Settlement and Cultural Development at Chalcatzingo

Research reveals a change from farming village to major center with long-distance trade ties.

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Some of the earliest developments of social stratification and complex religious practices in Mesoamerica can be traced to the Olmec culture that existed on Mexico's southern Gulf Coast from about 1150 to 550 B.C. Possibly due to a belief that complex cultures cannot arise in tropical environments, some scholars have attributed Olmec origins to other regions and other cultures; however, the pre-Olmec stratigraphic sequence recently uncovered at San Lorenzo (*1*) suggests that Olmec cultural development is basically indigenous to the Gulf Coast region. Other new data indicate that we must not credit Olmec culture alone for developments in social and religious complexity early in the Formative period. Parallel developments may have taken place at least as early in Oaxaca, Chiapas, and possibly even western Mexico (*2*). By 1150 B.C., however, stylistic motifs that many scholars identify as Olmec were used on ceramics in widespread areas of Mesoamerica, and by 900 B.C. both portable and monumental Olmec-style stone art could be found in areas far distant from the Olmec heartland on the Gulf Coast. The actual nature of this cultural diffusion and the manner of its acceptance in other regions is still unclear and raises a number of questions. For instance, was cultural development in these other regions stimulated or influenced by Olmec culture?

In this article we discuss research conducted at a major Formative period archeological site in highland central Mexico—Chalcatzingo (Fig. 1) (*3*). While investigating cultural development in the highlands was one goal, the research project also studied external influences on this region, particularly Olmec influences. Chalcatzingo, which is about 120 kilometers southeast of Mexico City, is the only archeological site in Mexico's central plateau known to have Olmec-style bas-relief carvings. Our research, begun in 1972, was carried out as a cooperative project of the University of Illinois and Mexico's Instituto Nacional de Antropologia e Historia. The investigations included determination of the archeological chronology at the site, the basic culture pattern, site size, housing, ceremonialism (as expressed in architecture and ceramics), and patterns of social stratification, subsistence, and craft production. Ecological research included intensive palynological studies of all major excavation units and analyses of land-use practices and strategies, water control systems, vegetation zones, and modern crops and yields. A further step was to consider Chalcatzingo in terms of its immediate sphere of social and economic interaction. For reasons of geographical constraints and ancient and modern settlements, we defined this area of local interaction as the Amatzinac-Tenango River valley. Chalcatzingo is near the center of this valley (Fig. 2). An intensive surface reconnaissance covering more than 500 square kilometers of the area was undertaken and all pre-Hispanic sites were mapped and sampled. Later, as the settlement patterns became clearer and as hierarchical patterning emerged from the data on Formative period sites, several minor sites within the survey area were excavated for comparative data.

At the time our research was begun, speculation regarding Chalcatzingo was already highly developed. No Formative period ceremonial architecture was known to exist at the site, which suggested to some investigators that it had functioned as a religious shrine before the development of the Olmec sites with architecture on the Gulf Coast (*4*). Other archeologists saw Chalcatzingo as an Olmec colony, an Olmec outpost, or a trade control center linking the highlands with the Gulf Coast (*5–7*). Among other things, our research served to test these hypotheses. We present a brief overview of the research results, together with tentative conclusions that we have reached on the basis of our analyses to date.

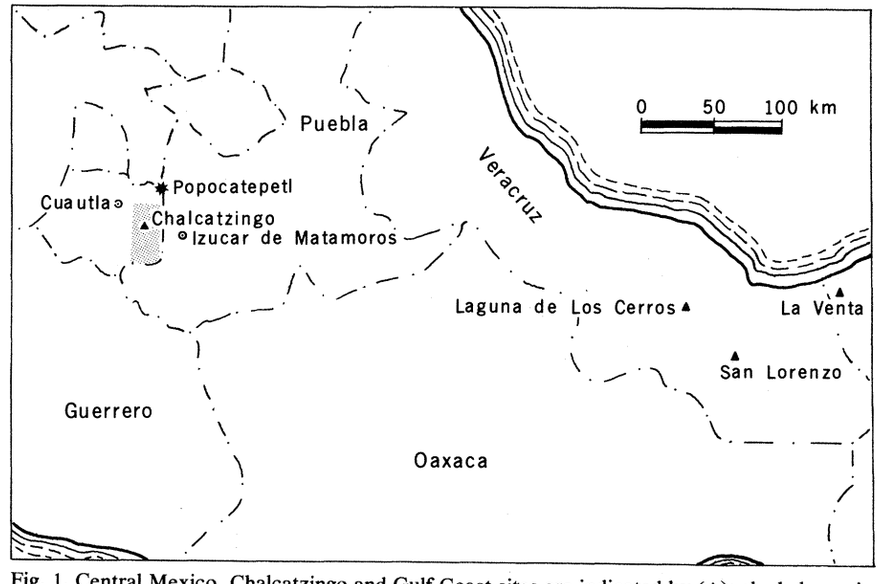

Fig. 1. Central Mexico. Chalcatzingo and Gulf Coast sites are indicated by (▲); shaded area is the project's survey area.

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Geography

The Amatzinac-Tenango River flows along the alluvial plains extending southward from the volcano Popocatepetl (Fig. 1). These plains characterize the eastern quarter of the state of Morelos. The rivers and barrancas within the valley of the Amatzinac-Tenango River are deeply incised, thereby affording only a small amount of good valley-bottom farmland. Regions west and east of this valley system (the Rio Cuautla and Izucar de Matamoros valleys) have humid valley-bottom lands with finer grained soils and are now considered to be prime agricultural lands. Numerous archeological sites in those valleys attest to similar agricultural importance in pre-Hispanic times. The soils of the Amatzinac-Tenango valley are coarser and do not retain moisture for any appreciable time. In addition, there are few areas of accessible surface water and a scarcity of areas with high natural humidity within the valley. It is only the north central portion of the valley near Chalcatzingo that has a significant expanse of good agricultural soils. There, rainfall and irrigation agriculture are now practiced. The only significant change in the pattern of land use occurred during the hacienda period when sugar cane was grown throughout the valley, even in marginal areas, with the use of intensive irrigation. The revolution of 1910 ended the domination of the agricultural lands of Morelos by haciendas, and agricultural land use in the Amatzinac-Tenango valley shrank nearly to pre-Hispanic limits.

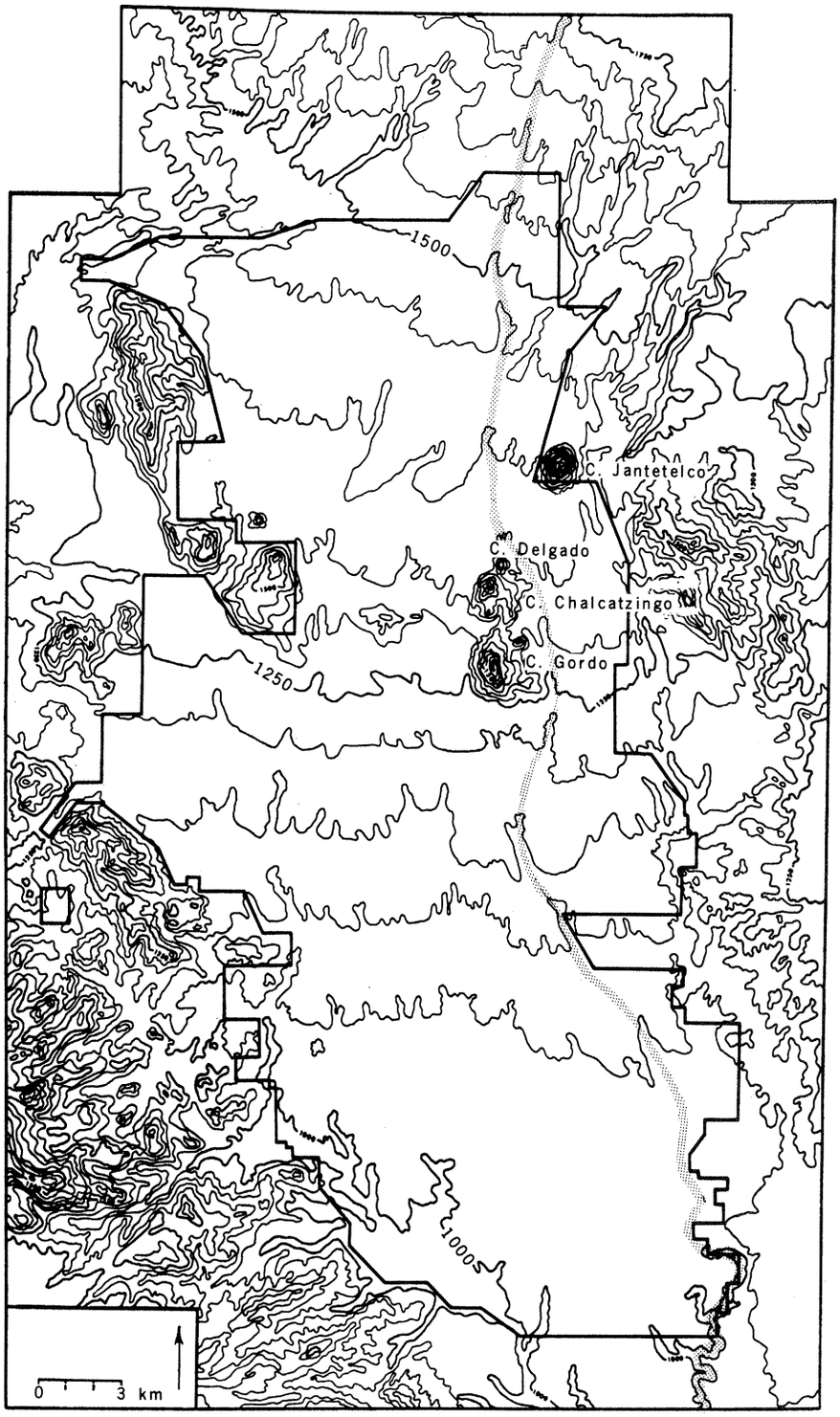

Fig. 2. The Amatzinac-Tenango valley survey area. Shaded area is the Amatzinac-Tenango River.

Within the valley, altitudes range from 1600 meters in the north to 1000 meters in the south. The southern valley lies in the climatic zone defined as *tierra caliente*, or hot country. Just south of Chalcatzingo, at about the 1250-meter contour, a major transition into the *tierra templada*, or temperate zone, occurs. The vegetation shows a change from the typical semitropical Rio Balsas thorn forest species of the southern valley to the more temperate woodland species of the northern valley. Chalcatzingo lies almost at the boundary of these zones and has access to plant and animal resources of both areas.

Excavations

The archeological zone at Chalcatzingo lies on the terraced western hillside of two large granodiorite peaks whose bare cliff faces tower 300 meters above the site. At the foot of the hillside is a small permanent spring and stream. The peaks, Cerro Delgado and Cerro Chalcatzingo, are the central group of three such imposing mountains that rise from the flat valley floor and are visible from many areas of Morelos (Fig. 2). The majority of the Formative period ceremonial and occupation areas occurs on the western hillside, but farming and habitation extended onto the eastern hillside as well. This eastern area, now called Tetla, contains Classic and Postclassic architectural remains, including pyramid mounds and a ball court.

The Chalcatzingo research has defined three major cultural phases covering more than a millennium of occupation during the Early and Middle Formative

periods. The placement of these phases within an absolute time frame is aided by almost 50 radiocarbon dates. Our laboratory work is still refining our phasing and subphasing. Accordingly, we consider the following divisions as tentative and have given them only letter designations rather than names: phase A (Early Formative, 1600 to 1000 B.C.); phase B (early Middle Formative, 1000 to 750 B.C.); and phase C (late Middle Formative, 750 to 550 B.C.) (Fig. 3). A minor Late Formative occupation as well as Classic and Postclassic occupations at the site are not discussed in this article.

Radiocarbon dates place the earliest occupation at Chalcatzingo at around 1600 B.C. The settlement, a small farming hamlet, was situated on the natural, unmodified hillside. The earliest phase A ceramics are characterized by hemispherical bowls, bowls with incurved rims, and ollas with flaring necks. Decoration is limited to simple red painted designs. These early ceramics are similar to those of the Nevada phase from the Valley of Mexico and the Tierras Largas phase from Oaxaca (*2*, *8*). Our sample of the early material is limited and comes from stratigraphic levels 5 meters deep in only one area of the site.

The vast majority of our phase A ceramics date to about 1150 to 1000 B.C., although the site may have been continuously inhabited from 1600 B.C. onward. This late Early Formative material belongs to what Grove (*9*) has described as the Tlatilco culture in other areas of Morelos. These ceramics are characterized by red-on-brown sherds, abundance of brown plainwares, occasional sherds with Olmec-like motifs, and fragments of D.2, K, and hollow D-K figurines. Although these deposits generally are highly disturbed, their extent indicates a settlement area of slightly less than 2 hectares.

There is some evidence to suggest that minor ceremonial or public architecture may have been a feature of many Tlatilco culture sites (*10*); several phase A structures covered by later architectural features on the site remain to be excavated. Although Chalcatzingo was the largest phase A site in the Amatzinac-Tenango valley (Fig. 4), there are few data to suggest that it was anything more than a small farming village adjacent to a permanent water supply, whose inhabitants exploited a small area of good agricultural land. The low quantity of decorated ceramics, including red-on-brown bottles or sherds with iconography of the Olmec type, suggests that Chalcatzingo was marginal to the mainstream of Tlatilco culture and had no significant interaction with the Gulf Coast. Ceramic similarities shared with the Izucar de Matamoros region do suggest significant interaction with that area.

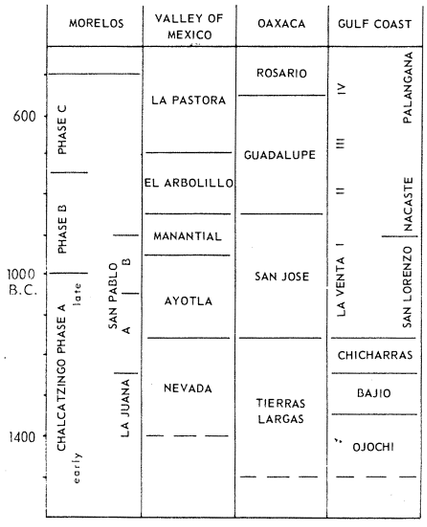

Fig. 3. Chronological sequence for central Mexico, Oaxaca, and the Gulf Coast.

At about 1000 B.C., a series of major changes began at Chalcatzingo. These seem to reflect local, regional, and almost pan-Mesoamerican reorganization of the sociopolitical and economic spheres. Palynological data show a period of intensive environmental modification at Chalcatzingo, with removal of trees and disturbance of the landscape. It is likely that these are the first attempts to modify the local environment to better suit cultural needs. Chalcatzingo grew in surface area, population, and regional importance at this time. Monumental public architecture was constructed and other public works carried out. The entire hillside was terraced to provide increased space for habitation and agricultural needs (Fig. 5). This terracing was planned and executed in such a way that rainwater runoff from the hills and site was channeled across the site, slowed by diversion dams, and redirected to prevent the destruction of the prime agricultural lands at the foot of the site. The diversion dams, one of which is 35 meters long and 7 meters high, are still effective in preventing erosion and the system is maintained today by the farmers who plant the terraces.

The occupation and ceremonial area at Chalcatzingo during the early Middle Formative (phase B) covered a minimum area of 20 hectares. The major feature on the site at that time may have been the long earthen platform mound built along the northern (downhill) edge of the site's uppermost major terrace (the "Plaza Central") (Fig. 5). The Plaza Central terrace also lies adjacent to the major group of bas-relief carvings. The platform mound is 70 meters long, 40 meters wide, and possibly had a height of almost 4 meters above the original terrace surface. In addition to the platform mound, our excavations uncovered phase B structures in the Plaza Central, at least one of which can be classified as ceremonial architecture. The platform mound and the phase B structures indicate a ceremonial function for this terrace during the early Middle Formative.

Phase B ceramics are similar to ceramics of the Manantial phase in the Valley of Mexico (*8*). Whiteware bowls with the double line–break rim motif and pseudo-grater bottom interiors are characteristic. Bowl bases are primarily flat although occasionally slightly rounded. An important ware is the so-called lacquer ware, or *laca*, which is usually orange although differences in slips and firing technique also created brown, red, and yellow *laca* wares. The C.2, C.3, and C.5 figurines are typical of this phase. Computerized analysis (*11*) indicates that C.2 figurines occur primarily in the nonceremonial or nonelite site areas, while the reverse is true for C.3 and C.5 types.

Our greatest quantity of archeological data relates to the late Middle Formative phase C occupation. At that time, Chalcatzingo reached its peak of development in terms of social and political complexity and overall size. The phase C site covered a minimum area of 25 hectares, not including the settlement areas on the north and east sides of the Cerro Delgado and the small scattered occupation areas near the spring. Two developments point to increased ceremonial activity. Stone-faced platform structures, about 18 meters long and up to 2 meters high and 5 meters wide, were constructed on three separate terraces north of the Plaza Central (Fig. 5). They increase the area we can define as having had ceremonial functions from 1 to nearly 6 hectares. A broken stone stela was found in situ in front of one of these platform structures. The Plaza Central's platform mound continued in use and a series of structures resembling houses was built along the terrace's south side. Artifact assemblages from these structures suggest that, with one exception, they served ritual, ceremonial, and, possibly, workshop purposes.

The single exception is a structure, located directly across the Plaza Central from the platform mound, which we believe was the single elite or high status

residence at Chalcatzingo at around 700 to 600 B.C. Its location and uniqueness suggest that the persons who resided in this structure held the prime authority at the site. It differs from other phase C dwellings in its slightly larger size, its location, and in the richer offerings associated with its subfloor burials. Seven burials occurred in crypts (cists) constructed of stone slabs. Several of these crypt burials included jade ornaments, and one included a serpentine Olmec figurine.

On each major terrace except for those with ceremonial constructions, there is one phase C house unit. These houses average nearly 8 by 10 meters in size. Their construction is unusual; the walls along the length of the house were made of rectangular adobe bricks, while the walls along the width of the house appear to have been constructed from *chamiza* (Compositae) stalks covered with mud plaster. Our limited data on phase B houses suggests that they were also of this approximate size but with *chamiza* and mud plaster walls only. The large floor area of all houses indicates that they may have served extended family groups. Evidence suggests that workshop activities in obsidian, hematite (grinding for pigment), and, occasionally, serpentine were carried out in some of the houses. With the exception of the Plaza Central elite house structure, subfloor burials in phase C houses occur with only ceramic vessel offerings. Burials in crypts or associated with jade are absent in the houses.

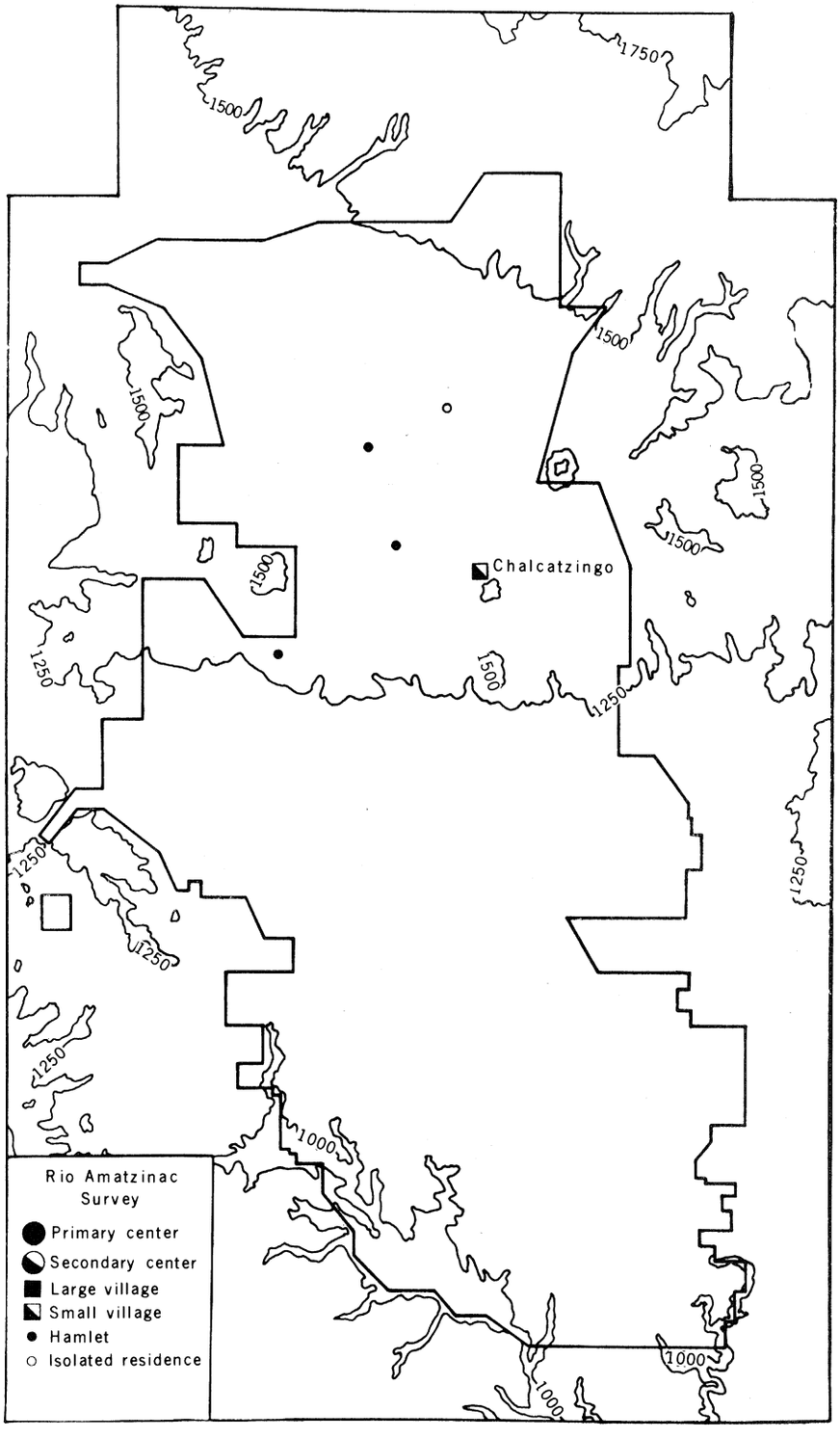

Fig. 4. Settlements of the Early Formative period.

Phase C ceramics are different than previous ceramics in form and design motifs, and new ceramic types appear among the artifacts. Whitewares are diminished in both quantity and quality. Bowls with pseudo-grater bottom interiors are no longer found and bowl bases are rounder and deeper. Bowl walls are often widely flaring. *Laca* wares also decline sharply in quantity, while a new orange slipped ware appears. This ware, which we call Peralta Orange, is characterized by composite silhouette bowls and narrow-necked ollas generally decorated with linear punctation. Our data indicate that Peralta Orange wares may be restricted in distribution to Amatzinac-Tenango valley sites. Polychrome wares characterized by red and black designs on a white background (occasionally red, black, brown, and orange on white) also occur during phase C. These polychromes appear in greatest abundance at Chalcatzingo and within the valley; small quantities have been found at one other Morelos site but they are virtually unknown in sites of the Valley of Mexico (*12*).

For either B or C phases it is difficult to associate the ceramics and figurines at Chalcatzingo to any significant degree with types known from the Gulf Coast. Phase C ceramics are most closely similar to those of the El Arbolillo and La Pastora subphases of the Valley of Mexico. During phase C the Chalcatzingo figurines and ceramics took on an individuality of their own and no longer completely mirrored general highland styles. In addition, the distribution of specific figurines and ceramics on the site supports other archeological data indicating increased ceremonial activity during phase C.

If one figurine type can be stated to be relatively restricted to Chalcatzingo and the surrounding valley, it is the C.8 type.

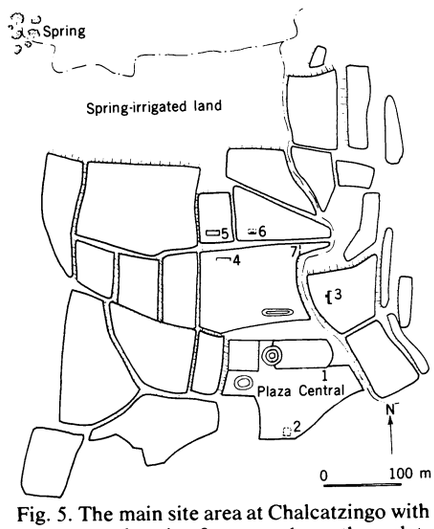

Fig. 5. The main site area at Chalcatzingo with terraces and major features: 1, earthen platform mount; 2, elite residence; 3, stone-faced platform mound with stela in situ; 4 and 5, stone-faced platform mound; 6, altar; and 7, diversion dam.

This type (Fig. 6) is far more naturalistic than the majority of highland Middle Formative figurines and is often finished with a highly burnished orange slip, a treatment lacking in other figurines. These C.8 figurines are rarely found at Valley of Mexico sites but appear in quantity at Chalcatzingo and are a phase C marker. They also occur in the Izucar de Matamoros valley to the east (*13*). Their presence in both areas may serve to delimit a major sphere of interaction during the late Middle Formative (similar interaction was noted for phase A as well).

In 1973, excavations on the second terrace north of the Plaza Central (Fig. 5) disclosed a large stone altar, identical in form to those from Gulf Coast Olmec sites. The altar, some 4 meters long, 2 meters wide, and 1 meter high, is the only altar of Olmec style ever found outside of the Gulf Coast. It differs from Gulf Coast altars in only one major respect. While each Gulf Coast altar is carved from a monolithic stone block weighing many tons, the Chalcatzingo altar is constructed of more than 18 large stone blocks, despite the fact that suitable monolithic boulders occur within 100 meters of the altar's location. This suggests that Chalcatzingo's interactions with the Gulf Coast were such that the construction of an altar was appropriate, but loose enough that Gulf Coast artistic conventions were not strictly adhered to.

The altar sits on the south side of a low walled patio area of about 50 square meters. More than 20 burials were uncovered in this patio area, including three within the altar's earthen core and a child burial at the altar's east front corner. The altar is built atop a thin layer of phase C deposits, and the ceramics and radiocarbon dates also place the patio and altar burials as phase C. Because it has been reassembled incorrectly, we know the altar was dismantled and reassembled during its history. Therefore, its original construction could have taken place during phase B. Such an explanation could account for the apparent time gap between Gulf Coast examples and the Chalcatzingo altar (*14*).

The problem of chronological placement of the altar illustrates the problem of a time frame for Chalcatzingo's bas-relief carvings as well, for in most instances they occur in areas of high erosion and our excavations were unable to recover datable materials associated with the reliefs. We believe that, stylistically, the reliefs show strongest similarities to the carved stone art of La Venta and, in particular, La Venta's stelae. This suggests a phase B and C placement. At least a dozen new reliefs and monuments, including stone stelae, were uncovered during our excavations. Several show such striking similarities to the art of La Venta that the person (or persons) responsible for the execution of these carvings obviously was intimately familiar with La Venta's art. An example of this is the relief carving, found during our 1972 field season, which we call the *volador* or "flying Olmec" relief (Fig. 7). The person depicted flies through the air carrying a torch in his right hand. Identical flying figures bearing torches appear on Gulf Coast jades (*6*, *15*), and the Chalcatzingo figure's pose and dress almost mirror those of figures carved on the upper portion of La Venta's Stela 3 [figure 68 in (*6*)]. There is no tradition of rock carving in the highlands prior to its appearance at Chalcatzingo, which means that it was imported as an already developed art form. However, while much of the iconography can be linked directly to Gulf Coast art, there are other characteristics of the bas-relief art that seem unique to Chalcatzingo and possibly represent highland religious concepts or a syncretism of highland and Gulf Coast beliefs.

Site Alignment

Although site alignments are frequently given by investigators, the actual significance of these during the Formative period is still a matter for debate. While usually attributed to astronomical orientations, alignments do vary through time, even at the same site. The use of a lodestone compass was recently suggested as having been used for Olmec site alignment and Chalcatzingo's inclusion within the Gulf Coast site alignment pattern was inferred (*16*). Our data disagree. The major alignment at La Venta and Laguna de los Cerros, both apparently contemporaneous with Middle Formative Chalcatzingo, is 8° west of true north. Although it is incorrectly drawn on some maps (*17*), the Stirling group at La Venta has an orientation of 7° east of true north. Unfortunately, the temporal position of the Stirling group is unclear. The earthen platform mound on the Plaza Central at Chalcatzingo has an alignment of 1° to 2° east of true north. Phase C structures and monuments align from 2° to 5° east of true north. Archeomagnetic samples from phase C, radiocarbon dated to about 600 B.C., indicate that, at that time, magnetic north was 5.6° ± 4° east of true north (*18*). The difference in magnetic declination between central Mexico and the Gulf Coast is only about 2°. Thus, Chalcatzingo does not mirror the Gulf Coast alignment pattern or confirm the use of a lodestone compass.

Fig. 6. Figurine heads of the C.8 type. Each head is 4 to 5 centimeters tall.

Exploitation of Raw Materials

A number of raw materials apparently used in craft production and, in one case, possibly, food production were found during our excavations. These include iron ore fragments (mainly hematite), jadeite and other green stone, obsidian, lime, and kaolin. Some iron ore pieces with grinding marks were apparently used in making hematite pigment. Several others were highly polished as mirrors, and one concave hematite mirror was found with a phase C high status burial. We believe that much of the iron ore used at Chalcatzingo (at least for grinding hematite pigment) is local and was derived from sources under Chalcatzingo's control (*19*). Iron sources along the western edge of the Amatzinac-Tenango valley, exploited by the Spanish soon after the conquest, are currently under our investigation.

Similar investigations are being conducted on kaolin clay. Our data suggest

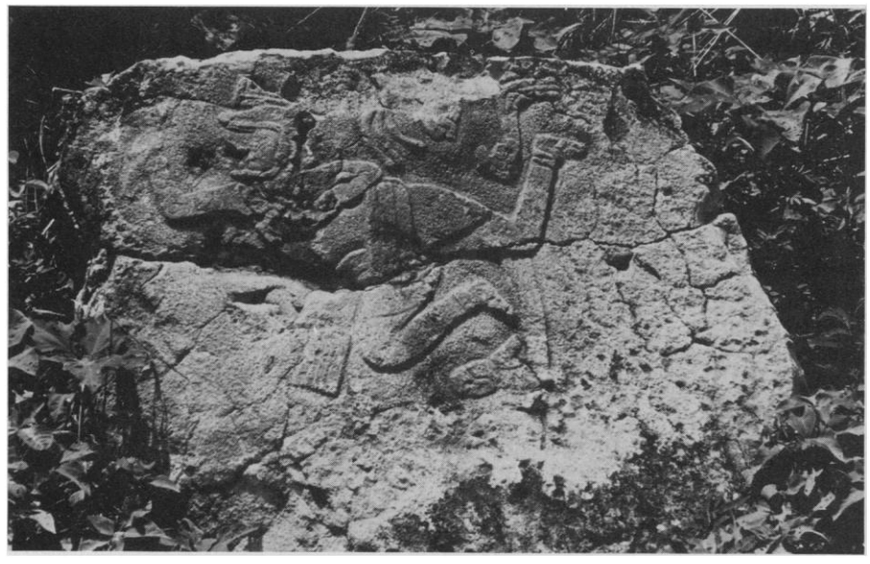

Fig. 7. The "flying Olmec" bas-relief carving. The rock face is 1.35 meters wide.

that Chalcatzingo and many of the smaller Middle Formative centers in the valley manufactured their own ceramics from local clays. X-ray diffraction tests conducted by us (*20*) show that the white slip used in the manufacture of whitewares is kaolin, a clay that has a restricted distribution and is relatively rare. Whitewares are important and abundant throughout much of northern Mesoamerica during the Middle Formative, and it is our impression (not yet confirmed by exhaustive tests) that kaolin is the white slip on many, if not most, Middle Formative whitewares. This would mean that whitewares could not have been manufactured unless kaolin was a significant item in the trade and exchange networks. It is relevant that Chalcatzingo is located adjacent to several kaolin sources that are the only sources in Morelos and some of the few in the entire central highlands (*21*).

Although lime plaster was used on public architecture in Early Formative Oaxaca (*2*), the use of lime in central Mexico is generally regarded as beginning with the Classic period. However, excavations of a phase C structure at Chalcatzingo disclosed a large deposit of lime overlain by several phase C burials. The nearest limestone sources occur about 4 kilometers to the west. The lime does not appear to have been used as plaster or paint and therefore may have been used in preparing corn for *masa*. A few *comal*- (griddle) like plates with roughened bases, of the type normally associated with tortilla making, occur as early as phase B; however, this is certainly not definitive evidence of tortillas in the Middle Formative period.

No source analyses have been carried out on jadeite by any project, partially because of the reluctance of museums and others to permit such analyses. Therefore, little can be said as yet about jadeite exchange networks in Mesoamerica. Preliminary studies (*22*) suggest that some jadeite beads found with high status burials at Chalcatzingo come from sources that also supplied La Venta, and that serpentine artifacts were manufactured on the site.

Regional Settlement

Only five Early Formative sites were revealed by our intensive surface reconnaissance of the valley (Fig. 4). This quantity stands in sharp contrast to settlement density in central Morelos and the Izucar de Matamoros valley where abundant surface water and high natural humidity combine to create excellent locations for agricultural villages. Early Formative sites there appear to be spaced at almost 1-kilometer intervals along the river margins. Such areas of accessible water and high natural humidity are rare in the Amatzinac-Tenango valley and were selected for Early Formative settlements. Within the valley, the phase A population density was apparently quite low, probably not in excess of 500 people. Chalcatzingo, the largest settlement, was small in relation to sites in central Morelos.

As mentioned above, Chalcatzingo was apparently marginal, both geographically and culturally, to the Tlatilco culture sphere. Our reconstruction on the basis of archeological data is that the Tlatilco culture sphere was composed of a series of loosely structured groupings of politically autonomous agricultural villages. The network of villages was bound together in a simple hierarchial arrangement, with ties relating primarily to the exchange and redistribution of both utilitarian and exotic raw materials. As the only village-size settlement in the valley during the Early Formative, Chalcatzingo must have been the focus for redistribution and exchange in that area. Interregional exchange must have taken place with villages in central Morelos and, to a somewhat larger degree, with the Izucar de Matamoros valley. While the valley iron sources may have been exploited on a minor scale during the Early Formative period, the same cannot be said for the kaolin sources. Kaolin sherds, typical of many Early Formative assemblages, are extremely rare at Chalcatzingo.

A completely different picture emerges for regional population organization during the Middle Formative. Fifty-seven sites were located by our reconnaissance (Fig. 8), a tenfold increase over the number found for the Early Formative period (*23*). The actual population increase must have been much greater. The initial growth of population in the valley during the Middle Formative may be linked to land and population pressures in the rich agricultural valleys of central Morelos and western Puebla, which caused movements of people into more agriculturally marginal areas including the Amatzinac-Tenango valley. The valley is marginal in terms of agriculture that is dependent on rainfall but has a high yield potential when irrigated. The hydraulic constructions at Chalcatzingo, mentioned above, attest to the existence of the necessary technology to carry out irrigation projects. Some settlement locations suggest that small-scale irrigation systems might have been used during the Middle Formative period in the valley, including at Chalcatzingo.

While the initial stages of population increase in the Middle Formative may have involved land and population pressures in nearby areas, there is little doubt that eventually Chalcatzingo itself provided attractions. The settlement data illustrate that villages and hamlets nucleated around Chalcatzingo during the Middle Formative (Fig. 8); possibly 50 percent of the valley's population was congregated within a 6-kilometer radius of the site. We believe that this nucleation occurred for socioeconomic reasons. Chalcatzingo was certainly a craft production and commodity redistribution center for the valley (and probably for a much larger region as well). The nucleation of villages around this primary center, a phenomenon not seen in the

data from other areas of the highlands of the same period, suggests a change from a redistributive economy to an incipient solar market economy of the type characteristic of the highlands in later culture periods.

Not only did Chalcatzingo dominate its regional economy, but its size, its basrelief carvings, and its place within the regional settlement pattern suggest that it was probably the major Middle Formative site in the central highlands. It may also be the earliest formal ceremonial center with monumental architecture in this area.

Conclusions

There seems little reason to believe that an important center such as Chalcatzingo would arise in a marginal agricultural area without other, nonagricultural stimuli. Early Formative Chalcatzingo may have been small and marginal, but its early role in the redistribution of resources within the valley and its access to valuable resources such as iron ore and kaolin proved to be significant during the Middle Formative. With increasing population throughout central Mexico, Chalcatzingo's role, in both the exploitation of local resources and the redistribution of these and imported commodities, grew. With commodities such as kaolin and hematite in increasing local and regional demand, Chalcatzingo emerged as an important hub of Middle Formative commerce.

There is little actual evidence of direct trade between the Gulf Coast and the highlands in the Early Formative. Early Formative exchange may have been indirect, conducted through a series of intermediaries. This pattern seems to have undergone change by 900 B.C. We believe that among the changes which occurred at Gulf Coast sites was the formalization of the economic networks through which the Gulf Coast received utilitarian and status commodities. This appears to have involved the establishment of more direct and secure ties with key resource areas, including the highlands. This was probably brought about as stratified society, with the concomitant need for status goods, developed throughout northern Mesoamerica. The supply of status goods could not equal the general demand, which stimulated the Gulf Coast centers to seek to ensure a supply of these commodities. At present we are left with a chicken-and-egg riddle because it is still uncertain to us whether Chalcatzingo attracted the attention of Gulf Coast Olmec centers because it was a growing center, or whether Chalcatzingo's development as a trade and ceremonial center was stimulated in part by Gulf Coast contacts. Grove (*7*) pointed out Chalcatzingo's position on a long-established route of trade connecting Morelos and the Valley of Mexico with areas to the south and east and the site's ability to "control" a large resource area, including the Valley of Mexico, Morelos, Guerrero, and portions of West Mexico.

While serving (at least by phase C) as the major highland center, probably with a large regional service area that included Morelos, the Valley of Mexico, and portions of Puebla, Chalcatzingo can also be thought of as having served the function of a gateway city (*24*) in the eastward flow of highland commodities.

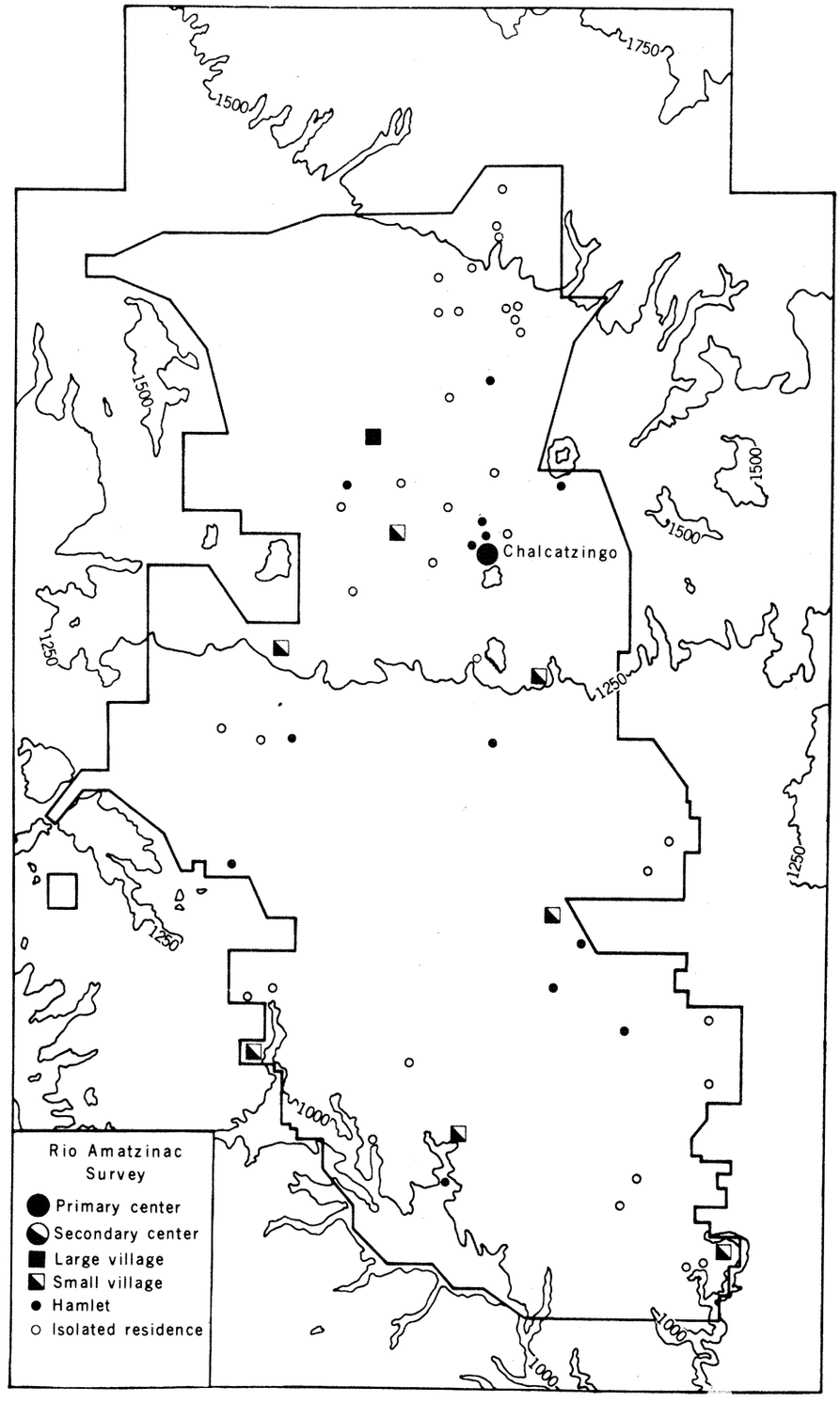

Fig. 8. Settlements of the Middle Formative period.

Such communities develop on the periphery of trade areas along natural routes of communication. Unlike cities that function as central places in a hexagonal or circular service area, a gateway city is located to one side of its service hinterland and has "an elongated, fanshaped service area which extends outward in the direction away from the national core area" (*25*). Such gateway cities are market communities serving both local and long-distance trade. Chalcatzingo was a highland center that also fulfilled a gateway function for the Gulf Coast (and other areas of demand to the southeast) (*26*).

We believe that a small number of Gulf Coast elite were among those present on the site, but that the Olmec aspects of Chalcatzingo should not be overstressed. While we have mentioned the Middle Formative Gulf Coast influences at the site, more than 98 percent of the artifacts relate to Chalcatzingo as a part of the local highland culture. The site's highland role was equally if not more important than its interactions with the Gulf Coast.

References and Notes

1. M. Coe, in *Magnetometer Survey of the La Venta Pyramid and Other Papers on Mexican Archaeology* (Archaeological Research Facility, Univ. of California, Berkeley, 1970), No. 8, pp. 21–34.
2. Public architecture with lime plaster appears in the Tierras Largas phase, 1450 to 1150 B.C., in Oaxaca [K. Flannery, Ed., *Preliminary Archaeological Investigations in the Valley of Oaxaca, Mexico, 1966–1969* (University of Michigan, mimeographed);_____ and J. Marcus, unpublished manuscript on file in the Department of Anthropology, University of Michigan]. Stone-faced ceremonial architecture that may be as old as monumental architecture on the Gulf Coast occurs in at least two sites in Chiapas [T. Lee, in *Mesoamerican Archaeology, New Approaches*, N. Hammond, Ed. (Univ. of Texas Press, Austin, 1974), pp. 1–20]. D.C.G. believes that early sophisticated ceramics in West Mexico from about 1400 to 1200 B.C. indicate cultural complexity there as well [D. Grove, *Am. Anthropol.* **75**, 1138 (1973); J. Oliveros, in *The Archaeology of West Mexico*, B. Bell, Ed. (West Mexican Society for Advanced Study, Jalisco, Mexico, 1974), pp. 182–20]; I. Kelly, in *ibid*, pp. 206–211].
3. Prior to our research, test excavations were carried out at the site in 1952 by R. P. Chan [*Inst. Nac. Antropol. Hist. Mex. Inf. No. 4* (1955)].
4. C. Gay, *Chalcacingo* (International Scholarly Book Services, Portland, Ore., 1972).
5. I. Bernal, *The Olmec World* (Univ. of California Press, Berkeley, 1969), p. 141.
6. P. Drucker, R. Heizer, R. Squier, *Excavations at La Venta, Tabasco, 1955* (Bulletin 170, Government Printing Office, Washington, D.C., 1959), pp. 253–270.
7. D. Grove, in *Dumbarton Oaks Conference on the Olmec*, E. Benson, Ed. (Dumbarton Oaks, Washington, D.C., 1968), pp. 179–185.
8. P. Tolstoy, in *Chronologies in New World Archaeology*, C. Meighan, Ed. (Seminar Press, New York, in press).
9. D. Grove, *San Pablo, Nexpa, and the Early Formative Archaeology of Morelos, Mexico* (Publications in Anthropology No. 12, Vanderbilt Univ., Nashville, 1974).
10. M. Porter, *Viking Fund Publ. Anthropol. No. 19* (1953), p. ➞ D. Grove, *Am. Antiq.* **35**, 62 (1970). D.C.G. has also observed probable Early Formative architecture at other sites in Morelos.
11. Figurine analysis was carried out by Dr. M. Harlan, University of New Mexico. More than 6000 figurine fragments have now been computerized [M. Harlan, thesis, University of Arizona (1975)].
12. P. Tolstoy (personal communication) indicated to D.C.G. that few, if any, sherds from his excavations at Zacatenco, El Arbolillo, or Tlatilco resemble the Chalcatzingo polychromes. Earlier published works also lack references to this distinctive type.
13. R. M. R. Robles, thesis, Escuela Nacional de Antropologia e Historia, Mexico (1971), p. 369; personal communication.
14. The fact that undated monolithic altars occur at both San Lorenzo and La Venta, are limited in number, and have strong stylistic similarities suggests that these altars occur at both of these Formative sites around 900 B.C. ± 100 years. For the same reasons we believe that the Chalcatzingo altar is contemporaneous with Gulf Coast examples.
15. M. A. Cervantes, *Anales* (Instituto Nacional de Antropologia e Historia, Mexico, 1967–1968), vol. 1, pp. 37–51.
16. J. Carlson, *Science* **189**, 753 (1975). Although the site is not directly mentioned in the text, the cover illustration depicts Relief I at Chalcatzingo, thereby implying that Chalcatzingo is an Olmec site and should be aligned within the Gulf Coast pattern.
17. The map used by Carlson [figure 2 in (*16*)] uses two different true norths, one for the main La Venta complex, the other for the Stirling group. A 22° rather than a 15° difference is shown.
18. Personal communication from D. Wolfman, who collected the 1972 Chalcatzingo samples for R. DuBois, University of Oklahoma, Norman.
19. Fifty samples from Chalcatzingo were analyzed by Dr. B. J. Evans of the University of Michigan, who has analyzed iron ore sources, manufactured mirrors, and the like in Oaxaca. Only two samples showed similarities to Oaxacan sources although it is known that Oaxacan iron ore commodities were widely traded during the Formative period [J. W. Pires-Ferreira, thesis, University of Michigan (1973)].
20. Conducted in cooperation with the Illinois Geologic Survey laboratories.
21. *Inst. Geol. Mex. Bol.* **40**, 260 (1923); *ibid.* **41**, 92 (1923).
22. Dr. C. Thomson received a Wenner-Gren Foundation grant to study the Chalcatzingo jadeite and serpentine artifacts.
23. At the time of the reconnaissance our ceramic analysis had not made a phase B and phase C separation in the Middle Formative, thus in the reconnaissance data we can speak only of general Middle Formative trends. All reconnaissance samples are being restudied to determine the phase B and phase C patterns.
24. K. Hirth, thesis, University of Wisconsin–Milwaukee (1974), pp. 233–237. In using the term gateway city, we are not implying that Chalcatzingo was itself a city.
25. A. Burghardt, *Ann. Assoc. Am. Geogr.* **61**, 269 (1971).
26. Chalcatzingo does not appear to have been alone in its role of gateway community for the Gulf Coast economy. The site of Chalchuapa, El Salvador, may have served a similar function. Olmec style bas-relief carvings occur at Chalchuapa together with the earliest monumental architecture known in that region—an interesting parallel to Chalcatzingo. ➞ R. Sharer, *Curr. Anthropol.* **15**, 165 (1974).
27. The project was under the direction of D.C.G. and codirectors J. Angulo and R. Arana. Funding was through NSF grant GS-31017 with supplementary funds in 1972 and 1973 from the National Geographic Society. K.G.H. was in charge of the reconnaissance, D.E.B. took responsibility for the ecological and palynological investigations, and A.M.C. took charge of the ceramic analyses. The cooperation of Instituto Nacional de Antropologia e Historia and the work of many participants, both Mexican and American, contributed greatly to the results discussed in this article.

NEWS AND COMMENT

Nuclear Navy: Rickover Thwarted Research on Light Weight Reactors

As a result of years of technical censorship of Navy research by Vice Admiral Hyman G. Rickover, the officer credited with having built today's nuclear navy, the Navy today sponsors no significant research on light weight, small reactors which many researchers believe have the potential for revolutionizing naval shipbuilding by enabling the construction of smaller but more powerful nuclear powered vessels.

Interviews with dozens of Navy officers, research administrators, scientists, and a former chief of Navy research indicate that, over the years, when Rickover has learned of proposals or studies concerning light weight reactors, he has gotten on the telephone to the research sponsor, become furious, used profane language, and told the sponsor's superiors that the work is a waste of time. On one occasion, he threatened to try to abolish the Office of Naval Research (ONR), the Navy's independent research arm. On another occasion, Rickover's office is credited with preventing a university engineer from giving an invited technical paper on light weight propulsion to a professional society meeting, and, subsequently, bringing about the termination of his $64,000 research contract.

Navy policy since 1975 has been to avoid doing research on light weight reactors, although studies of other aspects of light weight propulsion systems are allowed. "There's no reason for us to do research at complete loggerheads with the line organization of the Navy," says Assistant Secretary of the Navy for Research and Development, H. Tyler Marcy.

However, some researchers feel that Rickover's interference in ONR research matters has violated ONR's legislative mandate, which specifies that "all the duties [of ONR] shall be performed under the authority of the Secretary of the Navy, and its orders shall be considered as emanating from him." The purpose of this passage, which is in ONR's 1946