (*Gossypium* sp.) are also recorded at ca. 2500 cal BC. These crops likely continued to be cultivated in the Middle Formative period. Cotton in particular is documented in the sculpture as a component of elite dress.

Table 1. Occupational Chronology of San Andrés (von Nagy 2001:26)

Occupational Chronology of San Andrés

A.D. 1250 to 1520
Ahualulcos Cintla Ceramic Phase, Post Classic and Late Post Classic reoccupation

400 B.C to A.D. 1250
Hiatus with sporadic occupations

550 to 400 cal B.C.
Late Franco Ceramic Complex

650 to 550 cal B.C.
Early Franco Ceramic Complex (provisional)

750 to 650 cal B.C.
Late Puente Ceramic Complex

900 to 750 cal B.C.
Early Puente Ceramic Complex

1200 to 900 cal B.C.
Occupational hiatus attributed to rising water levels

1400 to 1200 cal B.C.
Regional Molina Ceramic Complex appears

2500 to 1400 cal B.C.
Continued occupation by modern maize, sunflower and cotton growers

5300 to 2500 cal B.C.
Pre-ceramic period, sporadic occupation by archaic maize and manioc farmers

Dates calibrated by Calib v4.2 (Bronk Ramsey 2000)

CHAPTER 4

PRECOLUMBIAN OBSIDIAN OF MESOAMERICA

John Pohl (1999:56) has remarked that the people of Mesoamerica had not so much a Stone Age culture as they did an obsidian culture. An understanding of what obsidian is, where it comes from, and how it was exploited to serve the purposes of Mesoamerican people is essential if archaeologists are to realize the types of information this material can provide. The first section of this chapter will review the significance of obsidian to Precolumbian societies as a material for utilitarian implements as well as for ceremonial and ritual items. The second section will discuss Formative period obsidian acquisition. The third segment of the chapter examines how obsidian artifacts are meaningful to the archaeological study of Formative period Mesoamerican peoples. Fourth, information is presented on the techniques of compositional and visual analysis used in the sourcing of Mesoamerican obsidian. The fifth section discusses technological typology. The final section is a review of previous projects that have attempted to source obsidian artifacts excavated at Formative period sites along the Southern Gulf Coast.

Obsidian is a natural volcanic glass produced when the intense heat and pressure of a volcano fuses masses of silica oxides together. This highly viscous, molten igneous rock (magma) pushes its way up to the earth’s surface, where it cools at differential rates, slow enough to permit the release of the lava’s vaporous components but rapid enough that its component ions do not have time to crystallize (Glascock 1994:113; Michels and Bebrich 1971:169). This process is called extrusive magma expulsion and is achieved through the flow of lava or by pyroclastic ejection of fragmented rock-like material (Glascock *et al*. 1998:16; Pastrana and Athie 2001:546).

Obsidian, usually dark and semi-translucent, is found in volcanic regions of the world, and its physical characteristics made it an excellent material for the production of tools and weapons in lithic societies. This volcanic glass is a cryptocrystalline rock that fractures conchoidally in a predictable and consistent manner, a type of fracture that creates a sharp edge unequaled by any other natural material (Glascock *et al*. 1998:16).

Obsidian's Significance to Mesoamerican Cultures

During the transitional period from the Late Archaic period to the Early Formative period (ca 2500 to 2000 cal BC), a significant shift in obsidian tool technology took place. The number of sedentary villages increased across the landscape, and a greater dependence on cultigens, such as manioc, chilies, pumpkin, chayote, and maize developed (Piperno and Pearsall 1998:297-310). This combination of events limited the majority of chipped stone tools to a non-specialized flake technology (Clark 2001b:553), in part because these food crops required only simple knives and choppers for processing.

By the Formative period, utilitarian obsidian constituted a disposable technology employed by individuals of all ages, social ranks, and genders throughout Precolumbian Mesoamerica (Moholy-Nagy 1999:300; Pohl 1999:56). Obsidian achieved a unique and venerated place both in everyday life, as knives, scrapers, and choppers, and in the realm of sacred ritual, as bloodletters and mirrors. Obsidian objects were used in burials as grave and cache offerings, crafted into jewelry, and transformed into symbolic artwork. Obsidian was one of the most extensively used lithic raw materials, and it held this significant position in all Mesoamerican societies from the Formative and Classic periods into the Spanish Colonial era (Schele and Freidel 1990:93; Sharer 1994:456).

Ritual self-sacrifice in the form of personal bloodletting was an integral part of Precolumbian cultures commonly practiced by at least 1200 to 1000 cal BC (Marcus 2001:81-82). The razor-sharp quality of obsidian made this process easier and less painful, and promoted a faster healing time (Keith Waterhouse 1997, personal communication). Among the Maya of the Classic period the obsidian lancet had evolved into a deity known as the Perforator God (cal AD 150-600)(Schele and Miller 1986:175-185).

Obsidian also appears to have been associated with Formative period rulership. At the site of La Venta, an obsidian core incised with an avian figure was found in Tomb C, or the Cist Tomb (Figure 6). Joralemon (1996:55) suggests this figure is a deity identified with rulership. At La Venta, Altar 4 is a multi-ton basalt sculpture representing a seated human figure wearing a bird headdress and feathered cape. The figure is seated under a stylized feline face that forms the top of this stone carving. At Oxtotitlan Cave in Guerrero, a human figure wears the costume and mask of a bird whose profile and pose is similar to that carved on the La Venta obsidian core. The throne upon which that figure is seated closely resembles the top of Altar 4 at La Venta. Kent Reilly (1995:41) and Joralemon (1996) explain that the iconography and avian attributes portrayed on these items were associated with rulership and ritual. They believe that the symbolism represented owls and harpy eagles, predatory birds that signified day and night. The shaman-rulers assumed the guise of these creatures to achieve the power of cosmic flight that allowed them to travel between the natural and supernatural worlds. The choice of an obsidian core for the La Venta avian deity's portrait and its subsequent burial in an elite tomb in the most sacrosanct precinct of the site demonstrate the sacredness ascribed to obsidian during the Middle Formative period (Figure 2).

Figure 6. Formative period representations of avian figures. Upper left, obsidian core from La Venta Tomb C. Note inscribed design (Pastrana 1994:26). Lower left, partial drawing of the La Venta core's incised design (Joralemon 1996:55). Upper right, drawing of figure in Mural 1, Oxtotitlan Cave, Guerrero, Mexico (Reilly 1996:39). Lower right, front of La Venta Altar 4. (Reilly 1996:26).

Obsidian was the primary material for chipped stone tools throughout Mesoamerica during the Formative period along the Gulf Coast (Hester and Shafer 2001:663; Pastrana 1994:19). The sources for this essential raw material were limited to two regional locations, the east-to-west neovolcanic chain of Central Mexico and the highland volcanic ridge running through Guatemala (Pastrana 2001:546; Pires-Ferreira 1978:52). A rapid increase in demand for obsidian may have facilitated the creation and expansion of multiple early acquisition routes to obsidian sources (Hirth 1992:19). These routes eventually expanded to cover every part of Mesoamerica and evolved in complexity to become the basis for a long-distance transportation network that would ultimately carry an extensive inventory of goods and services across the landscape (Clark 2001a:280).

Long distance exchange systems did more than expedite the movement of materials from point A to point B. Early trading participants may have been members of relatively open societies with extensive contacts. They may have entered into intra-group alliances as food procurement strategies intensified and as agricultural and trade economies evolved (Stark 2000:34). Social interaction among distant societies was a way to ensure alternative solutions to subsistence unpredictability. Movement of commodities, within or between societies, helped sustain the reciprocal dependency that could assure survival (Hirth 1984:1). Exchange or redistribution of materials could be facilitated by feasting, gaming, drinking, the gifting of prestige goods, and the exchange or movement of group members through arranged agreements or marriages (Fox 1994:202; Hill and Clark 2001:2,3; Zeitlin and Zeitlin 1996:13). Thus, the growth in size and complexity of acquisition, transfer, and exchange played a key role in the development of societies, specifically in the evolution of interaction spheres (Braswell 1994:173).

Some items acquired through exchange networks were considered necessities, such as salt or cultigens, while others were sumptuary goods, such as quetzal feathers, jade, and jaguar skins. Obsidian is unique in that it falls into both categories. It was a necessity as a cutting instrument at sites along the southern Gulf Coast because no stone was indigenous to the region. It was also an early status item when imported as prismatic blades that were then redistributed by aggrandizing individuals (Clark 1987:262; Jackson and Love 1991:48). By the Middle Formative period, obsidian was being acquired both as a raw material and as finished blades through the Mesoamerican long distance exchange network.

Models of trade and exchange within Formative period Mesoamerica have been the subject of numerous investigations and discussions (e.g., Browman 1978; Brumfiel and Earle 1987; Charlton 1984; Clark and Lee 1984; Drennan 1984; Guderjan *et al*. 1989; Hammond 1972; Hirth 1984; Nelson 1994; Pires-Ferreira 1973, 1976, 1978; Pires-Ferreira and Flannery 1976; Sanders 1984). Although there seems to be little doubt that the exchange of goods was an integral part of the pan-Mesoamerican economic system, David Grove (1987:438) states that many economic models proposed by archaeologists are too simplistic and that the motivation for exchange was more than economic or utilitarian. The marking of status and the accumulation of symbolic power among the elite may have been a more significant element of the process than the commodities themselves.

Hirth (1994) and Curtin (1984) consider elites to have been the overseers of inter-regional acquisition or exchange systems. For them, Mesoamerican trade systems are of two kinds. The first was a means of controlling access to essential utilitarian resources used by a major portion of the populace and, in this arrangement, was a basis for elite power and wealth. A second form involved elite interaction to acquire exotic sumptuary goods in order to reinforce or modify existing social hierarchies. Hirth (1994:20) identifies the former model as "resource procurement," and the latter as "status legitimation." Here again, obsidian acquisition falls into both categories.

The data on obsidian are not sufficient at present to characterize the exchange systems of the La Venta polity. Rather, this thesis focuses on acquiring initial data on sources from which models may be built in the future.

Obsidian's Significance to Archaeological Inquiry

Obsidian's natural properties make it a valuable material for archaeological inquiry. First, the virtual indestructibility of obsidian artifacts in most archaeological contexts provides an excellent record of the items used by an ancient people. Second, obsidian artifacts retain unique tangible markings created during production. Clark's replication and use-wear experiments have shown that the manufacturing technique, function, and skill of the craftsperson can be interpreted from the physical record ingrained on each artifact (Clark 1982; 1988:211-253). The technical typology for obsidian production methods used in this study was developed by Clark (1988:11-16) and is described at the end of this chapter.

Third, obsidian's tendency to absorb water over time makes it useful in determining chronometric or relative dating, depending on depositional environmental conditions. Newly exposed surfaces of obsidian begin to absorb water, and over time a "rind" or hydration layer accumulates along the edge. This layer can be microscopically measured, and thus dating can be generated. Ann Freter (1992, 1993) provides a detailed account of this complex and highly variable dating method.

Fourth, the fact that the chemical composition of obsidian from a particular source is generally homogeneous and differs significantly from other flows or sources. This condition creates a contrast between sources that can be measured and whose defining characteristics can lead to the identification of individual sources. If thorough comparative sourcing data are produced through analysis of complete or significant portions of obsidian collections from Formative period sites, details concerning acquisition, production, and distribution can be illustrated.

Sourcing Mesoamerican Obsidian

For decades, researchers have pursued fast, low-cost, and reliable methods for sourcing obsidian. The results of this pursuit have been an assortment of procedures, with varying levels of accuracy, by which the characteristics of the volcanic glass can be identified. The earliest method employed was simple visual inspection, a problematical method in and of itself. Numerous other early techniques include measurements of density, thermoluminescence, radioactivity, and magnetic properties. These procedures resulted in low reliability and lacked accurate source to source distinctions (Braswell 2000:269,270; Glascock *et al*. 1998:18).

Cann and Renfrew (1964) published an article on archaeometric obsidian sourcing. Using optical spectrography to identify the ratios of two rare trace minerals, barium and zirconium, in Mediterranean obsidian, they determined that recognition of the parts-per-million clusters could be linked to specific geologic sources. The following year, Weaver and Stross (1965) used X-ray fluorescence to identify notable differences in trace element make-up between sources in Mesoamerica. The use of obsidian sourcing methods at Formative period sites along the southern Gulf Coast of Veracruz and Tabasco soon followed (Hester *et al*. 1971; Jack and Heizer 1968).

The most accurate sourcing technique today involves an analysis of the chemical make-up of the obsidian, specifically of the trace elements. Volcanic obsidian is generally composed of five major elements: quartz, alumoxide, sodium oxide, potassium, and ironIIIoxide + ironIIoxide. The remaining trace elements are usually present in concentrations of less than 1% of the total composition. It is the measurement of these constituent trace elements and their respective contributions to the composition that provide the “finger-print,” or “signature” for individual source identifications (Clark 1988:42; Glascock *et al*. 1998:18-19; Michels, 1971:171). The more trace elements that can be identified and quantified, the more accurate the results. Although some obsidian can be heterogeneous within a flow, intra-source variability is significantly less than inter-source variability. Therefore, each source is essentially unique in its signature from others.

Two analytical methods currently favored for source determination are X-ray fluorescence spectroscopy (XRF) and neutron activation analysis (NAA) (Braswell 2000:270). The accuracy, accessibility, and accumulation of comparative data have made these two relatively comparable techniques effective for obsidian sourcing. NAA was selected for compositional testing of San Andrés obsidian, based on the rationale below.

Even though highly accurate compositional testing procedures are available today, there remain obstacles in the application of these techniques to large obsidian collections from Mesoamerica. Attempting to analyze collections solely through a chemical assay procedure, such as NAA or XRF, is expensive and difficult in the vast majority of cases. The techniques and expensive equipment required for this type of analysis are not usually available in Latin America, and most governments in Mesoamerican countries will allow only small portions of any archaeological collection to be exported for analysis. The cost of operating and maintaining research reactors and associated facilities, equipment, and personnel must be considered, as well as adherence to the strict programs and regulations required for the disposal of irradiated materials created during NAA and high-precision XRF (Braswell 2000:270). To meet these expenses, fees must be paid for each item analyzed. Currently, prices can range from $15.00 to $45.00 per specimen, an expenditure that prohibits the sourcing of more than a few hundred specimens from any one collection that may include thousands, perhaps tens of thousands, of pieces.

To overcome the difficulties outlined above, the investigator must develop a sampling strategy that will most accurately provide the types of information desired in the research study. Detailed economic analysis is possible only when the obsidian study involves the majority of the collection and includes all artifact types (Braswell 2000:270). Whenever possible, the ultimate goal of obsidian sourcing methodologies would be to analyze each specimen within a collection and assign it accurately to a specific source location. When sourcing a complete collection is not possible, the largest feasible sample should be examined. The efficacy and potential benefits of analyzing large collections are documented by the work of Clark (1988), with 5749 specimens from La Libertad, Peraza Lope (Braswell 2001:19), with more than 14,000 specimens from Mayapan, and Aoyama (1999) with 91,916 specimens of chipped stone from the Copán Valley and La Entrada region of Honduras.

At this point in time, it does not appear that a single technique or technology by itself will accomplish the goal of large-scale analysis. A combination of methods, however, has shown excellent results with accuracy rates greater than 90%. An accurate sourcing of entire collections can be attained by combining chemical assay techniques with visual identification procedures (Braswell 2000:276; Clark 1988:42; Tykot and Ammerman 1997:1006). This combination of procedures was utilized in the analysis of the San Andrés obsidian collection that is the subject of the following chapter.

Neutron Activation Analysis

Over the past twenty-five years, substantial advances have been made in the chemical assay of obsidian (Glascock *et al*. 1998:24-32). Neutron activation analysis (NAA) is successful due to its ability to measure several elements that are critical to obsidian source identification simultaneously and discretely, regardless of artifact size and matrix (Clark 1988:42; Glascock *et al*. 1998:19; Tykot and Ammerman 1997). NAA procedures have become so accurate that, in some cases, specific quarry and workshop locations within a single source area can be determined (Glascock *et al*. 1998:61).

NAA procedures require that samples be irradiated by thermal neutrons. The neutrons captured by the nuclei of the atoms within the sample activate the nuclei, causing them to become unstable and to begin emitting gamma rays at energy levels particular to the specific radioactive nuclei. Radioactive nuclei are identified by measuring their gamma ray energy levels; assessment of these intensity levels allows for a quantitative analysis of specific elements contained within the specimen. This process is accomplished through multiple irradiations, allowing a period of decay, and then measuring the various elements in the specimen.

NAA enables the identification of up to twenty-seven separate elements that, if necessary, can be further enhanced to refine particular subsets within an element. NAA procedures on obsidian can determine a larger number of elements with a finer degree of sensitivity and accuracy than any other methods (Glascock 2001; Glascock *et al*. 1998:20-24). Nevertheless, the expense of complete NAA procedures is often not necessary; the source of most Mesoamerican obsidian specimens can be determined through an abbreviated-NAA procedure that reduces costs and provides a more prompt and efficient analysis without sacrificing accuracy (Braswell 2000:57; Glascock 1994:124; Glascock *et al*. 1998:57-61). This short irradiation procedure ensures an accuracy level in the 95% confidence range. Any dubious results can be submitted to the long irradiation procedure for conclusive testing if required (Glascock 2001).

The Missouri University Research Reactor (MURR), under the direction of Dr. Michael D. Glascock, was selected to analyze the San Andrés material for several reasons. Missouri has had extensive experience in the investigation of Mesoamerican obsidian, in both large and small projects (Braswell 1994:178; 2000:270; Cobean *et al*. 1991:70-73; Glascock 2001; Glascock *et al*. 1998:33-57). MURR's database on primary and secondary obsidian sources is the most comprehensive accumulation of New World obsidian source data in existence (Cobean *et al*. 1991; Glascock *et al.* 1994:119-120). Detailed information on NAA procedures is available at http://web.missouri.edu/

~glascock/archlab.html.

Another significant reason MURR was selected for this analysis was their participation in a National Science Foundation funding program (Grant SBR-9802366) that allows projects approved by the MURR Board of Directors to qualify for substantial cost reduction. In the case of the San Andrés specimens, the researcher was granted a reduction from the standard $45.00 per sample cost to a $15.00 per sample cost.

Visual Sourcing of Obsidian

An approach to obsidian sourcing that combines acute macroscopic visual observation with methods of compositional analysis, in this case neutron activation analysis, can substantially assist in resolving problematic issues and can provide an efficient and accurate sourcing methodology to obtain information for entire obsidian collections (Tykot 1998:79; Weisler and Clague 1998). Studies by Aoyama (1994,1999), Braswell (1994, 2000), Clark (1978, 1988), Darling (1999), Grove (1987:380-383), McKillop (1995), Tykot (1997), Tykot and Ammerman (1998), and others have shown the success and efficacy of this type of methodological approach.

Tests to determine the accuracy of visual attribution were conducted by Ammerman on obsidian from an ancient site in Calabria, Italy, were successful (Ammerman 1979). His results indicated that initial visual distinctions between different source material provided a statistically higher success rate than those made on the basis of chance or random selection. Ammerman adds that visual sourcing is pragmatic when applied to large sets of lithic material and that small quantities from secondary sources have a greater likelihood of being detected and submitted for compositional analysis (Ammerman 1979:99). Weisler and Clague (Weisler and Clague 1998) also conducted tests to determine the accuracy of visual sourcing within a specific collection of obsidian from Polynesia. Their tests resulted in perfect accuracy of source determination and were verified by energy dispersive x-ray fluorescence, another form of compositional analysis. Braswell (2000) has substantiated the accuracy of visual source attribution of Mesoamerican obsidian.

The visual identification of obsidian by source is comparable to the identification of ceramics: both take a high degree of preparedness but can produce precise, reproducible results. Specific optical criteria for obsidian identification can be identified and results can be duplicated by other researchers (Braswell 1994; 2000:279; Clark 1978). An effective methodology for sourcing an entire collection of obsidian artifacts requires a combination of multiple intensive visual observations, compositional analyses, and comparison with a source reference collection (Braswell 2000).

Visual source identification is possible only when certain prerequisites are met: (1) the geology of the source regions is recognized and understood; (2) the archaeological sources of obsidian have been thoroughly documented; and (3) the artifacts to be sourced have unique macroscopic attributes (Weisler and Clague 1998:109). The obsidian collection from San Andrés meets these requirements for accurate visual sourcing. The visual identification of the collection was complemented by compositional analysis.

Analytical Conditions. The visual criteria employed for the San Andrés obsidian specimens are similar to those presented by Braswell (2000:270-272). To obtain the most accurate results when developing visual classifications, consistency and uniformity are essential, both in the material sampled and in the conditions under which they were analyzed. The use of uniform fluorescent lighting during the macroscopic analysis provided a degree of consistency for comparison, as did the use of a white background for reflected and refracted light comparisons. Sunlight and incandescent light were also employed for specialized resolution.

Microcrystalline Properties. During volcanic activity, molten magma is transformed through an accelerated process of solidification caused by rapid cooling. Chemical compounds contained within the magma may begin to crystallize, forming crystallites, microlites, and other light-refracting structures. These incipient crystals are solidified at varied stages, ranging from amorphous to crystalline states, and are referred to as microcrystalline inclusions (Michels and Bebrich 1971:171-172). Some obsidian sources contain a variety of these inclusions, some contain only one, and some contain none.

Macroscopic Properties. Multiple graduated types of banding, clouding, mottling, surface texture, and color are present in obsidian and can be observed on a macroscopic level. The color of obsidian is a result of the chemical composition and physical properties involved during the solidification process (Michels and Bebrich 1971:173). The size, quantity, and distribution of minute inclusions within obsidian flows affect the light refraction, producing a variety of color values and degrees of optical opacity. These macroscopic inclusions are referred to as particulates. The density of the particulates can range from virtually clear to opaque; they affect the value of the color without a meaningful change of hue. These variations assist in the visual identification of obsidian from specific sources. The combination of microcrystalline and macroscopic properties provides a visual fingerprint, normally unique to each source that can be identified and classified.

Technical Typology

The terminology used in this thesis to type obsidian specimens is based on a technical typology proposed by John Clark (1988:11-48,211-219). This typology classifies and describes each item of obsidian in terms of the production sequence of the artifact, and is a continuation of the studies begun by Don Crabtree (1968), Payson Sheets (1992), and others. The typology includes not only finished products, but items that are considered by-products, refuse, or debitage.

The working or “knapping” of obsidian is an irreversible breaking of the stone in a specified manner to form a tool or implement. Because the stone is constantly being diminished in size, the process is reductive. Each product removed from the original core stone, as well as the core itself, retains and exhibits unique attributes that are indicative of the manufacturing technique used. These attributes include a positive record of the fracture on the ventral surface of the detached piece and a negative record left on the core. The specific attributes on the detached piece are dependent on the manufacturing technique and on the type, direction, and force exerted.

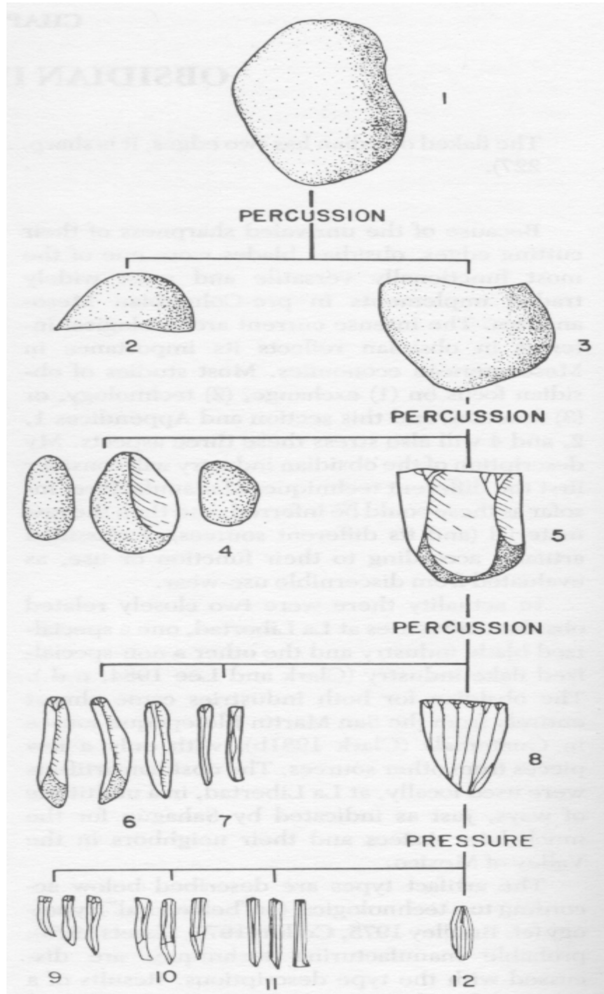
Each of the various product groups produced from the core involves sequential and repetitive steps that are dependent upon the manufacturing technique employed. These product groups can be identified by their method of sequential detachment from the core and are considered the technological types. Mesoamerican obsidian production is composed of two manufacturing techniques or industries, the blade and the flake industries. Each possesses its own characteristic technological types.

The Blade Industry

The production of obsidian blades is considered a specialized procedure. The steps involved in the production of blades are illustrated in Figure 7. The original nodule of raw material is generally broken in order to produce a flat surface or platform from which blades will be detached by percussion or pressure. The core is further modified by the removal of decortation flakes, which encircle the rough core and contain the stone's natural cortex. Macroflakes are the result of additional core shaping.

A striking force, generally with a hammerstone, produces percussion-type blades that are differentiated by size, such as large macroblades and small percussion blades. They are removed from the macrocore until the core is reduced to a size and form that facilitates the implementation of a pressure technique that produces prismatic blades. Except for prismatic blades, all of the above procedures are accomplished by direct or indirect percussion. The segments of all blades, regardless of production method, are identified as proximal (the platform end), medial (the central portion), and distal (the end opposite the platform) (Figure 8).

First-series blades are the ones removed initially from the polyhedral core, in a sequential, circular order. These first-series blades are identified by the preservation of percussion scars on the dorsal surface of the proximal end, scars that are created by the detachment of the final series of percussion blades. Similarly, the bulbar characteristics and pressure scars remain on the ventral surface. These blades are usually shorter andmore irregular in shape than later series blades. This fact is due to the initial conical



1-Large nodule of raw obsidian. 2-Platform preparation flake. 3-Core Pre-form. 4-Macroflakes. 5-Macrocore. 6-Macroblades. 7-Small percussion blades. 8-Large polyhedral core. 9-First-series blades. 10-Second-series blades. 11-Third-series blades. 12-Exhausted polyhedral core.

Figure 7. Schematic representation of Mesoamerican blade industries (Clark 1988:12).

shape of the polyhedral core. As the sequence continues around the perimeter of the core, the core becomes more elongated, producing a longer and finer blade.

Second series blades, or those from the subsequent ring around the perimeter of the core, can be identified by their greater length and the partial percussion scars not removed by the first-series blades. These scars are generally found toward the distal end of the blade. The third, fourth, and following series blades become virtually indistinguishable from one another and are identified as final-series blades.

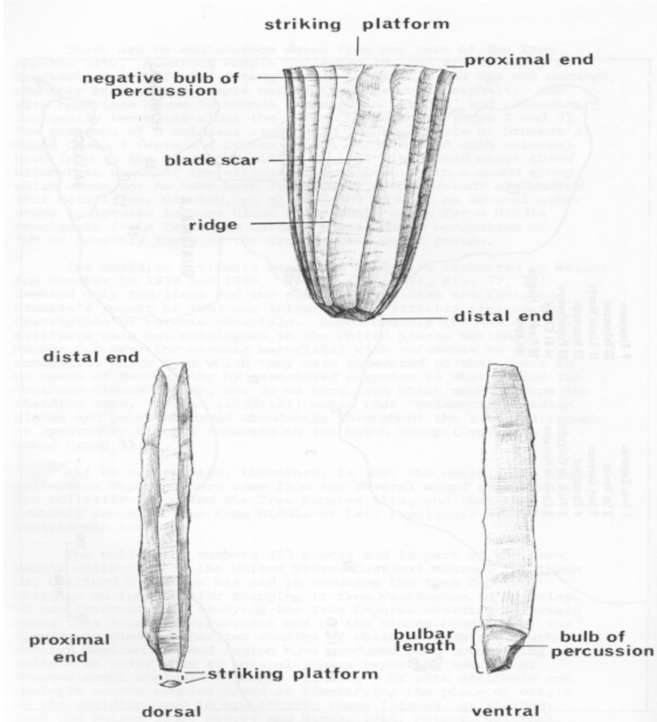


Figure 8. Identification of core and blade parts (Hester 1971:82).

The blades recovered at San Andrés include portions of macroblades; small percussion blades; and first, second, and third series blades. Evidence indicates that preparation phases for the production of blades, including platform preparation, cortex removal (decortation flakes), core preforming, macroflakes, macrocores, and polyhedral cores, has not been found in the material excavated at San Andrés. This lack of production evidence may be due to the limited excavation area; perhaps, a blade workshop with these distinguishing components does exist at the site. More likely, this situation is a result of the fact that only finished products (blades) were imported.

Pressure produced prismatic blades are a technological advancement over flaked edges (Figure 10). Clark (2001:554) states that prismatic blades first appeared in the

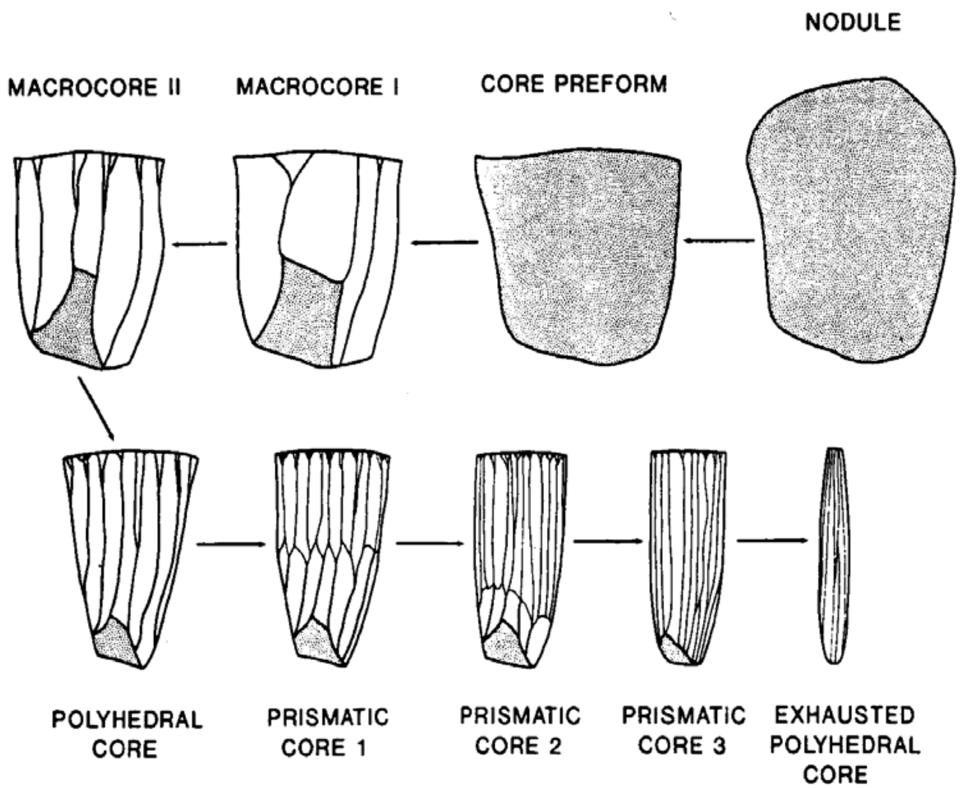


Figure 9. Schematic view of the core-reduction sequence during production of prismatic blades (Clark and Bryant 1997:115).

Early Formative period around 1400 cal BC. At this time, blades were manufactured at the quarry sites and exported to the Gulf Coast Lowlands as finished products. Beginning in the Middle Formative period (ca 1000 cal BC), production and exchange shifted, and macrocores became items for export to polities that would now require their own blade-makers. This timeline puts the early La Venta site squarely in the transitional period, and evidence shows that blade production took place at La Venta, most likely at Complex C, D, and H, according to the quantities of blades, core rejuvenation flakes, and other prismatic blade production debris found at these localities (Chávez 1990:26-27).

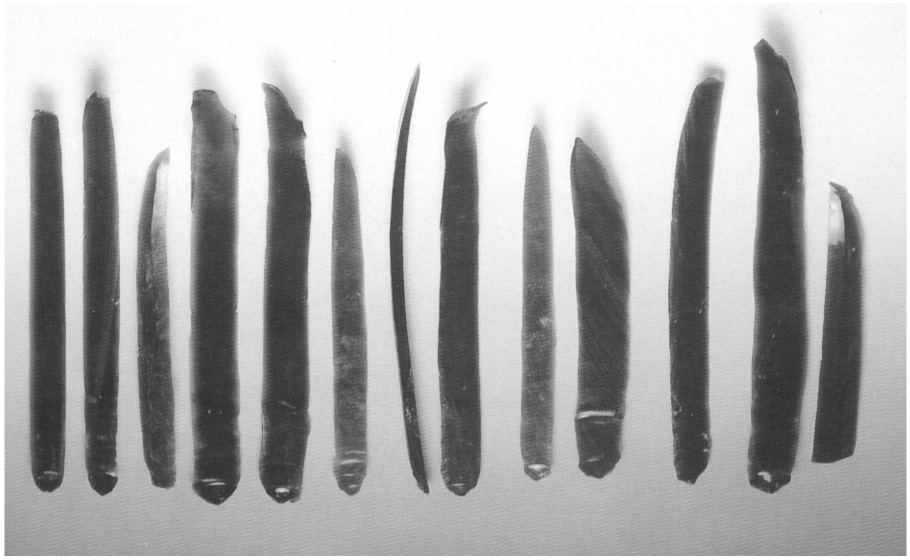


Figure 10. Examples of Mesoamerican prismatic obsidian blades (Clark 1994:46)

There is no evidence of blade manufacture at San Andrés, and finished blades may have been distributed from one of the elite areas of the La Venta urban center. At La Venta, evidence for flake and bipolar percussion is present in the form of resultant debitage material, hammerstones, and anvils (Chávez 1990:27-29). It should be noted that obsidian from practically any source is sufficient for use in a flake tool industry. The production of blades, however, requires a high quality of glass, and some Mesoamerican sources do not meet this standard (Jackson and Love 1991:53).

The Flake Industry

The flaking process is simple and unspecialized; the resulting sharp flakes and fragments are also uncomplicated but adequate and efficient (Figure 11). Sharp-edged flakes are detached from a spall by hammerstone percussion. Clark identifies a spall as a large chunk of obsidian that is either human-made or natural (Clark 1988:15). The term “spall” allows differentiation from an intentionally prepared core used in the blade industry. There is no set pattern involved in this reduction procedure, and flakes are detached by direct percussion to any portion of the spall.

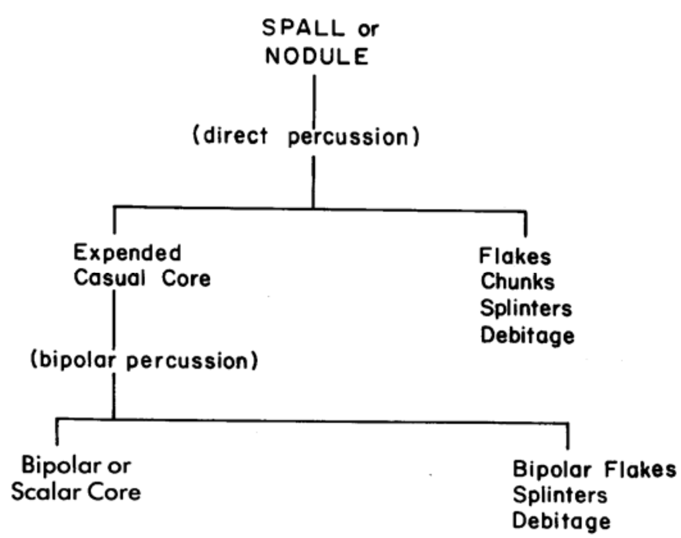


Figure 11. General behavioral model of Mesoamerican flake industries (Clark 1988:13).

Bipolar Percussion

Bipolar percussion is a specific technique used in the flake industry. The abundance of bipolarly produced obsidian artifacts used at San Andrés demands that a more specific description be given. This simple technique involves placing the obsidian piece that is to be flaked on an anvil, usually another rock or stone, and then striking the piece with a hammerstone (Figure 12). Bipolar percussion is basically a shattering of any piece of obsidian and is an effective method for producing additional sharp edges from new or used pieces of obsidian. Objects produced by this technique are detectable by the percussion or shatter marks left on both ends of the product.

Clark (Clark 1988:219) has demonstrated that the bipolar technique is useful in reducing small pieces of obsidian into usable flakes. The method is a non-wasteful and efficient procedure for producing more sharp edges from material that would not otherwise be usable.

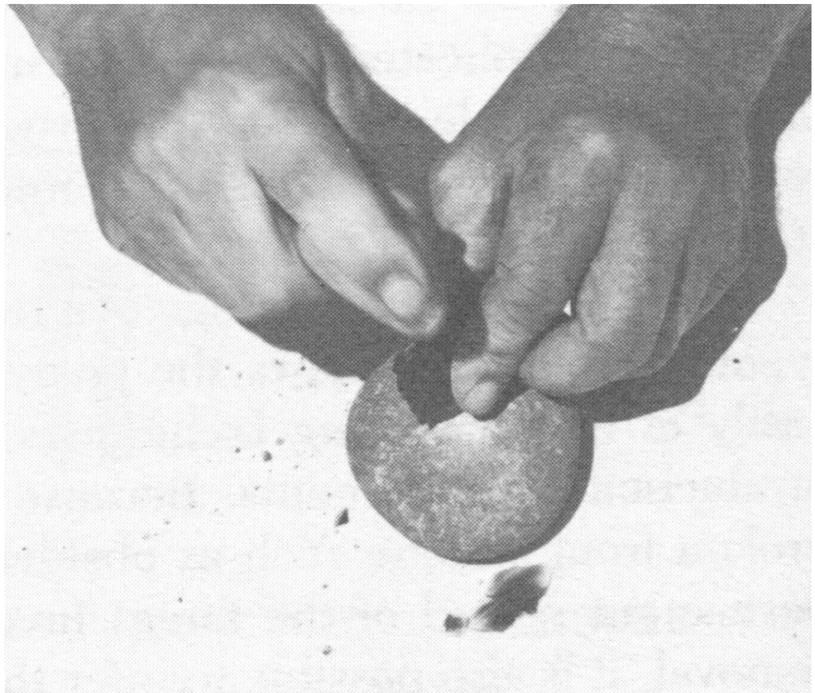


Figure 12. Example of bipolar percussion. The obsidian is held on top of the anvil stone and struck with the hammerstone (Clark 1988:14)

Bipolar cores are pieces of obsidian from which bipolar flakes have been removed. As more and more bipolar flakes are detached, the piece becomes thin and rectangular in shape. When the bipolar core becomes too thin for flakes to be removed from the face of the stone, the corner is detached. This detached corner is referred to as a bipolar corner flake; it is an indication of maximum utilization of a piece of obsidian material. Additional typological categories include fragments, which are pieces of flakes or cores. Flake fragments possess no bulges or bulbs indicative of applied force; if a bulb of force is present, the piece is considered a flake, not a fragment.

Previous Formative Period Obsidian Source Studies

Previous studies aimed at sourcing Formative period Mesoamerican obsidian artifacts can be divided into early studies, those prior to 1980, and examinations conducted after 1980, when a flow of new sourcing data and advancements in compositional analysis were produced. There are two main conclusions from all of these earlier obsidian studies that were based on excavated material. First, the urban centers of San Lorenzo, La Venta, Tres Zapotes, and Chalcatzingo, received the majority of their obsidian material from one or two separate sources. Second, it appears that these primary sources were different at each site (Cobean *et al*. 1971:84; Grove 1987:380-383; Jack *et al*. 1972:137; Stokes 1999:11). A secondary conclusion is that a series of minor sources was also present at each site. All of these determinations are supported by the findings at San Andrés.

The conclusions relating Formative period centers to obsidian sources indicate the advantages inherent in the study of obsidian. Even so, most earlier obsidian studies have not fully analyzed the obsidian artifacts. Clark (1988:1) states that the full potential of obsidian analysis is generally not obtained. He attributes this unfulfilled capability to two major factors; one, obsidian artifacts have been deemed unsuitable for detailed analysis because of their sheer quantity and assumed uniformity; and two, the obsidian material has been examined in an incomplete way. These factors have led to incorrect assumptions regarding obsidian's role in economic and societal development (Braswell 1994:187; Clark 1986; Glascock *et al*. 1998:20-22). Another reason for inaccurate or incomplete data was the technological limitations of compositional sourcing techniques that hindered early attempts at sourcing, and cursory examinations did not attempt to extract all the information present in an obsidian collection.

There are five reasons leading to the drawbacks outlined above. First, consideration was not given to the entire collection even when possible; second, chronological and stratigraphic controls were not employed; third, no evaluation was made as to production techniques; fourth, cultural contexts were not observed; and finally, compositional sourcing was not visually extrapolated to the entire collection. Basic evidence derived from using all of these techniques is required to draw fundamental inferences concerning artifact acquisition, production, and function. Future accumulation of these data will eventually allow more accurate estimations of the social, political, and economic impact obsidian had during the Formative period.

The limitations inherent in earlier sourcing studies led to inaccurate or incomplete results. This situation has been remedied by a clearer understanding of the chemical deviations between intersource and intrasource obsidian, the ability to determine more trace elements, and better interpretation of the compositional data (Braswell *et al*. 2000:270). Today, all the major obsidian sources in Mesoamerica are known and can be identified by elemental analysis (Glascock *et al*. 1998:16-17).

Early Sourcing Studies

Robert Jack, Thomas Hester, and Robert Heizer (Jack and Heizer 1968; Jack *et al*. 1972) reported on their sourcing of obsidian artifacts from a number of sites in northern and central Veracruz, Mexico, using x-ray fluorescence. Their analysis of 19 obsidian blades excavated in 1967 and 1968, near the Middle Formative Stirling Acropolis at La Venta (Figure 2), showed that a Guatemalan source, most likely San Martín Jilotepeque

(Sisson 1976:574), and an “unknown source” were the major contributors to the ceremonial center’s obsidian. Pachuca and El Chayal obsidian were identified as minor suppliers. Obsidian from the Middle to Late Formative site of Tres Zapotes was analyzed by Jack and Heizer (1968); their results indicated that the Zaragoza, Puebla, source was the main supplier, with Orizaba, Guadelupe Victoria, and Pachuca also contributing along with up to possibly four other unknown sources.

Another early sourcing project conducted by Robert Cobean (1971) used x-ray fluorescence to analyze 201 obsidian specimens from Early Formative San Lorenzo. This analysis determined that the Guadelupe Victoria source, in Puebla, Mexico, was the primary supplier of material at the site during its period of ascendancy as a major Gulf Coast urban center (ca. 1380-1010 cal BC). Obsidian from El Chayal, in Guatemala, and Otumba, in the State of Mexico, were secondary sources. These conclusions were corroborated by later neutron activation analysis procedures on an additional 65 artifacts from San Lorenzo (Cobean *et al*. 1991:84).

Edward Sisson (1976:562-578) presented the results of 91 obsidian specimens tested by neutron activation analysis from seven small Formative period sites in the northwestern portion of the Chontalpa region. These sites are located approximately 25 to 50 kilometers east of La Venta. Sisson’s Formative period obsidian material is significant because it was collected from smaller peripheral sites that he considered were dependent on larger centers, such as La Venta or even possibly San Lorenzo (Sisson 1976:568). Guadelupe Victoria was identified as the major provider of obsidian to these sites during the Early Formative period; El Chayal, San Martín Jilotepeque, and Zinapécuaro in Michoacán (today, known as the Ucaréo-Zinapécuaro complex [Pastrana and Athie 2001:549]) were considered to be secondary sources. By the Middle Formative period, the list of suppliers had changed; Guadelupe Victoria was still represented, but Pachuca, Otumba, and an "unknown source" were also present (Sisson 1976:565,566).

Later Sourcing Studies

Chalcatzingo, in Puebla, southwest of the Gulf Coast region, is a site contemporaneous with La Venta. David Grove (1987:380-383) and associates have used visual observations to sort obsidian artifacts from different activity areas at the site and to select specimens for neutron activation analysis. The results of their examination indicate that Otumba and Paredón materials dominate the collections, and Pachuca material is minimally represented.

Middle Formative period burials at the site of Copán, in western Honduras, contained ceramics, greenstone, and iconography associated with the Gulf Coast (Fash 1991:67-70). Aoyama (1999:59-69), using visual criteria and neutron activation analysis, examined 2,014 obsidian artifacts from this region that dated from 900 to 300 cal BC. He found 99.5% of the obsidian was from Ixtepeque, a source close to the border between Guatemala and Honduras. Six pieces were from the local La Esperanza source, and four were from El Chayal, in central Guatemala. The overall low percentage of prismatic blades (2.7%), as well as a substantial percentage of artifacts containing cortex (20.5%), suggests the raw material had been imported primarily as large flake spalls or small nodules during this period (Aoyama 1999:63). Procurement activities, production techniques, tool functions, and relationships to associated cultural material were also part of Aoyama's examination. From this comprehensive approach, he has been able to discern patterns regarding exchange, manufacture, and use from the Early Formative period (1800-1200 cal BC) through the Early Postclassic period (cal AD 900-1200).

Brian Stokes (1999) reported on thirteen pieces of Formative period obsidian recovered from Isla Alor, an unmounded Río Barí site, downstream from both San Andrés and La Venta (Figure 4). Stokes analyzed five pieces of Formative period Isla Alor material through x-ray fluorescence. One piece was assigned to Zaragoza and four to the Otumba source (Stokes 1999:18).

A recent survey made of the Tuxtla Mountain region (Santley *et al*. 2001) included Early and Middle Formative period obsidian artifacts from Matacapan, La Joya, and Bezuapan, Veracruz, approximately 130 kilometers west-northwest of La Venta. Some 200 samples, out of 23,700 specimens, were selected by their visual characteristics in an attempt to include all possible sources. The source attributions were then determined by neutron activation analysis. It was concluded that during the Early Formative period (ca 1800-1200 cal BC) Guadelupe Victoria, Zaragoza, Orizaba, and Paredón obsidians had been imported. During the Middle Formative period (1200-400 cal BC), Guadelupe Victoria and Orizaba material was still used, but obsidian from Paredón and Zaragoza was replaced by material from San Martín, Guatemala.

Despite the limitations of some of the early techniques, the data show how widespread the obsidian exchange networks were during the Formative period. These examinations also indicate that a limited number of sources dominated the obsidian material, but the primary sources differed between the major centers. Techniques available today may make a re-analysis of some of these earlier efforts more conclusive.

CHAPTER 5

THE SAN ANDRES OBSIDIAN RESEARCH PROJECT

This chapter begins with a description of the San Andrés obsidian collection and the objectives of the research project. An account of the procedures and methodologies employed in this project to determine sources, production methods, and use-wear patterns is then presented. The process for selecting obsidian specimens for neutron activation analysis and the determination of visual criteria for San Andrés obsidian sources are described. A discussion of the results of these analyses and their extrapolation to the remainder of the collection follows. The production and reduction strategies employed on obsidian artifacts from the site and the presumption of tool function conclude the chapter.

The entire obsidian collection generated from the excavations at San Andrés in 1997 and 1998 is composed of 835 pieces, with a total weight of 670.0 grams. For this Formative period research project, 199 pieces, weighing 165.2 grams, were eliminated from consideration because they dated to the Post-Classic period or later (AD 1200+), or had equivocal chronological provenience due to wall collapses during excavation. No obsidian from the Late Formative to the Middle Postclassic periods (ca 400 cal BC to A.D. 1200) was encountered because of the extended hiatus at the site (von Nagy *et al*.

2001:5-7) (Table 1). The obsidian used in this project, corresponding to the Formative period, amounted to 636 pieces, weighing 504.8 grams and covering a time span from approximately 1400 to 400 cal BC.

The primary objective of this project was to determine the source of each specimen of Formative period obsidian recovered at San Andrés and to correlate those results with the chronological time frame developed for the site. Secondary objectives included the recognition of the contextual situations in which the artifacts were encountered, the identification of the manufacturing technologies employed, and the function of the artifacts. This investigation provides the data needed to observe diachronically the import, use, and deposition of obsidian material at San Andrés. These findings can then be compared to the ascension, reign, and decline of the nearby major Gulf Coast center of La Venta between 900 and 400 cal BC, to discern possible patterns of influence.

Analytical Procedures

In May 2000, this researcher sorted all the obsidian artifacts recovered at San Andrés, according to stratigraphic levels within each of the units of excavation. The material was further sorted according to the site's tentative chronology; the later, non-Formative period and equivocal specimens were removed. The remaining artifacts were then examined macroscopically (10x magnification) under fluorescent and diffused sunlight, in a procedure similar to that of Cobean and colleagues (1971:667) for San Lorenzo obsidian and of Braswell (1994:179-180) for Quelepa, El Salvador, obsidian. The intent of this initial observation was to distinguish visually differences in color, texture, and inclusions, in an attempt to determine the largest number of possible sources in the collection, the same goal that David Grove had when he visually sorted the obsidian from Chalcatzingo (Grove 1987:380). As a result of this procedure, 20 individual specimens were chosen to be submitted for NAA to determine the place of origin. The visual analysis and selection was performed at the New World Archaeological Foundation (NWAF) Laboratory in San Cristóbal de Las Casas, Chiapas, Mexico, where the San Andrés obsidian collection is in storage. In July, 2000, during a visit to the NWAF, John E. Clark, of Brigham Young University, also examined, weighed, and analyzed the collection for use-wear patterns and methods of manufacture. The Instituto Nacional de Antropología e Historia (INAH) approved the export of the 20 NAA obsidian samples to the United States. This researcher reviewed the test samples at Florida State University in September, 2000, with assistance from Clark.

The 20 test samples were sent to the Missouri University Research Reactor in October 2000, where they underwent an abbreviated-NAA procedure. In March, 2001, this researcher returned to the NWAF laboratory in San Cristóbal with the NAA results (Table 3) and the unused portions of the test samples to compare and identify the remainder of the collection visually. Multiple, intensive, macroscopic comparisons were made between the NAA material and each individual piece in the project's collection, according to the set of visual criteria presented in Table 4.

The first round of the combined NAA and visual analysis allowed the majority of pieces to be assigned to specific sources. Familiarity with the collection developed as a result of continual handling of the material and repeated close observation. The 20 NAA samples became the comparative collection for the remainder of the assemblage. Added to this visual comparative reference set were samples the researcher had collected from the Precolumbian obsidian sources of Ixtepeque, El Chayal, and San Martín Jilotepeque in Guatemala, together with material from Cerro de las Navajas and Paredón in Mexico.

Upon conclusion of the re-analysis of the collection, an additional 12 pieces were selected for a second round of NAA. Of those, six items were selected because of their visual distinction from the remainder of the collection, and six more specimens were selected to verify the comparative assumptions the researcher had made visually. When results of this second round of NAA were received (Tables 2 and 3), final comparisons and determinations were made for the entire Formative period collection (Appendix A, Table 13).

Neutron Activation Analysis of San Andrés Obsidian

According to the report of research results received from Michael Glascock (2001) of the Missouri University Research Reactor, the initial 20 samples were prepared for testing by slicing off ~100 mg portions, which were further reduced to ~25 mg in weight. The samples were placed in high-purity polyethylene vials and subjected to abbreviated neutron activation analysis.

This short procedure irradiated the samples for five seconds in a thermal neutron flux of $8x10^{13}$ neutrons cm^{-2} s^{-1}. Following irradiation, the samples were allowed to decay for twenty-five minutes and then were mounted in a fixed position in front of a high-purity germanium (HPGe) detector. Six radioactive elements (barium, chlorine, dysprosium, potassium, manganese, and sodium) were measured for twelve minutes. It was found that the element Ba was below the detection level in about half the artifacts.

Note that the zero listed in Table 2 for several barium measurements is intended to indicate that the elements are below the detection level, rather than an actual concentration of zero parts per million.

Following the measurement of the five elements, a comparison between the San Andrés artifacts and MURR's Mexican and Guatemalan source database was made. The elemental signature of each artifact was overlaid on a plot of manganese versus sodium to contrast them against known sources, and 18 of the initial 20 specimens fell within the 95% confidence range.

Table 2. Concentrations of elements measured by abbreviated-NAA.

SAMPLE ID	Ba (ppm)	Cl (ppm)	Dy(ppm)	K (%)	Mn (ppm)	Na (%)
	Barium	Chlorine	Dysprosium	Potassium	Manganese	Sodium
TFD001	0	348	4.00	3.88	173	2.83
TFD002	552	405	1.25	3.73	562	3.18
TFD003	824	434	1.84	5.08	543	2.33
TFD004	0	995	6.91	3.93	362	2.94
TFD005	0	957	6.99	3.85	379	3.04
TFD006	0	1012	7.78	4.16	364	2.95
TFD007	0	361	3.72	3.96	170	2.79
TFD008	0	1032	7.79	4.25	366	2.94
TFD009	0	1016	7.73	4.58	361	2.86
TFD010	666	395	1.71	3.66	554	3.17
TFD011	1029	1204	1.44	3.25	636	3.28
TFD012	0	1026	7.28	4.14	362	2.94
TFD013	468	592	4.60	3.81	247	2.92
TFD014	707	326	1.69	3.53	554	3.14
TFD015	0	960	6.92	4.20	366	2.95
TFD016	470	482	3.92	4.24	253	2.96
TFD017	0	1296	15.19	3.26	1157	3.82
TFD018	1179	547	1.87	2.92	532	2.85
TFD019	415	621	4.18	4.16	255	3.00
TFD020	1013	459	1.95	3.14	529	2.85
TFD021	574.2	535	5.19	4.66	253	2.79
TFD022	701.1	303	2.18	3.52	558	3.13
TFD023	0.0	929	7.62	4.34	367	2.97
TFD024	124.4	887	8.46	5.32	356	2.33
TFD025	562.2	562	4.78	4.14	252	2.92
TFD026	48.1	881	7.30	4.59	361	2.78
TFD027	118.7	732	7.77	3.98	366	2.92
TFD028	568.1	566	5.08	4.07	267	2.94
TFD029	133.5	869	7.62	4.19	377	3.05
TFD030	894.5	432	3.31	3.58	394	3.02
TFD031	929.7	472	2.98	3.30	649	3.04
TFD032	1220.8	482	2.08	3.49	537	2.81

The two remaining artifacts, TFD011 and TFD003, contained anomalies that required additional comparison. Sample TFD011 is consistent with El Chayal, but it has a slightly higher than usual sodium concentration. The high barium count (>1000 ppm) is an indicator of Guatemalan origin. Further elemental comparison determined that Tajumulco (TAJ), in western Guatemala, is a probable source for this sample. Dr. Glascock (2001) has suggested that a long irradiation procedure be run on this piece to verify the source assignment.

Artifact TFD003 contains a low concentration of Na and a higher concentration of K than the normal profile for San Martín Jilotepeque (SMJ) material. This effect has been noticed in a number of samples tested previously that were ultimately sourced to San Martín. It should be further noted that the SMJ source area is extensive, and numerous workshop and quarry areas have been confirmed at distant locations (Braswell 2000:2), raising the possibility of greater than normal heterogeneity within the entire flow. Additionally, the visual identification of SMJ obsidian is considered exceptionally accurate due to the distinctiveness of the glass's surface texture (Braswell 2000:276), verified by the fact that TFD003 was visually identified as SMJ in three separate test observations. Based on this information, the sample has been assigned to SMJ.

The second round of NAA procedures provided an additional obsidian source to the collection and verified earlier visual assumptions and assignments. Based on abbreviated-NAA procedures, determinations were made for the source of each of the 32 samples from San Andrés. The results are shown in Table 3.

Table 3. NAA source identification of San Andrés samples.

MURR ID	NAA SOURCE ATTRIBUTION	SAN ANDRES FS#
TFD001	UCAREO, MICHOACAN, MEXICO	498
TFD002	PICO DE ORIZABA, VERCRUZ, MEXICO	617
TFD003	SAN MARTÍN JILOTEPEQUE I, GUATEMALA	872
TFD004	PAREDON, PUEBLA, MEXICO	460
TFD005	PAREDON, PUEBLA, MEXICO	266
TFD006	PAREDON, PUEBLA, MEXICO	536
TFD007	UCAREO, MICHOACAN, MEXICO	190
TFD008	PAREDON, PUEBLA, MEXICO	458-A
TFD009	PAREDON, PUEBLA, MEXICO	458-B
TFD010	PICO DE ORIZABA, VERCRUZ, MEXICO	043
TFD011	TAJUMULCO, (PALO GORDO), GUATEMALA	293-A
TFD012	PAREDON, PUEBLA, MEXICO	293-B
TFD013	ZARAGOZA, PUEBLA, MEXICO	293-C
TFD014	PICO DE ORIZABA, VERCRUZ, MEXICO	755-A
TFD015	PAREDON, PUEBLA, MEXICO	755-B
TFD016	ZARAGOZA, PUEBLA, MEXICO	835
TFD017	SIERRA DE PACHUCA I, MEXICO	394
TFD018	SAN MARTÍN JILOTEPEQUE I, GUATEMALA	569
TFD019	ZARAGOZA, PUEBLA, MEXICO	012-A
TFD020	SAN MARTÍN JILOTEPEQUE I, GUATEMALA	012-B
TFD021	ZARAGOZA, PUEBLA, MEXICO	048
TFD022	PICO DE ORIZABA, VERCRUZ, MEXICO	091
TFD023	PAREDON, PUEBLA, MEXICO	453-A
TFD024	PAREDON, PUEBLA, MEXICO	029-A
TFD025	ZARAGOZA, PUEBLA, MEXICO	029-B
TFD026	PAREDON, PUEBLA, MEXICO	453-B
THF027	PAREDON, PUEBLA, MEXICO	280
TFD028	ZARAGOZA, PUEBLA, MEXICO	232
TFD029	PAREDON, PUEBLA, MEXICO	300
TFD030	OTUMBA, STATE OF MEXICO, MEXICO	407
TFD031	EL CHAYAL, GUATEMALA	492
TFD032	SAN MARTÍN JILOTEPEQUE I, GUATEMALA	T89

Visual Criteria Employed on San Andrés Obsidian

The obsidian artifact types recovered at San Andrés are comprised of prismatic blades, flakes, and bipolar products. Because the collection is one of relatively uniform artifact types, the NAA specimens and the comparative sample were composed of prismatic blades, flakes, and fragments that are comparable to the majority of the collection.

Figure 13. Map showing obsidian sources recovered at San Andrés as identified by neutron activation analysis (after Clark and Pye 2000:8).

Compositional analysis through NAA determined that there were 9 different sources present in the collection from San Andrés. Each of these sources possesses one or more distinctive visual characteristics (Table 4). The following section describes these characteristics and how they were used to develop the visual criteria for source identification of the San Andrés obsidian collection.

The Pachuca, Orizaba, San Martín, El Chayal, and Paredón sources are relatively unambiguous in their visual identifications. Pachuca can be identified easily by its green color and crystalline texture. The material from Orizaba is distinctive from any other source in the collection because it is bright and clear with slight cloudy gray bands. The material from El Chayal has a milky-gray to gray-reddish or amethyst color and a relatively smooth surface with a waxy appearance. The rough-pitted surface of San

Table 4. Visual criteria for sourcing San Andrés obsidian.

SOURCE	REFRACTED COLOR	COLOR RANGE*	REFLECTED COLOR	COLOR RANGE*	LIGHT TRANSMISSION	SHARPNESS – DIFFUSION	INCLUSIONS	SURFACE TEXTURE - LUSTER	REFERENCE NUMBER**
UCARÉO	Dense black with blue tint at thin edge.	-	Black.	-	Opaque except bluish tint at finest of edges.	None.	Particulates, can only be seen at thinnest edges.		498, 190
PACHUCA	Green to green gold.	-	Dark green to green-gold.	-	Transparent with green-gold tint.	High clarity, fine glass, crystalline.	Seldom present.	Extremely fine, crystalline, glossy.	394
ORIZABA	Clear and bright, blue-gray to black bands possible.	-	Clear to light silvery-gray	N7 to N6	Transparent zones, bands vary from moderate to low translucence.	Excellent clarity, similar to hand blown glass.	Light brown spherulites and macroscopic black globulites causing filmy, spiderweb-like bands	Glassy, lusterous, ultrafine pitting due to inclusions at surface.	43, 617, 755-A
ZARAGOZA	Dense black with gray tint at fine edge.	-	Black.	N 0.75	Opaque until close to fine edge where it is crystal gray.	None.	Particulates, from opague to lateral banding of dark gray to black.	Fine, smooth texture has muted or satin finish.	12-A, 835, 293-C
OTUMBA	Black with gray bands	-	*Black to gray, similar to Ucaréo and Zaragoza.*	-	Can be opague, except where thin, translucent gray at edges.				407
EL CHAYAL	Medium gray, waxy appearance. Thicker portions muddied roseate hue, darker gray to black bands possible.	5YR-2/ 1 (Gray)	Medium gray to black.	N1 to N 0.5 (Neutrals)	Medium translucence with bands running to opaque.	Diffused light, similar to frosted glass.	Frequent dark gray to black banding, usually wide and irregular when present, dusty appearance.	Medium luster, fine pitting due to inclusions.	293-A
SAN MARTÍN	Dark gray with course particulate causing reddish-brown hue. Highly variable due to particulate inclusions.	10Y-2/ 1 (Gray)	Light gray to black.	10YR-3/2 to 10Y-2/1 (Gray)	Medium to low translucence depending on density of particulates.	Variable, from semi-clear to cloudy, determined by particulate densities.	Prevalent, from dusty particulates to sand grain-size can produce cloud-like formations. Irregular black banding.	Sand blast texture due to inclusions. Orange-peel surface is unique, low luster may have oily sheen.	872, 569, 12-B
PAREDÓN	Black to dark gray with fine particulate creating light beige tint.	10YR-4/1 (Gray)	Crystalline gray.	5Y2 to 10Y2 (Gray)	Transparent with gray tint.	High clarity, fine glass, crystalline.	Interior globulite inclusions (0.5-1.0 mm) appearing as round-to-oblong black spheres with sharply defined edges. Smaller stipple-like particulates are common. Quartz-like inclusions when at the surface	Extremely fine, very similar to Pachuca material. Glossy.	266, 460, 536, 458-A, 458-B, 293-B, 755-B

All descriptions are based on NAA samples and are intended only to be representative of pieces in the San Andrés collection.

* Color range is determined from The Munsell Book of Color, Volumes I and II, Glossy Collection. Identification presented as hue-value/chroma, gray and neutrals indicate special Munsell classification.

** Reference numbers are the FS numbers from the field excavations.

Martín obsidian differentiates it from that of El Chayal, as do the different hues of reddish-brown that may be present in some samples. A side-by-side comparison with the NAA samples can accurately identify the proper source. The Paredón obsidian is distinctive in its crystalline texture, similar to Pachuca's, but it's transparent-gray color and unique globulite inclusions assist in the assignment.

The Zaragoza and Ucaréo materials require closer comparison. These sources are separated from the rest of the collection due to their opaque black color; both are very dense. At the thinnest of edges, the material's translucency can be observed macroscopically. Zaragoza tends to a gray color, and Ucaréo tends to a blue color. The opaqueness of the Zaragoza and Ucaréo obsidians contrasts with all other San Andrés source specimens, which are transparent to varying degrees.

Further analysis of the San Andrés obsidian is planned. The accuracy level of the visual criteria and identifications will be determined when future additional archaeometric testing of the collection is conducted.

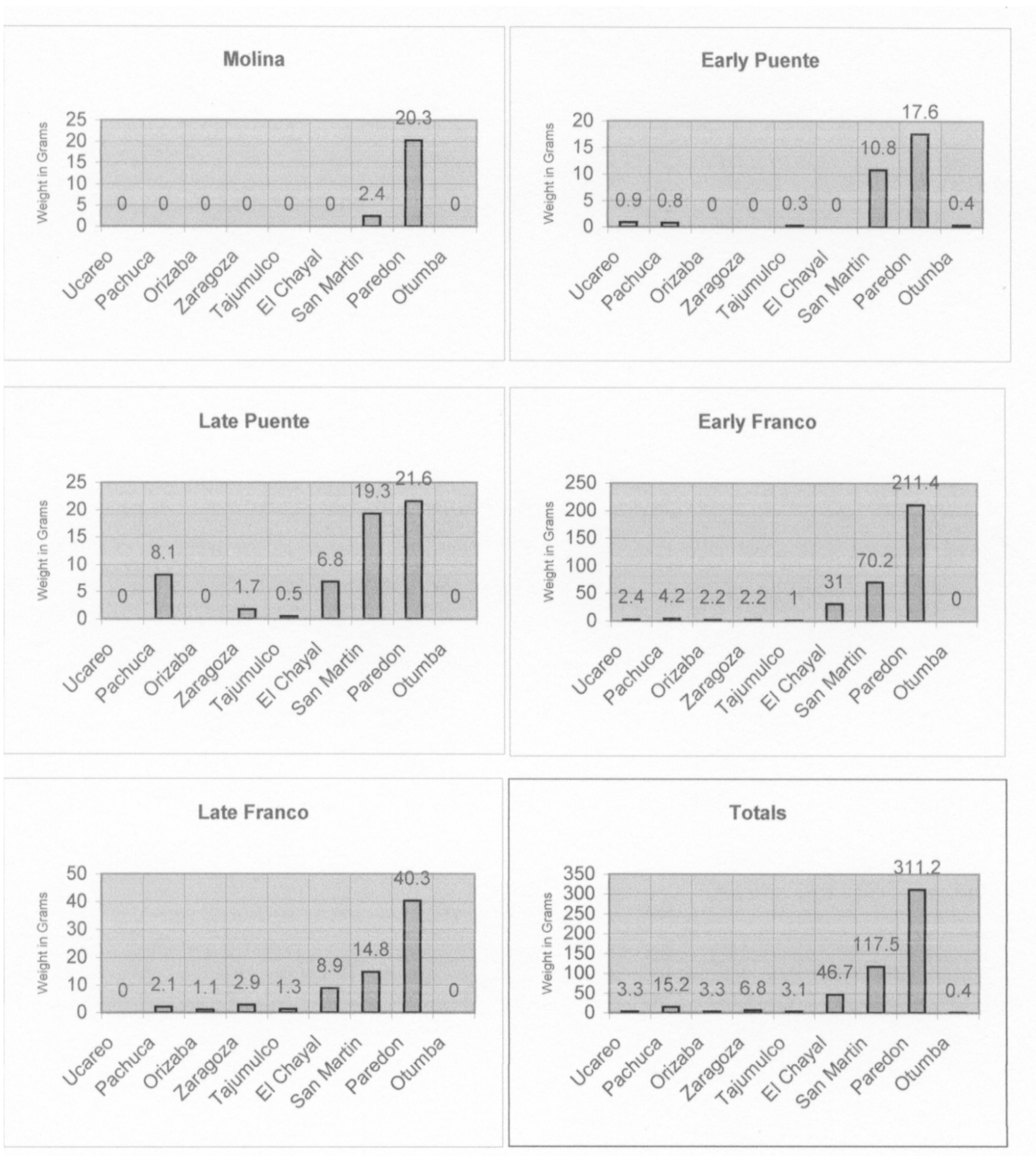
Quantitative Results of NAA and Visual Analysis

The quantitative results and the obsidian sources identified for San Andrés, based on the NAA results and macroscopic examinations, are presented in Table 5. This series of bar charts, arranged by chronological phase, illustrates visually the sources of obsidian by weight. It is evident that Paredón and San Martín Jilotepeque materials are dominant throughout the Middle Formative period, and El Chayal's presence is substantial compared to the relatively minor amounts from other sources.

Overall, the Paredón source material accounts for 61.7% of the entire collection.

San Martín (23.0%) and El Chayal (9.2%) are the only other major obsidian sources. Pachuca furnished 2.8%, and the other five sources (Ucaréo, Orizaba, Zaragoza, Tajumulco, and Otumba) totaled only 3.4% of the assemblage. The Paredón and San

Table 5. Weight of Imported Obsidian by Source and Phase.
The chronological sequence is left to right ,down the columns.



Martín Jilotepeque sources are the only ones present during all periods of occupation, and they account for the greatest percentage of material during each temporal period. Cumulative measurements of quantity and weight are presented according to excavation units and chronological phase in Appendix A, Table 9; details of the complete obsidian collection are presented individually in Appendix A, Table 13.

A chronological review of the obsidian artifacts shows that during the Molina phase (1400-1200 cal BC), only six pieces, weighing 22.7 grams, entered the archaeological record, and these pieces were limited to Units 7 and 8. Paredón (89.5%) and San Martín Jilotepeque (10.5%) were the only sources of this material.

During the Early Puente phase (900-750 cal BC), following a three hundred year hiatus, people once again utilized the areas of Units 7 and 8, and obsidian appeared in Unit 1. Units 7 and 8 contained minimal amounts of obsidian from Paredón (12.8 grams), from San Martín (1.2 grams), and a single piece from Pachuca (0.2 grams).

In Unit 1, a different picture of the Early Puente phase emerged. Six sources of obsidian were present in the total obsidian recovered (16.6 grams), but the majority was from Paredón (4.8 grams, 29.0%) and San Martín (9.6 grams, 57.8%). Pachuca, Otumba, Ucaréo, and Tajumulco are represented, but only by minimal amounts, each less than a gram. A single specimen represented the only appearance of Otumba obsidian at San Andrés.

The Late Puente phase (750-650 cal BC) produced a near doubling of the obsidian material over the Early Puente phase (54.7 grams to 31.4 grams). Units 7 and 8 produced no obsidian, but obsidian did occur in Units 1, 3, and 5. Six sources were still present, but the El Chayal and Zaragoza sources replaced Ucaréo and Otumba. Paredón (21.6

grams, 39.5%) and San Martín (17.1 grams, 31.3%) were nearly equal in their presence during this phase. Pachuca's appearance increased to (7.5 grams, 13.8%), El Chayal accounts for 6.3 grams (11.4%), and Tajumulco and Zaragoza were minimally represented.

The Early Franco phase (650-550 cal BC) showed a nearly six-fold increase (593%) in obsidian material over the Late Puente phase (324.6 grams to 54.7 grams). This amount represented the largest quantity of obsidian from the greatest number of sources (8 sources) during any time period. Obsidian was recovered in Units 5, 7, and 8, while Units 1 and 3 contained no obsidian material. Paredón accounted for 65% of the material, followed by San Martin at 21.5% and El Chayal at 9.6%. Ucaréo, Pachuca, Orizaba, Zaragoza, and Tajumulco material combined represented only 3.9%. The total of 324.6 grams of obsidian attributed to the Early Franco phase represents 64% of the entire San Andrés collection for all Formative time periods examined.

Obsidian from the Late Franco phase (550-400 cal BC) dropped to a total of 71.4 grams. Paredón (55%), San Martín (22.1%), and El Chayal (12.2%) were the largest contributors, while Pachuca, Orizaba, Zaragoza, and Tajumulco contributions amounted to a combined 10.1%. Unit 1 provided 82% of the material, and Unit 3, 18%. Units 5, 7, and 8 contained no obsidian during this phase. This period marked the end of the Formative period occupation; almost a millennium and a half passed before these areas were reoccupied during Late Classic and Postclassic periods.

Obsidian Industries at San Andrés

In this study, the technologies employed in the production of San Andrés obsidian artifacts were determined visually. Prismatic blade, flake, and bipolar production were three reduction strategies present at San Andrés. Appendix A, Table 10, presents a quantitative assessment of the obsidian manufacturing techniques used during the primary occupational periods at the site.

The data show the increased significance of bipolar reduction over time. Five prismatic blade segments were attributed to the Molina phase (1400-1200 cal BC), while a single piece showed that bipolar percussion had been utilized early in the area's occupation. Later, following the initial hiatus at San Andrés, evidence from the Early Puente phase (900-750 cal BC) indicated a high frequency of bipolar production that was representative of the site's overall obsidian collection. Almost 65% of the entire collection (411 of 636 pieces) was attributed to bipolar reduction.

Throughout the Middle Formative period at San Andrés, flake implements were minimally represented (7.5%), compared to blades (28%) and bipolar products. During the Late Puente and Early Franco phases, the bipolar to blade numerical ratio remained relatively constant, at around 2 to 1. The Late Franco phase ratio increased to 4 to 1.

The modal weights for the blades, flakes, and bipolar products from Units 1, 3, and 5 (Appendix A, Table 12) indicate that average prismatic blade weight remained relatively constant, between 1.0 and 1.2 grams through all time phases, but the average weight of bipolar products decreased through time, ranging from 0.89 grams in the Early Puente phase down to 0.44 grams in the Late Franco phase. These weights suggest that greater amounts of obsidian entered San Andrés during the Early Puente, Late Puente, and Early Franco phases compared to other periods. These three phases also saw a higher rate of recycling through bipolar reduction.

The Function of Obsidian Tools at San Andrés

Use-wear analysis of San Andrés obsidian was limited to wear on the artifacts that was visible macroscopically. The observation and recording of wear patterns was conducted by John Clark at the New World Archaeological Foundation, and interpretations in this thesis are based on the results of his use-wear replication experiments (Clark 1988:33-42, 221-253).

The functions of most Mesoamerican obsidian tools were cutting and scraping. A cutting function is attributed to tools whose striations run parallel to the cutting edge; a scraping function is attributed to tools with perpendicular markings. Each of these two functional categories was further divided into sub-categories labeled very hard, hard, medium, soft, and none (Clark 1988:33). These classifications were based on possible materials that the specimens were used to cut or scrape (Table 6). It should be noted that there are variables that can produce discrepancies in the wear-patterns. Traces of wear could have been affected by three factors operating individually or in combination: changes in the method of usage, alternation between the materials worked, and the number of motion repetitions.

Except for unique usage situations, it is most likely that tools, especially blades, had multiple applications during their use-life. For example, when a blade was fresh (in its sharpest, unused state), it may have been utilized to filet fish or fowl; as the edge wore down, it may have been used to cut or scrape soft wood, and later bone or other hard material. Usually, only the final use is apparent on the tool. It is also difficult to determine whether the wear patterns on bipolarly produced objects occurred before or after the bipolar production procedure.

Table 6. Degree of use and possible work materials (Clark 1988:33-43, 245-248)

TYPE OF USE	CUTTING	SCRAPING
VERY HARD	Limestone	Dry hardwood
	Shell	Fresh bone
	Fresh bone	Cooked bone
	Cooked bone	
	Antler	
	Dry hardwood	
HARD	Dry hardwood	Dry hardwood
	Green hardwood	Green hardwood
	Dry softwood	Dry softwood
	Dry reed	Cooked bone
		Fish
MEDIUM	Dry hardwood	Green softwood
	Green hardwood	
	Dry soft wood	
	Green softwood	
SOFT	Dry hardwood	Cooked bone
	Green hardwood	Fish
	Fish	Fresh hide
	Bird	
NONE	Green softwood	
	Fresh hide or flesh	
	Vegetables	

At first glance, the San Andrés obsidian collection has what appears to be an unexpectedly large percentage of unused implements. Only one in 7.7 specimens shows any use-wear macroscopically. This situation may be the result of a ritual deposition of materials associated with ceremonial feasting activities. The midden in Units 7 and 8 contained a major portion of the obsidian that has been recovered at San Andrés, as well as numerous ceramic serving vessels, figurines, shark tooth, greenstone, bone, asphalt, carbon, and groundstone. These items appear to be associated with a ritual feasting and gifting event and were all deposited together in this midden. If the ritual deposition of feasting material hypothesis is correct, the excess unused obsidian would have been deliberately buried with the other feast accouterments. Alternatively, use-wear experiments indicate many uses of obsidian implements left no macroscopically visible damage to the edge. Therefore, lack of use cannot be presumed (Clark 1988:34-40, 246).

Table 7. Type and degree of macroscopically determined use-wear by ceramic phase and percentage of specimens displaying use-wear compared to total number of specimens present in entire collection. Use wear numbers based on observations by J. E. Clark. Inferences drawn must be tempered by the realization that use-wear evidence was minimal within the collection, and its appearance can be easily disguised.

PHASE	TYPE	DEGREE OF WEAR				USE-WEAR TOTALS	% of all Specimens	SPECIMENS IN ENTIRE COLLECTION
		Very Hard	Hard	Medium	Soft			
MOLINA 1400-1200 cal BC	Blades	-	-	2	1	3	60%	5
	Bipolar	-	-	-	-	-	-	1
	Flakes	-	-	-	-	-	-	-
EARLY PUENTE 900-750 cal BC	Blades	-	2	-	3	5	42%	12
	Bipolar	-	1	-	-	1	8%	13
	Flakes	-	-	-	-	-	-	4
LATE PUENTE 750-650 cal BC	Blades	1	2	-	2	5	22%	23
	Bipolar	-	-	3	5	8	18%	44
	Flakes	-	-	1	-	1	9%	11
EARLY FRANCO 650-550 cal BC	Blades	2	5	16	11	34	29%	117
	Bipolar	-	-	-	3	3	1%	270
	Flakes	-	1	-	1	2	9%	23
LATE FRANCO 550-400 cal BC	Blades	-	2	2	8	12	50%	24
	Bipolar	-	1	-	2	3	4%	86
	Flakes	-	2	-	1	3	30%	10

Table 8. Macroscopically observed use-wear patterns of San Andrés obsidian. Percentage is of total use-wear type in Formative period collection. Use wear numbers based on observations by J. E. Clark.

UNIT	TYPE	VERY HARD	HARD	MEDIUM	SOFT	TOTALS	% of TYPE
1	Blades	1	5	2	12	20	11%
	Bipolar	-	2	3	7	12	3%
	Flakes	-	2	-	1	3	6%
3	Blades	-	1	-	-	1	0.5%
	Bipolar	-	-	-	-	-	-
	Flakes	-	-	1	-	1	2%
5	Blades	-	-	1	-	1	0.5%
	Bipolar	-	-	-	-	-	-
	Flakes	-	-	-	-	-	-
7	Blades	-	4	12	9	25	14%
	Bipolar	-	-	-	1	1	0.2%
	Flakes	-	1	-	-	1	2%
8	Blades	2	1	5	4	12	7%
	Bipolar	-	-	-	2	2	0.4%
	Flakes	-	-	-	1	1	2%
TOTALS	Blades	3	11	20	25	59	32%
	Bipolar	-	2	3	10	15	4%
	Flakes	-	3	1	2	6	13%

A situation where use-wear is not macroscopically apparent may be created when cutting soft substances, such as fruits, vegetables, meat, or fresh hides. Even cutting hard substances may result in no visible wear if the implements were used only for a short time. Another factor that adds to this illusion of lack of use is the fact that a large number of artifacts are the result of bipolar percussion (411, or 65%). This method of production creates a profusion of small chips and flakes, many of which are too small to use. Another cause of misidentification of tool use is post-depositional damage, such as crushing or abrasion, by which subtle signs of soft cutting wear can be masked (Clark 1988:246-247).

At San Andrés, the number of artifacts with soft and medium wear patterns accounted for 77% of the total for pieces exhibiting any use-wear; very hard usage accounted for only 4%. Only two of the artifacts exhibited use-wear associated with scraping; all the others indicated cutting wear.

CHAPTER 6
SAN ANDRES AND FORMATIVE PERIOD OBSIDIAN

This chapter synthesizes the data from the preceding chapters and introduces hypotheses about the social dimensions of obsidian acquisition and use. The chapter begins with a chronological interpretation of the obsidian at San Andrés, followed by a discussion of La Venta obsidian production. The chapter concludes with considerations of the sociopolitical relationship between La Venta and San Andrés, obsidian trade and acquisition, and the quantity of obsidian recovered at San Andrés.

Discussion of the San Andrés obsidian collection should begin with consideration of the amount of material contained in the entire collection, 504.8 grams or 17.8 ounces. First, this quantity of material could be produced from a single polyhedral core. The amount of obsidian present is not substantial, especially when considering the 1000-year time period under discussion. Second, the units of excavation were of an exploratory nature, covering only a small portion of the estimated site area. The effects of these two facts on the interpretation of the archaeological record could bias the statistical and interpretive conclusions reached in this report. Accordingly, the comments and suggestions that follow concerning San Andrés are, by their very nature preliminary hypotheses, and the proposals are presented with the understanding that additional evidence from the region will, at the very least, modify these arguments.

The initial appearance of prismatic obsidian blades in Mesoamerica occurred around 1530-1260 cal BC. (Cobean *et al.* 1971:666). As Mesoamerican societies developed hereditary inequality, emergent elites began to take on key roles in the acquisition, use, and redistribution of prismatic blades (Clark 1987:262; 2001:554). Based on evidence of production debitage, obsidian blades were manufactured at or near the obsidian quarry sites and were transported as finished products to distant regions, through various means, such as long distance exchange. At any point in the transport chain, leaders might have redistributed the blades to the local populace as a means of personal aggrandizement (Braswell 1996:73-74; Chase and Chase 1992:5).

At the onset of the Middle Formative period (ca 1200 cal BC), patterns of obsidian production and exchange changed significantly. The presence of obsidian workshop debris at civic-ceremonial sites indicates that the technology for the production of prismatic blades began to spread from the quarry sites to the regional capitals (Clark 1987:260; Jackson and Love 1991:48). Raw material in the form of obsidian macrocores was prepared at the quarry site specifically for transportation to urban centers where blades were produced locally (Clark 2001:554). Because no evidence for blade manufacture has yet been uncovered at San Andrés, archaeologists assume that the production sites were located elsewhere. Chávez (1990:31) has documented obsidian workshops at La Venta, in Complex D (Figure 2), close to elite residences, possibly those of the obsidian importers. At San Andrés, there is also the possibility that the production debitage was destroyed during repeated bipolar percussion reduction activity.

A Chronological Interpretation of San Andrés Obsidian Artifacts

The Molina Ceramic Phase (1400-1200 cal BC)

The earliest appearance of obsidian at San Andrés occurred during the Molina phase occupation, dated between 1400 and 1200 cal BC (von Nagy *et al.* 2001:6). Though an *in situ* pit feature with figurine and ceramic fragments was found in Unit 1, obsidian artifacts were found only in the secondary Molina deposits of Units 7 and 8, which had been redeposited from the nearby settlement (Figure 14). During this period, San Andrés was most likely a small farming hamlet (von Nagy *et al.* 2001:5). Archaeologists have little evidence regarding its social make-up. Nevertheless, the presence of prismatic obsidian blades suggests more social differentiation, such as the institution of "Big Men," than might otherwise be suspected.

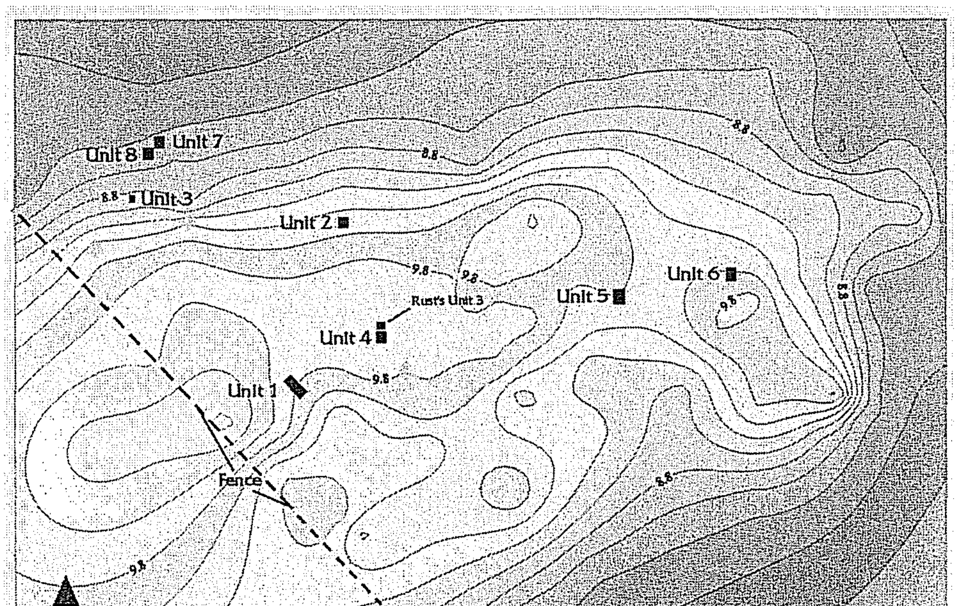


Figure 14. Preliminary map of San Andrés. Contours are in meters (Heide and Perrett 2001).

Despite the limitations imposed by the meagerness of Molina cultural material, it is possible to suggest that traditions were initiated during the Molina phase that continued through every ensuing occupation of the site. The data suggest possible characteristics of San Andrés society. First, obsidian at San Andrés was dominated by material from the Paredón source (89.4% in the Molina phase, 61.7% overall), indicating an early economic connection to the eastern Mexican Plateau or the western Gulf Coast. Second, obsidian from San Martín, Guatemala (10.6% during the Molina phase, 23.0% overall), was present as the second leading source. Third, prismatic blades (a specialized technology) and bipolar reduction (a non-specialized technology) were both present. Fourth, the presence of prismatic blades at this early date may imply elite presence since prismatic blade production and distribution appear to be associated with elites elsewhere in Mesoamerica at this time (Clark 1987:262; 2001:554; Jackson and Love 1991:48).

Homogeneity within the source material both in the Molina phase and later phases throughout the Formative period at San Andrés is notable. Compositional correspondence within the Paredón material may indicate that the majority of obsidian from this source came from the same quarry or outcrop, probably the Coyaco source location (see Appendix B, Paredón). The similarity of all the San Martín Jilotepeque material identified by NAA indicated it was from Quarry Source 1 (Table 3), a pattern that also would account for the long-term consistency at San Andrés.

The means by which Molina phase residents of San Andrés procured obsidian remains poorly understood. It is not known whether obsidian entered the region through the efforts of distant exporters, through the procurement efforts of local importers, or a combination of both through inter-regional exchange.

The brief occupation of the Molina phase ended abruptly when water levels rose. The development of a brackish swamp forced the inhabitants of San Andrés to leave the area. Evidence for the development of low density settlements after this period was found along adjacent estuaries, on La Venta Island, and in other surrounding areas during the hiatus (von Nagy *et al.* 1999:7).

The Early Puente Ceramic Phase (900 to 750 cal BC)

The Early Puente phase at San Andrés followed a three hundred year hiatus in occupation of the site caused by a rise in water levels. A rapid reoccupation of the area followed the formation of fertile elevated levees associated with the appearance of the Río Barí, a situation that was ideal for Formative period farming peoples.

The appearance of fertile levee soils in the San Andrés region indicates a close association of this settlement with the rise of the La Venta polity. La Venta's growing economic and ideological influence beyond the polity itself is displayed in monumental stone sculptures that appeared during this period across Mesoamerica, from Central Mexico to El Salvador. Each sculpture, for example, that from El Viejón (Figures 3 and 21), bears attributes credited to the distinctive La Venta art style (see Chapter 2).

Early Puente deposits at San Andrés include living debris intermixed with levee silts, demonstrating that the river channel was active in this location. Excavations encountered Early Puente deposits with obsidian in Units 7 (33%) and Unit 8 (13%), although the majority of obsidian came from Unit 1 (54%). Five pieces of obsidian, including two with evidence for cutting hard material, were mixed with ceramics, bone, stone, asphalt, a figurine, and carbon (Unit 1, Levels 14-18). Even though more *in situ* deposits were encountered during this phase than in the Molina phase, obsidian frequencies increased only modestly from the Molina phase (22.7 grams) to the Early Puente phase (31.4 grams).

The number of Early Puente phase sources increased dramatically in contrast to the quantity of obsidian. Expanding La Venta polity contacts may be demonstrated by the increase from two obsidian sources in the Molina phase to six in the Early Puente phase. New sources included Ucaréo in Michoacán (2.9%), Pachuca (green-gold glass) (2.7%), Otumba (1.3%), and Tajumulco (1.0%). Paredón material still accounted for 56.1% of the Early Puente obsidian, and San Martín supplied 36%.

The Early Puente phase yielded one of the most distinctive obsidian artifacts of the collection. One of the earliest traces of Early Puente occupation, Feature 14, Unit 1, was dug into the sterile river levee soils that represented the occupational hiatus. This pit feature included a lancet-shaped obsidian blade (FS 693), as well as ceramics (Figures 15 and 16). The blade was distinguished by its unique form and flawless sharp edge. These characteristics might indicate its use as a blood-letter (John Clark, personal communication, 2000). The blade had been retouched at the tip, a feature consistent with the bloodletting hypothesis.

Marcus (2001:81) suggests that blood-letting rituals had been established between 1530 and 1260 cal BC, based on the fact that obsidian blades and other sharp objects probably used as blood-letters, such as shark teeth and stingray spines, were discarded near ritual-related structures in early villages (Marcus 2001:81-82). Ritualized blood-letting was thought to have been practiced by the emerging Gulf Coast elite in the Formative period (Joyce *et al.* 1986:1); the San Andrés Early Puente blade may provide further confirmation of this hypothesis.

An offering of groundstone objects, including a polished celt (Feature 16, Unit 1), also occurred in the earliest phase of the Early Puente occupation, along with Feature 14 (Figures 16 and 17). Groundstone offerings are a hallmark of La Venta ceremonial complex (Drucker *et al.* 1956: 372; Drucker *et al.* 1959). The groundstone and obsidian lancet offering together show that San Andrés was participating in Mesoamerican ritual practices.

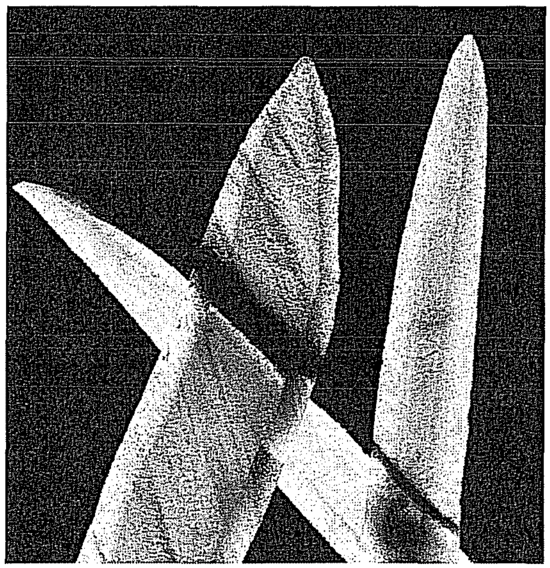


Figure 15. Examples of obsidian lancet-type prismatic blades (Serra 1994:93).

Late Puente Ceramic Phase (750 to 650 cal BC)

Evidence for feasting activity appears in the Late Puente phase. Unit 1, Feature 9, a trashpit, yielded the best evidence for Late Puente occupation as well as feasting activity. Feature 9 contained pottery refuse as well as figurines, greenstone, groundstone, hematite, asphalt, and faunal remains that were highly burned. The ceramic assemblage included cooking, serving, and storage vessels, ranging in size from small, individual serving dishes to large serving platters. 20 pieces of obsidian blades and flakes occurred in the feature.

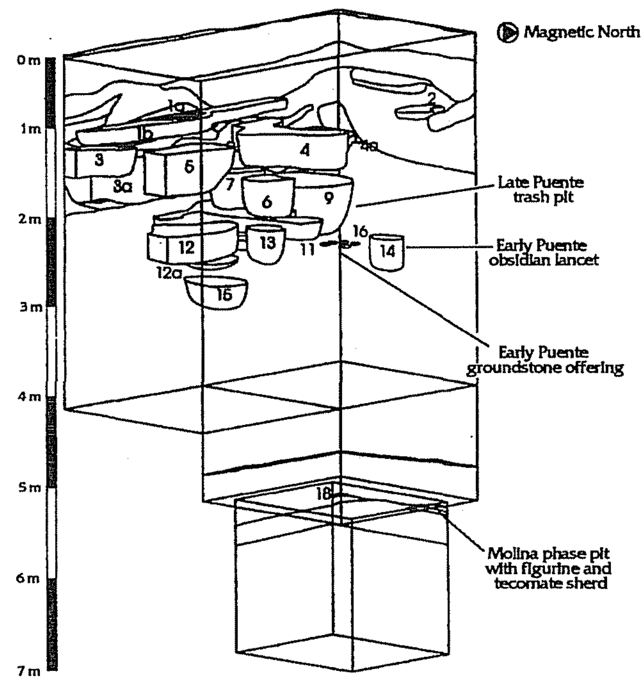


Figure 16. San Andrés Unit 1, Features 1-18 (after Pope and Pohl 1998:7).

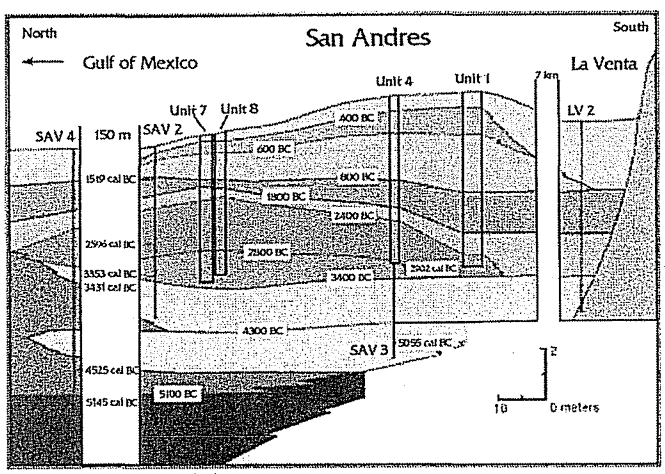


Figure 17. Stratigraphy of San Andrés, Tabasco (Pope et al. 2001:1370).

Other units also yielded Late Puente middens containing obsidian. Unit 3, Level

11, was dense midden that contained numerous turtle bones and a ceramic bird whistle as well as a piece of Zaragoza obsidian with a bipolar edge. In Unit 5, Levels 4, 5, and 6 probably represent occupational refuse, with 15 pieces of obsidian, mostly bipolar flakes, along with ceramics, bone, charcoal, asphalt, wood, shell, white rocks, and hematite.

During Late Puente times, which spanned ca 100 years, the weight of imported obsidian at San Andrés nearly doubled from the 150-year long Early Puente phase, from 31.4 grams to 54.7 grams. These data suggest an increase in population or activity or both that would have coincided with the development of the La Venta polity. The average weight per obsidian artifact dropped from 1.05 to 0.78 grams, as bipolarly reduced objects tripled in frequency, and the blade count doubled. Six sources were represented. The Ucaréo and Otumba sources were absent but were replaced by obsidian from Zaragoza and El Chayal. All of the obsidian was associated with bone, ceramic, shell, and charcoal materials indicative of food preparation and storage.

Obsidian importation showed signs of a significant change. This phase is the only one in San Andrés occupation in which the Paredón source was not dominant, although it still remained the singe largest imported obsidian source. By gram weight, Paredón (39.5%) and San Martín (31.3%) were practically equal in their contribution to the assemblage. The change may have been the result of closer relations with sites in Chiapas that were exchange nodes for obsidian. Material from El Chayal, in central Guatemala, made its first appearance at the site and accounted for 11.4% of the total. Pachuca obsidian increased to 13.8%, and Zaragoza and Tajumulco accounted for the other 4.0%.

An examination of the sources yields clues about the obsidian exchange routes.

Evidence from Upper Grijalva Basin sites in Chiapas, including La Libertad, Santa Marta Rosario, and Guajilar, indicates a high proportion (averaging 96% of the individual assemblages) of San Martín Jilotepeque obsidian contemporaneous with San Andrés' Late Puente period (Clark 1988:5,275). The substantial increase at San Andrés of San Martín obsidian and the appearance of material from El Chayal, which was probably being funneled through the same exchange system (Clark 1988:275-276), may have signaled a growing regional affiliation between the La Venta polity and the Upper Grijalva Basin of Chiapas.

Compositional analysis of ground stone from San Andrés may also show that other lithic material was imported to San Andrés during this phase, possibly from sources that were part of the exchange system operating among sites along the Upper Grijalva River drainage. The importation of andesite, diorite, quartzite, granite, and basalt from these trade nodes lends credence to the existence of exchange patterns and the economic alliance these two regional areas may have shared (Du Vernay 2001:37).

The Early Franco Phase (650 to 550 cal BC)

All of the evidence from San Andrés indicates that the 100 year period of the Early Franco phase was the most active in the site's history, probably reflecting the interregional dominance of La Venta. Early Franco occupation is represented by a series of floors, including hearth pits, in Unit 5. A piece of Pachuca obsidian with evidence of cutting on medium material occurred inside a cached ceramic vessel, along with a greenstone bead. An *in situ* Early Franco midden, excavated in Units 7 and 8, may provide insight into ritual feasting activities that took place during this period. Oversized ceramic vessel fragments and nearly complete vessels included serving and storage containers in the form of jars, urns, platters, and bowls, suitable for serving large numbers of people. These vessels were associated with asphalt, daub, abundant bone, carbon, maize-grinding implements, and a substantial amount of obsidian that may have been used in the course of the celebration. Two inscribed jade plaques and two cylinder seals, all possibly with glyphic elements, were found, along with a drilled shark tooth, numerous solid clay figurines, and a large hollow figurine head (12.7 cm high). These artifacts have elite associations and may be indicative of ritual gifting that occurred during the feast, perhaps in conjunction with elites from La Venta.

In the Unit 7 and 8 midden feature, 179 pieces of obsidian, weighing 146 grams, were recovered. This measure constitutes 28% of the total amount of obsidian in this entire study and includes portions of 58 prismatic blades, or 32 % of all the identifiable prismatic blades. The 121 bipolar pieces account for 29% of all the bipolar material in the Formative period collection. In addition, a groundstone mano (FS 276) found in the feature has an unusual hole chipped into one side (Figure 18). The damage may have been caused when the mano fragment was used as an anvil stone during bipolar reduction sequence (Figure 12). The depth of this hole would indicate extensive bipolar activity. Because of the close contextual association between the mano and the amount of bipolar flaked obsidian, it may be assumed that the bipolar reduction took place at San Andrés and was specifically performed to provide cutting edges during this feasting event. The presence of this quantity of obsidian in the ritual feasting midden, together with the fact that many blades were unused may indicate that all the materials used, in the celebration were discarded once the feasting event was finished.

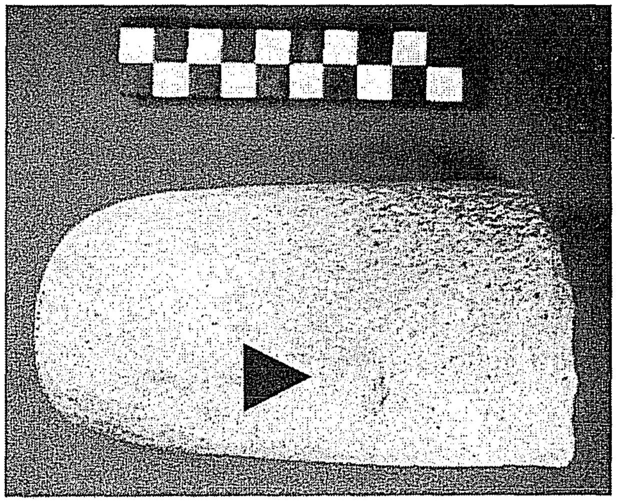


Figure 18. Mano fragment (Du Vernay 2002:49)

Another significant Early Franco activity is represented by large, sherd-packed trash pits in Units 1 and 5 that represented considerable deep digging. In Unit 1, Levels 7-11 contained abundant obsidian, with some showing cutting on light and medium materials, examples of hard cutting wear, and some pieces exhibiting no wear. The ceramics showed evidence of intense heat, though the obsidian was not heat damaged.

Overall, the obsidian artifacts attributed to the Early Franco phase showed a fivefold increase in quantity over the amount from Late Puente (70 pieces to 410 pieces). The weight of obsidian rose from 54.7 grams to 324.6 grams, close to a 600% increase. Eight sources were now present, but Paredón again dominated, representing 65% of the collection. San Martín fell to 21.5%, El Chayal to 9.6%, and Pachuca to 1.3%. These alterations in importation sources may be a sign of diminished relations with the Chiapas trade network or a re-emergence of Central Mexican contacts.

The Late Franco Phase (550 to 400 cal BC)

Lack of levee sedimentation during the Late Franco phase indicates that the river channel had moved elsewhere. A sharp decrease in the amount of obsidian indicates a reduction of activity at San Andrés. The location of obsidian at San Andrés during this period was limited to Units 1 and 3. Total obsidian weight dropped 77%. Bipolar production accounted for 72% of the objects, and average per piece weight dropped to 0.6 grams. Seven sources were still present, with Paredón providing 55%, San Martín 22%, and El Chayal 12%. Ucaréo dropped out again, and Pachuca, Orizaba, Zaragoza, and Tajumulco comprised a combined 11%.

By around 400 cal BC, San Andrés was essentially abandoned. This event coincided with the effective end of La Venta's reign as a political and economic power (Pohl 1999:30; von Nagy *et al.* 2001:6). Changes in the river system, notably the appearance of a channel of the Grijalva River in the region (Sisson 1976), may have caused population centers to relocate. At this point in time, San Andrés experienced its second hiatus, this one lasting 1400 years. Sporadic reoccupation of the site did not take place until the Late Classic period, and more continuous occupations did not occur until the Postclassic periods (AD 900 to 1521).

The Post Formative Activity

A late cache or possible urn burial dating to Late Classic or Postclassic times occurred near the surface of Unit 4 and included an obsidian flake fragment that appeared to be a perforating tool. One of the urns was topped by a broken Middle Formative Tecolutla Incised plate and was associated with a groundstone mano and a greenstone bead. The cache may be a deliberate attempt to relate back to Formative period ritual.

La Venta Obsidian Production and San Andrés

Rojas Chávez's (1990) study of La Venta lithics that suggests that the production of obsidian tools occurred at special activity sites within La Venta center. Examination of the artifacts from Complexes D and H shows that these areas were probably blade and tool production sites. Debitage from these sites showed a substantially higher number of core correction flakes, platform rejuvenation flakes, crested flakes, and modified flakes than did debitage from any other location. These types of materials indicated typical corrections that were made to cores as they were being reduced in blade production. Of the 187 prismatic blades found at these two complexes, only 21 showed signs of use, suggesting that blades were being made for export and not for use at the sites. The associated material also included anvil and hammerstones used in bipolar reduction (Chávez 1990:29).

Rojas Chávez (1990:31) notes that only two cores have been found in Formative period contexts at La Venta: one is the incised core buried in Tomb C, and the other is a fully exhausted core. He does not specify the location of the exhausted core. The scarcity of obsidian cores is curious, because core correction flakes and platform rejuvenation flakes were found at La Venta Complexes C, D, and H. The quantities of these flakes indicate that polyhedral cores were formed and core corrections were made prior to and during the production of prismatic blades. The large number of prismatic blades attributed to La Venta obsidian workshops would have required a much greater quantity of exhausted cores. One possible reason the cores are not present may be due to extensive reworking of the material through bipolar reduction. Craftpersons could have reduced the cores to a minimal state and then smashed the small column of volcanic glass through bipolar percussion. Large flakes from this procedure could have been reduced further bipolarly.

The information derived from La Venta's workshops demonstrates that the blade, flake, and bipolar industries existed side-by-side and that obsidian was imported in small amounts that were worked and re-worked until all the material had been thoroughly utilized. This researcher hypothesizes that the products of these workshops would then have been distributed to surrounding sites, such as San Andrés. A comparison of San Andrés and the La Venta workshop sources is planned for the future, in an effort to support or refute this hypothesis. Regardless of the outcome, lithic evidence from La Venta indicates that obsidian was considered a precious material to the ancient inhabitants of the region during the Formative period (Chávez 1990:31).

Considerations of San Andrés Obsidian

At least nine distant sources of volcanic glass are present at San Andrés, but the Paredón and San Martín Jilotepeque materials dominate throughout all occupational periods. Based on previous obsidian source analyses (see Chapter 4, Previous Obsidian Source Studies of the Southern Gulf Coast), the consistent acquisition of obsidian from two primary sources is a common occurrence in other Formative period sites. Nevertheless, the almost exclusive use of Paredón and San Martín Jilotepeque obsidian is unlike that of any other major Gulf Coast Formative period center. The quantity of obsidian recovered is modest in comparison to later periods, and this situation appears to have been common throughout the region during this Formative period (Stokes 1999:19).

The production of obsidian tools recovered at San Andrés was accomplished through reduction methods that included prismatic blade production, requiring specialized technology. This activity appears to have taken place elsewhere, most likely at La Venta. Also evident were flaking techniques that could have been accomplished by most people at San Andrés. Bipolar reduction was increasingly employed through the Middle Formative period, in an effort to extend the use-life of the material. Finally, the apparent use-wear patterns and the associations of the obsidian artifacts to other cultural material suggest that a principal function of the obsidian artifacts recovered was for food preparation, including large-scale feasting activities.

These conclusions about San Andrés obsidian prompt a series of questions regarding the socioeconomic relationship between San Andrés and La Venta. Why were the amounts of obsidian so meager? Why were the sources of San Andrés obsidian, and possibly by extension, La Venta's, different from any other major Gulf Coast center during the Formative period? Why did feasting events occur at San Andrés? The researcher proposes possible hypotheses that address these questions.

The Socioeconomic Relationship between San Andrés and La Venta

The researcher assumes a robust agricultural economy at San Andrés, based on analysis of evidence collected from the excavations and paleoecological cores by the "Early Agriculture on the Gulf Coast Lowlands of Mexico Project." Micro and macrobotanical remains indicate successful experience with many cultigens, including maize, by 5100 cal BC. By the Middle Formative period the site's riverside location provided access to fertile levee lands and directly linked these extensive agricultural lands to the riverine transportation system.

The ritual feasting and gifting activity documented at San Andrés is generally associated with elite sponsorship (Hayden 2001:28), a fact that suggests that San Andrés had built and maintained a level of prominence substantial enough to warrant an elite affiliation with La Venta. This prominence may have been the result of dependable agricultural production, which may have increasingly supported a growing population of non-food producing individuals at La Venta (von Nagy *et al.* 2001:3).

Brumfiel (1992:558) points out that the political power achieved or acquired by Mesoamerican elites stemmed from the control of social relationships, natural resources, and the subsistence economy. Agricultural commodities were stored at the household level and periodically collected and transported to markets, in a program designed to meet the demands of the region's non-agricultural populace (Hirth 1992). San Andrés may have been a natural collection point at the center of food production areas. The two unmounded sites immediately adjacent to the east and west of San Andrés (Figure 4) may have been homesteads for the farming families working the extensive fields around San Andrés. Drennan (1984:107) argues that agricultural production and distribution have limited geographical ranges, determined by the points of energetic inefficiency of transport. Time constraints for food transportation were based on storage facilities, spoilage, and the level of participation in the exchange and acquisition network. Under these conditions, agricultural products would have been limited primarily to intra-regional distribution; in the case of San Andrés, the majority of produce leaving the site may have been destined for the people residing on La Venta Island. Water transport on the Río Barí from San Andrés to La Venta would have made this process efficient.

This researcher has also based the suggestion of large-scale food production at San Andrés on the premise that La Venta Island was permanently occupied. Populations had increased to the point at which, by the Late Puente and Early Franco periods (750 to 550 cal BC), occupational zones surrounded much of the city's core, eliminating agricultural lands. Rust (1992:124-125) has presented evidence that clusters of houses, lithic workshops, and storage repositories surrounded the central La Venta district. Extended ceremonial complexes, burials, and ceremonial offerings were present, and elite residential and artisan areas filled the landscape (Drucker *et al.* 1959; Heizer, Drucker *et al.* 1968; Heizer, Graham *et al.* 1968). This researcher suspects that urban population increases and the spatial expansion of the city would have forced out any local agriculturalists, thereby requiring that primary food production be located away from the site. Logically, externally produced agricultural products from areas like San Andrés could have been brought to the food dependent population, in this case, La Venta (Hirth 1992:20-21). In addition to San Andrés, the other sites along the Río Barí, both mounded or unmounded, also appear to have been directly tied to agricultural production (Rust 1992:126; Rust and Sharer 1988:242).

Feasting Events at San Andrés

This researcher proposes that the feasting events that occurred at San Andrés may have been part of an elite strategy designed to maintain a dependable flow of food from suppliers to consumers. These events may have tied economic, cultural, and political aspects of the society together in ritual feasting (Dietler 2001:68-75; Hayden 2001:29).

The information generated by the multidisciplinary investigations of the "Early Agriculture on the Gulf Coast Lowlands of Mexico Project" points to repeated occurrences of special offerings and elite feasting events at specific locations within San Andrés. These activities occurred from the latter part of the Early Puente to the Early Franco periods (800 to 550 cal BC). The artifactual assemblages recovered at these special activity areas are consistent with those associated with factional competition (Brumfiel 1994:6-12): expected feasting, drinking, and gifting activities.

These elite rituals and feasts may have been related to the transportation of agricultural products from San Andrés to La Venta, as suggested above. Paramounts, who supervised the exchange of commodities, may directly or indirectly have controlled the flow of goods by influencing the providers, i.e., the farmers (Brumfiel and Earle 1987:6). This control could have been accomplished through feasting, gift giving, ritual performance, and the sharing of the harvest.

Sahlins (1968:88-90) proposed that leaders gain the indebtedness of their followers by the apportioning of favors, generally in the form of high status gifts or lavish food and drink. The value accorded to gifts may have depended on long-distance acquisition or the skill, time, and resources required to produce the item (Drennan 1976; Helms 1993). For example, long-distance obsidian procurement and its intersite distribution by factional leaders was a method of gifting used to promote the allegiance of their followers (Clark 1987:278-281). The value of the obsidian would have been measured by its utility, as well as its exotic, symbolic, and ritualistic nature.

Trade or Acquisition Networks

An examination of San Andrés obsidian sources has led to unexpected conclusions about distances traveled by people or raw materials. Even though all obsidian had to be imported to La Venta and San Andrés, the closest sources of obsidian were not necessarily those most exploited. The nearest source to La Venta is Pico de Orizaba, 335 kilometers (200 miles) to the west-northwest (Figure 19). The obsidian from this source, however, comprised only 0.7% percent of the total weight of the obsidian. On the other hand, Paredón, the primary source for San Andrés obsidian, is located 510 kilometers (300 miles) to the northwest of La Venta, and San Martín, the second leading supplier, is 510 kilometers (300 miles) to the southeast. This evidence suggests that geographic considerations were not paramount to the importers of obsidian to La Venta, a situation also observed at other Formative period sites (Jackson and Love 1991:53). Greater significance may have been ascribed to political alliances that linked centers in keeping with the political factionalism model used here.

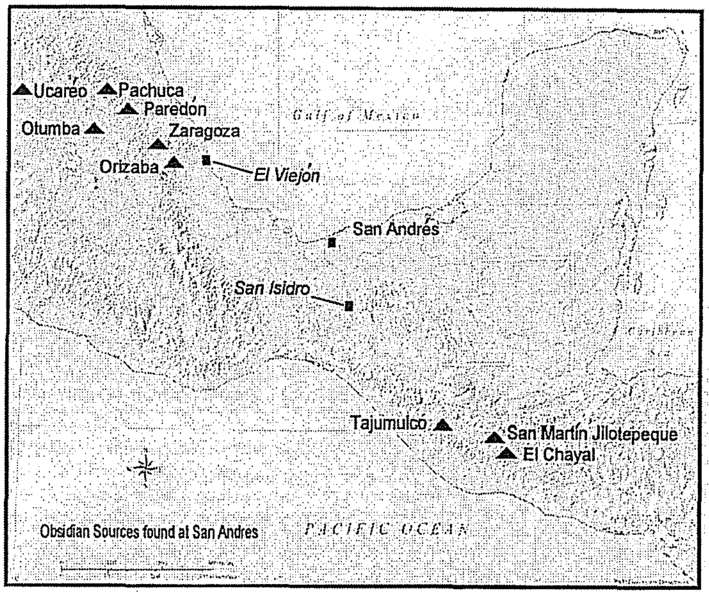


Figure 19. Obsidian sources present in San Andrés and the location of possible trade centers (after Clark and Pye 2000:8).

The two primary sources, Paredón and San Martín, accounted for the majority of the Formative period collection, providing 61.7% and 23.0% of the material respectively. El Chayal (9.1%) is the only other relatively significant source. The sources of Pachuca

(2.8%), Zaragoza (1.3%), Ucaréo and Orizaba (0.7% each), Tajumulco (0.6%), and Otumba (0.1%) comprise only minute portions.

The nine sources of obsidian documented at San Andrés present one of the most diverse collections yet found in Mesoamerica during the Formative period. Further work with obsidian collections should shed light on how distinctive San Andrés is. The small amounts of material that are not from Paredón, San Martín, or El Chayal may have reached San Andrés through a number of ways, such as elite gifts, itinerant travelers, or a mixing of source material at a trade center supplying San Andrés with obsidian.

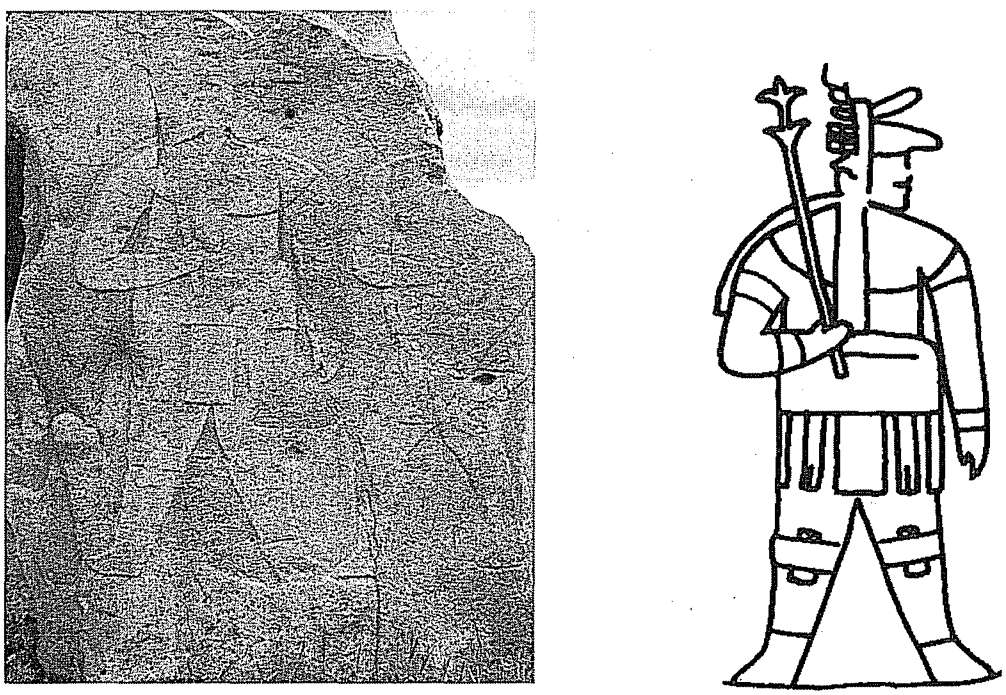
The main question posed by the current data is how the primary obsidian sources arrived in the La Venta polity. This researcher proposes that the majority of obsidian found in San Andrés was procured, over time, through two separate distribution centers. El Viejón, on the western coast of Central Veracruz might have supplied the obsidian from Paredón, and San Isidro, in the Upper Grijalva River Basin, might have provided the San Martín Jilotepeque and El Chayal material (Figure 19). The geographic locations of El Viejón and San Isidro fit well with Grove's (1968:182) contention that Formative period trade nodes were located on passes controlling trade routes. Both sites are located on water systems that directly connect to the La Venta region, El Viejón via the Gulf Coast and San Isidro via the Grijalva River. Such water routes would most likely have been the preferred mode of transport by a riverine society like that of La Venta.

El Viejón was a Formative period center located on the Gulf of Mexico in Central Veracruz. Wilkerson (2001:802) contends that the site would likely have controlled the north-south sea level trade route along the Gulf Coast. Thomas (1993:228-233) indicates that, based on Spanish colonial records, the El Viejón region was the easternmost point of a traditional indigenous route that led to the Basin of Mexico. The route would have extended west from El Viejón across the mountain pass north of Cerro Cofre de Perote and onto the Central Plateau. From here, the most efficient route for transportation would have been northwest toward the Apan region, where Paredón is located (Charlton and Spence 1982:34-35) (Figure 20). This route would have avoided the mountains around the Basin of Mexico's eastern perimeter. It is known that obsidian, asphalt, salt, ceramic

Figure 20. El Viejón and the Mexican Obsidian sources present at San Andrés (triangles). Note possible trade route from the Basin of Mexico to the Gulf and the pass near Cerro Cofre de Perote, marked by a dotted line (after Clark and Pye 2000:8).

vessels, basalt, and hematite were some of the exchange items that passed through El Viejón (Wilkerson 1981:192), and its location would have made the regulation of trade goods efficient and effective.

Wilkerson (1981:191-194) suggests that the Middle Formative period introduction of platform mounds, specific figurine types, and new ceramics and their related technology at El Viejón indicate a close association with La Venta. Stela 1, a monumental stone sculpture in the La Venta art style (Figure 21) (see Chapter 2, La Venta), and the appearance of southern Gulf Coast ceramics (Wilkerson 2001:802) suggests a direct La Venta presence at El Viejón, possibly for the purpose of controlling exchange. The iconographic symbolism depicted on Stela 1 at El Viejón provides an ideological link to the Gulf Coast, where Middle Formative art at La Venta includes a focus on maize iconography. Both figures carved on the stela are holding objects that have been identified as "cornstalk scepters" (Wilkerson 1981:191; 2001:802). Manos and metates, which are traditionally used to grind maize, appear in the central Veracruz region in the Ojite Phase (ca 1500-1200 cal BC), just prior to the rise of La Venta's polity.



a. b.

Figure 21. El Viejón Stela 6, La Venta style monumental stone sculpture. a. Photo of carving. Note two facing figures (Wilkerson 1981:191). b. Line drawing of the left-hand figure. Note maize stalk in figure's right hand, the first occurrence of the maize motif in this area (Clark and Pye 2000:228).

The Formative period site of San Isidro, located on the banks of the Grijalva River in the northern piedmont of the Chiapas Plateau (Figure 22), is situated at the point where canoe traffic would have become possible downstream to the Gulf of Mexico. The site was on a historically known trade route connecting the interior of Chiapas, and by extension the Guatemala Highlands, to the Gulf Coast (Lee 1989:221; Lowe 1981:234). It was positioned at a point where the trade traffic could be controlled. Unfortunately, in June of 1966, the Netzahualcoyotl Dam, also known as *Mal Paso,* at the confluence of the Grijalva and La Venta Rivers, flooded the site. Six months of salvage archaeology was conducted immediately prior to the inundation (Lowe 1981; Navarrete 1966), producing significant evidence of relationships with La Venta. The limited investigation revealed substantial evidence of San Isidro's connections to La Venta. The astronomically oriented E-group architectural complex, comprised of a north-south aligned long mound with a pyramidal structure to the west, first appeared at La Venta. Similar complexes appeared later at San Isidro and other Upper Grijalva sites further upstream, including Chiapa de Corzo, Mirador, and La Libertad (Clark and Hansen 1999:3; Lowe 2001:644) (Figure 22). Clark (1999:6) postulates that only someone with detailed knowledge of the layout of La Venta could have planned and measured the complex at Chiapa de Corzo. It is possible that the same could have been said of San Isidro if more extensive investigations had been conducted at the site.

At San Isidro, artifacts showed striking similarities to those from La Venta. A series of offerings laid out in directionally oriented cross patterns contained polished stone celts that were typical of La Venta (Lowe 1981:252). Figurines and ceramic vessels containing Gulf Coast iconographic elements corresponded to La Venta ceramic complexes; these features are attributed to influence from the Gulf Coast center (Lee 1989:207, 208, 215; Lowe 2001:644; Lowe 1981:242-255). Ceramics similar to those from San Isidro were also found at San Andrés (von Nagy *et al.* 2001:5). All of these circumstances are attributed to the ascendancy of La Venta.

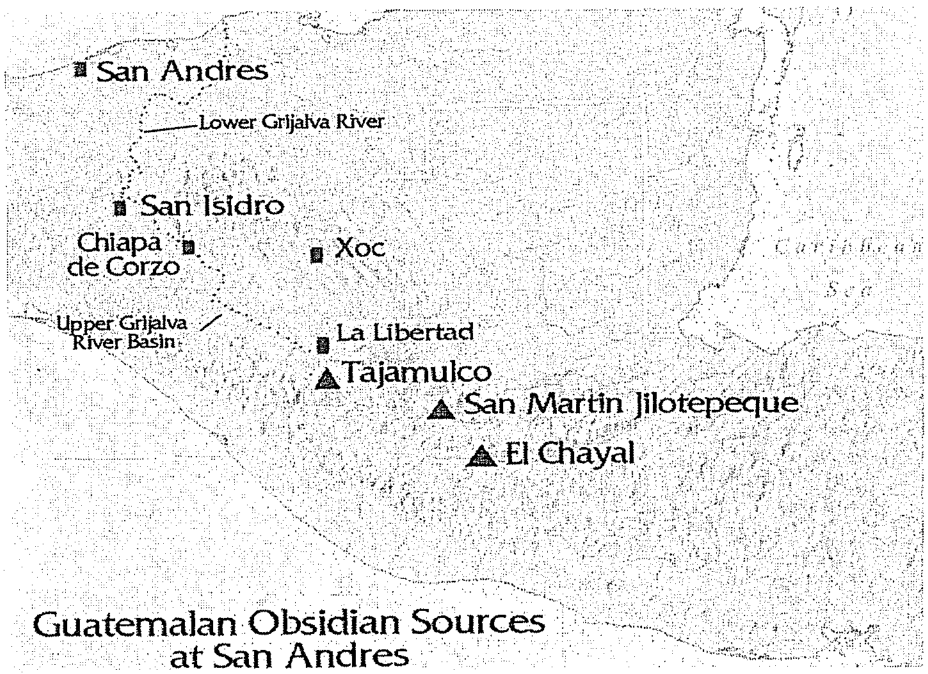


Figure 22. San Andrés, Upper Grijalva Basin sites (squares), and Guatemalan obsidian sources (triangles) (after Clark and Pye 2000:8).

A combined compositional and visual source analysis of obsidian recovered at Grijalva River sites by Clark and Lee (Clark 1988; Clark and Lee 1984; Lee 1989:214-215) indicates that three Guatemalan obsidian sources accounted for all of the material at these sites during the later stages of the Early Formative period (1400 to 1200 cal BC), prior to the introduction of prismatic blade technology. San Martín Jilotepeque supplied 50%, El Chayal 25%, and Tajumulco 25%. The quality of the obsidian from Tajumulco is poor, however, and while it was sufficient for flake industry production, it was not used in the manufacture of prismatic blades (Jackson and Love 1991:53). The introduction and expansion of prismatic blade use after 1200 B.C. would have caused a substantial decrease in the use of Tajumulco material. The ratio of San Martín to El Chayal obsidian found in Chiapas was two to one, essentially the same ratio that was identified in the San Andrés study.

There seems little doubt that the sites of San Isidro and El Viejón were directly connected economically and logistically, through waterborne transportation, to La Venta and in turn to San Andrés. Thus, the La Venta urban center had social connections with, possibly even a physical human presence in, distant centers that controlled a range of exotic items that could be readily transported to and from the southern Gulf Coast region. These items included jade, serpentine, ilmenite, magnetite, quartz, granite, diorite, andesite, and basalt. Ceramic styles and figurines flowed through both trade centers via La Venta (von Nagy *et al.* 2001:5,6). It was the movement of obsidian that was the common denominator among the three sites. The relationships that La Venta appears to have had with these two trade centers might explain the dominance of Paredón, San Martín, and El Chayal obsidian at San Andrés.

Obsidian Quantities at San Andrés

González Lauck (2000, personal communication) has noted that the quantities of obsidian, particularly prismatic blades, recovered archaeologically throughout the La Venta polity are modest in relationship to obsidian in later Mesoamerican societies. This assessment is in agreement with similar conclusions about the Formative period Gulf Coast reached by others (Clark 2001:554; Stokes, 1999:17). The sparse amount of obsidian recovered at San Andrés (493 grams or 17.5 ounces) is indicative of this

Formative period circumstance.

In the excavation units where Formative period obsidian was recovered at San Andrés (Units 1, 3, 5, 7, and 8), numerous associated artifacts suggest that these locations may have been specialized activity areas used for community feasts. For example, a substantial amount of obsidian from an Early Franco feasting event was deposited in a midden located in Units 7 and 8, and much of this obsidian does not show any sign of use-wear. This midden contained the material remains of a feast, and all items appear to have been ritually deposited upon completion of the event. The obsidian contained in this midden was likely present for the preparation of the feast and appears to have been deposited whether or not it was actually used. This deposition may have required that the burial of all items associated with the feast be deposited. The limited quantities of obsidian at San Andrés prompt questions as to why a lithic resource, already in limited supply, would be intentionally removed from circulation? Cyphers (1996:59) and Stark (1993:302) have commented on the possibility of stone having a "sacred" significance among Formative societies along the Gulf Coast.

At these types of special activity areas and feasting middens at San Andrés, the everyday tools and household items that were characteristic of craft production areas or residences are not evident. Middle Formative households and craft areas usually contained a broad assortment of specialized and non-specialized tools for performing a variety of everyday tasks, such as sewing, hide-tanning, spinning, and wood-working (Clark 1988:46). Obsidian tools, including unifacial or bifacial scrapers, choppers, drills, burins, projectile points, and other chipped stone implements would normally be expected at residential or craft areas, as seen at La Libertad (Clark 1988: 33-43), San

Lorenzo (Coe and Diehl 1980:246-259), and in the Copán Valley (Aoyama 1999:65-69). The collection of obsidian tools at San Andrés is limited to knife blades and flakes with sharp edges and little evidence of use-wear.

According to Burton (1987:306), specialized activity areas would contain a more restricted special-purpose tool and artifact assemblage than would be anticipated for a residential site. At San Andrés, distinctive types of refuse are exhibited in the ritual deposition of oversized food serving and storage vessels along with the obsidian and groundstone used to prepare the meal. The abundant floral and faunal material recovered from these same middens may be the remains of the feast itself. Ritual gift exchange is considered an integral part of many feasts (Hayden 2001:29-30), and the presence of a shark tooth pendant, cylinder seals, greenstone objects, and figurines recovered in association with these feasting deposits may strengthen the special location hypothesis.

Dietler and Hayden (2001:8-10) point out that as a general rule, in addition to the significant amounts of particular types of refuse deposited at the place of the feast, these locations are often set apart from residences spatially and may be connected with ritual architectural structures. Hayden (2001:39-40) adds that special structures were erected to hold ritual paraphernalia and the objects used in communal feasts. Daub wall material and clay floors were uncovered during the excavations at San Andrés. These objects may be remnants of residential structures, and most likely some of them were. Nonetheless, at the Precolumbian site of El Cerén in El Salvador, which dates to A.D. 590, Brown (2001) has proposed that a wattle and daub, clay-floored building (Structure 10) was a center for the production of community feasting and ceremonial activities. She has identified a number of functionally distinct activity areas, including locations for food preparation, ceramic vessel storage, and protection of ceremonial and ritual items. The structures indicated by the adobe and wattle and daub evidence at San Andrés may have been kitchen or storage facility floors, or stages for ritualized feasting events. This interpretation does not preclude the existence of house structures, only that they may be unidentifiable at this point.

The specialized activity area hypothesis is one possible explanation for the scant amount of obsidian recovered at San Andrés, but it does not explain the dearth of Formative period obsidian along the rest of the Gulf Coast. Prismatic blades seem to have been the primary imported obsidian item throughout all phases at San Andrés, but many of the blades were recycled through increased levels of bipolar reduction to extend their use-life. This situation suggests a shortage of raw material. The ability to transport large quantities of stone material is evident in the monumental stone sculpture and offerings found at La Venta, some individual pieces weigh upwards of 30 tons (Drucker and Heizer 1956:368-375; Williams and Heizer 1965:5, 7, 18-20). Therefore, if the supply of obsidian in the La Venta polity was limited, it does not appear to have been due to a lack of physical capability to transport stone material. Nonetheless, the question regarding the limited quantities of obsidian along the Gulf Coast during the Formative period remains an enigma.

CHAPTER 7

CONCLUDING REMARKS

Most of the archaeological investigations into the Formative period along the southern Gulf Coast of Mexico has centered on the major ceremonial centers of San Lorenzo and La Venta. San Andrés, a small mounded site near La Venta, presents an opportunity to examine the social, economic, and political relationships that developed between an urban center and a subsidiary site within this region and time period. Through the analysis of the San Andrés Formative period obsidian collection, clues to the nature and extent of this relationship have begun to emerge.

Analysis of the recovered obsidian has shown the presence of prismatic blades, along with flakes, beginning in the Molina phase (1400-1200 cal BC) and continuing throughout the Formative period occupational phases (900-400 cal BC). The presence of prismatic blades, generally associated with elites (Clark 1987:262) during the early stages of the Middle Formative phase (ca 1200 cal BC), suggests that social status at San Andrés was more differentiated than initially expected. These blades may have been produced outside of San Andrés. During Middle Formative times, lack of blade production debitage at San Andrés and evidence for obsidian workshops located near elite residences at La Venta center (Chávez 1990:31,32) support the idea that the raw material was imported to La Venta through elite-controlled acquisition networks. Blades and flakes may have been produced in the urban center's lithic workshops and redistributed to the people of San Andrés. As the edges of these implements were dulled from usage or a need for additional sharp edges arose at San Andrés, the material's use-life was extended through bipolar reduction, a technique that effectively utilized the material to its fullest extent. Bipolar reduction increased as the Middle Formative period progressed.

Obsidian implements may have been part of an asymmetrical exchange pattern between La Venta and San Andrés. If such a system existed, this system of exchange would have been dependent on the downward flow of utilitarian or exotic sumptuary goods acquired by the La Venta elite and redistributed to the people of San Andrés and other members of the larger polity. In return, the people of San Andrés may have provided agricultural products to the non-food producers in the urban core. Rust (1988:242) and von Nagy and his collaborators (2000:2-3) contend that evidence relating to maize and cultural artifacts from their investigations support these assumptions.

The relatively large number of obsidian sources represented at San Andrés was unexpected. The nine obsidian sources identified through visual and compositional analysis may indicate that San Andrés did, indeed, benefit from La Venta's far-reaching acquisition network. The paucity of obsidian in Formative San Andrés was curious, especially in view of the number of sources present.

The increases in the quantity of obsidian recovered at San Andrés, from the Early Puente (900-750 cal BC) through the Early Franco periods (650-550 cal BC) (Appendix A, Table 10), uphold the assumption of population growth at San Andrés concomitant with the rise of La Venta as a preeminent urban center (González Lauck 1996:80; Rust and Sharer 1988:104). Similarly, the reduction in the quantity of obsidian present during the Late Franco phase (550-400 cal BC) is reflective of the acknowledged abandonment of the La Venta center (Coe 1994:74).

The long-term dominance of obsidian from Paredón and San Martín Jilotepeque at San Andrés suggests enduring acquisition networks. Because the locations for these two sources are each more than 500 kilometers from San Andrés in opposite directions, it may be argued that their presence was due to two separate acquisition networks. One network may have involved importation of items such as jade, greenstone, ceramics, and obsidian from the Guatemalan Highlands to the southeast, possibly through the key site of San Isidro in Chiapas. The other network may have introduced similar type goods from the northern Basin of Mexico, via the trade center at El Viejón, on the western Gulf Coast.

The obsidian items, in combination with associated artifacts, imply that San Andrés shared in the prosperity of La Venta's dominion of the region, and that the inhabitants emulated some of the socio-religious activities of the urban center's elite (Rust 1992:127; Rust and Sharer 1988:104). The appearance of various types of ceramic figurines, incised greenstone, ritual blood-letters, cylinder seals, and a shark tooth pendant, indicates San Andrés' participation in an ideological system directed by La Venta's nobility.

Substantial evidence in the form of elaborate food serving vessels, oversized food storage containers, and manos and metates in association with faunal and botanical remains, reinforces the hypothesis of ritualized feasting. Such feasts would have included large-scale food preparation, gifting, drinking, and ritual discard at special community activity areas. The evaluation of obsidian tool types and use-wear evidence indicates a generally uniform pattern of tools used for light and medium cutting that is consistent with food preparation and activities associated with ritual feasting. The elite from La Venta, or from San Andrés, or in association with each other, may have sponsored these activities to reinforce elite status, to endorse patron-client relationships, and to validate the San Andrés leadership. The generosity displayed to the community would have contributed to the accumulation of prestige for both the La Venta and San Andrés elite.

Increased quantities of artifacts associated with feasts in Late Puente (750-650 cal BC) and Early Franco (650-550 cal BC) phases may indicate an increase in population, power, and wealth at San Andrés during La Venta's ascendancy. The increase in the obsidian that entered San Andrés mirrored this trend. Conversely, as La Venta declined as a capital center, the quantity of obsidian at San Andrés fell as well until the polity was effectively abandoned after 400 cal BC.

The overall quantity of obsidian artifacts recovered from San Andrés is considered minor compared to later Mesoamerican societies (Stokes 1999:17). The reasons for this limited lithic quantity remain unknown, and the apparent ritual deposition of usable obsidian only adds to the enigma.

Considerations of Past and Future Research

It is remarkable to think that the study of Paleolithic and Archaic peoples throughout the world has revolved almost solely around the detailed study of stone tools. Nonetheless, until the 1970s, meager attention was given to lithics found in Post-Archaic period sites, outside of minimal chronological and economic considerations (Braswell 2001:217). In the 1960s, Donald Crabtree presented a technological typology developed through his stone tool replication experiments (Crabtree 1968) that was followed by a behavioral typology of chipped stone artifacts formulated by Payson Sheets (Sheets 1972). Field reconnaissance of trade routes and obsidian sources by Thomas Charlton added to the expanding corpus of data on Mesoamerican obsidian (Charlton, 1976, 1978, 1982). Robert Cobean's field collections, together with Michael Glascock's laboratory analysis, led to the most complete collection of Mesoamerican obsidian source data yet assembled (Cobean *et al*. 1991; Glascock *et al*. 1998).

The importance of considering each obsidian artifact and extracting the maximum amount of information should be a primary goal of the archaeologist. Aoyama (1999:5) states that what is needed are finely controlled stratigraphic excavations and analyses that will delineate the obsidian industry. Recent work by Clark (1988, 1989, 1997), Braswell (1994, 1996, 2000), Aoyama (1994, 1999), McKillop (1995), Darling (1999), and others has raised the analysis of Precolumbian obsidian artifacts to a new degree of sophistication. Their efforts and methodologies have shown conclusively that it is not only possible to analyze entire obsidian collections, regardless of quantity, but that this is the best way to arrive at the most complete and accurate data. By combining the results of neutron activation analysis with visual identification and extrapolating the results to the entire collection, archaeologists can determine obsidian acquisition and technological production methods, knowledge that can add significantly to our understanding of Precolumbian socioeconomic processes.

The San Andrés project has attempted to follow a conjunctive approach to lithic studies in order to answer a number of questions, but, as with many research efforts, it has raised many more questions. Why was the Paredón source so dominant for so long at

San Andrés? Did this dominance occur at other Río Barí sites, and, most significantly, in the La Venta center as well? Were there differences in the types of material provided for particular social levels or particular tasks? How many other sources have escaped detection due to limited excavations, and are the percentages identified for the current San Andrés collection a valid indicator of the actual overall situation locally and inter-regionally? How was the obsidian imported, and what procedures were followed during its redistribution to a differentiated society? These and other questions may be answered with further research that compares the sources, percentages, functions, manufacturing methods, and contextual deposition of obsidian artifacts among Formative period Gulf Coast sites. This type of comparison can be applied to nearby mounded Río Barí sites, such as Isla Yucateca and San Miguel, and to unmounded sites, such as Isla Chicozapote and Isla Alor.

At La Venta, more investigative work is needed in craft production areas and in residential zones of different status to produce comparable obsidian-related data. Determining whether the Formative period La Venta obsidian assemblages are comparable to those at San Andrés would add significant insight into the production and redistribution processes. Further investigation of El Viejón may produce evidence explaining the movement of materials and the socioeconomic relationships between the Gulf Coast and the Basin of Mexico.

The previous obsidian sourcing projects outlined in Chapter 4 have provided a solid foundation upon which to build. Nonetheless, those conclusions should be updated as new evidence, new technologies, and new understanding of the questions arise. For example, the source at Paredón was unknown prior to 1976, and the Ucaréo source material was incorrectly attributed until the 1980s. Elemental analysis can now differentiate between sources that could not be isolated previously, and the "unidentified source" category has been all but eliminated. The success and accuracy of visual comparison and identification has allowed entire obsidian collections to be analyzed thoroughly instead of using only small samples. These advancements have provided an opportunity to elicit extensive anthropological evidence from volcanic glass. Comparative data can now be gathered from contemporaneous sites throughout Mesoamerica, using a standardized methodology for data collection. New investigations adopting these methodologies can add substantial information to the growing corpus of Mesoamerican obsidian studies on a local, regional, and pan-Mesoamerican basis. Obsidian's ubiquity in every region of Formative Mesoamerica, its durability and resilience, and archaeologists' ability to trace its source of origin, make it an ideal material to elucidate prehistoric social, political, and economic relationships.

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APPENDIX A

Table 9. Middle Formative period ceramic complexes
and radiocarbon dates from San Andrés and La Venta, Tabasco, Mexico.
(Pope *et. al*. 2001; Rust 1988; Sisson 1978; von Nagy *et. al*. 2001)

Ceramic Complex	**Project**	**Location**	**Sample ID**	**Radiocarbon Range B.P.**	**Calibrated calendar yrs. B.C.**	**Sample Material**
Estero	Pohl & Pope, Barí 1	Unit 1, level 41	Beta-112672	3720-3640	2197-1941[1]	Charcoal
	Pohl & Pope, Barí 1	Unit 8, Level 15	Beta-122242	3870-3720	2465-1984[1]	Charcoal
	Rust, Barí 1	Unit 2-3, Level 10	Beta-18198	3400-3280	1690-1520[2]	N/A
	Pohl & Pope, Barí 1	Unit 1, Feature 18	Beta-112671*	3140-3040	1488-1135[1]	Charcoal
Molina	Pohl & Pope, Barí 1	Unit 1, Feature 18	Beta-106946	3030-2870	1405-920[1]	Charcoal
	Sisson, T-8	Unit 1, Level 8	GX-1839	3245-3035	1530-1260[2]	N/A
	Sisson, T-1	Unit 2, Level 6	GX-1837	2975-2735	1260-860[2]	N/A
Early Puente	Squier, La Venta	Pit C, 255-270cm	UCLA-1276b	3010-2850	1260-1000[2]	Charcoal
	Heizer. La Venta, 1968	Stirling Platform, pottery sounding	UCLA-1355	2960-2840	1220-990[2]	Charcoal
	Squier, La Venta	Pit C, 240-253cm	UCLA-1276a	2845-2685	1000-820[2]	Charcoal
	von Nagy, ESP-50	Op-9, Level 14	Beta-85654	2560-2440	790-520[2]	N/A
Late Puente	Rust, La Venta Complex E	Op-29-1, Level 3	Beta-17484	2770-2590	980-780[2]	N/A
	Pohl & Pope, Barí 1	Unit 1, Feature 9	Beta-112669*	2560-2460	800-409[1]	Charcoal
	Pohl and Pope, Barí 1	Unit 7, Level 15	AA33926*	2550-2460	797-410[1]	*Zea mays* cob
	Heizer, La Venta	Unit 1968-9, 101.6-106.8 cm	UCLA-1351	2540-2380	760-400[2]	Charcoal
Early Franco	Pohl and Pope, Barí 1	Unit 7, Level 9, BGS clay	Beta-122241	2530-2450	792-409[1]	Charcoal
Late Franco	Pohl and Pope, Barí 1	Unit 1, Feature 3a	Beta-112668	2430-2250	764-182[1]	Charcoal
	Sisson T-5	Unit 1, Level 9	GX-1842	2425-2235	800-200[2]	N/A

* AMS dates [1] Calib 4.2 (Stuver *et al*. 2000) [2] OxCal 3.5 (Bronk Ramsey 2000)

APPENDIX A

Table 10. Quantitative Analysis of San Andrés Obsidian Artifacts by Source and Phase

Chronological Phases by Unit

UNIT 1

SOURCE	MOLINA			EARLY PUENTE			LATE PUENTE			EARLY FRANCO			LATE FRANCO			TOTALS		
	1400-1200 BC			900-750 BC			750-650 BC			650-550 BC			550-400 BC					
	Quant.	Weight	% weight	Quant.	Weight	% weight	Quant.	Weight	% weight	Quant.	Weight	% weight	Quant.	Weight	% weight	Quant.	Weight	% weight
UCARÉO	-	-	-	1	0.9	5.4	-	-	-	-	-	-	-	-	-	1	0.9	0.8
PACHUCA	-	-	-	1	0.6	3.6	3	0.7	2.2	-	-	-	9	2.1	3.6	13	3.4	3.2
ORIZABA	-	-	-	-	-	-	-	-	-	-	-	-	3	1.1	1.9	3	1.1	1.2
ZARAGOZA	-	-	-	-	-	-	1	1.0	3.2	-	-	-	5	2.9	5.0	6	3.9	3.8
TAJUMULCO	-	-	-	1	0.3	1.8	1	0.5	1.7	-	-	-	3	1.3	2.2	5	2.1	2.1
EL CHAYAL	-	-	-	-	-	-	5	4.4	14.2	-	-	-	16	8.9	15.3	21	13.3	12.6
SAN MARTÍN	-	-	-	8	9.6	57.8	18	16.0	51.1	-	-	-	34	14.8	25.3	60	40.4	37.8
PAREDÓN	-	-	-	6	4.8	29.0	15	8.6	27.6	-	-	-	43	27.2	46.7	64	40.6	38.0
OTUMBA	-	-	-	1	0.4	2.4	-	-	-	-	-	-	-	-	-	1	0.4	0.5
TOTALS	-	-	-	18	16.6	100.0	43	31.2	100.0	-	-	-	113	58.3	100.0	174	106.1	100.0

UNIT 3

SOURCE	MOLINA			EARLY PUENTE			LATE PUENTE			EARLY FRANCO			LATE FRANCO			TOTALS		
	1400-1200 BC			900-750 BC			750-650 BC			650-550 BC			550-400 BC					
	Quant.	Weight	% weight	Quant.	Weight	% weight	Quant.	Weight	% weight	Quant.	Weight	% weight	Quant.	Weight	% weight	Quant.	Weight	% weight
UCARÉO	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PACHUCA	-	-	-	-	-	-	10	6.5	28.9	-	-	-	-	-	-	10	6.5	18.3
ORIZABA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ZARAGOZA	-	-	-	-	-	-	1	0.7	3.1	-	-	-	-	-	-	1	0.7	1.9
TAJUMULCO	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
EL CHAYAL	-	-	-	-	-	-	3	1.5	6.6	-	-	-	-	-	-	3	1.5	4.2
SAN MARTÍN	-	-	-	1	0.6		2	0.9		-	-	-	-	-	-	3	1.5	41.0
PAREDÓN	-	-	-	-	-	-	2	12.3	54.8	-	-	-	7	13.1	100.0	9	25.4	34.6
OTUMBA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

TOTALS	-	-	-	1	0.6		18	21.9	100.0	-	-	-	7	13.1	100.0	26	35.6	100.0

Table 10. Continued

UNIT 5

SOURCE	MOLINA			EARLY PUENTE			LATE PUENTE			EARLY FRANCO			LATE FRANCO			TOTALS		
	1400-1200 BC			900-750 BC			750-650 BC			650-550 BC			550-400 BC					
	Quant.	Weight	% weight	Quant.	Weight	% weight	Quant.	Weight	% weight	Quant.	Weight	% weight	Quant.	Weight	% weight	Quant.	Weight	% weight
UCARÉO	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PACHUCA	-	-	-	-	-	-	2	0.4	23.5	2	0.2	8.7	-	-	-	4	0.6	15.0
ORIZABA	-	-	-	-	-	-	-	-	-	1	0.4	17.4	-	-	-	1	0.4	10.0
ZARAGOZA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TAJUMULCO	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
EL CHAYAL	-	-	-	-	-	-	2	0.4	23.5	-	-	-	-	-	-	2	0.4	10.0
SAN MARTÍN	-	-	-	-	-	-	1	0.2	11.8	-	-	-	-	-	-	1	0.2	5.0
PAREDÓN	-	-	-	-	-	-	4	0.7	41.2	4	1.7	73.9	-	-	-	8	2.4	60.0
OTUMBA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TOTALS	-	-	-	-	-	-	9	1.7	100.0	7	2.3	100.0	-	-	-	16	4.0	100.0

UNIT 7

SOURCE	MOLINA			EARLY PUENTE			LATE PUENTE			EARLY FRANCO			LATE FRANCO			TOTALS		
	1400-1200 BC			900-750 BC			750-650 BC			650-550 BC			550-400 BC					
	Quant.	Weight	% weight	Quant.	Weight	% weight	Quant.	Weight	% weight	Quant.	Weight	% weight	Quant.	Weight	% weight	Quant.	Weight	% weight
UCARÉO	-	-	-	-	-	-	-	-	-	3	2.4	1.0	-	-	-	3	2.4	0.9
PACHUCA	-	-	-	-	-	-	-	-	-	6	3.2	1.2	-	-	-	6	3.2	1.1
ORIZABA	-	-	-	-	-	-	-	-	-	1	0.2	0.1	-	-	-	1	0.2	0.1
ZARAGOZA	-	-	-	-	-	-	-	-	-	3	2.2	0.9	-	-	-	3	2.2	0.8
TAJUMULCO	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
EL CHAYAL	-	-	-	-	-	-	-	-	-	37	25.2	10.0	-	-	-	37	25.2	8.8
SAN MARTÍN	1	1.4	6.5	1	1.2	11.8	-	-	-	60	50.6	19.9	-	-	-	62	53.2	18.6

PAREDÓN	4	20.3	93.5	6	8.9	88.2	-	-	-	241	170.0	66.9	-	-	-	251	199.2	69.7
OTUMBA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TOTALS	5	21.7	100.0	7	10.1	100.0	-	-	-	351	253.8	100.0	-	-	-	363	285.6	100.0

Table 10. Continued

UNIT 8

SOURCE	MOLINA 1400-1200 BC			EARLY PUENTE 900-750 BC			LATE PUENTE 750-650 BC			EARLY FRANCO 650-550 BC			LATE FRANCO 550-400 BC			TOTALS		
	Quant.	Weight	% weight	Quant.	Weight	% weight	Quant.	Weight	% weight	Quant.	Weight	% weight	Quant.	Weight	% weight	Quant.	Weight	% weight
UCARÉO	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PACHUCA	-	-	-	1	0.2	4.9	-	-	-	1	0.8	1.2	-	-	-	2	1.0	1.3
ORIZABA	-	-	-	-	-	-	-	-	-	1	1.6	2.4	-	-	-	1	1.6	2.2
ZARAGOZA	-	-	-	-	-	-	-	-	-				-	-	-	-	-	-
TAJUMULCO	-	-	-		-	-	-	-	-	3	1.0	1.5	-	-	-	3	1.0	1.3
EL CHAYAL	-	-	-	-	-	-	-	-	-	6	5.8	8.4	-	-	-	6	5.8	7.9
SAN MARTÍN	1	1.0	100.0	-	-	-	-	-	-	11	19.6	28.6	-	-	-	12	20.6	28.0
PAREDÓN	-	-	-	3	3.9	95.1	-	-	-	30	39.7	57.9	-	-	-	33	43.6	59.3
OTUMBA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
														--				
TOTALS	1	1.0	100.0	4	4.1	100.0				52	68.5	100.0	-	-	-	57	73.6	100.0

TOTALS FROM ALL UNITS

SOURCE	MOLINA 1400-1200 BC			EARLY PUENTE 900-750 BC			LATE PUENTE 750-650 BC			EARLY FRANCO 650-550 BC			LATE FRANCO 550-400 BC			TOTALS		
	Quant.	Weight	% weight	Quant.	Weight	% weight	Quant.	Weight	% weight	Quant.	Weight	% weight	Quant.	Weight	% weight	Quant.	Weight	% weight
UCARÉO	-	-	-	1	0.9	2.9	-	-	-	3	2.4	0.8	-	-	-	4	3.3	0.7
PACHUCA	-	-	-	2	0.8	2.7	15	7.5	13.8	9	4.2	1.3	9	2.1	2.8	35	14.6	2.8
ORIZABA	-	-	-	-	-	-	-	-	-	3	2.2	0.7	3	1.1	1.6	6	3.3	0.7
ZARAGOZA	-	-	-	-	-	-	2	1.7	3.1	3	2.2	0.7	5	2.9	3.9	10	6.8	1.3
TAJUMULCO	-	-	-	1	0.3	1.0	1	0.5	0.5	3	1.0	0.4	3	1.3	1.8	8	3.1	0.6
EL CHAYAL	-	-	-	-	-	-	10	6.3	11.4	43	31.0	9.6	16	8.9	12.2	69	46.2	9.1
SAN MARTÍN	2	2.4	10.6	10	11.4	36.0	21	17.1	31.3	71	70.2	21.5	34	14.8	22.1	138	115.9	23.0

PAREDÓN	4	20.3	89.4	15	17.6	56.1	21	21.6	39.5	275	211.4	65.0	50	40.3	55.1	365	311.2	61.7
OTUMBA	-	-	-	1	0.4	1.3	-	-	-	-	-	-	-	-	-	1	0.4	0.1
TOTALS	6	22.7	100.0	30	31.4	100.0	70	54.7	100.0	410	324.6	100.0	120	71.4	100.0	636	504.8	100.0

APPENDIX A

Table 11. San Andrés Obsidian Industries

Blade, Flake, and Bipolar Products

By Source and Phase

UNIT 1

SOURCE	MOLINA 1400-1200 BC			EARLY PUENTE 900-750 BC			LATE PUENTE 750-650 BC			EARLY FRANCO 650-550 BC			LATE FRANCO 550-400 BC			TOTALS		
	Blades	Flakes	Bipolar	Blades	Flakes	Bipolar	Blades	Flakes	Bipolar	Blades	Flakes	Bipolar	Blades	Flakes	Bipolar	Blades	Flakes	Bipolar
UCARÉO	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	1	-	-
PACHUCA	-	-	-	1	-	-	-	1	2	-	-	-	2	-	7	3	1	9
ORIZABA	-	-	-	-	-	-	-	-	-	-	-	-	3	-	-	3	-	-
ZARAGOZA	-	-	-	-	-	-	1	-	-	-	-	-	1	1	3	2	1	3
TAJUMULCO	-	-	-	-	-	1	-	1	-	-	-	-	-	1	2	-	2	3
EL CHAYAL	-	-	-	-	-	-	-	-	5	-	-	-	3	2	11	3	2	16
SAN MARTÍN	-	-	-	5	-	3	8	1	9	-	-	-	6	1	27	19	2	39
PAREDÓN	-	-	-	-	2	4	5	3	7	-	-	-	7	5	31	12	10	42
OTUMBA	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	1	-
TOTALS	-	-	-	7	3	8	14	6	23	-	-	-	22	10	81	43	19	112

UNIT 3

SOURCE	MOLINA 1400-1200 BC			EARLY PUENTE 900-750 BC			LATE PUENTE 750-650 BC			EARLY FRANCO 650-550 BC			LATE FRANCO 550-400 BC			TOTALS		
	Blades	Flakes	Bipolar	Blades	Flakes	Bipolar	Blades	Flakes	Bipolar	Blades	Flakes	Bipolar	Blades	Flakes	Bipolar	Blades	Flakes	Bipolar
UCARÉO	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PACHUCA	-	-	-	-	-	-	3	4	3	-	-	-	-	-	-	3	4	3
ORIZABA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ZARAGOZA	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	1	-	-
TAJUMULCO	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
EL CHAYAL	-	-	-	-	-	-	-	-	3	-	-	-	-	-	-	-	-	3
SAN MARTÍN	-	-	-	-	-	1	1	-	1	-	-	-	-	-	-	1	-	2
PAREDÓN	-	-	-	-	-	-	1	-	1	-	-	-	1	-	6	2	-	7
OTUMBA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

TOTALS	-	-	-	-	-	1	6	4	8	-	-	-	1	-	6	7	4	15

Table 11. Continued

UNIT 5

SOURCE	MOLINA			EARLY PUENTE			LATE PUENTE			EARLY FRANCO			LATE FRANCO			TOTALS		
	1400-1200 BC			900-750 BC			750-650 BC			650-550 BC			550-400 BC					
	Blades	Flakes	Bipolar	Blades	Flakes	Bipolar	Blades	Flakes	Bipolar	Blades	Flakes	Bipolar	Blades	Flakes	Bipolar	Blades	Flakes	Bipolar
UCARÉO	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PACHUCA	-	-	-	-	-	-	-	-	2	-	-	2	-	-	-	-	-	4
ORIZABA	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	1
ZARAGOZA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TAJUMULCO	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
EL CHAYAL	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	2
SAN MARTÍN	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	1
PAREDÓN	-	-	-	-	-	-	-	-	4	1	-	3	-	-	-	1	-	7
OTUMBA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TOTALS	-	-	-	-	-	-	-	-	9	1	-	6	-	-	-	1	-	15

UNIT 7

SOURCE	MOLINA			EARLY PUENTE			LATE PUENTE			EARLY FRANCO			LATE FRANCO			TOTALS		
	1400-1200 BC			900-750 BC			750-650 BC			650-550 BC			550-400 BC					
	Blades	Flakes	Bipolar	Blades	Flakes	Bipolar	Blades	Flakes	Bipolar	Blades	Flakes	Bipolar	Blades	Flakes	Bipolar	Blades	Flakes	Bipolar
UCARÉO	-	-	-	-	-	-	-	-	-	3	-	-	-	-	-	3	-	-
PACHUCA	-	-	-	-	-	-	-	-	-	-	1	5	-	-	-	-	1	5
ORIZABA	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	1	-	-
ZARAGOZA	-	-	-	-	-	-	-	-	-	-	2	1	-	-	-	-	2	1
TAJUMULCO	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
EL CHAYAL	-	-	-	-	-	-	-	-	-	9	2	26	-	-	-	9	2	26
SAN MARTÍN	1	-	-	1	-	-	-	-	-	28	5	27	-	-	-	30	5	27
PAREDÓN	3	-	1	3	-	3	-	-	-	49	10	182	-	-	-	55	10	186
OTUMBA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TOTALS	4	-	1	4	-	3	-	-	-	90	20	241	-	-	-	98	20	245

Table 11. Continued

UNIT 8

SOURCE	MOLINA			EARLY PUENTE			LATE PUENTE			EARLY FRANCO			LATE FRANCO			TOTALS		
	1400-1200 BC			900-750 BC			750-650 BC			650-550 BC			550-400 BC					
	Blades	Flakes	Bipolar	Blades	Flakes	Bipolar	Blades	Flakes	Bipolar	Blades	Flakes	Bipolar	Blades	Flakes	Bipolar	Blades	Flakes	Bipolar
UCARÉO	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PACHUCA	-	-	-	-	-	1	-	-	-	-	1	-	-	-	-	-	1	1
ORIZABA	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	1	-	-
ZARAGOZA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TAJUMULCO	-	-	-	-	-	-	-	-	-	-	-	3	-	-	-	-	-	3
EL CHAYAL	-	-	-	-	-	-	-	-	-	2	1	3	-	-	-	2	1	3
SAN MARTÍN	1	-	-	-	-	-	-	-	-	9	-	2	-	-	-	10	-	2
PAREDÓN	-	-	-	1	1	1	-	-	-	14	1	15	-	-	-	15	2	16
OTUMBA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TOTALS	1	-	-	1	1	2	-	-	-	26	3	23	-	-	-	28	4	25

UNIT TOTALS

SOURCE	MOLINA			EARLY PUENTE			LATE PUENTE			EARLY FRANCO			LATE FRANCO			TOTALS		
	1400-1200 BC			900-750 BC			750-650 BC			650-550 BC			550-400 BC					
	Blades	Flakes	Bipolar	Blades	Flakes	Bipolar	Blades	Flakes	Bipolar	Blades	Flakes	Bipolar	Blades	Flakes	Bipolar	Blades	Flakes	Bipolar
UCARÉO	-	-	-	1	-	-	-	-	-	3	-	-	-	-	-	4	-	-
PACHUCA	-	-	-	1	-	1	3	5	7	-	2	7	2	-	7	6	7	22
ORIZABA	-	-	-	-	-	-	-	-	-	2	-	1	3	-	-	5	-	1
ZARAGOZA	-	-	-	-	-	-	2	-	-	-	2	1	2	1	2	4	3	3
TAJUMULCO	-	-	-	-	-	1	-	1	-	-	-	3	-	1	2	-	2	6
EL CHAYAL	-	-	-	-	-	-	-	-	10	11	3	29	3	2	11	14	5	50
SAN MARTÍN	2	-	-	6	-	4	8	1	12	37	5	29	6	1	27	60	7	71
PAREDÓN	3	-	1	4	3	8	6	3	12	64	11	200	8	5	37	85	22	258
OTUMBA	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	1	-
TOTALS	5	-	1	12	4	14	19	10	41	117	23	270	24	10	86	178	47	411

APPENDIX A

Table 12. Blades, Flakes, and Bipolar Reduction by Weight
(Units 1, 3, and 5 only)

UNIT 1

SOURCE	MOLINA			EARLY PUENTE			LATE PUENTE			EARLY FRANCO			LATE FRANCO			TOTALS		
	1400-1200 BC			900-750 BC			750-650 BC			650-550 BC			550-400 BC					
	Blade	Flake	Bipol	Blades	Flakes	Bipolar	Blades	Flakes	Bipolar	Blade	Flake	Bip	Blades	Flakes	Bipolar	Blades	Flake	Bipolar
UCARÉO	-	-	-	1/ 0.9	-	-	-	-	-	-	-	-	-	-	-	1/0.9	-	-
PACHUCA	-	-	-	1/ 0.6	-	-	-	1/ 0.3	2/ 0.4	-	-	-	2/ 0.2	-	7/ 1.9	3/ 0.8	1/ 0.3	9/ 2.3
ORIZABA	-	-	-	-	-	-	-	-	-	-	-	-	3/ 1.1	-	-	3/ 1.1	-	-
ZARAGOZA	-	-	-	-	-	-	1/ 1.0	-	-	-	-	-	1/ 0.7	1/ 0.7	3/ 1.5	2/ 1.7	1/ 0.7	3/ 1.5
TAJUMULCO	-	-	-	-	-	1/ 0.3	-	1/ 0.5	-	-	-	-	-	1/ 0.4	2/ 0.9	-	2/ 0.9	3/ 1.2
EL CHAYAL	-	-	-	-	-	-	-	-	5/ 4.4	-	-	-	3/ 3.6	2/ 1.0	11/ 4.3	3/ 3.6	2/ 1.0	16/ 8.7
SAN MARTÍN	-	-	-	5/ 6.2	-	3/ 3.4	8/ 6.2	1/ 1.0	9/ 8.8	-	-	-	6/ 5.9	1/ 0.9	27/ 8.0	19/ 18.3	2/ 1.9	39/ 20.2
PAREDÓN	-	-	-	-	2/ 1.4	4/ 3.4	5/ 4.5	3/ 1.6	7/ 2.5	-	-	-	7/ 5.8	5/ 1.8	31/ 19.6	12/ 10.3	10/ 4.8	42/ 25.5
OTUMBA	-	-	-	-	1/ 0.4	-	-	-	-	-	-	-	-	-	-	-	1/ 0.4	-
TOTALS	-	-	-	7/ 7.7	3/ 1.8	8/ 7.1	14/ 11.7	6/ 3.4	24/ 16.6	-	-	-	22/17.3	10/ 4.8	81/ 36.2	43/ 36.7	19/ 10.0	112/ 59.4

UNIT 3

SOURCE	MOLINA			EARLY PUENTE			LATE PUENTE			EARLY FRANCO			LATE FRANCO			TOTALS		
	1400-1200 BC			900-750 BC			750-650 BC			650-550 BC			550-400 BC					
	Blades	Flakes	Bipolar	Blades	Flakes	Bipolar	Blades	Flakes	Bipolar	Blades	Flakes	Bipolar	Blades	Flake	Bipolar	Blades	Flakes	Bipolar
UCARÉO	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PACHUCA	-	-	-	-	-	-	3/2.2	4/ 2.8	3/ 1.5	-	-	-	-	-	-	3/ 2.2	4/ 2.8	3/ 1.5
ORIZABA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ZARAGOZA	-	-	-	-	-	-	1/ 0.7	-	-	-	-	-	-	-	-	1/ 0.7	-	-
TAJUMULCO	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
EL CHAYAL	-	-	-	-	-	-	-	-	3/ 1.5	-	-	-	-	-	-	-	-	3/ 1.5
SAN MARTÍN	-	-	-	-	-	1/ 0.6	1/ 0.1	-	1/ 0.8	-	-	-	-	-	-	1/ 0.1	-	2/ 1.4
PAREDÓN	-	-	-	-	-	-	1/ 11.5	-	1/ 0.8	-	-	-	1/ 10.7	-	6/ 2.4	2/ 22.2	-	7/ 3.2
OTUMBA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

TOTALS	-	-	-	-	-	1/ 0.6	6/ 14.5	4/ 2.8	8/ 4.6	-	-	-	1/ 10.7	-	6/ 2.4	7/ 25.2	4/ 2.8	15/ 7.6

Table 12. Continued

UNIT 5

SOURCE	MOLINA 1400-1200 BC			EARLY PUENTE 900-750 BC			LATE PUENTE 750-650 BC			EARLY FRANCO 650-550 BC			LATE FRANCO 550-400 BC			TOTALS		
	Blades	Flakes	Bipolar	Blades	Flakes	Bipolar	Blades	Flakes	Bipolar	Blades	Flakes	Bipolar	Blades	Flakes	Bipolar	Blades	Flake	Bipolar
UCARÉO	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
PACHUCA	-	-	-	-	-	-	-	-	2/ 0.4	-	-	2/ 0.2	-	-	-	-	-	4/ 0.6
ORIZABA	-	-	-	-	-	-	-	-	-	-	-	1/ 0.4	-	-	-	-	-	1/ 0.4
ZARAGOZA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TAJUMULCO	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
EL CHAYAL	-	-	-	-	-	-	-	-	2/ 0.4	-	-	-	-	-	-	-	-	2/ 0.4
SAN MARTÍN	-	-	-	-	-	-	-	-	1/ 0.2	-	-	-	-	-	-	-	-	1/ 0.2
PAREDÓN	-	-	-	-	-	-	-	-	4/ 0.7	1/ 1.0	-	3/ 0.7	-	-	-	1/ 1.0	-	7/ 1.4
OTUMBA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TOTALS	-	-	-	-	-	-	-	-	9/ 1.7	1/ 1.0	-	6/ 1.3	-	-	-	1/ 1.0	-	15/ 3.0

UNITS 1, 3, and 5 TOTALS

SOURCE	MOLINA 1400-1200 BC			EARLY PUENTE 900-750 BC			LATE PUENTE 750-650 BC			EARLY FRANCO 650-550 BC			LATE FRANCO 550-400 BC			TOTALS		
	Blade	Flake	Bip	Blade	Flake	Bipolar	Blade	Flake	Bipolar	Blade	Flk	Bipolar	Blades	Flakes	Bipolar	Blades	Flakes	Bipolar
UCARÉO	-	-	-	1/ 0.9	-	-	-	-	-	-	-	-	-	-	-	1/ 0.9	-	-
PACHUCA	-	-	-	1/ 0.6	-	-	3/ 2.2	5/ 3.1	7/ 2.3	-	-	2/ 0.2	2/ 0.2	-	7/ 1.9	6/ 3.0	5/ 3.1	16/ 4.4
ORIZABA	-	-	-	-	-	-	-	-	-	-	-	1/ 0.4	3/ 1.1	-	-	3/ 1.1	-	1/ 0.4
ZARAGOZA	-	-	-	-	-	-	1/ 1.0	-	-	-	-	-	1/ 0.7	1/ 0.7	3/ 1.5	2/ 1.7	1/ 0.7	3/ 1.5
TAJUMULCO	-	-	-	-	-	1/ 0.3	-	1/ 0.5	-	-	-	-	-	1/ 0.4	2/ 0.9	-	2/ 0.9	3/ 1.2
EL CHAYAL	-	-	-	-	-	-	-	-	10/ 6.3	-		-	3/ 3.6	2/ 1.0	11/ 4.3	3/ 3.6	2/ 1.0	21/ 10.6
SAN MARTÍN	-	-	-	5/ 6.2	-	4/ 4.0	9/ 6.3	1/ 1.0	11/ 9.8		-	-	6/ 5.9	1/ 0.9	27/ 8.0	20/ 18.4	2/ 1.9	42/ 21.8
PAREDÓN	-	-	-		2/ 1.4	4/ 3.4	6/ 16.0	3/ 1.6	12/ 4.0	1/ 1.0	-	3/ 0.7	8/ 16.5	5/ 1.8	37/ 22.0	15/ 33.5	10/ 4.8	56/ 30.1
OTUMBA	-	-	-	-	1/ 0.4	-	-	-	-	-	-	-	-	-	-	-	1/ 0.4	-
TOTALS	-	-	-	7/ 7.7	3/ 1.8	9/ 7.7	19/ 25.5	10/ 6.2	41/ 22.4	1/ 1.0	-	6/ 1.3	23/28.	10/ 4.8	87/ 38.6	50/ 62.2	23/ 12.8	142/ 70.0

APPENDIX A

Table 13. San Andrés Obsidian Artifacts

The San Andrés Obsidian Collection

Listing contains all obsidian artifacts encountered during excavation.
Underlined FS numbers and italicized entries denote mixed, Post Classic
or other material not included in the research project.

UNIT 1

FS#	Unit	Level/Feature	Depth/cm	Date	Visual	NAA	Qty	Wgt	Description
194	*1-S*	*1 Surface*	*20-40*	*AD 1250+ Mixed*	*PAR*	-	*4*	*0.9*	*1 bipolar edge*
									2 small bipolar flake fragments
									1 bipolar flake
015	*1*	*2 Top soil*	*20-40*	*Mixed*	*PAR*	-	*6*	*4.4*	*1 large fragment*
									1 bipolar edge
									1 first series prismatic blade, medial
									1 bipolar flake on blade fragment
					PAC	-	*3*	*1.1*	*1 bipolar core fragment on pr blade*
									2 bipolar flakes
					SMJ	-	*10*	*4.6*	*1 pr blade, proximal.*
									1 pr blade, distal.
									2 bipolar cores on pr blades
									1 bipolar edge
									1 large fragment
									4 bipolar flake fragments
133	*1*	*2- F1/1A*	*85-95*	*600-400 BC Mixed LC/LF*	*PAR*	-	*4*	*1.3*	*4 bipolar flakes from pr blade.*
251	*1*	*8 Ceramic midden*	*105-115*	*750-550 BC Mixed LP/EF*	*SMJ*	-	*4*	*2.7*	*1 bipolar flake fragment on pr blade*
									3 Fragments of 1 pr blade, medial
					PAR	-	*2*	*2.0*	*1 bipolar core on pr blade*
									1 large fragment
029	1	3 Brown clay	40-60	550-400 BC Late Franco	CHY	-	2	1.0	1 bipolar flake from pr blade
									1 small bipolar flake from pr blade
					PAR	-	3	0.8	3 bipolar flake fragments from pr blades
							1	0.2	1 bipolar flake fragment
					PAR	PAR	3	2.1	1 bipolar flake fragment from pr blade
					ZAR	ZAR			1 pr blade, proximal, medium cutting edge
					ZAR	-			1 pr blade, distal
					SMJ	-	20	6.4	13 bipolar flake fragments
									1 bipolar edge
									2 bipolar core on pr blades
									4 bipolar flake from pr blade
					PAC	-	2	0.4	2 bipolar edges
038	1	3 Daub	40-60	550-400 BC	PAR	-	2	0.8	2 small bipolar core fragments
					PAC	-	1	0.2	1 bipolar flake on pr blade
043	1	4 Daub	40-60	550-400 BC	PAR	-	2	3.4	1 bipolar core
									1 pr blade, distal

					ORZ	-	2	0.6	2 fragments of same pr blade, proximal & distal, lancet point
					ORZ	ORZ	1	0.5	1 pr blade, medial

Table 13. San Andrés Obsidian Artifacts Continued

FS#	Unit	Level/Feature	Depth/cm	Date	Visual	NAA	Qty	Wgt	Description
048	I	3	40-60	550-400 BC	ZAR	ZAR	1	0.4	1 small flake
036	I	4 Brown clay	60-70	550-400 BC	PAC	-	2	0.7	1 bipolar edge, hard cutting
									1 bipolar flake
					SMJ	-	1	0.9	1 large fragment, light cutting
					ZAR	-	1	0.1	1 bipolar edge
					TAJ	-	1	0.6	1 bipolar flake
					PAR	-	3	1.8	1 large fragment
									2 small blade flakes
053	I	4	60-75	550-400 BC	SMJ	-	1	1.1	1 pr blade, medial, light cutting & scraping
					PAR	-	4	0.8	1 bipolar edge
									2 bipolar flake fragments
									1 bipolar flake
060	I	4 Brown clay	60-75	550-400 BC	PAR	-	1	1.0	1 bipolar flake from pr blade, medial
094	I	4 Brown clay	60-75	550-400 BC	PAC	-	1	0.1	1 very small blade fragment
					PAR	-	8	3.2	2 large fragments on pr blade
									4 bipolar flake fragment
									2 bipolar flakes
					SMJ	-	2	0.5	1 bipolar flake
									1 bipolar edge
099	I	5 Brown clay	75-80	550-400 BC	PAC	-	1	0.4	1 bipolar flake on pr blade
					CHY	-	3	1.0	1 bipolar flake fragment
									2 bipolar flakes, light wear on 1 edge, burned?
					PAR?	-	4	2.3	2 bipolar core on pr blade
									2 bipolar flake fragments
					SMJ	-	6	1.7	1 pr blade, proximal
									1 bipolar core on pr blade
									2 bipolar flakes
									2 bipolar flake fragments
115	I	5 Ceramic midden	80-85	550-400 BC	CHY	-	4	1.5	4 bipolar flakes from pr blades
					TAJ	-	1	0.3	1 small bipolar core fragment
					SMJ	-	1	0.6	1 bipolar flake on pr blade fragment
123	I	5 Ceramic midden	80-85	550-400 BC	PAR	-	4	2.8	1 pr blade, medial
									1 battered pr blade, medial, light wear
									1 bipolar flake
									1 bipolar core from pr blade
150	I	1-F3	85-95	550-400 BC	SMJ	-	2	1.4	2 pr blades, medial, very light cutting
196	I	6 Ceramic midden	85-95	550-400 BC	PAR	-	7	8.0	1 pr blade, medial, light cutting wear
									1pr blade wedge
									1 bipolar edge
									1 bipolar flake
									1 bipolar flake fragment
									2 bipolar cores on pr blade
					TAJ	-	1	0.4	1 percussion flake
					PAC	-	1	0.1	1 small distal tip of pr blade
					CHY	-	4	1.8	2 large fragments, hard cutting on original edge
									1 bipolar edge
									1 bipolar core on pr blade, medial
					SMJ	-	2	2.6	1 pr blade, proximal, pointed platform, light cutting
					SMJ	-			1 pr blade, medial, light cutting
232	I	7 Ceramic midden	95-105	550-400 BC	PAC	-	1	0.2	1 bipolar flake, light cutting
					PAR	-	1	0.3	1 bipolar flake on pr blade
					ZAR	ZAR	1	0.7	1 large flake
222	I	7 Ceramic midden	95-105	550-400 BC	SMJ	-	1	1.0	1 pr blade, medial, heavy scraping & medium cutting
					CHY	-	2	2.6	1 pr blade, proximal. Pointed platform, light cutting
									1 pr blade, proximal. Pointed bright platform

							1	1.0	1 large frag. on pr blade, medial, medium cutting
274	1	3-F3A	105-115	550-400 BC	PAR	-	1	0.2	1 pr blade, proximal. Pointed bright platform
280	1	4-F3A	115-125	550-400 BC	PAR	PAR	1	1.6	1 bipolar core
236	1	1-F4	100-110	750-550 BC Mixed LP/EF	SMJ	-	1	0.1	1 pr blade, medial near distal end

Table 13. San Andrés Obsidian Artifacts Continued

FS#	Unit	Level/Feature	Depth/cm	Date	Visual	NAA	Qty	Wgt	Description
240	1	2-F4	100-120	750-550 BC	SMJ	-	1	0.6	1 pr blade, proximal. Pointed platform, edge ground.
				Mixed LP/EF	PAC	-	1	0.3	1 large fragment
255	1	3-F4	120-130	750-550 BC	PAC	-	1	0.3	1 bipolar core on pr blade fragment
				Mixed LP/EF	SMJ	-	1	0.4	1 pr blade, medial
269	1	4-F4	130-140	750-550 BC Mixed LP/EF	SMJ?	-	1	0.5	1 bipolar flake
291	1	3-F4A	125-140	750-550 BC Mixed LP/EF	CHY?	-	1	0.5	1 bipolar flake fragment
283	1	8	105-115	750-650 BC	PAR	-	1	0.4	1 pr blade, proximal. Pointed platform
T88	1	9 Ceramic midden	115-125	750-650 BC	SMJ	-	2	1.2	2 pr blades, medial, light cutting
					SMJ	-	1	4.1	1 bipolar flake from very large blade or distal tip of core, light cutting
					PAR	-	4	2.0	1 bipolar edge
									2 bipolar flakes, light cutting on 1, medium on other
									1 bipolar flake fragment
293	1	10 Ceramic midden	125-140	750-650 BC	SMJ	-	5	6.3	2 pr blades, proximal. Pointed platforms, 1 w/double bulb, medium to heavy cutting on both
									1 bipolar flake fragment
									2 bipolar flakes from pr blade
					PAC	-	1	0.3	1 bipolar flake on pr blade, medial, medium cutting
					PAR	-	1	1.1	1 flake from tip of polyhedral core
					PAR	PAR	1	0.4	1 bipolar flake
					ZAR	ZAR	1	?	1 pr blade, medial
					CHY	CHY	1	0.5	1 flake fragment
381	1	2-F6	120-140	750-650 BC	PAR	-	1	0.1	1 bipolar flake fragment
327	1	?-F6	135 (?)	750-650 BC	PAC	-	1	0.1	1 bipolar flake, very small
298	1	11 Ceramic midden	140-160	750-650 BC Mixed LP/LF	SMJ	-	1	1.2	1 pr blade, medial
					ORZ	-	1	3.9	1 pr blade, medial
					PAR	-	5	4.2	1 pr blade, proximal
									2 large fragments
									1 flake, possible distal end of exhausted polyhedral core
									1 small bipolar core
					CHY?	-	1	0.8	1 bipolar corner flake
					TAJ	-	1	0.1	1 small flake
396	1-S	3-F5	145-155	750-650 BC	CHY	-	1	0.6	1 bipolar core
453	1-N	? –F9 – Dark gray pit	193	750-650 BC	PAR	PAR	3	3.2	1 pr blade, distal.
									2 pr blades, medial
					PAR	PAR	1	0.5	1 bulbar piece
484	1-N	? -F9 – Dark gray pit	200-210	750-650 BC	PAR	-	1	1.0	1 pr blade, distal, very heavy cutting
					CHY	-	2	1.6	2 bipolar flakes, light cutting on both
492	1-N	3-F9 – Dark gray pit	210-220	750-650 BC	SMJ	-	10	4.4	1 pr blade, proximal. Pointed platform
									1 bipolar core on pr blade, medial, medium cutting
									2 pr blades, medial
									1 pr blade, distal
									1 bipolar edge
									1 large fragment
									2 bipolar flake fragment
									1 bipolar core fragment
					PAC	-	1	0.3	1 large fragment on pr blade, medial
					CHY	CHY	2	2.1	1 bipolar core on pr blade, medial
					CHY	-			1 bipolar flake, light wear
					PAR	-	1	0.4	1 bipolar core
342	1	12 Orange-	100-120	900-750 BC	PAR	-	1	0.9	1 bipolar core on pr blade

		brown clay		Early Puente					
498	1	1-F11	170-180	900-750 BC	PAR	-	1	0.5	1 bipolar core
				Early Puente	UCA	UCA	1	0.9	1 pr blade, medial, hard cutting, heavy wear
596	1	3-F12	190-200	900-750 BC	SMJ	-	1	0.5	1 pr blade, proximal. Pointed platform, light cutting
569	1	23	210-220	900-750 BC	SMJ	-	1	0.1	1 bipolar flake
693	1	2-F14	240-254	900-750 BC	SMJ	-	1	4.0	1 pr blade, distal

Table 13. San Andrés Obsidian Artifacts Continued

FS#	Unit	Level/Feature	Depth/cm	Date	Visual	NAA	Qty	Wgt	Description
399	1-S	14A Orange-brown clay	145-155	900-750 BC	SMJ	-	1	2.7	1 bipolar core on pr blade, hard cutting
416	1-S	16 Gray-brown clay	140-150	900-750 BC	PAR	-	1	1.5	1 large fragment from pr blade, medial, hard cutting
394	1-S	14-F5	150-160	900-750 BC	PAC	PAC	1	0.6	1 pr blade, distal
407	1-S	14-B Orange-brown clay	150-160	900-750 BC	OTU	OTU	1	0.4	1 large fragment
458	1-S	18	160-170	900-750 BC	PAR	PAR	1	0.6	1 large fragment on pr blade
					PAR	PAR	1	0.9	1 bipolar core on large pr blade
479	1-S	2-F11	180-190	900-750 BC	SMJ	-	1	0.6	1 bipolarly battered from pr blade, medial
473	1-S	1-F12	170-180	900-750 BC	TAJ	-	1	0.3	1 bipolar flake
352	1-N	? Ceramic midden	120	900-750 BC	SMJ	-	1	1.4	1 pr blade, medial, light cutting wear
406	1-N	14-B Orange-brown clay	150-160	900-750 BC	SMJ	-	2	0.3	2 Very small pr blades, medial (Same blade)

UNIT 2

FS#	Unit	Level/Feature	Depth/cm	Date	Visual	NAA	Qty	Wgt	Description
012	*2*	*1 Surface*	*0-20*	*AD 1250+*	*ZAR*	*ZAR*	*5*	*2.3*	*2 pr blades, distal*
						-			*2 pr blades, medial*
									1 pr blade, medial
							2	*0.6*	*2 pr blades, medial*
							4	*2.0*	*2 pr blades, medial*
					SMJ	*SMJ*	*2*	*1.2*	*1 pr blade, proximal*
									1 pr blade, medial
225	*2-S*	*2 Surface*	*40-60*	*Mixed*	*PAR*	-	*1*	*0.6*	*1 unusual partial platform*
					PAC	-	*2*	*1.8*	*1 pr blade, medial*
									1 large split pr blade, medial

UNIT 3

FS#	Unit	Level/Feature	Depth/cm	Date	Visual	NAA	Qty	Wgt	Description
769	*3*	*1 Surface*	*17-40*	*Mixed*	*SMJ*	-	*1*	*0.7*	*1 bipolar flake fragment*
					PAR	-	*6*	*2.5*	*2 large fragments*
									2 bipolar flakes
									1 bipolar core on pr blade, medial
									1 bipolar flake fragment
777	3	3 Dark brown clay	40-50	550-400 BC Late Franco	PAR	-	2	0.8	2 bipolar flakes
784	3	3 Dark brown clay	50-60	550-400 BC	PAR	-	4	1.6	4 bipolar flakes
800	3	5 Dark brown clay	70-80	550-400 BC	PAR	-	1	10.7	1 pr blade, proximal, very large, hard cutting
808	3	6 Dark brown clay	80-90	750-650 BC Late Puente	PAR?	-	2	12.3	1 small bipolar flake
									1 pr blade, distal
815	3	7 Dark gray-brown clay	90-100	750-650 BC	PAC	-	5	3.1	1 plunging blade tip
									2 large fragments

									1 bipolar flake
									1 pr blade, medial
819	3	8	85-100	750-650 BC	SMJ	-	1	0.1	1 pr bladed, fragment
835	3	10 Dark gray clay	110-120	750-650 BC	PAC	-	3	2.4	1 large fragment
									1 pr blade, fragment
									1 bipolar core on pr blade, medial
					ZAR	ZAR	1	0.7	1 pr blade, proximal
850	3	11 Dark gray clay	120-130	750-650 BC	PAC	-	1	0.2	1 bipolar edge

Table 13. San Andrés Obsidian Artifacts Continued

FS#	Unit	Level/Feature	Depth/cm	Date	Visual ID	NAA	Qty	Wgt	Description
380	3	13	120-140	750-650 BC	SMJ	-	1	0.8	1 bipolar flake
					CHY	-	3	1.5	3 bipolar flakes
859	3	12 Dark gray brown clay	130-140	750-650 BC	PAC	-	1	0.8	1 large fragment, medium cutting on old & fresh edges
872	3	14	150-160	900-750 BC Early Puente	SMJ	SMJ	1	0.6	1 bipolar flake

UNIT 4 (RP3)

FS#	Unit	Level/Feature	Depth/cm	Date	Visual ID	NAA	Qty	Wgt	Description
536	*4*	*1 Surface*	*10-20*	*AD 1250+*	-	-	*4*	*3.1*	*1 large split pr blade, proximal fragment*
					-	-			*2 pr blade, medial fragments*
					-	-			*1 large fragment*
					PAR	*PAR*	*1*	*0.8*	*1 pr blade, medial*
540	*4*	*2 Surface*	*20-30*	*550-400 BC*	-	-	*1*	*0.2*	*1 pr blade, medial*
617	*4*	*3 Surface*	*25-37*	*AD 1250+*	-	-	*1*	*1.1*	*1 pr blade, medial*
					ORZ	*ORZ*	*1*	*0.9*	*1 pr blade, medial*
746	*4*	*2 F1 – Ceramic urn deposit*	*64-73*	*AD 1250+*	-	-	*1*	*0.1*	*1 very small flake fragment*
735	*4*	*2 F 1, Deposit 2,Urn*	*70 ?*	*AD 1250+*	-	-	*1*	*0.2*	*1 bipolar flake fragment*
756	*4*	*9 Orange-brown clay Mixed*	*70-80*	*750- 650 B.C. Late Puente*	-	-	*1*	*0.6*	*1 pr blade, medial*

UNIT 5

FS#	Unit	Level/Feature	Depth/cm	Date	Visual	NAA	Qty	Wgt	Description
003	*5*	*1 Tan loam, surface*	*0-20*	*AD 1250+*	-	-	*2*	*1.1*	*1 pr blade, distal*
					-	-			*1 large fragment*
					-	-	*7*	*2.3*	*1 large fragment*
					-	-			*1 bipolar flake*
					-	-			*3 bipolar flake fragments*
					-	-			*2 pr blade, medial*
					-	-	*3*	*1.2*	*1 pr blade, proximal. Pointed platform*
					-	-			*1 pr blade, medial*
					-	-			*1 bipolar flake*
097	*5 Ext-A*	*1 Tan loam, surface*	*0-20*	*750-600 BC Mixed PC/EF*	*PAR?*	-	*1*	*0.4*	*1 bipolar flake on pr blade, medial*
					PAC	-	*1*	*0.2*	*1 large fragment*
					PAR?	-	*1*	*0.3*	*1 bipolar flake fragment*
129	*5*	*2-6 Tan loam*	*20-40*	*750-600 BC*	*?*	-	*1*	*0.1*	*1 small bipolar flake fragment*
099	*5 Ext-A*	*2 Tan loam*	*20-40*	*750-600 BC*	*PAC*	-	*1*	*0.1*	*1 small bipolar flake*
112	*5 Ext-*	*?-F2*	*20-40*	*750-600 BC Mixed*	*PAC*	-	*1*	*1.2*	*1 pr blade, medial*

	A			*PC/EF*					
???	*5*	*3 Brown clay*	*38-60*	*750-600 BC Mixed*	*CHY*	*-*	*3*	*1.0*	*3 bipolar flake fragments*
					PAC	*-*	*2*	*0.9*	*1 pr blade, distal*
									1 bipolar flake on pr blade, medial
019	*5*	*3 Tan loam*	*38-60*	*750-600 BC*	*PAC*	*-*	*1*	*0.1*	*1 bipolar flake fragment*
					PAR?	*-*	*2*	*0.2*	*1 bipolar flake fragment*
									1 pr blade, medial
091	5	4 Brown clay	60-80	650-550 BC Early Franco	ORZ	ORZ	1	0.4	1 bipolar flake

Table 13. San Andrés Obsidian Artifacts Continued

FS#	Unit	Level/Feature	Depth/cm	Date	Visual	NAA	Qty	Wgt	Description
027	5	4 Brown clay	60-80	650-550 BC	PAR	-	4	1.7	1 pr blade, distal, medium cutting
									1 bipolar edge
									2 bipolar flakes
					PAC	-	2	0.2	2 long bipolar splinters
074	5	5-F4	80-90	750-650 BC Late Puente	PAR	-	2	0.3	2 bipolar flake fragments
					PAC	-	1	0.1	1 bipolar flake fragment
058	5	5 Mottled clay	80-100	750-650 BC	PAR	-	2	0.4	2 bipolar flake fragments
					SMJ	-	1	0.2	1 bipolar flake
085	5	6 Mottled clay	80-100	750-650 BC	CHY	-	2	0.4	2 bipolar flake fragments
					PAC	-	1	0.3	1 bipolar flake fragment

UNIT 7

FS#	Unit	Level/Feature	Depth/cm	Date	Visual	NAA	Qty	Wgt	Description
121	*7*	*Surface*	*0-20*	*AD 1250+*	*-*	*-*	*30*	*21.4*	*1 whole, lipped pr blade*
									1 bipolar core on macroblade, proximal
									1 pr blade, proximal
									1 pr blade, distal
									1 bipolar core on macroblade, medial
									12 bipolar flakes
									12 bipolar flake fragments
									1 bipolar flake
131	*7*	*2 Dark brown clay*	*20-40*	*Mixed AD 1250+*	*-*	*-*	*4*	*1.6*	*1 pr blade, proximal*
									2 bipolar flakes
									1 bipolar core
					-	*-*	*9*	*2.6*	*1 pr blade, distal, lancet*
					-	*-*			*3 large fragments*
					-	*-*			*5 bipolar flakes*
149	7	3 Dark gray clay	40-60	650-550 BC Early Franco	SMJ	-	1	0.7	1 large fragment
					PAR	-	4	0.4	2 bipolar edge
					PAR				2 bipolar flake
					CHY	-	1	0.2	1 small bipolar flakes
159	7	4 Gray midden	60-80	650-550 BC	PAR	-	4	1.4	4 bipolar flakes on pr blade fragments
					SMJ	-	1	0.1	1 pr blade, medial
170	7	4-F1 Gray midden	60-80	650-550 BC	SMJ	-	1	0.2	1 bipolar flake
176	7	5-F1 Gray midden	80-100	650-550 BC	SMJ	-	22	9.9	1 percussion flake, not bipolar
									2 pr blade, proximal, hard cutting on one
									1 pr blade, distal, medium cutting
									7 bipolar flake fragments
									2 bipolar edges
									8 bipolar flakes
									1 large fragment, hard cutting on original edge
							7	8.8	2 bipolar flakes
									1 pr blade, medial

									1 pr blade, proximal, medium cutting
									3 pr blades, medial, light cutting on two
					PAR	-	16	12.6	1 bipolar flake fragment
									1 bipolar flake
									1 pr blade, proximal, light cutting
									3 bipolar cores on blades
									3 pr blades, medial, medium cutting
									5 bipolar flake fragments
									1 pr blade, distal tip
									1 pr blade, proximal, medium cutting on one
178	7	5	80-100	650-550 BC	PAR	-	2	2.0	1 large fragment
									1 bipolar core
							2	0.9	2 bipolar flakes on pr blade

Table 13. San Andrés Obsidian Artifacts Continued

FS#	Unit	Level/Feature	Depth/cm	Date	Visual	NAA	Qty	Wgt	Description
195	7	6 Gray midden	100-120	650-550 BC	SMJ		1	0.1	1 small bipolar flakes
					PAR		3	0.2	3 small bipolar flakes
236	7	6-F1B Gray midden	100-120	650-550 BC	PAR	-	1	0.6	1 pr blade, distal
231	7	6-F1B Gray midden	100-120	650-550 BC	PAR	-	19	14.0	3 bipolar flake fragments
									8 bipolar flakes
									4 pr blades, proximal
									2 pr blades, distal
									2 pr blades, medial
							2	0.9	1 pr blade, distal
									1 bipolar flake
190	7	6-F1B Gray midden	100-120	650-550 BC	PAR	-	20	26.6	2 pr blades, proximal, soft cutting on one edge
									2 pr blades, medial, medium cutting on one edge
									3 bipolar cores
									2 bipolar flake fragments
									11 bipolar flakes
					SMJ	-	5	2.3	3 bipolar flakes
									1 large fragment
									1 bipolar core on blade fragment
					CHY	-	7	4.6	1 large fragment
									1 pr blade, proximal (single ridge), medium cutting
									1 large fragment on pr blade, medial
									4 bipolar flakes
					CHY	-	4	3.6	4 bipolar flakes
					UCA	-	2	1.6	2 pr blades, proximal
					PAR	-	1	0.8	1 pr blade, medial
					PAR	-	1	0.7	1 pr blade, distal
					PAR	-	2	0.6	2 bipolar edges
					UCA	UCA	1	0.8	1 pr blade, medial
251	7	7 Brown-gray silty clay (BGS)	120-140	650-550 BC	ORZ	-	1	0.2	1 - ½ bowtie break on pr blade, medial
					PAR	-	55	29.3	4 bipolar edges
									11 bipolar flake fragments
									23 bipolar flakes
									3 bipolar cores on blade fragments
									1 pr blade, proximal
									5 pr blades, medial
									4 pr blades, distal, light cutting wear
									1 large fragment
									1 bipolar edge
									2 bipolar flakes
					ZAR	-	1	.2	1 bipolar flake fragment
					PAC	-	2	0.4	2 bipolar flake fragments
					SMJ	-	10	11.6	1 pr blade, proximal
									3 pr blades, medial
									2 pr blades, distal

									1 bipolar core on large pr blade, medial, light cutting
									1 bipolar flake
									1 large fragment
									1 pr blade, medial
					CHY	-	26	17.0	1 split large pr blade, medial
									3 bipolar cores
									2 bipolar edges
									2 bipolar flakes
									11 bipolar flake fragments
									2 pr blades, proximal
									4 pr blades, medial
									1 pr blade, distal
					ZAR	-	1	1.8	1 percussion flake

Table 13. San Andrés Obsidian Artifacts Continued

FS#	Unit	Level/Feature	Depth/cm	Date	Visual	NAA	Qty	Wgt	Description
835	7	7 BGS clay	120-140	650-550 BC	PAR	-	4	1.8	3 bipolar flake
									1 pr blade fragment, hard scraping wear
					PAC	-	3	2.0	1 bipolar core
									2 bipolar flake fragments
					ZAR	-	1	0.2	1 very small flake fragment
266	7	7-1 BGS clay	120-140	650-550 BC	PAR	-	18	13.8	1 pr blade, distal
					PAR	-			14 bipolar flakes
					PAR	-			1 bipolar core on macroblade segment
					CHY	-			1 pr blade, distal
					PAR	-			1 bipolar flake
					PAR	PAR	1	0.5	1 pr blade, proximal
					PAC	-	1	0.8	1 large fragment on pr blade, medial
					PAR	-	10	10.3	1 pr blade, distal
									2 large fragments
									4 bipolar flakes
									1 bipolar core
									1 pr blade, proximal
									1 pr blade, medial
					SMJ	-	2	2.6	1 pr blade, medial
303	7	8 BGS clay	140-150	650-550 BC	SMJ	-	3	3.0	1 plunging blade
									2 pr blades, proximal
					PAR	-	4	3.2	1 large fragment on pr blade, proximal
									1 bipolar core on pr blade, medial
									1 bipolar flake
									1 pr blade, medial, heavy cutting
							13	7.7	1 large fragment
									1 bipolar edge
									3 blade fragments (ribbons)
									2 bipolar flake fragments
									2 bipolar flakes
									2 bipolar cores
									2 pr blades, medial
249	7	6-F4 Gray midden	100-120	650-550 BC	PAR	-	4	3.1	1 whole pr blade , hard cutting on both edges
									1 pr blade, distal
									2 bipolar flakes
278	7	7-F4 BGS clay	120-140	650-550 BC	PAR	-	1	1.6	1 pr blade, medial
							7	8.5	1 large fragment
									1 pr blade, proximal, medium cutting
									2 bipolar cores on pr blade, medial
									3 bipolar flakes
					SMJ	-	2	4.7	1 pr blade, medial, medium cutting
									1 pr blade (2 fragments of same blade)

284	7	7-F4 BGS clay	120-140	650-550 BC	PAR	-	1	0.3	1 bipolar flake
251	7	7-F5 BGS clay	120-140	650-550 BC	PAR	-	1	2.2	1 pr blade, distal
					SMJ	-	1	0.3	1 pr blade, medial
216	7	6-F1	?	650-550 BC	SMJ	-	4	6.3	1 pr blade, proximal
									3 pr blades, medial
					PAR	-	28	13.9	2 pr blades, distal
									26 bipolar flakes on pr blades
379	7	7-F1	120-140	650-550 BC	PAR	-	1	0.5	1 pr blade, medial
							16	11.6	16 bipolar flakes
731	*7*	*8 Collapse*	*N/A*	*650-550 BC*	*CHY*	-	*1*	*0.3*	*1 pr blade, medial*
???	*7*	*9 BSG clay*	*150-170*	*750-550 BC Mixed E/F & L/P*	-	-	*5*	*3.9*	*1 pr blade, distal*
					-	-			*3 bipolar flakes*
					-	-			*1 bipolar edge*
					-	-	*1*	*0.4*	*1 pr blade, medial*
					-	-	*1*	*0.5*	*1 bipolar flake*
966	*7*	*9 BGS clay*	*150-170*	*750-550 BC*	*PAR*	-	*1*	*0.9*	*1 pr blade, medial*

Table 13. San Andrés Obsidian Artifacts Continued

FS#	Unit	Level/Feature	Depth/cm	Date	Visual	NAA	Qty	Wgt	Description
331	*7*	*9 BGS clay*	*150-170*	*750-550 BC Mixed E/F & L/P*	*PAR*	-	*5*	*0.2*	*1 pr blade, distal tip*
					SMJ	-			*1 pr blade, medial*
					PAR	-			*3 bipolar flakes*
					PAC	-	*1*	*0.3*	*1 bipolar flake*
395	7	10 Gray silty soil	170-190	900-750 BC	SMJ	-	1	1.2	1 pr blade, distal, light cutting
					PAR	-	1	5.6	1 bipolar core on large macroblade fragment, near distal end
							5	3.3	2 pr blades, proximal
									1 bipolar flake fragment
									2 bipolar flakes
763	*7*	*South wall Collapse*	*N/A*	*1400-1200 BC*	*PAR*	-	*3*	*11.2*	*2 pr blades, proximal*
									1 bipolar flake from bulbar part of macroblade
460	7	12 Black clay	200-210	1400-1200 BC	PAR	-	1	0.9	1 pr blade, proximal, pointed edge, medium cutting
						PAR	1	1.1	1 pr blade, distal
658	7	North wall	200	1400-1200 BC	PAR	-	1	15.0	1 bipolar core on large macroblade fragment
485	7	14-F5 Gray silty clay	225-235	1400-1200 BC	PAR	-	1	3.3	1 large blade fragment
569	7	17	282-300	1400-1200 BC	SMJ	SMJ	1	1.4	1 pr blade, medial, medium cutting

UNIT 8

FS#	Unit	Level/Feature	Depth/cm	Date	Visual	NAA	Qty	Wgt	Description
293	*8*	*2 Dark brown clay*	*20-40*	*Mixed PC/EF/LP*	*ORZ*	-	*1*	*0.7*	*1 pr blade, medial*
377	*8*	*3 Dark brown clay*	*40-60*	*Mixed PC/EF/LP*	*PAR*	-	*2*	*2.4*	*1 flake fragment*
									1 pr blade, distal
300	8	4 Dark brown clay	60-80	650-550 BC Early Franco	SMJ	-	3	6.0	2 pr blades, medial
					CHY	-	6	5.8	3 bipolar flakes
									1 C. core (?)
									1 pr blade, medial, extremely hard cutting
					PAR	PAR			1 pr blade, distal, medium cutting
341	8	5 Brown midden	80-100	650-550 BC	ORZ	-	1	1.6	1 pr blade, proximal, medium cutting
					PAC	-	1	0.8	1 large fragment, soft cutting
					PAR	-	6	4.7	1 pr blade, proximal, hard cutting
									1 bipolar edge
									1 bipolar flake fragment
									2 pr blades, medial, medium cutting
									1 pr blade, distal
					SMJ	-	2	1.6	2 pr blades, proximal
353	8	6 Brown	100-120	650-550 BC	PAR	-	8	8.5	3 bipolar edges

		midden							4 bipolar flake fragments
									1 large fragment
					TAJ	-	3	1.0	3 bipolar cores on pr blade
					SMJ	-	1	2.4	1 pr blade, medial, soft cutting
386	8	7 BGS clay	120-140	650-550 BC	PAR	-	13	22.2	4 bipolar flakes
									2 pr blade, distal
									2 pr blade, medial
									1 pr blade, proximal, medium cutting
									1 pr blade, proximal
									1 pr blade, proximal
									1 pr blade, proximal
									1 pr blade, proximal
					SMJ	-	2	3.2	1 pr blade, proximal, soft cutting
									1 pr blade, distal, soft cutting

Table 12. San Andrés Obsidian Artifacts Continued

FS#	Unit	Level/Feature	Depth/cm	Date	Visual	NAA	Qty	Wgt	Description
436	8	7-F1	120-140	650-550 BC	PAR	-	3	4.1	1 whole pr blade
									1 bipolar flake fragment
					SMJ	-	2	1.5	2 bipolar from pr blades, medial, light cutting
							1	4.3	1 pr blade, distal twisted, very hard cutting
443	8	8 BGS clay	140-160	650-550 BC	SMJ	-	1	0.6	1 pr blade, medial
416	8	8 BGS clay	140-160	650-550 BC	PAR	-	1	0.2	1 bipolar flake
472	8	11 Silty loam	180-190	900-750 BC	PAR	-	2	3.5	1 pr blade, medial
									1 platform rejuvenation flake
					PAC	-	1	0.2	1 bipolar flake
477	8	12 BGS clay	190-200	900-750 BC	PAR	-	1	0.4	1 bipolar flake
T89	8	14 Dark silty clay	220-240	1400-1200 BC Molina	SMJ	SMJ	1	1.0	1 pr blade, medial, soft cutting
755	*7/8*	*Collapse*	*N/A*	*N/A*	*PAR*	-	*18*	*56.4*	*1 pr blade, proximal*
									2 bipolar flakes
									1 c. core
									2 bipolar flakes from large macroblade
									1 whole pr blade
									1 whole pr blade
									4 pr blades, proximal
									5 pr blades, medial
									1 pr blade , distal
					PAR	*PAR*	*1*	*1.9*	*1 pr blade, medial*
					TAJ	-	*1*	*3.2*	*1 direct percussion flake*
					ORZ	*ORZ*	*1*	*0.5*	*1 pr blade, medial*

APPENDIX B

Description of the Obsidian Source Areas Identified at San Andrés

A major goal of this thesis was the identification of sources for the obsidian artifacts excavated at San Andrés. According to the NAA results, nine individual sources have been identified, and each will be reviewed. The Mexican sources include Paredón, Pachuca, Orizaba, Zaragoza, Otumba, and Ucaréo; El Chayal, San Martín Jilotepeque, and Tajumulco are in Guatemala (Figure 23).

Although source areas may be given a common identifying name, such as Pachuca or El Chayal, they actually refer to geographic obsidian regions and may consist of numerous regional source groups, sometimes separated by kilometers and known locally by different names. Employing a source taxonomy defined by R. C. Green (1998), the primary sources in the Pachuca geographic region, for example, are not in Pachuca, Hidalgo, but in an area beginning some twenty kilometers south of the city. This area is bordered on the west by the small town of Nopalillo, in the Municipality of Epazoyucan. The regional source group is located in a series of hills known as the Sierra de la Pachuca. Within the Sierra are several compositional subgroups; the major one is called Cerro de las Navajas, or Hill of the Knives, and is comprised of dozens of mines that make up the source locality. Other compositional subgroups within the Sierra include Cerro de Minillas, El Ocote, Huasca, Cerro Pelón, La Esperanza, Cruz del

Milagro, San Lorenzo Zembo, and Rancho Guajalote (Cobean 1991:7; Pastrana 2001:548).

Figure 23. Map of Obsidian Sources present at San Andrés (after Clark and Pye 2000:8).

Some researchers are satisfied with the identification of only the major source area and the lumping of any possible subgroup material under the generic designation. This situation is another example of failure to utilize all the information present in the obsidian artifacts. Future research will undoubtedly begin identifying subgroups as standard procedure (Glascock *et al*. 1998:39-45). This differentiation will become necessary as more definitive models for the exploitation, production, and transportation of obsidian are interpreted (Green 1998:227-228).

The Mexican Sources

Six Mexican sources of obsidian were represented at San Andrés. These included Paredón, Pachuca, Zaragoza, Ucaréo, Otumba, and Orizaba. The Paredón source supplied 90.6% of the Mexican obsidian at San Andrés, and constituted over 60% of the total material by weight from all sources, even though it is located 510 kilometers northwest of the site. This quantitative dominance held true through all time periods starting with the earliest deposit of obsidian between 1400 to 1200 B.C., and continued until 400 B.C. (Table 6). Nearby Pachuca, at 3% of the collection, was the closest competitor, and all other Mexican sources in the assemblage are relegated to trace element status.

Paredón. The Paredón compositional subgroup is comprised of at least three separate source localities running along the eastern edge of Laguna Tecocomulco, adjacent to the colonial trade route between Tulancingo and Apan, in Hidalgo (Charlton, et al. 1978:807). The sources are located along a series of ridge tops and barrancas that extend for about seven kilometers and are named after the small villages adjacent to the source localities: Coyaco, Tres Cabezas, and Paredón. Local people today refer to the volcanic material as *estrate*, and are not accustomed to using the word "obsidiana" (personal observation 2001).

The techniques for extraction were simple. Naturally exposed cobbles were easily picked up along the barrancas and from broad, shallow, quarry pits that were dug along the ridge tops, three to four meters in diameter to about a meter in depth. Evidence of tool and core preparation is found around the pits (Charlton 1982:36-39).

Obsidian from Paredón was originally attributed to the Otumba source, located near the Late Formative-Early Classic center of Teotihuacán. The Paredón source group was first documented by A. C. Breton in 1902, but the records appeared to be lost and it became an unknown source. Then in 1975, Thomas Charlton recognized the site again and showed it to be a major supplier in the Formative period obsidian exchange network (Charlton 1978:807). Paredón obsidian may have been dominant because of its excellent blade-making quality, considered to be superior to many other Mexican sources (Charlton and Spence 1982:51).

Recent, more effective NAA procedures on obsidian artifacts from Oaxaca and Morelos, indicate that Paredón may have been a more significant source, with a wider distribution, during the Formative period than Otumba (Charlton *et al*. 1978:807; Glascock *et al*. 1998:21; Grove 1987:380-383). This conclusion is supported by the evidence from San Andrés. Cobean (1991) has tested additional material from San Lorenzo, and believes that the source that was labeled as the “Unknown A group” in the initial testing done in 1971 (Cobean *et al*. 1971:667-669) is actually from Paredón (Glascock *et al*. 1998:21). Indications are that the obsidian recovered in the Oaxaca Valley and attributed to Otumba, could in large part, actually be from Paredón. This new information calls into question any material attributed to Otumba prior to 1980, and Braswell *et al*. (2000:270) and Glascock *et al*. (1998:20-22) hold that samples tested prior to 1980, should be re-evaluated.

Otumba. Material from Otumba is present at San Andrés in the form of a single large fragment from the Early Puente phase (900-750 cal B.C.). This source was located near the Classic period metropolis of Teotihuacán, in the northeastern portion of the

Basin of Mexico. Material from Otumba, in conjunction with the Paredón and Navajas source areas, has been closely associated with the rise and success of Teotihuacán (Charlton 1978:1227).

Pachuca. Obsidian from the subgroups that fall under the designation of Pachuca is visually and physically the finest quality obsidian in Mesoamerica (Glascock *et al*. 1998:40; Oyarzabal 1994:22). The green-gold obsidian from the Pachuca source region, located 525 kilometers to the northwest of La Venta, has been identified at San Andrés, and it is one of the most investigated obsidian sources in Mesoamerica (Sanders and Santley 1983; Santley 1984).

The unique color of the material from Pachuca ranges from dark green to green-gold glass, and two subgroup elemental fingerprints have been identified. The color and crystal-like clarity of this material have made it visually identifiable and distinguishable from any other principal source in Mesoamerica. Because of these discrete visual characteristics, compositional analysis is unnecessary (Braswell 1994:179). Nonetheless, a piece of Pachuca obsidian was included in the San Andrés NAA sample in order to have its presence archaeometrically identified and recorded.

Pachuca was one of the earliest sources known to be exploited in the region, as is demonstrated by the presence of a green blade from Sierra de las Navajas found in association with the Late Pleistocene mammoth kill excavated at Santa Isabel Iztapan in the Basin of Mexico (Cobean *et al*. 1991:74). Formative period usage of Pachuca's green-gold obsidian has been documented at a number of major sites, including San Lorenzo (Cobean *et al*. 1971:667), Chalcatzingo (Grove 1987:382), Tres Zapotes, La Libertad, Chiapas (Clark 1988:43), El Arbolillo, D.F. Mexico, Acatepec, Puebla, and

Tierras Largas, Oaxaca (Pires-Ferreira 1976:298), as well as La Venta, Tabasco (Hester *et al*. 1971).

On a trip to Sierra de Las Navajas in 2001, I observed that the hills are honeycombed with vertical mine shafts and conical quarry pits, evidence of past extraction activity. Outlines of the stone foundations of Prehispanic houses and workshops are still evident, situated between piles of production debris. Today, local families are exploiting the same sources, and in some cases the same mines, in basically the same manner. They transport the material from the mines down to their kin-group house compounds in the foothills of the pine-forested ridge. There, the entire family (men, women, and children) knap, cut, grind, and polish the material to make obsidian craft items that are then transported and sold throughout Mexico's many craft markets as gifts, souvenirs, and keepsakes.

Zaragoza. The Zaragoza, Puebla, regional source group, 415 kilometers northwest of La Venta, is close to the border with Veracruz and is considered to be a significant supplier for southern Mesoamerica during the Formative period (Cobean *et al*. 1991:73; Pastrana and Athie 2001:549). The source area spreads west and south from the town of Zaragoza covering a minimum of thirty square kilometers and consists of a series of intermittent but geologically related flows and outcrops. No mines or workshops have been discovered in the northern portion of the source area. In the southern region, near the town of Oyameles, a large obsidian flow several meters thick is exposed on the side of a barranca. Nearby are numerous conical pits, 3-7 meters wide and 2 to 3 meters deep, that were filled to capacity with enormous quantities of obsidian debitage. On the southernmost edge of the resource zone is the large archaeological site of Cantona, which contained a number of obsidian workshops, probably dating to the Formative period (Cobean *et al*. 1991:73).

Zaragoza obsidian has been archaeometrically identified at Formative period sites. These sites include San Lorenzo Tenochtitlán, “Unknowns” C and C^1 (Cobean *et al*. 1991:73), Laguna Zope in Oaxaca, thought to be Zeitlan’s “Unknown 1, Cerros de la Mesas, Tres Zapotes, and La Venta (Hester *et al.* 1971).

Orizaba. Pico de Orizaba in Veracruz, near the border of Puebla, is an extinct volcanic peak that is the highest point in Mexico, at 5610 meters. Trace element analysis indicates that the obsidian produced by this volcano was one of the most widely distributed obsidian material during the Early and Middle Formative periods (2000 to 400 cal B.C.), a time coeval with the rise and expansion of ranked societies throughout Mesoamerica (Clark 2001) (Cobean *et al*. 1991:72; Hester *et al*. 1971). The Orizaba group contains an extensive quarrying system of tunnels and shafts that were carved into the extensive obsidian flow that forms a major portion of the canyon wall. Large accumulations of debris resulting from years of obsidian production are piled at the base of the cliffs located on the northern slopes of the volcano (Cobean *et al*. 1991:72-73).

The compositional subgroup known as Pico de Orizaba, located in the Ixtetal Valley to the northeast of the volcano and 350 kilometers to the west-north-west of San Andrés, is the nearest known source of obsidian found at La Venta (Hester *et al*. 1971) and San Andrés. A second subgroup, named after the town of Guadalupe Victoria, is located on the western side of the volcanic cone. Early x-ray fluorescence tests showed the presence of Guadalupe Victoria obsidian at La Venta, but tested material was from a surface collection and may not be indicative of Formative period use (Hester *et al*. 1971).

The quality of the material originating from the Guadalupe Victoria source in Puebla, Mexico, is not considered adequate for blade making (Clark 1989:274), and material from the Guadalupe Victoria sub-group has not been identified at San Andrés.

Ucaréo. Ucaréo is located in Michoacán and is the westernmost source that supplied obsidian to San Andrés, 760 kilometers away. For many years, Ucaréo obsidian had been attributed to Zinapécuaro, a distinctly different compositional subgroup located fifteen kilometers to the southwest (Pastrana and Athie 2001:549). During the development of Cobean's source database, neutron activation analysis by MURR showed that their were three compositional signatures for the area's obsidian; Ucaréo 1 and 2, and Zinapécuaro. It was the Ucaréo 1 source location that was dominant (Glascock *et al*. 1998:43).

Ucaréo's obsidian was formed by a major lava eruption and flow, and extensive surface pit-like quarries are still visible (Cobean *et al*. 1991:75). Obsidian transported from this source has been detected as far away as Ambergris Caye, Belize, a distance of 1500 kilometers (Guderjan *et al*. 1989:366). It is possible that the small amount of Ucaréo obsidian found at San Andrés (4 pieces weighing 3.3 grams) arrived along the Gulf Coast as a part of the material coming from through the El Viejón trade node. Ucaréo material could have been delivered directly to the Tecocomulco region, or it could have arrived there from the Basin of Mexico. (Charlton and Spence 1982:50-51).

The Guatemalan Sources

Three sources of obsidian located in Guatemala have been detected at San Andrés (Figure 23). These sources are part of a crescent shaped volcanic ridge running from the Pacific Coast of eastern Chiapas, through Guatemala, and into El Salvador and southern

Honduras. In Guatemala, the inhabitants living in and around obsidian sources do not use the term "obsidian" or *obsidiana*; instead, they refer to the glassy stone by its indigenous name, *chay*.

El Chayal. The obsidian area referred to as El Chayal (Place of Obsidian) in the Department of Guatemala, Guatemala, 560 kilometers from La Venta, is considered one of the largest source areas of obsidian in Mesoamerica. At least five outcrops, which were heavily exploited throughout Precolumbian times, covers an area over 110 square kilometers (Pastrana and Athie 2001:550). El Chayal source material was widely utilized by the Maya throughout their cultural domain (Sidrys 1977, 1978).

San Martín Jilotepeque. San Martín Jilotepeque is another large obsidian area (60 square kilometers), located approximately forty-five kilometers west of El Chayal, in the Department of Chimaltenango. The San Martín source area is approximately 510 kilometers distant from San Andrés. Paleoindian bands from the Quiché Region of Guatemala were exploiting this source as early as 12,000 years ago (Braswell 1996:71-74; Cobean *et al*. 1991:77; Gruhn *et al*. 1977).   San Martín Jilotepeque is the name of the large town closest to the regional source groups. Other names by which the compositional subgroups are known include Río Pixcayá, Aldea Chatalun, and Pachay.

Pachay is a small, contemporary community next to a major outcrop with numerous workshops. A nearby Precolumbian site contains an eight meter high pyramidal structure and Post Classic monumental sculptures, some of which have been moved to the municipal courtyard in the town of San Martín (Braswell 1996). Small and exhausted polyhedral cores, broken or rejected prismatic blades, and associated debitage cover a fifty square meter area to a depth of 30 to 50 centimeters (personal observation

2000). During the Middle Formative period, obsidian from San Martín was the dominant material found in the Maya Lowlands and the Chiapas Highlands (Clark 1988:43; Pastrana and Athie 2001:550). Braswell (1996) performed extensive analyses of the San Martín Jilotepeque source area and has concluded that of the numerous outcrops only one, San Martin 1, was utilized during the Formative period. This conclusion is supported at San Andrés, where all compositionally tested samples have been identified as coming from San Martín 1.

Tajumulco. A third Guatemalan source, Tajumulco, is present at San Andrés in small quantities (3.1 grams). Tajumulco is located in southwestern Guatemala, 450 kilometers from the Gulf Coast. Tajumulco obsidian was widely used during the Formative period in the Soconusco Region prior to the introduction of prismatic blade technology. This material is not technically obsidian, but ignimbrite, a visually and fundamentally similar material. It is formed, however, from the compaction of molten ash during volcanic activity. Ignimbrite is inherently more granular, containing inclusions and fine debris that lessen the quality of the glass. The irregularity and flawed composition of the material make it unsuitable for the production of fine pressure blades, but it is acceptable for flake tool production (Clark 1989:272-273; Jackson and Love 1991).

The sources of the obsidian found at San Andrés are varied geographically and quantitatively. The distances sited from each source to the La Venta and San Andrés area are straight-line distances, the actual topographical distances are much greater. Considering the distances of transport and obsidian material options available to the ancient people over the thousand-year time span, the consistency of the ratios of imported obsidian from the major sources is remarkable. This factor may address questions concerning the methods of acquisition at La Venta and San Andrés. The consistency in procurement may indicate, on one hand, a long and unbroken tradition of obsidian importers at La Venta, or, on the other hand, perhaps it may be evidence of an outstanding group of obsidian exporters and merchants.