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by

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I. INTRODUCTION

In 1982 we initiated a program of archaeological fieldwork at the site of Matacapan, a large Classic Period urban center in the Tuxtlas Region of the South Gulf Coast of Veracruz, Mexico (see Figure 1). Our working hypothesis was that Matacapan contained an enclave of merchants from the the city of Teotihuacan in Central Mexico. That research had two principal objectives: (1) to define the structure of the Teotihuacan barrio, that portion of Matacapan where past research indicated that Teotihuacan materials were most highly concentrated; and (2) to establish the context of the barrio within the urban center of Matacapan. The following is a report of that research. Our presentation is divided into several parts. First, we discuss a general model describing Teotihuacan influence throughout Mesoamerica. We then summarize the methods we employed during surface survey and excavation, review the settlement history of the site, as defined by the survey, and discuss the evidence we retrieved from a series of excavations conducted in the Teotihuacan barrio. Next, we present an analysis of the obsidian assemblage, outlining major sources of variability across space and through time. Obsidian, we believe, was an important commodity traded to the Tuxtlas by Teotihuacan. We close with a prospectus for future research.

II. A MODEL OF TEOTIHUACAN INFLUENCE IN MESOAMERICA

Recent research has demonstrated that the ancient city of Teotihuacan was the dominant political, economic, and religious authority in Central Mexico from the beginning of the Christian Era until the eighth century A.D. (Millon 1973, 1981; Sanders, Parsons, and Santley 1979). Coincident with this development was an episode of marked Teotihuacan influence throughout Mesoamerica (Pasztory 1978a, 1978b). By influence we mean the occurrence of architecture, sculpture, or material technology of supposed Teotihuacan origin, derivation, or inspiration at centers presumably not politically incorporated by the Teotihuacan state. Teotihuacan influence is particularly marked throughout Mesoamerica in the Middle Classic: ca. A.D. 400-700, the period of time when the city attained its maximum size and internal complexity (see Table 1). Various motives have been suggested to account for this episode; however, as more and more evidence accumulates, it has become apparent that domination of long-distance exchange was a primary element behind the contacts.

Sites exhibiting contacts with Teotihuacan fall into three generic classes (see Figure 1) (Santley 1983). _Teotihuacan enclaves_ are sites such as Kaminaljuyu that apparently contained barrios of resident Teotihuacanos. Enclaves are typically located in positions to dominate the movement of goods; either they are situated on routes of exchange or they occupy central positions relative to several lines of transit. They are also located near deposits of prized raw materials widely traded in antiquity; Kaminaljuyu, for example, is located near the key El Chayal obsidian source (Sanders and Michels 1977), whereas El

Grillo, another site with Teotihuacan architecture in West Mexico, occurs near deposits of semiprecious stone (P. Weigand, personal communication). Interactive nodes, the second class of contact situation, define politically important centers that were centrally located with respect to demand for exotic goods. Enclaves of resident foreigners do not appear to have been present at interactive nodes, though in at least one case, from Oaxaca, there was a barrio of foreigners at Teotihuacan (Millon 1973). Receiver nodes constitute the third class of site in contact with Teotihuacan. Type and amount of Teotihuacan influence at receiver nodes is generally quite variable, and typically it is restricted to portable material technology. We believe that receiver nodes functioned either as outlets for Teotihuacan goods or markets for exotica transported by Teotihuacan merchants. The amount of Teotihuacan influence--the number of different media of Teotihuacan inspiration or derivation--exhibits a distinct pattern of falloff when graphed in terms of distance to Tikal and Monte Alban, suggesting that interactive nodes may have also served as major points of supply (Appel n.d.; Santley 1983).

The goods widely traded over the landscape appear to have come from a number of centers, not just Teotihuacan. Obsidian provides the most complete data set currently available. Not only is green obsidian from the Pachuca source in southern Hidalgo widely distributed throughout Mesoamerica but also raw material from the El Chayal source near Guatemala City and the Zaragoza source near Pico de Orizaba volcano in central Veracruz (Appel n.d.; Moholy-Nagy 1975; Santley 1983; Zeitlin 1978). Moreover, each of these sources is surrounded by exchange spheres dominated by obsidian from a particular source. Pachuca obsidian occurs in frequency only in Central Mexico and the Valley of Oaxaca. Zaragoza obsidian, on the other hand, is very common on the Gulf Coast and Isthmus of Tehuantepec, whereas El Chayal obsidian dominates assemblages in the Guatemalan Highlands and southern Maya lowlands. Centers controlling access to these sources also exhibit pronounced Teotihuacan contacts, not only in portable goods but in sculpture and architectural style as well. Elsewhere, Santley (1983) has argued that this patterning may represent an attempt by a confederation of power centers, all under the influence or aegis of Teotihuacan, to monopolize long-distance exchange throughout the most densely settled parts of Mesoamerica. Ties between Teotihuacan and centers in control of other scarce resources, or who occupied central locations relative to distribution, appear to have been particularly important, and the epigraphic evidence suggests that intermarriages between local dynastic elites and persons with strong Teotihuacan connections or affiliations were frequently employed to solidify or buttress politico-economic linkages (Coggins 1975; Marcus 1980; Sanders 1977).

Sumptuary goods such as cacao, cotton, jade, greenstone, ilmenite, turquoise, feathers, and shell may have also been traded long distances through the same network (Brown n.d.; Parsons and Price 1971; Webb 1975). These goods also exhibit

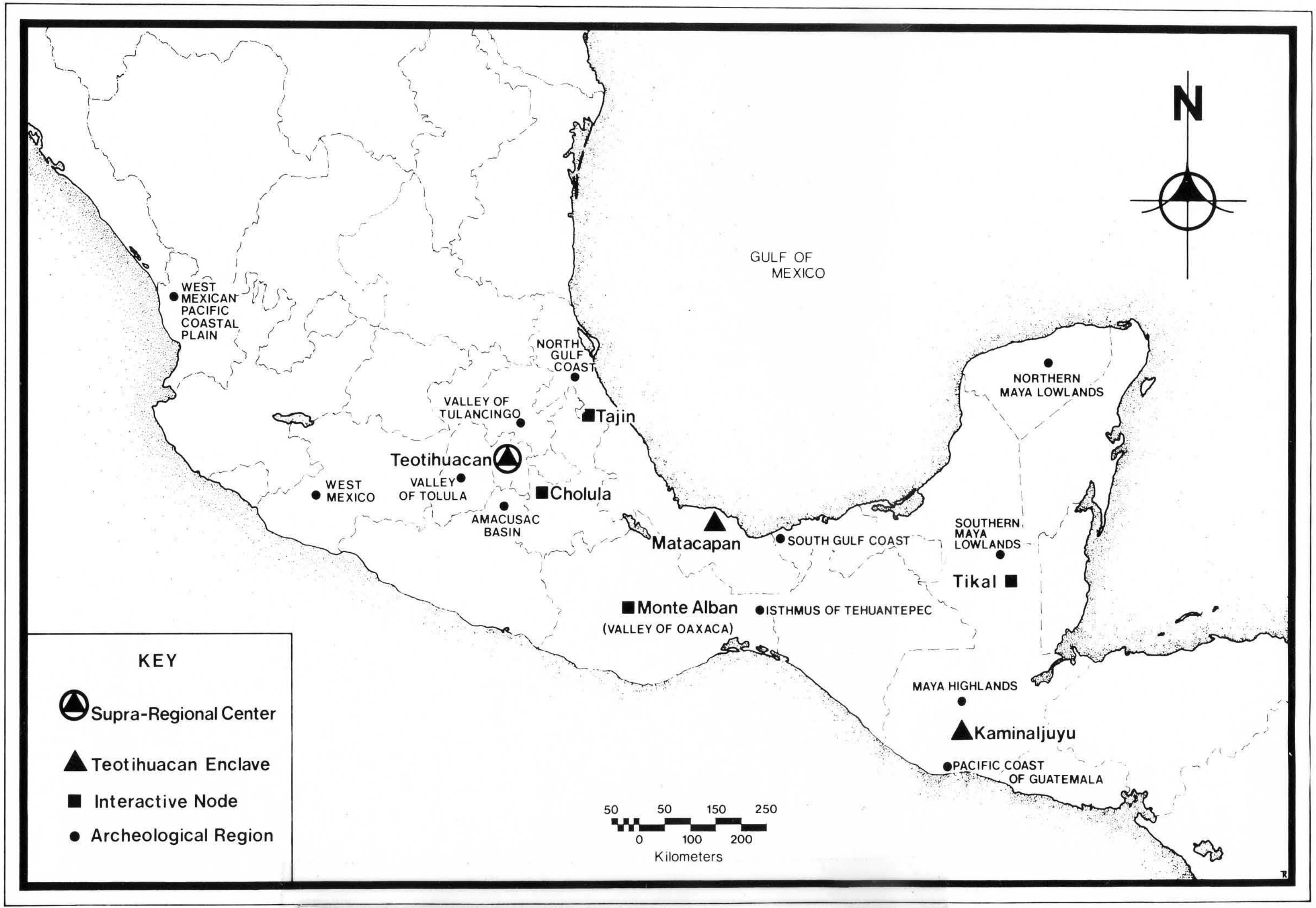


Figure 1: Mesoamerica showing Major Classic Period Centers.

many of the properties that make obsidian so amenable to long-distance exchange; that is, they are goods to which foot transport adds little to the final delivery cost (Santley 1984). Teotihuacan pottery, cylindrical tripod bowls in particular, is also widely distributed. In most cases, however, these goods are locally made imitations of Teotihuacan pottery, not actual imports from the urban zone (Ball 1983). This is quite sensible economic behavior, given the extraordinary cost consumers would have had to bear if pottery had been traded long distances in great amounts (Sanders and Santley 1983).

If this model is an appropriate characterization of Middle Classic exchange dynamics, then what was Teotihuacan's role in the system? We submit that Teotihuacan served as a major production place, at least as far as obsidian technology is concerned. More importantly, we postulate that Teotihuacan also played an important role in transporting long distances goods produced both in the urban zone and in other major centers. The sites of Kaminaljuyu and Matacapan seem to have had key roles in the trading network dominated by Teotihuacan. We have attributed this circumstance to two properties of the unusual spatial position that Kaminaljuyu and Matacapan occupied.

First, all the evidence at our disposal suggests that substantial quantities of goods were exchanged long distances in the Middle Classic (Parsons and Price 1971; Santley 1983; Spence 1977). Although the number of goods entering any one site may not have been considerable large, the total amount traded across all of Mesoamerica must have been exceedingly large. Quantity of goods in circulation is directly linked to the degree that demand must be monitored in some fashion, and given a foot mode of transport and its resultant constraining effects on transportation efficiency, nodes in the network should be located at points where lines of transit converge and/or where geographic position affords freedom of movement in several directions. This would allow for less lag time between order and eventual delivery, especially if goods were also stockpiled at those same places. Kaminaljuyu, it should be mentioned, is situated on the major communication route from the Pacific Coast of Guatemala to the Maya lowlands. Similarly, Matacapan is centrally located relative to the Gulf Coast and the Rio Coatzacoalcos and the Rio Papaloapan, two major routes of riverine traffic from the coast into the interior.

Second, both Kaminaljuyu and Matacapan are located near key resources or in unusually diverse resource zones. Kaminaljuyu, we have every reason to believe, dominated the exploitation of the El Chayal obsidian deposit, one of the major types of obsidian traded in volume to the Maya lowlands (Hammond 1972; Moholy-Nagy 1975; Parsons and Price 1971). Matacapan is not located near obsidian deposits but is near the only available source of igneous rock for grinding implements and monumental sculpture on the South Gulf Coast. Both Kaminaljuyu and Matacapan, then, may have also served as production points for goods or raw materials traded long distances. This is definitely the case

Table 1 : Chronological Concordances (after Blanton 1978; Coe 1966; Ortiz 1975; and Sanders, Parsons, and Santley 1979).

Sidereal Years	Basin of Mexico	Tuxtlas Region	Valley of Oaxaca	Maya Region
1200	MAZAPAN	EARLY POSTCLASSIC	PERIOD V	EARLY POSTCLASSIC
1100				
1000		L. LATE CLASSIC	PERIOD IV	
	COYOTLATELCO			LATE CLASSIC
900				
800		E. LATE CLASSIC		
	METEPEC			
700				
	XOLALPAN		PERIOD IIIb	MIDDLE CLASSIC
600		L. MIDDLE CLASSIC		
500	TLAMIMILOLPA			EARLY CLASSIC
400		E. MIDDLE CLASSIC	PERIOD IIIa	
300	MICCAOTLI			PROTOCLASSIC
200		EARLY CLASSIC	PERIOD II	LATE PRECLASSIC
	LATE TZACUALLI			
100 A.D.				
0	E.TZACUALLI			
100 B.C.	PATLACHIQUE	TERMINAL PRECLASSIC	PERIOD LATE I	
200				
300	TICOMAN III	LATE PRECLASSIC	PERIOD EARLY I	MIDDLE PRECLASSIC
400	TICOMAN II			
500	TICOMAN I		ROSARIO	
600		MIDDLE PRECLASSIC	GUADALUPE	
	CUAUTEPEC			
700				
	LA PASTORA			
800			SAN JOSE	
900	EL ARBOLILLO	EARLY PRECLASSIC		
1000				

at Kaminaljuyu (Sanders and Michels 1977); however, at Matacapan there is no evidence that the site dominated basalt tool manufacture, to judge from the survey and excavations carried out in 1982. Certainly, Matacapan was a major central place, but basalt technology was not produced for exchange by specialists at levels remotely comparable to those recorded at Kaminaljuyu. The site's key spatial position consequently may have been the primary determinant behind the Teotihuacan presence in the Tuxtlas. It may have also acted as a major way station for merchants carrying goods from northern Mesoamerica to the southern lowlands. Matacapan, we point out, is located roughly midway between Teotihuacan, Monte Alban, and Tikal, three major sites in Middle Classic network associated with Teotihuacan.

We suggest that obsidian was a primary good exchanged long distances in the Middle Classic (see Table 1). We warrant this claim with the following evidence. First, the amount of material from different sources utilized during the Formative Period conforms to the pattern one would expect under conditions of down-the-line exchange (Pires-Ferreira 1975; Santley 1983; Spence 1978; Zeitlin 1978). In down-the-line exchange systems goods are passed reciprocally between adjacent settlements, and there are few specialists involved in exchange or transfer (Renfrew 1975, 1977). In the Classic Period, in contrast, patterns of obsidian falloff undergo marked change. Obsidian from sources controlled either by Teotihuacan or Teotihuacan linked polities rises dramatically in frequency at consumer sites, much more than one would predict given distance decay as the only factor (Santley 1983; Zeitlin 1982). In fact, the general pattern is one of falloffs beyond about 100 kilometers, then increases in proportion of the sample at 275-425 kilometers from the source (Santley 1983). Likewise, sites using disproportionately large amounts of these obsidians exhibit more profound Teotihuacan influence in other media (e.g., ceramics, sculpture, ritual-ceremonial paraphernalia, and architecture). This shift in source utilization, we believe, implies the emergence of a trading system based on directional middleman exchange and that Teotihuacan played a major role in structuring the rearrangement.

In addition, there is strong evidence that obsidian working was the dominant element of the craft economy of ancient Teotihuacan. Studies by Rene Millon (1973, 1981) and associates (Ester 1976; Spence 1977, 1981, 1984) have defined nearly 600 craft workshop entities, and of that total nearly one-fifth had obsidian working as their primary focus. Obsidian workshops group into several major classes. Local workshops appear to have produced goods primarily for consumption by the inhabitants of the city and its immediate hinterland. Regional workshops, in contrast, seem to have manufactured goods for export beyond the boundaries of the Teotihuacan state. Many of these regional workshops aggregated into clusters which grew to substantial size, and many seem to have processed a single kind of implement or tool preform, blade cores and prismatic blades in particular. The total amount of obsidian working was considerable. Spence (n.d.), for example, has estimated that regional workshop production alone involved several thousand craftsmen and their dependents. Santley (1984), in an independent study, has suggested that these workshops were capable of producing sufficient output to provide for the annual domestic needs of at least several million consumers. Much of the production of Teotihuacan's obsidian industry, it would appear, was destined for exchange throughout Mesoamerica.

Third, the way the Teotihuacan polity was organized closely fits the dendritic model of politico-economic organization (Santley, Kerley, and Kneebone n.d.). In dendritic central place systems large-scale industries come to dominate the economic climate of the principal urban center (Johnson 1970; Smith 1976). This community, generally referred to as a primate center, exerts profound effects on local regional economic structure; lesser centers function as bulking places for the major industry in the primate center, and a nested central place hierarchy is inhibited from developing because most economic connections between communities are vertical. We have identified fourteen properties of dendritic systems, and of these thirteen are evident at Teotihuacan and in its immediate hinterland. These include the presence of a primate center, a large-scale industry dominating the urban economy, a size-sequential site distribution, location of rural centers to control the bulking of goods to the primate center, factory workshop production, and the concentration of all marketing facilities in the primate center, among others (Santley n.d.a). There is also strong reason to believe that dendritics describe the organization of other aspects of Teotihuacan's regional economic structure as well (e.g., lime extraction and grain production) not only in the Basin of Mexico but also in neighboring regions of Central Mexico (Sanders, Parsons, and Santley 1979; Sanders and Santley 1983; Santley n.d.a, n.d.b).

This evidence, we believe, firmly supports the proposition that Teotihuacan contacts throughout Mesoamerica were economically motivated and that Teotihuacan was the hub of the system. Why this was so we have attributed to Teotihuacan's need to diversify energy acquisition, to invest in economic strategies that spatially and temporally average energy production (Sanders and Santley 1983; Santley n.d.a; Santley and Ortiz 1983). The Basin of Mexico, the core region over which Teotihuacan had direct political control, is an area characterized variable by subsistence risk. Rainfall levels and frost problems fluctuate greatly from year to year, and occasionally lean years fall in sequence. Risk of this sort has tremendous effects on agricultural production, including foodstuffs obtained from irrigated land. Such risks have a greater effect as rainfall levels become less. They will also play a greater role in affecting system structure as population density rises and when physiographic circumscription inhibits movement out of the region.

One way to alleviate stress is by system investment in economic strategies that diversify energy acquisition. Obsidian working is a very adaptive way to solve this problem because lithic production and use are only partly conditioned by the same factors that affect agricultural production. In order to succeed in diversification, however, the fledgling manufacturing node must control access to raw materials, it must be in a position to create scarcity, and this in turn requires that it be located near raw material deposits and contain a large population capable of impeding access and underwriting production. These developments should occur when demographic levels begin to exceed local support capacity of local subsistence systems. Once the diversification process begins, resources can be brought in from distant regions as a bank against local perturbations. Colonization of the obsidian source region and proliferation of the city's craft economy occur early in Teotihuacan's history (Spence 1984). The city's craft economy emphasizes obsidian working, and this development occurs at a time when the population of the Teotihuacan Valley had increased several fold. The shift to obsidian working also happened immediately in the wake of the eruption of the volcano Xitle, which undermined agricultural subsistence in the southern part of Basin of Mexico--the geographic unit in which Teotihuacan is located--and forced populations to relocate in the drier, more environmentally risky central Basin (Sanders, Parsons, and Santley 1979). The relative lack of population in the southern Basin until much latter in the sequence implies that the effects of this catastrophe were long-term. Archaeological and ethnohistoric evidence from Tula, Tenochtitlan, and their environs suggest that successor states in the Basin of Mexico were similarly organized (Healan, Kerley, and Bey 1983; Sanders, Parsons, and Santley 1979; Sanders and Santley 1983; Santley n.d.b; Santley, Kerley, and Kneebone n.d.).

III. FIELDWORK METHODOLOGY

In 1982, archaeological fieldwork was begun at Matacapan (see Figure 2). Matacapan, we suspected, was an important site in the long-distance exchange system dominated by Teotihuacan. Our research concentrated on defining the structure, function, and development of the Teotihuacan barrio, a small mound group to the west of the main plaza where Teotihuacan materials had been found by Juan Valenzuela (1945). Valenzuela's work indicated that the barrio consisted of four structures arranged around a small plaza: two temple mounds, one of which was constructed in pure Teotihuacan style, and two large residential platforms and associated middens (see Figure 3). Two fieldwork tasks were conducted in the 1982 season. First, a systematic survey of the site was begun to place the materials we were obtaining from the barrio into a wider context. Second, a series of stratigraphic excavations were undertaken in Teotihuacan barrio to produce a ceramic, figurine, and lithic chronology. This information, we hoped, would allow a definition of the organization of space within the barrio and changes through time. More excavations were conducted than planned because the tests of midden deposits showed that the Middle Classic levels were buried at least 50 centimeters below contemporary ground surface. This required that the project engage in a more intensive program of subsurface exploration. For this reason, we did not undertake a total

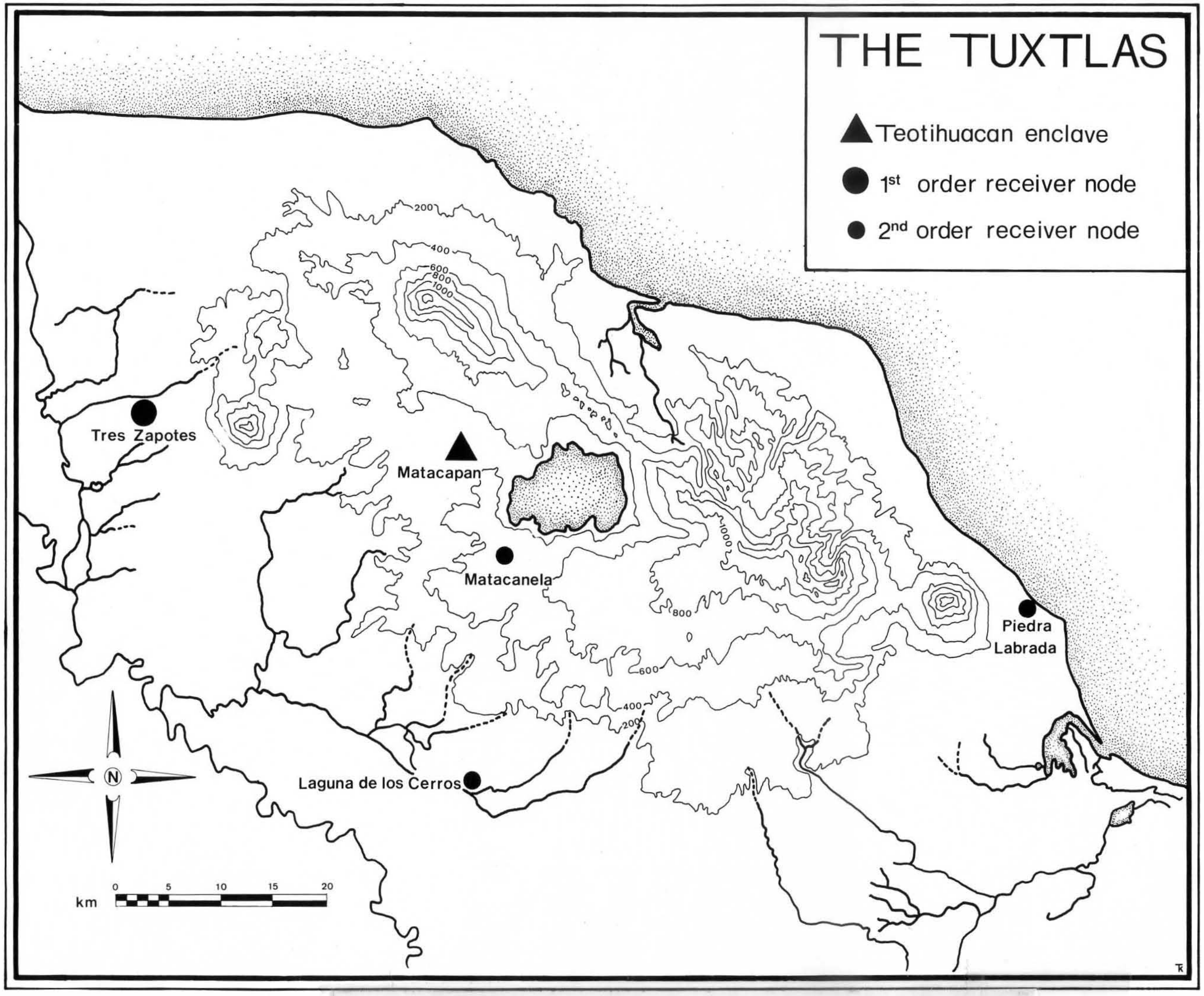


Figure 2: The Tuxtlas Region showing the Location of Major Archaeological Sites.

pickup of all materials on the surface of the barrio as originally intended. All materials retrieved in the field were classified in the laboratory. Fieldwork and laboratory operations were run concurrently to allow for productive feedback between the survey, test excavations, and the analysis.

A. SURFACE SURVEY METHODS

The objective of the surface survey was the production of a map of the ancient site. The survey, we felt, would provide important information on settlement size and configuration, socioeconomic organization, settlement history, and variability therein. The actual survey involved two fieldwork tasks. The first consisted of the preparation of a topographic base map plotting the distribution of standing architecture and other surface features. All surface features encountered during this phase were mapped using a transit at a scale of 1:1,000. A one-meter contour interval was selected so that the map would contain information on major public buildings and small unobstrusive house mounds. The topographic map also provided an array of control points for the systematic survey. All of the central portion of Matacapan, an area 1.1 square kilometers in size, was mapped in this fashion (see Figure 4).

The second phase of the survey involved the collection of surface materials from the area originally surveyed by the mapping team. Originally, we had planned to undertake an extensive survey of the site, then obtain at least one controlled collection from each structure or surface anomaly. However, given the scale of the survey area, proveniencing sampling unit locations soon proved to be a major fieldwork operation in itself. Thus, we decided to confine surface collection to the area physically mapped by the transit team. The area from which collections were taken was therefore much smaller, but the amount of information retrieved was significantly greater, as multiple samples were drawn from each surface feature or area. Consequently, rather than restricting the intensive survey to only the Teotihuacan barrio, an intensive systematic survey involving controlled collection procedures was carried out throughout all of "downtown" Matacapan: in essence, that area which contained most of the site's civic-ceremonial and high status residential architecture.

Surface collection involved stratified systematic interval transect sampling (Redman 1973). Each modern agricultural field constituted a zonal stratum across which an array of transects was laid out oriented to the cardinal directions. The distance between each transect selected for survey was systematized to insure adequate spatial coverage. The 3 by 3 meter square was the basic collection unit. Sampling square were arranged 10 to 15 meters apart within each transect to facilitate unit proveniencing. Collection procedures were controlled. By controlled collection procedures we mean the retrieval of all surface materials--pottery, lithics, ground stone, etc.--from sampling units following vegetation removal. Care was also taken

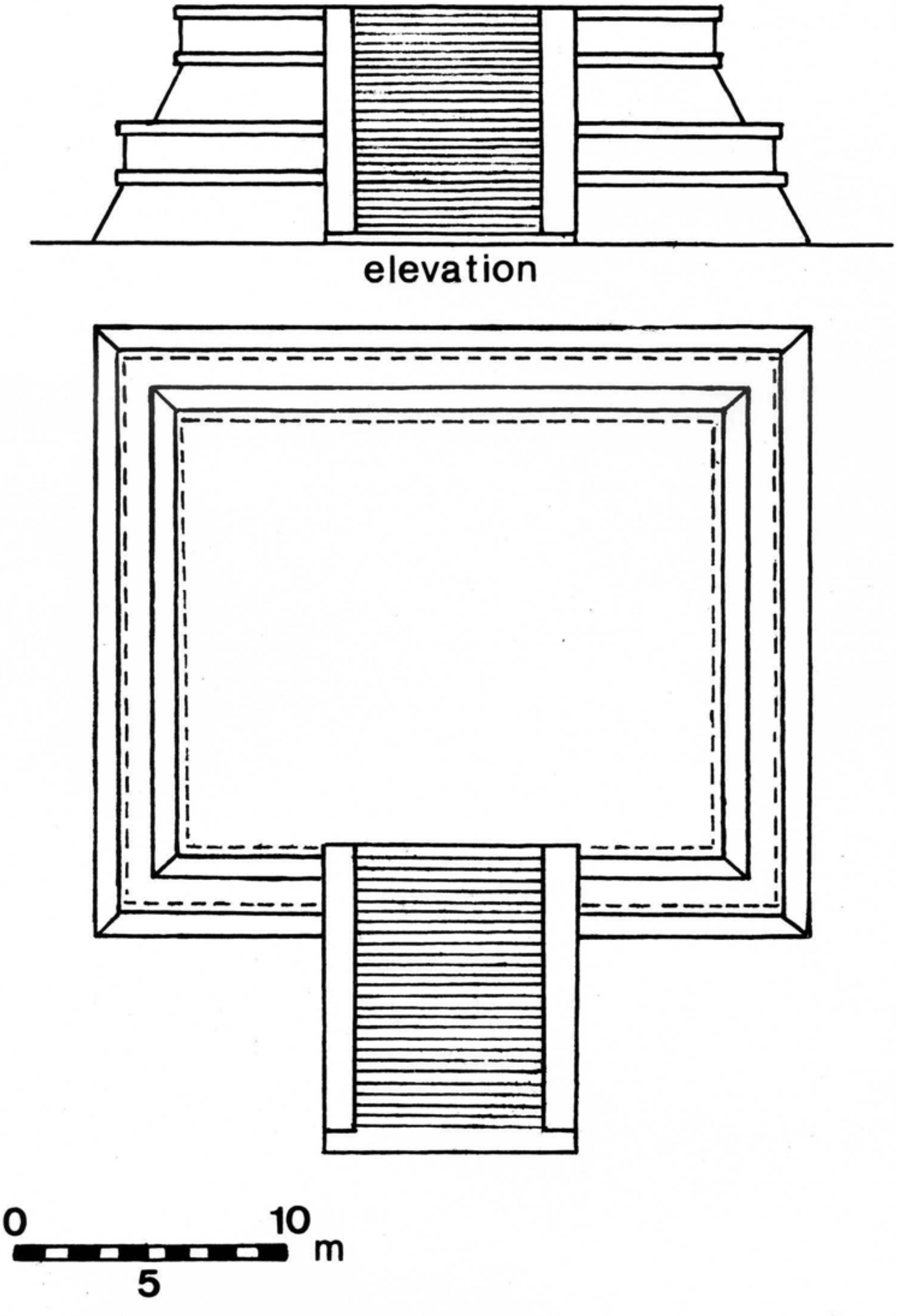


Figure 3: Reconstruction of Mound 2
at Matacapan (after Valenzuela 1945).

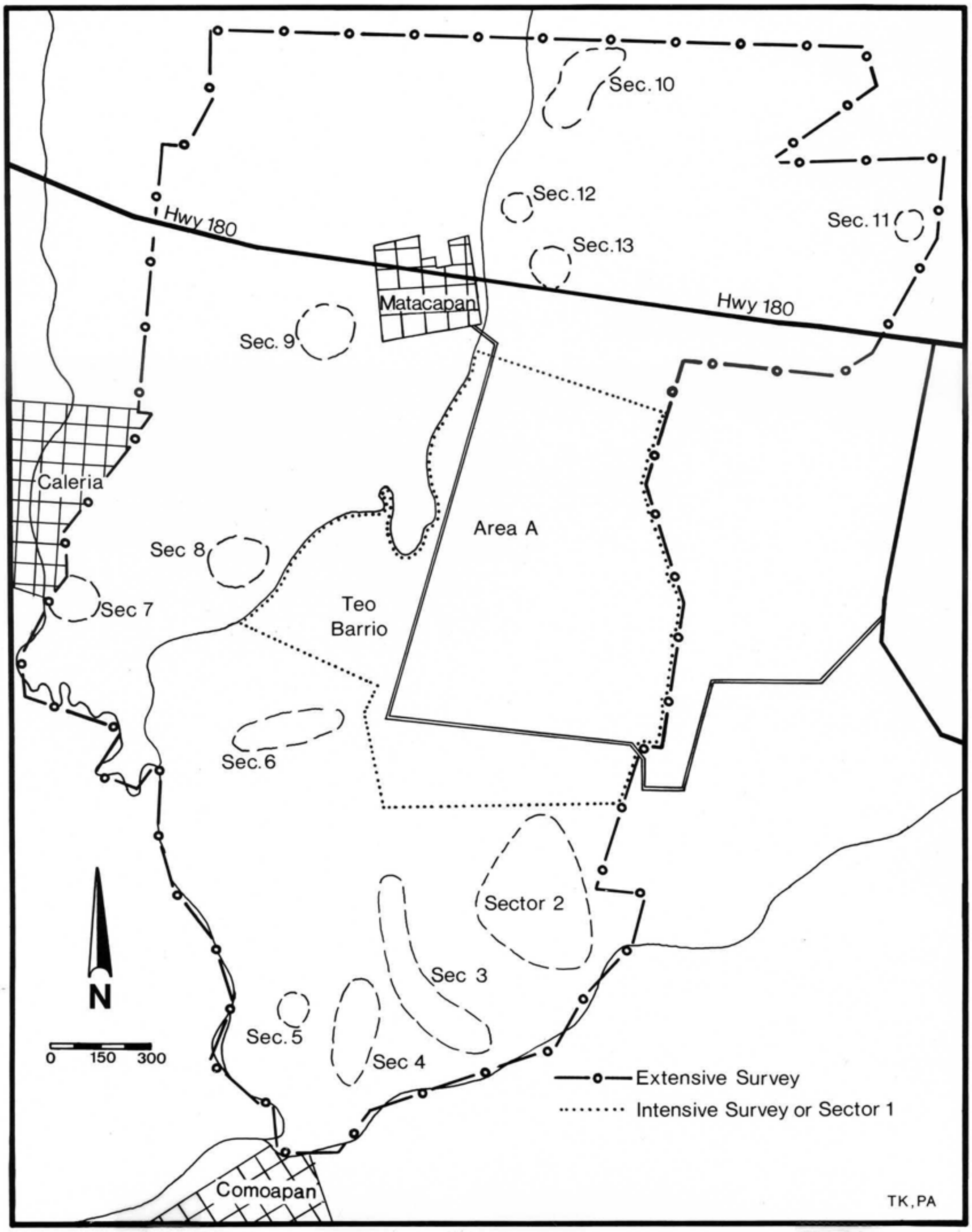


Figure 4: Planimetric Map of Matacapan showing Areas surveyed in 1982.

to sample all surface architecture. Whenever survey transects did not bisect a mound or other surface feature, secondary transects perpendicular to the primary alignment were laid out. All sampling units were assigned a horizontal provenience based on absolute distance from the primary datum. Altogether, we were able to survey 1.1 square kilometers of central Matacapan from which 1,053 surface collections were obtained. To our knowledge this is the most intensive survey employing controlled collection procedures ever attempted at an urban site in Mesoamerica. For example, at Teotihuacan an area more than 35 square kilometers was surveyed by Mapping Project archaeologists from which about 5,000 collections were made (M. Spence, personal communication). Our sampling intensity is approximately five times that employed at Teotihuacan, one of the most intensively studied sites in Mesoamerica.

During the final month of the 1982 field season, it became apparent that we would not be able to survey all of Matacapan using this methodology. At the same time we knew that to change reconnaissance procedures in midstream would greatly compromise the quality of the survey data base. As a result, it was decided to complete the survey of the site's main civic-ceremonial precinct, then conduct an extensive survey of outlying areas of occupation, which would be surveyed using intensive procedures at a later date. The extensive survey utilized the reconnaissance procedures employed by the Basin of Mexico Project (Sanders, Parsons, and Santley 1979). An additional 4.5 square kilometers of urban occupation was systematically surveyed in this manner. All architecture, concentrations of surface refuse, and other features were mapped with compass and tape. Surface collections, however, were restricted to mounds or areas where there were concentrations of surface pottery. These data were plotted on 1:5,000 photographic enhancements of the site obtained from the _Compania Mexicana de Aerofoto_ in Mexico City. Information on contemporary land use, surface visibility, hydrography, topography, and soil conditions was also recorded.

Surface reconnaissance consequently focused on obtaining a large number of controlled samples from central Matacapan. Because the horizontal location of each sample was known, the surface materials could be accurately related to features that appeared on the topographic map. Moreover, because the number of sampling units was large and the collection procedures controlled, statistical analyses of spatial patterning of the archaeological materials could be undertaken without bias overly affecting the integrity of the survey data base. Information was also retrieved from a large area of urban occupation surrounding Matacapan's main complex of public buildings. Because of time constraints, survey procedures were extensive, emphasizing minimum data retrieval for maximum areal coverage. This information is being used to isolate areas that will be intensively surveyed at a later date.

The Matacapan Project developed the following nomenclature to divide the site into spatial subunits. The survey indicated that the site consisted of 13 hotspots, or areas that contained standing surface architecture and/or high densities of surface materials. Each of these we termed a <u>sector</u>, a discrete district or barrio of the site. In the case of Sector 1, downtown Matacapan, several groups of mounds were plainly visible on the surface. Each of these subgroups we called an <u>area</u> to distinguish them from the larger entity of which they were obviously a part. Areas in turn could be divided into <u>subareas</u> and these in turn into excavation squares.

B. STRATIGRAPHIC EXCAVATION METHODS

Twenty-two stratigraphic excavations were undertaken to establish a pottery and figurine chronology and to obtain information on subsurface variability within the Teotihuacan barrio. Altogether, we excavated 103,000 potsherds, 3,600 pieces of chipped and ground stone, 300 figurine fragments, and about 1,000 miscellaneous objects (e.g., censers, candeleros, small double-chambered artifacts that probably served as personal incense burners, earspools, adornos to large incense burners or ceramic vessels, beads, pendants, and spindle whorls).

Excavations employed the procedures developed by the University of Missouri Tula Project (Diehl 1974) and the Tulane University Tula Project (Healan 1979), with modifications. The basic excavation unit was the 3 by 3 meter square, which was subdivided into nine 1 by 1 meter collection loci. All test pits were excavated in arbitrary levels whenever cultural stratigraphy was absent or exceeded 10 centimeters in depth. All earth from the northwest locus of each excavation was screened, the remainder excavated with trowel and shovel. Each northwest locus also provided a two-liter flotation sample. The space within each pit was segregated into discrete zones whenever discontinuous lateral deposits were discovered. Subleveling, in contrast, was employed whenever cultural stratigraphy was encountered, and subzoning and subleveling were used simultaneously if complex features appeared. Both vertical and horizontal provenience units were merged when necessary so that natural entities such as a room or refuse midden could be isolated. Whenever a stratigraphic excavation reached seemingly sterile deposits, a 1 by 1 meter preview pit was excavated in the northwest corner of the square and all earth screened. If artifact-bearing strata were not encountered after an additional one meter of excavation, the test pit was terminated.

Individual excavation squares were located to insure adequate spatial coverage. Pit locations were not selected using random sampling procedures, because of the small number of excavations and consequent effects of small sample size on sample representiveness. The locations of all excavation squares were therefore biased. Initially, four squares were begun near the northeast corners of Mounds 1, 2, 3, and 22. Subsequently, the excavation group was divided into three teams, each concentrating activity in a different portion of the barrio. Each team, consisting of one or more archaeologists and four workmen, excavated two pits simultaneously. Eventually, the team probing the area around Mounds 1 and 2 was moved to Group A. Altogether, 385 cubic meters of archaeological deposits were excavated using this methodology.

C. LABORATORY ANALYSIS METHODS

Laboratory analysis ran concurrently with field research. Virtually all of the material retrieved in the field was classified immediately after entering the laboratory facility in order to maximize the amount of feedback between survey, excavation, and analysis. Initially, all artifacts were sorted into general groups (e.g., ceramics, chipped stone, figurines, ground stone, etc.), then stored for more specialized analyses after an adequate sample of materials had been obtained.

Ceramics were grouped into a series of morphological classes based on research by Ortiz (1975) and Coe and Diehl (1980). Since chronology was a major objective of the ceramic analysis, morphological classes were defined on the basis of paste characteristics, surface color, and decorative mode, three variables past research in the Tuxtlas had indicated are very time sensitive. A sample of 10,000 rimsherds was further classified by vessel form. By the end of the 1982 season a total of fifty-six different ceramic wares and seventy-four discrete vessel forms had been distinguished in the excavated materials. An attribute analysis was also conducted on all rims from Pits 8 and 20. The attribute analysis provided a more detailed picture of variability in paste texture and style of decoration, two variables that constituted the basis for class definition. It also provided the project with some basis for evaluating observer bias, the degree to which different analysts classifying the same material would sort the ceramics into different groups. That bias, we estimate, involves about 5 percent error in observer intersubjectivity. All ceramics from the surface survey were also grouped by major ware and vessel form whenever possible.

Obsidian was classified using the analytic framework developed by the Tulane University Tula Project (Healan 1979; Healan, Kerley, and Bey 1983). This analysis included identifying of general classes of local and imported raw material, the definition of technological classes of debitage (the waste produced during lithic tool manufacture), intermediate forms, and tool rejects, as well as the specification of functional tool types. An attribute analysis of all blade cores (fluted cylindrically shaped objects that were thrown away after blades were struck off), bifacially chipped objects such as projectile points, and a sample of all blade fragments was also completed.

All figurines, ground stone, and miscellaneous artifacts were also classified. Figurines were grouped by chronological period and general style only, based on facial shape, headdress style, body morphology, and technology of manufacture. Ground stone, in contrast, is uncommon at Matacapan. The same may be said for earspools, spindle whorls, candeleros, beads, and pendants. In these cases each specimen was described individually. The faunal and floral material have yet to be studied in detail.

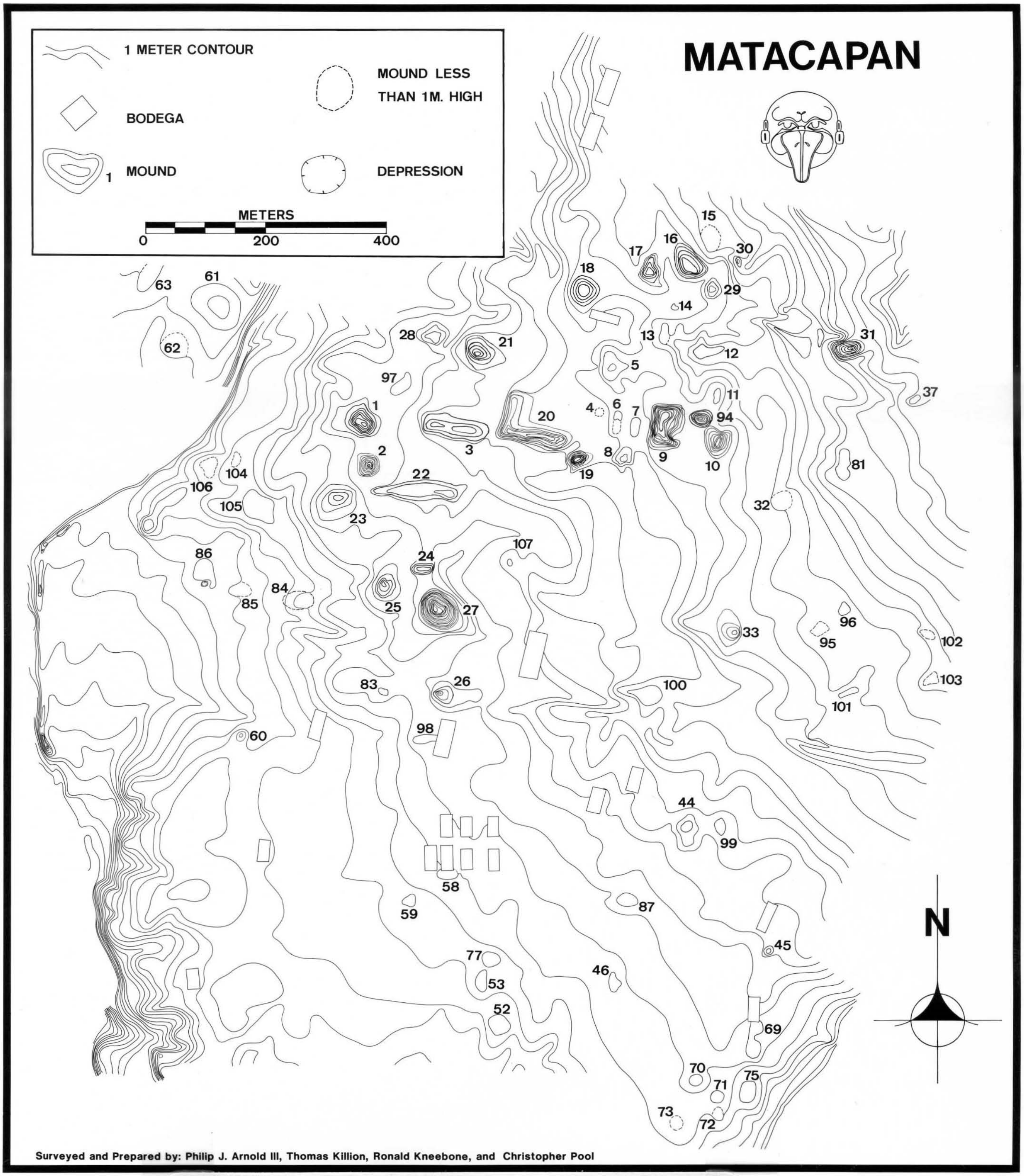
D. DISTRIBUTION STUDY METHODS

Studies of spatial patterning were facilitated by distribution analyses of the frequency, density, and multiple covariation and association of particular classes of materials found during field research. This aspect of our research provided a basis for distinguishing spatial patterns across the site and for quantitatively studying site structure and technology. The distribution analysis was performed with the aid of the IBM 3022 computer at the computing center of the University of New Mexico. Various bivariate and multivariate techniques were used to establish patterns of mutual covariation and association. The analytic categories so produced were then plotted spatially. Recall that the provenience of all collection loci is known; therefore, plots of materials, be they from survey or excavation, can reproduced with ease. This was accomplished using either individual artifact categories or hybrid variables defined as groups of mutually associating or covarying types. Both the typological and attribute data were coded onto computer forms in the field for transfer to the main frame after return from Mexico. This allowed the distribution analysis to begin immediately following the completion of field research.

IV. SETTLEMENT HISTORY

Matacapan has a long occupational history. Apparently, the site was first occupied during the Preclassic Period (see Table 1). Camano coarseware tecomates, large storage jars without necks which were sometimes decorated with rocker stamping, Ciruelo red rimmed bowls, and Xochiltepec whiteware occur in the deepest levels of Pits 8 and 19, suggesting an Early Formative date (Coe and Diehl 1980). Middle Formative pottery is also present. Formative pottery, however, does not occur in great numbers at Matacapan, although sometimes the deposits are very deep. These materials are also rare at Tres Zapotes (see Figure 2), implying that Formative Period Matacapan antedates the main occupations at Tres Zapotes. All of the Early and Middle Formative pottery we have found to date is mixed. This is because most of the Formative material derive from what appears to have been a household garden or agricultural plot. Today in many parts of rural Mesoamerica household refuse, including pottery, is still discarded near the residence. Frequently, part of the houselot is also used as a garden, and because decaying organic matter restores soil fertility, household gardens are often cultivated each year, which effects a considerable mixing of deposits. We suspect that similar processes were in operation at Matacapan in the Early and Middle Formative.

The Formative occupations at Matacapan therefore have great antiquity. Although the site was continuously inhabited for centuries, the Formative occupations are not substantial. Preclassic pottery occurs only in small pockets throughout the



Surveyed and Prepared by: Philip J. Arnold III, Thomas Killion, Ronald Kneebone, and Christopher Pool

Figure 5: Topographic Map of Central Matacapan.

Figure 5: Topographic Map of Central Matacapan.

Classic Period occupation zone. The Formative settlement pattern, then, is highly dispersed. Apparently, the Preclassic site consisted of a number of discrete household units that occupied different parts of the site. There is no evidence that these units were hierarchically ranked vis-a-vis one another. All of the ceramic materials are utility wares. Not present are status goods made of jade or serpentine or the elaborately carved or incised service wares that were so commonplace at San Lorenzo, the large Olmec center located on the Rio Chiquito near the border between southern Veracruz and western Tabasco. (Coe and Diehl 1980). This is precisely what we would expect if Matacapan were occupied by small groups of rural agriculturalists.

Sometime during the Middle Formative Period the entire site was covered by ash from San Martin volcano or one of its side vents. In undisturbed contexts the tephra (ash) layer is 30-40 centimeters deep. Apparently, the eruption was a catastrophic event that rapidly covered the Formative site. The eruption probably took place in late spring or early summer--the dry season--to judge from the lack agricultural plant remains preserved on the agricultural surface. Following the eruption it appears that the site was totally abandoned. Late Formative, Terminal Formative, and Protoclassic materials do not occur in stratigraphic contexts nor are they present in the surface samples.

Central Matacapan lay unoccupied until the Early Classic Period (see Table 1). These materials occur above the tephra layer but below the levels in which Teotihuacan and Middle Classic ceramics predominate. It would appear that Early Classic Matacapan was a fairly large site, though nowhere near the size it was to attain in the Late Classic. Early Classic sherds are consistently distributed over an area approximately one square kilometer in size. They also occur sporadically in outlying occupation zones. None of the civic architecture in downtown Matacapan can be assigned an Early Classic date with certainty, due to later mound construction. It seems likely, however, that Matacapan was probably only one of several Early Classic centers, all relatively equal in size. El Picayo, for example, was a major Early Classic site (Ortiz 1975), and what little evidence we have from Matacanela suggests that it also was.

In the Middle Classic ties with the city of Teotihuacan became pronounced (see Table 1). A mound complex was built by or for these foreigners. At least one structure, Mound 2, was constructed in typical Teotihuacan style, and chances are that Mound 1 was also a talud-tablero temple platform. Mounds 3 and 22, also in the Teotihuacan barrio, were presumably residential structures occupied by persons who used relatively great numbers of Teotihuacan style ritual-ceremonial paraphernalia. In 1982 we conducted a series of excavations behind Mound 3 and Mound 22 which encountered refuse dumps deposited by the occupants of the buildings, confirming their residential function. These deposits were also unusually rich in Teotihuacan materials (e.g., cylindrical tripod vases, candeleros, figurines, and green obsidian). In fact, tripods from cylindrical vessels are the most common support class from Middle Classic contexts in the barrio. Most of the cylindrical tripod vases at Matacapan are imitations of Teotihuacan vessels rendered in local paste, often in Tuxtlas Fine Orange or Fine Gray. Candeleros and Teotihuacan figurines were also manufactured using local clays. The Middle Classic mound orientation is quite different from the alignment buildings were to adopt in the Late Classic. This suggests that the abandonment of the barrio and the cessation of ties with Teotihuacan coincided with a major reorganization in community plan.

In the Late Classic, Matacapan grew tremendously in size (see Figure 5). There was not a collection locus in the 5.6 square kilometers mapped by the survey team that did not contain Late Classic utility wares. This estimate should be considered as a minimum as we have not been able to survey all outlying zones of suburban occupation. It is quite possible, then, that Late Classic Matacapan was considerably larger than the area physically mapped by the survey crew. Although the ceramic analysis is still in progress, it appears likely that we will be able to subdivide the Late Classic into two phases. This periodization is defined by changes in service ware frequency and obsidian source utilization. A substantial proportion of the Late Classic obsidian sample is green in color, indicating reliance on material from the Pachuca source complex in southern Hidalgo. In the early Late Classic green obsidian accounts for 12-22 percent of the sample, in contrast to the mean of 4 percent during the Middle Classic. In the late Late Classic the skew toward Pachuca obsidian increases even further, to about 28-40 percent. The obsidian retrieved from these deposits is identical to the material recently excavated by Tulane University at Tula, Hidalgo (Healan, Kerley, and Bey 1983). The same kinds of trade sherds from the Central Gulf Coast also occur at Tula as at Matacapan, implying contemporaneity. To our knowledge, this is the first recorded instance of Toltec obsidian trade with the South Gulf Coast.

Late Classic Matacapan is dominated by a large plaza (see Figure 5). A peculiar aspect of this plaza is that it was terraced. Four groups of public buildings are distributed around the plaza. Area A, located directly to the north, consists of eighteen mounds. Two of these structures, Mounds 9a and 20, are large platform mounds approximately 5-8 meters in height and 70-100 meters on a side. These buildings are our best candidates for royal palaces, given their unusually large size, that they have smaller, presumably residential structures, on top, and their association with all kinds of artifactual debris, including a wide variety of utilitarian pottery, lithics, ground stone, and bone. We have reason to believe that these two structures were occupied sequentially. Mound 9a is associated exclusively with Late and Terminal Classic materials, whereas the refuse associated with Mound 20 dates mainly to the Middle Classic Period. Mound 9a, moreover, is associated with a small ball court, a Late Classic hallmark on the South Gulf Coast. In addition, each of these structures is associated with a conical temple mound, Mounds 9b and 19. These buildings may represent funerary temples to elite descent lines. Alternatively, they may have functioned as shrines for local deities. The volume of fill present in these structures compares favorably with that of Mounds 1 and 2, the two principal temples in the Teotihuacan barrio.

A number of smaller mounds also occur in Area A. Typically, these mounds are rectangular in shape, several meters high, and 15 to 25 meters on a side. Excavations near the base of Mound 5 produced relatively great amounts of domestic trash, indicating that many of these structures probably had a residential function. Many of these structures are arranged around small plazas. Mounds 5, 13, 17, and 18, for example, are distributed around one such feature, Mounds 11 and 12 around another. The lithics associated with these structures are heavily skewed toward obsidian from the Pachuca source. This skew is most marked near Mound 18. Area A also contains a small ball court. Mounds 6 and 7 define the court to the east and west. The southern boundary is provided by Mound 8. The northern end, in contrast, was apparently left open.

A number of craft activity areas also occur in Area A (see Table 2). Thus far, we have been able to empirically define four different kinds of workshop entities. Ceramic workshops are localities where the density of surface pottery is unusually high and a substantial proportion of all materials consist of highly fired or misfired sherds. These same materials occurred in abundance in association with the ceramic kiln excavated in Pit 6. Altogether, twenty such loci occur in Sector 1, most of which are located in Area A. All of these workshops are small and are associated with particular mounds, suggesting production for local use.

A number of figurine workshops may also be present. These were defined by figurine molds which occasionally appeared in the samples. The distribution of figurine molds is not aggregated; rather, they occur throughout the occupation zone, implying manufacture by individual residences or temples.

Two types of obsidian workshops have also been distinguished. In Area A there are four such loci. Three are blade core workshops. At these loci obsidian densities are high, and a significant proportion of all materials consists of decortication flakes and blades, platform thinning flakes, platform facing flakes, error recoveries, exhausted cores, and unutilized blades, indicating core reduction and blade removal as principal activities. The fourth is a blade use workshop, a locality where prismatic blades were utilized for some task. Although the density of surface obsidian is high, reduction debitage is not present, suggesting that the tools were produced elsewhere. Moreover, many of the blades recovered have heavily battered use edges. With one exception where the proportion of Pachuca obsidian is exceedingly high, all workshops relied predominantly on gray obsidian.

Table 2: Summary Data on Sector Socioeconomic Structure at Matacapan

Sector	Size	# of Surface Collections	Pottery Density/M	# of Mounds	Workshop Type
1	1.1 km	1,053	2.2a	33	5 core-blade, 1 blade use, 20 ceramic
2	0.150	5	11.8	1	2 ceramic
3	0.038	5	12.9	3	
4	0.028	4	9.6	1	1 ceramic
5	0.008	1	6.4	0	
6	0.025	4	14.4	1	
7	0.022	3	11.6	0b	
8	0.014	3	9.2	3b	1 core-blade
9	0.014	3	7.3	1	2 core-blade, 1 blade use
10	0.064	3	10.1	0	1 ceramic
11	0.002	1	6.9	0	
12	0.024	1	16.1	0	
13	0.034	2	18.4	1	

a. Estimate based on all collection squares, including squares lacking surface materials

b. Number does not include mounds recently destroyed

Area B, the Teotihuacan barrio, is located immediately to the west of the main plaza (see Figure 6). Much of this architecture, the excavations have demonstrated, was originally constructed sometime in the Middle Classic. Mounds 1, 2, 3, and 22 were all built as a single unit early in the Middle Classic. The central part of Area B consists of a plaza built atop an artificially raised platform around which all of the barrio's civic architecture is distributed. Mounds 1 and 2, the two temple platforms, border the plaza to the west, whereas Mounds 3 and 22, the two residential structures, occur directly to the north and south, dividing the barrio into three zones: Subareas B-1, B-2, and B-3. Mounds 3 and 22 also support small mounds atop the main platforms. These presumably represent the remains of collapsed residential structures build atop the mounds. A number of small mounds also occur to the northwest of Mound 3. These structures, generally less than one meter in height, appear to have been built much later in the Late Classic after the major episode of barrio construction.

Areas C and D are located to the south of the main plaza. Area C consists of a cluster of buildings immediately southwest of the plaza. The dominant building in Area C is Mound 27 or El Gallo, the largest temple mound at Matacapan. El Gallo measures approximately 75 meters on a side and is nearly 15 meters tall. Local informants report finding basalt sculpture nearby. Area C also contains four smaller structures. Two of these buildings, Mounds 25 and 26, are temple platforms. Mounds 24 and 28, in contrast, appear to have had a residential function, perhaps for temple personnel. Area D lies several hundred meters to the southeast of the plaza. Six buildings were mapped by the survey team. The largest, Mound 29, is a temple platform, the remainder residential mounds.

The main area of mounded architecture in downtown Matacapan is surrounded by a large zone of residential occupation (see Figure 4). Surface occupation is literally continuous throughout the 4.5 square kilometers extensively surveyed by the mapping team, reflecting some sort of urban residential sprawl that radiates outwards 2-3 kilometers in all directions from the main plaza. Occupational density varies considerably, though in no area is surface pottery absent. This variability, we believe, reflects differences in population density. Altogether, we have defined thirteen occupation sectors. Sector 1 is the main zone of civic architecture in downtown Matacapan, Sectors 2-13 the outlying zones of urban occupation (see Table 2).

Each sector of urban occupation is an irregularly defined area where surface pottery is amply represented. Typically, each also contains one or more mounded structures. Generally, these are platform mounds, structures that originally functioned as the residences for sector elites. Occasionally, temple mounds also occur. Mean sector size is 3.5 hectares; however, there is considerable variability. Sector 2, the largest, covers more than 15 hectares; Sector 5, the smallest, only about 0.8 hectares. The density of surface refuse generally runs about 100 sherds per collection. Coarse utilitarian wares predominate. The samples from platform mounds, in contrast, are more skewed toward service wares, Fine Gray, Fine Orange, and Tuxtlas Polychrome in particular. Population densities within each sector may have been about 25-50 persons per hectare. In intervening areas, on the other hand, the density of occupation seems to have been much less, perhaps 5-10 persons per hectare. The total population of Late Classic Matacapan, then, may have been as large as 3600-7200 persons.

Several craft workshops were also discovered in the residential zone (see Table 2). Four of these are obsidian workshops. One of these workshop entities is located in Sector 8, about 400 meters to the west of the Teotihuacan barrio. The surface sample contained 55 pieces of obsidian. Included in the sample were irregular blades, prismatic blades, ridge blades, core trimming flakes, exhausted cores, and flake debitage, indicating core reduction and blade removal as dominant activities. The other workshops occur in Sector 9. One of these is a blade use workshop defined by significant numbers of prismatics, many of which exhibit extensive edge wear. The other two are core blade workshops. Interestingly, the density of surface obsidian is at least three times higher in outlying sectors than in downtown Matacapan. The average collection in the residential zone yielded 9.3 fragments, whereas in downtown Matacapan the average sample contained only about 3.4 pieces of obsidian. This difference remains even if the workshop samples are excluded from the analysis. Our conclusion is that outlying barrios performed important service functions for the politico-economic and religious elite in central Matacapan and that this service activity accounts for the relative lack of obsidian in the central part of the site. Outlying sectors also contain localities that we believe were ceramic workshops. These tend to be more widely distributed than obsidian workshops (see Table 2).

Limited information was also collected on the distribution of settlements surrounding the 5.6 square kilometer area surveyed by the mapping team. The main zone of population buildup was apparently surrounded by a number of small rural settlements or areas of suburban occupation. Five of these settlements were located between Matacapan and Lake Catemaco (see Figure 2). Each of these outliers consists of one or more temple mounds, which are often substantial in size, several platform mounds, and a small area of domestic occupation, defined by concentrations of surface ceramics. Each outlier covers an area approximately one to five hectares in size. The volume of mounded architecture is greater than one would expect based on the area of surface occupation alone. Recall that at Matacapan each site sector contained one or more platform mounds, but these were generally modest in size and only sometimes associated with temple architecture. Apparently, Sector 1 at Matacapan performed important central-place functions with respect to the urban center, as reflected by the scale of the civic architecture in downtown Matacapan. In rural settings, in contrast, some of these same functions may have been supplied locally; hence, the occurrence of more substantial temple architecture and other public buildings. Several areas of suburban occupation also specialized in ceramic production. One of these sites contains a workshop zone covering at least 35 hectares. Workshop sites associate directly with fine paste clay deposits. These deposits are unusually rich in montmorillonite and extend literally for kilometers

At least three levels of settlement are therefore indicated. The first consists of Sector 1, Matacapan's major zone of civic architecture. Central Matacapan in turn was surrounded by at least twelve sectors of urban occupation that were politically and economically dominated by the elite resident in Sector 1. The urban center of Matacapan was in turn surrounded by a number of outlying settlements. The presence of substantial public architecture in these settlements suggests that they exercised a certain amount of local autonomy. Exactly how these outliers were integrated into the regional system dominated by Matacapan remains unclear, however.

V. STRATIGRAPHIC EXCAVATIONS

The Matacapan Project also conducted twenty-two stratigraphic excavations. These excavations provided important information on ceramic and figurine chronology as well as a large sample of imported obsidian. The stratigraphic excavations also furnished information on the depth of deposits, the range of feature types that might be located in trash middens, and the sequence of occupation: information that would be useful in designing a more extensive program of lateral excavations. Since a detailed examination of changes in barrio configuration, activity patterning, and their relationship to the process of Teotihuacan contact was a major project goal, nineteen test excavations were placed in the Teotihuacan barrio. This group of excavations was termed *Operation I* (see Figure 6). These excavations were located in three different parts of the barrio. *Operation I-A* was situated in the area around Mounds 1 and 2 and the barrio plaza located to the east, *Operation I-B* in the area to the north of Mound 3, and *Operation I-C* directly to the south of Mound 22. *Operation II* and *Operation III* excavations were conducted in the main mound group to the east of the barrio (see Figure 11).

A. OPERATION I-A

Six stratigraphic excavations were conducted in Operation I-A (see Figure 6). Pits 3, 4, 9, 10, and 12 were located around Mounds 1 and 2, whereas Pit 1 was placed in the barrio plaza near the southeast corner of Mound 3. These excavations were undertaken to date the major episodes of public building construction in the barrio. The buildings themselves were not excavated; rather, we assumed that construction periods could be dated by trash in association with the structures. We were also interested in obtaining information on changes in the use of space and the historical development of the barrio as a

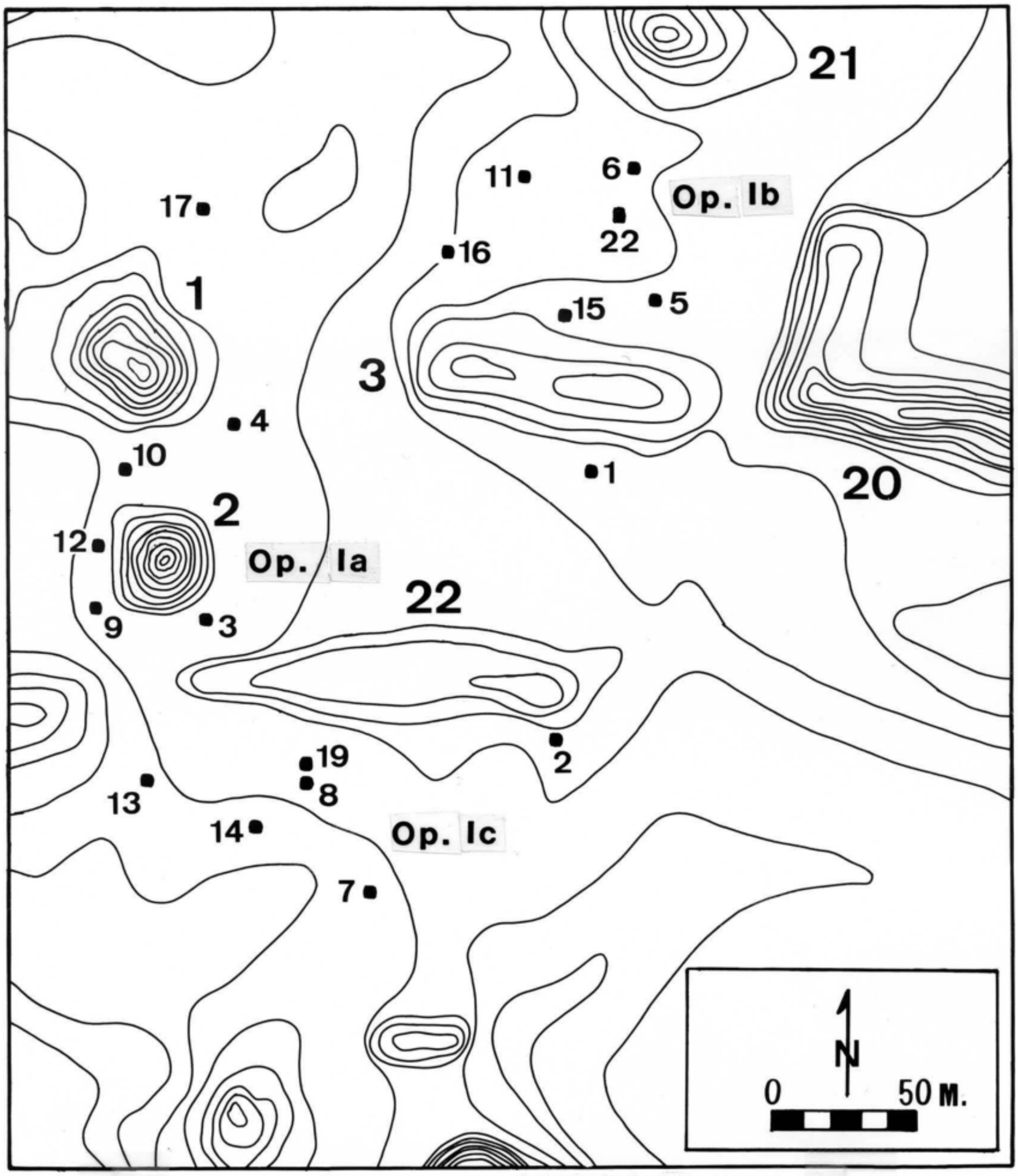


Figure 6: Topographic Map of Operation I showing the Location of Excavations.

structural unit. This area had also been tested by Valenzuela (1945). Therefore, we knew that Teotihuacan materials would be present in significant numbers.

Operation I-A produced little cultural stratigraphy. Apparently, the main architecture was built as a single unit sometime in the Middle Classic. This activity obliterated most traces of earlier construction. Formative and Early Classic pottery, however, was present, indicating earlier phases of use. Pit 1 exposed a compacted earthen surface that sloped to the south near the bottom of the excavation. This surface was apparently slopewash from some construction under Mound 3. Associated pottery suggested that the surface was Early Classic in date.

Mounds 1 and 2 were constructed on a series of long, narrow basalt ridges. Chunks of basalt were brought in and mixed with earth to create a level ground surface. The number of angular basalt chunks increased with depth. The plaza surface was rebuilt several times, and each time the fill used as plaza subflooring contained more trash. This refuse was relatively rich in Teotihuacan materials, indicating that the fill was obtained locally, probably from within the barrio. All six excavations produced comparatively little cultural material, and most of the pottery was concentrated in the first half meter of the profile. No artifacts were found on or embedded in the plaza surfaces. This lack of material we attributed to sweeping activities, a common cultural practice near ceremonial architecture in the Postclassic Period.

B. OPERATION I-B

Seven pits were excavated in the northern barrio (see Figure 6). These excavations were undertaken to define open-air activity areas behind Mound 3. Here, Valenzuela (1945) had also uncovered Teotihuacan materials, including figurines and candeleros. This area, we thought, might contain specialized manufacturing and storage facilities associated with the Teotihuacan presence at Matacapan. Pits 5, 15, and 16 were placed in an alignment paralleling the northern boundary of Mound 3. Pits 6, 11, and 22 were located farther north near the northern edge of the area we defined as the Teotihuacan barrio. Pit 17 was situated about 50 meters north of Mound 1.

In the Middle Classic the northern barrio functioned as an open-air multipurpose activity area. Portions of this area were paved with puddled sandy ash, perhaps to facilitate drainage during the rainy season. Pits 5, 11, and 16 encountered traces of a series of ash pavements. In every case the surface was badly preserved, due to repeated use, exposure to precipitation, and/or rodent activity following abandonment. Occasionally, the pavement was a discrete consolidated entity 10-15 centimeters thick, but more often it survived only as a thin layer or cap. Generally two, sometimes three surfaces were superimposed one atop another.

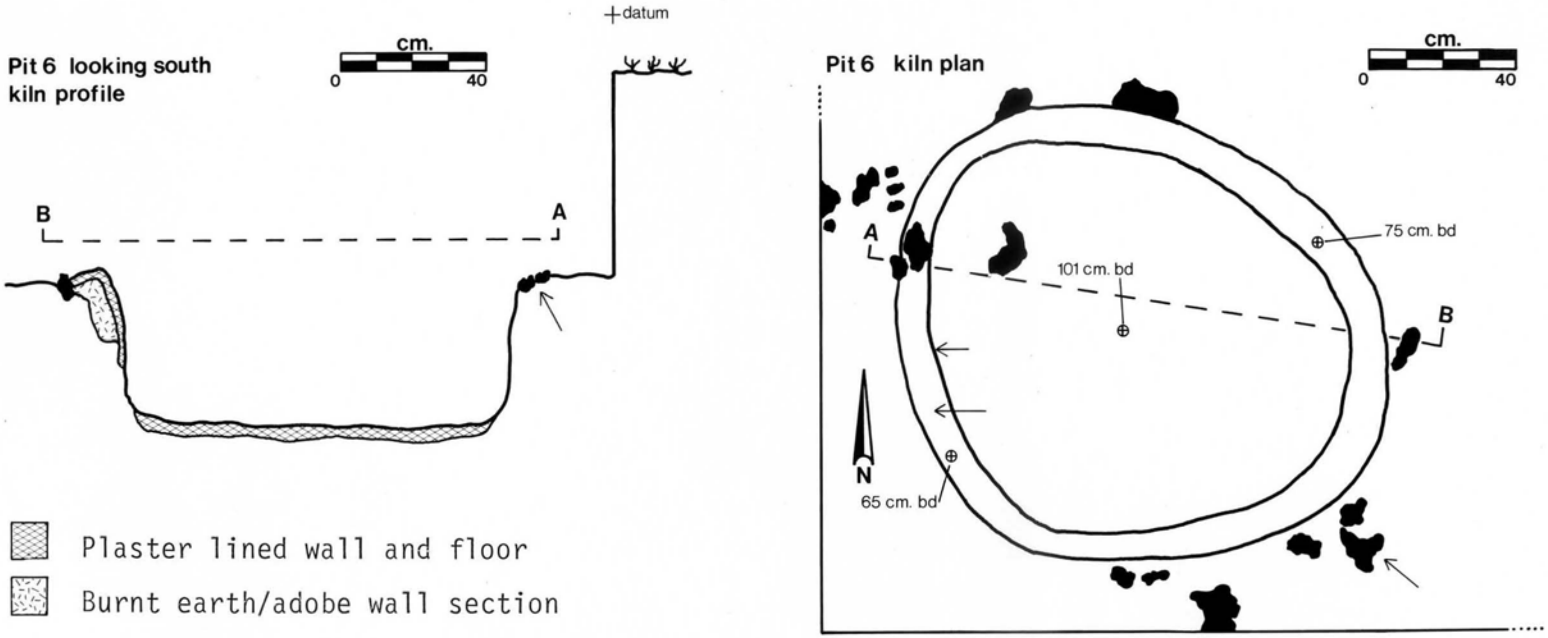


Figure 7: Ceramic Kiln excavated in Pit 6.

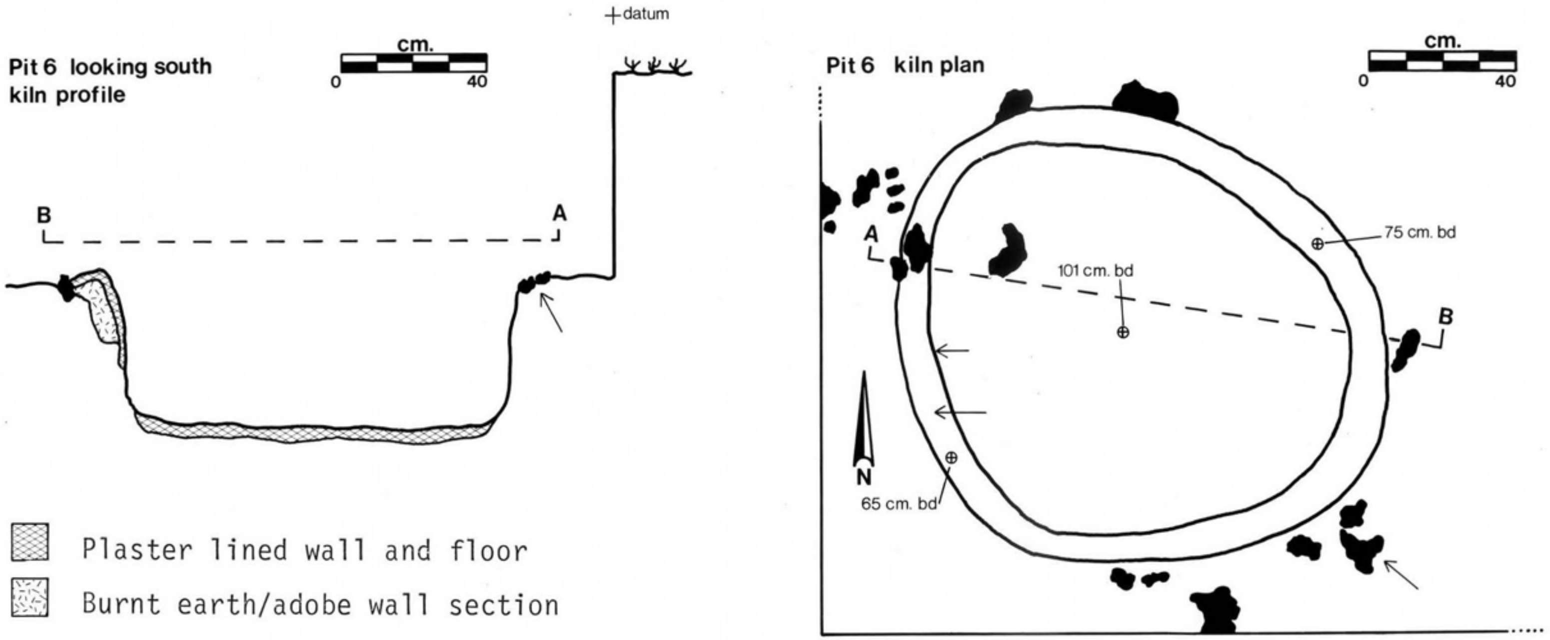


Figure 7: Ceramic Kiln excavated in Pit 6.

Three activity zones were distinguished in Operation I-B, based on associated trash. Parts of the western section of the northern barrio served as a refuse dump for material used by the occupants of Mound 3. Debris of all kinds was discarded in great amounts, including Teotihuacan cylindrical tripod bowls and candeleros. This trash was especially common in deeper levels in the excavations. Hewn rock rubble was also present, indicating that renovations of Mound 3 sometimes involved removal of the previous facade. The zone of trash accumulation extended from Pit 16 west to Pit 17. The midden was also used as a burial locus. One burial was encountered in Pit 16. This interment was disturbed; only femur and tibia fragments were present, and these were disarticulated, indicating secondary burial. The individual was buried with six vessels (four plates, one bowl, and a small spouted monochrome jar). A second burial was excavated in Pit 17. This individual was placed in a sitting position, with the legs arched back toward the trunk and the head facing downward. Specific age and sex determination was not made. The individual was an adult, however, to judge from overall stature and post-cranial epiphyseal closure.

A large portion of the area directly behind Mound 3 was apparently a raised platform or terrace where many day-to-day domestic activities were presumably conducted. Refuse was relatively uncommon, except below each pavement, and the trash contained artifacts of all types and bone and plant remains, indicating that Mound 3 was a residential structure. Curiously, obsidian was unusually abundant. Much of this material was gray; however, green obsidian from the Pachuca source near Teotihuacan was also present, sometimes in very notable amounts. The gray material contained irregular pressure blades, ridge blades, eraillure flakes, exhausted cores, and other core-blade debitage, demonstrating that blade core reduction and core rejuvenation took place at this locus. The green material, in contrast, was represented largely by spent prismatic blades.

To the north of the paved terrace we encountered a ceramic production zone. Pit 6 produced a small circular updraft kiln that was approximately one meter in diameter (see Figure 7). This feature was constructed of straw tempered daub, with the interior surface laminated with plaster. The daub was rock-hard and reddish-yellow in color, indicating that the interior of the feature had been repeatedly exposed to high temperatures. The kiln was left in place so that archaeomagnetic samples could be obtained at a later date. Associated with this feature were fragments of vitrified clay, several stone burnishers, and many large sherds from Coarse Orange jars. These sherds were wasters, fragments from vessels that had broken or warped during firing. Many of these sherds were highly fired, sometimes over-fired, to judge from paste color. We suspect that some were also used as kiln lids, a common practice both today in Mesoamerica and probably also in the past (D. Healan, personal communication).

C. OPERATION I-C

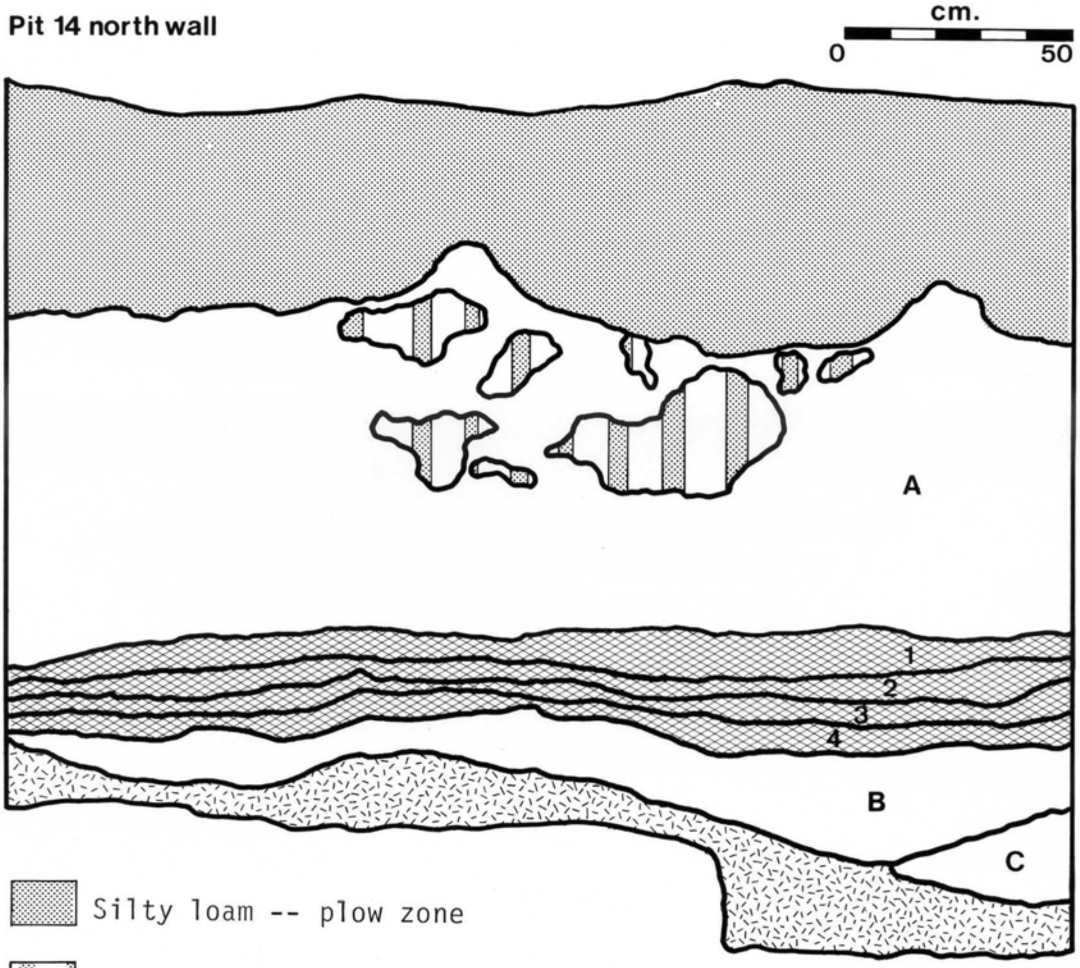
Six excavations were conducted in Operation I-C to search for activity surfaces and middens deposits associated with Mound 22 (see Figure 6). This area had not been tested by Valenzuela (1945). Therefore, excavation was necessary to determine whether this structure was physically a part of the Teotihuacan barrio. Pits 2, 8, 13, and 19 were located directly to the south of Mound 22, a low platform mound comparable in size and shape to Mound 3. Pits 7 and 14, in contrast, were situated farther south in the natural depression between Mound 22 and Mound 24. These excavations were the most productive we conducted in 1982. A large refuse dump rich in domestic trash was uncovered as well as a series of stratified Middle Classic floors and a Formative Period agricultural surface and associated midden.

Except for Pit 2, all excavations were located south of the terrace that adjoined the rear of Mound 22. It would appear that much of this area was used as a trash dump in the Middle Classic. Refuse was especially common at 90-170 centimeters below datum (B.D). Garbage of all sorts was encountered. Ceramics were unusually abundant, but manos, metates, figurines, obsidian, and animal bone were also very common. This was particularly the case in Pits 2, 8, and 19 where an average 10-centimeter level yielded more than twenty two-liter bags of materials. The fact that the middens contained all types of refuse normally expected from a household unit suggested that Mound 22 was a domestic structure. The large sample of cylindrical tripod bowls, candeleros, vessels with Central Mexican style excision, and Teotihuacanoid figurines found in the midden indicated that Mound 22 was occupied by persons with strong Teotihuacan affinities. The midden encountered in Pit 13 was fundamentally different. Although ceramics were present in significant amounts, utilitarian pottery, manos, metates, and animal bone were more uncommon. Ritual artifacts such as ladle censers, prong-rim censers, figurines, and elaborately decorated bichrome and polychrome pottery, however, occurred in much greater numbers. The dump's location near a small temple platform (Mound 23) suggested that the midden was nondomestic. The assemblage represented pointed to a similar conclusion: that is, the area to the east of Mound 23 served as a temple dump, not as a domestic refuse midden.

Burials were also placed in trash middens. Pit 2 produced an exceptionally well preserved burial. The individual was found lying on its side in a crouching position. The legs were flexed toward the chest, with the hands crossed to the right of the chest. The individual was a female, aged 22-27 years, based on the width of the greater sciatic notch, the incidence of a sceptal aperture in the olecranon fossa of the right humerus, the relative wear of the sacro-illiac articulation, postcranial epiphyseal closure, cranial suture closure, and dental wear. The skeleton also exhibited evidence of intentional deformation. The skull had a marked degree of fronto-occipital deformation which caused the left parietal to bulge significantly, producing an exaggerated asymmetrical appearance. In addition, all eight incisors were mutilated. The upper central incisors had two symmetrically placed, V-shaped grooves cut into the crown, while the upper lateral and all four bottom incisors only had a single V-shaped groove. No grave goods were found associated with the skeleton, except for six copper rings on the right hand, two each on the index, middle, and little fingers. Period assignment is difficult, due to the lack of grave goods. The copper rings imply a Postclassic date (R. Diehl, personal communication); however, the style of dental mutilation is distinctly Classic Period in appearance (F. Bustamante, personal communication). No burial pit was detected either during the excavation or in the pit profile. Two pieces of hewn basalt were found 40-50 centimeters above the skeleton in direct correspondence with the positioning of the body. These stones may have originally demarcated the top of the burial pit. If so, then the burial probably dates to the Middle Classic, as the stones are associated with Teotihuacan tripod supports.

Farther to the south the refuse midden terminates. Little evidence of occupation was discovered in pits 7 and 14 in the first 150 centimeters of the archaeological deposit. Most of the material encountered consisted of very small potsherds. This deposit, then, probably represents slopewash from Mound 22. At 150-190 centimeters B.D. there were a series of earthen living surfaces (see Figure 8). Each of these surfaces was a compact earthen floor set upon a sandy loam substratum. No post holes or other structural features were found in association, but Teotihuacan materials, including tripod supports and candeleros, occurred both above and below the surfaces, indicating a Middle Classic date. Because the surfaces were built of compacted earth, they looked quite different from the prepared surfaces found in Operation I-B. Subsequent excavation demonstrated that they had been constructed to seal a trash midden that contained great amounts of Middle Classic garbage, including Teotihuacan materials. In Pit 7 the trash midden extended to more than 300 centimeters B.D.

All of the Teotihuacan barrio originally rested on a layer of black granular volcanic ash. The ash layer, however, was only encountered in Pits 8 and 19, due to earth removal for mound construction in later time periods (see Figures 9 and 10). At first, we thought that the ash layer was an ancient humus horizon because its texture was extremely friable, but after subsequent excavation we discovered additional artifact-bearing strata. The soil below the ash was dark brown and had a very compact matrix, very different from the light brown sandy loams above the ash. Also, there was a major shift in the kinds of ceramics below the ash. Coarse wares, especially tecomates and complex silhouette bowls, were very common, and Fine Orange and Fine Gray, diagnostics in the ceramic assemblage above the tephra, were only occasionally represented. Moreover, this deposit was 100-150 centimeters deep. This deposit was Formative Period in date. Present were Early Preclassic hallmarks such as Camano Coarse, frequently with rocker-stamping or finger-punctate decoration, as well as Ciruela Red-Rimmed and Xochiltepec White, two Middle



░ Silty loam -- plow zone

▥ Mix of snady loam and silty loam

▩ Compacted earthen/ash surfaces

▨ Coarse sandy loam with a high percentage of angular pebbles and cobbles

A Sandy loam

B Compacted clay soil

C Compacted clay soil with moderate quantities of angular pebbles

Figure 8: North Profile of Pit 14 showing Stratified Middle Classic Living Surfaces.

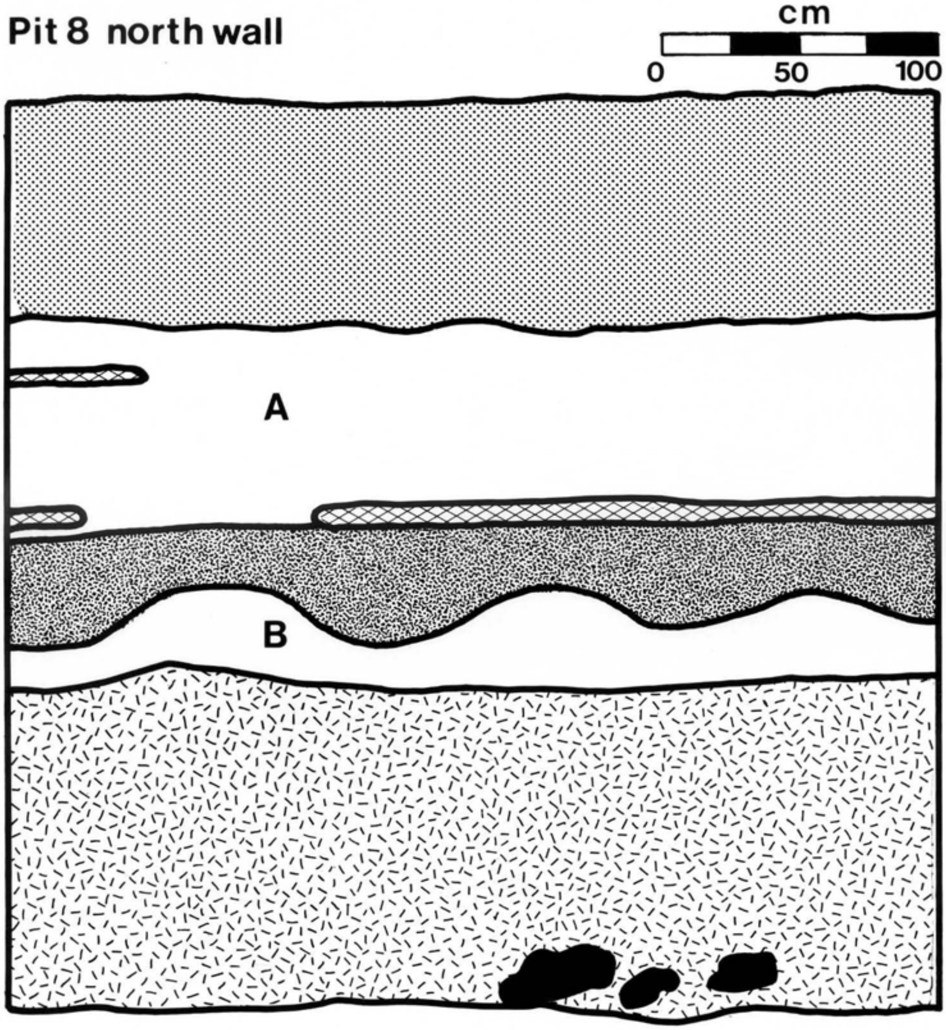
Preclassic types common at San Lorenzo (Coe and Diehl 1980) (see Table 1).

What we had discovered was the remains of a small Olmec site that had been covered by volcanic ash sometimes in the Middle Formative. The tephra layer was internally differentiated, with both fine grained substrata and more granular layers being represented. Except for an occasional gopher burrow, the Formative horizon was totally sealed. The ash layer was particularly well preserved in Pit 8 (see Figure 9). Here, the lower surface of the ash undulated, whereas its upper surface was more level. In addition, the upper surface was baked hard, indicating prolonged exposure to sunlight. The ash layer sloped to the southeast. Pit 19 was excavated three meters directly to the north of Pit 8 to expose another portion of this deposit (see Figure 10). Again the tephra layer was encountered, but the boundary between it and the underlying Preclassic deposit was more nearly level, and the undulating surface excavated in Pit 8 was not detected. These ash layers may have come from the same volcanic event that covered Tres Zapotes and Cerro de las Mesas with tephra around 600 B.C. (Chase 1981).

In our opinion, Pits 8 and 19 had exposed portions of a Middle Preclassic houselot. The undulating surface excavated in Pit 8 were the ridges and furrows of an agricultural plot in use at the time of the eruption. Three ridges were present in the north profile and parts of four in the south profile. The ridges were 72-110 centimeters a part, with crests 12-22 centimeters above the swales. No plant casts or carbonized remains were uncovered on the ridges, suggesting that the field had just been cleared of vegetation prior to the eruption. The high density of refuse, particularly domestic ceramics, indicated that the plot was a small household garden placed adjacent to a residence.

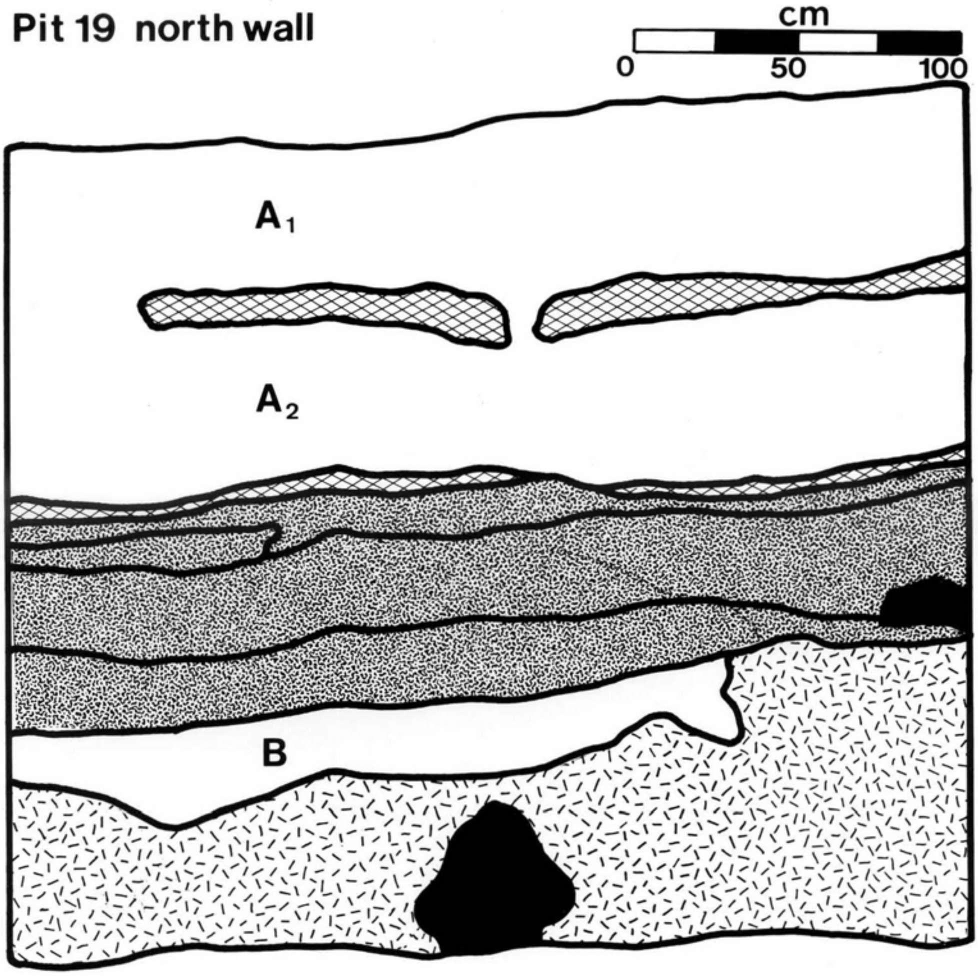
According to Payson Sheets (1982: 113), soil ridging is a maintenance technique done for various reasons, including moisture retention, drainage of excess moisture, root aeration, and erosion control, particularly in sloping terrain. Ridging is also performed today near Matacapan, generally to channel runoff, and with few exceptions furrow and slope directions always correspond. Recall that in Pit 8 the Formative ground surface dipped sharply to the southeast, paralleling the direction of the furrows. Ridging is also a cultivation technique reserved for plots cropped every year or every few years. It requires the use of the hoe or some substitute implement, and only rarely is it applied to fields under extensive cultivation. The evidence at hand demonstrates that agricultural systems in the Tuxtlas contained an intensive component during the Formative Period. Intensive gardening may have begun as early as the Early Formative.

Although the ash layer was also exposed in Pit 19, there was no evidence of ridging. Here, the Formative Period ground surface was more nearly level, in contrast to the steeper slope it displayed in Pit 8. Apparently, barrio topography was consider-



░	Silty loam -- plow zone
▨	Compacted earthen/ash surface
▓	Volcanic ash layer grading from fine grain above to coarse below
▒	Coarser sand/loam with high percentage of pebbles and cobbles
A	Sandy loam
B	Compacted clay soil

Figure 9: North Profile of Pit 8 showing the Formative Period Agricultural Surface and Volcanic Ash.



▨	Compacted earthen/ash surface
▩	Volcanic ash layers grading from fine grain above to coarse below
⬚	Coarse sandy loam with high percentage of pebbles and cobbles
A_1	Silty loam -- plow zone
A_2	Mix of sandy loam and silty loam
B	Compacted clay soil

Figure 10: North Profile of Pit 19 showing Stratified Ash Deposits.

ably altered in the Classic Period. In the Middle Formative Period the area under Mound 22 was a flat ridge, whereas under the terrace to the south there was a shallow depression 5-6 meters lower than the ridge top. We suspect that the area under Mound 22 was the residence of a small Olmec Period household and that the houselot garden was located directly to the south to take advantage of runoff. Two lines of evidence support this claim. First, there was an alignment of rocks in the northeast corner of Pit 19. This alignment, which occurred immediately under the tephra fall, could have been a wall foundation. Domestic structures tend to be placed in such locations because drainage is better. Second, pottery densities from the Formative deposit exposed in Pit 19 were higher than those in Pit 8 where the garden plot was situated. Past research elsewhere in Mesoamerica indicates that refuse densities at Formative sites generally decreased with distance from the residence, with the highest densities being recorded within a short distance of the house (Santley 1977; M. Winter, personal communication).

D. OPERATIONS II AND III

Only three excavations were conducted outside the Teotihuacan barrio (see Figure 11). These excavations were placed in Area A, the main mound group. Limited testing by Valenzuela (1945) and Ortiz (1975) suggested that most of the architecture in Group A had been constructed in the Late Classic (see Table 1). Operation II was located midway between the Teotihuacan barrio and Ortiz's excavations north of Mound 9. Pit 20 was situated west of Mound 6, one of three mounds bounding a small ball court, while Pit 21 was located directly to the southeast of Mound 5, a low residential mound. Operation III consisted of only one excavation, Pit 18. Operation III was placed north of Mound 18 (see Figure 11). Here, an unusually dense concentration of green obsidian from the Pachuca source in southern Hidalgo was discovered during the surface survey. Pit 18 was undertaken to date that concentration.

Pit 20 exposed a series of compact ash surfaces similar to the pavements exposed in Operation I-B. These pavements represented a series of plaza subsurfaces associated with the mounded architecture. A buried terrace retaining wall associated with Mound 6 was discovered in the west profile. This wall was constructed of rock rubble and associated directly with one of the ash surfaces, supporting the claim that plazas were intentionally surfaced. Teotihuacan materials such as copaware (a fine paste, differentially burnished tan ceramic ware typically produced as small pitchers at Teotihuacan) and cylindrical tripod supports occurred in association. Teotihuacan occupation therefore extended beyond the barrio. Also, it appeared that some of the public architecture in Area A contained Middle Classic substructures. No such surfaces were encountered in Pit 21. This excavation produced little cultural stratigraphy and few artifactual materials. Copaware, however, was present, indicating Teotihuacan occupation in the vicinity.

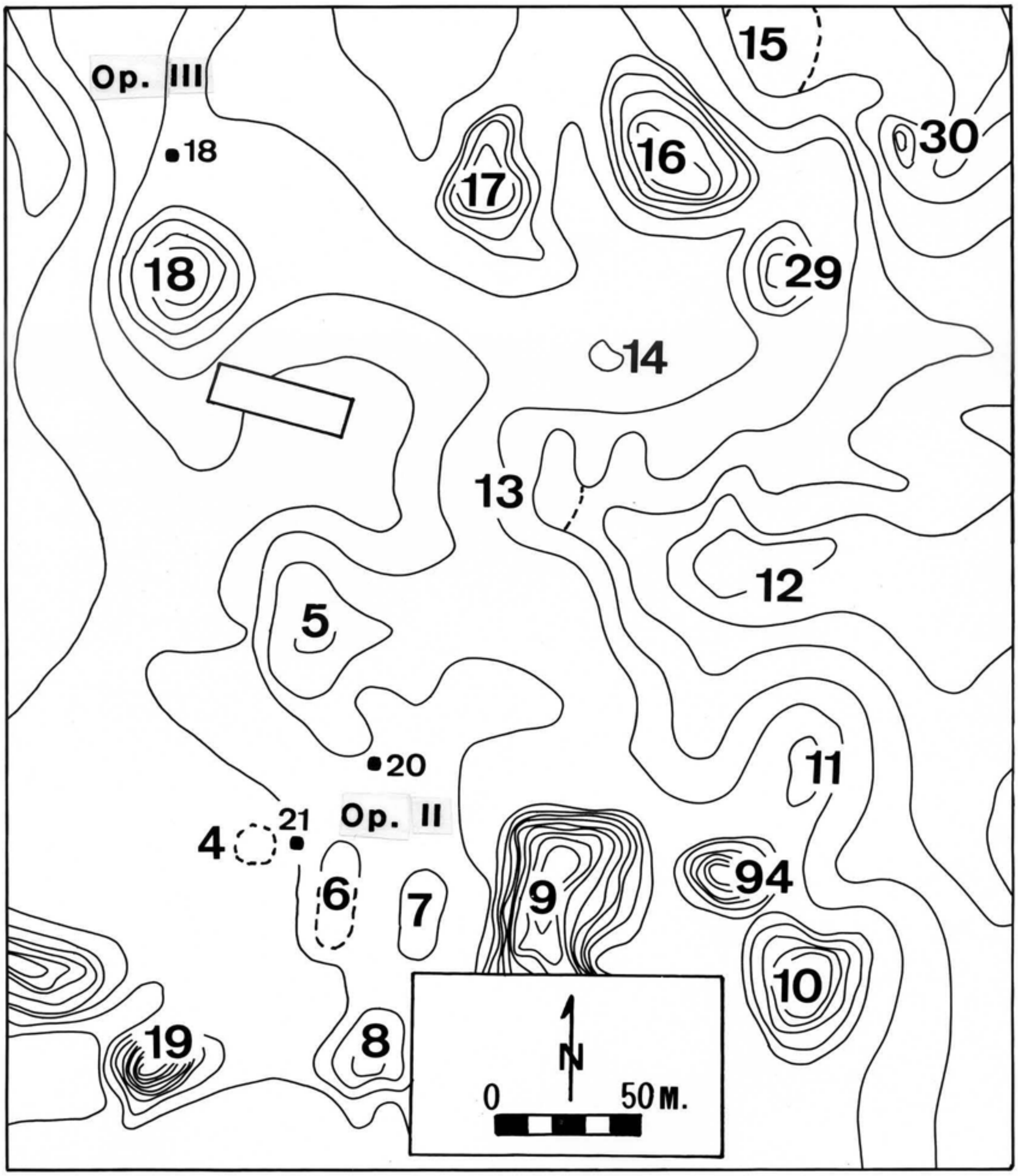


Figure 11: Topographic Map of Operations II and III showing the Location of Excavations.

Operation III was placed directly to the north of Mound 18. The surface collections from the area around Mounds 13, 17, and 18 contained significant amounts of green Pachuca obsidian (ca. 38 percent). Although few materials were obtained from stratigraphic contexts, a substantial proportion of all obsidian was green. Virtually all of the sample consisted of spent prismatic blades. These blades were morphologically identical to material recently excavated at the obsidian workshop in Tula, Hidalgo (Healan, Kerley, and Bey 1983). Associated ceramics indicated that this deposit was Late Classic in date (ca. A.D. 700-900). Much of this material, then, may have come from Tula, not Teotihuacan. To our knowledge, this is the first recorded instance of Toltec obsidian trade with the South Gulf Coast. We do not know whether participation in this long-distance distribution system required a Toltec presence at Matacapan.

VI. OBSIDIAN EXCHANGE WITH THE TUXTLAS REGION

An aim of the Matacapan Project was to investigate the process of Teotihuacan contact with the Tuxtlas Region. This project was viewed as the first stage of a long-term program of research designed to study the rise of complex in the Tuxtlas and the role long-distance exchange networks had in structuring socioeconomic complexity. Our working hypothesis was that Matacapan contained an enclave of merchants from Teotihuacan and that control of the long-distance exchange of obsidian from the Pachuca and Otumba sources in Central Mexico and the Zaragoza source near Pico de Orizaba volcano in central Veracruz was an important element behind the contact process. Analysis of the obsidian assemblage was therefore a major aspect of our research at Matacapan. The Tuxtlas is one region of Mesoamerica where obsidian does not naturally occur. Thus, all of the obsidian present at Matacapan had to be traded long distances. Obsidian working is also a subtractive technology; it involves the removal of masses of material to shape implements. Consequently, aspects of the structure of the production-distribution system can be established through the analysis of implements and debitage. Because the array of sources utilized at a site can be characterized using physiochemical techniques, obsidian provides an opportunity to unambiguously reconstruct changing exchange alignments. Although our material has not been submitted yet for trace element analysis, we can distinguish several sources based on visual inspection. These are discussed below.

A. BLADE CORE REDUCTION

Replication studies of Mesoamerican polyhedral blade core technology have contributed greatly to our understanding of blade manufacturing sequences (Clark 1982; Crabtree 1968; Sheets and Muto 1972; Sheets 1975a). A major assumption underlying such studies is that manufacturing sequences and attributes replicated by experimental research can be identified on archaeological specimens. Thus far, replication studies have not been successful in totally duplicating past assemblages; however, they have provided quite useful information on the general sequence of blade core reduction, the series of activities involved in each stage of the manufacturing sequence, and the kinds of associated material byproducts. The technological analysis of obsidian assemblages, then, attempts to answer questions concerning manufacturing processes at archaeological sites. Because obsidian working produces great amounts of debitage, it is also possible to reconstruct the form in which the material entered and left particular sites. The archaeological context (e.g., quarry vs. consumer site, urban vs. rural site, domestic vs. workshop site, and elite vs. commoner site) factors the interpretation of the settlement's place within the prehistoric production-distribution system. Prismatic blades are numerically predominant at Matacapan. Consequently, the technological analysis that follows deals primarily with blade core reduction and blade manufacture. The steps involved in this dynamic process are presented in terms of the reduction sequence from quarry to consumer, as indicated by data currently available for Mesoamerica.

1. MACROCORE REDUCTION

Obsidian occurs in two forms at geological sources in Mesoamerica: as large blocks and as nodules. The geological context is technologically significant because it affects initial reduction and the types of debitage produced. Nodular obsidian appears as small cobbles both on the surface and in subterranean contexts. Block obsidian, in contrast, usually occurs as large subsurface veins. In general, vein obsidian was preferred because of its lack of internal flow planes and inclusions in comparison to nodular obsidian. Size may have also been a factor as vein obsidian may be obtained in large lots with little external cortex. The density of material may have also been an important consideration because nodular obsidian frequently occurs as widely scattered cobbles, not as aggregated series of large veins.

Variability in obsidian desposit structure apparently affected precolumbian exploitation patterns. Obsidian was procured in source regions either by collecting surface nodules, surface pitting or stripping, or by shaft mining. Nodules occur on the surface or in stream beds where erosion or water courses have cut into the terrain. Here, collecting suitably sized surface nodules may be employed as a procurement strategy so long as these are present on the surface. Obsidian also occurs in nodular form in subsurface contexts. Stripping stream banks or pitting localities where obsidian is present near the surface are two extraction techniques that were employed at nodular deposits. Different quarrying procedures were required to obtain block or vein obsidian. Vertical shafts were sunk into the ground until a vein was reached. Tunnels were then extended horizontally until the vein was exhausted or flow irregularities prevented further mining. Sometimes vertical shafts descended to the same mine for ventilation and light. Different forms of obsidian can occur at the same source. Surface nodules have been reported at Zacualtipan and Metzquititlan in the Zacualtitpan region, Barranca de Izatla in the Pachuca region, Pizarrin in the Tulancingo region,

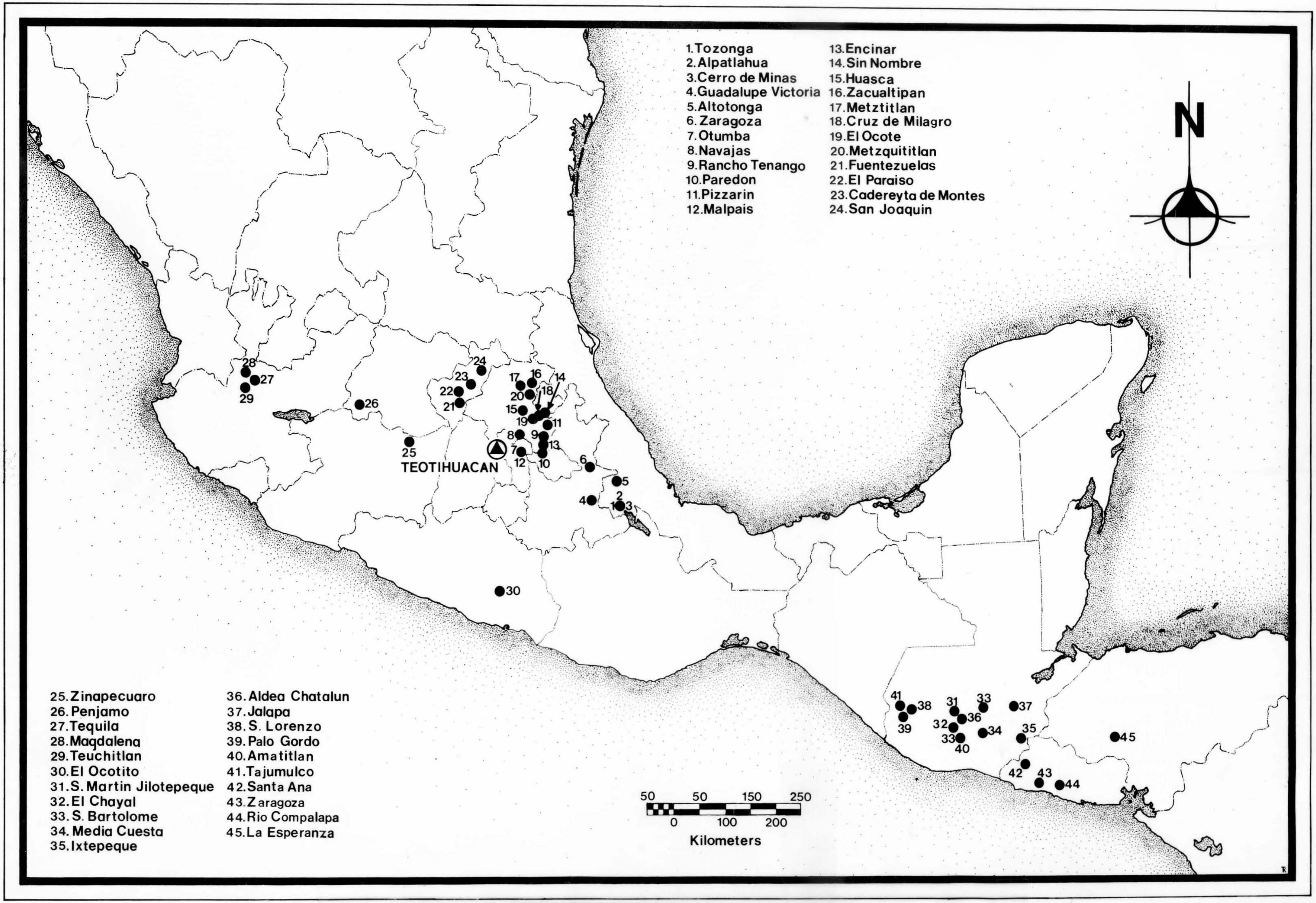


Figure 12: Major Obsidian Sources in Mesoamerica.

Coyaco and Tres Cabezas in the Tecocomulco region, and Barranca de Santa Maria, Barranca de los Ixtetes, Barranca de las Navajas, Salto de las Penas, and the TA-79 quarry site in the Otumba region, all in Central Mexico (Charlton and Spence 1982); subsurface pitting is known from La Joya in West Mexico, El Chayal in Highland Guatemala, and and the Metzquititlan, Zacualtitpan, Cerro de los Pelados, Cruz del Milagro, Cerro Pinal, La Esperanza, San Lorenzo Zembo, Pizarrin, Coyaco, Barranca de los Ixtetes, Salto de las Penas, and TA-79 localities in Central Mexico (see Figure 12) (Charlton and Spence 1982; Coe and Flannery 1964; Healan 1979; Kerley n.d.; Santley n.d.a; Spence and Parsons 1972; Weigand and Spence 1982). Shaft mining, on the other hand, is much more restricted in distribution. It occurs at Pico de Orizaba in central Veracruz and at the Cruz del Milagro, Cerro Pinal, Salto de las Penas, and QA-79 localities in the Pachuca and Otumba regions in Central Mexico (Charlton and Spence 1982; Healan 1979; Stocker and Cobean 1981).

The methods used to quarry obsidian in Central Mexico appear to have varied systematically through time, depending on the deposits exploited and the structure of the production-distribution system (Charlton and Spence 1982; Santley n.d.a). In the Early and Middle Formative periods (ca. 1500-650 B.C.), surface collecting, augmented perhaps by some shallow pitting, was probably the major procurement strategy at nodular sources in the Otumba region. As surface material became exhausted and population levels climbed, subsurface deposits were more heavily exploited, beginning probably in the Late Formative Period (ca. 650-300 B.C.). Much of the obsidian used in the Basin of Mexico in the Late Formative consisted of nodular material from the Otumba region, although Pachuca obsidian was now procured in greater amounts (see Figure 12) (Sanders et al. 1975; Santley 1977). Given the increase in regional population in Central Mexico, procurement probably involved a switch to surface pitting. The shift to shaft mining probably did not occur until the late Terminal Formative or Early Classic Period (ca. 100 B.C.-A.D. 400) when the scale of the obsidian production-distribution centered at Teotihuacan increased dramatically (Charlton and Spence 1982; Spence 1984). Teotihuacan's production-distribution system and apparently Tula's and Tenochtitlan's as well relied quite heavily on obsidian from the Pachuca region (Charlton and Spence 1982; Healan, Kerley, and Bey 1983; Santley, Kerley, and Kneebone n.d.; Spence 1981). Several localities in the Pachuca region contain both surface pits and true mines. We suspect that the pits largely predate the shaft mines. The surface pits at Pachuca, then, may have represented an attempt by Teotihuacan miners to apply to vein obsidian localities a quarrying strategy that had worked very well earlier at nodular deposits in the Otumba region farther to the south. Obsidian from vein sources was also the primary material exchanged long distances in the Classic Period to sites such as Matacapan. Nodular obsidian continued to be heavily exploited; however, procurement was generally for local consumption except in areas where vein obsidian was lacking.

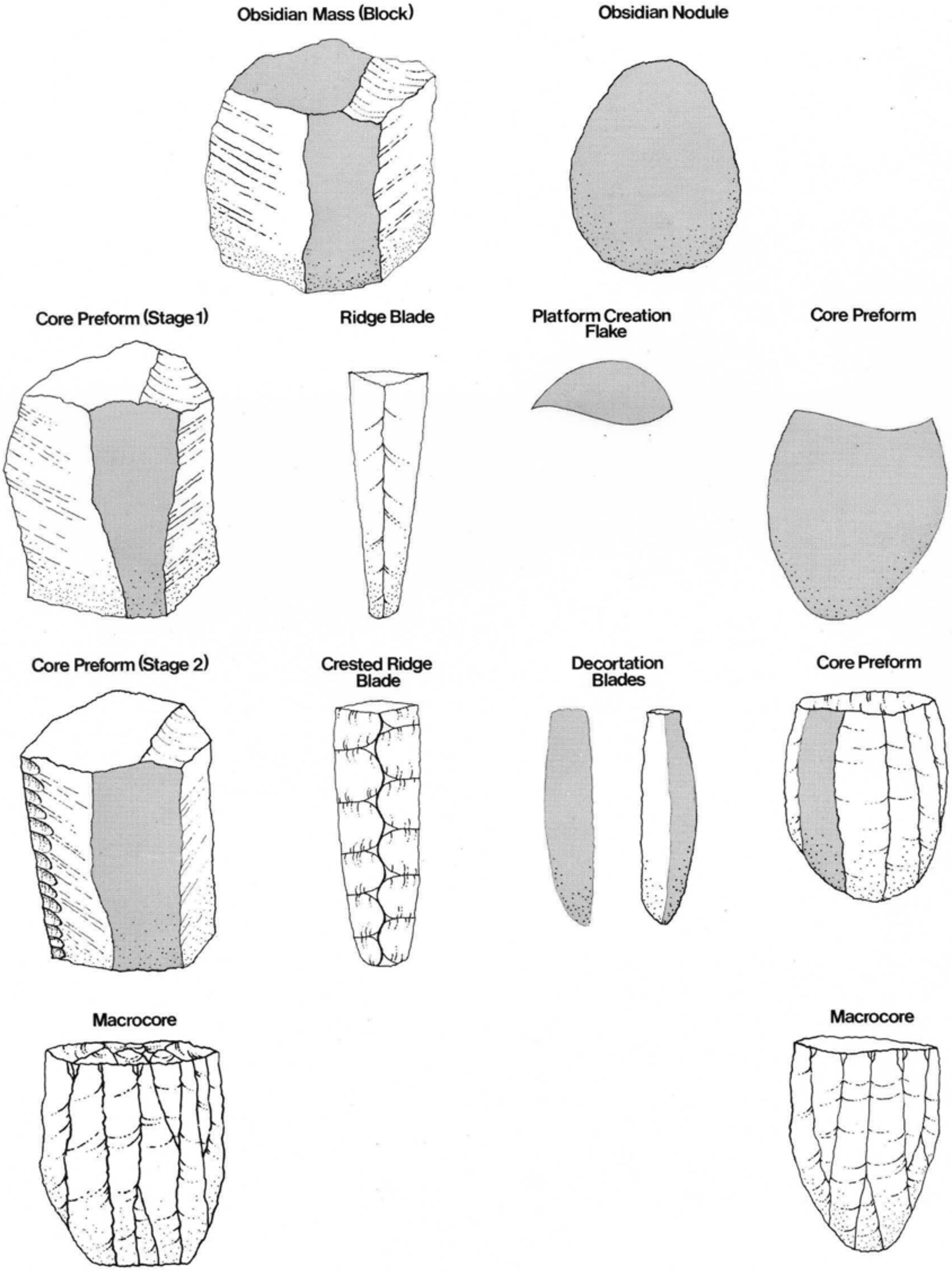


Figure 13: Macrocore Reduction Sequence.

Informal visits and casual surface surveys at obsidian sources allow a number of generalizations about quarrying activities (Charlton and Spence 1982; Coe and Flannery 1964; Graham and Heizer 1968; Healan, Kerley, and Bey 1983; Holmes 1900; Michels 1975; Spence and Parsons 1972; Sheets 1975b; Stocker and Cobean 1981). Finished artifacts are rare, indicating that the predominant activity was the initial reduction of obsidian masses to obtain preforms which were transported to other localities for further processing. The absence or low frequency of domestic artifacts or architecture suggests that workmen did not live at the mines. The main product from quarry sites seems to have been a core preform or macrocore (see Figure 13). Macrocores are generally cylindrical in shape with flat proximal and distal surfaces and wide parallel but irregular percussion blade scars on the lateral surfaces (Healan 1979). Most of the macrocores described thus far appear to be core rejects left at the quarries rather than the actual exports (Abascal 1981; Coe and Flannery 1964; Healan 1979; Holmes 1900; Lopez and Nieto 1981; Lopez, Nieto, and Cobean 1981; Sheets 1975b; Spence and Parsons 1972; Stocker and Cobean 1981). There is great variability in platform preparation on macrocores; some platforms are completely covered with cortex (the eroded or palinated exterior surface of an obsidian block or nodule), whereas others have single or multifaceted platforms. The majority, however, have single-faceted platforms.

The debitage produced during macrocore reduction differs at vein and nodular obsidian sources. Nodular obsidian ranges in size from small pebbles to large boulders. The initial step in the reduction process involved the selection mass of obsidian about the size of a football. This nodule was split in half. Each hemisphere had exterior surfaces that were covered with cortex and a flat faceted proximal surface without cortex. Using the faceted proximal surface as a platform, rinds of percussion blades and flakes were taken off around the lateral surface to remove the cortex. This decortication debitage consisted of both primary and secondary blades and flakes (see Figure 13). Primary decortication blades and flakes have dorsal surfaces that are totally covered with cortex and represent the first step in macrocore reduction. Secondary decortication blades and flakes, in contrast, have cortex on only part of the dorsal surface and were probably removed after primary decortication. Decortication blades and flakes may be distinguished from other percussion debitage at workshop sites by their size (hence the terms macroblades and macroflakes) and ventral characteristics of heavy percussion such as large prominent bulbs of force, pronounced ripple marks and fissures, and pronounced hinge terminations. These types of debitage are very common at the Zacualtipan and Otumba obsidian sources in Central Mexico (Healan 1979; Lopez and Nieto 1981).

Cortex debitage is not very common at block obsidian deposits. Block obsidian was quarried by mining or occasionally by surface pitting when the vein was near the surface. Quarry reduction involved several steps. First, large blocks of obsidian were knocked off the vein and pulled to the surface. These blocks usually had cortex on only one or two surfaces. The blocks were then reduced by removing large percussion flakes to straighten the broken or shattered surfaces. The size and shape of these flakes varies considerably, and more work is required to determine the precise sequence of reduction that took place. The heavy percussion work involved in mining vein obsidian also produced great amounts of obsidian shatter (Healan 1979; Stocker and Cobean 1981).

Several other kinds of blade and flake debitage are also present. Large flat percussion flakes were probably produced during the creation of corners on nodules and blocks to prepare the macrocore for ridge blade removal. These large flat flakes could have also been produced during platform creation. Ridge blades are the most distinctive class of debitage found at quarry workshops (see Figure 13). A ridge blade has a prominent dorsal ridge formed by two dorsal facets intersecting at a very acute angle. Ridge blades also have very thick triangular cross-sections and are generally very long. In many instances, the dorsal ridge has been straightened by removing a series of transverse flakes, which gives the blades a distinctive crested appearance. Formerly, it was believed that both types of ridge blades were taken off to produce the initial straight or parallel ridges required for successful pressure blade removal (Crabtree 1968); however, experimental replication has shown that ridge blades are not necessary to transform the quarry mass into a pressure core preform (D. Healan, personal communication). Current opinion holds that ridge blades were struck off to remove unwanted lateral obsidian masses and to reduce the block to appropriate size before shipment to other locations. The removal of ridge blades is also an error recovery technique used during pressure blade removal. This is discussed below.

2. PRISMATIC BLADE CORE REDUCTION

Macrocores were transported to habitation sites after they had been shaped at the quarries. The low proportion of decortication and percussion debitage in workshop assemblages at Tula indicates that the macrocores entering the obsidian workshop zone were extremely refined (Healan, Kerley, and Bey 1983). It is unclear whether all percussion reduction was completed at the quarries or at other processing stations located between the mines and the city. Percussion debitage and obsidian with cortex is also present in workshops at Teotihuacan, sometimes in great amounts. In part, this may be a function of the greater reliance Teotihuacan had on material from the Otumba source where nodular material is more common (Spence 1981, 1984). It also suggests that more of the macrocore reduction process in the Middle Classic Period took place in urban workshops, not at the quarries. Once macrocores entered urban workshops, one of three reduction strategies was possible: blade core, uniface, or biface. Blade core reduction involved the manufacture of a cylindrical or bullet shaped polyhedral core from which blades could be removed, whereas uniface or biface production consisted of working a piece of obsidian on one or both sides to shape a tool such as a projectile point or knife. Urban workshops at Tula and Teotihuacan appear to have specialized in either blade core or biface/uniface manufacture. Neither of these strategies, however, is mutually exclusive. For example, a macrocore damaged in transport could have easily been repaired for biface or uniface production. Debitage from the initial stages of macrocore reduction could have also been routed into biface workshops, especially the large percussion flakes and blades. Errors that occurred in reducing a prismatic blade core also produces debitage that may have been recycled into biface or uniface production.

In order to remove prismatic blades the macrocore platform must be worked further and the lateral core ridges must be straightened. Platform preparation requires careful planning, and the platform surface must be made as flat as possible. Platform preparation produces platform faceting flakes. These flakes exhibit three characteristics: a multifaceted dorsal surface, a very flat flake body, and the presence of blade scars along the proximal edge of the flake. These flakes can be distinguished from biface manufacturing flakes by their flat shape and the appearance of blade scars. The flat shape of the flake body probably resulted from resting the core platform on an anvil during percussion to decrease flake curvature. Probable platform faceting flakes lack the proximal blade scars but have a flat form and a multifaceted dorsal surface. Once the platform had been faceted, blades could be removed or the first stage of platform grinding completed.

Prismatic blades with ground platforms has been used as an Early Postclassic Classic hallmark in Mesoamerica (see Table 1). Many blades from Middle and Late Classic contexts at Matacapan and rural sites in the Teotihuacan Valley, however, have ground platforms. We suspect that grinding the core platform, a very labor-intensive task, reduced the chances of error during later blade removal, thereby increasing the number of fine blades a knapper could remove from a core of specified size. Moreover, once grinding was completely, less time was required for blade removal. Data from Tula indicate that grinding was a two-staged process (Healan, Kerley, and Bey 1983). The initial stage probably involved extensive pecking of the platform surface (D. Healan, personal communication). Pecking creates microcracks in the obsidian which prevent the pressure tool from slipping and facilitate blade removal. Platforms prepared in this fashion are coarse ground. Coarse ground platforms occur primarily on initial series and irregular blades, not on fine prismatic blades.

The next stage in polyhedral core reduction involved the straightening of the lateral core ridges prior to blade removal. Although the majority of all percussion blades were removed at the quarries, some additional percussion work also took place at urban workshops (see Figure 14). These percussion blades are usually much smaller than macropercussion blades. They were

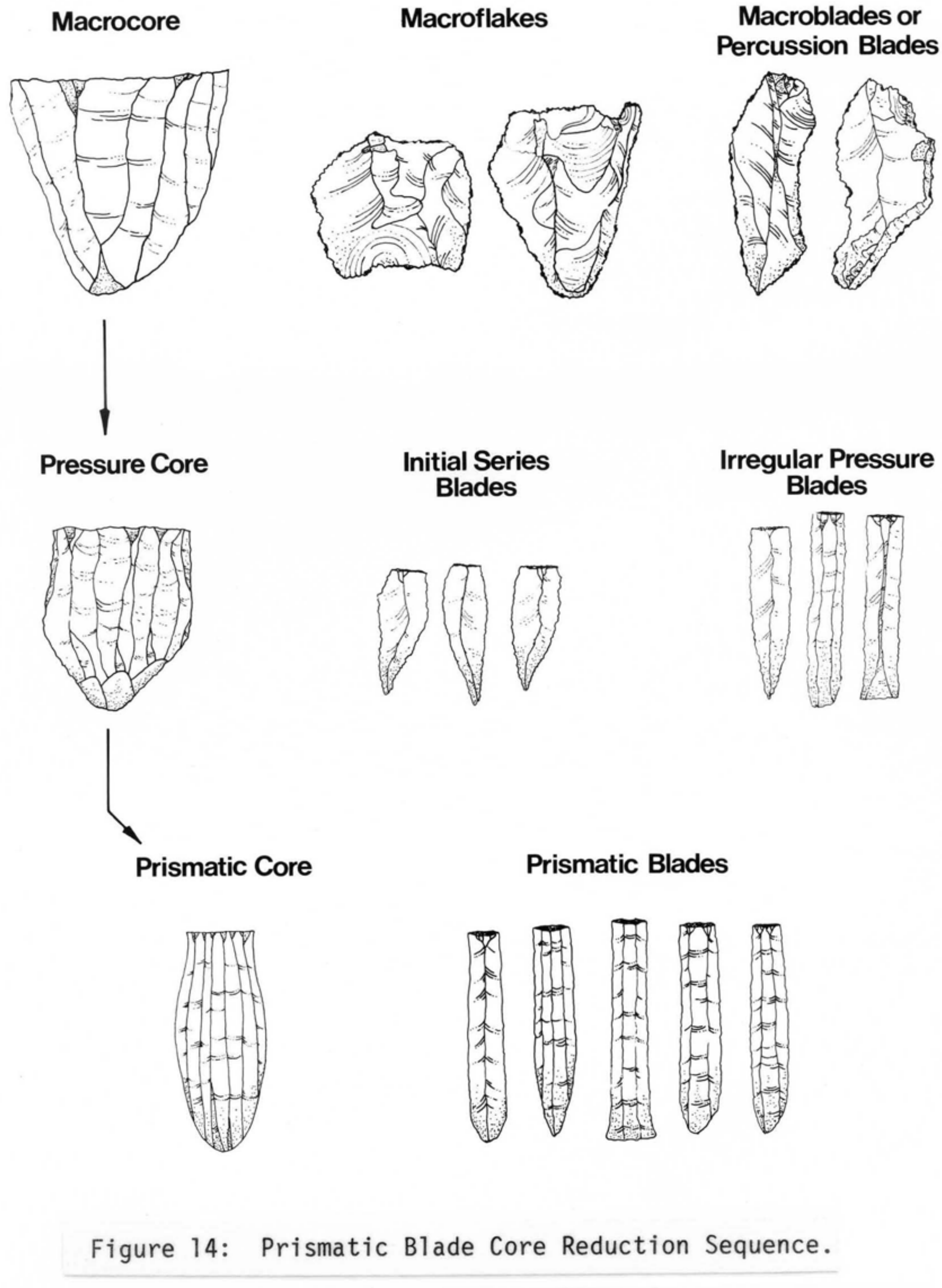


Figure 14: Prismatic Blade Core Reduction Sequence.

taken off to remove lateral obsidian masses, hinges, and cortex left on the macrocore after quarry reduction. They also probably removed any damage the core sustained during transport to the workshop. Core trimming flakes--percussion flakes taken off the core face--were probably also removed at this time.

Once percussion has established a series of regular ridges around the lateral core face, pressure blade removal could begin. A core ready for prismatic blade removal is called a polyhedral pressure core or simply polyhedral core. Initial series blades illustrate the shift from percussion to pressure removal techniques (see Figure 14). On initial series blades the scars on the dorsal surface indicate previous percussion removals, while the ventral surface shows evidence of removal using pressure techniques. Initial series blades tend to be asymmetrical in shape and short--they do not run down the entire length of the core. Many of these blades also exhibit crushing along the platform rim, the result of platform grinding.

After a rind of initial series blades has been removed, blades that run down the entire length of the core can now be taken off. Irregular pressure blades are removed before fine prismatic blades (see Figure 14). Irregular pressure blades may be distinguished from fine pressure blades by several characteristics. First, the dorsal ridges of irregular pressure blades are not completely straight, although they are quite regular. These blades also exhibit substantial core rim preparation on the platform edge. This rim preparation includes evidence of abrasion and scars from short blades run down the lateral core ridges to remove overhang and strengthen the platform. In addition, because irregular pressure blades were the first sequence of pressure blade removals to completely run down the core length, sometimes remnant percussion facets are present on the distal end of the dorsal blade surface (see Figure 15). The irregular pressure blade series involves a continuum of blade removals which become increasingly more regular with each circuit.

Sometime during the irregular pressure blade sequence the second stage of platform grinding was completed. Although it is unclear exactly how this second stage was accomplished, we suspect that some coarse textured substance such as <u>tezontli</u> (a local basalt) or sand was used as an agent to grind the core platform. A pink material was found strongly adhering to blade platforms from Oxtotipac and Xometla, two Toltec Period (Coyotlatelco Phase) sites in the Teotihuacan Valley, at Tula north of the Basin of Mexico, and from Late Classic contexts at Matacapan (Healan, Kerley, and Bey 1983; Santley, Kerley, and Kneebone n.d.). This substance may represent the remnants of the material used in the second stage of the grinding process. In the workshop dump at Tula great numbers of irregular pressure blades were discarded unutilized even though they appear to have been perfectly usable as cutting implements (Healan, Kerley, and Bey 1983). Apparently, craftsmen at Tula established standards for blades exchanged to consumers.

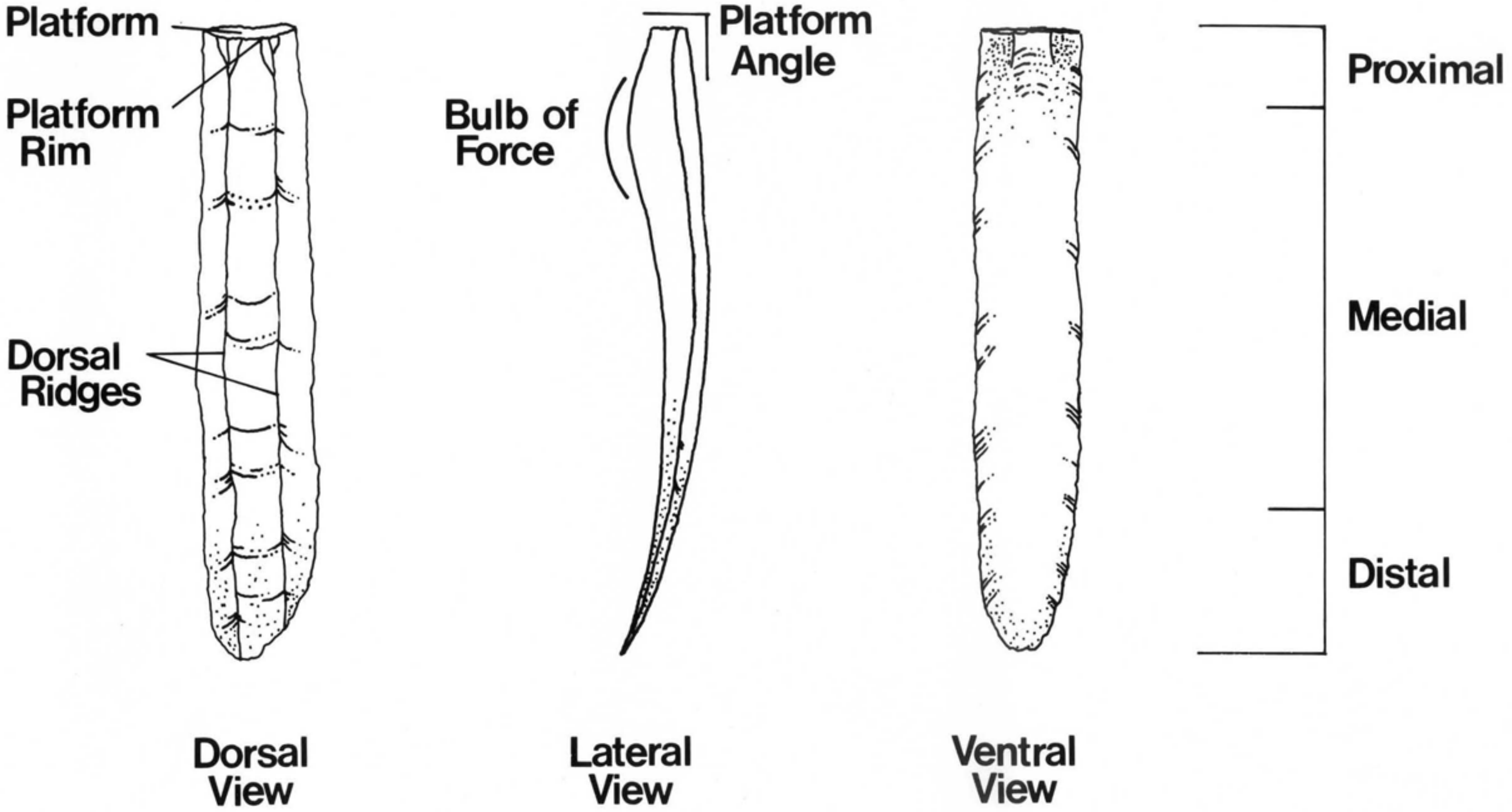


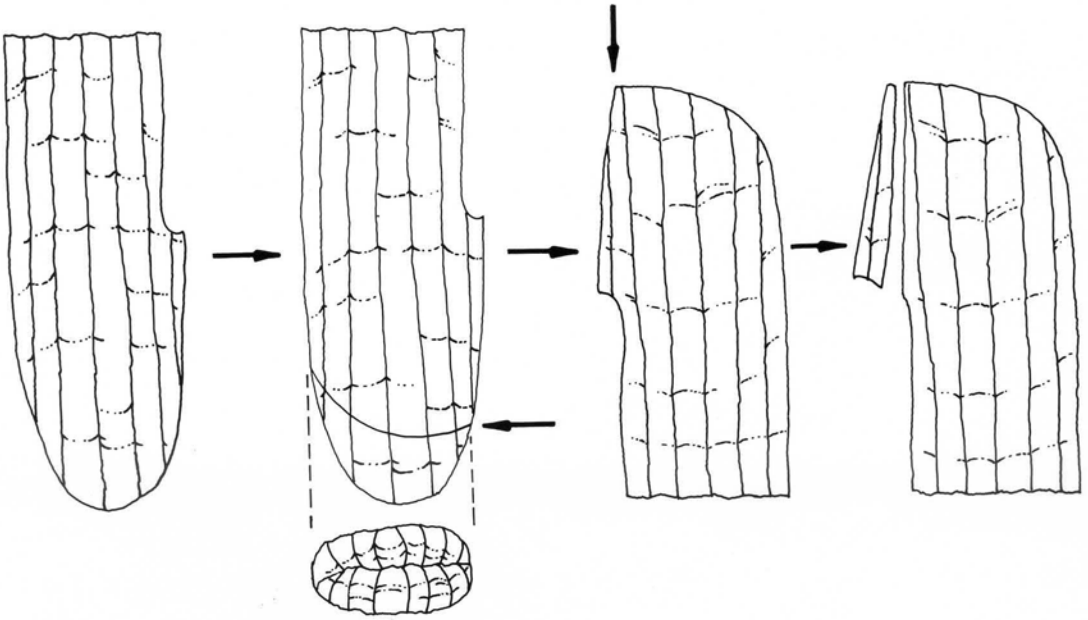
Figure 15: Prismatic Blade Morphology.

The removal of prismatic blades was the final stage in prismatic pressure core reduction (see Figure 14). Prismatic blades are pressure blades that have perfectly straight and parallel dorsal ridges and lateral edges (see Figure 15). While many prismatic blades have only one or two dorsal ridges, some may have as many as five. During blade removal, especially as the core diameter decreases, pressure blades with multiple dorsal ridges may have been taken off prior to the removal of blades with only one or two ridges. Cores with ground platforms required very little subsequent rim modification during prismatic blade removal. For cores with faceted platforms, however, the prismatic blades taken off may have been very similar morphologically to the terminal circuit of irregular pressure blades removed from cores with ground platforms. In other words, the rim of a core with a faceted platform was repeatedly prepared throughout the entire sequence of pressure blade removals. Unfortunately, there are no studies of the technology of blade removal at Classic Period workshops at Teotihuacan where faceting was the dominant technique of platform preparation.

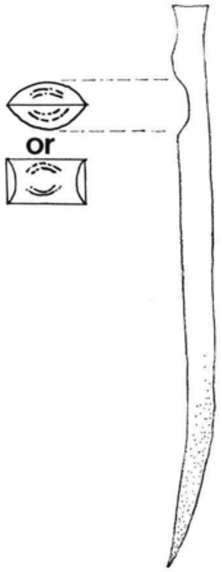
Following blade removal, prismatic blade cores were discarded. Many exhausted cores were thrown away without being used for other purposes once blades could no longer be removed. A pressure blade core can be reduced only so long as it has a sufficient diameter to produce blades. If the diameter of the platform is reduced more rapidly than the medial core diameter during blade removal, additional blades cannot be pressed off. Rejuvenation of a core with this problem involves truncation of the proximal core end, usually by a bipolar percussion technique, and refaceting and grinding the proximal end of the core distal (see Figure 17). Though shorter, blades can still be removed until the truncated core no longer has sufficient diameter. Pressure blade cores were also discarded when the knapper encountered inclusion planes in the obsidian which prevented further blade removal. Similarly, fatal mistakes such as hinges from manufacturing errors or plunging blades that took off too much of the distal core mass could prohibit additional pressure blade removal.

3. PRODUCTION ERRORS AND ERROR RECOVERIES

Even the best of craftsmen make some mistakes. The types of errors made and the range and effectiveness of error recovery techniques employed by prehistoric knappers allow inferences about skill or level of craft specialization. The most common error made during blade manufacture was the hinge fracture (see Figure 16). A hinge will occur when insufficient or misdirected force causes a blade or flake to terminate short of the core distal, leaving a gouge on the core face. A hinged blade or flake will have a rounded distal termination. Hinges were very serious errors in blade manufacture and required a great deal of strength and skill to recover the core for further blade removals.



Hinge Removal from Core Distal



Manufacturing Error Flakes
with Variation in Form

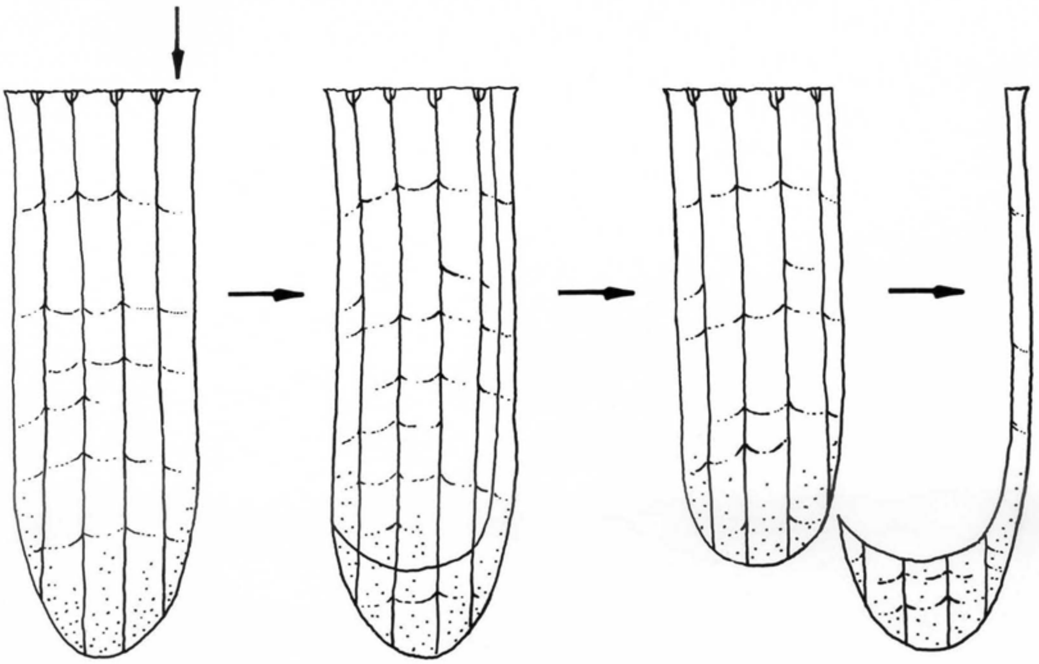
Figure 16: Hinge Removal and Manufacturing Error Flakes.

A number of hinge recovery techniques have been identified in the debitage from obsidian workshops at Tula (Healan, Kerley, and Bey 1983). If the hinge was not set extremely deep into the core face, the worker attempted to remove pressure blades from both sides of the hinge. Each blade removed half of the hinge. These hinge recovery blades exhibit one half of the hinge on the dorsal surface. This recovery technique, however, risks making the hinge larger if the removal blade is taken off too close to the hinge. If the hinge was set very deep into the core face, the knapper may have placed the pressure tool point directly on the hinge surface and attempted to strike the hinge off. The resulting blade would have been short since it did not run down the entire core length, and its proximal end would have had a concave faceted surface.

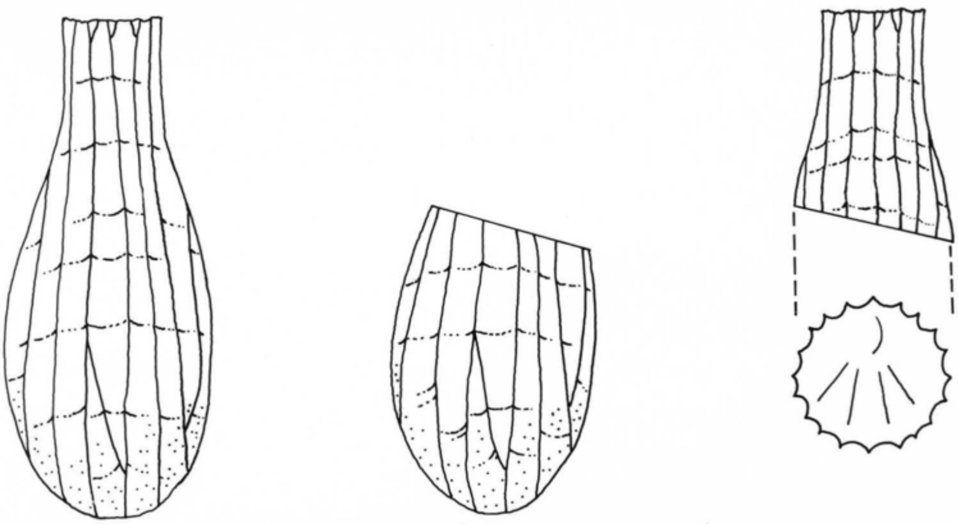
Other hinge recovery techniques required more drastic reductions of the core mass. The removal of a percussion blade or flake from a pressure blade core was the most destructive. Percussion removals take off substantial amounts of the core mass but they reproduce the the regular parallel ridges along the core face. Hinges may also be removed by striking off a percussion flake from the distal end of the core. A distal core truncation flake is scooped-shaped but lacks pressure blade scars on its dorsal surface. Distal core truncation flakes also have unprepared platforms. These flakes were struck off to leave a sufficient angle between the facet surface and the core face so that additional blades could be removed. The distal end of the core was then used as a platform for pressing off a pressure blade which terminated into the hinge and removed it from the core face.

Transverse flaking of the dorsal ridge below the hinge was another recovery technique. Transverse flaking, however, radically alters the core ridge, destroying the parallel ridges. Transverse flaking also gives the core face where the hinge had been a "crested" appearance. Removal of this surface produces a crested blade which may be taken off either by pressure or by percussion. These crested blades are considerably smaller than crested ridge blades removed during macrocore reduction. Primary crested blades also exhibit the proximal ends of transverse flake scars. Secondary crested blades bear remnant transverse flaking on their dorsal ends but lack the proximal ends of the transverse flake scars.

Hinges were not the only kinds of errors made during blade manufacture. Manufacturing error flakes are small oblong flakes that detach from the ventral blade surface below the bulb of force (see Figure 16). Sometimes these flakes have parts of the blade's dorsal ridges and a rolled appearance. Manufacturing error flakes are a type of bending fracture that occurred when the proximal end of the blade was pushed too far out as the blade broke away from the core surface. Usually, the proximal end of the blade broke first, leaving a concave distal surface only a few millimeters below the platform. Occasionally, whole or proximal blade fragments were recovered at workshops with a ventral



Plunging Blade Truncating the Prismatic Core



Proximal Core Truncation

Figure 17: Plunging Blades and Proximal Core Truncation.

concavity below the bulb of force which was the result of the detachment of manufacturing error flakes. Manufacturing error flakes are not eraillure flakes, although they occur in the general area of the bulb of force.

Plunging blades are blades that removed the distal end of the pressure core (see Figure 17). Plunges generally occur when too much force is applied to the proximal end of the core as the blade is being removed. Plunging blades may have also been produced when the worker's weight was too far over the core platform. Plunges are not fatal errors because they do not destroy the parallel ridges of the core. However, they do remove portions of the core length, sometimes a substantial proportion.

Sometimes exhausted cores were recycled for purposes other than blade manufacture. At Tula, for example, a number of cores were reflaked into unifaces or bifaces. Many of these cores show pronounced distal flaking as if they had been used as wedges or as choppers. The medial cross-sections of exhausted cores could have also been ground into ornaments for personal or ceremonial use. A number of core fragments also show evidence of percussion flaking for no apparent reason. This may represent child's play. Also, it seems unlikely that apprentices would be allowed to practice on usable blade cores. Discarded cores, however, would have provided a plentiful supply of material for apprentice craftsmen to practice their skills.

To recapitulate, prismatic blade manufacture is a complex activity involving a number of discrete tasks. Those tasks may be performed either at one locality or at several different sites. Moreover, the kinds of debitage present allow for the identification of the form obsidian entered and left various sites, and because different sources of obsidian can be characterized, the distribution system to which sites were attached can be defined. The kinds of errors present and their recoveries also provide important information on problems encountered in working obsidian and the skill of the craftsman or knapper processing the material.

B. ASSEMBLAGE VARIABILITY AT MATACAPAN

A total of 4,704 pieces of obsidian were retrieved by the Matacapan Project in 1982. Of these, 3,377 specimens were obtained from the excavations. The intensive surface survey provided another 1,126 specimens. An additional 201 pieces were obtained by grab samples (i.e., the ad hoc collection of materials from an area of undefined size) in the plaza next to Mound 18. The surface materials generally derive from contexts that are Late Classic in date (see Table 1). The excavated materials, on the other hand, span the Classic Period, although most derive from Middle Classic deposits. The lithic assemblage from Matacapan is unusual in two respects. First, except for four quartzite bifaces, all of the material is obsidian. This contrasts with assemblages from sites in other areas of lowland Mesoamerica where locally available chert, quartzite, or chalcedony make up a

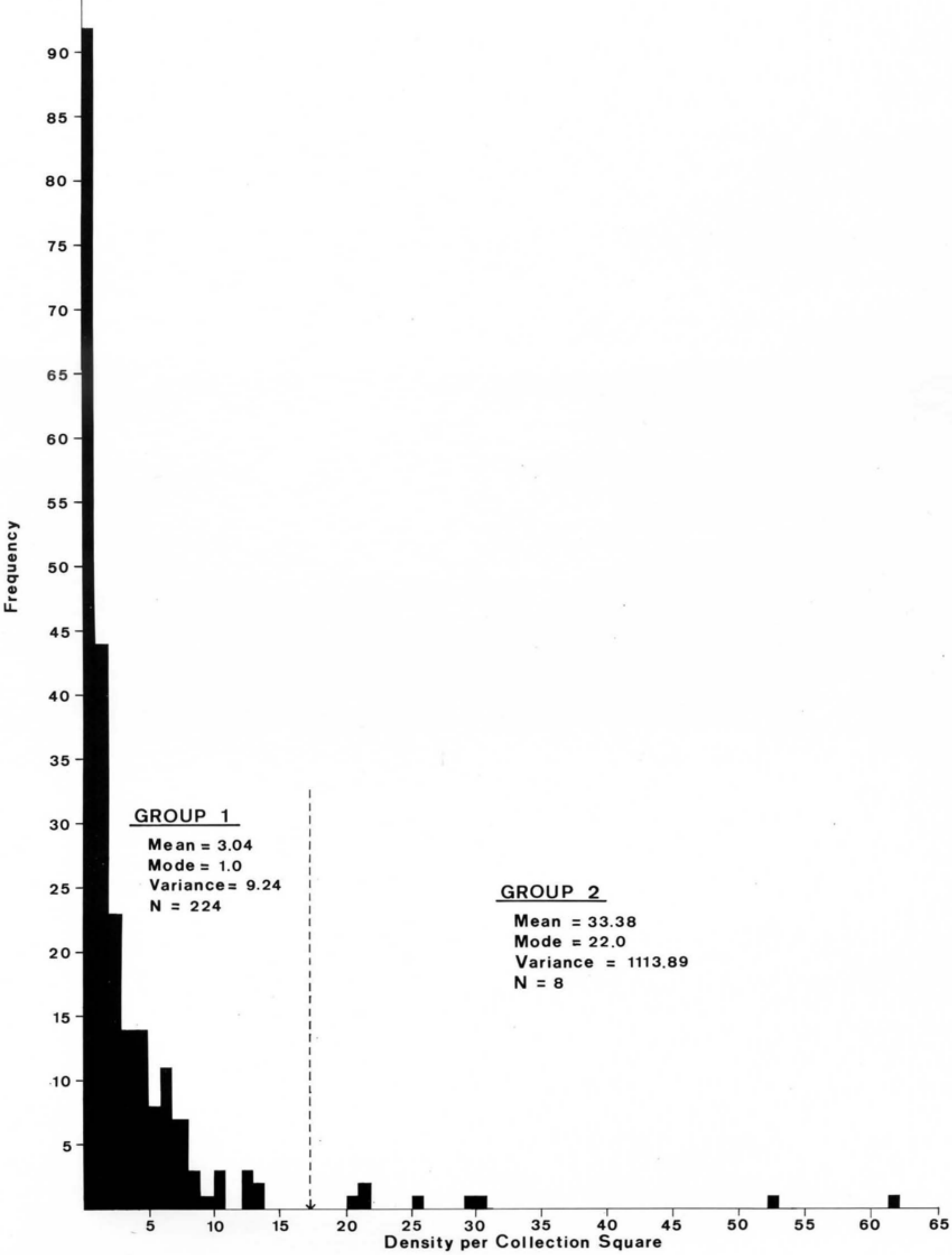


Figure 18: Histogram of Surface Obsidian Densities.

significant proportion of all materials utilized (Coe and Diehl 1980; Moholy-Nagy 1976). Second, virtually all of the assemblage consists of fine prismatic blades or material from blade core reduction. Bifaces, flake tools, and their debitage is uncommon, at least in central Matacapan.

Thus far, we have identified three different kinds of obsidian. Type of obsidian refers to the color of the glassy matrix as determined by visual inspection. Green obsidian comes from the Pachuca source region in southern Hidalgo. Many specimens of green obsidian also exhibit a distinctive golden sheen when held up to the light, a hallmark of Pachuca obsidian. Although the sample of gray obsidian has not been physiochemically characterized yet, we suspect that most of this material was obtained from the Zaragoza source near Pico de Orizaba in central Veracruz. Some Otumba and El Chayal obsidian is probably also present, although we cannot distinguish them yet. Green and gray obsidian comprise virtually all of the lithic material utilized during the Classic Period. In contrast, during the Formative Period the primary variety utilized at Matacapan was a clear obsidian that sometimes had a smokey appearance. This material was chipped both into flakes and prismatic blades. Meca, a variegated red and black obsidian, is present only in minor amounts.

Characterization of the production-distribution system requires an assemblage classification. At Matacapan formal classes were established for the sample of surface obsidian first. Assemblage classes were defined based on two variables: frequency of specimens per provenience unit and sample composition. Frequency classes were established by constructing histograms to observe multimodality in the distribution of obsidian densities. Sample composition was monitored by reduction technology, as indicated by the kind and amount of manufacturing debitage.

Figure 18 plots sample frequency against the number of specimens per collection locus (zero units excluded). Apparently, the frequency distribution is trimodal. Most of the samples contain 1-14 specimens (mean = 3.04, mode = 1.00). The second group includes all samples with 21-31 pieces of obsidian (mean = 25.33, mode = 22.00), the third all samples with 53-62 specimens (mean = 57.50). The difference of means test indicates that the means for groups one and two differ significantly ($t = 1.967$, $df = 228$, $p<.025$). The difference between groups two and three, however, is not significant at any commonly accepted level ($t = 0.549$, $df = 6$, $p>.1$), indicating that both could have come from the same population. Two groups of collection loci therefore appear to be represented. The first group is defined by all those collection units that contain comparatively little obsidian. In the second obsidian is much more common (mean = 33.38, mode = 22.00).

Figures 19 and 20 were constructed to determine the degree to which this variability is linked to type of obsidian. Only

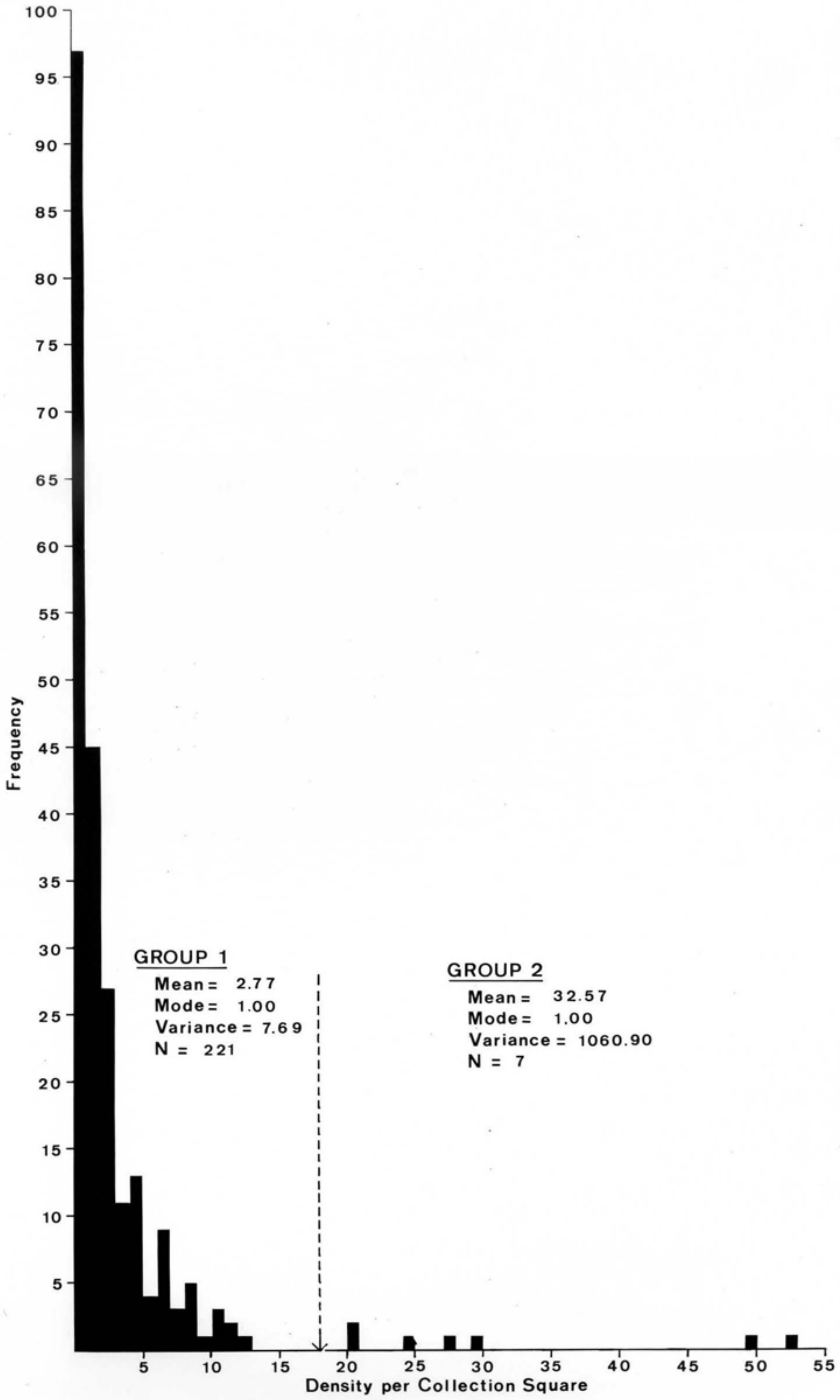


Figure 19: Histogram of Surface Gray Obsidian Densities.

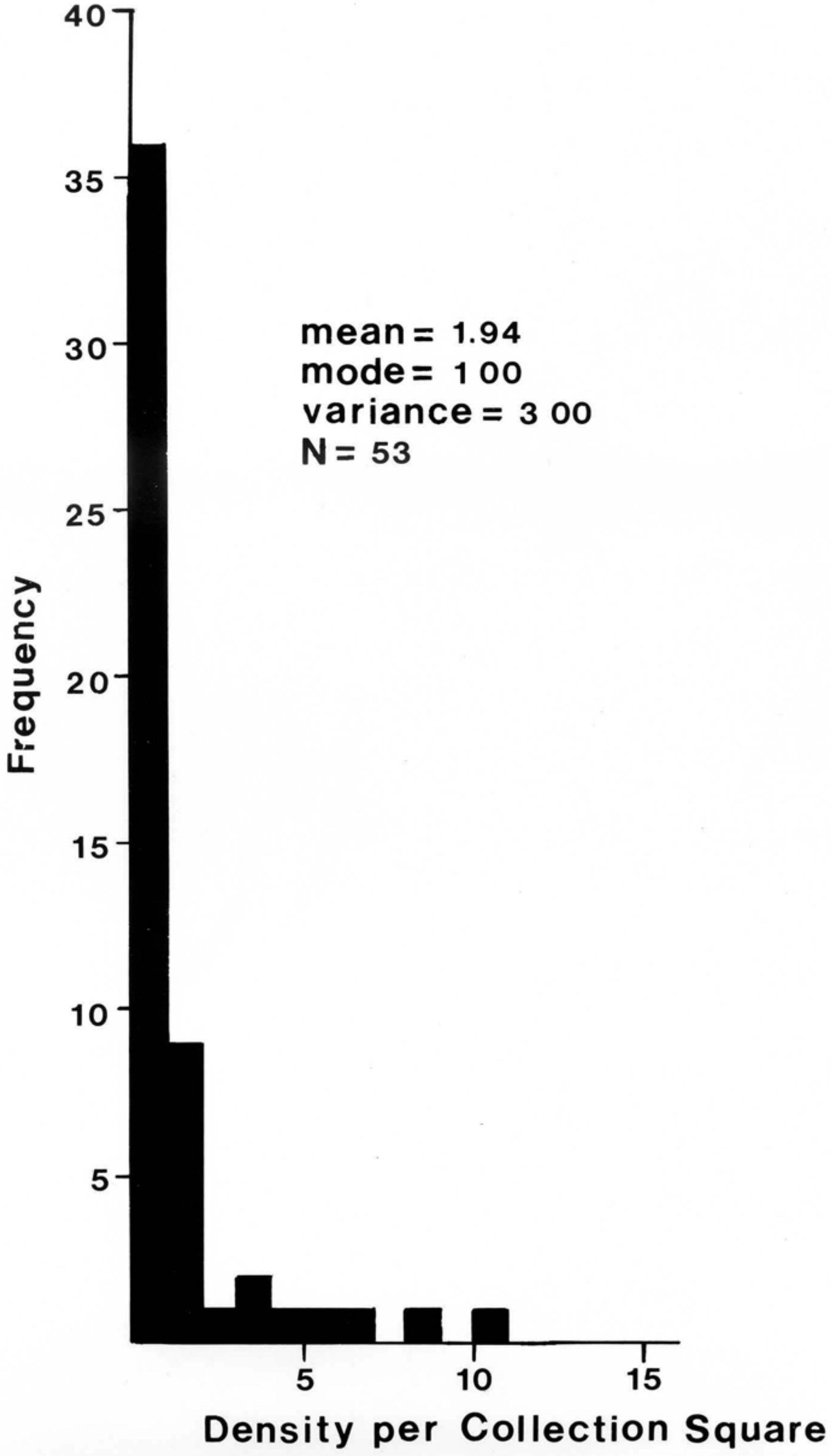


Figure 20: Histogram of Surface Green Obsidian Densities.

two types of obsidian were distinguished: green and gray. The frequency distribution of gray obsidian is slightly bimodal (see Figure 19). This distribution matches that for total obsidian (see Figure 18). This contrasts with the distribution of green obsidian which is distinctly unimodal (see Figure 20). Difference of means tests were again conducted, this time controlling for modal group. Expectably, the difference of means for group one (t = 0.976, df = 443, p>.1) and group two (t = 0.044, df = 13, p>.1) are not significantly different if gray obsidian is compared to total obsidian. Moreover, the modes for each set of group are virtually identical. Correlation regression yielded similar results (r = 0.9859, t = 88.768, p<.001), demonstrating that nearly all of the variability in sample density is a function of the behavior of gray obsidian.

Two reduction technologies are present in the collection. Decortication flakes, platform trimming flakes, percussion blades, irregular blades, ridge blades, plunging blades, core truncation flakes, core trimming flakes, manufacturing error flakes, eraillure flakes, and exhausted polyhedral cores are classes of debitage produced during blade core reduction and prismatic blade removal (see above). In contrast, percussion flakes, thinning flakes, flake cores, irregular chunks, and unidentified flakes come from a technology devoted to the manufacture of bifaces, unifaces, and flake tools. Flake and biface tool debitage is not very common at Matacapan in comparison to core-blade debitage.

Variability in collection density and composition suggests the presence of three classes of assemblages. Type I assemblages include all those sample units that contain significant amounts of obsidian (mean = 33.25 pieces of obsidian) and evidence of core-blade reduction and/or use (mean = 4.75 pieces of debitage). Evidence of core-blade reduction is also present in Type II assemblages (mean = 1.26), but the absolute density of surface material per collection unit is always much less (mean = 4.20). Type III is a residual category defined by low frequencies of surface obsidian (mean = 2.45) and no core-blade debitage. The means for all three classes of assemblage are significantly different (Type I/Type II: t = 5.479, df = 72, p<.001; Type I/Type III: t = 3.683, df = 161, p<.001; Type II/Type III: t = 4.474, df = 219, p<.001). There are also significant differences in the average quantity of debitage in each assemblage class. Type I may be distinguished from Type II on the basis of the frequency of core-blade debitage (t = 1.937, df = 7, p<.05) and the frequency of flake tool debitage (t = 2.646, df = 7, p<.025), both of which are significantly more common in Type I. Likewise, Type I can be distinguished from Type III in terms of the incidence of core-blade and flake tool debitage (t = 2.646, df = 7, p<.025; t = 2.540, df = 7, p<.025). Types II and III, however, differ only in terms of the frequency of core blade debitage (t = 8.079, df = 65, p<.005), not flake tool debitage (t = 0.573, df = 113, p>.1). This suggests that relatively equal amounts of flake tool working was associated with the production of Type II and Type III assemblages.

Table 3: Difference of Proportions Tests for Different Classes of Obsidian Assemblages from Surface Contexts at Matacapan.

Artifact Class	%I	%II	Z	%I	%III	Z	%II	%III	Z
Green Obsidian	10.2	6.1	0.44	10.2	13.2	0.25	6.1	13.2	1.54
Gray Obsidian	89.8	93.9	0.44	89.8	86.8	0.25	93.9	86.8	1.54
Percussion Blades	0.3	1.1	0.21	0.3	0.0	0.68	1.1	0.0	1.31
Irregular Blades	5.6	13.3	0.62	5.6	0.0	2.95	13.3	0.0	4.63
Prismatic Blades	68.8	62.2	0.37	68.8	87.9	1.57	62.2	87.9	4.39
Ridge Blades	1.5	1.1	0.10	1.5	0.0	1.53	1.1	0.0	1.31
Decortication Flakes	0.3	0.4	0.04	0.3	0.0	0.68	0.4	0.0	0.79
Platform Trimming F.	3.0	11.5	0.74	3.0	0.0	2.16	11.5	0.0	4.30
Core Trimming Flakes	0.8	0.4	0.16	0.8	0.0	1.11	0.4	0.0	0.79
Core Truncation Flakes	0.3	0.0	0.45	0.3	0.0	0.68	0.0	0.0	0.00
Eraillure Flakes	0.3	0.0	0.45	0.3	0.0	0.68	0.0	0.0	0.00
Plunging Blades	0.0	0.4	0.18	0.0	0.0	0.00	0.4	0.0	0.79
Manufacturing Error F.	0.0	0.4	0.18	0.0	0.0	0.00	0.4	0.0	0.79
Blade Cores	1.9	1.4	0.11	1.9	0.0	1.72	1.4	0.0	1.48
Percussion Flakes	1.1	0.4	0.72	1.1	0.5	0.23	0.4	0.5	0.10
Biface Thinning Flakes	1.1	0.4	0.27	1.1	0.8	0.09	0.4	0.8	0.33
Unidentified Flakes	12.0	4.7	0.86	12.0	6.9	0.55	4.7	6.9	0.62
Chunks	1.1	0.4	0.27	1.1	0.8	0.09	0.4	0.8	0.33
Points	0.8	0.4	0.16	0.8	0.8	0.00	0.4	0.8	0.33
Bifaces/Unifaces	0.8	1.1	0.08	0.8	2.4	0.29	1.1	2.4	0.63
Blade Debitage	14.3	29.9	0.93	14.3	0.0	4.73	29.9	0.0	7.13
Flake Tool Debitage	3.4	5.8	0.28	3.4	9.0	0.55	5.8	9.0	0.80

The difference of proportions test was applied to establish the degree to which different assemblage types could be segregated in terms of the relative frequencies of different kinds of debitage (Table 3). Type I assemblages can be distinguished from Type III in terms of the proportion of irregular blades ($Z = 2.950$), the proportion of platform trimming flakes ($Z = 2.158$), the proportion of exhausted blade cores ($Z = 4.725$), and the proportion of total core-blade debitage ($Z = 4.725$). Similarly, Type II assemblages differ from Type III with respect to the proportion of irregular blades ($Z = 4.633$), prismatic blades ($Z = 4.390$), and the proportion of platform trimming flakes ($Z = 7.134$). These differences should not come as a surprise since Type III was defined on the basis of no core-blade debitage. Interestingly, there are not significant differences in the relative frequencies of different classes of debitage between Type I and Type II assemblages. This lack of difference suggests that the activity sets that produced both assemblages were very comparable. The two, however, should not be considered as examples of the same kind of behavior because activity intensity, the scale of obsidian working, differs enormously.

Two subclasses of Type I assemblages may also be distinguished. Type IA assemblages include all collection loci with abundant core-blade debitage (mean = 6.17), whereas in Type IB core-blade debitage, although present, is much less common (mean = 0.50) and the proportion of prismatic blades is unusually high (87.5 percent). The difference of means test indicates that Type IA and Type IB assemblages do indeed differ significantly in terms of the amount of core-blade debitage present ($t = 2.023$, $df = 6$, $p<.05$). Type IA also contains more flake tool debitage than Type IB, though the difference in absolute frequencies is not statistically significant ($t = 1.014$, $df = 6$, $p>.05$). Type IA, then, is defined by greater amounts of total blade debitage, total debitage, and unidentified flakes. Type IB, in contrast, is characterized by comparatively little reduction debitage, virtually no core-blade debitage, and relatively large numbers of utilized, often heavily battered prismatic blades.

In summary, three classes of obsidian assemblages are represented at Matacapan. These may be distinguished from one another not only in terms of differences in the proportions of different kinds of debitage but also in terms the absolute amount of different types of material present. All Type I loci appear to be workshop entities. Two activity sets are indicated: core reduction and blade removal (Type IA) and blade use (Type IB). The same kinds of core-blade and flake tool debitage occurs in Type II assemblages; however, the intensity of reduction activity is much less. Type II assemblages, we suggest, represent a household or domestic blade industry. Type I localities, on the other hand, appear to have produced a substantial amount of the obsidian blades used at Matacapan. Also, the proportion of irregular blades, platform trimming flakes, and manufacturing errors is much higher at Type II loci than at Type I loci, as is the ratio of blades to core-blade debitage (Type I = 4.82, Type II = 2.08). This suggests that Type I knappers were more

Table 4: Difference of Proportions Tests for Different Classes of Obsidian Assemblages from Surface Contexts in Different Site Sectors at Matacapan.

Artifact Class	Type I			Type II			Type III		
	%1	%2-13	Z	%1	%2-13	Z	%1	%2-13	Z
Green Obsidian	15.4	4.6	0.51	6.1	7.9	0.87	13.6	12.0	0.18
Gray Obsidian	84.6	95.4	0.51	93.6	92.1	0.87	36.4	38.0	0.18
Percussion Blades	0.0	0.8	0.18	1.1	0.9	0.20	0.0	0.0	0.00
Irregular Blades	4.4	6.9	0.15	13.3	13.4	0.04	0.0	0.0	0.00
Prismatic Blades	72.1	65.4	0.20	62.2	61.6	0.17	90.1	78.3	1.46
Ridge Blades	0.0	3.1	0.36	1.1	1.4	0.36	0.0	0.0	0.00
Decortication Flakes	0.7	0.0	0.17	0.4	0.5	0.21	0.0	0.0	0.00
Platform Trimming F.	5.9	0.0	0.49	11.5	13.0	0.56	0.0	0.0	0.00
Core Trimming Flakes	0.7	0.8	0.02	0.4	0.5	0.38	0.0	0.0	0.00
Core Truncation Flakes	0.0	0.8	0.18	0.0	0.0	0.00	0.0	0.0	0.00
Core Rimming Flakes	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.00
Core Facing Flakes	0.0	0.0	0.00	0.0	0.0	0.00	0.0	0.0	0.00
Eraillure Flakes	0.0	0.8	0.18	0.0	0.0	0.00	0.0	0.0	0.00
Plunging Blades	0.0	0.9	0.00	0.4	0.5	0.21	0.0	0.0	0.00
Manufacturing Error F.	0.0	0.0	0.00	0.4	0.5	0.21	0.0	0.0	0.00
Blade Cores	0.7	3.1	0.53	1.4	1.4	0.05	0.0	0.0	0.00
Percussion Flakes	0.0	2.3	0.31	0.4	0.5	0.21	0.3	1.1	0.50
Biface Thinning Flakes	0.0	2.3	0.31	0.4	0.5	0.21	1.0	0.0	0.41
Unidentified Flakes	11.0	13.1	0.09	4.7	3.7	0.61	4.2	15.2	1.89
Chunks	0.7	0.8	0.02	0.4	0.5	0.21	0.7	1.1	0.18
Points	1.5	0.0	0.25	0.4	0.0	0.96	0.7	1.1	0.18
Bifaces/Unifaces	0.7	0.8	0.02	1.1	0.9	0.20	2.1	3.3	0.32
Blade Debitage	12.5	16.2	0.15	29.9	31.9	0.56	0.0	0.0	0.00
Flake Tool Debitage	1.5	5.4	0.30	5.8	5.1	0.37	6.3	17.4	1.64

efficient producers of blades than Type II workmen. The ratio of flake tools to flake debitage points to the same conclusion (Type I = 0.44, Type II = 0.29). Knappers at Matacapan received their material from workshops at primary production centers controlling source regions. Consequently, they represent a scale of specialized activity that was a magnitude of order less intensive than that recorded at primate centers such as Tula and Teotihuacan (Healan, Kerley, and Bey 1983; Spence 1981, 1984). Type III is interpreted as a domestic blade use assemblage. Although there are moderate differences in the amount of flake tool debitage present in different assemblages, the proportion of this material is relatively constant from one class to the next.

C. SPATIAL PATTERNING IN ASSEMBLAGE COMPOSITION

A total of 1,126 pieces of obsidian were collected by the intensive survey. Eight hundred and forty pieces were obtained from the systematic survey of downtown Matacapan, another 286 specimens during the extensive survey of outlying occupation zones. Table 4 gives the proportion of different classes of tools and debitage found in Sector 1 and Sectors 2-13, controlling for assemblage type. As is readily apparent, there is little variation in the relative frequencies of most classes of tools and debitage from one site sector to the next. Green obsidian is somewhat more common in Type I assemblages in Sector 1, and prismatic blades occur more often in Type III assemblages in Sector 1. Type III assemblages in Sectors 2-13 contain more unidentified flakes and flake tool debitage. None of these differences, however, is statistically significant, indicating a high degree of consistency in sample composition no matter what the spatial context.

There is significant variability in the number of specimens per assemblage type from different site sectors. In general, the samples from rural Matacapan contain more obsidian than the collections from downtown Matacapan. Most of this variability is a function of the behavior of Type II ($t = 2.792$, $df = 64$, $p<.01$) and Type III assemblages ($t = 5.899$, $df = 153$, $p<.001$). Table 5 presents the mean number of specimens per class of material per assemblage type in different site sectors. As expected, the means for Type I assemblages closely correspond. Interestingly, green obsidian is 3.5 times more common in Sector 1 than in Sectors 2-13. The larger sample size for Type II and Type III assemblages in Sectors 2-13 appears to be mainly a function of the number of prismatic blades. The means for Sector 1 are 2.33 and 1.89 blades per collection unit, for Sectors 2-13 4.44 and 4.24 blades, respectively. In addition, points and bifaces, uncommon at Matacapan, occur more often in assemblages in outlying occupation zones, typically by a factor of 4:1.

We suspect that this variability implies significant differences in the activity structure of different parts of Matacapan. For example, outlying sectors of occupation may have performed important support activities for the elite resident in Sector 1, and these activities may have required the use of greater numbers

Table 5: Mean Number of Specimens per Collection in Different Classes of Obsidian Assemblages from Surface Contexts in Different Site Sectors at Matacapan.

Artifact Class	Type I		Type II		Type III	
	1	2-13	1	2-13	1	2-13
Green Obsidian	5.25	1.50	0.30	0.00	0.28	0.65
Gray Obsidian	28.75	31.00	3.49	6.89	1.80	4.76
Percussion Blades	0.00	0.25	0.04	0.11	0.00	0.00
Irregular Blades	1.50	2.25	0.51	0.89	0.00	0.00
Prismatic Blades	24.50	21.25	2.33	4.44	1.89	4.24
Ridge Blades	0.00	1.00	0.05	0.00	0.00	0.00
Decortication Flakes	0.25	0.00	0.02	0.00	0.00	0.00
Platform Trimming F.	2.00	0.00	0.49	0.44	0.00	0.00
Core Trimming Flakes	0.25	0.25	0.00	0.11	0.00	0.00
Core Truncation F.	0.00	0.25	0.00	0.00	0.00	0.00
Erail1ure Flakes	0.00	0.25	0.00	0.00	0.00	0.00
Plunging Blades	0.00	0.00	0.02	0.00	0.00	0.00
Manufacturing Errors	0.00	0.00	0.02	0.00	0.00	0.00
Blade Cores	0.25	1.00	0.05	0.11	0.00	0.00
Percussion Flakes	0.00	0.75	0.02	0.00	0.01	0.06
Biface Thinning F.	0.00	0.75	0.02	0.00	0.02	0.00
Unidentified Flakes	3.75	4.25	0.14	0.56	0.09	0.82
Chunks	0.50	0.25	0.02	0.00	0.01	0.06
Points	0.50	0.00	0.00	0.11	0.01	0.06
Bifaces/Unifaces	0.25	0.25	0.04	0.11	0.04	0.18
Blade Debitage	4.25	5.25	1.21	1.56	0.00	0.00
Flake Tool Debitage	0.50	1.75	0.19	0.56	0.13	0.94
Total Obsidian	34.00	32.75	3.79	6.89	2.08	5.41

of prismatic blades and other implements. Likewise, certain activities such as hunting would have been conducted by peasants living in Sectors 2-13, not elites residing in downtown Matacapan. The greater density of materials in Sectors 2-13 may also be a function of the skill of the knapper, as monitored by tool: debitage ratios. This proposition cannot be supported. Although the ratios of debitage to tools are consistently higher for Type I assemblages in Sector 1 (5.76 verses 4.05 for blades, 1.50 verses 0.14 for flake tools), they are more or less equal for Type II and Type III assemblages. Therefore, differences in the amount of obsidian found in Type II and Type III assemblages in different occupation areas appear to be linked to variations in production intensity and use, not the degree of skill of the knapper. Knappers in workshops in Sector 1, however, seem to have been somewhat better skilled than specialists producing blade and flake tools in Sector 2-13.

Different assemblages also account for different proportions of the number of collections in different site sectors. In Sector 1, for example, workshops comprise only 2 percent of all collection units, whereas in Sectors 2-13 they account for 13.3 percent of the sample ($Z = 4.209$, $p<.001$). Type II assemblages behave differently. The relative frequency of domestic obsidian working is very constant from one site sector to the next. Type II assemblages account for 28.6 percent of all units in Sector 1 and 30 percent of all units in Sectors 2-13 ($Z = 0.158$, $p>.1$). Type III assemblages are more common in Sector 1 (69.3 percent) than in Sectors 2-13 (56.7 percent), but the difference of proportions is not statistically significant ($Z = 1.375$, $p>.05$). Obsidian workshops, then, tend to correlate with occupation density. The density of structures and associated refuse is generally much less in central Matacapan than in the zone of urban occupation surrounding the main civic-ceremonial precinct. The main civic-ceremonial precinct also probably had a variety of important political, economic, and religious functions that were confined to the central part of the site. Those functions may have involved the use of obsidian tools that were produced and used in other parts of the site. The primary tool found in central Matacapan is the spent prismatic blade. More different kinds of tools, more bifaces, and more flake tool debitage occur in the urban occupation zone where the density of total obsidian is also much greater. More activities means more tools which may have accounted the greater incidence of workshops. Many of these workshops also occur near platform mounds. This suggests that obsidian working was supported by each sector's local elite.

The primary obsidian object entering Matacapan was the prepared polyhedral pressure core. Macrodebitage, percussion flakes, and percussion blades are uncommon at Matacapan, indicating that most primary reduction and core preparation occurred elsewhere. The cores entering Matacapan represented part of the output of large-scale obsidian workshops in production centers such as Tula and Teotihuacan. Macrocores and nodules were also distributed to the Tuxtlas, but in considerably less numbers, as indicated by the occasional occurrence of percussion blades and decortication flakes. Finished prismatic blades were also exchanged long distances, especially blades made of Pachuca obsidian from Central Mexico (see below). Most of the obsidian entering Matacapan was probably passed first to workshops engaged in core reduction and blade removal and then to domestic households scattered throughout the site. Some of these workshops occur in central Matacapan, others in outlying zones of urban occupation. Generally, there is one small obsidian workshop for each major area of urban occupation, although in some barrios there are no workshops. None, however, are present in suburban Matacapan or in rural sites in Matacapan's hinterland. Workshops engaged in blade use also received their obsidian from blade removal workshops. Prepared pressure cores and debitage from core-blade reduction were also distributed to domestic households, probably from workshops. This activity was not very common, to judge from the low frequency of exhausted cores and reduction debitage in domestic contexts.

In sum, variability in assemblage composition provides important information about the production-distribution system dominated by centers in obsidian source regions. These centers quarried obsidian and fabricated both blade cores and finished implements for distribution to consumer sites such as Matacapan. The same kinds of tools were used in roughly the same proportions in all contexts at Matacapan. This suggests that obsidian was a utilitarian commodity available to all social groups in approximately the same amounts. Obsidian is more common in urban residential contexts at Matacapan than in the site's main civic-ceremonial district. Most of this variability is a function of the behavior of domestic assemblages. Obsidian workshops are also more common in the urban residential zone. The increase in the density of obsidian in urban domestic contexts appears to be related to the greater incidence of use, not differences in skill and expertise of domestic knappers. Specialists in workshops in central Matacapan, in contrast, seem to have been somewhat better skilled than specialists in the urban zone in Sectors 2-13. The greater incidence of workshops in the zone of urban occupation probably represents an ordered adjustment to demand intensity and variability in activity structure. The amount of imported green obsidian is considerably higher in central Matacapan. Pachuca obsidian is also present in the zone of urban occupation, typically near elite residences. It does not occur in suburban Matacapan or at small rural sites. This suggests that green obsidian was a status good. The transport costs for this material must have been extraordinarily high, as it was distributed to the Tuxtlas primarily in blade form in the Late Classic. Transport adds little to delivery costs only when obsidian is shipped as prepared cores (Santley 1984). Cost, therefore, appears to have been a major factor affecting the kinds of obsidian used in different contexts and the form in which obsidian was exchanged long distances. Domestic households at Matacapan generally obtained processed cores or prismatic blades removed from cores after entry to Matacapan. Elites, in contrast, consumed more finished tools made of Pachuca obsidian.

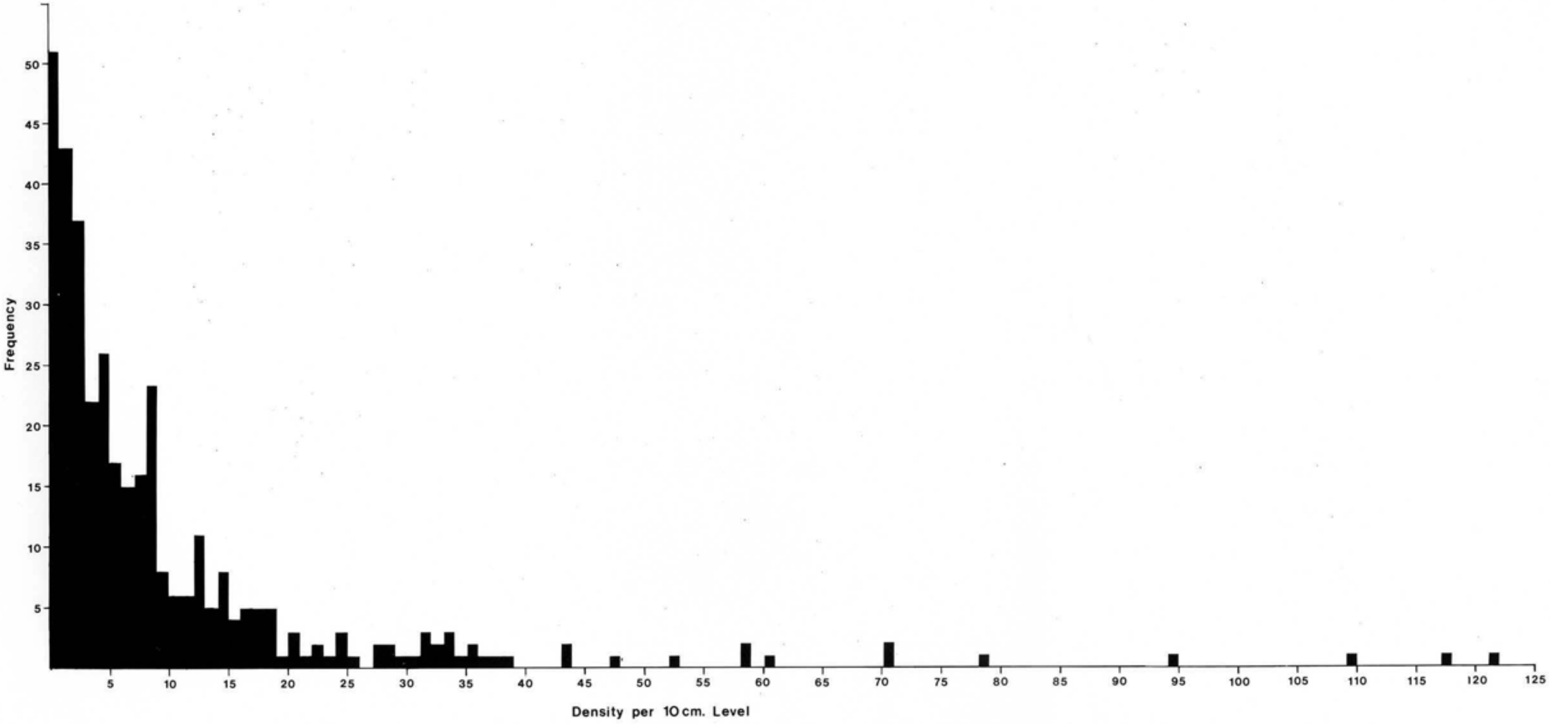


Figure 21: Histogram of Excavated Obsidian Densities.

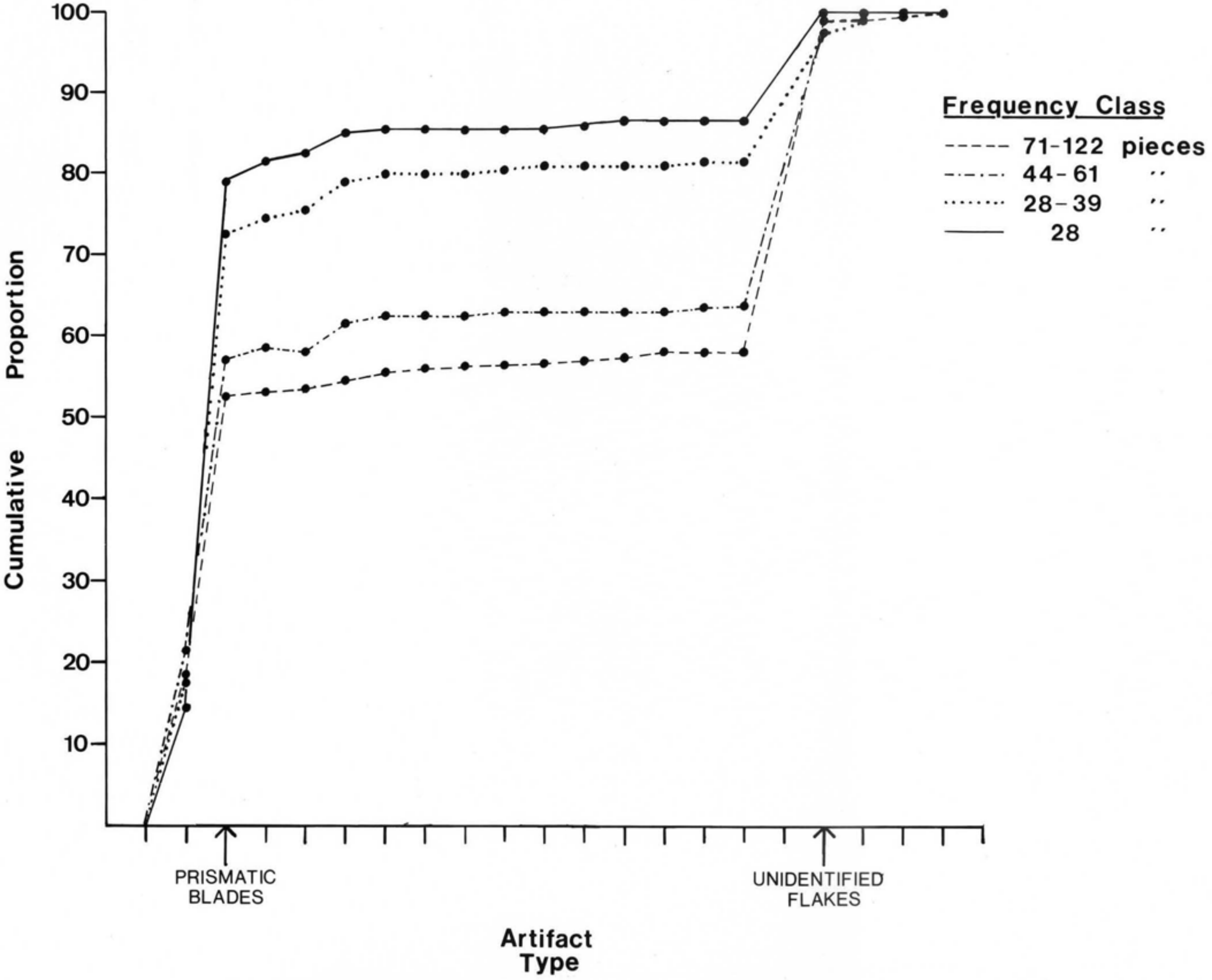


Figure 22: Cumulative Frequency Graph of Excavated Obsidian Artifact Types.

D. TEMPORAL SHIFTS IN PRODUCTION AND DISTRIBUTION

A total of 3,377 obsidian artifacts were recovered from the excavations. Of that total, 94.3 percent of the collection was gray obsidian and 4.79 percent green obsidian from the Pachuca source. The most common artifact was the prismatic blade which accounted for 55.2 percent of the excavated sample of obsidian. Irregular pressure blades were also relatively common (15.5 percent) as were unidentified flakes (19.2 percent). All other classes of material accounted for less than 4 percent of the collection. A substantial proportion of all material recovered consisted of reduction debitage. Core-blade debitage comprised 22.9 percent of the collection, flake tool debitage another 21.2 percent. The remainder of the sample consisted of a variety of projectile point types, particularly Tula points, unifaces, bifaces, punches, stemmed blades, and various kinds of utilized flakes.

The collection was divided into four groups based on frequency of occurrence: 1-26 pieces (n = 321), 28-39 pieces, (n = 20), 44-61 pieces (n = 7), and 71-122 pieces (n = 7) (see Figure 21). The relative frequencies for different artifact types present in each class were then calculated. These are presented in Figure 22 as cumulative frequencies. As is readily apparent, only two groups are present. Group I includes all units in which obsidian densities are high (44-122 specimens), Group II all levels that contain comparatively less obsidian. The two groups of units also differ in assemblage composition. Group I contains significantly greater numbers of unidentified flakes in comparison to Group II ($t = 2.207$, $df = 355$, $p<.025$). A substantial proportion of all Group II material, in contrast, are prismatic blades ($t = 2.219$, $df = 355$, $p<.025$).

There is also considerable variability in the absolute frequency of different classes of material present. Table 6 gives these data, expressed as the mean number of specimens per level per assemblage class. Also given is the ratio of Group I to Group II materials. However, sample sizes differ significantly. Differences in sample size can be controlled for by creating a ratio variable, in this case by dividing the ratio for each artifact class by the total ratio of Group I to Group II materials. A value greater than 1.00 indicates that the frequency of Group I materials is greater than expected given the differences in sample size. Conversely, a value less than 1.00 indicates that Group II contains more material than expected given the observed differences in frequency. These data are also presented in Table 6. Group I contains greater numbers of platform trimming flakes, core trimming flakes, core facing flakes, manufacturing error flakes, and unidentified flakes. Virtually all of this material is debitage from blade core reduction. Group I, then, appears to be a domestic assemblage devoted to prismatic blade manufacture. Group II, on the other hand, contains more percussion blades, prismatic blades, ridge blades, decortication flakes, thinning flakes, blade cores, points, bifaces, and chunks. Group II also appears to be a domestic

Table 6: Mean Frequency of Different Classes of Obsidian Artifacts in Different Assemblages from Excavated Contexts at Matacapan.

Artifact Class	Mean Type I	Mean Type II	I/II Ratio	I/II Ratio: Total Ratio
Percussion Blades	0.21	0.07	3.00	0.33
Irregular Blades	14.14	1.13	12.51	1.36
Prismatic Blades	25.79	5.03	5.13	0.56
Ridge Blades	0.50	0.17	2.94	0.32
Decortication Flakes	0.07	0.04	1.75	0.19
Platform Trimming F.	16.43	0.27	60.85	6.63
Core Trimming Flakes	0.86	0.04	21.50	2.34
Core Truncation Flakes	0.07	0.01	7.00	0.76
Eraillure Flakes	0.29	0.00	0.00	0.00
Plunging Blades	0.07	0.01	7.00	0.76
Core Rimming Flakes	0.00	0.02	0.00	0.00
Core Facing Flakes	0.14	0.01	14.00	1.53
Manufacturing Error F.	0.21	0.01	21.00	2.29
Blade Cores	0.21	0.04	5.25	0.57
Percussion Flakes	0.14	0.02	7.00	0.76
Bipolar Flakes	0.00	0.00	0.00	0.00
Biface Thinning Flakes	0.36	0.07	5.14	0.56
Unidentified Flakes	28.64	0.94	30.47	3.32
Chunks	0.21	0.10	2.10	0.23
Points	0.07	0.03	2.33	0.25
Bifaces/Unifaces	0.21	0.05	4.20	0.46
Flake Cores	0.00	0.01	0.00	0.00
Blade Debitage	18.4	1.82	10.11	1.10
Flake Tool Debitage	29.36	1.14	25.75	2.81
Total Obsidian	73.86	8.05	9.18	0.00

assemblage. The main activities represented are biface manufacture and repair, blade and biface use, as well as some blade working. Moreover, many of the percussion and ridge blades present in the assemblage show evidence of utilization, indicating debitage recycling. Both groups contain relatively equal numbers of irregular blades, core truncation flakes, plunging blades, and percussion flakes.

Group I assemblages occur in two contexts: at the base of Mounds 1 and 2; and in middens on or behind the terrace surfaces to the rear of Mounds 3 and 22. Much of the material in front of Mounds 1 and 2 is secondary fill laid down for the construction of plaza surfaces. In contrast, the material behind Mounds 3 and 22 comes from primary middens. It would appear that blade working was an open-air activity conducted primarily on the terraces attached to the rear of major residential platforms. The debitage from this activity was later discarded in refuse dumps behind each terrace. Some of this material was apparently later used as fill when the plaza was rebuilt. Group II assemblages occur throughout the barrio. They are also present throughout the occupation sequence. Group I assemblages, on the other hand, date primarily to late Middle Classic.

The volume of obsidian exchanged long distances also changes significantly through time. In the early part of the Middle Classic (see Table 1) each excavation provenience yielded an average of 5.56 pieces of obsidian. During the late Middle Classic there is a threefold rise in the amount of obsidian present at Matacapan (mean = 16.18 pieces). Thereafter, obsidian densities fall off: first to 9.09 pieces per level, then to 4.08 pieces per level. The period of pronounced Teotihuacan influence therefore coincides with a peak in obsidian importation. The material exchanged, however, is not primarily obsidian from the Pachuca source dominated by Teotihuacan. In the Middle Classic green obsidian accounts for only 3.9 to 4.0 percent of the collection. These figures compare favorably with that obtained for obsidian from early Late Classic contexts (3.3 percent). Deposits dating to the late Late Classic Period, on the other hand, are distinguished by a tremendous rise in the relative frequency of green obsidian. Overall, green obsidian accounts for 15.3 percent of all late Late Classic material, and in some excavations the amount utilized was as high as 28 percent. The surface samples from the area around Mound 18 yielded values as high as 38-50 percent. Green obsidian utilization is correlated with time. A strong correlation coefficient was obtained when percentage utilized was plotted against median date/time period, although the results were not significant at any commonly accepted level ($r = 0.7423$, $t = 1.567$, $p>.1$). A stronger correlation coefficient was obtained when the data were transformed exponentially ($r = 0.8407$, $t = 2.196$, $p<.05$). Green obsidian utilization and mean density of material are also related curvilinearly, but in negative fashion ($r = -0.6906$, $t = 1.350$, $p>.1$). Thus, peaks in the relative amount of green obsidian utilized covary with decreases in the total volume of material imported to Matacapan. The greatest amount of obsidian utilized was coinci-

Table 7: Obsidian Source Utilization and Platform Preparation from Different Chronological Contexts at Matacapan.

A. Source Utilization

Period	Median Date	Total	% Green	% Gray
Late Late Classic	A.D. 900	326	15.3	84.7
Early Late Classic	A.D. 700	1082	3.3	96.7
Late Middle Classic	A.D. 500	1569	3.9	96.1
Early Middle Classic	A.D. 300	400	4.0	96.0

B. Green Prismatic Platform Preparation

Period	Median Date	Ground Platforms		Faceted Platforms	
Late Late Classic	A.D. 900	13	86.7%	2	13.3%
Early Late Classic	A.D. 700	2	66.7%	1	33.0%
Late Middle Classic	A.D. 500	2	50.0%	2	50.0%
Early Middle Classic	A.D. 300	2	50.0%	2	50.0%

C. Gray Prismatic Platform Preparation

Period	Median Date	Ground Platforms		Faceted Platforms	
Late Late Classic	A.D. 900	10	25.0%	30	75.0%
Early Late Classic	A.D. 700	26	33.8%	51	66.2%
Late Middle Classic	A.D. 500	31	18.9%	133	81.1%
Early Middle Classic	A.D. 300	12	24.5%	37	75.5%

dent with the episode of Teotihuacan occupation at Matacapan. In contrast, when Matacapan was importing significant amounts of green obsidian, that material appears to have come from Tula, not Teotihuacan (Healan, Kerley, and Bey 1983).

The obsidian blades used at Matacapan derive from cores with platforms that were prepared in several different ways. Platform preparation is an important stage in the core reduction because it affects that number of fine prismatic blades that may be removed from a mass of standard size. Faceted platforms result from flaking to produce a surface suitable for blade removal. Ground platforms, on the other hand, are the result of a two stage reduction process. First, the platform is pecked with a hammerstone to achieve a relatively level surface. The facets are then ground completely flat during the irregular pressure blade sequence with an abrasive substance such as sand. Apparently, fewer irregular blades have to be taken off cores with ground platforms, and this reduces the amount of debitage produced during blade removal. At Matacapan the ratio of irregular blades-to-prismatic blades with faceted platforms is 1:1.4. A substantial proportion of the sample also have ground platforms, and expectably the ratio of irregulars-to-prismatics is much lower: ca. 1:2.1. Blades with ground platforms date to all phases of the Classic Period, not simply the late Late Classic Period when grinding was supposedly introduced as a platform preparation technique (see Table 7).

In general, there is a strong positive relationship between median date/time period and the proportion of the sample that is ground ($r = 0.8182$, $t = 2.012$, $p<.05$). By type of obsidian a somewhat different picture is indicated (see Table 7). The proportion of the sample of green proximals with ground platforms also increases steadily with time ($r = 0.9384$, $t = 3.841$, $p<.05$). In the Middle Classic approximately 50 percent of the sample of Pachuca obsidian exhibits grinding. The proportion with ground platforms rises to 66.7 percent in the early Late Classic and 86.7 percent in the late Late Classic. In contrast, the proportion of gray obsidian blades that is ground does not increase with time ($r = 0.3439$, $t = 0.5179$, $p>.3$). In fact, the proportion of gray blades with ground platforms peaks in the early Late Classic, not the Middle Classic when long distance obsidian exchange was presumably dominated by Teotihuacan. In addition, 73.1 percent of all green prismatics have ground platforms, whereas only 23.9 percent of the sample of gray pressure blades are ground. The proportion of gray material with ground platforms is always significantly less than the proportion of green prismatics that is ground, and this difference becomes more marked with time ($r = 0.8775$, $t = 2.588$, $p<.05$). Reduction technologies, then, appear to have become more efficient with time, and this increase in efficiency is largely the result of changes in the technology of working Pachuca obsidian.

A large number of irregular pressure blades also occurs in the sample (see Table 8). Irregular pressure blades have dorsal ridges that are not completely straight. These blades are a

Table 8: Platform Preparation for Irregular and Prismatic Blades from Different Chronological Contexts at Matacapan.

A. Platform Preparation for Gray Irregulars

Period	Median Date	Ground Platforms		Faceted Platforms	
Late Late Classic	A.D. 900	1	12.5%	7	87.5%
Early Late Classic	A.D. 700	12	18.2%	54	81.8%
Late Middle Classic	A.D. 500	18	14.9%	103	85.1%
Early Middle Classic	A.D. 300	7	28.3%	18	72.0%

B. Proportion of Gray Irregular and Prismatic Blades with Ground and Faceted Platforms

	Ground Platforms		Faceted Platforms	
Period	Irregulars	Prismatics	Irregulars	Prismatics
Late Late Classic	9.1%	90.9%	18.9%	81.1%
Early Late Classic	31.6%	68.4%	51.4%	48.6%
Late Middle Classic	36.7%	63.3%	43.6%	56.4%
Early Middle Classic	36.8%	63.2%	32.7%	67.3%

transitional type struck off the core after the initial series but before the removal of fine prismatics. The virtual lack of initial series blades indicates that cores were distributed to Matacapan in finely prepared form. Most of the sample of irregular blades, indeed most reduction material, consists of gray obsidian. Overall, 17.3 percent of the sample of irregular gray blades is ground, whereas 23.9 percent of the sample of fine gray pressure blades have ground platforms. As the proportion of the sample of prismatics that is ground should closely match the proportion of the sample of irregulars with ground platforms if all blades were imported to Matacapan in core form, it appears that a portion of the sample of gray obsidian was distributed to the Tuxtlas as finished prismatic blades. The absolute frequency of gray prismatics, however, closely parallels the absolute frequency of gray irregulars, implying that most of the gray obsidian that entered Matacapan was exchanged as prepared pressure cores ($r = 0.9514$, $t = 4.369$, $p<.05$). The same may be said for gray blades with faceted platforms ($r = 0.9554$, $t = 4.575$, $p<.05$). The consistent occurrence of gray obsidian error recoveries--plunging blades, ridge blades, distal core truncations, and hinged blades--points to the same conclusion.

Through time the pattern is different. In the Middle Classic the proportion of irregular gray blades with ground platforms matches the proportion of gray prismatics that is ground, suggesting that most of this material was exchanged in core form (see Tables 7 and 8). Differences in proportion become pronounced only in the Late Classic. Correlation regression indicates that there is a strong relationship between median date/time period and difference of proportion, demonstrating that the movement of gray prismatics with ground platforms in blade form is largely a Late Classic phenomenon ($r = 0.8985$, $t = 2.895$, $p<.1$). The proportion of irregular gray blades with faceted platforms is also nearly identical to the proportion of gray prismatics that is faceted in the Middle Classic, again suggesting that most of this material was exchanged in core form. In the Late Classic, in contrast, the proportion of irregular blades with faceted platforms is significantly higher than that for gray prismatics. This suggests that much of the distribution of blades with faceted platforms in the Late Classic was in core form but that some of the prismatics left processing stations in central Matacapan for use in areas of domestic occupation.

Platform preparation also appears to have had an effect on the proportion of pressure blades that are irregulars (see Table 8). In general, irregulars account for 32.5 percent of the sample of gray blades with ground platforms, whereas when the platform was prepared by faceting, 42 percent of all blades are irregular. This difference, we submit, is the result of differences in the efficiencies (i.e., amount of wastage) between the two reduction technologies. It would appear that more blades can be removed from a core with a prepared ground platform, and the difference in efficiency between the two technologies, if our data are representative, is on the order of 10 percent. In the Middle and early Late Classic irregular blades account for 32.7

to 51.4 percent of the sample of faceted blades, but in the late Late Classic only 18.9 percent of all faceted blades are irregulars. Correlation regression demonstrates that this variability is not related linearly with time period ($r = -0.3076$, $t = 0.457$, $p>.3$). Irregular blades account for 31.6 to 36.8 percent of all blades with ground platforms in the Middle Classic and early Late Classic, and the proportion that is irregular also drops sharply in the late Late Classic. The proportion of ground irregular blades, however, is inversely correlated with time ($r = -0.8631$, $t = 5.841$, $p<.025$). In reality, the relationship is curvilinear, as indicated by the increase in the magnitude of the correlation coefficient when the variables are transformed exponentially ($r = -0.9524$, $t = 19.521$, $p<.0025$). The finding that irregulars account for 30 to 50 percent of all blades is consistent with the results of recent replicative experiments which suggest that significant numbers of irregular blades are produced when faceted cores are reduced. Proportions of .09 to .10, however, are considerably less than what one would expect if all blades came from cores reduced at Matacapan. The implication is that in the Middle and early Late Classic most of the gray obsidian distributed to Matacapan entered the site as prepared polyhedral cores. Then, in the late Late Classic prismatic blades began replacing polyhedral cores as the primary good imported to Matacapan. A higher proportion of blades from ground cores was exchanged in blade form, as indicated by the significantly lower proportion of ground irregulars.

In contrast, green obsidian occurs mainly as prismatic blades (see Table 9). Core-blade reduction debitage such as decortication flakes, ridge and plunging blades, manufacturing error flakes, and exhausted cores is rare at Matacapan. Altogether, there are 178 pieces of green obsidian, which represents approximately 5 percent of all excavated materials. Included in the sample are 150 prismatic blades, four irregular blades, two platform trimming flakes, one core facing flake, one percussion blade, and twenty unidentified flakes. Overall, prismatics account for 94.4 percent of all green obsidian. In the Middle and early Late Classic 91.1 to 93.3 percent of all green obsidian are prismatic blades, but in the late Late Classic that figure rises to 100 percent. The proportion of blades in the sample therefore increases with time; however, the correlation is weak and not statistically significant ($r = 0.6007$, $t = 1.129$, $p>.3$). The amount of debitage present per period is also not strongly correlated with the total number of green prismatics ($r = 0.3495$, $t = 0.528$, $p>.3$), indicating that sample size has little effect on the amount of green debitage retrieved. The amount of green obsidian debitage from core-blade reduction cannot account for the number of prismatic blades in the sample if green pressure cores were reduced at Matacapan. Moreover, the ratio of irregulars-to-prismatics is much lower than what one would expect if green obsidian was mainly distributed to Matacapan in core form.

It appears that most of the green obsidian at Matacapan entered the South Gulf Coast as prismatic blades. In the Middle and early Late Classic some green obsidian was distributed to the Tuxtlas as prepared cores, but in the late Late Classic all of the Pachuca obsidian at Matacapan was traded in blade form. The blades exchanged to Matacapan in the late Late Classic are morphologically identical to the blades produced in the workshop complex recently excavated at Tula, the center in Central Mexico in control of the Pachuca mines around A.D. 900-1200 (Healan, Kerley, and Bey 1983; Santley, Kerley, and Kneebone n.d.). The late Late Classic at Matacapan represents a time period when the Tuxtlas obtained a significant amount of its obsidian from Central Mexico, and the material obtained consisted primarily of prismatic blades, not macrocores or prepared pressure cores. The evidence from Tula indicates that obsidian workshops manufactured primarily blades, not cores--a finding our data from Matacapan strongly support (Healan, Kerley, and Bey 1983).

The general pattern of long-distance obsidian exchange on the South Gulf Coast is quite complex. Obsidian was exchanged not only as prepared macrocores but also as prismatic blades. Decortication flakes are also present, suggesting that occasionally nodules or partly processed blocks were distributed to Matacapan. In the Middle Classic most of the obsidian traded to Matacapan entered the Tuxtlas as prepared macrocores. A small amount of gray obsidian was also distributed to Matacapan in blade form. Not much green obsidian occurs at Matacapan in the Middle Classic. Most of the Pachuca obsidian present, however, was distributed as prismatic blades, not as cores. In the late Late Classic platform, grinding became more common, and the efficiency of core reduction increased. Blades began replacing cores as the material traded long distances, and much of this obsidian came from the Pachuca source controlled by Tula. Both green and gray obsidian were exchanged in blade form, although most gray obsidian was still distributed as prepared macrocores.

The intensity of long-distance exchange peaks in the Middle Classic when the Teotihuacan barrio was built at Matacapan. The

Table 9: Green Obsidian from Different Contexts at Matacapan

Time Period	Median Date	Prismatic Blades[a]		Irregular Blades[b]		Other Debitage[c]	
		f	%	f	%	f	%
Late Late Classic	A.D. 900	50	100.0	0	00.0	0	00.0
Early Late Classic	A.D. 700	31	91.1	1	2.9	2	5.9
Late Middle Classic	A.D. 500	55	93.2	2	3.4	2	3.4
Early Middle Classic	A.D. 300	14	93.3	1	6.7	0	0.0

a. Total prismatic blades including proximals
b. Total irregular blades including proximals
c. Platform trimming flakes, core facing flakes, and percussion blades

Teotihuacan presence at Matacapan appears to have had little effect on the proportion of green obsidian exchange. Most of this obsidian was routed to populations living in Highland Mexico, including the Valley of Oaxaca (Appel n.d.; Santley 1983; Santley, Kerley, and Kneebone n.d.). We suspect that most of the obsidian utilized on the South Gulf Coast came from the complex of sources around Pico de Orizaba. That complex of sources may have been controlled by El Tajin, a major urban center with close ties to Teotihuacan (Zeitlin 1978, 1982). Furthermore, we suspect that much of this obsidian was distributed by Teotihuacan merchants who maintained agents at key sites such as Matacapan. If so, then Teotihuacan appears to have simply taken advantage of already extant exchange networks, increasing only volume of exchange. On the other hand, the amount of green obsidian exchanged climaxes in the late Late Classic. Tula, therefore, seems to have replaced local Gulf Coast networks with its own, which supplied as much as 40 percent of all material utilized. This realignment in exchange spheres coincided with the decline of El Tajin, the collapse of major centers in the southern Maya lowlands, and Toltec expansion in Central Mexico around A.D. 800-1000.

The exchange of obsidian in core form is a very efficient distribution strategy. This is because obsidian is a very brittle substance and blades can be very easily damaged during transport unless they are individually packaged. More, if obsidian is shipped long distances in core form, transport adds little to the final delivery cost (Santley 1984). Exchange in core form, then, is a least-cost distribution strategy aimed at providing the greatest number of consumers with the cheapest possible obsidian technology. Distribution strategies of this sort are closely tied to pricing policies that are discriminatory in character (Lloyd and Dicken 1972; Sanders and Santley 1983; Santley 1980). Under conditions of discriminatory pricing consumers close to a point of supply pay rather more and distant consumers rather less than they would if the delivery price varied directly as a function of distance. The production center absorbs freight rates or production costs. This makes the point of supply seem closer than it would if pricing was conditioned solely by the frictional effects of distance. Pricing strategies of this sort can only work if goods are shipped long distances in volume. The data from Matacapan suggest that Teotihuacan increased the amount of goods distributed long distances. Thus, Teotihuacan may have used bulk trading as a vehicle not only for attracting clients but also for increasing individual demand.

Exchanging obsidian as prismatic blades is a more inefficient distribution strategy because distance adds a significant cost to the delivery price. This is particularly the case for transportation systems that are foot powered. Several benefits, however, would accrue to a production point practicing such a distribution strategy. First, by exchanging blades the production center maintains a monopoly on obsidian technology, because consumers cannot recycle reduction debitage. Recall that reduction debitage such as irregular blades, ridge blades, and plunging blades were extensively utilized at Matacapan in the Middle Classic when obsidian was distributed long distances primarily as prepared macrocores. Recycling strategies of this type are not possible when obsidian is exchanged as prismatic blades. Second, by shifting to ground platforms the production point actually increases the number of products obtained from a volume of raw material of specified size. This would allow for a slight reduction in cost per specimen, which may have been used as a mechanism for attracting consumers. Third, by distributing blades the production center would be in a position to dictate the terms of trade and to set the final cost charged regardless of the distance involved. Monopolistic strategies of this type are only possible once demand curves are established and alternative sources of raw material are lacking or insufficient to meet local needs. It may be no coincidence, then, that this change in distribution strategy occurred precisely at the same time as competing centers such as El Tajin, Monte Alban, Xochicalco, Teotihuacan, and Kaminaljuyu declined in importance or were abandoned (Blanton 1978; Diehl 1983; Hirth n.d.; Sanders and Michels 1977; Sanders, Parsons, and Santley 1979).

VII. CONCLUDING REMARKS

In 1982 we initiated a program of archaeological research at Matacapan. Our working hypothesis was that the Teotihuacan barrio was occupied by an enclave of merchants from the Basin of Mexico metropolis and that control over the long-distance exchange of obsidian and other exotics such as cacao, semi-precious stone, and tropical feathers was a primary impetus behind the contact process. The 1982 field season involved an intensive survey of downtown Matacapan where most of the site's civic-ceremonial architecture is located and a series of stratigraphic excavations in the Teotihuacan barrio to collect information on chronology and barrio structure. We also undertook two sets of excavations outside of the barrio and completed an extensive survey of outlying zones of urban and suburban occupation. The extensive survey discovered that Matacapan is an enormous site covering at least 15 square kilometers. The survey also discovered a series of obsidian and pottery workshops. The ceramic workshops occur in association with clay sources where fine paste clays were mined in the Classic Period.

What we define as Teotihuacan occupation consists of a complex of artifacts of Teotihuacan inspiration or derivation that occur together: cylindrical tripod bowls, often produced in Fine Orange or Fine Gray; copaware; anthropomorphic figurines; candeleros; braseros; seal stamps; incensarios; and adornos. This complex is the most common in the area we have termed as the Teotihuacan barrio, but it also occurs elsewhere at Matacapan. Indeed, there is no part of central Matacapan we have investigated by excavation that does not contain Teotihuacan materials. We estimate that the area covered by Teotihuacan occupation occupies a square kilometer and may be as large as 5 square kilometers. This contrasts with the situation at Kaminaljuyu where the Teotihuacan manifestation was confined to the Mound

A/Mound B complex principally (Sanders and Michels 1977). It also suggests a different process of contact. Thus, rather than a small barrio of foreigners that presumably had a commercial function, Matacapan may have been physically conquered by Teotihuacan. If so, this would be the first good evidence of Teotihuacan political expansion beyond Central Mexico.

All archaeological materials belonging to the Teotihuacan complex consist of locally made imitations of objects extremely popular at Teotihuacan during the Late Tlamimilolpa, Xolalpan, and Metepec phases (ca. A.D. 450-700) (Muller 1978; E. Rattray, personal communication; Sejourne 1966). This observation applies not only to cylindrical tripod bowls but also to all of the copaware, candeleros, and figurines we have retrieved to date. Although this complex of artifacts is stylistically very similar to materials from Teotihuacan, the correspondences are not entirely exact. For example, although many of the Middle Classic figurines at Matacapan would fit into classes defined at Teotihuacan, there are marked differences in eye treatment and figurine size (W. Barbour, personal communication). The same may be said for hollow tripod supports from cylindrical vases which are more rounded and tapered than specimens from Teotihuacan (E. Rattray, personal communication). Obviously, we are dealing with persons who were highly familiar with Teotihuacan styles but who did not obtain their technology directly from Teotihuacan. It is also of interest that most of the Teotihuacan materials we have recovered thus far are either ritual-ceremonial paraphernalia (e.g., figurines and candeleros) or culinary objects used in food preparation and consumption (e.g., braseros and copaware). All of the remainder of the artifacts we have obtained from Middle Classic contexts were rendered in local Tuxtlas styles. Maintenance of foreign religious and dietary customs is precisely what we would expect if parts of Matacapan were occupied by persons from Teotihuacan. These Teotihuacanos also did not live in large multifamily apartment complexes as they did in the Basin of Mexico (Millon 1973; Sanders, Parsons, and Santley 1979). This suggests that the Teotihuacan component at Matacapan adopted local residential customs but maintained distinctive ideo-religious beliefs.

This evidence is consistent with the proposition that the Teotihuacan barrio was built for and occupied by foreigners from Teotihuacan. Those foreigners appear to have maintained Teotihuacan religious and cooking habits, but otherwise they seem to have adopted local customs, as reflected by the predominance of local technology and residential architecture. There is also evidence indicating that Matacapan received much of its obsidian from Teotihuacan or Teotihuacan affiliated polities such as El Tajin in the Middle Classic. It does not appear, however, that Matacapan served as a major distribution center for obsidian produced at Teotihuacan, although much of the obsidian exchanged to the South Gulf Coast and Maya lowlands may have passed through Matacapan. The workshop entities we have defined probably serviced only Matacapan and its immediate hinterland, not the entire Greater Tuxtlas Region. Matacapan, however, was more heavily dependent on obsidian from the Pachuca source in the Late Classic, that period of time when the Toltec state was rising in power and influence in Central Mexico. This obsidian was a status good, to judge from its association with elite architecture. The Tuxtlas Mountains is also the only source of vesicular basalt on the South Gulf Coast, but again it does not appear that Matacapan engaged in the large-scale production and distribution of manos, metates, or other basalt implements.

Matacapan, however, is situated near a large complex of fine paste calcareous clay sources. Several of these sources are rich in montmorillonite, whereas others may contain high proportions of kaolinite. Today, such clays are very widely distributed, especially as additives for pigments, slips, and other decorative coatings (Arnold 1980; Rye 1981). In addition, there is an extensive ceramic workshop zone in suburban Matacapan, and in one case the complex of ceramic workshop sites is directly associated with the clay sources. We believe that the occurrence of this resource was a primary factor behind the establishment of a Teotihuacan presence in the Tuxtlas. The association between a Teotihuacan presence and a site located near a resource that was widely traded in antiquity fits the pattern of Teotihuacan influence observed in other parts of Mesoamerica (Santley 1983). Unfortunately, we lack sufficient data to confirm this proposition. Additional research is therefore required. Our past work at Matacapan indicates several directions in which this research ought to proceed.

First, the systematic survey of the site should be completed. The survey should employ the same methodology used in 1982 to insure data comparability. This survey should concentrate on defining site boundaries and internal configuration. In particular, the craft workshops discovered in 1982 should be more intensively investigated. With regard to ceramic manufacture, we need information about the location of firing areas and sherd dumps and the location of residences occupied by potters where clay preparation and vessel forming probably took place. The survey should be conducted in several stages, with the location of collection units stratified by spatial zone and activity type. A similar strategy also ought to be conducted at those localities we suspect functioned as obsidian workshops. This would provide important information on the spatial organization of two fundamentally different crafts: ceramic manufacture, a craft involving an additive technology; and lithic reduction, a specialization involving a subtractive technology.

Second, a series of ceramic workshops established by the survey should be tested by stratigraphic excavation. Stratigraphic testing is necessary to ascertain the degree of congruence between the surface and subsurface contexts. Moreover, since many of the surface samples contain wares that occur throughout the occupation sequence, excavation is necessary to determine whether the workshop zones were in fact contemporary with the Teotihuacan presence at Matacapan. We are also interested in defining the array of wares produced. Copaware, for example, is one ceramic class that is extremely common in Middle Classic contexts both at Matacapan and at Teotihuacan. Was this ware fabricated at Matacapan? If so, was the copaware manufactured at Matacapan traded to Teotihuacan, and at what levels of intensity? These excavations will also provide much needed information on the development of the ceramic industry and changes in the organization of ceramic production through time.

Several of the workshops dumps defined in the zone of urban occupation should also be excavated. Our sample of excavated obsidian from chronologically sealed contexts is pitifully small. Moreover, most of the excavated sample we have obtained to date does not come from workshop localities. The workshop entities to be investigated should derive from different time periods, and the research to be conducted should concentrate on defining the structure of production and distribution. Incidence of error types, amount of waste produced, standardization in the size and shape of the finished product, and the amount and type of use are only a few of the kinds of data we must collect if we are to unambiguously describe the obsidian production-distribution system. An examination of the degree to which different production activities segregate spatially should also be undertaken. Recall that the periods from which the workshop dumps derive are characterized by radical shifts in source utilization, class of object exchanged, and technology of platform preparation. Such data are particularly important because they come from a region in which obsidian is not naturally occurring.

Finally, our knowledge of the settlement history of Matacapan is woefully incomplete. As we have seen, most of the material from the survey dates to the final period of occupation, the Late Classic. When earlier materials are present in significant quantities, they usually come from contexts where earlier occupations lie near the surface. This is particularly a problem with respect to the distribution of Middle Classic occupation at Matacapan and the spatial extent of the Teotihuacan residential zone. Clearly, a comprehensive test pitting program is beyond our field capabilities, but systematic investigations in areas we suspect contain Middle Classic occupation is not. Teotihuacan materials are present on the surface in Sector 8 and Sector 9, and they may occur elsewhere in the zone of urban occupation between the Rio Matacapan and the modern town of Caleria. Stratigraphic testing in this zone would supply that information. We also have reason to believe that this area harbors an Early Classic component, a time period that is still not well defined at Matacapan.

Many recent studies have employed long-distance exchange as a prime mover of sociocultural change, but relatively little research has attempted to understand exchange by investigating the structure of specialized production activities. We also know very little about what presumed trading centers looked like, what kinds of goods flowed through nodes in the network, and at what levels of intensity. However, if research is focused in this direction, we should be in a position to more clearly understand not only the local structure but also the operation of the larger system of which particular centers were integral parts. This research comes at a time when, given the burgeoning interest in trade and exchange, a problem oriented program of survey and excavation at Matacapan may provide the data necessary to bridge the substantive, methodological, and theoretical gaps that currently exist concerning our knowledge about Teotihuacan's rise and development, the role long-distance exchange had in conditioning those developments, and the organization of prehistoric production-distribution systems.

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