CHEMICAL ANALYSIS AND THE INTERPRETATION OF LATE PRECLASSIC INTERSITE CERAMIC PATTERNS IN THE SOUTHEAST HIGHLANDS OF MESOAMERICA

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RECENT CERAMIC RESEARCH[1]

The past decade has seen an intensification in archaeological activity in the highlands and Pacific coasts of El Salvador and Guatemala. The new evidence from these excavations has greatly altered previous interpretations of the culture-history of this region, particularly concerning the formation of highland Maya civilization in the Late Preclassic period (400 BC to AD 200). Recent excavations in western El Salvador (e.g., Sharer 1974; Sheets 1976; Demarest 1977, 1981) have demonstrated regional participation in the mainstream of the Mesoamerican cultural tradition. Indeed, the new evidence indicates that during the Preclassic period, developments in western El Salvador were critical to the development of complex society in southeastern Mesoamerica (cf. Sharer and Gifford 1970; Sharer 1974; Sheets 1979; Demarest 1981; Demarest and Sharer 1981). Meanwhile, archaeological investigations in the adjacent highlands and Pacific coast of Guatemala have confirmed the important role of that region in the rise of Maya civilization (see for example, Sedat and Sharer 1972; Graham 1976, 1978; Lowe 1977).

However, this intensified archaeological activity consisted of independent projects with little interproject coordination of research or results. The published reports have stressed interregional comparisons and connections with distant areas such as Central Mexico (e.g. Parsons 1967b; Sanders and Michels 1977) and the Maya lowlands (e.g. Sheets 1976, 1979; Dahlin 1979; Sharer and Gifford 1970). Consequently, intersite connections within the highlands themselves have remained rather ill-defined.

In order to address this problem of intersite comparisons, Arthur Demarest, Robert Sharer, and others collaborated in a series of studies between 1978 and 1981. This research included direct comparison of ceramic collections from the following regions: 1) western El Salvador (Chalchuapa, Santa Leticia, Atiquisaya); 2) central El Salvador (El Perical, El Cocal, and Rio Grande); 3) eastern El Salvador (Quelepa, Usulután); 4) highland Guatemala (Monte Alto, Kaminaljuyú, Salama Valley); and 5) western Honduras (Copan) (see Figure 7.1). The details of the methodology and results of these comparative ceramic studies have been presented elsewhere (Demarest 1981; Demarest and Sharer 1981, 1982). Of particular concern here is the patterning in the archaeological record revealed by this research. The interpretation of this patterning and the testing of alternative hypotheses regarding its significance provide some important insights into the development of complex society along the southeastern periphery of Mesoamerica.

THE LATE PRECLASSIC CERAMIC PATTERN

The direct comparisons revealed a clear pattern of ceramic unity for the coast and highlands of western El Salvador (Depts. Ahuachapan, Sonsonate, and Santa Ana) and southeastern Guatemala — also an ecologically and geographically unified area. Ceramic unity is seen in the identity of major black, red and orange types, as well as in the sharing of most Usulután types and the general similarity of the local variants of the red-on-buff domestic pottery (Demarest and Sharer 1981). The fine red (Santa Tecla), orange (Olocuitla), and black-brown (Pinos) types of Chalchuapa, Santa Leticia, and Atiquisaya were found to be duplicated at Kaminaljuyú and Monte Alto by identical types showing the same paste and surface characteristics, vessel form, and the same clusters of decora-
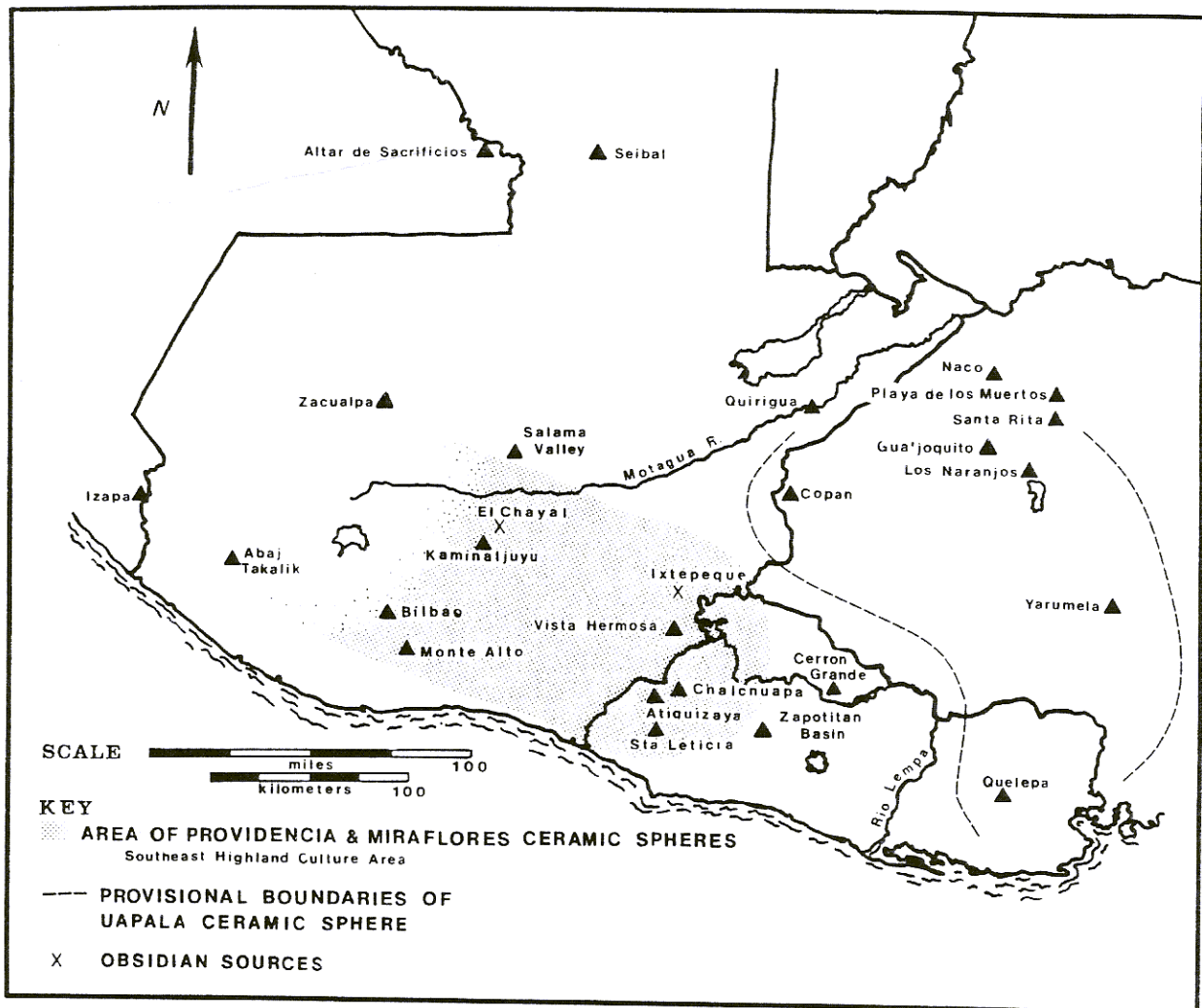
Figure 7.1. Southeast Highland Culture Area.

tive modes. Even the varied Usulután types of the Salvadoran highlands were shown to be identical to the Usulután-decorated red and cream wares of Kaminaljuyú and Monte Alto (Demarest and Sharer 1982). The Guatemalan Usulutáns appeared to form a quite similar, if somewhat reduced, version of the Salvadoran Usulután range. Similar red-on-buff domestic wares were found at all the southeastern highland sites (Demarest and Sharer 1981).

The similarity of the assemblages was especially striking given the extreme degree of decorative manipulation characteristic of these Late Preclassic ceramic groups: shared types are defined by quite distinctive and complex modal clusters. For example, the Santa Tecla Red Group, defined by its distinctive fine paste and deep-

red slip, was often found in western El Salvador with scalloped-flanged open bowls with double circumferential grooves above the flanges — sometimes with graphite paint in these grooves. The fine red wares at Kaminaljuyú included exactly this same combination of paste, slip, form and decorative modes (Demarest 1981:127-144). Similarly, the black-brown and Usulután types at sites in these regions shared not only slip appearance and vessel forms, but a large corpus of complex carved, incised and Usulután designs (Demarest and Sharer 1981, 1982; also cf. Sharer 1978a; Wetherington 1978c; Demarest 1981).

The strength and significance of modal and typological links among the southeastern highland types had been obscured by non-comparable classificatory meth-

ods and, thus, *methodologically-created* differences exist in the published monographs. These differences in published descriptions of the southeastern Guatemalan and western Salvadoran ceramics have clouded the distinct pattern of ceramic similarities in the southern periphery of Mesoamerica and have encouraged the selective identification and interpretation of long distance interregional connections. The correction of these distortive factors through direct comparisons of collections, reassessment of taxonomic logic, and reclassifications (Demarest and Sharer 1981) now has allowed a clear view of the actual ceramic unity of the Late Preclassic southeast highland assemblages.

The pattern of ceramic similarities in the southeast highland assemblages clearly justifies the application of the type-variety system concept of the ceramic sphere:

> The concept of ceramic sphere was defined to emphasize a high degree of content similarity between complexes. A ceramic sphere exists when two or more complexes share a majority of their most common types. Whereas, the horizon need imply no more than a few connections at the modal level, the sphere implies high content similarity at the typological level (Willey, Culbert and Adams 1967:306).

In more detailed statements, Demarest and Sharer (1981; Demarest 1981) have tentatively proposed and defined two sequential ceramic spheres and complexes having the following designations:

PROVIDENCIA CERAMIC SPHERE
(ca. 400 - 100 BC)

(Western El Salvador)	(Valley of Guatemala)
Chul Providencia Complex	Providencia Providencia Complex

MIRAFLORES CERAMIC SPHERE
(ca. 100 BC - AD 250)

(Western El Salvador)	(Valley of Guatemala)
Caynac Miraflores Complex Early Facet	Verbena Miraflores Complex
Caynac Miraflores Complex Late Facet	Arenal Miraflores Complex

These ceramic spheres are defined by the sharing of many red, orange, and black-brown monochromes, and the principal Usulután-decorated types by southeast highland sites during these two periods. The area sharing this set of types is shown in Figure 7.1. These shared monochromes and Usulután types constitute the bulk of the early Late Preclassic ("Providencia Sphere") ceramics of Kaminaljuyú, Chalchuapa, Santa Leticia, Atiquisaya, and Monte Alto. This Late Preclassic pattern may have extended as far northwest as Bilbao (Parsons 1967b; Demarest 1981:327-331). In the Terminal Preclassic "Miraflores Sphere," the inventory of types shared by these sites is augmented by a proposed Atecozol Group (alias Aguacate Orange:Atecozol Variety) and the distinctive coarse-incised "flower-pot" shaped vessels of the Mizata Ceramic Group (Arenal Coarse Incised in the Kaminaljuyú terminology). These connections in identical ceramic material are reinforced by similarities in the censer wares and red-on-buff, and red ollas. A greater number of shared decorative modes, design elements, and unusual vessel forms further unites the ceramic spheres.

At all sites in the spheres, shared modes cluster in the same complex patterns and appear at the same chronological position in the sequence. The only *consistent* regional differences relate to two features limited to the southeast Guatemalan sites: the use of purple paint and the characteristic Guatemalan fine white pastes. Yet even these uniquely Guatemalan features are applied to types whose vessel shapes, decorative treatments, and combinations of modes often correspond closely with the features of red-on-buff Salvadoran equivalents. Comparison to sites in adjacent regions (the Salama and Chixoy Valleys, the Zapotitan Basin, the Cerron Grande region, Copan, Quirigua, Quelepa, etc.) allows the plotting of approximate boundaries of the ceramic spheres, since sphere diagnostics rapidly disappear or become extremely minor types outside of the region plotted in Figure 7.1.

Clearly much remains to be done to test and refine this proposal of highland ceramic spheres. We need to extend comparative study to other sites as well as to more carefully reclassify and realign those assemblages already studied. Standardization of terminology for identical material is also in order. Once such reevaluations have been completed, these southeast highland Preclassic ceramic spheres should provide an explicit, standardized framework for intersite comparison and for interpretations of the Late Preclassic highland ceramic record — which is, in turn, a principal source of reconstructions of the rise of Mayan civilization (see for example, Willey and Gifford 1961; Sharer 1974; Lowe 1978; Dahlin 1979; Sheets 1979).

CULTURAL CORRELATES

A more difficult task is that of equating this regional ceramic pattern with specific interpretations of its meaning in cultural terms. Our ultimate goal in identifying patterns in the archaeological record is to derive and test hypotheses about ancient behavior, events, and evolutionary processes. However, the association of artifactual patterns with cultural phenomena is a tricky enterprise. Similarities in material culture are not easily correlated with other social, ethnic, or linguistic patterns. Thus, a rather thorough understanding of the archaeological record is necessary before we can explore the cultural and processual interpretation of patterning in the ancient remains. This more thorough understanding of the archaeological record requires 1) comparison of the pattern of intersite ceramic similarities to the intersite patterning apparent in other aspects of the archaeological record (e.g., figurines, sculpture, settlement patterns, lithics, etc.), and 2) the inductive and deductive exploration of the precise meaning of each of these overlapping patterns in the ancient remains.

Initial work on the first step, intersite comparison of non-ceramic evidence, indicates parallel sets of intersite similarities for the Late Preclassic sites of southeast Guatemala and western El Salvador (Demarest 1981:Chapter 7). Throughout the southeast highland region (Figure 7.1), strong similarities have been found in distinctive figurine types, ceramic artifacts, censer complexes, sculptural styles, lithic assemblages, and site layouts. This pattern has led to a second hypothesis that a single, unified "culture area" extended across the southeastern highlands during the Late Preclassic period (Demarest 1981; Demarest and Sharer 1981).

However, the identification of specific linguistic, economic and/or political correlates for this artifactually-defined "southeast highland culture area" leads to the second step: more detailed, long-term studies testing specific interpretations of the intersite similarities. Our attempts to refine and interpret the artifactual patterns have begun with neutron activation studies of obsidian and ceramics.

Initial results from neutron activation of obsidian indicate complex patterns of exchange within the southeast highlands. These networks demonstrate the interrelatedness of all sites within this culture area. For example, even a small isolated site such as Santa Leticia, in the highlands above the Chalchuapa zone, has obsidian from both the El Chayal and Ixtepeque sources (Demarest 1981:Chapter 3; Nievens n.d.). As in ceramics, sculptures, and ceramic artifacts, it appears that wider networks of trade and communication crosscut local systems to such a degree that *within* the southeast highland region, geographical and cultural distance were only very loosely correlated. This interconnectedness can also be seen in the similarity of the sculptural monuments and ceremonial complexes of such distant sites as Monte Alto and Santa Leticia. Further chemical analyses of larger samples of obsidian from numerous southeast highland sites should help to more specifically plot the communication networks that generated such surprising connections.

COMPOSITIONAL ANALYSES OF SOUTHEAST HIGHLAND CERAMICS

Chemical analysis of the ceramic pastes provides an important approach to the investigation of specific connections in the highlands. These analyses have the potential to reflect the cultural significance of shared types or groups within the ceramic sphere: for examples, does the hypothesized ceramic sphere pattern result from the overlapping ranges of typological units of pottery which was manufactured at specific centers and subsequently *traded* throughout the southeast highland area? Or, do the sphere diagnostics represent a shared body of *ideas* about ceramic manufacture and style? If, in a more complex situation, the patterns result from both of these factors, which types, pastes or slips are spread by long-distance trade, and which are locally produced according to a shared set of stylistic and technological guidelines?

With these general questions in mind, samples were submitted for instrumental neutron activation. Analysis of the Preclassic ceramics represented a departure from the ongoing paste characterizations of Maya pottery in that the latter have focused on production and exchange during the Classic period (AD 300 - 900). An immediate concern (and one that proved to be justified) was that data on previously analyzed pottery would have limited value for comparison to the highland samples — due to differences in clay and temper resources as well as technology. Given the limited analyses carried out, this aspect of the research on Miraflores and Providencia Sphere pottery is treated essentially as an independent investigation focused on the sites of Kaminaljuyú, Chalchuapa and Santa Leticia.

The Late Preclassic samples selected were primarily of the fine red (at Kaminaljuyú "Verbena Fine Red"; at Chalchuapa and Santa Leticia "Santa Tecla Red"), fine orange ("Olocuitla Orange" in El Salvador; at Kaminaljuyú "Verbena Red-orange"), and black-brown (Mi-

raflores Black-brown ware at Kaminaljuyú: Pinos Black-brown group in El Salvador). The analysis of these three major monochrome groups was expected to give a preliminary indication of possible paste differences between what are macroscopically identical ceramics found at all of the southeast highland sphere sites. This information would aid initial interpretations of the cultural significance of the shared ceramic pattern. The compositional studies could also help resolve specific problems. For example, two minor types in western El Salvador, Canchon Fine-incised (black) and Providencia Purple-on-fine-red, are relatively common in Kaminaljuyú. Chemical analyses of the pastes allowed testing of the hypothesis that these types were trade wares imported form the Kaminaljuyú region. More limited sampling was also undertaken for the central Salvadoran Cerron Grande Basin sites (see Figure 7.1) of El Cocal, Rio Grande, and El Perical, including the analysis of a few fine-tempered Late Preclassic sherds. In addition, samples of the coarse-tempered Atecozol (alias Aguacate) and related ceramic groups, were included to contribute toward a characterization of abundant pottery from Kaminaljuyú and Chalchuapa that was likely to have been locally produced.

Neutron irradiation and subsequent gamma-spectra analysis followed routine procedures. Only a summary of the analytical steps will be presented here as an extensive description has been published (Bishop, Harbottle and Sayre 1982). A cleaned edge of a sherd was drilled with a tungsten-carbide drill, removing approximately 200 mg of ceramic paste. About 40 mg of homogenized dried power was accurately weighed into ultra-high purity fused quartz for irradiation. Included with each activation were 6 U.S.G.S. standard rock samples, against which final elemental concentrations were determined. Samples and standards were irradiated for 16 hours at the Brookhaven High Flux Beam Reactor at fluxes of 1.8×10 neutrons/cm/sec. Following a 9 day cooling period, samples were counted using a Nuclear Data 2400 4096-channel pulse height analyzer linked to a Princeton Gammatech Ge-Li detector capable of 1.82 keV resolution on Cobalt-60. Reliable peak values were obtained for the elements, Rb, Cs, Ba, Sc, La, Ce, Eu, Lu, Hf, Th, Cr, Fe, Co, Sm, and Yb (a shorter irradiation and count for the short-lived Na and K is as yet incomplete).

STATISTICAL ANALYSIS

A total of 130 samples were submitted for initial grouping according to their similarity using the log-transformed oxide concentrations of 15 elements. Em-

ploying a matrix of mean-Euclidean distances and an unweighted pair-wise average linkage clustering method (Sneath and Sokal 1973:122-124, 228-234), a resulting dendrogram revealed tendencies for site-specific patterning. This patterning was most pronounced for samples from Santa Leticia. Kaminaljuyú specimens tended to form two groups, to some degree reflecting a separation of the brown-black from the red or orange ceramic types. Less cluster pattern, hence more compositional diversity, could be observed for samples from Chalchuapa and the Cerron Grande region. Some of the heterogeneity of the latter two regions doubtlessly can be related to the inclusion of several coarsely tempered samples.

Hierarchical cluster analysis of Euclidean distances seldom provides an adequate description of ceramic compositional relationships. One reason for potential distortion is its reliance on the absolute magnitude of the measurements. Thus a single anomalous elemental concentration will tend to exaggerate the dissimilarity of the specimens. A second reason for distortion is more subtle and relates to elemental intercorrelation. It has been noted for some time (Harbottle 1970) that pairs of elements can be highly correlated as a result of similar chemical properties; even correlations exceeding 0.90 are not uncommon (Brooks *et al.* 1974). The data therefore violate the Euclidean space requirement of variable independence (Blacklith and Reyment 1971:11).

The importance of considering variable correlation is not always recognized. For example, Farnsworth *et al.* (1977:458) state "under the assumption that the eighteen diagnostic elements can be treated as independent variables, the statistical analysis is straightforward." Given that they employ multiple elements of the Rare Earth series which are strongly correlated in nature, the basic assumption is false.

While such studies have overlooked the distortive effects of elemental correlation, other investigators have ignored its essential utility. For example, Wilson (1978) questions the value of determining more than one element out of a number that have been determined to be highly correlated. This position ignores the great value of distinctive patterns of elemental correlation for characterizing raw material procurement regions (Bishop, Rands and Holley 1982) The degree to which certain sets of elements tend to covary is reflective of each element's ionic charge and radius as well as their response to specific environmental conditions (Bishop 1980). As shown below, the mutual correlations can be used to identify more clearly the observed variations in the individual raw material procurement regions; the elemental correlation patterns may also be used during the

Table 7.1 Comparative Elemental Means and Standard Deviations

	Santa Leticia n = 33		Chalchuapa n = 27		Kaminaljuyú n = 36		Cerron Grande Region* n = 10	
Rb	82.0	(18.6)	75.0	(17.5)	84.3	(14.5)	60.7	(12.3)
Cs	5.61	(1.6)	3.19	(1.1)	3.47	(0.7)	4.24	(1.2)
Ba	748.0	(120.0)	1160.0	(202.0)	1960.0	(429.0)	2370.0	(446.0)
Sc	25.2	(3.36)	25.5	(5.72)	22.1	(3.17)	21.3	(3.52)
La	23.4	(3.4)	22.4	(5.29)	20.1	(3.73)	24.1	(3.27)
Ce	54.8	(11.7)	49.0	(14.3)	45.9	(7.64)	46.5	(7.88)
Eu	1.54	(.227)	1.57	(.327)	1.18	(.227)	1.52	(.198)
Lu	.618	(.098)	.620	(.117)	.450	(.109)	.549	(.064)
Hf	4.94	(.809)	4.85	(.930)	5.14	(1.02)	5.18	(.647)
Th	7.64	(1.32)	6.78	(1.60)	8.14	(1.43)	6.54	(1.05)
Cr	15.9	(6.19)	16.2	(8.48)	13.8	(5.55)	18.5	(7.08)
Fe	5.92%	(1.02)	5.92%	(1.57)	5.84%	(1.19)	4.54%	(.79)
Co	17.7	(11.0)	16.7	(7.88)	16.0	(8.90)	9.93	(3.39)
Sm	5.74	(.99)	5.24	(1.68)	4.28	(1.03)	5.85	(.58)
Yb	3.79	(.604)	3.59	(.696)	2.68	(.711)	3.30	(.280)

Elemental concentrations expressed as oxides in parts per million except Fe which is reported as percent.
* Cerron Grande Region specimens include only the Olocuitla, Santa Tecla and Pinos ceramic types.

calculations of probability contours for individual groups of specimens.

The major dendrogram clusters of Santa Leticia samples and the Black-brown Kaminaljuyú subdivision were used as trial groups. Using the Brookhaven program ADCORR (Sayre 1973a) an individual group variance-covariance matrix was calculated as well as the multidimension group centroid. The Mahalanobis distances from the centroid to all specimens were calculated as was the probability of the membership of a sample in that group given its distance from the centroid. These probabilities are based on Hotelling's T, a multivariate extension of Student's t, thereby adjusting for the sam-

pling uncertainly inherent when working with small numbers of samples. If the ratio of the number of samples to variables is not sufficiently high (approximately 3 to 1), probabilities tend to become inflated. Thus, after several trial passes through the data set, 10 elements (Cs, Ba, Sc, Th, Cr, Fe, La, Ce, Lu and Sm) were retained to meet the minimal statistical requirements. When the Black-brown focused Kaminaljuyú group was evaluated taking the elemental correlation pattern into account, it was found that most of the red and orange Kaminaljuyú types also had high probabilities of group membership. The indicated specimens were then merged into a single Kaminaljuyú group and probabilities were recalculated
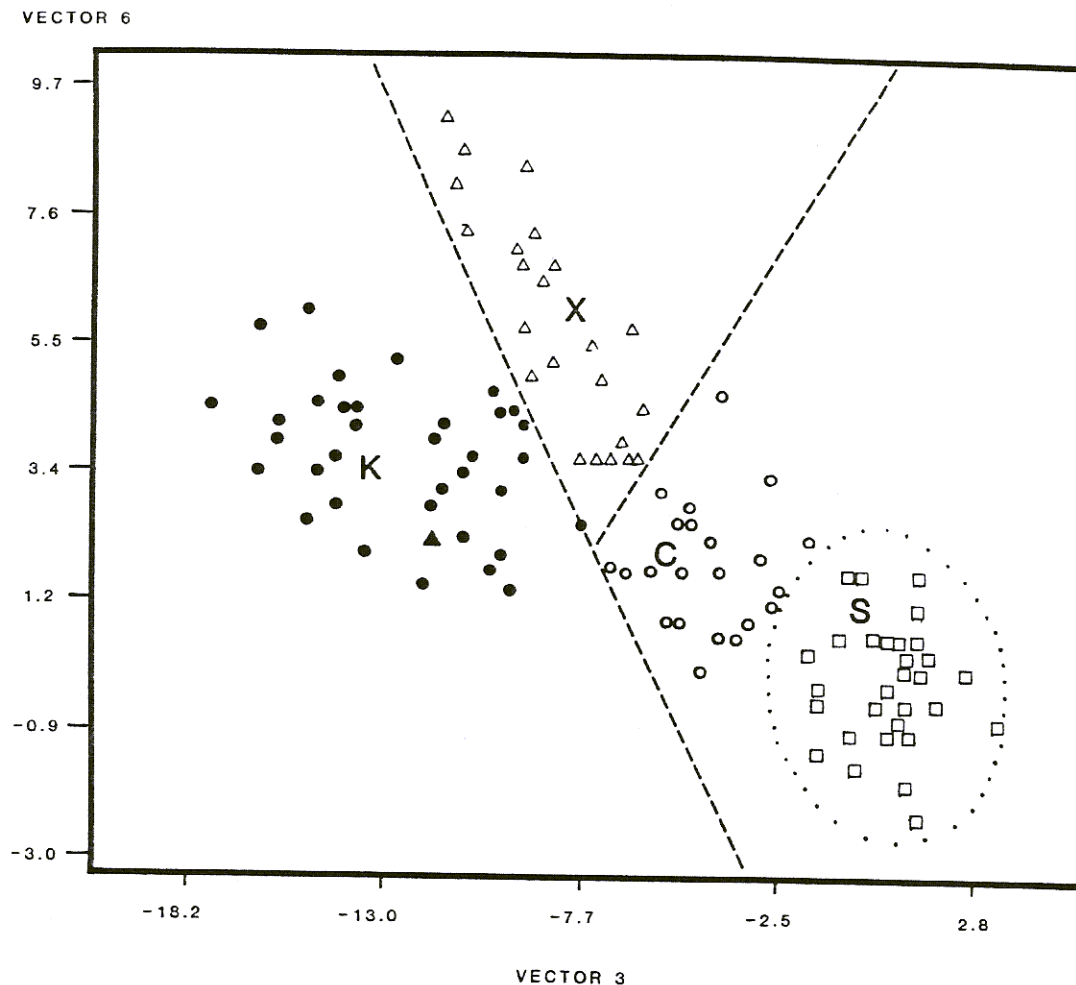
Figure 7.2. Plot of data points relative standardized characteristic vectors 3 and 6. S = samples of Santa Leticia provenience, C = samples of Chalchuapa provenience, K = samples of Kaminaljuyu provenience, X = samples from Cerron Grande region, * = Canchon Fine-incised sample found at Chalchuapa. A 95% probability ellipse encloses the Santa Leticia specimens. Dashed lines are added to draw attention to the separation of the groups.

— all samples now lying with a 95% confidence interval.

Specimens of the more tightly clustered Santa Leticia group were found to lie within a similarly constructed 95% confidence interval including the samples of Providencia Purple-on-fine-red. Chalchuapa likewise could be characterized by a single primary unit, excluding for the most part, more heavily tempered samples of the Atecozol (Aguacate) and Guazapa Ceramic groups. Although some tendency toward group formation was evident for the Cerron Grande samples, a majority of the samples were scattered throughout the dendrogram. This may have been caused in part by the inclusion of samples

from several sites in the region; thus, we fail to achieve a sufficient "center of gravity" in the compositional space of any individual site. A 10 sample trail group derived from the small number of members limits the extent of rigorous statistical testing and it is therefore considered less well defined than the other compositional groups.

The relationship between the various compositional units can now be illustrated. First, however, note the overall chemical similarity of all groups in terms of absolute concentrations of elements (Table 7.1). Indeed, it is only through utilization of both elemental concentrations *and* elemental correlations that the chem-

Table 7.2 Compositional Group Membership

Typological unit	Site or Region			
	Santa Leticia	Chalchuapa	Kaminaljuyú Region	Cerron Grande
Santa Tecla Red	9	8		3
Miraflores Fine Red			7	
Providencia Purple-on-Fine-Red	7		3 (1)	
Pinos Black-brown	8 (2)	3		5
Black-brown Coarse Incised			3 (1)	
Black-brown Fine-incised, Canchon, Verbena			10 (3)	
Olocuitla Orange	9	8		4
Aguacate-like Coarse Ware		1	5	
Atecozol			3 (1)	
Misc.				
Guazapa		3		
Tepeto		3 (2)		
Other		1	3 (3)	11

Table indicates the number of typed specimens from a site that constitute the compositional group for that site or region. Numbers in parentheses indicate those specimens from a site that occur outside of the 95% confidence interval defined for that site. Cerron Grande region numbers given to indicate the number and type of specimens analyzed.

istry of the compositional groups can be adequately distinguished.

The characteristic vectors (eigenvectors) of a variance-covariance matrix for a group provide a description of the group distribution from which all correlation has been removed. These vectors constitute a new set of coordinate axes that in no way alters the relative positions of the data points; only the origin of the vectors have been moved to the group centroid and vector directions have been oriented toward the maximum and minimum variances within the group. Each specimen may now be defined by coordinates obtained by the projection of the data points upon the characteristic vectors. In addition,

if each of the characteristic vector coordinates for a sample is divided by the square root of the characteristic variance (eigenvalue) a set of standardized coordinates will result which will define a standardized vector from the centroid to the data point; the length of the vector is now the Euclidean distance divided by the standard deviation of the group in that direction (Sayre 1973b).

Since the Santa Leticia samples formed the least dispersed cluster, it was selected as the reference group whose variance-covariance pattern could provide a basis from which the compositional dissimilarity between groups could be illustrated. All sample data points were projected onto the Santa Leticia standardized characteristic
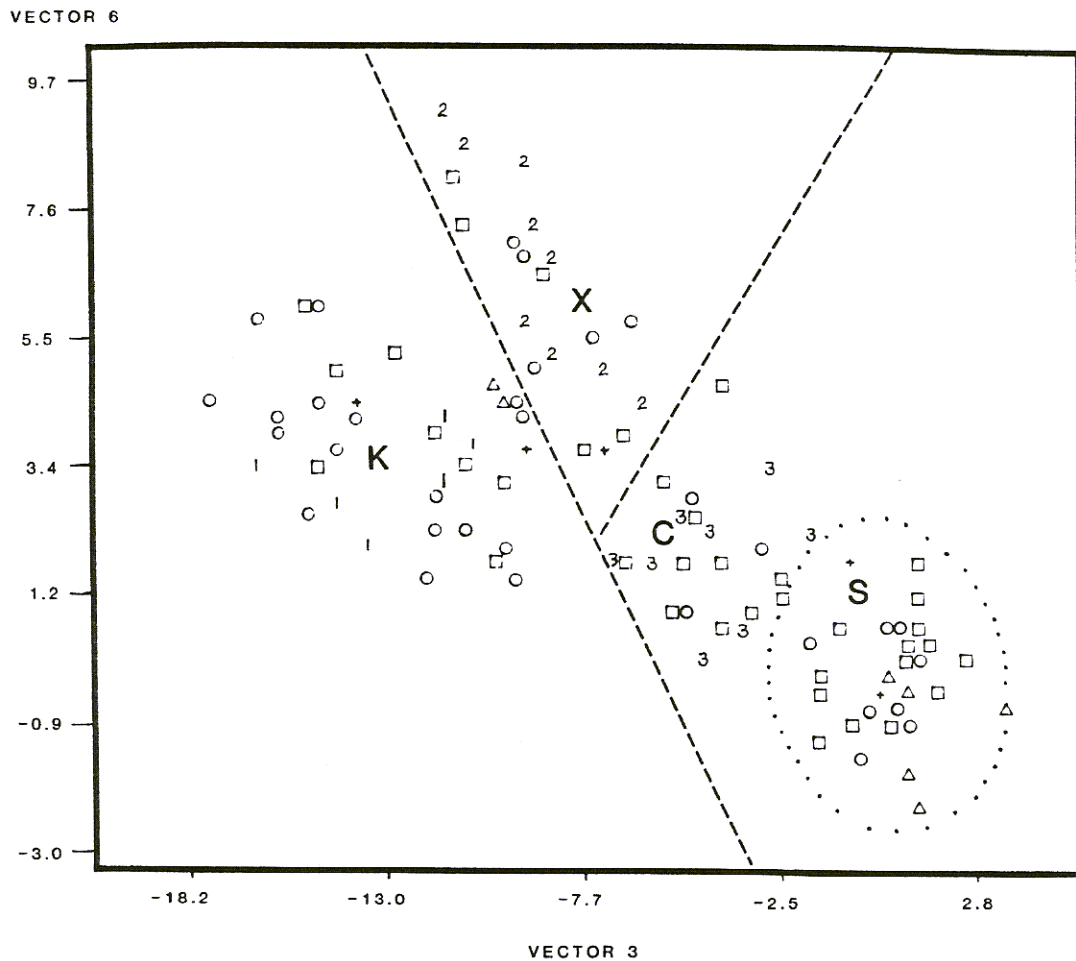
Figure 7.3. Plot of ceramic typological units. Coordinates and divisions are the same as for Figure 7.2. R = Santa Tecla Red, Miraflores Fine Red, Olocuitla Orange; P = Providencia Purple-on-Fine-Red; B = Pinos Black-brown, Canchon Fine-incised, Black-brown Coarse Incised, Black-brown Fine Incised; 1 = other Kaminaljuyu (K) samples; 2 = other Cerron Grande (X) samples; 3 = other Chalchuapa (C) samples; S = Santa Leticia samples.

vectors. Inspection of vector histograms revealed that a combination of Vectors 3 and 6 illustrated virtually total separation of all groups, including the Cerron Grande samples (Figure 7.2). Since pottery from Santa Leticia formed the reference group, a 95% probability ellipse has been drawn around the data points. Only the samples constituting the Santa Leticia, Chalchuapa, Kaminaljuyú groups and the specimens from Cerron Grande are shown in Figure 7.2. However, *all* samples are listed in Table 7.2, including the 13 divergent samples that were outside of the multivariate 95% confidence interval for any

group. The elemental loadings on the characteristic vectors showed that Vector 3, which largely separates Santa Leticia and Chalchuapa from Kaminaljuyú, is predominantly composed of Ba, Th, and Lu. The samples from the Cerron Grande region, occupying an intermediate position on Vector 3, tend to be higher on Vector 6. The latter is more heavily weighted on Ba, Sc, Th and Fe.

Our previous experience with volcanic aplastics in pottery has shown that Ba and Th values may be influenced by the abundance of volcanic material or its state of weathering (Bishop and Rands 1982). Nonethe-

less, the essential fineness of the textures of the present samples (with particles seldom exceeding a medium temper size range) and the strong site specificity of the resultant groups gives one more confidence that we are indeed seeing culturally significant distinctions in the data rather than merely temper related variation. It should be noted also that the plot of Vectors 3 and 6 illustrate inherent group distinction on only two of the 10 dimensions. In fact, it is variation on the additional dimensions that serves to emphasize that the Cerron Grande materials are not a single adequately characterized group.

Additional interpretation of the data is provided by Figure 7.3, where different symbols have been used to illustrate the distribution of red or orange types (R), and Brown or Black-brown (B). Attention is also called to the Providencia Purple-on-fine-red specimens (P).

This preliminary analysis of pottery from the proposed Miraflores and Providencia spheres strongly argues for site or region-specific production for the ceramic types under investigation. Even for all of the Cerron Grande materials, there is patterned variation away from the samples of Santa Leticia, Chalchuapa, and Kaminaljuyú. And, importantly for this paper, the Cerron Grande region Santa Tecla Red and Olocuitla Orange appear to be from an unknown source elsewhere in the highlands. Actual trade between regions is indicated only for a single Canchon Fine-incised sherd found at Chalchuapa, apparently made from a clay source at or near Kaminaljuyú (symbol * in Figure 7.2).

As was seen in Table 7.2, very few of the specimens from a given region (other than those which differed in the amount of temper) failed to have membership in a regionally specific group. At Santa Leticia, the Providencia Purple-on-fine-red specimens, which on the dendrogram formed a separate small cluster next to the main group of Santa Leticia specimens, were found to be similar to the others from the site when the pattern of elemental correlations was considered. The stronger intratype similarity may have been due to little more than minor differences in paste preparation or subtle shifts to the specific procurement location.

No obvious compositional differences are noted between the orange or red slipped pottery, nor, for that matter, from the brown slipped specimens. The previously noted cluster separation between the brown and orange or red slipped samples from Kaminaljuyú, did not hold up when considering elemental correlation. Given this set of data, regionally specific composition and inferred local production appear to transcend typological distinctions.[2]

IMPLICATIONS AND DIRECTIONS FOR FUTURE RESEARCH

The general implication of these initial compositional analyses is that the striking similarity of the Providencia and Miraflores sphere diagnostic types principally reflects shared ideas about ceramic style and technology rather than widespread exchange from specialized production centers. The identical major fine red and orange monochromes, black-brown types, and coarse-tempered wares all appear to be locally produced within each subregion of the southeast highlands (e.g. Valley of Guatemala, Chalchuapa basin). This interpretation parallels the patterns found in other artifactual categories; the region perfectly fits the "culture area" concept (cf. Demarest and Sharer 1981). Such a sharing of ideas in ceramics, sculpture and iconography, figurines, censer complexes, and so on, suggests that the artifactual patterns reflect a culturally-unified population in the Late Preclassic periods.

Future research must explore the sources and implications of this Late Preclassic cultural unity in the southeast highland area. Common ethnic and linguistic origins are one obvious possibility. However, regardless of common origins, similarities in culture (and its artifactual fossils) can only be maintained through continual communication and interaction between groups. Long-distance trade in a few specific types such as Canchon Fine-incised may have been one such channel of communication. Long-distance trade in obsidian (Nievens n.d.) also may have helped to maintain communication networks between sphere sites (Demarest and Sharer 1981; Nievens n.d.; cf. Michels 1979b). Of even greater interest is the possibility that networks of political and ideological interaction were critical in maintaining the kind of close similarity observed in the material culture of the region. Though more difficult to explore, it is such political and religious networks that may ultimately hold the key to understanding the development of complex societies in southeastern Mesoamerica (cf. Freidel 1979; Demarest 1981:347-387; Demarest and Sharer 1981).

ENDNOTES

has been provided by the Museum of Fine Arts and Mr. Landon T. Clay. Research at Brookhaven National Laboratory is conducted under contract with the U.S. Department of Energy and supported by its Office of Basic Energy Sciences.

2. A methodological note is in order. It may have appeared that the kind of group differentiation being conducted would have been an appropriate application of multiple discriminant analysis. This was in fact attempted, but an interesting problem arose. You will recall that a majority of the Cerron Grande specimens were not sufficiently homogeneous to be placed into a single group. When just the Santa Leticia, Chalchuapa, and Kaminaljuyú groups were considered, a subset of the available elements formed two discriminant axes which perfectly differentiated the groups. However, use of the

classification option within the SPSS or BMDP discriminant programs revealed that many of the samples from the Cerron Grande region had very high probabilities of group containment within the Kaminaljuyú unit. The reason for this was simple. Elements that were important to reflect the divergence of the Cerron Grande samples were not important for the discrimination of the three basic groups. Even using a direct discriminant solution, where all variables are entered into the discriminant equations, the elements crucial to reveal the uniqueness of the Cerron Grande pottery were weighted so low as to cause little difference in the calculated probabilities.

Discriminant analysis is a powerful and useful statistical technique. However, the indiscriminant use of discriminant analysis in this case would have given a quite different view of Kaminaljuyú-Cerron Grande ceramic relationship than actually exists.