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CASE STUDIES WITH ARCHAEOASTRONOMIC APPROACH IN THE STATE OF TABASCO, MEXICO

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ABSTRACT

In the year of 2016 started the Research Project Archeology, Archaeoastronomy, Calendar and Landscape Olmec and Maya (PIAACPOM). It focuses on archaeoastronomy, and in this field season, research was steered in the state of Tabasco, Mexico.

The work is centred on the methodology of the case studies, which allow to know in greater detail each of the archaeological zones. The places researched in this paper are the Olmec site La Venta and the Zoque like archaeological zone of Malpasito, and also San Claudio and Comalcalco, these representatives of the Mayan culture. All of them have an architecture in which a series of measurements have been carried out. The objective is to know in more detail the intention of their orientation and, to a certain extent, the relations with the surrounding landscape, in these cultural regions.

The work will cover cases of orientations ranging from the relationship between settlements, such as La Venta, to the general profile of a site and the relationship it has with the landscape, in the case of Malpasito and San Claudio. The architectural component is also studied, such as a burial chamber, a temple structure at Comalcalco or the *orientation axis* of some structures at San Claudio. The different levels of information complement each other and help to better understand the intention that existed about orientation in Mesoamerica.

In summary, it is possible to see how the orientation was considered in the planning of spaces, constructions, building traces, location, among others, from the smallest to the largest structures. In this work it will be shown with different cases how the result is in some way the same. The orientation was an aspect of great relevance in Mesoamerica, and it reveals that it can be associated with iconography, architecture, settlement and landscape.

KEYWORDS: Solstice, equinox, starting step, orientation axis, landscape.

1. INTRODUCTION

The sky and the landscape were inseparable parts of ancient Mesoamerican civilizations, as has already been demonstrated by the most enthusiastic academics, for example, Franz Tichy, Anthony Aveni, and Johanna Broda of the old guard, as well as Stanisław Iwaniszewski, Ivan Šprajc, Pedro Francisco Sánchez Nava and Jesús Galindo Trejo, of the new generation. Also, similar conclusions have been reached by those who have dealt with the topic of the general orientations of ancient cities such as Ignacio Marquina, James Dow and René Millon, and Horst Hartung.

With this in mind, I proposed to launch an archaeoastronomical and landscape research project based on the study of alignments of the architecture placed in archaeological zones, opened to the public and remaining under the custody of the Mexican National Institute of Anthropology and History (INAH). The project focuses on Mayan and Olmec cultures and some possible cultural continuity found in the present Mixe-Zoque communities at Tabasco. Four sites are Mayan: Pomona, Moral-Reforma, San Claudio, and Comalcalco, one is Olmec: La Venta and one is of a possibly Zoquean origin: Malpasito (Figure 1).

Till now, only the first season, in 2016-2017, has been carried out. In the present paper, I will limit myself to the short description of simple examples from those four sites. The objective of this work is to present some progress on the results. I will focus on three main topics: families of orientations, prominent landforms used to mark calendrical intervals, solstices and equinoxes, and aspects of symmetrical relationships among diverse architectural structures. In some cases, these examples extend beyond solar alignments and include possible alignments to the Moon and Venus, like in sites of Comalcalco and San Claudio.

2. METHODOLOGY

The research project is based mainly on a methodology established over decades by scholars such as those mentioned above. The measurements in the field were made with a theodolite brand YOM3, model 4T3OP-10, the year 2002, assembled in Mexico, whose error of the readings is 30 seconds of arc in each. The theodolite was placed at a certain distance from one end of the wall. Each horizon point was measured, both the altitude and azimuth angles were recorded. Observations of the Sun were made to convert the measured sightlines into the azimuths relative to true north. The error of the measurement was always compared with the data provided by NASA and other specialized astronomy software. The procedure used to calculate the results is that of Positional Astronomy that has been used from the beginning by specialists such as Aveni (1991) or Šprajc (2001). The results were realised on the date of the measurement (2017), and then they were projected backward in time to the epoch when the structures were built. Finally, the results were also compared with the data administered by NASA and astronomical software (*Sky Charts*).

The geographical coordinates are displayed in the WGS84 datum. To obtain the geographic coordinates was handled a GPS Garmin brand, model etrex. The abbreviations used in this work are δ= declination (apparent), A= azimuth (astronomical or true), and h= height of the local horizon (without considering the correction by refraction).

The project studies architectural structures of the past that have been exposed for hundreds of years to various weather destructive causes, and alterations made by wild and domesticated animals and people. That is why the alignments are not 100% reliable.

Before entering the subject, some fundamental concepts should be defined. A common problem in Mesoamerican archaeoastronomy is that of measuring wall azimuths for association with calendrical and astronomical events. The proper definition of the *orientation axis* of architectural features (buildings, plazas) is one of the main issues that can affect the results since this depends on how it is conceived of and on the decisions regarding components that should be taken into consideration. In contrast to the symmetry axis, the *orientation axis* does not necessarily rely on the alignments of the structure's lateral sides. Aveni and Hartung (1989) determined that the symmetry axis would be the sightline perpendicular to the facade of the structure. In my opinion, the *orientation axis* is determined by the architectural segment that creates the link between the structure and the level on which was built. For example, elevated shrine erected on the top of the pyramid would undoubtedly possess conceptually different symmetry axis than the steps located on the level of the plaza. This is because any person ascending the structure and crossing different spaces would differently perceive the links with his/her actual position and the surroundings. The *starting step* is the architectural element that marks the position of a stairway, located on the ground level. This architectural element is usually in good condition, and therefore seems to be a reliable source of data. Another concept is that of astronomical-calendrical family. Each such family is based on three aspects: the interval must be fixed (e.g. 52), the dates associated with that interval and the initial counting point must be specified (e.g. December 21) and there must be a universe of cases. Each family is defined through the concept of intervals of days. Intervals of days are counted from the

nearest solstice and refer to the numbers of days between those solstices and particular dates.

To date, more than 150 measurements were recorded in six archaeological sites of Tabasco. However, in this paper, for each site, only one or two measurements were selected to show their potential. Orientation patterns can be identified because:

1) An archaeological context that has been talked about for decades but its importance has been deciphered gradually and despite having suffered looting or destruction, the information it has provided is very rich. No doubt the true orientation is an aspect that cannot be left aside. For example, the Tomb of the Nine Lords of Temple IX has been a question since 1926, by Frans Blom and Oliver La Farge, or the long mound or elongated platform D8 and mound D1 of La Venta since 1952 by Phillip Drucker.

2) The presence of intervals of significant days for calendrical such as the interval of 73 days, such as the case of La Venta.

3) The presence of the mountain as a marker of time. Indicate solar events such as equinoxes and solstices. In this regard, the cases of San Claudio and Malpasito are presented.

4) The presence of the mountain playing a role of first importance in the general layout of the settlement as it happens in Malpasito.

3. COMALCALCO

In the year 649 A.D., the city of Comalcalco was conquered by Tortuguero, an ally of the kingdom of *B'aakel*, whose capital was the city of Palenque. In fact, the Palace of Comalcalco is very similar to that of Palenque, especially in its proportions and appearance. Thus, the architecture, the sculpture, the stucco ornamentation are similar on both sites, corresponding to the Late Classic Period (600-900 A.D.). For example, in the fine and well-finished stucco representation of the nine lords over the three walls of the burial chamber of Temple IX resembles much of the Palencan wall painting.

The funerary chambers or funerary crypts of Comalcalco are spaces of rectangular shape with corbel arch or vaulted ceilings (Gallegos Gómora and Armijo Torres, 2014:17-18), located inside the architectural structure. Besides, they are usually boarded up (covered) by a staircase that ascends to the sanctuary. In Comalcalco, two of the three known chambers were oriented to the West.

3.1 The Tomb of the Nine Lords of the Temple IX

The first reference of the burial chamber of Temple IX was made by Frans Blom and Oliver La Farge in 1926 (Andrews, 1989:95-102; Blom and La Farge, 1926:106). Scholars found it desecrated and ransacked (pillaged), even with some remains of bones and oysters on the floor. In this, the surface was painted on red color and they reports four bricks that were thought to be the basis for the sarcophagus made of perishable materials. The three walls were painted in red too. Today, most of the structure no longer exists and it can be observed as a reconstruction of the 1960s in the archaeological site.

Temple IX is located at the Great Acropolis. The two structures, the Palace and the Temple IX, are in front of the plaza. In addition the two structures are oriented to the plaza. Therefore, it is possible that Temple IX is related to the Palace.

The stucco-patterned decoration of the camera features three scenes with three human characters (celebrities) each. There are three of them on the north wall, three on the south wall and three on the east wall (Andrews, 1989). In the past they had been called "The Nine Lords of the Night" because the characters were associated with in Central Mexico, an issue that has been overcome. The specialists have already indicated that it is the tomb of a *k'uhul ajaw*, "sacred lord", of Comalcalco and the other characters are their priests and the *ajk'uhuun*, "conservatives", who are part of the court (Armijo Torres, 2003:36). According to the epigraphic reading of Marc Zender (Armijo Torres, 2016:249), five characters carry the titles of *ajk'uhuun* and *yajawk'ahk'*. The researchers associated the characters with the Nine Lords of the Night because the number nine was the sacred number of the underworld, and so far it is only possible to associate the number nine with the Mayan culture and not for the deities of the night, because they have not been identified. In other words, the characters do not represent deities because they are human beings and have rather been identified as priests by their attire, but the number nine if it is associated with the underworld and therefore the funeral contexts. Therefore, the characters are priests and belong to the Comalcalco elite; they are the companions and the portraits of the royal court of this ancient city.

The relationship between the funerary chamber and the underworld seems to be supported in the mythical state. The Mayan rulers, especially those from the lowlands, became the god of corn to represent their resurrection from the underworld (Juárez Cossío et al., 2016:48), content aspect in the *Popol Vuh*. This implicitly makes manifest the incarnation of the cosmic tree in his person (Schele and Freidel, 2011:98). So, the ruler recovers its essence from the underworld as an intermediary between the forces over natural and the terrestrial world (Florescano Mayet, 2014:49). In other words, he legitimizes himself both in its rulership role and before the eyes of

other cities. The speech could represent the investiture or legitimate enthronement, of ruler of Comalcalco, in the underworld or emerging from there. If we consider the previous thing, the scene of the personages is one of the best representations of the entire site and for that reason it is so important to know all the aspects including, which is the orientation.

First, it highlights the intention of its builders to orientate it to the west. That is, it is a funerary temple with access from the west, in which nothing obstructs the visual of the local horizon. Within it, there are nine characters modelled in stucco distributed in three of its walls.

At present the burial chamber is closed by a grid that does not allow measurements with great accuracy but if you obtain values close to the true, approximate. Once making the measurements of the south and north walls and obtaining averages, it is concluded that their orientation is between 24° and 27° of declination.

The values of the North Wall are δ = 24°.3, A = 295°.9 and h = 0° and the coordinates are 18°.277638 N, 93°.200444 W and 26 m asl. The result, for sunset, is circum-solstitial because it means the azimuth is circum-solstitial, because the correct value of the azimuth of the summer solstice sunset at Comalcalco in the year 600 A.C. is 294°.9 at the height of 0°. The error is around 1°. The other data is δ = 23°.6.

The values of the South Wall are δ = 27°, A = 298°.8 and h = 0° and the coordinates are 18°.277638 N, 93°.200444 W and 26 m asl. The south wall could be associated with Venus because it is maximum western elongation since their values ranged from 24°.1667 to 27° and this astronomical phenomenon was known and favoured by the orientations in Mesoamerica with greater emphasis in the seventh century and beyond, and appeared as a star in the afternoon before the solstices, between April and June in the north extreme (Šprajc, 1998:25). The error with respect to the extreme north is negligible. However, in this temple there are no elements so far to justify temples connexions to this planet, but in one of the associated temples there is indeed two large star representations (*Ek'*) that on occasion can be identified with Venus, when it is accompanied by *chaak* and means 'big/red star'. It´s the decoration of the facade of Temple VII, a structure that in its configuration corresponds to the same plaza together with Temple IX, at the Plaza of the Great Acropolis. The sunken space is limited to the north by the temples VI, VII and VIII, to the east by the Great Acropolis and to the west by a series of structures of few dimensions and little known. What is the relationship between Venus and the underworld? Venus can be a *nahual*, an animic entity that generates problems, sometimes it is a light of bad omen.

4. MALPASITO

4.1. Steam bath

The region of archaeological zone of Malpasito had a pre-Hispanic occupation between the years 650-900 A.D. and is partially attributed to proto-Zoque architecture (Cuevas Reyes, 2004). His steam bath is in the best characterized structures of the site and is one of the most representative examples of Mesoamerica. It is located at Structure 18 of the ballcourt.

The structure is rectangular with access to the west, just in the direction where a remarkable local horizon is found, since it has at least four prominent hills and whose forms and association, side by side, seem significant, among which the Hill of the Pava a height around 860 m asl. According to the *orientation axis* of the access stairway, the orientation to the west exceeds the 24° of declination. The data is δ = 24°.4, A = 293°.3 and h = 7°.4±20'. The measurement station has the coordinates 17°.338138 N, 93°.598888 W and 234 m asl. It could well be the summer solstice, where the Sun ends its path, because the correct value of the azimuth of the summer solstice sunset at Malpasito in the year 600 A.D. is 292°.5, so the error is of 0°.8. The other data is δ = 23°.6.

The steam bath is usually located near the ballcourt, and both form a ritual architectural unit and that is why it is not surprising that they can be associated with an astronomical event of such importance as the solstice.

4.2 The guiding axis of the site

The Malpasito settlement is located on a semivertical axis, which begins north of the site, in Structure 43; crosses the Main Plaza, in the centre of the site, passes over the ballcourt and the first part ends in the Acropolis, which represents the south and the highest part of the site with the presence of structures. Between the ballcourt and the Acropolis, the guiding axis continues through a series of levels through large staircases, or in other words, stepped overlays on the natural slope, which was enabled for these purposes. It is easily appreciated that the Acropolis is crowned by the highest part of the slope. The axis crosses said crown or top of the slope and continues its imaginary trajectory without distorting itself to reach its end, at the top of Hill Mono Pelado or Mono Pelón, the hill with one of the highest altitudes in the state of Tabasco. The axis has approximately A = 21° or 201°. Between the top of the hill and the Acropolis there are 2.77 km.

4.3 The Acropolis and the local west horizon

Located at the top of the stairway; that is to say, on the access of the Acropolis, it is possible to observe that the Sun sets on the top of Hill el Chato during the days of the equinoxes. The data are: δ = 0°.2, A = 264°.4, h = 18°.15. The measurement station has the coordinates 17°.337444 N, 93°.599388 W and 274 m asl. In the year 600 A.D., the sunset on the top of the hill occurred in March very close to the equinox. It happens on March 17 and the data are: A = 264°.1 at the same height, h = 18°.15, and δ = 0°, therefore the error is 0°.3.

It is one of the hills discussed above, distinguishable on the horizon and astronomical milestone. The other hills, la Copa, la Pava, las Flores as well as the Mono Pelado, are non-solar in nature, because they are outside the solar arc; they have a different meaning, but complementary, in the Mesoamerican worldview.

5. LA VENTA

5.1 The hidden side of the landscape

The following site is one of the earliest in Mesoamerica with a planned layout, 1200–400 B.C., and perhaps also one of the most enigmatic, for all that has already been said (González Lauck, 2014:31). It seems that La Venta privileged the path of the Sun towards the summer solstice at dusk, but in an unusual way. Of course, the above is valid for the observation point in the upper part of Structure C-1, and its coordinates are 18°.103250 N, 94°.040833 W and 44 m asl.

The Olmecs occupied Los Tuxtlas nuclear core, a set of volcanoes of great dimensions, among which San Martín Tuxtla (1680 msnm) and Santa Marta Tuxtla (1640 msnm), and bodies of water such as the great Catemaco Lagoon. In general, the Olmec sites had these volcanoes as part of their landscape (Šprajc and Sánchez Nava, 2015), and one of the most distant sites among them all, and larger, La Venta, maintained its importance on the local horizon.

What is interesting is that the Sun was behind the massif of the volcanoes during several months of the year. Everything seems to indicate that they could not be observed with the naked eye and it was only possible when the Sun was behind.

Day after day, during the sunsets, the Sun entered the mountain massif of Los Tuxtlas since mid-April. Then they could see how it illuminated the highest parts, approximately between May 3 and 7. Finally it was moving away from the mountainous massif towards the Gulf of Mexico at the beginning of June. But as the dimension that the Sun occupies from the equinox on the horizon, day by day it was shrinking to stop at the summer solstice, about ten days out, never really separated from Los Tuxtlas. Finally, the Sun was still there other days when it began its return, to leave the region of Los Tuxtlas by the end of August. The total count of days approaches that of one third of the year.

Los Tuxtlas would begin to see when the rainfall increased with respect to the driest months, March and April, as it has been in recent years according to the record of the *Meteorological Station 00027026*, of the National Meteorological Service, between 1951 and 2010. A few days later, the area of the three great volcanoes illuminates, towards the beginning of May, with the first increase in rainfall and shortly afterwards the first zenith step happened. A few days later, the heavy rains would have arrived to stay up to eight months. In fact, in our investigation we had to wait for the Sun to settle behind Los Tuxtlas to take the photographs because the days when it was necessary to make measurement were cloudy.

For the above works and some other, it is known that in La Venta the astronomical-calendrical principles were taken into account. Specifically, the presence of the interval of 73 days (Galindo Trejo, 2011).

5.1 The E-Group

Structures D1 and D8 have been identified as an E-Group by some researchers (Aimers and Price, 2006). What is an E-Group and how does it work? It is defined, in its simplest form (Blom, 1924), as a platform oriented north-south and east of it, is a mound from which you can make the observations of the sunsets behind the platform. It is the foundational set of the settlement and can be related to creation myths and deities. In the case of La Venta one of the sculptures, the Altar 4, could represent the birth of the gods.

In general, it has been thought that these types of architectural assemblages are of Mayan origin. However, they may well be present in other cultural areas such as the State of Guerrero (Martz de la Vega et al., 2017) or in the Puebla-Tlaxcala Valley (Flores Esquivel, 2010).

So far, the two structures, D1 and D8, have not been studied as a Group E. Only a simulation is presented based on its location and existing cartographic materials (González Lauck, 2014), and not from field measurements because the structures are covered by vegetation. Two important issues can be added to the data we already know. The first is that the platform would cover the entire solar arc for the sunrises and a little more, as far as the major lunar standstill to the north, as originally have been thought for this architecture. And the second is that the mound reached at least seven meters in height,

growing more in height than the platform itself, as was the case of Lost World of Tikal (Fialko, 1988).

The coordinates of Structure D1 are 18°.098638 N, 94°.040722 W and 34 m asl. After making an approximation of the values that could be observed in the set, it is only necessary to say that they are significant with respect to the few data that are already supported for the site and that, in addition, they are of great importance, subject to doing a work with more detail in the field.

The center of the platform marks, in the sunrise, the dates close to March 4 and October 9, approximately the dates that correspond to the same interval of days that they found, each one by its side, Galindo Trejo (2011) in Structure C-1 and Šprajc and Sánchez Nava (2015) in Complex A, with date of April 9. The presence in the site of the two pairs of dates of the family of the interval of 73 days to the east is interesting. The approximate data are A = 96°.7 ±1° and h = 0°, remembering that it is only a simulation and that it is necessary to perform measurements in the field. On the other hand, in Martz de la Vega et al. (2017) we proposed to make, at least, one measurement from the East Platform in the direction of the Frontal Mound. If we rotate the azimuth 180°, we get 276°.7 ±1°. The altitude is also 0°. The result was surprising because the dates are near April 4 and September 7. The interval approaches that of the family of 78 days, one of the families of the *trecenas* as it was developed in Martz de la Vega et al. (2016). In that work the interaction between the two families was discussed, that of 73 and that of the *trecenas* 78 to be five days apart, because the five is a calendrical interval to consider. The *trecena* is based on the number thirteen, a sacred number in Mesoamerica related to the heavens.

6. SAN CLAUDIO

6.1 The Structure 12B and the starting step

Structure 12 contains two separate basements so we divide it into Structure 12A or south and Structure 12B or north.

The orientation of Structure 12 was studied by Sánchez Nava and Šprajc (2011:25). They concluded that the declination is greater than ±26° and therefore is not within the solar arc. Its values are to the east: δ = −26°.1, A = 117°.5 and h = 0°.6 and to the west: δ = 26°.1, A = 297°.5 and h = 0°.1, for the coordinates 91°.161111 N, 17°.337500 W and 70 m asl.

The Basement of Structure 12B can instead be associated with the winter solstice because its most remarkable element, a staircase with three steps of 10 cm of height that lead to the upper part to an enclosure with stone walls, in its *starting step* presents the declination of −24°.4 east over the part of the local horizon where the mountain descends to the level of the "zero horizon". The other data are A = 115°.6 and h = 0°.3. The coordinates of the station are 17°.337333 N, 91°.160333 W and 81 m asl. The declination of the winter solstice in San Claudio, in the year 500 A.D., was -23°.6, and the azimuth at a height of 0°.3 was 114°.9, then the difference is 0°.7. The exploration of this stairway few years ago, provided the following information:

"In the first of the steps of this stairway three spear points of the so-called eccentrics were found for showing whimsical and very elaborate shapes, two of them with jagged edges and a third whose silhouette outlines the body of a snake." (Romero Rivera, 2002:66).

That is to say, an offering was found consisting of three eccentrics below the *starting step*, and this is a further antecedent that the *starting step* has a particular importance. In fact, I have proposed that the *orientation axis* of the structures can be studied from the *starting step* or, in case of their absence, from the first steps. By courtesy of José Luis Romero Rivera it is possible to talk about the shape of one of the eccentrics, the SCLEX003, which reminds the scepters of Tláloc of the Center of Mexico, and which are associated archaeologically to the high parts of the mountains and deposits of water, as ichnographically to the thunder and water. This remember, with the presence of the lagoon and the hill, the complex hills-water-corn.

Figure 1. A map showing the locations of different archaeological zones in study. 1. La Venta, 2. Comalcalco, 3. Malpasito, 4. Pomoná, 5. Moral-Reforma, and 6. San Claudio. Adapted from http://www.cartocritica.org.mx/

6.2 Structures 1 and 69

Structure 69 was not measured because it is outside the perimeter zone of the National Institute of Anthropology and History (INAH); however, a simulation based on cartography is presented here. This structure has a singular interest because its dimensions are among the largest of the site along with Structure 1 (in Group II), considering both are of the temple type. In addition, it turned out to have a re-

markable position with respect to Structure 1 and the local southwest horizon. In fact, there is a hill (SCL001), with no name detected so far, which observed from Structure 1 was the approximate location of the major lunar standstill of the Moon, δ = -28°.5 (the value of the declination was corrected by lunar parallax, because δ = -28°.9), A = 236°.9 and h = 6°.8. The declination of the standstill of the Moon in the year 500 A.D. on average it was 28°.8. The error seen as the difference of the declinations is 0°.3. The coordinates of Structure 1 are 17°.335944 N, 91°.158805 W and 78 m asl.

If the observation is made from Structure 69, the Sun would stand on the same hill, SCL001, very close to the winter solstice. The data for the year 500 A.D. are: A = 242°.6 ±1°, h = 6°.8 and δ = 23°.6. The solstice day, March 19. The Structure 69 has the coordinates 17°.334861 N, 91°.153066 W and 64 m asl, and is in Group I.

From Structure 4, the local horizon is very similar to Structure 1. Structure 4 is located in the same group as Structure 1, and they are facing each other. The difference is that the Structure 4 is the one closest to the San Claudio Lagoon, on the edge, a few steps from the water level. Its coordinates are 17°.335111 N, 91°.159 W and 72 m asl. In its local horizon, the value of the standstill of the Moon also approaches the top of Hill SCL001, since the declination is -27°.2. For the year 500 A.D. the average declination was -28°.8, with error 1°.6. However, what stands out most about Structure 4 is that from it was possible to observe, at the lowest point of Hill SCL001, the winter solstice at the sunset, since its declination is -23°.9 at a height of 5°.8 and an azimuth of 242°.7. The azimuth that is obtained when calculating the winter solstice at the same height, 5°.8, for the year 600 A.D. it is 243°. Therefore the error is 0°.29. In fact, the knowledge of the movement of the Sun and the Moon could work, among other things, for agriculture (Iwaniszewski, 2006).

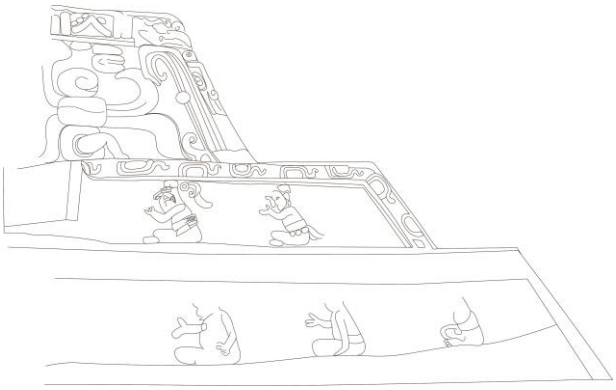

Figure 2. Reconstruction of the stucco decoration of Temple IX. The motif of Ek' (star) can be seen at the top left.

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