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SOURCES OF STONES USED IN PREHISTORIC MESOAMERICAN SITES

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A N N O U N C E M E N T

The Archaeological Research Facility institutes with this publication the series CONTRIBUTIONS OF THE UNIVERSITY OF CALIFORNIA ARCHAEOLOGICAL RESEARCH FACILITY which will not appear on a regular schedule but only as manuscripts and funds to publish them are available.

Publication of the numbered REPORTS OF THE UNIVERSITY OF CALIFORNIA ARCHAEOLOGICAL SURVEY will be continued, but as implied by the title, will be limited to papers pertaining to California and the Far West. The REPORTS, which are published under the auspices of the Archaeological Research Facility, provide a means of publishing data and research results secured between 1948 and 1960 by the Archaeological Survey of Berkeley and the Archaeological Research Facility since that time.

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SOURCES OF STONES USED IN PREHISTORIC

MESOAMERICAN SITES

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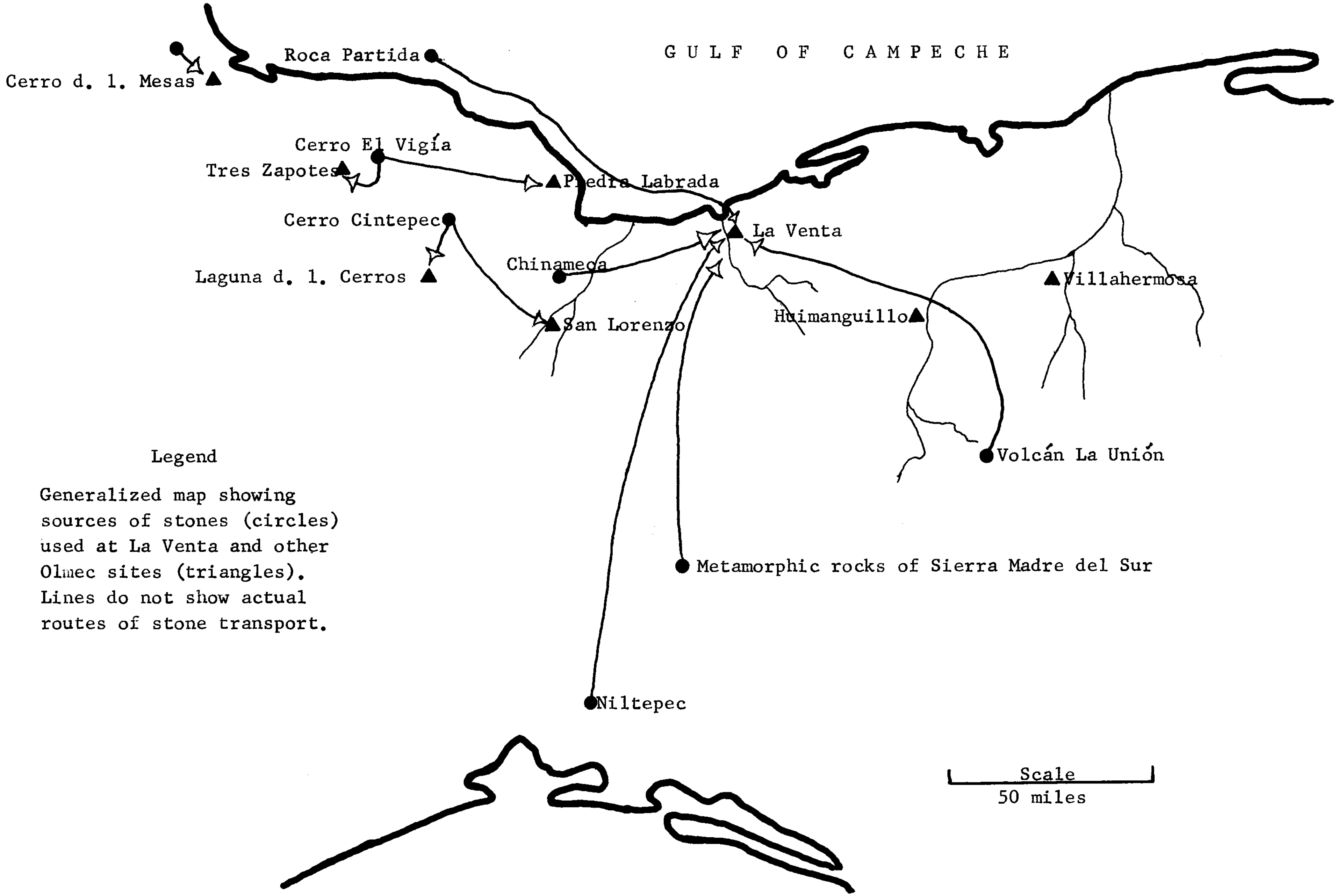

GULF OF CAMPECHE
Roca Partida
Cerro d. l. Mesas
Cerro El Vigía
Tres Zapotes
Piedra Labrada
Cerro Cintepec
La Venta
Chinameca
Laguna d. l. Cerros
Villahermosa
San Lorenzo
Huimanguillo
Volcán La Unión
Legend
Generalized map showing sources of stones (circles) used at La Venta and other Olmec sites (triangles). Lines do not show actual routes of stone transport.
Metamorphic rocks of Sierra Madre del Sur
Niltepec
Scale
50 miles

Map 1

SOURCES OF ROCKS USED IN OLMEC MONUMENTS

Howel Williams and Robert F. Heizer

INTRODUCTION

This paper provides information on the question of the sources of the stones used by the Olmecs—the designation applied to a prehistoric people living during the first millennium B.C. on the lowland Gulf of Mexico coastal plain in what are now the Mexican states of Veracruz and Tabasco—to carve their altars,[1] stelae, and colossal heads. The data contained herein supersede that reported in Heizer and Williams, 1960. There has been agreement among those interested in this question that most of the rocks, despite their great size and weight, must have been transported for very long distances, and an answer to the problem of provenience must be found before a satisfactory estimate can be made of the total labor involved in constructing the Olmec ceremonial sites[2] or the means and routes by which multiton stones[3] were transported to the sites. Map 1 shows a generalized delineation of source localities of stones.

We spent the last two weeks of January, 1960, examining the geology of the Tuxtla Mountains, visiting the La Venta site, inspecting the Olmec monuments housed in the museum and in the outdoor museum called the Parque Olmeca or La Venta Park at Villahermosa, in the Museo Jalapa, and in the Museo Nacional de Antropología in Mexico City. During part of this time we were fortunate in having the company of Dr. Philip Drucker. We returned to Mexico during the last week of January, 1962, and again for a few days during the following June, to continue our reconnaissance of the Tuxtla Mountains, to examine volcanic rocks exposed in the mountains south of Villahermosa, and to study the Olmec monuments acquired during the interim by the Museo Jalapa.

The late Ing. Hugo Contreras of Petroleos Mexicanos in Coatzacoalcos, and his successor Ing. Roberto Gutierrez Gil, gave us much valuable geological information and were of great help in providing transportation on several of our trips. We are also grateful to Dr. Alfonso Medellin Zenil and to Drs. Roberto and Jorge Williams of the Museo Jalapa who kindly assisted us in many ways, to Sr. Carlos Sebastian Hernandez, Conservador of the Museo Regional in Villahermosa, and to Dr. Philip Drucker who not only accompanied us in the field but also collected a suite of specimens for us from the vicinities of Huazuntlan and Soteapan. Finally, we thank the Committee on Research, the Associates in Tropical Biogeography, and the Archaeological Research Facility, all of the University of California, Berkeley, for generous financial aid.

Petrographic methods have long been used as an aid in the study of ancient pottery, but far too little use has been made of such methods in the study of other artifacts, particularly of stone monuments (Wallis 1955; Shotten 1963). The sources of rocks at Stonehenge have been determined (Atkinson 1956) and similar studies have been made in Egypt (Lucas 1962) and Bolivia (Ahlfeld 1946). Bell (1947) has shown the wide network of trade implied by the varied and distant sources of stone, copper, and shells found at the Spiro site in Oklahoma. Recent investigation of the trace-element composition of Mediterranean obsidians has thrown a great deal of new light on prehistoric trade contacts (Cann and Renfrew 1964). In Mexico petrology in the service of archaeology is no new thing, as a reading of the works of Fischer (1877) and Ordoñez (1892) will demonstrate. Our experience in Mexico, Guatemala, Peru, and Bolivia shows that, in general, examination of the weathered surfaces of monuments by means of the hand-lens alone is unsatisfactory. Accurate identification is often impossible, even by a specialist, without microscopic inspection. We emphasize therefore that when comparing rocks used in ancient implements or monuments and attempting to identify their sources, it is essential for the geologist to get fresh chips for microscopic study. Even chips between half an inch and an inch across and a quarter of an inch thick will suffice to prepare the thin sections the geologist needs for study under the petrographic microscope.[4] If the archaeologist thinks that a monument or other artifact would be seriously damaged by removal of a chip, he should if possible permit the geologist to scratch a little powder from the specimen. Damage done by discreet chipping or scratching will almost always be trivial compared with the scientific results to be obtained. One purpose of this report is to stress the need for closer cooperation between the archaeologist and the geologist in the study of ancient stone artifacts.

In the pages which follow we discuss first the geological setting of the Olmec sites—particularly the nature and distribution of the volcanic and metamorphic rocks which the Olmecs used extensively—and then examine in more detail the petrographic characters of the rocks from which some of the monuments were carved.

GEOLOGICAL SETTING OF THE OLMEC SITES

Most Olmec monuments[5] are carved from volcanic rocks, a minority are fashioned from metamorphic rocks (Curtis (1959). It seems proper, therefore, that we begin by describing the volcanic fields adjacent to the lowland Olmec sites in Veracruz and Tabasco.

Tuxtla Mountains

The Tuxtla Mountains lie close to the heart of the Olmec country. They consist predominantly of volcanic rocks that were laid down on an eroded basement of Early and Middle Tertiary sedimentary rocks, some of which are to be seen along the western and southwestern flanks of the mountains (Maps 1, 2).

Two groups of volcanic rocks are easy to distinguish; namely, a Plio-Pleistocene group of lavas, pyroclastic rocks, and tuffaceous sediments, especially widespread on the southwestern side of the Tuxtla Mountains; and a younger group of Late Pleistocene and Recent age that forms most of the opposite side, including the huge cones of San Martín Tuxtla, San Martín Pajapan, Santa Marta, and Pelón. Topographic forms within the belt occupied by the younger group are only slightly modified by erosion so that the eruptive vents and constructional slopes of the volcanoes are easy to detect. Within the belt occupied by the older group no original volcanic forms persist, the landscapes there being almost entirely the product of erosion.

Virtually nothing had been published concerning the geology of the Tuxtla Mountains prior to Friedlaender's account of a reconnaissance he made in 1922 and Sonder's accompanying account of the specimens that Friedlaender collected (Friedlaender and Sonder 1923). Unfortunately for the present purpose, their main concern was with the younger Quaternary volcanoes and their products rather than with the Plio-Pleistocene volcanic rocks which supplied most of the materials employed by the Olmecs. Between 1950 and 1952 three papers were published by petroleum geologists concerning the Tuxtla region. As might be expected, these deal principally with the stratigraphy of the marine Tertiary beds and with the general structure rather than with the petrography of the volcanic rocks. Particularly noteworthy in the present connection is the paper by R. Ríos Macbeth (1952). In 1962 F. Mayer Perez Rul published a volcanological study of the region based mainly on examination of aerial photographs, and therefore concerned much more with geomorphology than with petrography.

Plio-Pleistocene volcanic rocks: Volcanism began in the Tuxtla region at least as early as Oligocene times, as shown by the presence of marine tuffaceous sediments of that age, and it has continued intermittently ever since. Seas retreated from the region about the close of the Miocene period; then, following an interval of erosion, subaerial volcanoes began to erupt during the Pliocene period.

Plio-Pleistocene lavas are poorly exposed in the country adjoining the highway between Santiago Tuxtla and San Andrés Tuxtla, where they consist mainly of fine-grained, olivine basalts and perhaps also of andesites interbedded with tuffaceous sediments. None of these rocks resemble those which the Olmecs carved.

About 4 kilometers west of Santiago Tuxtla, however, there is a conspicuous ridge that culminates in the peak formerly called Cerro Santiago but now known as Cerro El Vigía. This was undoubtedly a principal source of Olmec lithic material, especially for the nearby site of Tres Zapotes. Friedlaender was told that Cerro El Vigía was sacred to the Indians and that some of the lavas from there had been used for monuments, specifically for making two stone rabbits and a toad, which Friedlaender states were formerly kept in Santiago Tuxtla but are now in the plaza at San Andrés Tuxtla (cf. Blom and La Farge 1926:I:19; Seler-Sachs 1922:pl. 5, no. 2). Friedlaender was the first to call attention to the exceptionally coarse-grained nature of the olivine- and augite-rich basalts (fig. 4a) which are widespread on the upper slopes of Cerro El Vigía. Our observations show that many Tres Zapotes monuments were carved from these distinctive basalts, among them the following: Tres Zapotes Colossal Heads No. 1 (Stirling 1943:pl. 4) and No. 2 (Heizer, Smith and Williams 1965); Monument F (Stirling 1943:pl. 8a); a rectangular stone basin adorned with pecten shells (illustrated here in pl. 1a, and earlier by Blom and La Farge 1926:I:fig. 24) now to be seen in the plaza of Santiago Tuxtla; Monument C, also from Tres Zapotes (now in the Museo Nacional in Mexico City); Monument 9 from San Lorenzo (Stirling 1955:pl. 18b); and two unpublished sculptures which we refer to in our notes as the "Frog Altar" and "Jaguar Throne" from Piedra Labrada and now in the Museo Jalapa. We do not doubt, even though we were unable to visit the Tres Zapotes site, that there exist locally other Olmec monuments carved from the basalts of Cerro El Vigía.

It was from the upper slopes of Cerro El Vigía, close to the summit, that the Olmecs secured much of the material they carved. Hereabouts the massive, coarsely porphyritic basalts have been weathered spheroidally so that the slopes are littered profusely with huge, round, smooth-faced boulders, some more than 3 meters in diameter. On one

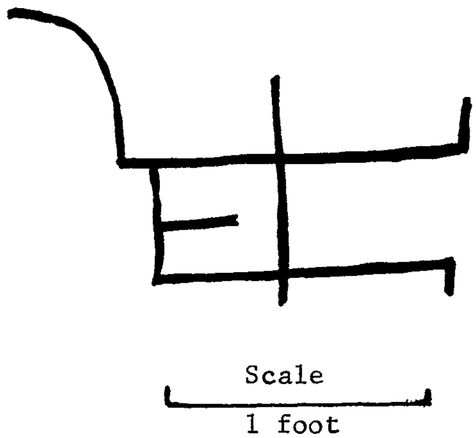


Figure 1. Petroglyph on boulder on Cerro El Vigía

boulder we found some crude petroglyphs (illustrated above) but as far as we know, no sculptured monuments have been found among them. Presumably the Olmecs rolled or dragged the boulders downslope before they began to carve them.

We found no likely sources of stone material in the country directly south of San Andrés Tuxtla and west of the highway. The Plio-Pleistocene rocks thereabouts, though deeply eroded, are poorly exposed; some valleys incised in them are partly filled by Recent flows of dark, fine-grained basalt such as that which produces the beautiful waterfall known as El Salto de Eyipantla, just south of San Andrés Tuxtla.

Along the southern flanks of the Tuxtla Mountains, particularly on the slopes of Cerro Cintepec and in the vicinity of Soteapan and Huazuntlan, the alluvial fans contain many large boulders of coarsely porphyritic olivine-augite basalts indistinguishable from many of the rocks used by the Olmecs at La Venta, San Lorenzo, and adjacent sites. Some of the boulders that we saw measured 3 meters across, scores of them measured approximately 2 meters across. We did not have time to trace the boulders to their source, but this must be on and near the top of Cerro Cintepec where the boulders must be even larger and still more numerous. In our opinion this area was almost certainly the main source from which the Olmecs derived their volcanic stones, and we believe that the material they used was not quarried from lavas in situ but was selected from detached and rounded boulders in the alluvial fans. Unfortunately we were unable to reconnoiter the slopes north of Volcán San Martín Pajapan which, according to F. Mayer Perez Rul (1962) are also occupied by Plio-Pleistocene lavas, but after flying over these deeply dissected, heavily wooded slopes, we doubt that the Olmecs obtained any of their materials there.

Late Pleistocene and Recent volcanic rocks: The four principal Quaternary volcanoes of the Tuxtla Mountains—San Martín Tuxtla, San Martín Pajapan, Santa Marta, and Pelón—are aligned in a northwest-southeast direction, roughly parallel to the adjacent coast line of the Gulf of Campeche. Each major volcano bears on its thickly wooded flanks a cluster of smaller, parasitic cinder cones such as may be seen close to the highway between San Andrés Tuxtla and Lake Catemaco and close to the margins of the lake itself. All of the major volcanoes and many of their parasites have erupted within the last few thousand years, indeed San Martín Tuxtla discharged lavas and cinders as recently as 1793 (Mozino 1913; Friedlaender and Sonder 1923). The Olmecs undoubtedly witnessed and suffered from many of these outbursts.

All of the lavas collected by Friedlaender and described by Sonder from these youthful volcanoes, and all that we saw around Lake Catemaco, are dark, vesicular, olivine-augite basalts which, though similar mineralogically to the older basalts of Cerro El Vigía and Cerro Cintepec, are texturally quite different in lacking the large and abundant phenocrysts that typify most of the older basalts and having a very much finer-grained groundmass. None of the Quaternary basalts that we examined resembled the basalts of the sculptured Olmec monuments. Nevertheless we think that the basalt columns that were used extensively at La Venta, in the tombs, entryways, platforms, and Ceremonial Court, were almost surely derived from Quaternary flows.

Dr. Alfonso Medellin Zenil informed us of the occurrence of columnar basalts near the Hydroelectric Plant in the canyon of Río Huazuntlan, close to the localities from which we believe that the Olmecs obtained much of their sculpture material. At our request Dr. Philip Drucker kindly collected samples of these columnar basalts from both the Huazuntlan and Soteapan falls, as well as samples from boulders on the intervening slopes. The bouldery material resembles that from the slopes of Cerro Cintepec and some of it may well have been used by the Olmecs, but the columnar basalts are quite different from those employed at La Venta. The latter (see fig. 2c) are pale gray lavas crowded with large crystals of fresh olivine and are quite devoid of phenocrysts of feldspar. The columnar basalts from Huazuntlan and Soteapan, on the contrary, are dark gray lavas carrying abundant large, subparallel laths of feldspar, almost completely devoid of olivine and augite phenocrysts; moreover, the few olivine crystals which they contain show extensive alteration to greenish serpentine. Besides, as Dr. Drucker informs us, most of the columns in the basalts at Huazuntlan and near Soteapan are much larger than those used at La Venta, some of them having maximum diameters of about 4 feet, and most having minimum diameters of about 2 feet. It would have been extremely difficult to transport such heavy columns from the deep gorges in which they are found. Accordingly the source of the La Venta columns must be sought elsewhere, and we suggest that it may have been from the islet close to the coast near Punta Roca Partida (see pl. 1b).

One of us (H.W.) flew northwestward along the coast from Coatzacoalcos with the late Ing. Hugo Contreras of Petroleos Mexicanos. Almost all of the cliffs over which we flew seemed to be cut out in thin sheets of basalt separated by layers of basaltic tuff and scoria. Along the northern base of San Martín Tuxtla volcano, west of the hamlet of Montepío, we flew over two conspicuous headlands. On one headland, Punta Organo, we saw thin, steeply dipping dikes of basalt cutting beds of rotten scoria; on the other, Punta Roca Partida (a photograph of which is shown in Friedlaender and Sonder 1923), we saw a large body of columnar basalt cutting thick deposits of cross-bedded scoria. Friedlaender was certainly correct in saying that this second headland marks the remains of a parasitic cone. Not far to the west, very close to the shore, we flew over a rocky islet of columnar basalt, perhaps the remnant of a lava flow from this cone (pl. 1b). Friedlaender's map shows that he collected a sample here but unfortunately Sonder did not describe it, and we were unable to collect a specimen for ourselves. It is important, therefore, that the islet be revisited for we think that the Olmecs of La Venta may have obtained their basaltic columns here.[6] It would not have been difficult to snap off the columns at their base, load them on rafts during the calm weather, and transport them along the coast to the mouth of Río Tonala, 130 kilometers to the southeast, and thence upstream for another 16 kilometers or so to La Venta. Such an operation would have been simpler than transporting commensurate columns overland for much shorter distances.

It is appropriate to add that nowhere in the Tuxtla Mountains did we find any sources of the obsidian which the Olmecs used, nor did we find any fragments of obsidian in the beds of any of the rivers that drain down from the mountains south of Villahermosa. The most abundant source of obsidian that we know of in Central America is in the south-eastern part of Guatemala, particularly on the volcano known as Ixtepeque, and on the adjacent volcanoes of Laguna de Obrajuelo and Agua Blanca. Smaller occurrences of obsidian are scattered through the highlands west of Guatemala City (Coe and Flannery 1964), but the nearest of these Guatemalan sources lies approximately 500 kilometers from the Olmec country, and the great obsidian fields of Ixtepeque lie more than 600 kilometers away. Perhaps the Olmecs got some of their obsidian from these distant sources, but more likely there were sources nearer to hand—somewhere in the Mexican volcanic province to the north and west (cf. West 1964). X-ray fluorescence analysis of nine obsidian samples is described and commented upon in two brief papers appearing in the present volume.

La Unión Volcano

This Quaternary volcano, which is still in a solfataric stage of activity, was first identified as such by Mullerried (1933) who described it under the name of El Chichón. It lies on latitude 17° 20' N. and longitude 93° 12' W., approximately 60 kilometers S. 20° W. of Villahermosa and twice that far southeast of La Venta.

The volcano has a steep-walled summit-crater with a breach on its southwest side. A huge pelean dome rises from the floor of the crater, its top towering high above the crater-rim, and a thick flow of lava extends from the base of the dome through the breach toward Río Osthuacan.

Mullerried identified a rock from the summit of the volcano as hornblende andesite, and all of the six samples collected for us through the help of the late Ing. Hugo Contreras are also hornblende andesites. In addition all of the lava boulders that we examined in the bed of Río Osthuacan, close to the village of that name, were composed of exactly the same kind of andesite. A few boulders measured as much as 2.5 meters across though they lie 12 kilometers downstream from their source. Closer to the volcano there must be more and even larger boulders.

Here it should be noted that three of the Olmec monuments found at La Venta appear to have been carved from the La Unión lava; namely Altar 7 (see p. 20), a monument depicting a monkey with the hands clasped behind its head, said to have been bulldozed from the La Venta site some time between 1956 and 1960 (both of these are now to be seen in the La Venta Park in Villahermosa), and Monument No. 21 from La Venta (Drucker, Heizer and Squier 1959:pl. 51a), now in the Museo Villahermosa. In addition we found many broken fragments of pale gray hornblende andesite, identical with that from La Unión volcano, in a recently opened pipeline trench on the north side of the La Venta site. No comparable andesites have been observed by us in the Tuxtla Mountains nor among the Tertiary lavas in the mountains south of Villahermosa. It seems reasonably certain therefore that the Olmecs of La Venta obtained some of their lithic materials either from La Unión volcano itself or from boulders in the bed of the river that drains its slopes. Thence to La Venta transport may have been by way of water, though there is a short stretch of the Río Osthuacan above the village of Sayula where the river runs through a rocky gorge that would have been difficult, if not impossible, to negotiate in heavily loaded rafts.

Tertiary Volcanic Rocks Near Teapa

Remnant patches of Tertiary lavas are widespread among the mountains south of Villahermosa, but as far as we have been able to tell none of these lavas were used by the Olmecs.

In the foothills stretching westward from Teapa to near Pichucalco, 13 kilometers away, all of the lavas that we saw were hornblende-rich, biotite-bearing dacites or rhyodacites characterized by large crystals of quartz. Interbedded with these flows are tuffaceous sediments and volcanic conglomerates.

Pebbles, cobbles, and boulders carried down from the mountains by the Río Teapa are composed mainly of hornblende diorite. Why the Olmecs made no use of these rocks poses an interesting question, for they are attractive and well suited to sculpture. Perhaps their hardness or small size discouraged their use for this purpose. The volcanic detritus accompanying the diorites consists almost entirely of pyroxene- and hornblende-andesite. Some of it consists of hornblende-biotite dacite, but olivine-augite basalt, if present, must be very rare.

In the bed of Río Puyacatengo, about 3 kilometers east of Río Teapa, and in the intervening area, almost all of the volcanic rocks are dense, dark bluish-gray, vitrophyric hornblende andesites; a few are hornblende-bearing pyroxene andesites. None of these andesites resemble those of La Unión volcano, and coarsely porphyritic olivine-augite basalts, similar to those used in most of the Olmec monuments, are conspicuously absent.

Finally, in the bed of Río Tacotalpa, 16 kilometers east of Teapa, most of the debris is composed of foraminiferal limestones and metamorphic rocks. Among the sparse volcanic debris are some cobbles of hornblende-biotite dacite, but most consist of dense, vitrophyric types of hornblende- and pyroxene-andesite, quite unlike any of the lithic materials used by the La Venta Olmecs.

Cerro Acalapa and Arroyo Sonso

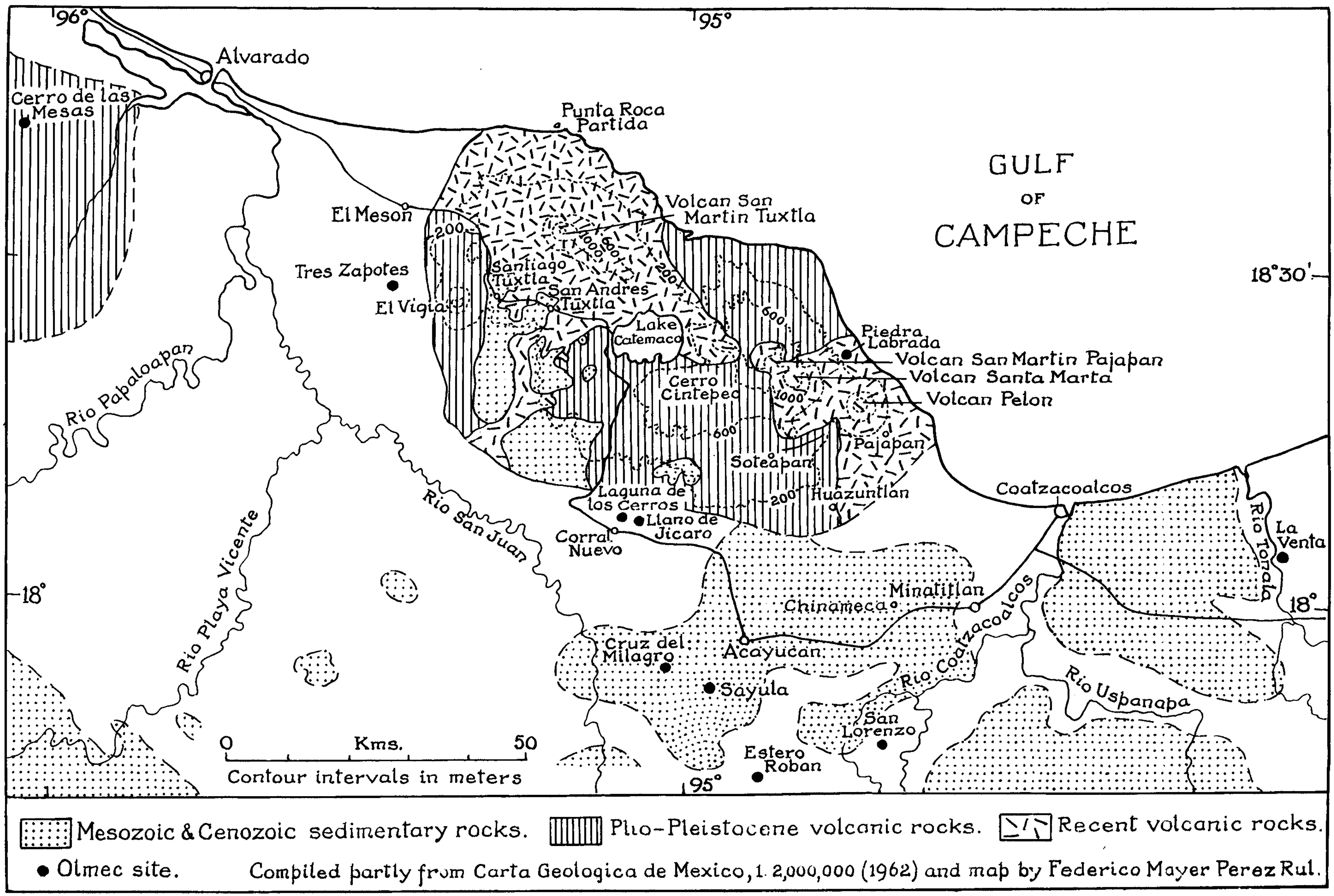
Blom and La Farge (1926) mention that they were told of exposures of igneous rocks not far from La Venta, along the road between Minatitlan and Las Choapas, and they and others have suggested that the Olmecs may have obtained some of their materials from this region. But when we visited the area and climbed the Cerro Acalapa, accompanied by Ing. Roberto Gutierrez Gil, we found no lava flows nor any pyroclastic deposits. The only rocks thereabouts are Tertiary sediments, some of which contain small pebbles and a few cobbles of igneous rocks. This entire area may therefore be eliminated as a possible source of materials for the Olmec monuments.

Cerro de las Mesas and Vicinity

The Olmec site of Cerro de las Mesas lies close to the edge of an extensive belt of Cenozoic volcanic rocks (maps 2, 3). Unfortunately, we found no literature dealing with the character of these rocks and were unable to examine the region ourselves except in a cursory fashion. It appears, however, that before the imposing Quaternary volcanoes of Orizaba and Cofre de Perote began to grow, a thick sequence of Tertiary lavas, pyroclastic rocks, and tuffaceous sediments had been laid down in this region. No geologist seems to have described Cofre de Perote, but Waltz (1910) says that the lavas of Sierra Negra to the south are hypersthene-augite andesites and that the youngest flows of Orizaba are hornblende- and pyroxene-andesites, some with and some without hypersthene.

Through the good offices of Dr. Matthew Stirling, we obtained small fragments from seven of the monuments at Cerro de las Mesas and one from the nearest volcanic outcrop, at the intersection of the road from Piedras Negras with the Cordoba-Veracruz highway. The outcrop sample is a hornblende andesite tuff crowded with vitric, crystal, and lithic fragments. Bits of varitextured andesite are mingled with crystals of plagioclase, fewer of olive-green and russet hornblende, and still fewer of hypersthene and pale green augite. These constituents lie in a micropumiceous matrix of glass shards and dust. What is important in the present connection is to note that all but one of the samples from the monuments at Cerro de las Mesas are composed of hypersthene-bearing hornblende andesite lava; the exception (Stela 3) is an andesite tuff essentially similar to the outcrop sample just described. This suggests that lavas of the same mineralogical composition are present not far away, and that these localities supplied most of the rocks required.

Since all of the rocks from Cerro de las Mesas that we examined contain hypersthene, whereas none of those used in the Olmec sites to the


96°
95°
Alvarado
Cerro de las Mesas
Punta Roca Partida
GULF OF CAMPECHE
Volcan San Martin Tuxtla
El Meson
Tres Zapotes
El Vigia
Santiago Tuxtla
San Andres Tuxtla
Lake Catemaco
18°30'
Piedra Labrada
Volcan San Martin Pajapan
Volcan Santa Marta
Volcan Pelon
Cerro Cintepec
Pajapan
Soteapan
Huazuntlan
Coatzacoalcos
Rio Papaloapan
Rio San Juan
Rio Playa Vicente
Laguna de los Cerros
Llano de Jicaro
Corral Nuevo
Rio Tonala
La Venta
18°
Minatitlan
Chinameca
Rio Coatzacoalcos
Cruz del Milagro
Acayucan
Sayula
Rio Uspanapa
San Lorenzo
Estero Roban
0 Kms. 50
Contour intervals in meters
200
600
1000
Mesozoic & Cenozoic sedimentary rocks.
Plio-Pleistocene volcanic rocks.
Recent volcanic rocks.
Olmec site.
Compiled partly from Carta Geologica de Mexico, 1:2,000,000 (1962) and map by Federico Mayer Perez Rul.

Map 2

east contain this mineral, we conclude that there was probably no transfer of lithic material from one region to the other.

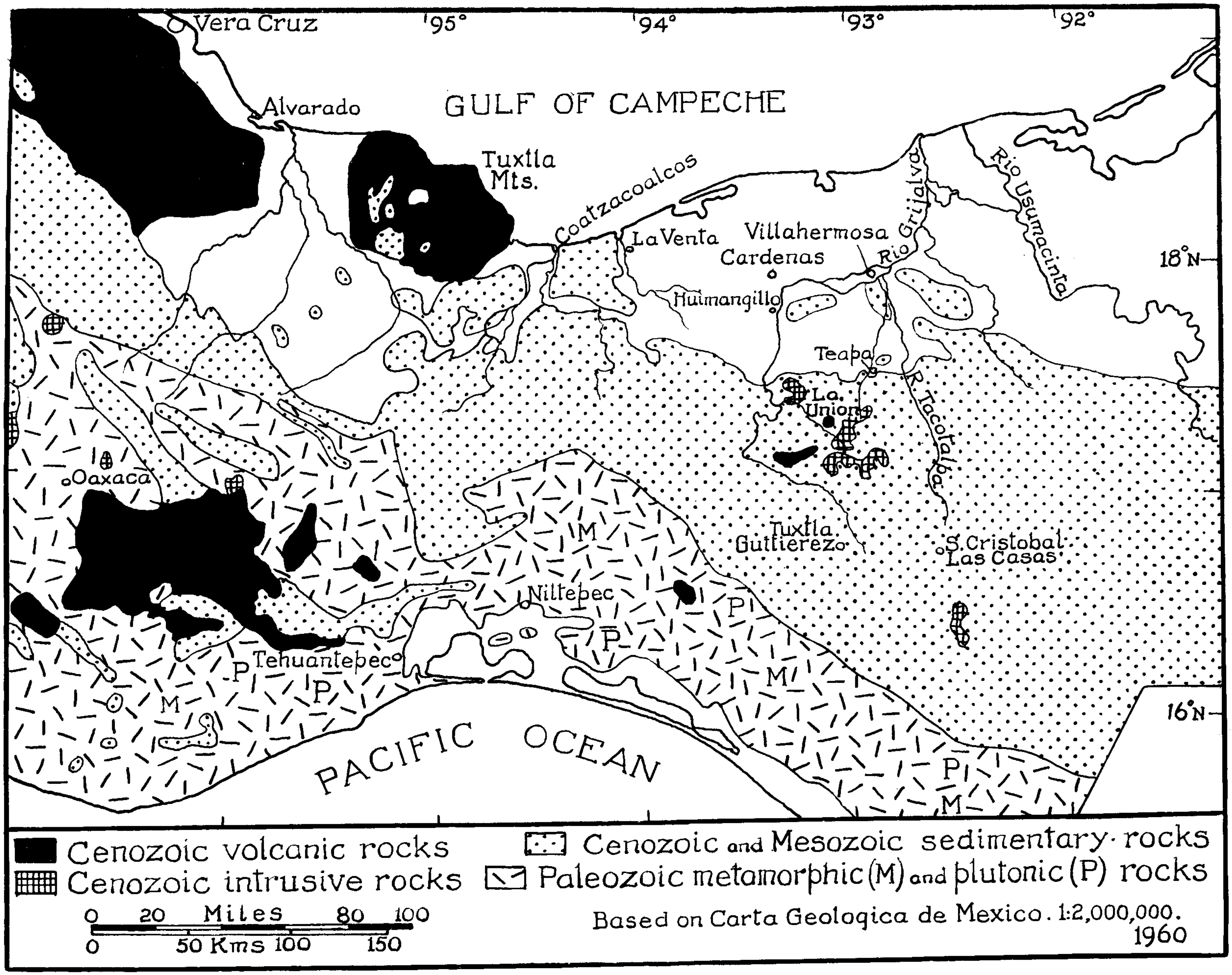
Metamorphic Terrains

Until more field work is done there is little to add to what Curtis (1959) has already written about the nature and provenience of the metamorphic rocks used by the Olmecs at La Venta. His list included the following types: pumpellyite schist, muscovite-actinolite schist, actinolite schist, actinolite-epidote gneiss, quartzite, and several varieties of meta-andesite or metadiorite, serpentine, and jadeite. Two other types can now be added to his list—these are from unpublished monuments recently (post-1955) included in the collection at La Venta Park in Villahermosa. One of these monuments is composed of chlorite-actinolite-epidote-albite-sphene schist containing many small porphyroblasts of magnetite; the second is an incompletely sculptured block 8 feet long, 40 inches high, and 44 inches wide, which looks at first glance like a solid concrete park bench. It is composed of chlorite-muscovite schist riddled with stringers and lenses of coarsely granular quartz. This monument is thus far unnumbered and unpublished and is designated as No. 27 in the Parque Olmeca.

All of these metamorphic rocks are characteristic of the greenschist facies of metamorphism, and without doubt, as Curtis says, all came from the belt of Paleozoic rocks that forms part of the Sierra Madre del Sur (map 3). Ing. Roberto Gutierrez Gil tells us that there are serpentines near Niltepec, and other serpentines probably await discovery elsewhere in the adjacent mountains. We do not doubt that it was from the bed of a stream draining areas of serpentine and related ultrabasic rocks in these mountains that the Olmecs obtained the waterworn cobbles of ilmenite from which they fashioned their amazingly perfect concave mirrors (Gullberg 1929).

Chinameca Limestone

Limestones of Late Jurassic and Early Cretaceous age are present on the small hill east of the village of Chinameca, approximately 60 kilometers from La Venta, where they have been uparched by the rise of a subterranean salt dome. Many slabs of these limestones were used for building materials at La Venta. As Map 2 shows, Chinameca lies roughly midway between La Venta and the slopes of Cerro Cintepec from which the Olmecs obtained most of the volcanic rocks they used for their monuments.


Vera Cruz
95°
94°
93°
92°
GULF OF CAMPECHE
Alvarado
Tuxtla Mts.
Coatzacoalcos
La Venta
Villahermosa
Cardenas
Rio Grijalva
Rio Usumacinta
18°N
Huimangillo
Teapa
La Union
R. Tacotalpa
Oaxaca
Tuxtla Gutierez
S. Cristobal Las Casas
M
Niltepec
P
Tehuantepec
16°N
PACIFIC OCEAN
Cenozoic volcanic rocks
Cenozoic intrusive rocks
Cenozoic and Mesozoic sedimentary rocks
Paleozoic metamorphic (M) and plutonic (P) rocks
0 20 Miles 80 100
0 50 Kms 100 150
Based on Carta Geologica de Mexico. 1:2,000,000. 1960

Map 3

PETROGRAPHIC NOTES ON VOLCANIC ROCKS USED FOR OLMEC MONUMENTS

Monuments from Cerro de las Mesas

Thin sections were prepared from six samples sent to us by Dr. Matthew Stirling. We hope that the following descriptions will facilitate the search for the sources from which the rocks were derived.

Stela 3: This is composed of hornblende andesite tuff (fig. 3*b*) essentially similar to the outcrop sample collected not far away by Dr. Stirling. Approximately a third of the tuff consists of angular chips of colorless and pale gray glassy andesite ranging in size from minute specks to a diameter of 5 mm. Many of these chips exhibit perlitic cracks. About half of the tuff consists of broken phenocrysts of plagioclase that show oscillatory zoning and a range in composition from sodic bytownite to medium labradorite. There are also many phenocrysts of olive-green hornblende, a few of hypersthene and pale green diopsidic augite, and rare minute flakes of biotite. Quartz and sanidine seem to be absent.

Stela 4: A porphyritic, pilotaxitic oxyhornblende-hypersthene andesite. About 40 per cent of this lava consists of labradorite-bytownite phenocrysts with pronounced oscillatory zoning and a maximum length of about 2 mm. Approximately a third consists of reddish brown crystals of oxyhornblende, many of them fringed with magnetite. Almost all of these hornblendes measure less than 0.25 mm. in length, but a few exceed 2.0 mm. Stumpy subhedral prisms of hypersthene, none more than 0.25 mm. in length, constitute about 5 per cent of the bulk; augite is much less plentiful. The remainder of the lava is a dense, porous pilotaxitic groundmass of oligoclase microlites and interstitial 'cryptofelsite,' and many of the irregular pores are partly lined with minute spheroids of cristobalite.

Monument 6: An andesite similar to that in Stela 4 above, illustrated in Figure 3*c*.

Stelae 8 and 9: These are carved from tridymite-rich oxyhornblende andesites (one of which is illustrated in fig. 3*a*). Both samples are characterized by abundant phenocrysts of brown hornblende, some of them 3 mm. long, almost wholly replaced by dense intergrowths of granular augite and magnetite. Zoned phenocrysts of plagioclase, though fewer, are generally of the same size and composition as those in the andesites already described; the same can be said of the subordinate small phenocrysts of hypersthene. The pilotaxitic matrix is marked especially by many clear, porous patches rich in tridymite and by the presence of a little fumarolic hematite-dust.

Stela 10: A fine-grained hornblende andesite. This lava contains many slender prisms of olive-green hornblende 1.0 mm. or less in length, and zoned crystals of plagioclase of the same size, accompanied by a few minute crystals of hypersthene and augite in a dense pilotaxitic matrix.

Two monuments housed in Museo Jalapa and labeled "Late Cerro de las Mesas" were examined with a hand lens. One of these monuments depicts the head of a rain-god; it consists of pale gray, vesicular porphyritic hornblende andesite, many of the hornblendes measuring as much as 1.0 cm. in length. There are a few recognizable grains of pyroxene, but phenocrysts of plagioclase were not detected. This andesite is almost surely from the same source as those described above. The other monument, however, is composed of extremely fine-grained, dark gray basalt containing many slender laths of plagioclase in an irresolvable groundmass devoid of identifiable minerals.

Monuments from Tres Zapotes

Three monuments were examined in the plaza of Santiago Tuxtla, all of which are reported to have come from Tres Zapotes. One of the Tres Zapotes monuments is a giant head designated Tres Zapotes Colossal Head No. 2 (Heizer, Smith and Williams 1965) and the other (Monument F) depicts a reclining figure in the form of a large tenon (Stirling 1943:pl. 8a). These monuments are carved from the same distinctive basalt as were the following: Monument C from Tres Zapotes, now housed in the Museo Nacional in Mexico City; Monument 9 from San Lorenzo, now housed in the Museo Jalapa; and the unpublished "Frog Altar" and "Jaguar Throne" from Piedra Labrada, also in Jalapa. What makes this basalt distinctive is the unusual abundance of large crystals of olivine and augite, and the paucity of large crystals of plagioclase. Identical basalt, as we have noted, is widespread on the upper slopes of Cerro El Vigía where it occurs as huge spheroidal and ovoid boulders.

There is considerable variation in the proportion of the phenocrysts and in the augite-olivine ratio in the coarse-grained, picritic basalts of El Vigía. Generally, however, the olivine and augite phenocrysts each make up approximately a quarter of the total volume and range in size from 0.5 to 5.0 mm. Exceptionally, some of the stumpy augites measure as much as 2.5 cm. across. In hand specimens the olivine crystals appear pale green, in thin sections they are colorless except for thin rims of russet colored iddingsite. The augite crystals, which appear black in hand specimens, generally show a pale yellowish green color in thin sections, though some of them exhibit a beautiful and delicate oscillatory zoning, almost colorless shells alternating rapidly with greenish ones. The optic angles of the augites vary between 55° and 60°, and all show strong inclined dispersion. Plagioclase, which makes up about 40 per cent of the typical basalt, never forms large phenocrysts but occurs as divergent laths, mostly between 0.25 and 0.5 mm. in length, but occasionally as much as 1.0 mm. long. In composition it varies only slightly from medium labradorite. The remaining tenth of the basalt consists of minute granules of iron ore and augite, fine needles of apatite, and flakes of hematite.

Stela C from Tres Zapotes (Stirling 1939, 1940; Thompson 1941; Coe 1957), now in the Museo Nacional in Mexico City, is carved from a quite different kind of basalt, essentially identical with that used in making La Venta Stela 3 and the basalt of the columns surrounding the plaza or "court" at La Venta. We cannot be certain, but probably all came from the same source. All are characterized by an abundance of small phenocrysts of olivine and an absence of phenocrysts of augite and plagioclase. Approximately 15 per cent of the dense, intergranular basalt used to make Stela C at Tres Zapotes consists of ovoid crystals of fresh olivine, mostly less than 0.5 mm. in maximum dimension but occasionally about 1.0 mm. across. The remainder consists of divergent, slender laths of plagioclase, subhedral grains of augite, and iron ore. The fact that Tres Zapotes Stela C is not carved from the same stone as most of the other sculptures at this site (which came from nearby Cerro El Vigía) but is made of a stone which was more abundantly used at the La Venta site is of especial interest since it raises the possibility that Stela C may have been carried to Tres Zapotes from another site, possibly from La Venta itself, though it seems to date from after the abandonment of the La Venta site. Stela C is unique in bearing an early date (Stirling, 1939, 1940; Coe 1957) and is the only monument of its kind attributable to the Olmecs.[7]

A darker, slightly more vesicular but otherwise similar basalt was used to make the rectangular basin ornamented with *Pecten* shells to be seen in the plaza of Santiago Tuxtla and reported to have been brought from Tres Zapotes (pl. 1*a*).

Monuments from San Lorenzo and Adjacent Sites

A magnificent collection of monuments from San Lorenzo and other sites to the south of the Tuxtla Mountains is to be seen in Museo Jalapa. Most of these monuments, including the justly famous giant heads from San Lorenzo discovered by Matthew Stirling (as well as many of the monuments from La Venta which are in Mexico City or Villahermosa), are carved from essentially identical basalts derived from the slopes of Cerro Cintepec and the vicinity of Soteapan. Among the monuments from this area we include the following:

- a. San Lorenzo: All of the giant heads (Monuments 1, 2, 3, 4, 5) as well as Monuments 10 and 11 (Stirling 1955)
- b. Potrero Nuevo, near San Lorenzo: Monument 2
- c. Llano de Jicaro: Monument 8, called "Señor de los Animales" of "La Divinidad del Monte" (Medellin 1960:pl. 22)
- d. Estere Rabón, Sayula: Monument 5 (Medellin 1960:pl. 1)
- e. Corral Nuevo: Monuments 1 and 28
- f. Laguna de los Cerros: Monuments 3, 5, 9, 11, and 19 (Medellin 1960)
- g. La Cruz del Milagro: (unpublished monument)
- h. Cuenca de Coatzacoalcos (pl. 2a,b): Small, hunched jaguar figure (unpublished)

In addition to the foregoing monuments in Museo Jalapa, the following monuments from La Venta are carved from the same kind of basalt: Colossal Head No. 2 (earlier known as Monument 2) in Museo Villahermosa; and the following monuments housed in La Venta Park at Villahermosa: Altars 1, 3, 4, 5, 6, and 10, as well as Monument 13. Monuments 19 and 23 from La Venta, now housed in the Museo Nacional, Mexico City, also appear to have been carved from the same basalt.

No useful purpose would be served by describing the slight variations to be noted in the textures and proportions of the constituent minerals of these basalts. They differ from the basalts of Cerro El Vigía in that they contain abundant large phenocrysts of feldspar, fewer and generally smaller phenocrysts of augite and olivine, and in the much more extensive alteration of the olivine to iddingsite (fig. 4b).

A sample from one of the San Lorenzo colossal heads (referred to as Monument 4 by Stirling, 1955, and now in Museo Jalapa) will suffice for detailed description. This is a porphyritic, intergranular, and in part diktytaxitic iddingsite-augite basalt. Phenocrysts of zoned calcic labradorite-sodic bytownite range in size from about 1.0 to 5.0 mm., most of them approximating 3.0 mm. in length. Together with the feldspar phenocrysts they constitute about 60 per cent of the total volume. Phenocrysts of pale green augite, mostly about 1.0 mm. in diameter but occasionally 3.0 mm. across, constitute approximately 20 per cent of the whole. Crystals of olivine, mostly between 0.2 and 0.5 mm. in diameter and rarely more than 1.0 mm. across, constitute about 6 per cent; all are replaced by deep russet iddingsite and hematite. Granules of magnetite, abundant needles of apatite, and flakes of hematite make up the remainder. An essentially similar basalt, used at La Venta in carving Altar 4, is illustrated in Figure 2b.

Monuments from La Venta

Ten of the La Venta monuments that we examined closely resemble in composition the basalt just described from one of the San Lorenzo giant heads, and it may well be that other La Venta monuments were made of basalt from the same source. We call attention now to monuments carved from other kinds of basalt.

The polygonal columns used so extensively at La Venta probably come, as noted earlier, from a rocky islet close to the shore west of Punta Roca Partida. They consist of dense, dark gray, intergranular olivine-augite basalt (fig. 2c). Except for a few small feldspars, olivine is the only mineral that can be recognized with the aid of a hand lens, and it makes up between 10 to 15 per cent of the total volume. A few olivine crystals measure 5.0 mm. in length; most measure between 0.5 and 1.0 mm., and many are only about 0.1 mm. long. Some crystals are altered along their margins to pale yellow-green antigorite or golden iddingsite, but most of them are perfectly fresh. Subhedral and roundish granules of gray-green diopsidic augite—few measuring as much as 0.5 mm. in maximum dimension and most measuring less than 0.1 mm.—occur between subparallel laths of labradorite, mostly 0.1 to 0.2 mm. long. Phenocrysts of plagioclase are notably lacking. Euhedral grains of magnetite, a few as much as 0.2 mm. in diameter, are scattered throughout, and some of the minute, triangular and polygonal spaces between the feldspars and augites are occupied by cristobalite.

Stela 2 is carved from a strongly porphyritic basalt that differs mainly in texture from the basalt used to make the San Lorenzo heads. It contains abundant phenocrysts of olivine, up to about 1.0 mm. across, all marginally altered to iddingsite, and of greenish augite, up to 3.0 mm. across. What makes it distinctive is the trachytoid texture of the dense matrix which consists of swarms of subparallel, closely packed microlites of andesine along with minute granules of augite and iron ore. In addition, the phenocrysts of labradorite are generally corroded and heavily charged with inclusions of ore and augite.

Stela 3, the largest of the La Venta stelae, and Stela C from Tres Zapotes are carved from essentially identical basalt.

Figure 5. "Stela" from La Venta site, now in the Parque Olmeca, Villahermosa, Tabasco.

A monument now in La Venta Park, Villahermosa, was discovered at the La Venta site in April 1959. It is 8 feet 5 inches high, 30 inches wide, and 18 inches thick (pl. 2d). Pellicer (1959) lists this as No. IX but does not illustrate it. He calls it a "stela of a bearded man hugging a monster." Figure 5 is a hasty sketch of the design on this slab, but it is heavily eroded and can be made out only in part. It is illustrated here because it seems possible that our record, imperfect though it may be, may be the best available for some time to come.

A second, unnumbered and heretofore not illustrated, La Venta monument, probably found in 1959, is a large boulder designated as No. 27 in the La Venta Park at Villahermosa but listed as No. 25 in the folded end map of Pellicer (1959). It is approximately circular, and measures 72 inches in diameter and 40 inches in thickness (pl. 2c). Axe-sharpening grooves occur in the upper surface, but it is otherwise unworked. We believe that this may be an example of a boulder brought to the site but never sculptured.

Both of the monuments mentioned above consist of basalt which is distinctive by reason of the comparative scarcity of olivine and the corresponding abundance of augite, the presence of many large phenocrysts of plagioclase—almost all of them with thin, clear rims and turbid cores—and an extremely dense, intergranular matrix. We have been unable to determine the source of this basalt, but almost certainly it lies in the Tuxtla Mountains and not in the highlands south of Villahermosa.

Notably different is the basalt of the La Venta monument called the "Abuelita" and designated as Monument 5. This is a dense, olivine-rich, intergranular basalt devoid of porphyritic feldspar. Approximately 20 per cent consists of olivine crystals, mostly between 0.5 and 1.0 mm. long but exceptionally 2.0 mm. long; some of these crystals are wholly replaced by iddingsite, but in most the iddingsite is restricted to the margins. Only a single phenocryst of augite was seen in thin section. The remainder of the basalt consists of slender microlites of labradorite—few of which exceed even 0.1 mm. in length—separated by equally small, subhedral granules of augite and iron ore. The lava resembles most closely that of the La Venta columns and Stela 3, the main difference being that the groundmass is finer grained. It was probably derived from a Quaternary flow in the Tuxtla Mountains.

MISCELLANEOUS NOTES ON OTHER MONUMENTS

The crudely rectangular "footing-blocks" in some of the La Venta structures consist mainly of augite-olivine basalts, rich in conspicous phenocrysts of feldspar and identical to many of the lava boulders of the Soteapan area and to the basalts of the Giant Heads of La Venta.

Thus far all of the monumental rocks that we have described, not only from La Venta but also from Tres Zapotes, San Lorenzo, and adjacent sites, are basalts of essentially the same mineralogical composition, distinguishable from each other only on account of variations in their content of olivine, augite, and plagioclase phenocrysts, their degrees of alteration, and their textures. There are, however, at least three monuments at La Venta which are carved from quite different lavas; namely, hornblende andesites probably derived from La Unión volcano or from the bed of the adjacent Río Osthuacán. These three sculptures are Monument 21 (Drucker, Heizer and Squier 1959:200-201) housed in the Museo at Villahermosa, Altar 7, and the remarkable monkey statue (Pellicer 1959: pl. 27; pl. 1_c_ herein) housed in La Venta Park.

The andesite of Altar 7 is illustrated in Figure 2_a_. It is a vitrophyric hornblende-augite andesite. Approximately a quarter of the lava is made up of beautifully euhedral phenocrysts of hornblende, some of which measure 4.0 mm. in length. The mineral is pleochroic from pale yellow to deep brown in color, and most of the crystals are fringed with magnetite. Phenocrysts of pale green diopsidic augite, which measure between 1.0 and 3.0 mm. in length and constitute about 15 per cent of the bulk, are also euhedral. Microphenocrysts of labradorite, mostly less than 0.25 mm. long, constitute about 30 per cent, and euhedral grains of magnetite about 4 per cent. The remainder of the andesite is a matrix of dark glass and cryptofelsite containing many vesicles lines with minute spheroids of cristobalite. This lava is virtually identical with one of those collected from La Unión volcano.

The other five samples of andesite collected from La Unión volcano by us and those seen in the bed of Río Osthuacan differ from the foregoing only in having a pilotaxitic matrix composed of oligoclase microlites and interstitial cryptofelsite and in having more and larger phenocrysts of labradorite, some of which measure 3 mm. in length. Identical andesites occur as irregular blocks in an occupation deposit containing manos and metates which we noted on the north side of the La Venta site in 1962 during excavation of a pipeline trench.

In the course of our examination of stone monuments in the museums in Mexico City, Jalapa, and Villahermosa, we have noted a number of non-Olmec sculptures, or sculptures of Olmec type but of uncertain provenience, and we provide here some observations on the kinds of stones these are made of in the hope that the information may prove useful to other workers. Since we are not primarily interested in these sculptures, we did not make any effort to locate the sources of the rocks from which they were made.

1. Large seated figure in courtyard of Universidad Juarez de Tabasco, said to have been brought to Villahermosa from "el zona de La Venta." It is shown here in Plate 3a, b. The statue measures 1.4 m. across the base and is 1.735 m. high. It is carved from an extremely vesicular, pale gray andesite or basalt containing many large phenocrysts of augite, some of them half an inch long but containing only a few phenocrysts of feldspar. Accessory crystals of hornblende may be present.

2. The "Monumento Tortugas" or "Monumento Phallico" in the Museo Villahermosa seems, from a study with a hand lens, to be hornblende-rich, augite andesite devoid of large phenocrysts of feldspar. We hazard a guess that this type of lava, as well as that from which the large seated figure was carved, is more likely to have come from the highlands south of Villahermosa than from the Tuxtla Mountains.

3. Three sculptured monuments[8] in the Museo Villahermosa (pl. 4a-c) are said to have been found long ago in the Municipio de Huimanguillo, not far to the east of Villahermosa. A seated cross-legged figure (pl. 4b) is

carved from a highly vesicular augite-olivine basalt, the augite crystals measuring 2 to 3 mm. in diameter. The third sculpture (pl. 4c) is a "Janus" figure made of extremely vesicular pale gray intergranular augite-olivine basalt.

4. Monument fragment from three or four miles south of Soteapan. In 1962 we found, near the "road" leading from the highway to Soteapan, a flat, sculptured stone which we collected and left at the Pemex headquarters in Coatzacoalcos in the hope that it would be sent to the Museo Jalapa. It consists of an olivine-poor, augite-rich andesite different from any of the lavas used to make the monuments at San Lorenzo and La Venta. Phenocrysts of colorless augite, between 0.5 and 1.5 mm. long, make up about 10 per cent of the volume; phenocrysts of labradorite are more than twice as abundant, most of them measuring between 0.25 and 2.0 mm. in length. The minute, rounded grains of olivine scarcely exceed one per cent of the volume, and all are altered to a greenish-yellow montmorillonite-like clay. But the most distinctive feature of the lava is the fact that its dense matrix has a pilotaxitic rather than an intergranular texture, and consists of slender microlites of oligoclase, specks of iron ore and augite, and interstitial "cryptofelsite." The lava presumably came from a nearby, but unidentified, source in the Soteapan area.

5. Estela No. 1, El Viejon, Municipio Actopan: This monument, which is illustrated by Medellin (1960:pl. 9), consists of a different kind of lava from any we saw in the field and from any used in all other monuments that we examined. It was found about 30 kilometers north of Cempoala, a considerable distance outside the Olmec "heartland," and we describe it here since the data may be of interest to others. Medellin may be correct in assigning it to Olmec authorship, but we reserve opinion on this point. It is a pale gray, hornblende-biotite andesite or dacite. Phenocrysts of zoned plagioclase, mostly between 0.5 and 2.0 mm. long, constitute approximately 30 per cent of the volume. Their composition seems to range from sodic andesine to calcic oligoclase. Prisms of hornblende and flakes of biotite, mostly from 0.25 to 1.0 mm. in maximum dimension, are present in roughly equal amounts, together making up slightly less than 10 per cent of the whole. Both of these mafic minerals, but especially the hornblende, are converted largely to granular magnetite. The groundmass, which is cloudy with "kaolin" and hematite dust and splotched with calcite, consists of cryptofelsite and microfelsite, including a few small, irregular, clear patches of quartz. We think that this kind of lava is more likely to be of Tertiary age rather than Quaternary, and suppose that it came from some nearby source in the area lying between Veracruz and Jalapa.

6. "El Luchador Olmeca": The well known sculpture of a wrestler said to have been originally found by a native farmer on the Río Uxpanapa not far above its confluence with the Coatzacoalcos River (Corona 1962). Our notes on the stone are lost, but it is certain that the rock is distinctive and that no other monument seen by us in Veracruz or Tabasco is made of the same material. It may be an imported piece judging from its petrology, and its non-local origin is also suggested by the remarkable realism which is displayed. The piece is a puzzle, and some very special elucidation may be necessary to account for its existence.

7. Stela 1, "Piedra Labrada": This beautifully carved shaft was first described by Blom and La Farge (1926:41) and more recently by Melgarejo (1960). It bears calendrical glyphs indicating its date as 1483 A.D. Without microscopic study, we have tentatively identified the rock as an augite basalt or andesite, but do not know its source. It is, of course, much more recent than most of the sculptures described here.

APPENDIX I

Computation of the Weights of Some of the Larger Olmec Sculptured Pieces

Site	Monument	Weight (short tons)
La Venta	Stela 1	5.5
	Stela 2	10.5
	Stela 3	25.3
	Altar 1	36.5
	Altar 2	5.5
	Altar 3	13.7
	Altar 4	33.7
	Altar 5	18.6
	Altar 7	4.3
	Colossal Head No. 1	24.0
	Colossal Head No. 2	11.8
	Colossal Head No. 3	12.3
	Colossal Head No. 4	19.8
San Lorenzo	Colossal Head No. 1	25.3
	Colossal Head No. 2	20.0
	Colossal Head No. 3	9.4
	Colossal Head No. 4	6.0
	Colossal Head No. 5	11.6
Tres Zapotes	Colossal Head No. 1	7.8
	Colossal Head No. 2	8.5

NOTES

1. While certain rectangular, flat-topped stone sculptures from the sites of La Venta and San Lorenzo look like what are usually called "altars," there is not the slightest evidence that they were so employed. We retain the term as a purely descriptive one.

2. Some estimates of the amount of labor required to raise the earth structures and associated features at the La Venta site have been made earlier (Heizer 1960, 1961).

3. See Appendix I.

4. Compare our remarks with those written by Keiller, Piggott and Wallis (1941) in connection with their investigation of the sources of the stones used in making Neolithic stone axes in the British Isles: "At the outset...it was recognized that an examination of stone implements by their macroscopic characters alone would not suffice for their precise identification. Even if a freshly fractured surface is available, it is doubtful whether a correct identification can be made, except perhaps with such distinctive rocks as are found in the Presely Mountains and at Bwlch Mawr. It cannot be too strongly stressed that modern microscopical methods, applied to thin sections, form the only satisfactory criterion in the identification of [the stone of] implements."

5. Good bibliographies to publications dealing with these sculptured pieces can be found in Jones (1963), Garcia Payon (1963), and Smith (1963). Medellin (1960:map opp. p. 80) shows the location of Olmec and Olmec-related sites on the Gulf Coast of the states of Tabasco and Veracruz. A list of La Venta monuments can be found in Drucker, Heizer and Squier (1959:App. I).

6. One end of the islet has been lowered to about sea level, and from its appearance from the air this area looks like a quarry. We have thus far, in spite of several attempts, been unable to visit this locality.

7. There are other early dated sculptures from the area, such as the Tuxtla Statuette (Holmes 1907, 1916), but this is a small, portable object and not comparable to the much larger Stela C. If Stela C, now broken at each end, was originally three times the size of the presently known midsection, it would weigh about three-quarters of a ton.

8. One of these (pl. 4a) is highly vesicular and characterized by large augite phenocrysts 3 to 4 mm. in diameter and small olivines. It portrays a seated and cross-legged figure with the face tilted back to a nearly horizontal plane and rather resembles an Olmec sculpture described over thirty years ago by Nomland (1932), who believed that the figure represented a proboscidean. In 1962 we made a visit to the village of Moloacan on Arroyo Sonso to look for this sculpture but learned that it had been transported to Europe about 1932 or 1933 by a Swiss geologist named Tappolet(?) who was employed by the Aguila Oil Company.

EXPLANATION OF PLATES

Plate 1 a. Rectangular stone basin adorned with *Pecten* shells, from Tres Zapotes. Now in plaza at Santiago Tuxtla.

b. Rocky islet of columnar basalt west of Punta Roca Partida. Note probable quarry area in foreground.

c. Monument depicting monkey with the hands clasped behind its head, from La Venta site. Now in Parque Olmeca, Villahermosa, Tabasco.

Plate 2 a,b. Small hunched jaguar figure from Cuenca de Coatzacoalcos. Now in Parque Olmeca, Villahermosa, Tabasco.

c. Large boulder, approximately circular, measuring 72 inches in diameter and 40 inches in thickness, from La Venta. Same location as a.

d. Monument discovered after 1955 at La Venta. It is 8 feet 5 inches high, 30 inches wide, and 18 inches thick. Pellicer (1959) calls this a "stela of a bearded man hugging a monster." See Figure 5 (p. 19) for sketch of design on this slab.

Plate 3 a,b. Large seated figure carved from vesicular, pale gray andesite, measuring 1.4 m. across the base and 1.735 m. high. Said to have been brought to Villahermosa from La Venta in 1905 by Don Policarpo Valenzuela. Now in Universidad Juarez de Tabasco. Photos supplied by courtesy of Dr. Carlos Sebastian Hernandez, Conservador del Museo Regional de Tabasco.

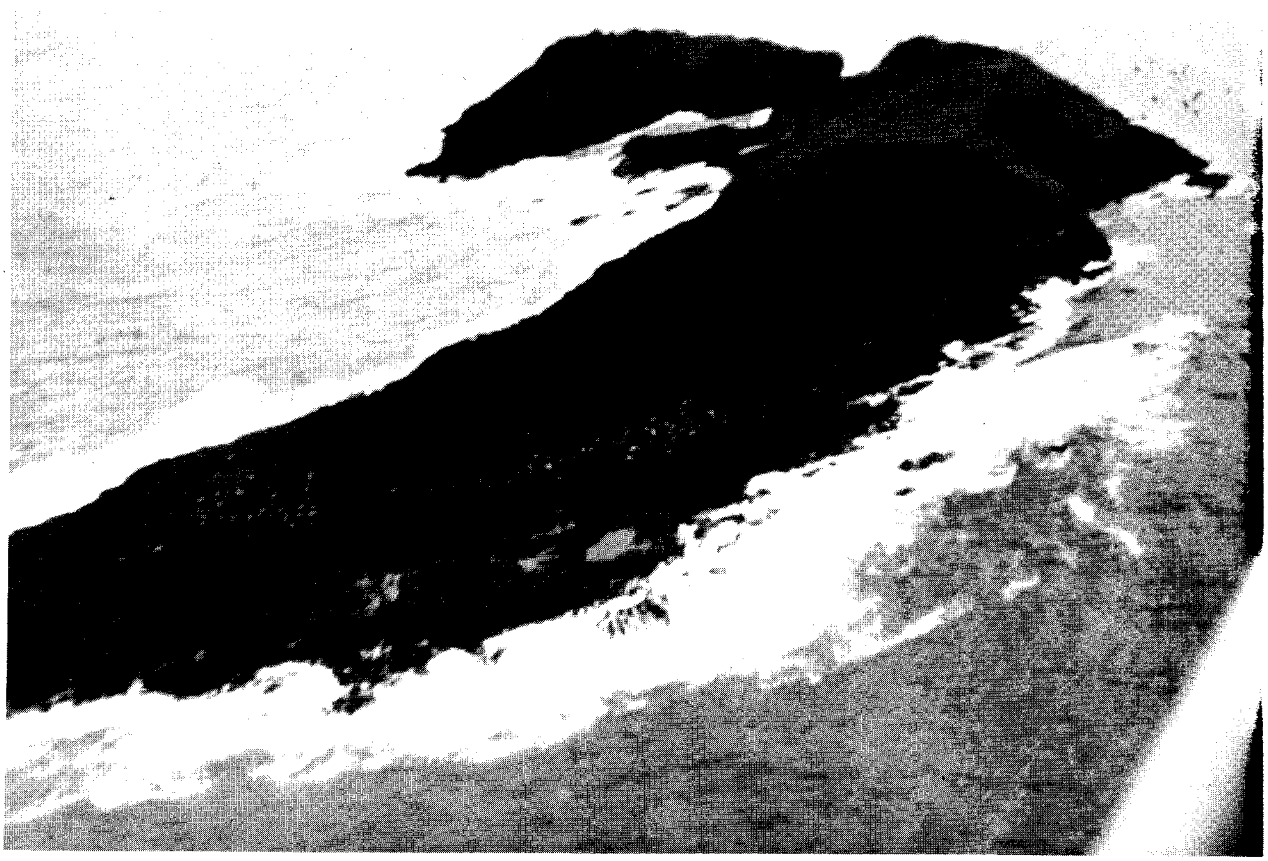
Plate 4 a. Sculptured figure, highly vesicular, probably from the Municipio de Huimanguillo, not far to the east of Villahermosa. Now in the Museo Villahermosa.

b. A seated, cross-legged figure carved from highly vesicular augite-olivine basalt. Same location as a.

c. "Janus" figure made of extremely vesicular pale gray intergranular augite-olivine basalt. Same location as a.

a

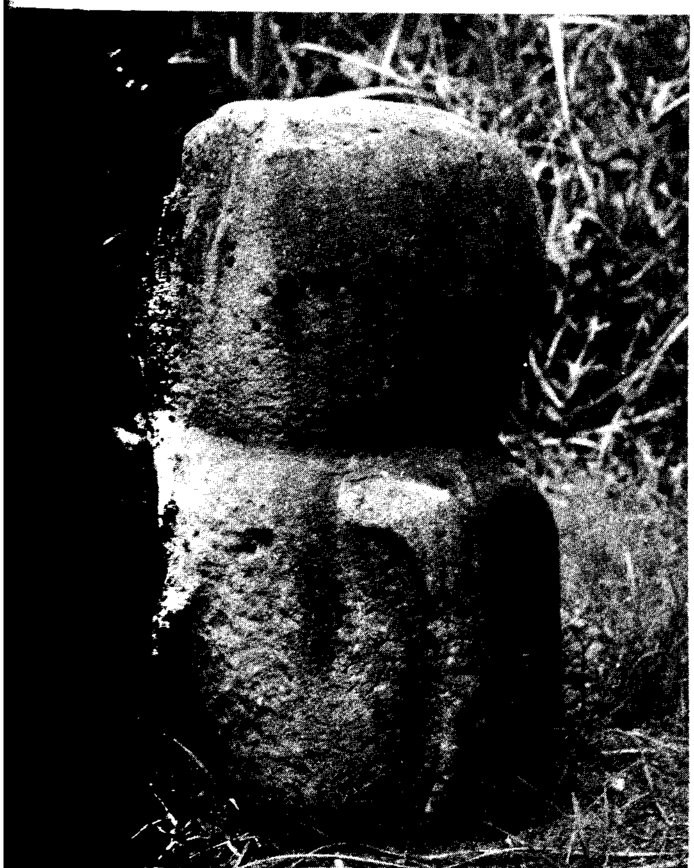
c



b

a

c

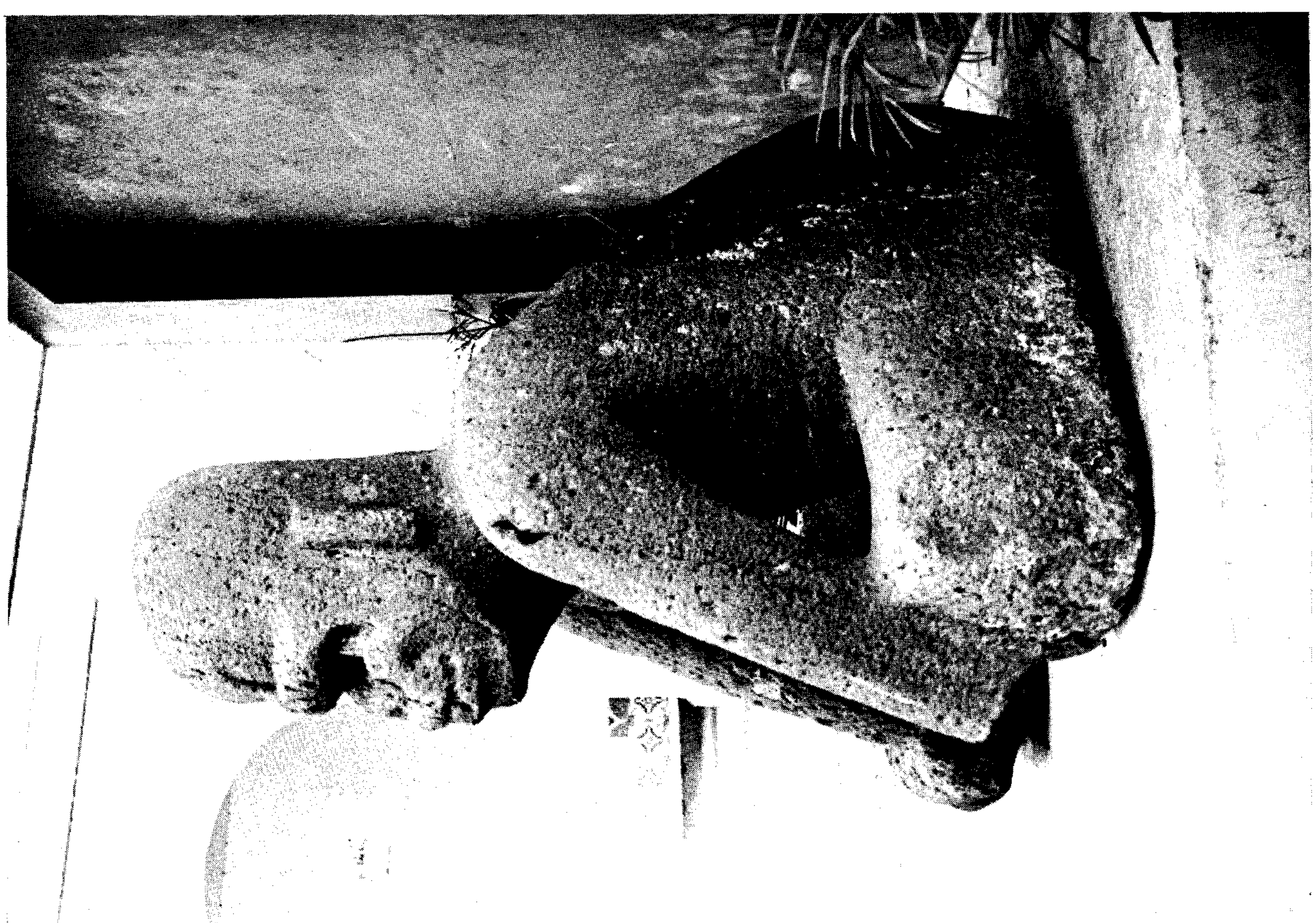


b

d

Plate 2

b



a


GRAN JAGUAR CON MASCARA CULTURA
DE LA VENTA, 1er. MILENARIO ANTES J. C

a

b

c

Plate 4

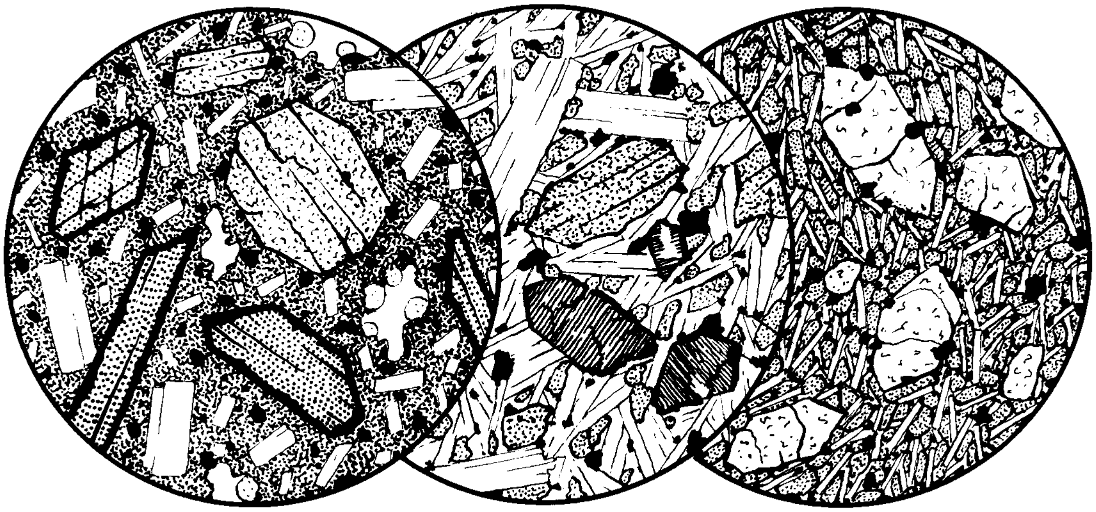


Figure 2. Lavas used in some of the monuments at La Venta. Diameter of each field 2.5 mm.

a. Hornblende-augite andesite of Altar 7. Spheroids of cristobalite line the vesicles.

b. Olivine-augite basalt of Altar 4. Olivine largely replaced by russet iddingsite.

c. Olivine-augite intergranular basalt from one of the columns.

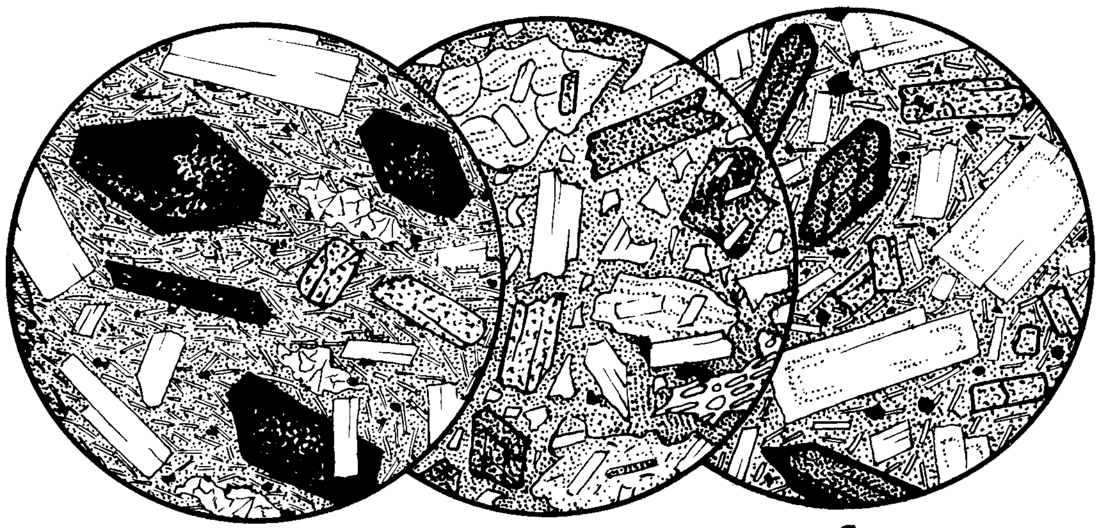
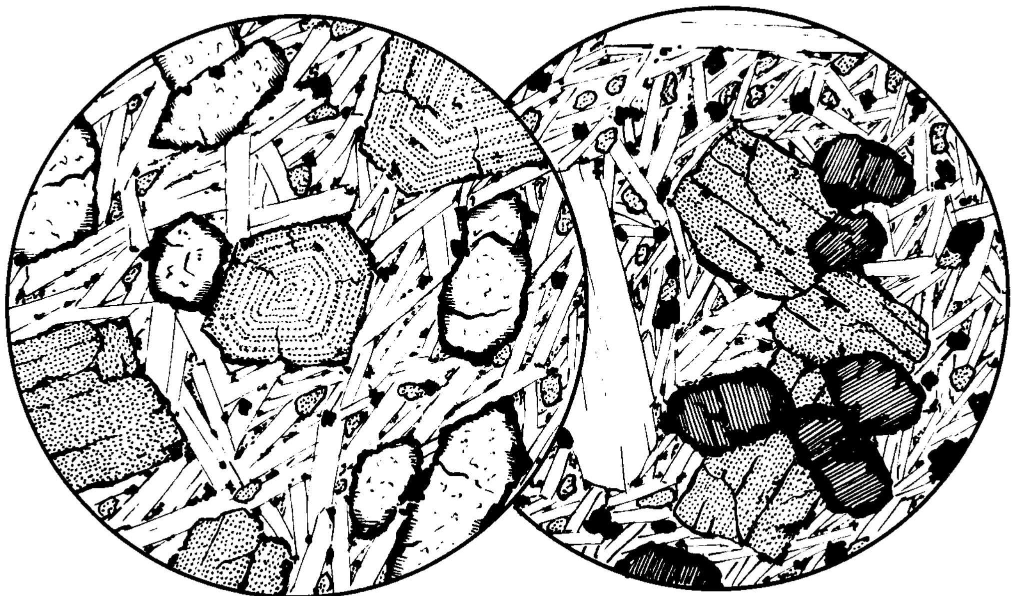


Figure 3. Andesites used in some of the monuments at Cerro de las Mesas. Diameter of each field 2.5 mm.

_a_. Oxyhornblende-hypersthene andesite with tridymite-filled pores, Stela 9.

_b_. Andesitic crystal-vitric-lithic tuff, Stela 3. Chips of vitrophyric andesite, one of them pumiceous, and broken crystals of dark green hornblende, paler hypersthene, and colorless plagioclase in a matrix of glass-dust.

_c_. Oxyhornblende-hypersthene andesite, Monument 6. Brown hornblendes rimmed with magnetite; hypersthene and a little augite; phenocrysts of zoned labradorite-bytownite, and microliths of oligoclase in a matrix of 'cryptofelsite.'



a b

Figure 4. Basalts from Cerro El Vigía (a) and from one of the San Lorenzo giant heads, Monument 4, Museo Jalapa (b). Diameter of each field 3 mm.

a. Zoned phenocrysts of augite, and phenocrysts of olivine with only slight marginal alteration to magnetite and iddingsite.

b. Olivine phenocrysts completely altered to deep russet iddingsite; augite phenocryst unzoned; note also parts of two large plagioclase phenocrysts.

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Abbreviations Used

AA	American Anthropologist
AAnt	American Antiquity
BAE-B	Bureau of American Ethnology, Bulletin
KAS-P	Kroeber Anthropological Society, Papers

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