

The Cross Petroglyph: An Ancient Mesoamerican Astronomical and Calendrical Symbol

Un diseño representando un círculo doble dividido en cruz se encontró tanto grabado sobre rocas como en pisos de edificios por toda Mesoamérica. De probable origen teotihuacano, la figura sugiere conocimientos astronómicos y calendáricos. Como continuación de un trabajo anterior, reportamos aquí la existencia de varios ejemplos más de este dibujo, incluyendo un caso único que comprende un alineamiento astronómico doble (en el solsticio de verano y en los equinoccios) y ocurre cerca del Trópico de Cáncer.

Nuestra interpretación sugiere que los astrónomos teotihuacanos buscaron un lugar donde el sol en su posición en el cenit llega a su extremo más al norte, concepto astronómico notablemente sofisticado.

INTRODUCTION: THE NATURE OF THE QUARTERED CIRCLE

Of all the traits of Mesoamerican cosmology perhaps none is more pronounced nor widespread than the quadripartite division of the universe. We see this concept reflected in pre-Conquest calendars, religious games, color-coded cardinal directions, even in the morphology of certain Maya hieroglyphs. The quartered circle appears in many forms in the art and iconography of ancient America where it is interpreted in a purely symbolic manner to signify "sky", "heaven", "sun", or "time" - even "the day". Several examples are depicted in Fig. 1. However, our tendency to view ancient New World mental systems in too dim and intellectual light often results in the failure to penetrate beyond a purely symbolic level of inquiry. Consequently, we deny our-

selves the opportunity to explore a way of thought we characterize in our own culture as "pure science". Except in the case of the hieroglyphic writing, and then only grudgingly, we are unwilling to explore the possibility that the ancient Mesoamericans were organizing and systematizing fundamental observations pertaining to the natural world and using these data to create a self-correcting predictive system.

In this paper we attempt to shed light on a number of quartered circle designs pecked in the rocks and in the floors of buildings of ancient Mexico (hereinafter these are referred to as pecked crosses) which, at least in part, appear to have been utilized in a systematic way. A study of the basic properties of these pecked crosses reveals that their purpose transcends the purely symbolic. The carvings appear to have functioned as architectural benchmarks, devices for determining astronomical alignments, and calendar counting devices all at the same time. Our exploration of their properties leaves us with the distinct impression that the builders of the ancient cities of the Americas sought to create a style of ceremonial architecture which functioned in total harmony with the cosmos. The location, arrangement and execution of their architecture was, therefore, not purely formal.

The pecked crosses are numerous and widely distributed (see Fig. 3a). Their properties have been analyzed in detail elsewhere (Aveni, Hartung, and Buckingham 1978). In this paper, we look at two groups among these designs, those found in the environments of Teotihuacan and Alta Vista, Mexico. Representative examples of the petroglyphs along with a few from other regions of Mexico are pictured in Fig. 2. These aggregates best exemplify the theme of this paper; that quartered circles sometimes take on a functional aspect which seems to be connected with early attempts to practice scientific astronomy and develop a calendar.

1. THE TEOTIHUACAN SYSTEM

In Fig. 3b and 3c we pinpoint on a topographic map the location of all the pecked crosses in and around Teotihuacan discovered to date. When we examine them as a group we discover that they yield an impressive set of properties which implies that they bore a direct connection to the planning and orientation of the great ceremonial center:

- a) The axes of the cross petroglyphs located within the city are directed to within a degree of the prevailing direction of the Teotihuacan grid. The eccentric positions of some of the crosses on the floors of the buildings and the penetration of the designs through more than one layer of flooring implies that maintenance of the designs in situ was of considerable importance to the people who built Teotihuacan.
- b) Lines connecting the petroglyphs with each other or with prominent features in the ceremonial center fit the grid precisely. Two examples:

- 1) A line connecting the designs pictured in Fig. 2 a and 2 b lies almost exactly perpendicular to the Street of the Dead. Viewed to the west, this alignment correlates with a significant astronomical direction, the setting of the Pleiades star group at the time Teotihuacan was erected.
- 2) An alignment between the pecked circles Fig. 2 c (located at the summit of Cerro Gordo) and the center of the Pyramid of the Sun is exactly parallel to the Street of the Dead. This direction, when extended, passes through the center of the Ciudadela, a major structure in the southern part of the city.
- 3) A line connecting the center of the Pyramid of the Sun to a pecked circle on Cerro Maravillas (see Map, Fig. 3 b) lies exactly in the true east-west direction.
- 4) All other petroglyphs in the wider Teotihuacan environment are situated on rock outcrops which are tilted in the direction of the ceremonial center.
 - a) One of the most notable examples can be found at the ruins of Tepeapulco. Situated 33 km NNE of Teotihuacan, this trade route outpost was probably built in its present appearance during the Xolalpan phase, about AD 450. One of three pecked cross symbols at Tepeapulco is found at the SW end of a flattopped hill overlooking the ruins. The symbol, pecked on flat rock, has its axis oriented toward Cerro Gordo, the large mountain at the north end of the Street of the Dead. Viewing from Tepeapulco one sees a pair of low hills occupying the foreground position. They flank opposite ends of a saddleshaped feature from the center of which Cerro Gordo protrudes. The visual effect gives the impression that careful environmental considerations dictated the selection of the rock on which the Teotihuacanos would peck their symbol.
 - b) A pecked cross on the northern slope of Cerro Teponaxtle, 10 km south of Teotihuacan, is situated less than 1/2 minute of arc out of line with that parallel of geographic longitude which passes through the Pyramid of the Sun. The axis of this design does not point toward Teotihuacan but instead is directed to within $1\ 1/2^\circ$ of the orientation of the Teotihuacan grid. Cerro Patlachique blocks the view into the ceremonial center.

At this stage it is not possible to advance a single hypothesis to account adequately for the placement of all the Teotihuacan pecked cross symbols, but one conclusion emerges quite clearly. Enough order is present in the data to imply deliberate and conscious planning on the part of the Teotihuacano. The geography, astronomy and architecture of the great ceremonial center all appear purposefully connected. Ancient surveyors seemed concerned about

skewing the orientation of their city both from the cardinal directions and from the natural topographical trends, probably because the stars, as gods in their heaven, dictated that they must do so. Once the center was laid out, a link with the four cardinal directions had to be established. Therefore, it is not surprising that we find an alignment of one of the major pyramids fitting the true east-west direction. It also seems natural that architectural benchmarks in the wider environment would bear a geodetic connection with the main religious center. As surprising as the orderly arrangement of the signs in and around Teotihuacan might seem, we find that the people who built the great ceremonial center are due even more respect, for as we shall see, they carried their symbolism intact to the remotest regions of their empire.

2. SEEKING THE TROPIC OF CANCER

At the ceremonial center of Alta Vista 650 km northwest of Teotihuacan, the astronomers of ancient Mexico achieved the pinnacle of accuracy. Once the Teotihuacan empire spread beyond the area we now know as Mexico, we believe there arose a need to standardize the calendar by timing the motion of the sun throughout the year in all parts of the empire. One of the key sunwatching sites was the place where the sun turns around on its annual journey among the stars - the Tropic of Cancer. Here, with the approach of the summer rainy season, the sun migrates ever closer to the zenith or overhead position in the sky, standing precisely in that place on the first day of summer, June 21. It is only at the Tropic that the zenithal passage corresponds with the longest day of the year, the day when the sun attains its greatest northerly rising and setting positions along the horizon. These astronomical events, all separately important, happen at the same time in the latitude of the Tropic. Any sunseeking people would be expected to record the presence of the events at this very important place and the Teotihuacan colonists did so in a very special way.

A few kilometers south of the Tropic we find the ruins of Alta Vista. A complex of buildings dating from AD 450-650 (about five centuries after the Pyramid of the Sun was built) surrounds the main structure, a Sun Temple that had its corners arranged to point precisely toward the cardinal directions. Standing in Sun Temple and looking to the east, an observer sees the sun rise at the equinoxes on the southern flank of the most prominent peak on the local horizon. Now, the equinoxes represent the two dates of the year when days and nights are of equal length. On these dates (March 21 and September 20) the sun rises exactly in the east, sets exactly in the west, and attains its greatest daily motion relative to the horizon.

Cerro El Chapin is a plateau of dimensions 80 x 250 m located 6.5 km SW of the ruins. On its eastern summit we find a pair of pecked crosses separated by about 50 meters. From either petroglyph the observer sees the sun rise at the summer solstice at precisely the same point where the Sun Temple observer saw the equinox event three months earlier and where he would see it three months later. Furthermore, the axes of the pecked circles point in the general direction of the rising sun. Fig. 4 illustrates this curious double alignment.

In Fig. 5 we view the eastern horizon from the vantage point of a) the Alta Vista ruins and b) the El Chapin petroglyphs. For easy recognition in the vertical view on the topographic map of Fig. 4, we transfer the labels of peaks A through D onto the horizontal views in the photographs of Fig. 5.

Even though the horizons as viewed from the two observation points possess different elevations, the double alignment was engineered to work perfectly. But how was this remarkable task accomplished? Most probably, the Chapin site was selected first and the astronomical-topographical considerations then determined where the ceremonial center would be located.

The selection of El Chapin as an observing station surely must not have been a trivial project. First the Teotihuacan astronomers were required to seek the Tropic. This would entail a long-range program of repeated observations at many test sites around the time of the summer solstice. With a post set straight up in the ground or by passing the light of the noon day sun through a carefully aligned vertical tube, observers could pin down the location of the Tropic to within 10 or 20 kilometers. Next, one would need a noteworthy permanent landmark to register the solstitial sunrise as well as an appropriate backsight from which to make the annual observations and perform the attendant ritual. Any alignment parallel to the line from Chapin to Peak B in Fig. 4 will work but few could have made the event as dramatic as the viewer who visits Chapin at the Solstice actually sees it (1).

Next, astronomers would be required to lay out the equinox line in order to determine the proper place to build the Sun Temple. But determining the equinox is no simple matter. If the first days of autumn and spring fell midway between the beginnings of summer and winter, an observer could simply count days from the solstice and put markers in place at the mid-points in time between the first days of summer and winter. However, the seasons are not of equal duration, the winter-to-summer interval being six days longer. An averaging process consisting of double observations from opposite solstices would minimize the error, but the ancient astronomer would have to note that the position of sunrise remains nearly stationary for several days either side of solstice. This further complicates any day counting scheme.

Sighting the Pole Star is an alternate possibility though there is hardly reference to it in the chronicles. By making nightly observations, an observer would notice that all the stars circulate around the north celestial pole, a point in the sky marked closely by Polaris. With small corrections for the movement of Polaris to either side of the pivotal point, engineers could mark the mid-point of the migration of the Pole Star and extend the line from the sky vertically downward to the horizon with a plumb line. This would give the astronomers a north-south line. The east-west axis could be obtained by bisection of the north-south line using poles and ropes. Whether either of the aforementioned techniques or some other procedure was employed, the whole process of laying out the Tropic alignments required great organizational

capacity, a technology of considerable sophistication and a good deal of patient observing. But architects capable of planning and constructing Teotihuacan would surely be equal to the task of developing and producing the astronomical alignments we find today at the Tropic. Furthermore, given our knowledge of their abilities and interests, we might well expect Teotihuacan astronomers to erect solar alignments in other parts of their empire.

If we find a summer solstice alignment at the Tropic of Cancer we might also expect to anticipate winter solstice orientations there. An examination of Fig. 4 suggests the most obvious prediction to test our ideas. Suppose the notch adjacent to peak B is again the foresight. Then the backsight must lie somewhere along a line from peak B to the northwest (the line dotted with question marks in Fig. 4). A logical location for the backsight would be the NE slope of the hill marked 1 or the elevation immediately to the northwest of it (Position 2). Both areas should be carefully examined for signs of a cross petroglyph. The mountains west of the pueblo of Los Angeles (just off the northwestern edge of the map) offer an alternative place to search for another pecked cross symbol.

Even if no new discoveries are immediately forthcoming, the fact remains that the information about pecked cross petroglyphs at Teotihuacan and Alta Vista reveals an overwhelming number of coincidences which imply that the rulers of ancient Mexico 15 to 20 centuries ago were anything but passive when it came to viewing and describing the natural world. The evidence is there for all to see. We must view the role of astronomy in city planning with more introspective eyes. The Teotihuacanos were not simply waiting for natural events to befall them. They were making a conscious and ambitious, if somewhat laborious, attempt to find out in advance where and when important celestial phenomena would happen. In a sense, their astronomical goals were even more lofty than those of the Greeks, for in the process they sought to make themselves a part of the events as they actually took place by virtually integrating nature into their sacred ceremonial space.

At this stage, we can only wonder at how many other times and in how many other places in their long history the people of ancient Mexico rose to a similar challenge.

NOTES

- (1) The actual task of marking the date of arrival of the sun at solstice by watching sunsets is in itself quite formidable because the sun shows drastically as it approaches and recedes from its horizon extremes. Ethnologist Ruth Bunzel (1932: 512) provides us with concrete evidence on the matter of horizon sun watching by contemporary native people of this region. She refers specifically to the pekwin or shaman who around the time of the solstice observes the position of sunrise and sunset over distant landmarks. Ceremonies are held for several days around each solstice and

the announcement of the actual arrival of the sun at its extreme positions is made eight days before. The planting of prayer sticks occurs precisely on the solstitial date. On another occasion the warning interval is ten days. The evidence suggests that the shaman may have struggled considerably with the problem of predicting precisely when the sun would come to a standstill.

REFERENCES

- Aveni, Anthony F., Horst Hartung and B. Buckingham
1978 The Pecked Cross Symbol in Ancient Mesoamerica. "Science", 202:
267-279. New York.
- Bunzel, Ruth
1932 Introduction to Zuni Ceremonialism. Bureau of American Ethnology,
47th Annual Report 1929-1930. Washington, D.C.

FIGURE CAPTIONS*

Fig. 1: The Quartered Circle in Ancient Mexican Iconography

- a) A mythological animal devours the sun, which is represented by a quartered circle. A total eclipse on the sun results. The frieze on the Temple of the Plumed Serpent at Xochicalco (AD 800) in Central Mexico is filled with other astronomical and calendrical symbolism.
- b) Calendar wheel from the Book of Chilam Balam of Kaua. The earth is at the center and from it emanate the cardinal and intercardinal divisions of the cosmos. The days flow around the horizon. The diagram is thus made to symbolically unify space and time, a goal so lofty even modern physicists of our own western culture who devised the theory of general relativity still seek it. After C.P. Bowditch, 1910, "The Numeration. Calendar Systems and Astronomical Knowledge of the Mayas", Cambridge: Harvard Press, Fig. 64.
- c) Three Maya hieroglyphs, abstract expressions of the quadripartite view of nature.
 1. Lamat, day sign from Palenque, Temple of the Inscriptions.
 2. Yaxkin, month sign from El Cayo.
 3. Kin or "day", Dresden Codex, pg. 61.

After J.E.S. Thompson, 1971, "Maya Hieroglyphic Writing", Norman, University of Oklahoma Press.

* All maps, drawings, and photos unless otherwise specified are by H. Hartung.

- d) An Aztec game of patolli. Post-conquest chroniclers tell us that the indians played a game like pachisi on a board carved or painted in the floors of their ceremonial buildings. The four arms of the game board signify the cardinal directions. After Duran's "Book of the Gods, Rites and Ancient Calendar", ed. F. Horcasitas and D. Heyden. Norman, University of Oklahoma Press, 1977, P1. 32.
- e) Among the graffiti scratched on the walls of Building 5 E-60 of Group and f) G Complex (Los Acanaladores) at Tikal, Guatemala, appear several double circular designs. Each figure, about 10 cm in diameter, is bisected by a vertical axis. They may have been used as game boards or counting devices. Note the pair of inlaid stones (one has fallen out) symmetrically located within the inner circle of Fig. 1 f.

Fig. 2: Pecked Cross Petroglyphs

- a) A pair of designs at Teotihuacan. a) is carved in the floor of a building near the Pyramid of the Sun in the ceremonial center. b), pecked in a lone rock outcrop, is located 3 km to the west of a). A line between the two points to the setting position of Pleiades star group at the time Teotihuacan was built. The alignment also fits the east-west Teotihuacan axis perfectly.
- c) This petroglyph is carved on a rock at the summit of Cerro Gordo, 7 km north of the Sun Pyramid. It lies on the north-south Teotihuacan axis. The entire city is tilted $15\ 1/2^\circ$ horizontally out of line with the cardinal directions, probably to correspond to the astronomical alignment with the Pleiades.
- d) In almost all cases those petroglyphs which are carved on rock outcrops offer a commanding view of the horizon. This example, actually a square design, is located at the ruins of Tlalancaleca, near the modern city of Puebla. One of its axes points to the rising position of the sun at summer solstice.
- e) One of two pecked circles on the eastern summit of Cerro El Chapin at the Tropic of Cancer (latitude $23\ 1/2^\circ$ North). Like the companion design 50 meters to the north, it contains 260 holes and its axis points to the rising sun at the summer solstice. For three-quarters of the designs we find that the pattern on the axes of the cross arms consists of 10 holes counted from the center to the first circle, four between circles and four beyond the outer circle, perhaps to tally the number of months in a year.
- f) This large design occupies nearly 20 sq. meters of a lava bed near Durango, Mexico. The function of the pair of deep depressions near the center has not yet been determined. Note the stark resemblance between this petroglyph and the graffiti at Tikal, particularly Fig. 1 e).

Fig. 3: Maps showing the location of pecked crosses in Mexico and around Teotihuacan

- a) Pecked crosses discovered in Mexico to date.
- b) Large-scale map of Teotihuacan showing positions of designs in the wider environment.
- c) Enlargement of main portion of the ceremonial center showing placement of several pecked designs in the floors of the buildings.

Fig. 4: Topographic map of the region around the ruins of Alta Vista near the Tropic of Cancer, showing the equinoctial alignment from Sun Temple, Alta Vista and the summer solstice alignment from pecked cross petroglyphs on the summit of Cerro El Chapin. Both lines are directed toward the pinnacle, peak B, on the eastern side of the map. A hypothetical winter solstice alignment beginning somewhere north of the ruins and terminating on peak B is also shown. The discovery of a marker somewhere along this line would further strengthen the suggestion that Teotihuacan astronomers, journeying to the northerly reaches of their empire, deliberately imposed a solar calendar on the landscape at the Tropic. The present-day Tropic of Cancer, which is located south of the ruins, is also pictured. At the time of the formation of Alta Vista it would have been located slightly north of the ruins. Contour intervals are 100 meters.

Fig. 5: The eastern horizon as viewed from two sun-watching stations on the Tropic. Peaks A through D from the map of Fig. 4 are labelled.

- a) The horizon from the Alta Vista ruins. The Sun Temple lies in the foreground. At the equinox the sun rises in the notch to the right of peak B.
- b) The same section of horizon viewed from 6.5 km SSW of the ruins - the location of the pecked crosses on the summit of Cerro El Chapin. One axis of the cross shown in the foreground points in the general direction of peak B where the sun rises on the first day of summer. Both petroglyphs on Chapin are composed of 260 holes which were probably used to tally the days of the ritual calendar which was known to have possessed 260 days.

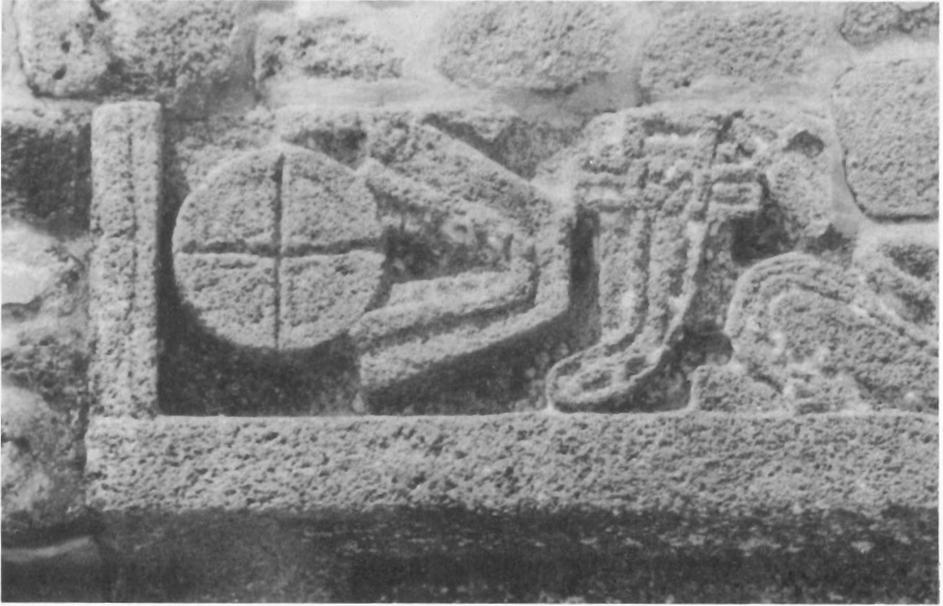


Fig. 1a

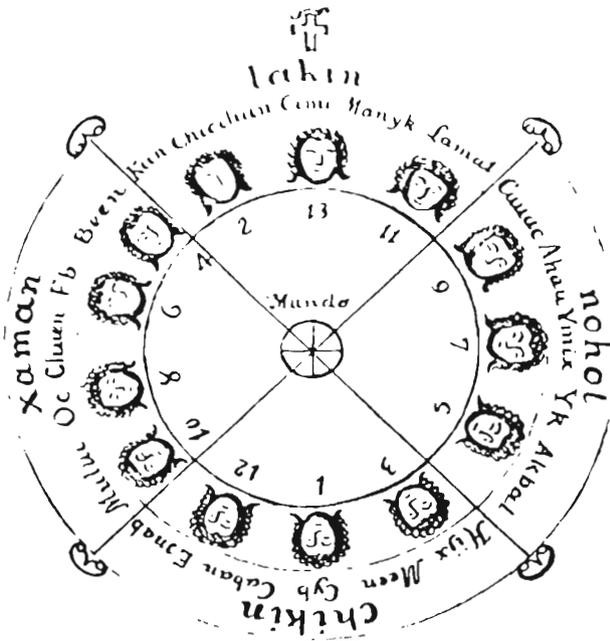
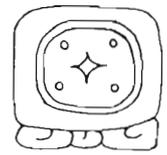
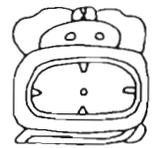


Fig. 1b



Lamat



Yaxkin



Kin

Fig. 1c

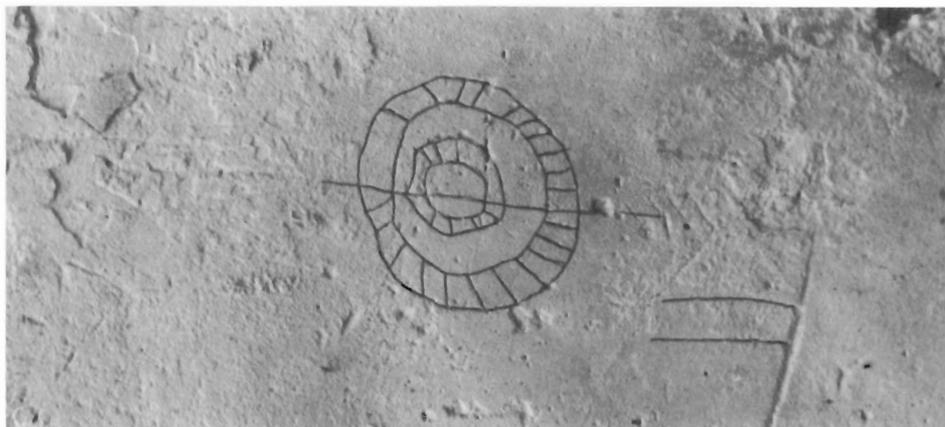


Fig. 1f

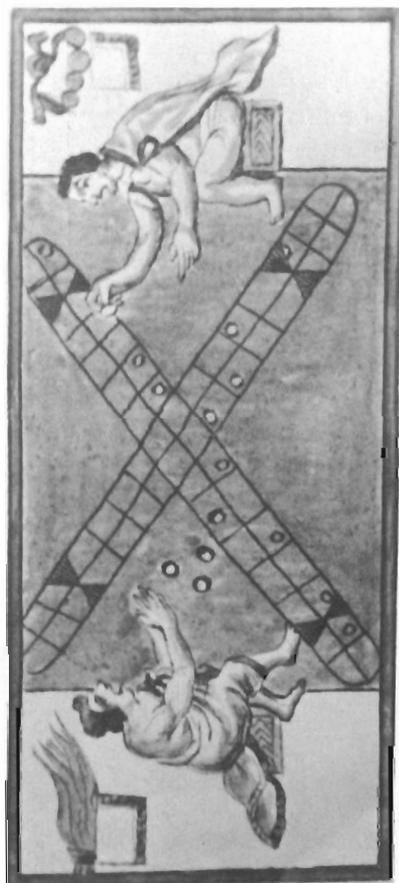


Fig. 1d

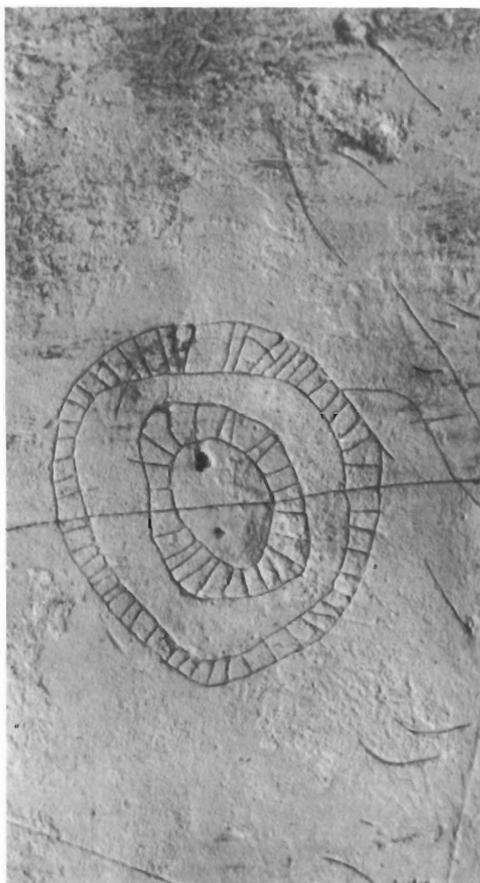


Fig. 1e



Fig. 2a



Fig. 2b



Fig. 2d



Fig. 2c



Fig. 2e



Fig. 2f

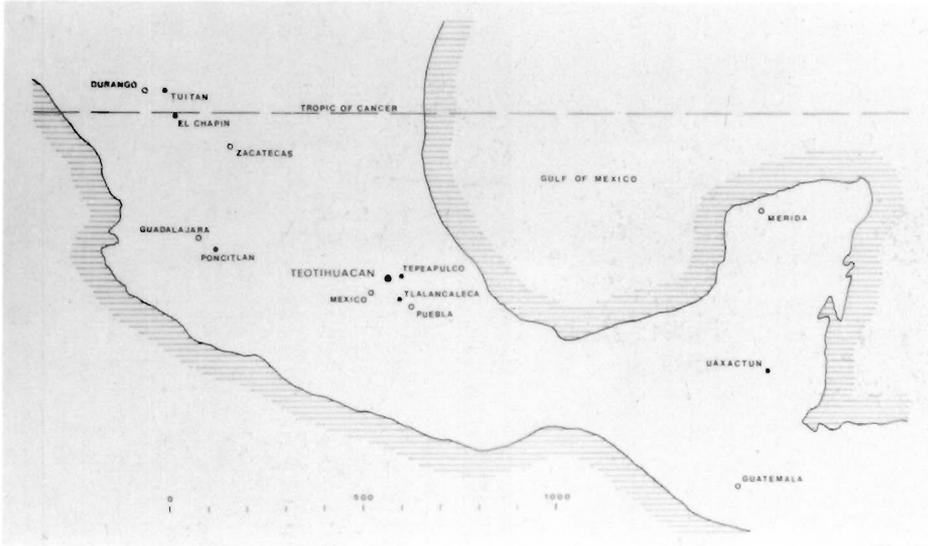


Fig. 3a



Fig. 3b

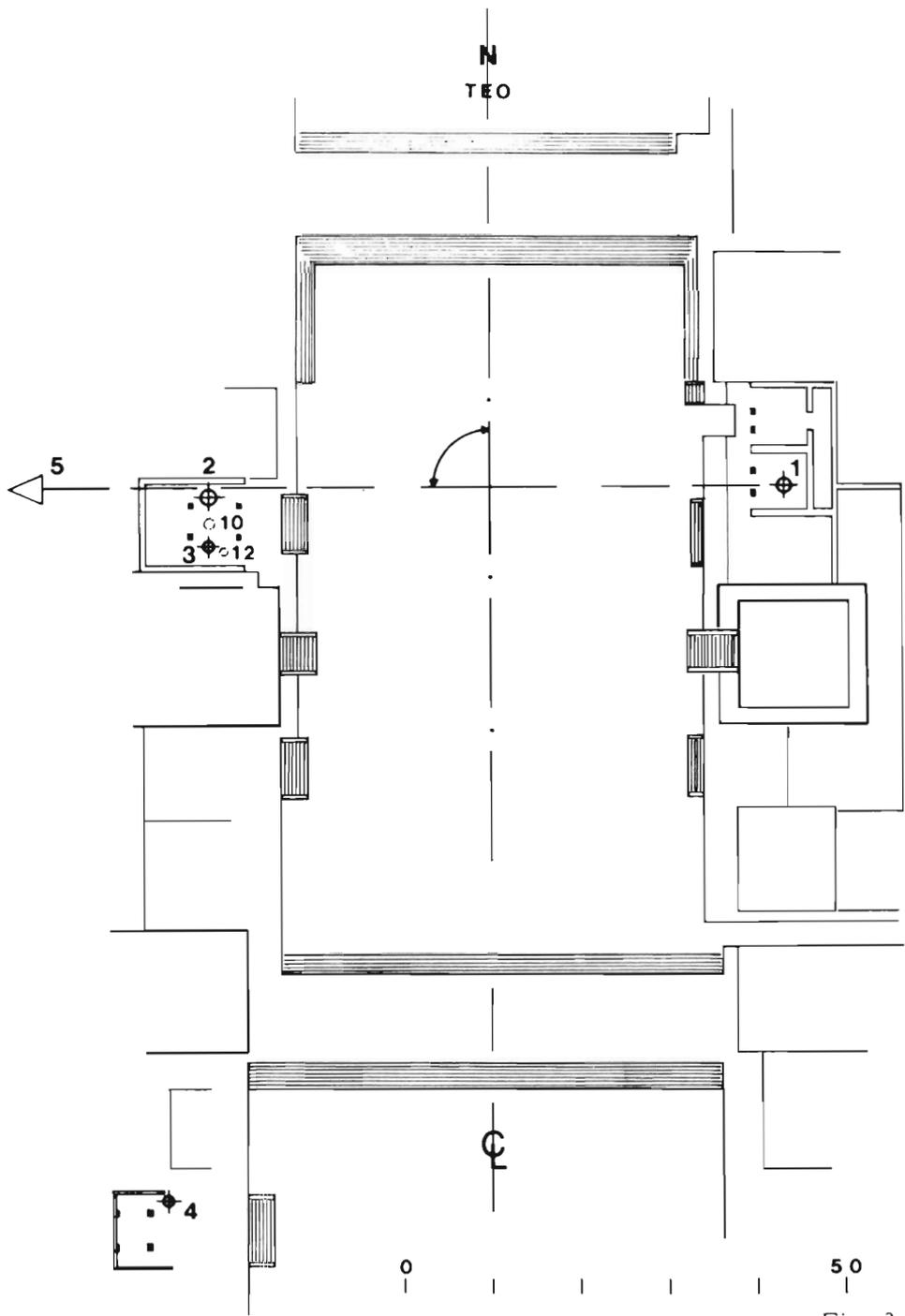


Fig. 3c

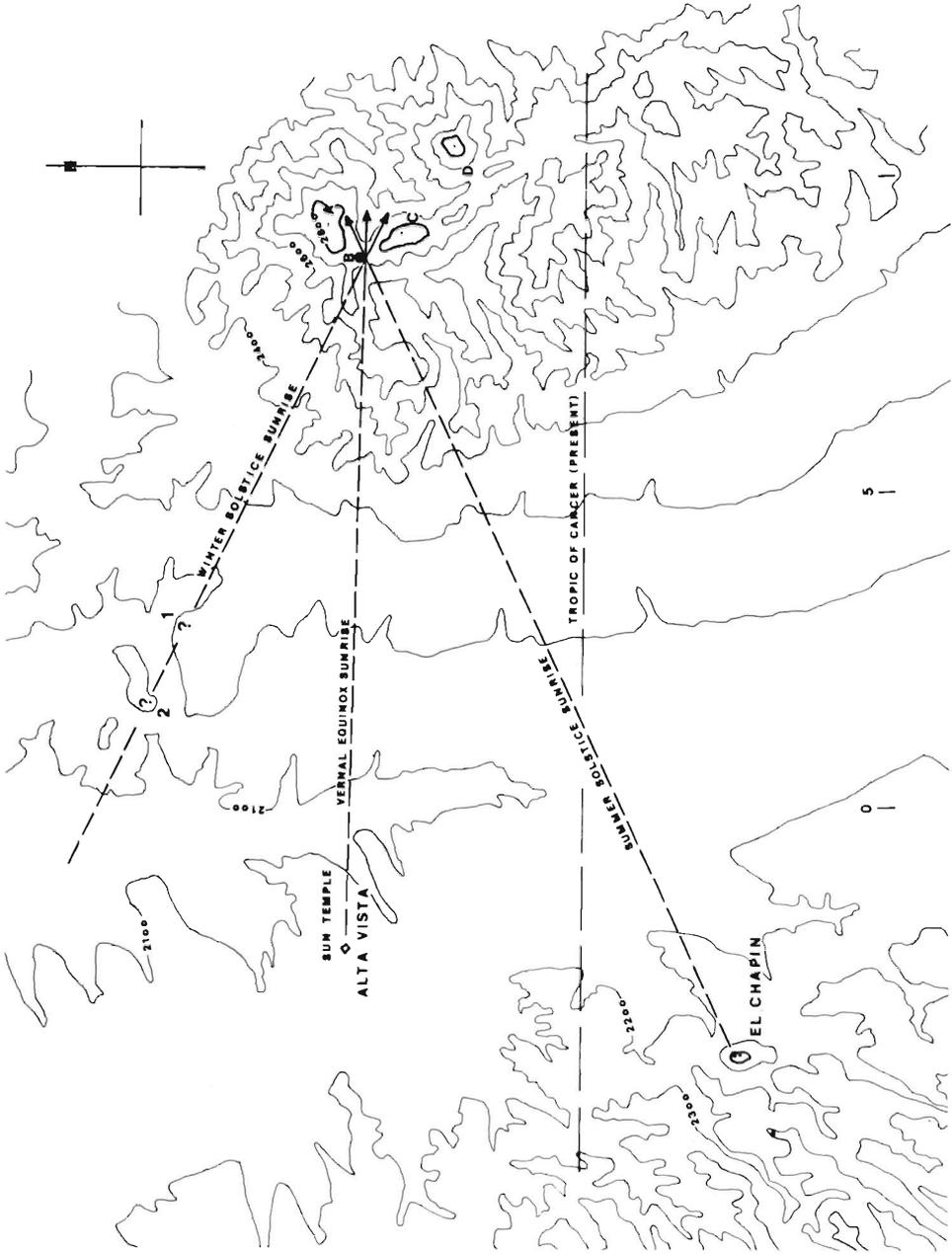


Fig. 4



Fig. 5a



Fig. 5b